Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

Final Report

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Directorate-General for Environment
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LIST OF ABBREVIATIONS

$\mu g/m^3$	Microgram(s) per cubic metre
ng/m^3	Nanogram(s) per cubic metre
AAQ Directives	Ambient Air Quality Directives
AQP	Air Quality Plan
As	Arsenic
BaP	Benzo[*a*]pyrene
C_6H_6	Benzene
Cd	Cadmium
CLRTAP	Convention on Long-Range Transboundary Air Pollution
CO	Carbon monoxide
EC	European Commission
ECA	European Court of Auditors
EEA	European Environment Agency
EU	European Union
EUROSAI	European Organisation of Supreme Audit Institutions
GAINS	Greenhouse gas – Air pollution Interactions and Synergies Model of IIASA
LEZ	Low Emission Zone
Ni	Nickel
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
O_3	Ozone
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PM	Particulate matter
PM_{10}	Particulate matter with a diameter of 10 µm or less
$PM_{2.5}$	Particulate matter with a diameter of 2.5 µm or less
SO_2	Sulphur dioxide
WHO	World Health Organization

EXECUTIVE SUMMARY

Context of the Ambient Air Quality Directives

Poor air quality is a major environmental and socio-economic concern that poses important risks to human health. To minimise the negative impacts of air pollution, the European Union adopted *Directive 2008/50/EC on ambient air quality and cleaner air for Europe* and *Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air* (hereinafter: AAQ Directives).

The overarching objective of the AAQ Directives is to *improve air quality, minimising the harmful effects of air pollution on health and environment*. To enable the achievement of this objective, the AAQ Directives contain a set of provisions that enshrine air quality standards for key pollutants (sulphur dioxide, nitrogen dioxide, particulate matter and fine particulate matter, lead, carbon monoxide, benzene, ozone, arsenic, cadmium, nickel, polycyclic aromatic hydrocarbons), establish a common framework for monitoring and assessment of air quality, collection and reporting of data on air quality and provision of information for citizens concerning air quality and exceedances of regulated limits, and requires that Member States draft and implement air quality plans in case of exceedances of limits to keep exceedance periods as short as possible.

Objectives of the study

The study to support the fitness check of the AAQ Directives focusses on assessing the implementation (including successes and challenges) of the AAQ Directives. This retrospective exercise, focussing on the period 2008 to 2018 has the aim of identifying what worked well or less well in the implementation of the AAQ Directives and covers all articles and provisions of the AAQ Directives, looking at the role they played in meeting the objectives of the directives. This evaluation process has also included the identification of any excessive administrative burdens, overlaps and/or synergies, gaps, inconsistencies and/or obsolete measures which may have appeared over time. Furthermore, the study to support the fitness check has addressed to what extent the air quality governance between EU, national, regional and local levels, respectively, is coherent.

In addition to the support study for the fitness check, the air quality and the AAQ Directives have been the focus of reviews by other institutions. Most notably, the European Court of Auditors produced a report on air pollution that recommended the strengthening of AAQ Directives and the promotion of effective action by the European Commission and the Member States including better policy coordination and public information. Furthermore, the EUROSAI Working Group on Environmental Auditing drafted a joint report on air quality which concluded that more action needs to be taken to improve the effectiveness and efficiency of the measures taken at national, regional, and local level to address air quality.

Methodological framework

The support study to the fitness check is designed in line with the European Commission's Better Regulation Guidelines and builds on the Fitness Check Roadmap using as its basis the five evaluation criteria: i.e. *relevance, effectiveness, efficiency, coherence, EU added value*. For this study, the evaluation criteria have been operationalised in *10 evaluation questions*.

Answers to the evaluation questions were compiled using data from the EEA e-Reporting database, a comprehensive literature review and extensive consultation of stakeholders. Stakeholders from national, regional and local public authorities, industry and trade associations at national and EU level, civil society organisations at national and EU level, citizens and research institutes and universities were consulted by means of an open public consultation and a targeted questionnaire. In addition, 7 dedicated case studies were conducted covering examples in Bulgaria (with a focus on Plovdiv agglomeration), Germany (Berlin agglomeration), Ireland (public information provision), Italy (Sicily region), Slovakia (Kosice region), Spain (Madrid), Sweden (environment and ecosystem impacts). Furthermore, two meetings with relevant stakeholders took place to assist in identifying and confirming the issues for the evaluation and to receive feedback on findings.

Baseline and implementation state of play

Prior to the adoption of the Directive 2008/50/EC and Directive 2004/107/EC, the EU air quality legal basis was framed by the Council Directive 96/62/EC on ambient air quality assessment and management (Air Quality Framework Directive), the Council Directive 1999/30/EC (First Daughter Directive) regulating limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead, the Directive 2000/69/EC (Second Daughter Directive) introducing limit values for benzene and carbon monoxide and Directive 2002/3/EC (Third Daughter Directive) relating to ozone. Directive 2008/50/ EC merged most of the existing EU air quality legislation into a single directive with the exception of Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air (Fourth Daughter Directive) which continued to be a stand-alone directive.

The objective of having common methods to *monitor and assess* air quality in the Member States was set in the previous Air Quality Framework Directive and its daughter Directives which similarly to the current AAQ Directives required the assessment of compliance with ambient air quality standards on the basis of common methods and criteria. The AAQ Directives further harmonised the approach and extended the requirement to monitor and assess to five pollutants (see below) that had not been regulated in the preceding directives. Overall, progress has been made in ensuring that monitoring and assessment is performed in line with the EU requirements which was already the case in 2008 and continued up until 2017. Hence, most zones in the Member States has the minimum number of sampling points required by the AAQ Directives and compliance with these requirements has increased since 2008.

The AAQ Directives introduced *air quality standards* for five additional pollutants, i.e. $PM_{2.5}$ (limit and target values) in Directive 2008/50/EC and As, Cd, Ni, BaP (target values) in Directive 2004/107/EC, and they reinforced previously existing standards for other regulated pollutants. However, they did not introduce any modifications to the existing EU standards for other pollutants. In terms of exceedances, Member States did not meet the standards in all zones in the EU for the baseline year 2008, in particular for O_3 but also for PM_{10}, NO_2 and BaP. Overall, the number of zones reporting exceedances of the target/limit values provided has decreased significantly over the period 2008 to 2017.

The requirements for *reporting and disseminating information to the public* have also developed substantively since the adoption of the AAQ Directives. Prior to 2008, AirBase was not updated in real time, thus not allowing the dissemination to the wider public of real time information on the state of air quality. The subsequent implementation of the Air Quality e-Reporting system based on Implementing Decision 2011/850/EU vastly improved the process of reporting and the ability to disseminate accurate and real time information.

The AAQ Directives also reinforced requirements for Member States to prepare and implement *air quality plans* for zones and agglomerations within which concentrations of pollutants in ambient air exceed the relevant air quality target values or limit values, plus any temporary margin of tolerance, where applicable. The AAQ Directives leave the choice of means to achieve these standards to the Member States but require that the exceedances periods are kept as short as possible. While no consistent data is available on how Member States dealt with exceedances prior to the implementation of the AAQ Directives, evidence on measures taken by Member States after 2008 indicates that air quality plans are developed where exceedances are registered.

Stakeholder consultation results

A broad range of stakeholders were consulted to inform this fitness check, including Member State authorities (national, regional and local), NGOs, industry, researchers and the scientific community, international organisations, and citizens. For this support study stakeholder input was obtained through the following activities: an online questionnaire open to the public; an information-gathering questionnaire sent to targeted stakeholders; two stakeholder workshops; and direct consultation with the Ambient Air Quality Expert Group. In addition, ad hoc contributions from stakeholders were taken into account.

Overall, stakeholders consider that the AAQ Directives have been effective in meeting their objectives and have: supported monitoring of air quality; established air quality standards across the EU; and made information on air quality available across the EU. While stakeholders generally agreed that the Directives had contributed to better air quality, stakeholder expressed concerns about widespread exceedances of air quality standards. Stakeholders agreed that the Directives remain relevant, noting that the pollutants covered continue to warrant policy intervention. Regarding the coherence between the objectives of the AAQ Directives and other EU policy, stakeholders noted the contributions of other EU legislation, such as the National Emissions Ceilings Directive (Directive 2016/2284/EU) and legislation targeting emissions sources, to air quality goals. However, stakeholders emphasised the need to ensure a coordinated approach to pursuing climate and air quality goals, particularly in the transport, energy and agriculture sectors. Regarding EU added value, stakeholders broadly supported the conclusion that the Directives provided an EU added value, particularly in terms of establishing common air quality standards.

Subsidiarity and proportionality

Under the principle of subsidiarity, the EU should act only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States, either at central or at regional and local level. The study finds benefits from the EU intervention to harmonise air quality monitoring, assessments and standards, i.e. from preventing different and changing requirements in the Member States that may negatively affect a level playing field. Furthermore, the trans-boundary nature of air pollution further warrants the need for EU action. However, at the same time Member States, hereunder regions and municipalities, are encouraged to choose the measures that best fit their local conditions – i.e. that reduce air pollution most cost-effectively.

This flexibility of measure choice is also in line with the principle of proportionality, i.e. that the best measures are implemented to achieve the objectives of the AAQ Directives. Furthermore, the study finds that the measures are proportional to the problem of air pollution by having contributed to significant reduction. Finally, proportionality is pursued by setting minimum thresholds for air quality while at the same time allowing Member States to determine whether to impose stricter standards.

Findings and conclusions

Relevance

Pollutants, limit and target values, air quality plans

Overall, air quality across European countries continues to be a source of concern for citizens for health and environmental reasons given that a considerable share of the EU population continues to be exposed to air pollution at levels that exceed the regulated limit values for the protection of health. It should be noted that even these are not fully protective given that there are no identified lower thresholds below which no harm is caused for some pollutants, such as fine particulate matter. Scientific evidence has grown over the past decades on the harmful effects of the pollutants that are currently regulated by the AAQ Directives. Accordingly, the AAQ Directives objectives of improving air quality and minimising the harmful effects on health and environment and the pollutants regulated by the AAQ Directives continue to be highly relevant. Furthermore, there is a growing body of scientific research which indicates without being conclusive that there may be additional harmful effects, including caused by pollutants that are not currently regulated by the AAQ Directives, such as black carbon, ultrafine particles and ammonia.

The provisions on air quality standards (limit and target values) have also been pivotal and highly relevant in incentivising action across Member States and ensuring a more harmonised approach towards air quality across Europe. Several of the air quality standards in the AAQ Directives were set at levels less stringent than the 2005 WHO Air Quality Guidelines for protection of human health. Recent research indicates that they do not fully reflect the scientific evidence on adverse health effects at lower concentrations of pollutants such as $PM_{2.5}$, PM_{10} and SO_2. The AAQ Directives also do not set short-term standards for $PM_{2.5}$, to protect against peaks of pollution.

Further to limit and target values, the AAQ Directives also require the preparation and implementation of air quality plans for zones and agglomerations within which concentrations of pollutants in ambient air exceed the relevant air quality target values or limit values, plus any temporary margin of tolerance, where applicable. The stakeholder consultations and case studies confirm that the air quality plans are one of the most fundamental elements of the AAQ Directives for incentivising remedial action by Member States. However, a drawback is the absence of a clear requirement for Member States to report on implementation of air quality plans or update them with new measures when progress is insufficient. This makes compliance verification difficult.

Monitoring and assessment, information and reporting

The monitoring and assessment provisions of the AAQ Directives have been essential to ensure common methods to monitor and assess air quality across all Member States. The European Commission has, for example, provided a substantive amount of guidance on monitoring. Nevertheless, the AAQ Directives leave some room for interpretation which can impose challenges in terms of comparability of monitoring and assessment approaches. The types and representativeness of monitoring stations is highly relevant to modelling, but this link is not clearly addressed in the AAQ Directives. Another set of relevant provisions of the AAQ Directives concern public information and reporting. The provisions requiring that Member States collect data and report it to the EEA, as well as making it publicly available, are essential in raising public awareness concerning air quality. Commission guidance on monitoring, assessment and reporting is very relevant to the effective implementation of the AAQ Directives. Guidance for modelling and for development of air quality plans is also highly relevant but has advanced more slowly during the past ten years.

Effectiveness

Effectiveness of monitoring and assessment regimes

Most Member States have been in line with the monitoring and assessment requirements of the AAQ Directives, which have encouraged the availability of reliable and comparable data, as such, enabling the monitoring of trends. Most zones in the Member States have the minimum number of sampling points required by the AAQ Directives. Compliance has in general increased for the different air pollution types since the start of the implementation of the AAQ Directives.

Evidence from consultation of relevant stakeholders indicates that flexibility and ambiguity of criteria for classifying measurement stations are identified as possible factors that have led to differences in the way this has been done in the Member States. Regarding external factors, resource constraints (costs, qualified staff) may have led to a varied coverage or qualities of the EU territory with monitoring networks. In terms of other possible external factors, no firm conclusions can be drawn from the analysis.

Effectiveness of air quality standards

The overall observation is that exceedances of targets/limits have decreased over time for most pollutants - both when measuring via the number of Member States experiencing exceedances and via the share of zones in the EU reporting exceedances. Hence, it is here concluded that the actions provided for by the AAQ Directives have been effective. Several Member States have made use of the opportunity to apply for a time extension to comply with the targets/limits for PM_{10} and NO_2. While the zones with PM_{10} time extension grants given have led to above-average performance of the zones, the zones with granted NO_2 time extensions have done worse than average. However, the overall conclusion is that the actions provided for by the AAQ Directives have been effective.

The mandatory nature of the air quality standards has been identified as an important positive element in achieving the standards. However, despite their mandatory nature, some Member States struggle, as shown above, to comply with limit/target values of key pollutants. The assessment of factors behind the non-achievement of the standards also points to linkages between the different objectives of the Directives. Effectiveness of air quality plans and measures appears to influence the achievement of the environmental objectives. The correct siting of sampling points, on the other hand, is a prerequisite for correct monitoring and assessment of air quality, and thereby for effective plans and measures. Furthermore, also external factors such as geography and meteorological conditions, socio-economic conditions, public awareness and other EU policies have played a role in how air quality objectives are being achieved.

Effectiveness of air quality information and reporting

The conclusion is that information is made available for use by the public. However, the information is of mixed quality, partly because Member States have taken varied approaches, both to the dissemination itself, but also to the collection, assessment and reporting of data. The finding is based on the analysis of information on responsible authority websites, stakeholder consultation and case studies.

A driving factor influencing the achievement of the objective of making information on air quality available to the public is that there actually is a public demand for information. A factor which may hinder the achievement of this objective is found to be that Member States have taken varied approaches, both to the dissemination itself, but also to the collection, assessment and reporting of data.

Effectiveness of air quality plans and to avoid, prevent or reduce the effects of poor air quality

Member States reporting exceedances have also prepared air quality plans as required by the AAQ Directives. Road transport is one of the main sources for the exceedances of NO_2 and also of PM_{10}. Many measures to reduce such emissions therefore focus on this sector – e.g. congestion charges, speed limits, the promotion of cleaner vehicles and public transport. A main source for PM_{10}, and to a lesser degree also for NO_2, exceedances is that of domestic heating. Measures here include the promotion of shifts towards low-emission fuels, retrofitting, green public procurement as well as public information services. Effectiveness is encouraged by the flexibility for the Member States, hereunder regions and municipalities, to choose the measures that best fit their local conditions – i.e. the most cost-effective measures. This is an issue that is analysed in more detail under the efficiency evaluation criterion within this study. This said, insufficient coordination between authorities in the Member States is pointed out as a hindering factor for reaping all the benefits from the flexible provisions.

An external factor such as public awareness has influenced the choice of measures resulting from the air quality plans. Furthermore, measures to improve air quality is not solely steered by the air quality plans but also influenced by other EU legislation as well as other Member State actions. Regarding internal factors, for example, the guidance from the EU to implementing measures is by some stakeholder considered not to have been sufficient, while it is by others (in particular NGOs) is considered to be key in facilitating enforcement action.

Efficiency

Costs and benefits of AAQ Directives

Costs have been quantified for some measures, though data are limited. A lower bound estimate of health benefits is estimated here in the order of EUR 50 billion from 2008 to 2016, corresponding to 31,000 equivalent attributable deaths over the period. Benefits increase strongly over time as more areas meet the air quality limit values. Precise attribution of costs and benefits to the AAQ Directives is not possible given additional environmental legislation on both air quality and climate in particular. This further legislation, to the extent it directly addresses air pollution, is driven partly by the requirements of the AAQ Directives. There is evidence to support the position that benefits are being achieved cost-effectively and equitably, with countries designing control strategies targeted on the sources chiefly responsible for exceedance at a local level. However, the robustness of this conclusion is limited because there is little ex-post data available to describe actual costs and to quantify the precise effect of actions. Synergies with other policies were examined and suggest co-benefits, particularly from measures concerning transport (e.g. via measures that reduce traffic) and climate (e.g. via measures that reduce fossil fuel use).

Significant cost variations are observed across Member States and sectors, though these reflect the extent and primary source of exceedances at a local level. A lack of full compliance means that there are significant health costs arising from poor implementation, which is defined here as a failure to meet the limit values. These costs are highest at the start of the period (2008 to 2012) given the original dates for compliance with limits for NO_2 and PM_{10}, though declined significantly as exceedances of the limit values were eliminated. Where evidence is available, the costs of compliance appear proportionate to the benefits achieved, though limited availability of data on costs for local measures is problematic for the assessment.

Efficiency of monitoring, reporting and assessment

Estimates based on data provided by eight Member States indicate that the per capita administrative *costs* are between EUR 0.14 and 0.98 per year per person. Based on a sample of three Member States, administrative *burdens* per capita are estimated between EUR 0.12 and 0.38 per year. The assessment indicates that the benefits achieved by the AAQ Directives and the cost of poor implementation are far higher than the administrative burden. Some areas of inefficiency relate to:

- the extent to which devolution of the requirements of the AAQ Directives to local level is supported by funding and a facilitative role being adopted by national institutions;

- variation in the availability of guidance in Member States;
- the level of use of modern IT and media technology.

Costs of reporting to the public varied significantly, though this is likely related to variation in the activities undertaken and unavailability of cost data for the full range of authorities undertaking information provision.

Coherence

Coherence of air quality legislation with other environmental and sectoral legislation

Overall, the analysis has found strong internal coherence of the AAQ Directives and strong coherence with related air pollution legislation governing emissions – i.e. the National Emissions Ceilings Directive (Directive 2016/2284/EU), the Industrial Emissions Directive (Directive 2010/75/EU) and the Medium Combustion Plants Directive (Directive 2015/2193/EU). Coherence with related legislation was strengthened over the evaluation period with the release of the 2013 Clean Air Policy Package. While broadly coherent with the environmental legislation reviewed, gaps were identified – for example, measures under the Nitrates Directive can support reductions in agricultural air emissions, but this legislation does not identify air quality as a goal (Directive 91/676/EEC).

Furthermore, the AAQ Directives are coherent and synergies can be found with EU climate policy and with sectoral policies; however, some issues were identified. Studies have shown that action for climate mitigation and air pollution should, overall, be mutually supportive, and there has been a growing recognition of these links in EU policy documents. EU climate and energy policy measures for energy efficiency and most renewable energy sources have supported better air quality. The use of certain types of biomass combustion, however, may have weakened the benefits of the Renewable Energy Directive (Directive 2018/2001/EU) for air quality and may have negatively affected air quality in specific locations. EU legislation and policy documents for road transport set air quality among their goals, limit vehicle emissions and promote alternatives to current transport systems; however, during the evaluation period, EU provisions for controlling vehicle emissions in the Type Approval Framework have had shortcomings. Reforms to the Framework adopted during the evaluation period may address some of these shortcomings. In the 2014-2020 programming period, the CAP's rural development funding supports actions to reduce agricultural emissions.

Coherence with EU funding and taxation legislation

EU funding has supported Member State action on air quality. Member States have allocated about EUR 2 billion from European Structural and Investment Funds (ESIF) for air quality investments in the 2014-2020 programming period. Moreover, a further EUR 166 billion in ESIF resources has been allocated for investments in the low-carbon economy, environmental protection and resource efficiency and network infrastructure: these investments are expected to have indirect contributions for clean air. Financing under the European Fund for Strategic Investments and the Connecting Europe Facility are expected to provide further indirect benefits for air quality, and significant EU research funding has addressed issues relevant for clean air. A much lower level of EU funding has, however, supported investments that may hinder air quality objectives.

Tax policies at both EU and Member State levels may also be at odds with air quality goals. EU taxation legislation allows Member States to tax diesel fuel at a lower rate than petrol. In most Member States diesel is taxed at a lower rate and tax treatment of company cars encourages transport by private vehicles. These tax incentives may have encouraged greater private use of diesel vehicles, which – together with weaknesses in vehicle testing under the Type Approval Framework during the evaluation period – may have worsened air quality.

EU added value

Harmonised framework for air quality

The AAQ Directives brought EU added value by ensuring a more harmonised and coordinated approach towards the regulation of air quality standards for pollutants compared to what Member States could have achieved through single national regulations. The AAQ Directives introduced limit and target values for five additional pollutants that previously had not been regulated at EU level, i.e. fine particulate matter, arsenic, cadmium, nickel, benzo[*a*]pyrene (as a marker of polycyclic aromatic hydrocarbon). Prior to the introduction of the AAQ Directives, air quality standards varied considerably across Member States in terms of the type of pollutants that were regulated, the level of protection (weaker or stricter limits) and the legal nature of the regulations (binding or voluntary, limit values or guidelines, obligation of results or obligation of means). In line with the principle of subsidiarity, the EU intervention to harmonise standards is justified to prevent different and changing requirements in individual jurisdictions from negatively affecting the creation of a level playing field in addressing air quality challenges. Furthermore, the transboundary nature of air pollution further warrants the need for EU action.

The AAQ Directives also provide a common framework for air quality assessment and monitoring and brought comparability in terms of monitoring and assessment systems and networks across Member States. This resulted in increased availability of better quality and comparable information about air quality which was made available to the wider public. This is in particular a result of the implementation of a more modernised solution for data collection and reporting in near real time via the Air Quality e-reporting database. Wider dissemination of information led to more awareness and potentially incentivised (legal) action by citizens, authorities and relevant organisations, as evidenced by the high number of court cases. However, some difficulties were reported in relation to the fact that the AAQ Directives do not explicitly provide for the right to access to justice.

Synergies and coordination of air quality action

Added value in terms of synergies with other Community objectives can be found both at EU and Member State level but further national coordination between authorities within Member States and exploration of possible synergies can be sought. The AAQ Directives provide for a clear definition of roles between relevant institutions at EU and those at national level. At national level, the AAQ Directives' requirements to set up air quality plans, monitor and assess air quality and provide information to the public had a positive effect on improving the governance systems of some Member States with regards to air quality but this varied depending on what the Member State had previously in place. Nevertheless, evidence from the case studies and stakeholder consultation suggests that coordination between public sector authorities can be further improved within Member States, in particular in relation to the responsibilities and coordination in the implementation of the air quality plans and coordination between authorities at national, regional and local scale.

Overall, evidence collected from the study to support the fitness check indicates that the broad framework set by the AAQ Directives is broadly fit for purpose but certain provisions need to be strengthened or facilitated to further incentivise effective action at EU level and within Member States.

RÉSUMÉ ANALYTIQUE

Contexte des directives sur la qualité de l'air ambiant

La mauvaise qualité de l'air représente une préoccupation majeure en matière environnementale et socio-économique, mais elle fait aussi peser des risques importants sur la santé humaine. Afin de minimiser les impacts négatifs de la pollution de l'air, l'Union européenne a adopté la *directive 2008/50/CE concernant la qualité de l'air ambiant et un air pur pour l'Europe* et la *directive 2004/107/CE concernant l'arsenic, le cadmium, le mercure, le nickel et les hydrocarbures aromatiques polycycliques dans l'air ambiant* (ci-après, les « directives QAA »).

L'objectif principal des directives QAA est d'*améliorer la qualité de l'air pour ainsi réduire les effets nocifs de la pollution de l'air sur la santé et l'environnement*. Afin d'accomplir cet objectif, les directives QAA prévoient un ensemble de dispositions consacrant certaines normes de qualité de l'air relatives aux principaux polluants (dioxyde de soufre, dioxyde d'azote, matière particulaire et particules fines, plomb, monoxyde de carbone, benzène, ozone, arsenic, cadmium, nickel et hydrocarbures aromatiques polycycliques). Elles établissent également un cadre commun pour la surveillance et l'évaluation de la qualité de l'air, la collecte et la communication de données sur la qualité de l'air, ainsi que la mise à disposition d'informations aux citoyens à propos de la qualité de l'air et des dépassements des limites réglementaires. Enfin, elles exigent des États membres d'élaborer et de mettre en œuvre des plans relatifs à la qualité de l'air dans les cas de dépassement des limites, afin que la période de dépassement soit la plus courte possible.

Objectifs de l'étude

L'étude à l'appui du bilan de qualité des directives QAA se concentre sur l'analyse de leur mise en œuvre (y compris les succès et les défis). S'intéressant à la période allant de 2008 à 2018, cet exercice rétrospectif a pour but d'identifier les mesures les plus efficaces ainsi que celles ayant rencontré moins de succès dans la mise en œuvre des directives QAA. En outre, il couvre l'ensemble des articles et dispositions des directives QAA et examine leur contribution à l'accomplissement des objectifs fixés dans les directives. Le processus d'évaluation comprenait également l'identification des charges administratives excessives, des chevauchements et/ou synergies, des lacunes, des incohérences et/ou des mesures obsolètes qui auraient pu se manifester au fil du temps. De surcroît, l'étude à l'appui du bilan de qualité des directives s'est penchée sur le degré de cohérence de la gouvernance en matière de qualité de l'air entre les autorités européennes, nationales, régionales et locales.

Outre l'étude à l'appui du bilan de qualité, la qualité de l'air et les directives QAA ont fait l'objet d'examens par d'autres institutions. En premier lieu, la Cour des comptes européenne a remis un rapport sur la pollution atmosphérique recommandant le renforcement des directives QAA ainsi que la promotion d'une action efficace de la Commission européenne et des États membres, notamment par une meilleure coordination des politiques et une information accrue du public. En outre, le groupe de travail sur l'audit d'environnement EUROSAI a établi un rapport conjoint sur la qualité de l'air, selon lequel une action plus forte est nécessaire pour améliorer l'efficacité et l'efficience des mesures prises à l'échelle nationale, régionale et locale afin de lutter contre la pollution de l'air.

Cadre méthodologique

L'étude à l'appui du bilan de qualitédes directives a été réalisée en adéquation avec les Lignes directrices pour une meilleure réglementation de la Commission européenne et a défini cinq critères d'évaluation sur la base de la feuille de route du bilan de qualité: *pertinence, efficacité, efficience, cohérence, valeur ajoutée de l'Union européenne*. Pour cette étude, les critères d'évaluation ont été retranscris à travers *dix questions d'évaluation*.

Les réponses aux questions d'évaluation ont été compilées à l'aide d'informations issues de la base de données du système de déclaration en ligne des informations sur la qualité de l'air de l'Agence européenne pour l'environnement (AEE), d'un examen approfondi de la documentation et d'une consultation extensive des parties prenantes. Des parties prenantes émanant des autorités nationales, régionales et locales, de l'industrie et d'associations professionnelles nationales et européennes, d'organisations de la société civile nationales et européennes, des citoyens ainsi que d'instituts de recherche et d'universités ont été interrogées par le biais d'une consultation publique ouverte et d'un questionnaire ciblé. En outre, sept études de cas spécifiques ont été réalisées, couvrant des exemples en Bulgarie (principalement l'agglomération de Plovdiv), en Allemagne (agglomération de Berlin), en Irlande (sur le thême de information du public), en Italie (région de la Sicile), en Slovaquie (région de Košice), en Espagne (Madrid) et en Suède (sur le thême des impacts environnementaux et sur les écosystèmes). De surcroît, deux réunions rassemblant les parties prenantes concernées ont été tenues afin d'aider à l'identification et la confirmation des points d'intérêt pour l'évaluation, ainsi que pour recueillir des commentaires sur les résultats.

Référentiel et état d'avancement

Avant l'adoption de la directive 2008/50/CE et de la directive 2004/107/CE, la base juridique concernant la qualité de l'air dans l'UE était établie par la directive 96/62/CE du Conseil concernant l'évaluation et la gestion de la qualité de l'air ambiant (directive-cadre sur la qualité de l'air), la directive 1999/30/CE du Conseil (première directive fille) relative à la fixation de valeurs limites pour l'anhydride sulfureux, le dioxyde d'azote et les oxydes d'azote, les particules et le plomb dans l'air ambiant, la directive 2000/69/CE (deuxième directive fille) concernant les valeurs limites pour le benzène et le monoxyde de carbone, ainsi que la directive 2002/3/CE (troisième directive fille) relative à l'ozone. La directive 2008/50/CE est venue regrouper la majorité des législations de l'UE existantes relatives à la qualité de l'air au sein d'une seule directive, à l'exception de la directive 2004/107/CE concernant l'arsenic, le cadmium, le mercure, le nickel et les hydrocarbures aromatiques polycycliques dans l'air ambiant (quatrième directive fille), qui a continué de s'appliquer de manière autonome.

L'objectif poursuivi par la création de méthodes communes pour *la surveillance et l'évaluation* de la qualité de l'air au sein des États membres était défini dans la précédente directive-cadre sur la qualité de l'air, qui, à l'instar des actuelles directives QAA, exigeait un examen de conformité aux normes de qualité de l'air ambiant selon des méthodes et critères communs. Les directives QAA ont davantage harmonisé cette approche et étendu l'exigence de surveillance et d'évaluation à cinq autres polluants (voir plus bas) qui n'étaient pas réglementés par les précédentes directives. De manière générale, l'on peut constater des progrès sur la voie d'une surveillance et d'une évaluation effectuées conformément aux exigences de l'Union européenne dès 2008, qui se sont poursuivis jusqu'en 2017. Ainsi, la plupart des zones au sein des États membres disposent du nombre minimal de points de prélèvement requis par les directives QAA, et la conformité par rapport à ces exigences augmente depuis 2008.

Les directives QAA ont établi des *normes de qualité de l'air* pour cinq polluants supplémentaires : les particules en suspension $PM_{2,5}$ (valeurs limites et cibles) dans la directive 2008/50/CE, ainsi que l'arsenic, le cadmium, le nickel et le benzo[a]pyrène (valeurs cibles) dans la directive 2004/107/CE. En outre, elles ont renforcé les normes existantes pour d'autres polluants réglementés. Cependant, elles n'ont apporté aucune modification aux normes de l'Union existantes pour d'autres polluants. En ce qui concerne les dépassements, les États membres n'ont pas respecté les normes dans toutes les zones de l'UE pour l'année de référence 2008, notamment pour l'ozone (O_3), mais aussi pour les particules en suspension PM_{10}, le dioxyde d'azote (NO_2) et le benzo[a]pyrène (BaP). D’une manière générale, le nombre de zones ayant signalé des dépassements des valeurs cibles/limites fixées a drastiquement diminué au cours de la période allant de 2008 à 2017.

Les exigences concernant *la déclaration et la diffusion des informations au public* ont également évolué de manière importante depuis l'adoption des directives QAA. Avant 2008, AirBase (la base de données européenne sur la qualité de l'air) n'était pas mise à jour en temps réel, ne permettant donc pas la diffusion au grand public d'informations actualisées sur l'état de la qualité de l'air. La mise en œuvre ultérieure du système de déclaration en ligne des informations sur la qualité de l'air, fondé sur la décision d'exécution 2011/850/UE, a permis d'améliorer grandement le processus de déclaration d'informations ainsi que la capacité à diffuser des informations précises et actualisées.

Les directives QAA ont également renforcé les obligations des États membres d'élaborer et de mettre en œuvre des *plans relatifs à la qualité de l'air* pour les zones et agglomérations dans lesquelles les concentrations de polluants dans l'air ambiant dépassent les valeurs cibles ou limites pertinentes en matière de qualité de l'air, ainsi que toute marge de dépassement temporaire, le cas échéant. Les directives QAA laissent libre choix aux États membres des moyens employés pour respecter ces normes, mais exigent que les périodes de dépassement soient les plus courtes possible. Bien qu'aucune donnée cohérente ne soit disponible sur la manière dont les États membres géraient les dépassements avant la mise en œuvre des directives QAA, les résultats des mesures prises par les États membres après 2008 indiquent que des plans relatifs à la qualité de l'air sont élaborés là où les dépassements sont recensés.

Résultats de la consultation des parties prenantes

Un large éventail de parties prenantes ont été consultées pour informer ce bilan de qualité, rassemblant notamment les autorités (nationales, régionales et locales) de certains États membres, des ONG, des acteurs de l'industrie, des chercheurs et d'autres membres de la communauté scientifique, des organisations internationales ainsi que des citoyens. Aux fins de cette étude, les contributions des parties prenantes ont été recueillies à travers les activités suivantes : un questionnaire en ligne ouvert au public, un questionnaire de collecte d'informations adressé à des parties prenantes ciblées, deux ateliers avec les parties prenantes et une consultation directe avec le Groupe d'experts sur la qualité de l'air ambiant. En outre, l'étude a pris en considération les contributions ad hoc des parties prenantes.

De manière générale, les parties prenantes considèrent que les directives QAA se sont montrées efficaces en ce qui concerne l'accomplissement de leurs objectifs et ont : contribué à la surveillance de la qualité de l'air ; établi des normes de qualité de l'air dans l'UE et rendu les informations sur la qualité de l'air disponibles à travers toute l'UE. Bien que les parties prenantes se soient généralement accordées quant au fait que les directives QAA ont contribué à l'amélioration de la qualité de l’air, elles ont également exprimé des inquiétudes quant à l'étendue des dépassements des normes de qualité de l'air. Les parties prenantes ont convenu que les directives QAA restaient pertinentes, notant que les polluants couverts continuent de justifier l'intervention politique. En ce qui concerne la cohérence entre les objectifs des directives QAA et d’autres politiques de l'UE, les parties prenantes ont relevé les contributions d'autres législations de l’Union européenne, telles que la directive sur les plafonds d'émissions nationaux (directive (UE) 2016/2284) ainsi que la législation visant les sources d'émissions, à l'accomplissement des objectifs de qualité de l'air. Cependant, les parties prenantes ont insisté sur la nécessité de garantir une approche coordonnée dans la réalisation des objectifs en matière de climat et de qualité de l'air, notamment dans les secteurs des transports, de l'énergie et de l'agriculture. Au sujet de la valeur ajoutée de l'Union européenne, les parties prenantes ont largement soutenu la conclusion selon laquelle les directives ont apporté une telle valeur ajoutée, notamment vis-à-vis de l'établissement de normes de qualité de l'air communes.

Subsidiarité et proportionnalité

En vertu du principe de subsidiarité, l'UE devrait intervenir uniquement si et dans la mesure où les objectifs de l'action envisagée ne peuvent être atteints par les États membres seuls, soit au niveau central soit à l'échelle régionale et locale. L'étude a mis en lumière certains avantages découlant de l'intervention de l'UE pour harmoniser la surveillance, les évaluations et les normes en matière de qualité de l'air, notamment en empêchant l'établissement d'exigences différentes et variables au sein des États membres, qui pourraient avoir un effet négatif sur les règles du jeu équitables. En outre, la nature transfrontalière de la pollution atmosphérique confirme encore la nécessité d'une action européenne. En parallèle, cependant, les États membres ainsi que les régions et municipalités visées dans les présentes sont encouragés à choisir les mesures les mieux adaptées à leurs conditions locales, c.-à-d. qui réduisent la pollution atmosphérique de la manière la plus efficace et la moins coûteuse.

La flexibilité du choix des mesures est également en accord avec le principe de proportionnalité, à savoir que les meilleures mesures soient mises en œuvre pour atteindre les objectifs énoncés dans les directives QAA. De surcroît, l'étude révèle que les mesures sont proportionnelles au problème de pollution atmosphérique, puisqu'elles ont contribué à une diminution importante. Enfin, le principe de proportionnalité est encore confirmé par l'établissement de seuils minimaux pour la qualité de l'air, tout en permettant aux États membres de décider s'il est nécessaire d'imposer des normes plus strictes.

Résultats et conclusions

Pertinence

Polluants, valeurs limites et cibles et plans relatifs à la qualité de l'air

D’une manière générale, la qualité de l'air reste une source de préoccupation pour les citoyens européens en matière de santé et d'environnement, puisqu'une partie considérable de la population européenne continue d'être exposée à des niveaux de pollution atmosphérique supérieurs aux valeurs limites réglementaires pour la protection de la santé. Il convient de noter que ces valeurs elles-mêmes ne permettent pas une protection totale, étant donné qu'aucun seuil inférieur en dessous duquel certains polluants ne sont pas nocifs n'a été identifié, notamment pour les particules fines. Au cours des dernières décennies, les preuves scientifiques des effets néfastes des polluants actuellement réglementés par les directives QAA se sont multipliées. Par conséquent, les objectifs des directives QAA relatifs à l'amélioration de la qualité de l'air, à la réduction des effets nocifs sur la santé et l'environnement ainsi qu'aux polluants réglementés par les directives QAA restent très pertinents. En outre, une part croissante des recherches scientifiques montre, sans toutefois tirer de conclusion, que d'autres effets nocifs pourraient exister, notamment causés par des polluants qui ne sont pas actuellement réglementés par les directives QAA, tels que le noir de carbone, les particules ultrafines et l'ammoniaque.

Les dispositions relatives aux normes de qualité de l'air (valeurs limites et cibles) se sont également montrées cruciales et hautement pertinentes dans les actions de promotion à travers les États membres et dans la garantie d'une approche plus harmonieuse de la qualité de l'air en Europe. Plusieurs des normes de qualité de l'air prévues par les directives QAA ont été définies à des niveaux moins contraignants que les Lignes directrices relatives à la qualité de l'air de l'OMS (mise à jour de 2005) pour la protection de la santé humaine. De récentes recherches indiquent qu'elles ne reflètent pas complètement les preuves scientifiques des effets néfastes sur la santé de polluants tels que les particules en suspension ($PM_{2,5}$ et PM_{10}) ainsi que le dioxyde de soufre

(SO_2) à des concentrations inférieures. En outre, les directives QAA n'établissent aucune norme à court terme visant les particules en suspension $PM_{2,5}$ à des fins de protection lors de pics de pollution.

Outre les valeurs limites et cibles, les directives QAA exigent également l'élaboration et la mise en œuvre de plans relatifs à la qualité de l'air pour les zones et agglomérations dans lesquelles les concentrations de polluants dans l'air ambiant dépassent les valeurs cibles ou limites pertinentes en matière de qualité de l'air, ainsi que toute marge de dépassement temporaire, le cas échéant. Les consultations des parties prenantes et les études de cas confirment que les plans relatifs à la qualité de l'air forment l'un des éléments les plus fondamentaux des directives QAA pour encourager les États membres à prendre des mesures correctives. Toutefois, on déplore l'absence d'obligation claire pour les États membres de fournir des rapports sur la mise en œuvre des plans relatifs à la qualité de l'air ou de les mettre à jour avec les nouvelles mesures lorsque les progrès sont insuffisants. Ceci rend difficile la vérification de la conformité.

Surveillance et évaluation, information et rapportage

Les dispositions visant la surveillance et l'évaluation contenues dans les directives QAA se sont révélées essentielles pour garantir l'établissement de méthodes communes pour surveiller et évaluer la qualité de l'air à travers tous les États membres. La Commission européenne a, par exemple, fourni un nombre considérable d'orientations relatives à la surveillance. Néanmoins, les directives QAA laissent une certaine marge d'interprétation qui peut rendre difficilela comparabilité des approches de surveillance et d'évaluation. Les types et la représentativité des stations de surveillance se montrent pertinents par rapport à la modélisation, mais ce lien n'est pas clairement abordé dans les directives QAA. Un autre ensemble de dispositions pertinentes des directives QAA concerne l'information du public et la déclaration d'informations. Les dispositions exigeant des États membres de collecter des données et de les déclarer à l'AEE, mais aussi de les mettre à la disposition du public, sont cruciales pour sensibiliser davantage le public à la qualité de l'air. Les lignes directrices de la Commission sur la surveillance, l'évaluation et le rapportage se montrent particulièrement pertinentes dans le contexte de la mise en œuvre des directives QAA. Les lignes directrices pour l'élaboration et le développement de plans relatifs à la qualité de l'air sont également hautement pertinentes, mais leur évolution s'est révélée plus lente au cours des dix dernières années.

Efficacité

Efficacité des système de surveillance et d'évaluation

La plupart des États membres sont en conformité avec les obligations relatives à la surveillance et à l'évaluation définies par les directives QAA. Ces obligations ont encouragé la disponibilité de données fiables et comparables, permettant ainsi la mise en place d'une surveillance des tendances. La plupart des zones dans les États membres sont dotées du nombre minimal de points de prélèvement requis par les directives QAA. La conformité a, de manière générale, augmenté pour les différents types de pollution atmosphérique depuis le début de la mise en œuvre des directives QAA.

Les résultats des consultations des parties prenantes concernées montrent que la flexibilité et l'ambiguïté des critères de classification des points de mesure sont considérés comme des facteurs possibles des différences dans la méthode employée par les États membres. En ce qui concerne les facteurs externes, les contraintes de ressources (coûts, personnel qualifié) pourraient avoir entraîné une inégalité de couverture ou de qualités du territoire de l'UE avec les réseaux de surveillance. S'agissant des autres facteurs externes potentiels, aucune conclusion ferme ne peut être tirée de l'analyse.

Efficacité des normes de qualité de l'air

L'observation générale est que les dépassements des valeurs cibles/limites ont diminué au fil du temps pour la plupart des polluants, tant en terme de nombre d'États membres connaissant des dépassements qu'en terme de zones de l'UE signalant des dépassements. Ainsi, l'on peut conclure que les actions prévues par les directives QAA se sont avérées efficaces. Plusieurs États membres ont saisi l'opportunité de demander une prorogation des délais afin de respecter les valeurs cibles/limites pour les particules en suspension PM_{10} et le dioxyde d'azote (NO_2). Bien que les zones ayant bénéficié d'une prorogation pour les particules en suspension PM10 aient enregistré des performances au-dessus de la moyenne, les zones s'étant vues accorder une prolongation de délais pour le dioxyde d'azote (NO_2) ont produit des résultats en dessous de la moyenne. Néanmoins, l'on peut globalement conclure que les actions prévues par les directives QAA se sont montrées efficaces.

La nature obligatoire des normes de qualité de l'air a été identifiée comme un élément positif important pour le respect des normes. Toutefois, malgré cette nature obligatoire, certains États membres peinent, comme montré ci-dessus, à respecter les valeurs limites/cibles pour les principaux polluants. L'évaluation des facteurs empêchant le respect des normes met également en lumière les liens entre les différents objectifs des directives QAA. L'efficacité des plans et mesures relatifs à la qualité de l'air semble influencer l'accomplissement des objectifs environnementaux. D'autre part, l'emplacement correct des points de prélèvement est une condition indispensable pour l'exactitude de la surveillance et l'évaluation de la qualité de l'air et donc pour des plans et mesures efficaces. De surcroît, certains facteurs externes (tels que la géographie et les conditions météorologiques, la situation socio-économique, la sensibilisation du public et les autres politiques de l'UE) ont également joué un rôle dans la méthode suivie pour atteindre les objectifs en matière de qualité de l'air.

Efficacité des systèmes d'information et de déclaration des informations sur la qualité de l'air

La conclusion est que des informations sont mises à disposition du public pour leur utilisation par ce dernier. Cependant, les informations présentent une qualité variable, en partie à cause du fait que les États membres ont adopté des approches diverses, tant pour la diffusion des informations elle-même que pour la collecte, l'évaluation et la déclaration des données. Les résultats se fondent sur l'analyse des informations issues des sites Internet des autorités responsables, des consultations avec les parties prenantes et des études de cas.

L'un des facteurs clés influençant l'accomplissement des objectifs liés à la mise à disposition du public d'informations relatives à la qualité de l'air est le fait qu'il existe effectivement une demande du public pour de telles informations. L'un des facteurs pouvant entraver la réalisation de cet objectif est lié au fait que les États membres ont adopté des approches diverses, tant pour la diffusion des informations elle-même que pour la collecte, l'évaluation et la déclaration des données.

Efficacité des plans relatifs à la qualité de l'air et destinés à empêcher, prévenir ou réduire les effets d'une mauvaise qualité de l'air

Les États membres signalant des dépassements ont également élaboré des plans relatifs à la qualité de l'air comme exigé par les directives QAA. Les transports routiers constituent l'une des principales sources de dépassement des seuils d'émission de dioxyde d'azote (NO_2) et de particules en suspension PM_{10}. Nombre des mesures visant à réduire de telles émissions se sont ainsi concentrées sur ce secteur, par exemple : les péages urbains, les limitations de vitesse, ainsi que la promotion de véhicules plus propres et des transports publics. L'une des principales sources de dépassement pour les particules en suspension PM_{10}, et dans une moindre mesure pour le dioxyde d'azote, est le chauffage domestique. Les mesures adoptées à ce sujet comprennent la promotion de la transition vers des carburants à faibles émissions, les rénovations, les marchés publics écologiques ainsi que les services d'information du public. L'efficacité est encouragée par la flexibilité accordée aux États membres, aux régions et aux municipalités dans le choix des mesures les mieux adaptées à leurs conditions locales, c.-à-d. celles qui sont les plus efficaces et les moins coûteuses. Cette flexibilité est analysée plus en détail dans la partie de cette étude dédiée aux critères d'évaluation de l'efficience. Ceci étant dit, le manque de coordination entre les autorités des États membres est souligné en tant que facteur empêchant de tirer tous les bénéfices de la flexibilité des dispositions.

Un facteur externe tel que la sensibilisation du public a influencé le choix des mesures découlant des plans relatifs à la qualité de l'air. En outre, les mesures visant à améliorer la qualité de l'air ne sont pas uniquement motivées par les plans relatifs à la qualité de l'air, mais sont aussi influencées par d'autres législations de l'Union européenne ainsi que par des actions des États membres. En ce qui concerne les facteurs internes, les lignes directrices de l'UE visant la mise en œuvre des mesures, par exemple, sont jugées par certaines parties prenantes comme insuffisantes, tandis que d'autres parties prenantes (notamment les ONG) les considèrent comme un élément essentiel facilitant les mesures d'application.

Efficience

Coûts et bénéfices des directives QAA

Les coûts ont été quantifiés pour certaines mesures, bien que les données disponibles soient limitées. Une estimation basse des bénéfices pour la santé est établie ici à 50 milliards d'euros pour la période allant de 2008 à 2016, correspondant à 31 000 équivalents décès attribuables sur la période. Les bénéfices augmentent fortement au fil du temps, alors que de plus en plus de zones respectent les valeurs limites en matière de qualité de l'air. Une attribution précise des coûts et des bénéfices des directives QAA ne s'avère pas possible en raison des législations environnementales supplémentaires visant tant la qualité de l'air que le climat en particulier. Ces législations supplémentaires, dans la mesure où elles visent directement la pollution atmosphérique, sont motivées en partie par les exigences contenues dans les directives QAA. Certaines preuves viennent appuyer l'idée que les bienfaits sont obtenus de manière efficiente et équitable : les pays désignent des stratégies de surveillance ciblées sur les sources principalement responsables des dépassements à l'échelle locale. Toutefois, la solidité de cette conclusion est limitée, puisqu'il n'existe presque aucune donnée ex post disponible pour décrire les coûts annuels et quantifier les impacts précis des actions. Certaines synergies avec d'autres politiques ont été examinées et suggèrent des co-bénéfices, notamment grâce aux mesures concernant les transports (par exemple, à travers des mesures qui réduisent le trafic) et le climat (par exemple, par le biais de mesures qui diminuent l'utilisation des carburants fossiles).

D'importantes variations de coûts sont constatées à travers les États membres et les secteurs, bien que ces variations reflètent l'ampleur et la source principale de dépassements à l'échelle locale. L'absence de conformité totale implique des coûts significatifs en matière de santé dus à une mise en œuvre insuffisante, reflétée par le manque de respect des valeurs limites. Ces coûts s'avèrent supérieurs au début de la période (de 2008 à 2012), en raison des dates initiales pour la mise en conformité avec les valeurs limites d'oxyde d'azote (NO_2) et de particules en suspension PM_{10}, et bien qu'ils aient sensiblement diminué à mesure que les dépassements des valeurs limites étaient éliminés. Lorsque des données sont disponibles, les coûts de mise en conformité semblent être proportionnels aux bénéfices obtenus, bien que la faible quantité de données disponibles sur les coûts des mesures locales reste problématique pour l'évaluation.

Efficacité de la surveillance, du rapportage et de l'évaluation

Les estimations fondées sur les données fournies par huit États membres indiquent que les *coûts* administratifs par habitant se situent entre 0,14 EUR et 0,98 EUR par personne et par an. Selon un échantillon de trois États membres, les charges administratives par habitant sont estimées à 0,12–0,38 EUR par an. Cette évaluation montre que les bénéfices obtenus grâce aux directives QAA ainsi que les coûts liés à la mise en œuvre insuffisante dépassent largement les charges administratives. Certains domaines d'inefficacité sont dûs à:

- dans quelle mesure le transfert des exigences contenues dans les directives QAA à l'échelle locale est soutenu par les financements et le rôle de facilitateur endossé par les institutions nationales ;
- la variation de disponibilité de lignes directrices au sein des États membres;
- le degré d'utilisation des technologies informatiques et médiatiques modernes.

Les coûts de communication des informations au public varient significativement, mais il est probable que ce phénomène soit lié aux divergences dans les activités entreprises et à l'indisponibilité de données sur les coûts pour l'ensemble des autorités impliquées dans la mise à disposition d'informations.

Cohérence

Cohérence des législations en matière de qualité de l'air avec les autres lois environnementales et sectorielles

De manière générale, l'analyse a mis en lumière une forte cohérence interne des directives QAA, mais aussi avec les législations correspondantes en matière de qualité de l'air régissant les émissions, c.-à-d. la directive sur les plafonds d'émissions nationaux (directive (UE) 2016/2284), la directive sur les émissions industrielles (directive 2010/75/UE) et la directive relative aux installations de combustion moyennes (directive (UE) 2015/2193). La cohérence avec les législations connexes s'est vue renforcée au cours de la période d'évaluation avec la publication, en 2013, du Train de mesures sur la qualité de l'air. Biens que les directives QAA soient généralement cohérentes avec les législations environnementales étudiées, certaines divergences ont été identifiées ; par exemple, les mesures prévues par la directive sur les nitrates (directive 91/676/CEE) peuvent contribuer à la réduction des émissions atmosphériques agricoles, mais le texte ne définit pas la qualité de l'air comme un objectif.

En outre, les directives QAA sont cohérentes avec la politique climatique de l'UE ainsi que les politiques sectorielles, créant également des synergies, mais certains problèmes ont été identifiés. Les études ont montré que les actions pour l'atténuation du changement climatique et de la pollution atmosphérique devraient, de manière générale, se renforcer mutuellement. De plus, nous assistons à une reconnaissance croissante de ces liens dans les documents politiques de l'UE. Les mesures politiques européennes en matière de climat et d'énergie (visant notamment l'efficacité énergétique et l'identification des sources d'énergie les plus renouvelables) ont participé à l'amélioration de la qualité de l'air. Toutefois, l'utilisation de certains types de combustion de biomasse pourrait avoir réduit les bénéfices apportés par la directive sur l'énergie renouvelable (directive (UE) 2018/2001) à la qualité de l'air et affecté négativement la qualité de l'air dans certains endroits. La législation et les documents politiques européens visant les transports routiers ont établi la qualité de l'air en tant qu'objectif, limitent les émissions des véhicules et promeuvent des alternatives aux systèmes de transport actuels. Cependant, au cours de la période d'évaluation, les dispositions de l'UE relatives à la surveillance des émissions des véhicules édictées dans le Cadre d'homologation européen souffraient de défauts. Les réformes du Cadre adoptées au cours de la période d'évaluation pourraient permettre de résoudre certaines de ces lacunes. Durant la période de programmation allant de 2014 à 2020, le fonds de développement rural de la PAC soutient les actions destinées à réduire les émissions agricoles.

Cohérence avec les financements européens et les législations de l'Union européenne en matière fiscale

Les financements européens ont soutenu l'action des États membres en faveur de la qualité de l'air. Les États membres ont alloué quelque deux milliards d'euros des Fonds structurels et d'investissement européens (Fonds ESI) aux investissements pour la qualité de l'air au cours de la période de programmation de 2014–2020. En outre, 166 milliards d'euros supplémentaires des Fonds ESI ont été attribués aux investissements dans l'économie à faible émission de carbone, la protection environnementale et l'efficacité des ressources, ainsi que l'infrastructure de réseaux. Ces investissements devraient offrir des bénéfices indirects pour la qualité de l'air. Les financements issus du Fonds européen pour les investissements stratégiques et du programme Connecting Europe Facility devraient aussi permettre des bénéfices indirects pour la qualité de l'air, et les financements de la recherche de l'UE ont couvert des thèmes pertinents pour la qualité de l'air. Toutefois, d'autres financements européens bien plus limités ont soutenu des investissements susceptibles de compromettre l'accomplissement des objectifs en matière de qualité de l'air.

Les politiques en matière fiscale déployées à l'échelle européenne comme au niveau des États membres pourraient également se trouver en contradiction avec les objectifs de qualité de l'air. La législation fiscale de l'Union européenne permet aux États membres de taxer le diesel à un taux inférieur à l'essence. Dans la plupart des États membres, le diesel est taxé à un taux inférieur, et le traitement fiscal des voitures de fonction encourage le transport en véhicule privé. Ces incitations fiscales pourraient avoir encouragé une utilisation accrue de véhicules privés fonctionnant au diesel, ce qui (associé aux lacunes en matière d'essai des véhicules dans le Cadre d'homologation européen) pourrait avoir nuit à la qualité de l'air.

Valeur ajoutée de l'Union européenne

Cadre harmonisé pour la qualité de l'air

Les directives QAA ont apporté une valeur ajoutée de l'Union européenne en garantissant une approche plus harmonieuse et mieux coordonnée de la réglementation des normes de qualité de l'air visant les polluants, par rapport à ce que les États membres auraient pu accomplir avec des réglementations nationales uniquement. Les directives QAA ont introduit des valeurs limites et cibles pour cinq polluants supplémentaires qui n'étaient auparavant pas réglementés à l'échelle européenne : les particules fines, l'arsenic, le cadmium, le nickel et le benzo[a]pyrène (en tant qu'indicateur d'hydrocarbures aromatiques polycycliques). Avant l'entrée en vigueur des directives QAA, les normes relatives à la qualité de l'air variaient considérablement d'un État membre à l'autre en ce qui concerne les types de polluants réglementés, le niveau de protection (limites plus faibles ou plus fortes) ainsi que la nature juridique des réglementations (contraignantes ou volontaires, valeurs limites ou lignes directrices, obligation de résultats ou obligation de moyens). Conformément au principe de subsidiarité, l'intervention de l'UE afin d'harmoniser les normes est justifiée pour empêcher que l'établissement d'exigences différentes et variables au sein des juridictions individuelles ne puisse affecter négativement la création d'une situation de règles du jeu équitables dans la lutte en faveur de la qualité de l'air. En outre, la nature transfrontalière de la pollution atmosphérique confirme encore la nécessité d'une action européenne.

Les directives QAA fournissent également un cadre commun d'évaluation et de surveillance de la qualité de l'air, mais elles ont aussi permis de comparer les systèmes et réseaux de surveillance et d'évaluation à travers les États membres. Ceci a entraîné une augmentation de la disponibilité d'informations de meilleure qualité et comparables sur la qualité de l'air ; informations qui ont été mises à la disposition du grand public. Ce phénomène découle notamment de la mise en œuvre d'une solution plus moderne de collecte de données et de rapportage d'informations en temps réel, à travers le système de déclaration en ligne des informations sur la qualité de l'air. La plus large diffusion d'informations a contribué à la sensibilisation du public et à encouragé potentiellement des actions (juridiques) de la part des citoyens, des autorités et des organisations compétentes, comme le montre le nombre élevé de procédures judiciaires. Cependant, certaines difficultés ont été signalées en rapport avec le fait que les directives QAA ne prévoient pas explicitement de droit d'accès à la justice.

Synergies et coordination des actions pour la qualité de l'air

La valeur ajoutée en matière de synergies avec les objectifs de l'Union européenne existe tant à l'échelle européenne qu'au niveau des États membres, mais il reste possible de renforcer la coordination nationale entre les autorités des États membres et d'explorer d'autres éventuelles synergies. Les directives QAA fournissent une définition précise des rôles entre les institutions pertinentes au niveau européen et celles à l'échelle nationale. Au niveau national, les obligations imposées par les directives QAA d'établir des plans relatifs à la qualité de l'air, de surveiller et d'évaluer la qualité de l'air ainsi que de fournir des informations au public ont eu un effet positif sur l'amélioration des systèmes de gouvernance de certains États membres vis-à-vis de la qualité de l'air, mais ces progrès ont varié en fonction du système dont l'État était doté auparavant. Néanmoins, les résultats des études de cas et des consultations des parties prenantes suggèrent que la coordination entre les autorités du secteur public peut encore être améliorée au sein des États membres, notamment en ce qui concerne les responsabilités et la coordination de la mise en œuvre des plans relatifs à la qualité de l'air, mais aussi la coordination entre les autorités nationales, régionales et locales.

D'une manière générale, les données recueillies par l'étude à l'appui du bilan de qualité indiquent que le vaste cadre établi par les directives QAA est globalement adapté, mais que certaines dispositions doivent être renforcées ou facilitées pour encourager davantage les actions efficaces à l'échelle européenne et au sein des États membres.

ZUSAMMENFASSUNG

Die Luftqualitätsrichtlinien in ihrem Zusammenhang

Schlechte Luftqualität ist ein großes ökologisches und sozioökonomisches Problem und eine ernsthafte Gefahr für die menschliche Gesundheit. Um die negativen Folgen der Luftverschmutzung zu mindern, hat die Europäische Union die *Richtlinie 2008/50/EG über Luftqualität und saubere Luft für Europa* und die *Richtlinie 2004/107/EG über Arsen, Kadmium, Quecksilber, Nickel und polyzyklische aromatische Kohlenwasserstoffe in der Luft* verabschiedet (im Folgenden „LQ-Richtlinien").

Das übergreifende Ziel der LQ-Richtlinien ist es, *die Luftqualität zu verbessern und die schädlichen Folgen der Luftverschmutzung auf die Gesundheit und die Umwelt zu minimieren*. Um dieses Ziel zu erreichen, enthalten die LQ-Richtlinien eine Reihe von Bestimmungen, die Grenzwerte für wichtige Luftschadstoffe (Schwefeldioxid, Stickstoffdioxid, Staub und Feinstaub, Blei, Kohlenmonoxid, Benzol, Ozon, Arsen, Kadmium, Nickel und polyzyklische aromatische Kohlenwasserstoffe) festlegen, einen einheitlichen Rahmen für die Überwachung und Bewertung der Luftqualität, die Erfassung und Meldung von Daten zur Luftqualität sowie die Information der Bürger über die Luftqualität und Grenzwertüberschreitungen vorgeben und die Mitgliedstaaten verpflichten, bei Überschreitungen der Grenzwerte Luftqualitätspläne zu erstellen und umzusetzen, die gewährleisten, dass die Grenzwerte möglichst schnell wieder eingehalten werden.

Untersuchungsgegenstand

Diese Untersuchung soll Daten für eine Eignungsprüfung der LQ-Richtlinien bereitstellen; ihr Schwerpunkt liegt auf der Umsetzung (d. h. den Erfolgen und Problemen) der LQ-Richtlinien. Diese retrospektive Analyse konzentriert sich auf den Zeitraum 2008 bis 2018 und soll ermitteln, was bei der Umsetzung der LQ-Richtlinien gut und was weniger gut funktioniert hat. Dazu wird analysiert, was die einzelnen Artikel und Bestimmungen der LQ-Richtlinien zur Erreichung der Ziele beigetragen haben. Im Rahmen dieser Evaluierung wurde außerdem untersucht, durch welche Maßnahmen ein unverhältnismäßig hoher Verwaltungsaufwand, Überschneidungen und/oder Synergien entstanden sind, wo Lücken und Widersprüche bestehen und ob bestimmte Maßnahmen im Laufe der Zeit obsolet geworden sind. Im Rahmen der Eignungsprüfung wurde ferner untersucht, ob die gesetzlichen Maßnahmen zur Luftreinhaltung auf europäischer, nationaler, regionaler bzw. lokaler Ebene kohärent sind.

Neben der Studie zur Unterfütterung der Eignungsprüfung wurden die Luftqualität und die LQ-Richtlinien auch durch andere Institutionen geprüft. Besonders hervorzuheben ist hierbei ein Bericht des Europäischen Rechnungshofs zur Luftverschmutzung, der eine Stärkung der LQ-Richtlinien und wirksame Maßnahmen durch die Europäische Kommission und die Mitgliedstaaten empfiehlt, zu denen eine bessere politische Abstimmung und mehr öffentliche Informationen gehören. Außerdem verfasste die Arbeitsgruppe Umweltprüfung der EUROSAI einen gemeinsamen Bericht zur Luftqualität, in der sie zu dem Schluss kam, dass die Wirksamkeit und Effizienz der Maßnahmen auf nationaler, regionaler und lokaler Ebene im Bereich Luftreinhaltung verbessert werden müssen.

Methodologischer Rahmen

Die Studie zur Unterfütterung der Eignungsprüfung ist gemäß den Richtlinien für bessere Rechtssetzung der Europäischen Kommission aufgebaut und nutzt die im Fahrplan für Eignungsprüfungen festgelegten fünf Bewertungskriterien, d. h. *Relevanz, Wirksamkeit, Effizienz, Kohärenz und europäischer Mehrwert*. Für diese Studie wurden die Bewertungskriterien durch *10 Evaluierungsfragen* operationalisiert.

Zur Beantwortung der Evaluierungsfragen wurden Daten aus der Datenbank der Europäischen Umweltagentur (EUA) für die elektronische Berichterstattung, eine umfassende Literaturrecherche und Interviews mit einer Vielzahl von Akteuren ausgewertet. In deren Rahmen wurden die Vertreter nationaler, regionaler und kommunaler Behörden, nationaler und europäischer Industrie- und Handelsverbände und nationaler und europäischer zivilgesellschaftlicher Organisationen, Bürger sowie Forschungsinstitutionen und Universitäten im Rahmen einer offenen Konsultation und mittels eines zielgerichteten Fragebogens befragt. Außerdem wurden sieben dedizierte Fallstudien mit beispielhaften Informationen aus Bulgarien (mit einem Schwerpunkt auf dem Ballungsraum Plovdiv), Deutschland (Ballungsraum Berlin), Irland (öffentlich zugängliche Informationen), Italien (Sizilien), Slowakei (Region Kosice), Spanien (Madrid) und Schweden (Auswirkungen auf Umwelt und Ökosysteme) durchgeführt. Abschließend erhielten betroffene Akteure in zwei Workshops die Möglichkeit, für die Evaluierung wichtige Probleme zu benennen bzw. zu bestätigen und sich zu den Untersuchungsergebnissen zu äußern.

Ausgangslage und Stand der Umsetzung

Vor der Verabschiedung der Richtlinien 2008/50/EG und 2004/107/EG wurde der Rechtsrahmen der EU im Bereich Luftqualität durch die Richtlinie 96/62/EG des Rates über die Beurteilung und die Kontrolle der Luftqualität (Luftqualitätsrahmenrichtlinie), die Richtlinie 1999/30/EG des Rates über Grenzwerte für Schwefeldioxid, Stickstoffdioxid und Stickstoffoxide, Partikel und Blei in der Luft (erste Tochterrichtlinie), die Richtlinie 2000/69/EG über Grenzwerte für Benzol und Kohlenmonoxid in der Luft (zweite Tochterrichtlinie) und die Richtlinie 2002/3/EG über den Ozongehalt (dritte Tochterrichtlinie) abgesteckt. Mit der Richtlinie 2008/50/EG wurden die meisten bestehenden europäischen Rechtsvorschriften zur Luftqualität in einer einzigen Richtlinie zusammengefasst, mit Ausnahme der Richtlinie 2004/107/EG über Arsen, Kadmium, Quecksilber, Nickel und polyzyklische aromatische Kohlenwasserstoffe in der Luft (vierte Tochterrichtlinie), die als eigenständige Richtlinie weiter besteht.

Schon mit der vorherigen Luftqualitätsrahmenrichtlinie und ihren Tochterrichtlinien wurde das Ziel verfolgt, gemeinsame Methoden zur *Überwachung und Beurteilung* der Luftqualität in den Mitgliedstaaten festzulegen, die ähnlich wie die jetzigen LQ-Richtlinien die Beurteilung der Luftqualität anhand gemeinsamer Methoden und Kriterien erfordert. Mit den LQ-Richtlinien wurde dieser Ansatz weiter harmonisiert und die Überwachung und Beurteilung auf fünf weitere Schadstoffe erweitert (siehe unten), die in den Vorgängerrichtlinien noch nicht reguliert waren. Insgesamt wurden Fortschritte bei der Durchsetzung erzielt, sodass schon 2008 und durchgehend bis 2017 zum größten Teil eine Überwachung und Beurteilung gemäß den Anforderungen der EU gewährleistet wurden. Das heißt, die meisten Gebiete in den Mitgliedstaaten verfügen über die in den LQ-Richtlinien geforderte Mindestanzahl an Probenahmestellen und seit 2008 erfüllen immer mehr Gebiete die rechtlichen Vorgaben.

Mit den LQ-Richtlinien wurden *Luftqualitätsstandards* für fünf zusätzliche Luftschadstoffe eingeführt, d. h. für PM2,5 (Grenz- und Zielwerte) in der Richtlinie 2008/50/EG und As, Cd, Ni, BaP (Zielwerte) in der Richtlinie 2004/107/EG; außerdem wurden die bestehenden Standards für andere regulierte Schadstoffe verstärkt. Allerdings blieben die bestehenden EU-Standards für andere Schadstoffe unverändert. Im Basisjahr 2008 konnten die Mitgliedstaaten nicht in allen Gebieten die europäischen Grenzwerte einhalten, insbesondere bei O_3, aber auch bei PM_{10}, NO_2 und BaP. Insgesamt ist die Zahl der Gebiete, die eine Überschreitung der vorgegebenen Ziel- bzw. Grenzwerte meldeten, zwischen 2008 und 2017 stark gesunken.

Die Anforderungen in Bezug auf die Übermittlung und Veröffentlichung von Daten haben sich seit der Verabschiedung der LQ-Richtlinien ebenfalls substanziell weiterentwickelt. Vor 2008 wurde die Datenbank AirBase nicht in Echtzeit aktualisiert, sodass der Öffentlichkeit keine Echtzeitdaten zur Luftqualität zur Verfügung standen. Die spätere Einführung der Datenbank für elektronische Luftqualitätsberichte auf der Grundlage des Durchführungsbeschlusses 2011/850/EU hat das Verfahren zur Berichterstattung und zur Verbreitung genauer Echtzeitdaten enorm verbessert.

Mit den LQ-Richtlinien wurden auch die Anforderungen an die Mitgliedstaaten verstärkt, für Gebiete und Ballungsräume, in denen die Konzentration von Schadstoffen in der Luft die einschlägigen Ziel- oder Grenzwerte für die Luftqualität, gegebenenfalls plus einer befristeten Toleranzmarge überschreitet, *Luftqualitätspläne* zu erstellen und umzusetzen. Die LQ-Richtlinien überlassen es den Mitgliedstaaten zu entscheiden, mit welchen Maßnahmen sie die Qualitätsstandards einhalten, wobei die Dauer der Überschreitungen jedoch möglichst kurz gehalten werden muss. Zu der Frage, wie die Mitgliedstaaten vor der Umsetzung der LQ-Richtlinien auf Grenzwertüberschreitungen reagiert haben, liegen keine durchgängigen Daten vor. Die Datenlage zu den Maßnahmen der Mitgliedstaaten nach 2008 weisen jedoch darauf hin, dass für Bereiche, in denen Überschreitungen gemessen werden, Luftqualitätspläne erstellt werden.

Ergebnisse der Konsultation

Zur Unterfütterung dieser Eignungsprüfung wurde eine große Bandbreite von Akteuren konsultiert, z. B. Behörden der Mitgliedstaaten (nationale, regionale und kommunale Ebene), NRO, Branchenverbände, Forscher und die Wissenschaftsgemeinde, internationale Organisationen und Bürger. Für diese Studie konnten sich die betroffenen Akteure über die folgenden Kanäle äußern: ein öffentlich zugänglicher Online-Fragebogen, ein gezielt an relevante Akteure versendeter Fragebogen zur Informationsbeschaffung, zwei Workshops und direkte Konsultationen mit der Expertengruppe der Kommission für Luftqualität. Außerdem wurden Ad-hoc-Beiträge berücksichtigt.

Der Großteil der befragten Akteure war der Ansicht, dass die LQ-Richtlinien ihre Ziele erreicht haben; insbesondere haben sie die Überwachung der Luftqualität gefördert, europaweit Standards zur Luftqualität festgelegt und dafür gesorgt, dass Daten zur Luftqualität in ganz Europa verfügbar sind. Obwohl die meisten Akteure sich einig sind, dass die Richtlinien zu einer Verbesserung der Luftqualität beigetragen haben, sind sie über die verbreiteten Überschreitungen der geltenden Luftqualitätsstandards besorgt. Die Akteure stimmen darin überein, dass die Richtlinien weiterhin relevant sind und die darin regulierten Luftschadstoffe weiterhin politische Interventionen erfordern. In Bezug auf die Kohärenz zwischen den Zielen der LQ-Richtlinien und der übrigen EU-Politik verwiesen einige Akteure auf die Beiträge anderer Rechtsvorschriften der EU, wie die Richtlinie über die Reduktion der nationalen Emissionen bestimmter Luftschadstoffe (Richtlinie (EU) 2016/2284) und die Vorschriften für Emissionsquellen zur Verbesserung der Luftqualität. Allerdings betonten sie auch, dass ein koordinierter Ansatz zur Erreichung der Klima- und Luftqualitätsziele notwendig ist, insbesondere in den Sektoren Verkehr, Energie und Landwirtschaft. Hinsichtlich des europäischen Mehrwerts stimmten die meisten Befragten der Aussage zu, dass die Richtlinien einen europäischer Mehrwert bieten, insbesondere durch die Etablierung gemeinsamer Luftqualitätsstandards.

Subsidiarität und Verhältnismäßigkeit

Nach dem Grundsatz der Subsidiarität sollte die EU nur tätig werden, sofern und soweit die Ziele der in Betracht gezogenen Maßnahmen durch die Mitgliedstaaten auf zentraler oder regionaler und lokaler Ebene nicht ausreichend erreicht werden können. Die Studie kommt zu dem Schluss, dass die EU-Maßnahmen zur Harmonisierung der Überwachung und Beurteilung der Luftqualität und Einführung von Standards Nutzen bringen, weil sie verhindern, dass unterschiedliche und wechselnde Vorschriften in den Mitgliedstaaten die Wettbewerbsbedingungen verzerren. Auch die Tatsache, dass Luftverschmutzung nicht an der Landesgrenze endet, macht europäisches Handeln notwendig. Gleichzeitig werden die Mitgliedstaaten und deren Regionen und Gemeinden ermutigt, die für ihre speziellen Bedingungen am besten geeigneten Maßnahmen zu ergreifen, d. h. die Maßnahmen, mit denen die Luftverschmutzung am kostengünstigsten gesenkt werden kann.

Diese Flexibilität bei der Wahl der Methoden entspricht auch dem Grundsatz der Verhältnismäßigkeit, weil sie gewährleistet, dass die Maßnahmen umgesetzt werden, mit denen sich die Ziele der LQ-Richtlinien am besten erreichen lassen. Ferner kommt die Studie zu dem Ergebnis, dass die Maßnahmen dazu beigetragen haben, die Luftverschmutzung wesentlich zu verringern und daher verhältnismäßig sind. Schließlich ist die Verhältnismäßigkeit auch dadurch gegeben, dass die Richtlinien zwar Mindeststandards für die Luftqualität vorschreiben, es den Mitgliedstaaten jedoch freigestellt ist, selbst strengere Standards festzulegen.

Ergebnisse und Schlussfolgerungen

Relevanz

Luftschadstoffe, Grenz- und Zielwerte, Luftqualitätspläne

Grundsätzlich ist die Luftqualität für die Bürger Europas weiterhin aus gesundheitlichen und ökologischen Gründen ein Anlass zur Sorge, weil die Konzentration von Luftschadstoffen, denen ein erheblicher Teil der europäischen Bevölkerung immer noch ausgesetzt ist, die zum Schutz der Gesundheit gesetzlich festgelegten Grenzwerte übersteigt. Dabei ist zu beachten, dass auch diese Grenzwerte keinen vollständigen Schutz bieten, weil noch keine Untergrenzen nachgewiesen wurden, unter denen bestimmte Schadstoffe, wie z. B. Feinstaub, nicht mehr schädlich sind. In den letzten Jahrzehnten wurden die schädlichen Auswirkungen der Schadstoffe, die derzeit durch die LQ-Richtlinien reguliert werden, in immer mehr wissenschaftlichen Studien nachgewiesen. Dementsprechend sind die Ziele der LQ-Richtlinien, die Luftqualität zu verbessern und die unter die Richtlinien fallenden Schadstoffe sowie deren schädliche gesundheitliche und ökologische Folgen zu minimieren, weiterhin äußerst relevant. Außerdem deuten immer mehr wissenschaftliche Studien zumindest auf weitere schädliche Auswirkungen hin, darunter von Schadstoffen, die bisher nicht unter die LQ-Richtlinien fallen, wie Ruß, Ultrafeinstaub und Ammoniak.

Die Festlegung von Luftqualitätsstandards (Ziel- und Grenzwerte) hat außerdem eine entscheidende und äußerst relevante Rolle dabei gespielt, in allen Mitgliedstaaten Maßnahmen zur Luftreinhaltung anzuregen und einen stärker harmonisierten Ansatz für bessere Luftqualität in ganz Europa sicherzustellen. Für viele Schadstoffe sind die in den LQ-Richtlinien festgelegten Luftqualitätsstandards weniger streng als die Luftqualitätsleitlinien der WHO zum Schutz der menschlichen Gesundheit von 2005. Aktuelle Forschungsstudien deuten darauf hin, dass sie die wissenschaftlichen Daten über die gesundheitsschädlichen Auswirkungen geringer Konzentrationen bestimmter Schadstoffe wie $PM_{2,5}$, PM_{10} und SO_2, nicht ausreichend berücksichtigen. Auch legen die LQ-Richtlinien keine kurzfristigen Grenzwerte für $PM_{2,5}$ fest, die vor Spitzen in der Schadstoffkonzentration schützen.

In Bezug auf die Ziel- und Grenzwerte verpflichten die LQ-Richtlinien die Mitgliedstaaten, für Gebiete und Ballungsräume, in denen die Konzentration von Schadstoffen in der Luft die einschlägigen Ziel- oder Grenzwerte für die Luftqualität, gegebenenfalls plus einer befristeten Toleranzmarge, überschreitet, Luftqualitätspläne zu erstellen und umzusetzen. Die im Konsultationsverfahren und den Fallstudien erfassten Daten bestätigen, dass die Luftqualitätspläne zu den wichtigsten Elementen der LQ-Richtlinien gehören und die Mitgliedstaaten zu Abhilfemaßnahmen anregen. Deren Wirkung wird jedoch davon beeinträchtigt, dass die Mitgliedstaaten nicht eindeutig verpflichtet sind, über die Umsetzung der Luftqualitätspläne Bericht zu erstatten oder diese durch andere Maßnahmen zu ersetzen, wenn sie nicht den gewünschten Erfolg erzielen. Dadurch lässt sich nur schwer prüfen, ob die Mitgliedstaaten ihre Pflichten erfüllen.

Überwachung und Bewertung, Information und Berichterstattung

Die Überwachungs- und Bewertungsvorschriften der LQ-Richtlinien haben entscheidend dazu beigetragen, dass alle Mitgliedstaaten einheitliche Methoden nutzen, um die Luftqualität zu überwachen und zu bewerten. Die Europäische Kommission hat außerdem umfangreiche Leitlinien erstellt, beispielsweise zum Thema Überwachung. Dennoch lassen die LQ-Richtlinien einen gewissen Interpretationsspielraum, der die Vergleichbarkeit der Überwachungs- und Bewertungsverfahren einschränkt. Die Art und Repräsentativität von Messstationen ist für Modellierung sehr relevant, dieser Zusammenhang wird in den LQ-Richtlinien jedoch nicht klar thematisiert. Auch die Bestimmungen zur Berichterstattung und Veröffentlichung von Informationen in den LQ-Richtlinien sind von großer Bedeutung. Die Bestimmungen, nach denen die Mitgliedstaaten Daten erfassen, der EUA melden und öffentlich zugänglich machen müssen, haben wesentlich dazu beigetragen, das Thema Luftqualität ins öffentliche Bewusstsein zu rücken. Die Leitlinien der Kommission zur Überwachung, Bewertung und Berichterstattung tragen wesentlich zur wirksamen Umsetzung der LQ-Richtlinien bei. Auch die Leitlinien zur Modellierung und zur Erstellung von Luftqualitätsplänen sind äußerst relevant, haben sich jedoch in den letzten zehn Jahren etwas langsamer entwickelt.

Wirksamkeit

Wirksamkeit der Überwachungs- und Bewertungssysteme

Die meisten Mitgliedstaaten erfüllen die Überwachungs- und Bewertungsanforderungen der LQ-Richtlinien, was die Verfügbarkeit zuverlässiger und vergleichbarer Daten gefördert hat, die die Erfassung von Trends ermöglichen. Die Mitgliedstaaten haben in den meisten Gebieten die von den LQ-Richtlinien geforderte Mindestzahl von Probenahmestellen eingerichtet. Generell haben die Fälle, in denen die Grenzwerte für unterschiedliche Luftschadstoffe überschritten werden, seit dem Beginn derUmsetzung der LQ-Richtlinien abgenommen.

Die Daten aus der Konsultation betroffener Akteure weisen darauf hin, dass die unterschiedlichen Messverfahren in den Mitgliedstaaten möglicherweise auf die Flexibilität und die mehrdeutigen Kriterien bei der Klassifikation von Messstationen zurückzuführen sind. Auch externe Faktoren, insbesondere begrenzte Ressourcen (Kosten, qualifizierte Mitarbeiter) könnten dazu beigetragen haben, dass Dichte und Qualität der Überwachungsnetzwerke innerhalb Europas variieren. In Bezug auf sonstige externe Faktoren lassen sich aus der Analyse keine eindeutigen Schlussfolgerungen ziehen.

Wirksamkeit der Luftqualitätsstandards

Insgesamt gesehen sind die Fälle, in denen Ziel- bzw. Grenzwerte überschritten wurden, für die meisten Schadstoffe mit der Zeit zurückgegangen, sowohl wenn man die Anzahl der Mitgliedstaaten berücksichtigt, in denen Überschreitungen vorkommen, als auch in Bezug auf den Anteil an Gebieten innerhalb der EU, die Überschreitungen melden. Daher kommt die Studie zu dem Schluss, dass die von der LQ-Richtlinie vorgeschriebenen Maßnahmen wirksam waren. Mehrere Mitgliedstaaten haben die in den Richtlinien vorgesehene Möglichkeit, eine Fristverlängerung für die Einhaltung der Ziel- bzw. Grenzwerte für PM_{10} und NO_2 zu beantragen, in Anspruch genommen. Während die Gebiete, in denen für PM_{10} eine Fristverlängerung gewährt wurde, besser abschnitten als der Durchschnitt, erzielten die Zonen, in denen die Frist zur Einhaltung der NO_2-Werte verlängert wurde, unterdurchschnittliche Leistungen. Dennoch lassen die Daten insgesamt den Schluss zu, dass die von den LQ-Richtlinien vorgeschriebenen Maßnahmen wirksam waren.

Der bindende Charakter der Luftqualitätsstandards wird als wichtiges positives Element bei der Erreichung der Standards genannt. Obwohl die Standards bindend sind, haben manche Mitgliedstaaten jedoch, wie oben dargestellt, Mühe, die Ziel- bzw. Grenzwerte für wichtige Luftschadstoffe einzuhalten. Wenn man die Faktoren untersucht, die zu Grenzwertüberschreitungen führen, deuten sich auch Wechselwirkungen zwischen den unterschiedlichen Zielen der Richtlinien an. So scheint es beispielsweise auch von der Wirksamkeit von Luftqualitätsplänen und -maßnahmen abzuhängen, ob die Umweltziele erreicht werden. Die korrekte Standortbestimmung der Probenahmestellen ist wiederum eine Voraussetzung für eine korrekte Überwachung und Bewertung der Luftqualität, und damit für wirksame Maßnahmen. Aber auch externe Faktoren, wie geografische und meteorologische Bedingungen, sozioökonomische Lage, öffentliche Aufmerksamkeit und die sonstige EU-Politik beeinflussen, wie Luftqualitätsziele erreicht werden.

Wirksamkeit der Informationen und Berichterstattung zur Luftqualität

Die Studie kommt zu dem Ergebnis, dass der Öffentlichkeit Informationen bereitgestellt werden. Allerdings variiert die Qualität dieser Informationen, weil die Mitgliedstaaten sowohl bei der Veröffentlichung der Daten, als auch bei deren Erfassung, Beurteilung und Meldung unterschiedliche Ansätze verfolgen. Dieses Ergebnis basiert auf der Analyse der auf den Websites der zuständigen Behörden verfügbaren Daten, einer Befragung betroffener Akteure und den Fallstudien.

Ob das Ziel, der Öffentlichkeit Informationen über die Luftqualität bereitzustellen erreicht wird, hängt entscheidend davon ab, ob die Öffentlichkeit diese Informationen tatsächlich nachfragt. Nach unserer Analyse wird die Umsetzung dieses Ziels womöglich auch dadurch behindert, dass nicht alle Mitgliedstaaten bei der Veröffentlichung von Daten, aber auch bei deren Erfassung, Beurteilung und Meldung die gleichen Ansätze verfolgen.

Wirksamkeit von Luftqualitätsplänen bei der Vermeidung und Minderung der Folgen von Luftverschmutzung

Alle Mitgliedstaaten, die Grenzwertüberschreitungen gemeldet haben, haben auch die in den LQ-Richtlinien vorgeschriebenen Luftqualitätspläne erstellt. Der Straßenverkehr ist eine der wichtigsten Ursachen für die Überschreitung der Grenzwerte für NO_2 und auch für PM_{10}. Daher konzentrieren sich viele Maßnahmen zur Senkung dieser Emissionen auf diesen Sektor, z. B. belastungsabhängige Abgaben, Geschwindigkeitsbeschränkungen und die Förderung saubererer Fahrzeuge und öffentlicher Verkehrsmittel. Eine der Hauptquellen für PM_{10} und in geringerem Maße auch für NO_2 ist die Gebäudeheizung. Zu den Maßnahmen in diesem Bereich gehören die geförderte Umstellung auf emissionsarme Brennstoffe, Nachrüstungen, die umweltorientierte öffentliche Auftragsvergabe und Öffentlichkeitsarbeit. Die Wirksamkeit dieser Maßnahmen wird dadurch gefördertt, dass die Mitgliedstaaten und auch die Regionen und Gemeinden selbst entscheiden können, welche Maßnahmen am besten zu den Bedingungen vor Ort passen, d. h. besonders kostengünstig sind. Dieses Thema wird im Abschnitt über das Bewertungskriterium „Effizienz" in diesem Bericht näher ausgeführt. Allerdings wird auch darauf hingewiesen, dass der Vorteil dieser flexiblen Regelung häufig nicht voll genutzt wird, weil sich die Behörden innerhalb der Mitgliedstaaten nicht ausreichend abstimmen.

Auch externe Faktoren, wie das Bewusstsein der Öffentlichkeit, haben einen Einfluss auf die Wahl der in den Luftqualitätsplänen aufgenommenen Maßnahmen. Ferner hängt es nicht allein von den Luftqualitätsplänen ab, mit welchen Maßnahmen die Luftqualität verbessert wird, sondern auch von anderen Rechtsvorschriften der EU und sonstigen Initiativen des jeweiligen Mitgliedstaates. Unter den internen Faktoren sind beispielsweise die Leitlinien der EU für die Umsetzungsmaßnahmen zu nennen. Während einige Akteure diese für unzureichend halten, sind andere (insbesondere NRO) der Ansicht, dass sie eine Schlüsselrolle für wichtige Durchsetzungsmaßnahmen spielen.

Effizienz

Kosten und Nutzen der LQ-Richtlinien

Für einige Maßnahmen wurden die Kosten quantifiziert, allerdings liegen nur begrenzt Daten vor. Nach einer Schätzung an der unteren Grenze lag der gesundheitliche Nutzen zwischen 2008 und 2016 um die 50 Mrd. Euro, was 31 000 weniger Todesfällen in diesem Zeitraum entspricht. Die Nutzen sind mit der Zeit stark gestiegen, weil immer mehr Gebiete die Luftqualitätsgrenzwerte eingehalten haben. Angesichts der übrigen Umweltvorschriften zum Schutz der Luftqualität und insbesondere des Klimas können Kosten und Nutzen entsprechender Maßnahmen nicht eindeutig den LQ-Richtlinien zugeordnet werden. Die ergänzende Gesetzgebung, die unmittelbar auf Luftverschmutzung abzielt, wird allerdings zum Teil verabschiedet, um die Anforderungen der LQ-Richtlinien zu erfüllen. Die Daten lassen die Schlussfolgerung zu, dass die Nutzen kosteneffizient und auf angemessene Art erzielt werden, weil die Länder ihre Luftqualitätskontrollstrategien auf die Quellen zuschneiden, die hauptsächlich zu Grenzwertüberschreitungen auf lokaler Ebene beitragen. Dieses Ergebnis ist allerdings mit Unsicherheiten behaftet, weil nur wenige Ex-post Daten zu den tatsächlichen Kosten und quantifizierten Auswirkungen der genannten Maßnahmen vorliegen. Bei der Analyse von Synergien wurden insbesondere positive Nebeneffekte in den Bereichen Verkehr (z. B. durch Maßnahmen zur Verkehrsreduktion) und Klima (z. B. durch Maßnahmen zur Senkung des Verbrauchs fossiler Brennstoffe) festgestellt.

Laut der Untersuchung variieren die Kosten stark zwischen den Mitgliedstaaten und Sektoren, was jedoch auf Umfang und wichtigste Quelle der Grenzwertüberschreitungen auf lokaler Ebene zurückzuführen ist. Die unzureichende Umsetzung, die hier als Überschreitung der Grenzwerte definiert wird, hat zu hohen gesundheitlichen Kosten geführt. Wenn man die ursprünglichen Daten zur Einhaltung der Grenzwerte für NO_2 und PM_{10} zugrunde legt, waren diese Kosten zu Beginn des Untersuchungszeitraums (2008-2012) am höchsten, sanken dann jedoch in dem Maße, in dem Maßnahmen gegen Grenzwertüberschreitungen Wirkung zeigten. Dass nur wenige Daten zu den Kosten lokaler Maßnahmen vorliegen, erschwert die Bewertung; allerdings deuten die verfügbaren Daten darauf hin, dass die Kosten für die Einhaltung der Grenzwert den erzielten Nutzen entsprechen.

Effizienz der Überwachung, Berichterstattung und Beurteilung

Schätzungen auf der Grundlage der von acht Mitgliedstaaten bereitgestellten Daten zeigen, dass die *Verwaltungskosten* zwischen 0,14 und 0,98 Euro pro Jahr pro Kopf liegen. Anhand von Stichproben aus drei Mitgliedstaaten lassen sich die Verwaltungslasten pro Kopf auf 0,12 bis 0,38 Euro jährlich schätzen. Dies deutet darauf hin, dass die Nutzen der LQ-Richtlinien und die Kosten aufgrund einer unzureichenden Umsetzung die Verwaltungslasten bei weitem übersteigen. Ineffizienzen gibt es bezüglich:

- Finanzierung und Unterstützung lokaler Behörden, an die die Umsetzung der LQ-Richtlinien übertragen wurde, durch nationale Stellen;
- uneinheitliche Bereitstellung von Leitlinien und Orientierungshilfen in den Mitgliedstaaten;
- ungleiche Nutzung moderner IT- und Medientechnologien.

Die Kosten für die Information der Öffentlichkeit variieren stark, weil sich die entsprechenden Maßnahmen unterscheiden und nicht für alle Behörden, die für die Veröffentlichung zuständig sind, Kostendaten verfügbar sind.

Kohärenz

Kohärenz zwischen den Rechtsvorschriften zur Luftqualität und anderen Umwelt- und sektorspezifischen Vorschriften

Insgesamt zeigt die Analyse eine starke Kohärenz zwischen den LQ-Richtlinien und anderen Rechtsvorschriften, die die Luftverschmutzung und Emissionen betreffen, z. B. die Richtlinie über die Reduktion der nationalen Emissionen bestimmter Luftschadstoffe (Richtlinie (EU) 2016/2284), die Richtlinie über Industrieemissionen (Richtlinie 2010/75/EU) und die Richtlinie über Emissionen aus mittelgroßen Feuerungsanlagen (Richtlinie (EU) 2015/2193). Die Kohärenz mit verwandten Rechtsvorschriften wurde im Untersuchungszeitraum durch die Verabschiedung des Maßnahmenpakets für saubere Luft im Jahr 2013 weiter gestärkt. Andere Umweltvorschriften sind im Prinzip kohärent, weisen aber Lücken auf. So können Maßnahmen, die unter die Nitratrichtlinie fallen, zwar auch die Emission von Luftschadstoffen in der Landwirtschaft senken, die Luftqualität wird in der Richtlinie aber nicht ausdrücklich als Ziel genannt (Richtlinie 91/676/EWG).

Nach unserer Analyse sind die LQ-Richtlinien kohärent und es konnten auch Synergieeffekte mit der Klimapolitik und sektorbezogenen Politik der EU gefunden werden; allerdings wurden auch einige Probleme identifiziert. Wie Studien zeigen, unterstützen sich Maßnahmen zum Klimaschutz und gegen Luftverschmutzung meist gegenseitig und dieser Zusammenhang spiegelt sich in den politischen Dokumenten der EU immer stärker wider. Klima- und energiepolitische Maßnahmen der EU zur Förderung von Energieeffizienz und erneuerbaren Energiequellen haben zur Verbesserung der Luftqualität beigetragen. Bestimmte Verbrennungsanlagen für Biomasse haben jedoch den Nutzen der Erneuerbare-Energien-Richtlinie (Richtlinie (EU) 2018/2001) für die Luftqualität eingeschränkt, weil sie die Luftqualität an einzelnen Standorten verschlechtern. Die Rechtsvorschriften und Programme der EU für den Straßenverkehr zielen unter anderem auf die Luftqualität ab, sie begrenzen die Fahrzeugemissionen und fördern Alternativen zum heutigen Verkehrssystem. Allerdings hatten die EU-Vorschriften zur Senkung der Fahrzeugemissionen im Rahmen des Typgenehmigungssystems im Untersuchungszeitraum gewisse Defizite. Die im Untersuchungszeitraum durchgeführte Reform dieses Systems dürften einige dieser Probleme beheben. Im Programmzeitraum 2014-2020 wurden im Rahmen der Gemeinsamen Agrarpolitik Maßnahmen zur Senkung von landwirtschaftlichen Emissionen aus Mitteln des Fonds für die Entwicklung des ländlichen Raums gefördert.

Kohärenz mit den EU-Finanzinstrumenten und mit Steuervorschriften

Einige Maßnahmen der Mitgliedstaaten zur Verbesserung der Luftqualität wurden mit EU-Mitteln gefördert. 2014 bis 2020 haben die Mitgliedstaaten rund 2 Mrd. Euro aus dem europäischen Struktur- und Investitionsfonds (ESI-Fonds) in Luftqualitätsmaßnahmen investiert. Weitere 166 Mrd. Euro aus dem ESI-Fonds flossen in Investitionen in die CO2-arme Wirtschaft, Umweltschutz, Ressourceneffizienz und den Ausbau der Netzinfrastruktur; diese Investitionen dürften mittelbar dazu beigetragen haben, die Luft sauberer zu machen. Fördermittel aus dem Europäischen Fonds für strategische Investitionen und der Fazilität „Connecting Europe“ bringen vermutlich weitere indirekte Nutzen für die Luftqualität; außerdem flossen viele Fördermittel der EU in Forschungsprojekte, die für saubere Luft relevant sind. Mit einigen wenigen EU-Mitteln wurden jedoch auch Investitionen gefördert, die den Zielen der Luftqualität entgegen stehen.

Auch die Steuerpolitik der EU und der Mitgliedstaaten behindern möglicherweise die Erreichung der Luftqualitätsziele. Die Steuervorschriften der EU erlauben es den Mitgliedstaaten, Dieselkraftstoff niedriger zu besteuern als Benzin. In den meisten Mitgliedstaaten wird Diesel geringer besteuert und die steuerliche Behandlung von Firmenwagen bietet Anreize für die Nutzung von PKWs. Diese Steueranreize haben möglicherweise die Dieselquote bei PKWs erhöht, was zusammen mit den Schwächen bei der Fahrzeugprüfung im Rahmen der Typgenehmigung im Untersuchungszeitraum die Luftqualität verschlechtert haben dürfte.

Europäischer Mehrwert

Harmonisierter Rechtsrahmen zur Luftqualität

Die LQ-Richtlinien gewährleisten, dass die Regulierung von Luftqualitätsstandards für Schadstoffe heute stärker harmonisiert und koordiniert ist als bei einer alleinigen einzelstaatlichen Regulierung durch die Mitgliedstaaten. Dadurch haben sie einen europäischen Mehrwert geschaffen. Die LQ-Richtlinien haben Grenz- und Zielwerte für fünf Luftschadstoffe eingeführt, die vorher nicht auf europäischer Ebene reguliert waren, nämlich für Feinstaub ($PM_{2.5}$), Arsen, Kadmium, Nickel und Benzo[a]pyren (als Marker für polyzyklische aromatische Kohlenwasserstoffe). Vor Einführung der LQ-Richtlinien gab es zwischen den Luftqualitätsstandards der einzelnen Mitgliedstaaten große Unterschiede, z. B. in Bezug auf die regulierten Schadstoffe, das Schutzniveau (mehr oder weniger strenge Grenzwerte) und die Rechtsnatur der Vorschriften (verbindlich oder freiwillig, Grenzwerte oder Leitlinien, Vorgabe von Ergebnissen oder Vorgabe von Maßnahmen). Gemäß dem Grundsatz der Subsidiarität sind Maßnahmen der EU zur Harmonisierung von Standards gerechtfertigt, wenn sie verhindern, dass unterschiedliche und wechselnde Anforderung in den einzelnen Rechtssystemen die Wettbewerbsbedingungen im Kampf gegen Luftverschmutzung verzerren würden. Auch die Tatsache, dass Luftverschmutzung nicht an der Landesgrenze endet, macht europäisches Handeln notwendig.

Die LQ-Richtlinien haben außerdem einen gemeinsamen Rahmen für die Beurteilung und Überwachung der Luftqualität festgelegt und so für eine bessere Vergleichbarkeit der Systeme und Netzwerke zur Überwachung- und Beurteilung in den einzelnen Mitgliedstaaten gesorgt. Dies hat dazu beigetragen, dass der Öffentlichkeit heute hochwertigere und vergleichbare Daten zur Luftqualität zur Verfügung stehen. Ermöglicht wurde dies insbesondere durch die Umsetzung einer modernisierten Lösung zur Datenerfassung und -meldung in Echtzeit über die Datenbank für elektronische Luftqualitätsberichte. Die bessere Verfügbarkeit von Informationen hat das Thema stärker ins Bewusstsein der Bürger gerückt und die Bürger, Behörden und betroffenen Organisationen möglicherweise auch zu (rechtlichen) Maßnahmen angeregt, wie die zahlreichen anhängigen Prozesse zeigen. Allerdings wurde auch das Problem angesprochen, dass die LQ-Richtlinien das Recht auf Zugang zur Justiz nicht ausdrücklich vorsehen.

Synergien und Koordination von Maßnahmen zur Luftqualität

Ein Mehrwert im Sinne von Synergien mit anderen Zielen der Gemeinschaft wurde sowohl auf europäischer Ebene als auch in den Mitgliedstaaten identifiziert. Dennoch können die Koordination zwischen den Behörden innerhalb der Mitgliedstaaten und die Suche nach möglichen Synergien weiter verstärkt werden. In den LQ-Richtlinien sind die Zuständigkeiten der zuständigen Stellen auf europäischer und nationaler Ebene klar abgegrenzt. In einigen Mitgliedstaaten hat die in den LQ-Richtlinien festgelegte Pflicht zur Erstellung von Luftqualitätsplänen, Überwachung und Beurteilung der Luftqualität und Veröffentlichung der entsprechenden Daten zu einer Verbesserung des Verwaltungssystems in Bezug auf die Luftqualität geführt, die abhängig von den bisherigen Regelungen stärker oder schwächer ausgefallen ist. Dennoch zeigen die Daten aus den Fallstudien und dem Konsultationsverfahren, dass die Koordination zwischen den Stellen der öffentlichen Hand innerhalb der Mitgliedstaaten noch verbessert werden kann, insbesondere in Bezug auf die Zuständigkeiten für und Koordination der Umsetzung der Luftqualitätspläne und die Koordination zwischen Behörden auf nationaler, regionaler und kommunaler Ebene.

Insgesamt zeigen die Daten, die im Rahmen dieser Studie zur Unterfütterung der Eignungsprüfung erhoben wurden, dass die LQ-Richtlinien einen umfassenden Rechtsrahmen bilden, der den verfolgten Zielen grundsätzlich entspricht. Einzelne Bestimmungen müssten jedoch gestärkt werden, um weitere Anreize für wirksame Maßnahmen auf europäischer Ebene und in den Mitgliedstaaten zu bieten.

1 INTRODUCTION

This report is the Draft Final Report of the *study supporting the Fitness Check of the EU Ambient Air Quality (AAQ) Directives, 2008/50/EC and 2004/107/EC*, also considering the corresponding Implementing Decision 2011/850/EC and Commission Directive (EU) 2015/1480.

1.1 Objective of study

Air quality is an important environmental and social concern that poses important risks to human health. To minimise the negative impacts of air pollution, the Directive 2008/50/EC on ambient air quality and cleaner air for Europe and Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air (hereinafter: AAQ Directives) were adopted.

The implementation of the AAQ Directives involves a wide variety of stakeholders at EU and national level which can lead to varying level of success in their implementation and/or challenges. In this context, the present study to support the fitness check focussed on assessing the implementation (including successes and challenges) of the AAQ Directives over the period they were in force. This retrospective exercise focussed on identifying what worked well or less well in their implementation and to compare actual performance with earlier expectations.

1.2 Scope of study

Using an evaluation framework designed in line with the Better Regulation Guidelines, the support study to the fitness check has assessed the performance of the AAQ Directives against five criteria: *relevance, effectiveness, efficiency, coherence, EU added value*. The study focussed on assessing whether the EU measures foreseen by the AAQ Directives have been designed to achieve their objectives without entailing disproportionate costs and, thus, continue to be justified.

The support study to the fitness check focussed on the implementation of the AAQ Directives over 2008 to 2018 covering the period over which the two directives were in force. The study also covered all the articles and provisions of the two directives, looking at the role they played in meeting the objectives of the AAQ Directives.

1.3 Structure of report

The Draft Final Report presents the results of the support study for the fitness check and the report is structured as follows:

- Chapter 1 – Introduction
- Chapter 2 – Context
- Chapter 3 – Evaluation criteria and questions
- Chapter 4 – Methodology
- Chapter 6 – Implementation state of play
- Chapter 7 – Findings
- Chapter 8 – Conclusions.

The report is adjoined by a number of appendices containing: Appendix A – Procedural Information; Appendix B – Consultation Synopsis; Appendix C – References; Appendices D to H – Detailed evidence per evaluation criterion; Appendix I – Case study summary; Appendix J – Case study reports.

2 CONTEXT

The support study takes outset in an understanding of the scope and objectives of the AAQ Directives (Section 2.1), of how the interventions are envisaged to lead to an achievement of the objectives (Section 2.2), and of what would have happened without the interventions – i.e. the baseline (Section 2.3).

2.1 AAQ Directives

The AAQ Directives 2008/50/EC and 2004/107/EC entered into force in 2008 and 2004, respectively.

The *Directive 2008/50/EC on ambient air quality and cleaner air for Europe* combined and replaced the previous Framework Directive (96/62/EC) and its First (1999/30/EC - limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air), Second (2000/69/EC - limit values for benzene and carbon monoxide in ambient air) and Third (2002/3/EC – ozone in ambient air) Daughter Directives, and the Exchange of Information Decision (97/101/EC) into one Directive.

The Directive was adopted with the aim (as per Article 1) of laying down measures aimed at:

- Defining and establishing the objectives for ambient air quality designed to avoid, prevent or reduce harmful effects on human health and the environment as a whole;
- Assessing the ambient air quality in Member States on the basis of common methods and criteria;
- Obtaining information on the ambient air quality in order to help combat air pollution and nuisance and to monitor long-term trends and improvements resulting from national and Community measures;
- Ensuring that information on air quality is made available to the public;
- Maintaining air quality where is good and improving it in other cases;
- Promoting increased cooperation between Member States in reducing air pollution.

The Directive thus merged most of the existing air quality legislations into a single directive with the exception of *Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air (Forth Daughter Directive)*. Directive 2004/107/EC remained valid as stand-alone piece of legislation.

The main instruments for air quality control set in the AAQ Directives are a set of *ambient air quality standards* that provide protection against excessive pollution concentrations. The standards are set based on the latest research on health effects of air pollution. The currently applicable standards as per the AAQ Directives are outlined in the table below.

Table 2-1 Standards for different pollutants according to the AAQ Directives

Pollutant	Concentration	Averaging period	Legal nature (date entering into force)	Permitted exceedances each year
Particulate matter ($PM_{2.5}$)	25 µg/m³	1 year	Target value to be met as of 1.1.2010 Limit value to be met as of 1.1.2015	n/a
Sulphur dioxide (SO_2)	350 µg/m³	1 hour	Limit value to be met as of 1.1.2005	24
	125 µg/m³	24 hours	Limit value to be met as of 1.1.2005	3
Nitrogen dioxide (NO_2)	200 µg/m³	1 hour	Limit value to be met as of 1.1.2010	18
	40 µg/m³	1 year	Limit value to be met as of 1.1.2010 *	n/a
Particulate matter PM_{10}	50 µg/m³	24 hours	Limit value to be met as of 1.1.2005 **	35
	40 µg/m³	1 year	Limit value to be met as of 1.1.2005 **	n/a
Lead (Pb)	0.5 µg/m³	1 year	Limit value to be met as of 1.1.2005 (or 1.1.2010 in the immediate vicinity of specific, notified industrial sources; and a 1.0 µg/m3 limit value applied from 1.1.2005 to 31.12.2009)	n/a
Carbon monoxide (CO)	10 mg/m³	Maximum daily 8 hour mean	Limit value to be met as of 1.1.2005	n/a
Benzene (C_6H_6)	5 µg/m³	1 year	Limit value to be met as of 1.1.2010**	n/a
Ozone (O_3)	120 µg/m³	Maximum daily 8 hour mean	Target value to be met as of 1.1.2010	25 days averaged over 3 years
Arsenic (As)	6 ng/m³	1 year	Target value to be met as of 31.12.2012	n/a
Cadmium (Cd)	5 ng/m³	1 year	Target value to be met as of 31.12.2012	n/a
Nickel (Ni)	20 ng/m³	1 year	Target value to be met as of 31.12.2012	n/a
Benzo[*a*]pyrene (BaP)	1 ng/m³	1 year	Target value to be met as of 31.12.2012	n/a

**Under Directive 2008/50/EU, the Member State could apply for an extension of up to five years (i.e. maximum up to 2015) in a specific zone. The request is subject to an assessment by the Commission. In such cases within the time extension period the limit value applies at the level of the limit value + maximum margin of tolerance.*

***Under Directive 2008/50/EU, the Member State was able to apply for an extension until three years after the date of entry into force of the new Directive (i.e. May 2011) in a specific zone. The request was subject to assessment by the Commission. In such cases within the time extension period the limit value applies at the level of the limit value + maximum margin of tolerance.*

Source: AAQ Directives

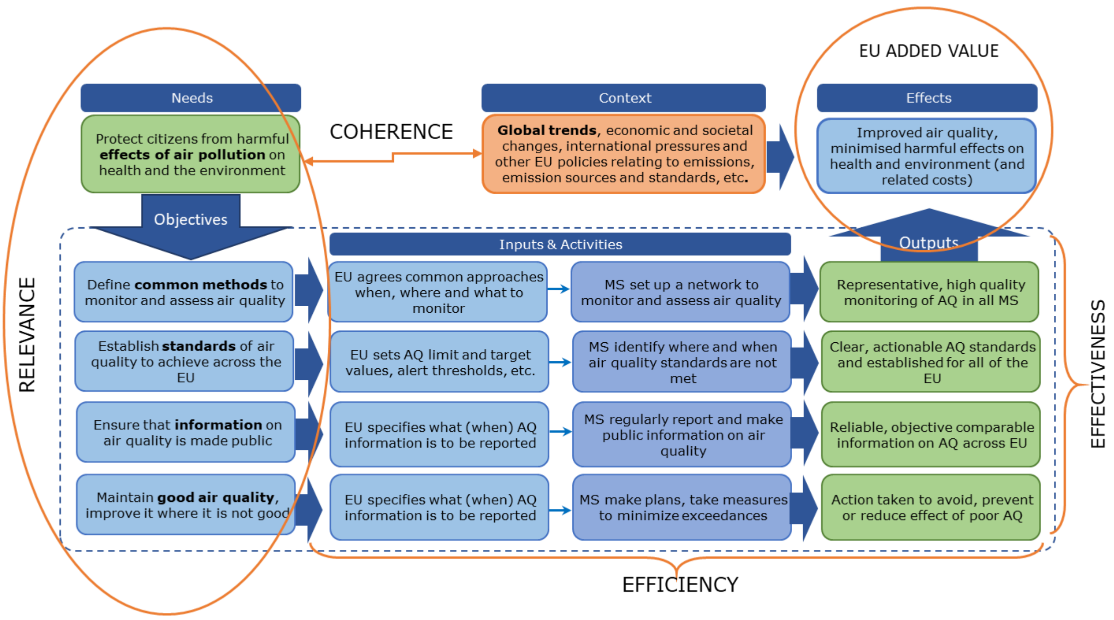
Directive 2008/50/EC also include provisions concerning monitoring and assessment of air quality (Articles 5-11), air quality plans (Article 23), information and reporting (Articles 26-27). The provisions of both Directive 2008/50/EC and Directive 2004/107/EC are assessed as part of this support study for the fitness check.

2.2 Intervention logic

The AAQ Directives *intervention logic* frames the evaluation questions for the study and defines the framework for the analysis. The intervention logic outlines the objectives of the AAQ Directives and the overall expected outputs and effects. The intervention logic also depicts the interrelations between the intervention of the AAQ Directives and the evaluation criteria. *Relevance* looks at the objectives of the intervention to assess the extent to which these are still relevant given current societal context and needs. The links between inputs and outputs as well as costs versus benefits are assessed by *efficiency* questions, and the achievement of outputs and reasons behind that progress is assessed under *effectiveness*. Effectiveness also considers the link between observed changes and the intervention. *Coherence* looks for synergies or conflicts between the intervention and other EU policies, as well as the global context. Finally, *EU-added value* aims to assess the additional changes that occur due to the intervention, compared to what could be achieved by national (local, regional) action alone. While the figure seeks to illustrate the main links, it does not capture all the complexities.

The context in the intervention logic considers two dimensions: 1) broader global context in terms of social, technological, environmental and political trends, and 2) EU policy development. The EU context refers to the 6th and 7th Environment Action Programme (EAP) objective on air quality, and to the dual objective of the Clean Air Program, where the AAQ Directives can contribute to achieving compliance with air quality standards at the latest by 2020. In addition, this context includes other Directives that relate to clean air: including NEC for setting total emissions, and source-specific emission standards (IED, Euro and fuel standards, etc.). These policies together with the AAQ Directives form the main pillars for ensuring good air quality, hence coherence among those is paramount.

Figure 2-1 AAQ Directives intervention logic



Source: European Commission, Evaluation and Fitness Check Roadmap

2.3 Baseline

The baseline is a description of what would have happened without the adoption and implementation of the AAQ Directives – i.e. *a scenario in which no additional EU-level air quality legislation would have been implemented apart from the legislation already in place at the moment of the adoption of the AAQ Directives in 2008*. Hence, this counterfactual scenario describes, in principle, the developments in air quality and air quality measures in the Member States from 2008 and onwards as they would have been expected to be with no policy change, and so the benchmarks with which the actual developments are measured against.

However, in practice, there is no actual data for such counterfactual development since 2008, and furthermore there are no comprehensive projections/estimates for such developments either. Hence, for the purpose of the analysis within this study the situation in 2008 is used as the baseline to compare with. The implicit assumption is that air quality and Member States' monitoring and assessment efforts, the definitions of air quality standards and their achievement, the provisions of air quality information to the public, and of the actions to avoid, prevent or reduce poor air quality would have remained at 2008 levels in the absence of the AAQ Directives.[1]

Air quality legislation

Before analysing the relevant baseline indicators for the different objectives/strands of the AAQ Directives, it is worth highlighting the main aspects of the EU legislative framework in place before 2008.

The air quality legislation at EU-level dates back to the 1980s when the Council Directive 80/779/EEC established the first EU limit values for SO_2 concentrations, followed by Council Directive 85/203/EEC setting air quality standards for NO_2. The first EU-level efforts on air quality built on national and international efforts to ensure air pollution control, in particular the 1979 Convention on Long Range Transboundary Air Pollution (CLRTAP). Subsequently, as highlighted above, the Council Directive 96/62/EC (Air Quality Framework Directive) was adopted followed by its daughter Directives setting concentration values for key pollutants as well as rules on performing monitoring and assessment, reporting, action plans and pollution reduction measures in the Member States.

Monitoring and assessment

The objectives / strands of the AAQ Directives that concern the aim of having common methods to monitor and assess air quality in the Member States, enabling comparable air quality assessments. This was, however, also the aim of the previous Air Quality Framework Directive and its daughter Directives – i.e. they similarly required the assessment of ambient air quality standards on the basis of common methods and criteria. More precisely, the Directives preceding the AAQ Directives required that the minimum assessment requirements are set and that they are linked to the specific concentration thresholds as well as the size of population within air quality zones and agglomerations.

While the Directives preceding the AAQ Directives set the overall framework for monitoring and assessments, Member States had their own regimes in place. Although there is no systematic evidence on the designs of the monitoring and assessment regimes in place in the Member States before 2008, there are indications that the approaches differed between Member States. This imposed challenges to the comparability of monitoring data collected across Member States with the consequence that there was no comprehensive assessment of air quality at EU-level. Most

[1] The developments in some of these baseline indicators since 2008 are presented in Chapter •: Implementation state of play.

zones in the Member States has the minimum number of sampling points required by the AAQ Directives, with the degree of compliance having increased since 2008.

The Commission Decision 2004/461/EC did already at that time provide for supplementing monitor station measurements with other methods such as modelling techniques and indicative measurements. However, no systematic data on the use of methods such as modelling techniques and indicative measures by the Member States was collected before or in 2008. Information on the amount of Member States using modelling techniques and indicative measurements is only available from 2013 and onwards reported under the provisions of Implementing Decision 2011/850/EU.

Air quality standards

Regarding the objective/strand of the AAQ Directives regarding establishing air quality standards, the AAQ Directives introduced standards for five additional pollutants, i.e. $PM_{2.5}$ (limit and target values), As, Cd, Ni, BaP (target values), and they reinforced previously existing standards for other regulated pollutants. As such, they did not introduce modifications to the existing EU standards for other pollutants such as PM_{10}, NO_2, NO_x, SO_2, CO, and O_3 that were introduced by the Air Quality Framework Directive (Council Directive 96/62/EC) and the three Daughter Directives (Council Directive 1999/30/EC, Directive 2000/69/EC, Directive 2002/3/EC).

Prior to the AAQ Directives, the approach to regulating air quality standards across Member States varied also substantively in terms of the level of protection (weaker or stricter limits) and the legal nature of the regulations (binding or voluntary, limit values or guidelines, obligation of results or obligation of means). Furthermore, only few Member States had standards in place for $PM_{2.5}$. A similar lack of air quality standards was found for most Member States for As, Cd and Ni prior to Directive 2004/107/EC – while more had standards for BaP. For O_3 around half of the Member States had standards prior to Directive 2002/3/EC, with a similar picture for CO and C_6H_6 prior to Directive 2003/69/EC. For PM_{10}, SO_2, NO_2 and NO_x, there is also evidence of standards in some Member States prior to Directive 1999/30/EC.

The air quality standards to be met in all zones in the EU (with time extensions for some zones regarding the PM_{10} and NO_2 limit values) were as shown in Table 2-2 (for selected pollutants) not met everywhere in the 2008 baseline year. This goes in particular for O_3 but also for PM_{10}, and NO_2 and BaP.

Table 2-2 Zones exceedances, 2008

	PM_{10} (days above)	$PM_{2.5}$	NO_2 (annual)	SO_2 (days above)	CO	C_6H_6	Pb	O_3 (target value)	As	Cd	Ni	BaP
Number of MS reporting exceedances	22	4	22	5	2	5	3	18	8	5	5	12
Share of zones with exceedances	37%	6%	28%	1%	0.4%	1%	0.6%	45%	2%	1%	2%	22%

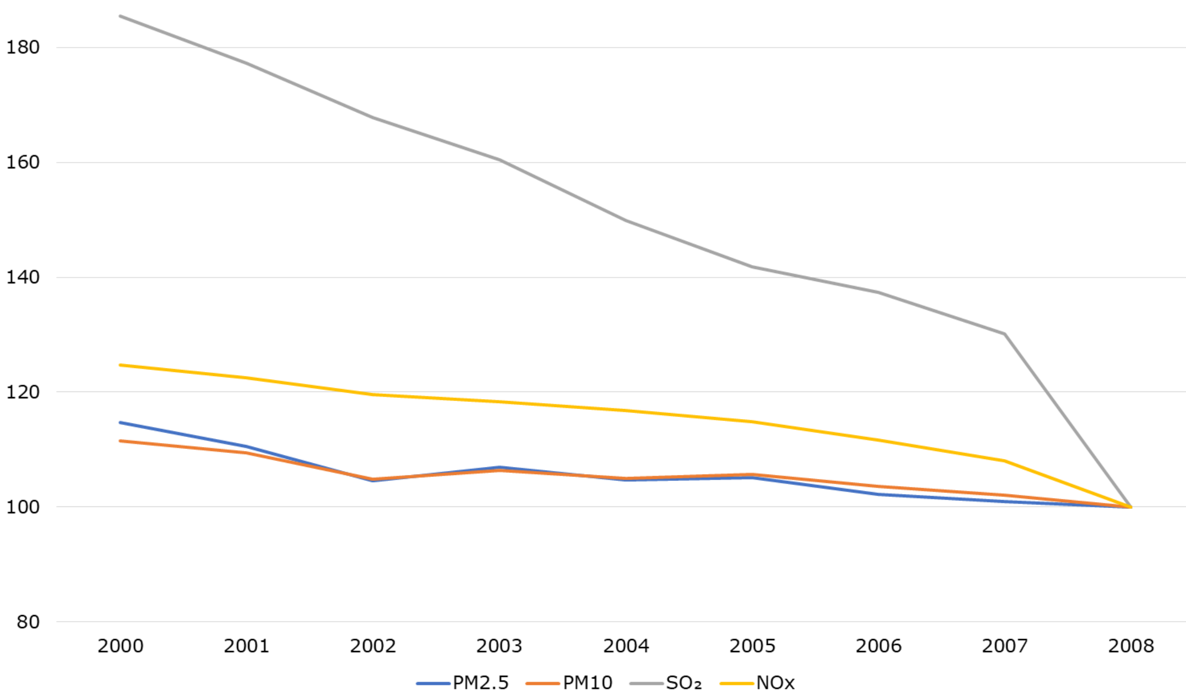
Source: Reporting on ambient air quality assessment in the EU Member States, 2008 - ETC/ACC Technical Paper 2010/11

Note: Target/limit values for $PM_{2.5}$, O_3, As, Cd, Ni and BaP only entered into force after 2008.

An alternative measure are the EEA estimates of the share of EU urban population exposed to selected air pollution concentrations above target/limit values. The data confirms that in 2008 there were exceedances for O_3 (for 15.3% of the EU urban population), NO_2 (12.3%), PM_{10} (23.9%), and also for $PM_{2.5}$ (12.6%).

Regarding air quality itself, Figure 2-2 shows that emissions in tonnes of the four pollutants: PM_{10}, $PM_{2.5}$, NO_x and SO_2 - in particular the latter – had decreased in the period 2000-2008. Such downward trend can be expected to have continued from 2008 and onwards without any new policy interventions – such as the AAQ Directives. In other words, such baseline developments must be addressed when assessing the contribution from the AAQ Directives to the actual development in air emissions since 2008.

Figure 2-2 Emissions by pollutant, EU-28 (tonnes, index: 2008 = 100), 2000 - 2008



Source: EEA and Eurostat database: env_air_emis

Information and reporting

Prior to 2008, reporting and public information requirements at EU-level were set out in the air quality legislation. However, the systems supporting the collection and dissemination of information on air quality were not up-to-standard or sufficiently modern. As per the 2005 Impact Assessment SEC (2005) 1133 [P3], the reporting obligations prior to the AAQ Directives were based on the Exchange of Information Decision and Air Quality Framework and daughter Directives but they did not enable the collection of real time data and its dissemination to the wider public. Furthermore, the system in place for reporting and dissemination of information was not in line with the EU requirements to establish a shared information system under the INSPIRE Directive (Directive 2007/2/EC).

Thus, at EU level, air quality data prior to 2008 were collected and reported in the AirBase consisting of multi-annual time series of air quality measurement data and their statistics for a representative selection of stations and for a number of pollutants. The AirBase was updated on a yearly basis, not in real time, thus not allowing the dissemination to the wider public of real time information on the state of air quality.

Finally, EEA website traffic monitoring data show (see Figure 5-5) that the number of visits to the EEA air quality website pages was relatively low in 2008 – both compared with the number of visits in later years and compared with the total number of EEA website visits. However, the development in more recent years is remarkable as further described in implementation state of play (section 5.3).

Actions to avoid, prevent or reduce effects of poor air quality

Regarding this objective/strand, the baseline situation is twofold. Firstly, regarding the preparation of air quality plans in the Member States where exceedances of target/limit values are registered, such requirements were already present in the Framework Directive 96/62/EC – i.e. with an obligation to inform the Commission every three years of the progress on the plan or programme. However, there is no comprehensive or consistent information available on the compliance with these requirements to establish a proper baseline situation.

Secondly and similarly, regarding measures – provided for by air quality plans – implemented in the Member States to avoid, prevent or reduce the effects of poor air quality, there is no comprehensive or consistent information available for the 2008 baseline situation.

3 EVALUATION CRITERIA AND QUESTIONS

The support study to the fitness check was designed in line with the European Commission's Better Regulation Guidelines and built on the Fitness Check Roadmap using as basis the five evaluation criteria: i.e. *relevance, effectiveness, efficiency, coherence, EU added value*.

For this study, the evaluation criteria have been operationalised in 10 evaluation questions.

The key evaluation criteria that the support study to the fitness check has investigated include:

- *Relevance* focussed on assessing the extent to which the AAQ Directives have been relevant in relation to actual needs and whether they have adapted to technological and scientific progress and EU priorities.
- *Effectiveness* focussed on assessing the extent to which the AAQ Directives have met their objectives and on the factors that have enabled or hindered the attainment of the initially set objectives. The study looked into the achievement of the different provisions of the AAQ Directives and their implementation, including the definition of methods to monitor and assess air quality, ambient air quality trends, access to information.
- *Efficiency* focussed on assessing the extent to which the costs associated with the implementation of the AAQ Directives were proportional with the benefits (both monetary and non-monetary, as well as assess whether the monitoring, reporting and assessment regimes are efficient or whether they create any unnecessary excessive administrative burdens.
- *Coherence* focussed on assessing the extent to which the AAQ Directives are complementary to other environmental and sectoral policies and investigate whether there are any contradictions affecting the implementation of the AAQ Directives.
- *EU added value* focussed on assessing the added value that the provisions of the AAQ Directives have brought in terms providing a common framework for dealing with air quality issues across Europe.

The related evaluation questions and judgement criteria are further presented below.

Table 3-1 Overview of evaluation questions

RELEVANCE
• EQ 1: How relevant are the goals and objectives of the AAQ Directives to the needs of citizens; do the AAQ Directives still address the most relevant pollutants and set relevant standards and obligations to protect human health and the environment; are the AAQ Directives sufficiently adapted or adaptable to evolving technical and scientific progress, and which elements have become redundant in the light of key EU air quality priorities?
EFFECTIVENESS
• EQ 2: What factors have contributed to meeting the objectives of the AAQ Directives or to failing to meet these objectives, in terms of: 1) defining common methods to monitor and assess air quality, and assessing ambient air quality in order to monitor trends; 2) establishing standards of air quality to achieve across the EU; 3) ensuring that information on air quality is made public; 4) maintaining good air quality, improving it where it is not good; to what level can these factors be attributed to provisions of the AAQ Directives?

EFFICIENCY
• EQ 3: What are the costs and benefits (monetary and non-monetary) associated with implementation of the AAQ Directives in the Member States, and in the EU; have the benefits (improved air quality) been achieved in a cost-effective manner and to what extent have costs been equitably distributed across different sectors? • EQ 4: Where there are significant cost differences between Member States and/or between different sectors and/or as regards costs to stakeholders (including social costs as a consequences of poor implementation), what is causing them; and are the costs of compliance proportionate to the benefits brought by the Directives? • EQ 5: How efficient are monitoring, reporting and assessment regimes, what are the administrative costs to the Member States and to the Commission; taking account of the objectives and benefits of the Directives is there evidence that they have caused unnecessary or excessive administrative burden? • EQ 6: Has the implementation of the AAQ Directives supported or hampered EU competitive-ness in the global economy; has the implementation of the AAQ Directives improved or been detrimental to economic, social and environ-mental sustainability?
COHERENCE
• EQ 7: To what extent do the AAQ Directives complement or interact with other environmental policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as the NEC Directive and IED Directive as well as EU climate legislation and policy); and how do these policies and legislation support or hamper the implementation of the EU air quality legislation? • EQ 8: To what extent do the AAQ Directives complement or interact with sectoral policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as energy, transport, agriculture, cohesion, taxation policies); and how do these policies support or hamper the implementation of the EU air quality legislation?
EU ADDED VALUE
• EQ 9: To which degree have the AAQ Directives, including common EU air quality standards and comparable air quality assessment, management and information approaches enabled Member States and their competent authorities to take successful action to improve beyond what would have been possible without EU action? • EQ 10: What has been the EU added value of the AAQ Directives, do the Directives and their means of implementation create synergies or overlaps with other Community objectives, and how has the distribution of responsibilities between EU, Member State, regional and local level impacted on air quality management?

Source: Authors based on Tender Specifications

4 METHODOLOGY

The support study to the fitness check relied on several sources of data and analytical methods for assessing the performance of the AAQ Directives in the reference period. The main data collection and analytical methods are presented below and are followed by a brief section on the main methodological limitations.

4.1 Data collection and analytical methods

4.1.1 Analysis of e-Reporting data

European air quality information, as reported by all EU Member States is collected, managed and made available via the European Environment Agency website, on the Air Quality e-Reporting database (previously AirBase)[2]. Information in this database is based on national reports from the Member States, based on the relevant reporting obligations. A quantitative and qualitative assessment was conducted using data reported on: assessment regimes, attainment of environmental objectives and air quality plans and measures. This informed assessment of effectiveness and efficiency.

Table 4-1 Summary of data used for the quantitative assessment

Data inputs	**Source**
Minimum number of sampling points for fixed measurements	Annex V in 2008/50/EC [P98] Annex III in 2004/107/EC [P96]
Zone population and zone type	Data flow B - Downloaded from the EEA/Eionet e-Reporting database on 23/05/2018 [D38]
Exceedance attainment status (assessment thresholds)	Data flow C - Downloaded from the EEA/Eionet e-Reporting database on 23/05/2018 [D38]
Sampling points used in the assessment (fixed and indicative measurements)	Data flow C - Downloaded from the EEA/Eionet e-Reporting database on 23/05/2018 [D38]
Information on the assessment methods - for models and objective estimation	Data flow D1b deliveries – as identified on the Eionet Reportnet 01/10/2018 (reporting deadline 30/09/2018)
Information on the attainment of environmental objectives	Data flow G – Downloaded from the EEA/Eionet e-Reporting database on 28/11/2018 [D38]
Information on Air Quality Plans	Data flow H deliveries as identified on the Eionet Reportnet 01/10/2018
Information on measures	Data flow K Downloaded from the EEA/Eionet e-Reporting database on 03/11/2018 [D38]

Source: Authors

Data reliability and limitations: The tools to conduct the quantitative analysis were based on a reliable and quality assured data set, namely e-reporting data compiled by the EEA from Member State reporting. As such, the data provides a valuable snapshot of the situation based solely on Member State own reporting. Despite that, some limitations should be noted:

[2] https://www.eea.europa.eu/data-and-maps/data/aqereporting-8 [D38]. The database also includes information from non-EU countries that are member and cooperating countries of the EEA and EIONET.

- Data currently available in this form (i.e. aggregated and collated by the EEA) covers 2013 to 2017. Information is not available in the same format for earlier years, which would enable assessment of longer term trends in a comparable manner.
- Reporting format has changed over the evaluation period, due to Implementing Decision 2011/850/EU. This means that for some datasets the timeline may be interrupted (in particular, data flow D1b).
- Data submitted by Member States is updated on a regular basis and new submissions are added. The study noted this where possible after the analysis has been done. However, some submissions since the date of download of specific datasets may not be reflected.

It is to be noted that the study did not conduct a full compliance check based on this data. The data was used to gauge an overview of the status for the different elements of the fitness check. More detail of the approach and data used is available in Appendix E.

4.1.2 Efficiency analysis

Efficiency analysis considered information on the costs and benefits of measures introduced in response to the AAQ Directives. These fell into two categories, the first dealing with monitoring and reporting systems (direct costs) and the second with the measures designed to reduce emissions and exposure to air pollutants (indirect costs). Consideration is given to how impacts are distributed across stakeholders, including Member States, the public and the sectors that have needed to undertake action, and to the effects of the Directives on EU competitiveness.

A variety of data were used in the assessment, including review of the literature, data collection from stakeholders including Member States and information from the open public consultation. Original analysis (described in Appendix F, F1.7.1 and F.2.4) was undertaken for assessment of the health benefits of complying with the legislation and the social costs of poor implementation. Ex-post data gathered on the costs and benefits of actions that have been taken was preferred to ex-ante or theoretical forecasts.

Data reliability and limitations: There are a number of problems in characterising the efficiency of the AAQ Directives. First, there is limited data availability on the costs and benefits of actions that have been undertaken to comply with the AAQ Directives, particularly with respect to ex-post information. Second, many estimates of cost and benefit are incomplete. Third, the effects of the AAQ Directives are part of a much larger body of legislation on air quality and environment more generally. This includes the Industrial Emissions Directive (Directive 2010/75/EU), Directives on vehicle emissions and fuel quality, the Climate and Energy Package and the Circular Economy Package. There are then transport measures that have some air quality benefit but are instigated primarily to address other purposes, e.g. for improved mobility or reduced congestion. The prime driver for many measures reported as being undertaken in response to the AAQ Directives frequently lies with other legislation. A further complication is that many of the actions undertaken to improve air quality have additional co-benefits, reducing emissions of greenhouse gases, congestion and so on (there are occasionally also trade-offs, but these are less significant). Assessment has thus needed to consider these issues when coming to conclusions on efficiency.

4.1.3 Literature review

The aim of the literature review was threefold, i.e. (i) to gain a deep understanding of the AAQ Directives, (ii) to establish the baseline and the implementation state of play and (iii) to collect secondary data on the main evaluation questions.

The support study for the fitness check relied on an extensive literature review of relevant reports and studies, academic literature, position papers published by experts, stakeholder opinions, legislation at Member State level and other relevant literature. The approach towards the literature review has been done in a systematic manner with the use of a comprehensive reference database in an Excel sheet with ID numbers. The ID numbers have been used throughout the report when referencing specific sources. The comprehensive list of literature reviewed for the purpose of this support study is presented in Appendix C of the report.

Data reliability and limitations: An extensive body of literature has been published on the topic of air quality and AAQ Directives treating to some extent the evaluation questions. The data reliability is high as the studies and reports used were peer reviewed. However, analysis made it clear that certain evaluation questions were treated more in-depth than others in the previously written literature. For example, evidence regarding the efficiency of the AAQ Directives has been particularly difficult to find in the literature whereas evidence to support the analysis of the relevance questions was more readily available. Furthermore, another limitation was related to the fact that analyses related to the situation prior to the AAQ Directives in the Member States were limited, and thus data gaps in terms of setting the baseline and making an exhaustive mapping of the situation ex-ante exist.

4.1.4 Analysis of legal documents

As a basis for the assessment of relevance and coherence in particular, the study included an analysis of legal provisions of the AAQ Directives provisions as well as the relation between the AAQ Directives and other policies or legislation at EU (and national level). An analysis has been carried out to assess whether there are any instances of redundancy / irrelevance of the provisions of the AAQ Directives (for relevance), and comparative analysis has been carried out to ascertain whether there are any instances of coherence, incoherence and gaps between obligations arising from the relevant AAQ Directives and other EU level legislation or policies.

Furthermore, the study encompassed an analysis of case law at EU and national level in relation to the AAQ Directives, as well as infringement procedures by the European Commission for non-compliance with the requirements of the AAQ Directives.

Data reliability and limitations: The reliability of the data and analysis is high given that it relies primarily on EU legislation, including the AAQ Directives, case law, infringement cases as well as secondary literature (e.g. reports or academic literature) analysing these aspects.

4.1.5 Consultation

The consultation processes involved several data collection activities, namely: (a) a targeted consultation, (b) an open public consultation, (c) seven case studies, (d) two workshops and the participation in three ambient air quality expert groups. These are further elaborated below. A more detailed account of the approach to the consultation of key stakeholders and results from the consultation process are presented in the Consultation Synopsis Report (Appendix B).

Targeted consultation

A targeted questionnaire was sent to some 160 representatives of public institutions at national, regional and local level; some 100 representatives of NGOs at national and EU level; some 80 representatives of industry and trade at national (including national chambers of commerce) and EU level; and some 90 research institutes or universities in EU Member States and some 90 research institutes or universities in Member States covering environmental, health and industry sectors. The associations at EU level were selected in order to ensure a multiplier effect. The initial deadline for responses was 24 July 2018, which was then extended to 15 September 2018.

In total, 43 responses were received. Of these, two organisations submitted position papers in lieu of completing the questionnaire and one provided feedback in email form. A number of respondents provided documents in addition to completed questionnaires. Respondents included 16 national authorities and five local or regional authorities (or associations of local governments) in Member States, ten NGOs, six educational or scientific organisations, five industry associations and one local authority employee responding in an individual capacity.

Data reliability and limitations: A key limitation of the questionnaire is the quality of the data received which varied across submissions. Some questionnaires submissions contained well substantiated argumentation and answers to all questions, whereas others only briefly noted the position of stakeholders with little or no elaboration of the rationales behind.

Open public consultation

A public stakeholder consultation was conducted online via a survey in the period 8 May 2018 to 31 June 2018 and targeted all interested parties, including citizens, companies, organisations, public authorities, etc.

The survey was structured in two parts. The first part concerned background information about the respondent and general questions on views and concerns of air quality, awareness of the Directives, and effects of EU policy and legislation on air quality. The second part consisted of specific related to the effectiveness, relevance, efficiency, coherence and EU added value of the AAQ Directives. Participants could provide additional statements by uploading submission papers at the end of the survey.

This open public consultation generated a total of 489 responses. The majority (51%, 248 responses) of respondents replied as individuals, followed by representatives in the Public Administration and Defence sector (64 responses, 40%) and Professions, Scientific and Technical Activities (33 responses, 14%). In addition, there were 29 responses (12%) representing Other Service Activities, which includes activities of professional membership organisations, trade unions, lobbyists and support groups, environmental and ecological groups, etc., with specific interests in issues related to air quality. Respondents came from 27 of the 28 EU Member States with the largest share from Belgium (21%), Germany (17%) and Italy (15%). The larger share of respondents from Belgium can be explained by a presence of EU-level and industry/civil society entities with headquarters in Brussels, Belgium. Furthermore, the large number of responses from Germany and Italy could be due to a prominence of specific types of industries directly or indirectly impacted by measures to improve air quality (e.g. energy production and supply). In addition to the responses on the consultation platform, seven stakeholders (three industry stakeholders, two local or regional authorities, two NGOs, one port authority, and one partnership of government authorities) submitted position papers by email during the consultation.

Data reliability and limitations: A key limitation in relation to open public consultations is that, while such consultations invite responses from a broad range of stakeholders, including private citizens, they cannot be taken to be representative of the general population. This is because respondents are self-selecting and may not be unbiased. Therefore, care has been taken to ensure that results from the open public consultation are not presented as representing the population at large.

Case studies

The study encompassed seven case studies covering different Member States, namely:

- Bulgaria (with a focus on Plovdiv agglomeration)
- Germany (Berlin agglomeration)

- Ireland (public information provision)
- Italy (Sicily region)
- Slovakia (Kosice region)
- Spain (Madrid)
- Sweden (environment and ecosystem impacts).

The case studies investigated more in depth several essential dimensions which fed into the analysis of this report, in particular:

- Levels of compliance with the requirements of the AAQ Directives, including improvements (or lack thereof) in terms of pollutant concentrations and/or exceedances;
- Governance systems for air quality including for air quality monitoring and assessment, as well as any issues or good practices related to implementation of air quality monitoring requirements and coordination between relevant authorities;
- Implementation successes and implementation challenges in terms of enforcing the provisions of the AAQ Directives in the Member States;
- Factors underlying or hindering the compliance with the AAQ Directives at national level;
- Costs of implementation and non-implementation of the AAQ Directives and benefits;
- Assessments of the effectiveness, efficiency, relevance, coherence and EU added value of the AAQ Directives in the Member States.

The case studies generated in-depth knowledge concerning the implementation of the AAQ Directives in the seven Member States. The case studies relied on: extensive desk research[3] and interviews with relevant authorities.

Data reliability and limitations: While the case studies provide in-depth examples of the implementation of the AAQ Directives in Member States, they are not a sufficient basis for generalisation to all EU Member States. Thus, the evidence from the case studies has been used in particular for the purpose of exemplification, whereas analysis of trends and patterns across Member States uses more comprehensive datasets, e.g. EEA dataset.

The case studies focus on gathering information ex-ante and ex-post the implementation of the AAQ Directives. Given the lack of a comprehensive review of the situation prior and after the AAQ Directives in the Member States, some data gaps still remain, which are highlighted throughout the report. In the analysis performed in the present report, the data from the case studies was further complemented with data from desk research and data from consultation activities.

Workshops and expert groups

The study also included several interactions in meetings and workshops with experts in the field of air quality as well as other key stakeholders. This included two stakeholder workshops and the participation to four Ambient Air Quality Expert Groups throughout the project:

- Stakeholder Workshop (1) on 18 June 2018
- Stakeholder Workshop (2) on 15 January 2019
- Ambient Air Quality Expert Group (1) on 29 and 30 January 2018

[3] Including amongst others the EUROSAI Joint Report on Air Quality, the Court of Auditors Special Report on Air Pollution: Our health is still insufficiently protected, EEA Report on Europe's Urban Air Quality.

- Ambient Air Quality Expert Group (2) on 11 and 12 March 2019
- Ambient Air Quality Expert Group (3) on 5 July 2018
- Ambient Air Quality Expert Group (4) on 11 March 2019.

4.2 Key terminology

The AAQ Directives make use of key terminology which for the purpose of this support study to the fitness check is important to define prior to presenting the results. Some key terms used throughout the report are:

- "Assessment" is understood as defined in Article 2 of Directive 2008/50/EC, i.e. "any method used to measure, calculate, predict or estimate levels". Meanwhile "common methods" are understood to be any methods that define criteria on how to measure, calculate, predict or estimate levels of pollutants in the ambient air.
- "Monitoring" is not directly defined in the Directives. The context in which "monitoring" is used in the Directives in some cases links to measurement of pollutant concentrations, e.g. referring to "monitoring sites". However, in the definition of subject matter Article 1(3), "monitoring" is used in the context of observing long-term trends. As such, for this report, "monitoring" is used to describe observing trends, while "measurement" is used to denote the sites/stations or sampling points where pollutant concentrations are measured, as well as the activity of assessing air quality via such measurements. However, where literature or stakeholders have referred to "monitoring" in the context of "monitoring network", i.e. the physical network of measurement stations or sampling points, or similar context, the original wording is retained.
- "Reporting" is referred to in Article 26 and 27 of Directive 2008/50/EC in relation to public information. The Member States have the obligation to make available public annual reports for all pollutants covered by the Directive. Furthermore, Member States are responsible for ensuring that the information on ambient air quality is made available to the European population.

5 IMPLEMENTATION STATE OF PLAY

The implementation of the AAQ Directives has now been undergoing for more than 11 years (Directive 2008/50/EC) respectively 15 years (Directive 2004/107/EC) and the results of the main provisions have had sufficient time to materialise. This chapter takes stock of the implementation state of play so far focussing on the key dimensions of the AAQ Directives related to the implementation of monitoring and assessment requirements, to the implementation of air quality standards, to the provision of reporting and public information, and the provision of air quality plans. The chapter is complemented by the assessments made in the findings chapter (in particular effectiveness) which focus more in-depth on the effects of the AAQ Directives provisions.

5.1 Monitoring and assessment

Since 2008 onwards, Member States were required to perform monitoring and assessment of air quality in line with the requirements of the AAQ Directives. To assist the Member States, further to the requirements set in the Directives, the European Commission with support from thematic experts produced an extensive body of guidance to support Member States in monitoring and assessment. Furthermore, the European Commission supported the set-up of networks to assist Member States and relevant authorities in performing monitoring and assessment in line with the requirements of the AAQ Directives. An overview of EU level guidance is presented below. Complementary to this, some Member States have further produced their own guidance to ensure the adequate implementation of the requirements to monitor and assess air quality.

Table 5-1 Guidance on monitoring and assessment

Overview of guidance
European Commission Guidance • Guide to the Demonstration of Equivalence of Ambient Air Monitoring Methods. Report by an EC Working Group on Guidance for the Demonstration of Equivalence, January 2010. • Guidance on air quality assessment around point sources under the EU Air Quality Directives 2008/50/EC, 2010. • Commission Staff Working Paper establishing guidelines for the agreements on setting up common measuring stations for $PM_{2.5}$ under Directive 2008/50/EC on ambient air quality and cleaner air for Europe. • Commission Staff Working Paper establishing guidelines for demonstration and subtraction of exceedances attributable to natural sources under the Directive 2008/50/EC on ambient air quality and cleaner air for Europe. • Commission Staff Working Paper establishing guidelines for determination of contributions from the re-suspension of particulates following winter sanding or salting of roads under the Directive 2008/50/EC on ambient air quality and cleaner air for Europe. • Guidance on the Commission Implementing Decision laying down rules for Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council as regards the reciprocal exchange of information and reporting on ambient air (Decision 2011/850/EU), Version of 15 July 2013 (IPR Guidance 1). • IPR Guidance ver. 2.0.1 - Member States' and European Commission's Common Understanding of the Commission Implementing Decision laying down rules for Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council as regards the reciprocal exchange of information and reporting on ambient air (Decision 2011/850/EU), 15 March 2018.
European Environment Agency Guidance • Guidance report on preliminary assessment under EC air quality directives. EEA Technical report No 11, May 1998.

Overview of guidance

- Reporting and exchanging air quality information using e-Reporting (No. EEA Technical report No 5/2012).

Joint Research Centre Guidance

- European Guide on with Receptor Models Air Pollution Source Apportionment with Receptor Models.
- A quality assurance and control program for $PM_{2.5}$ and PM_{10} measurements in European air quality monitoring networks, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES).

AQUILA[4]

- Guidance published on the AQUILA webpage: https://ec.europa.eu/jrc/en/aquila
- JRC-AQUILA Position Paper - Assessment on siting criteria, classification and representativeness of air quality monitoring stations, JRC, & AQUILA, 2013.

FAIRMODE[5]

- Guidance published on the FAIRMODE webpage: https://fairmode.jrc.ec.europa.eu/
- Guidance Document on Modelling Quality Objectives and Benchmarking, version 2.1. February 2017.

Source: Authors

As further elaborated under the effectiveness section, overall Member States have performed monitoring in line with the requirements of the AAQ Directives, although there are some instances in which monitoring and assessment should be improved (as evidenced by the infringement cases against Romania and Slovakia). Most zones in the Member States have the minimum number of sampling points required by the AAQ Directives. Compliance has in general increased for the different air pollution types since the start of the implementation of the AAQ Directives.

5.2 Air quality standards

The enforcement of the AAQ Directives standards led to a harmonised approach in tackling pollutant concentrations across Member States. Despite some progress having been made towards meeting the air quality standards established in the two AAQ Directives and the long-term objectives of achieving levels of air pollutions that do not affect human health, there are still instances of exceedances of air quality standards and high exposure of urban population to air pollution above the standards established by the AAQ Directives.

Zones with exceedances and population exposure

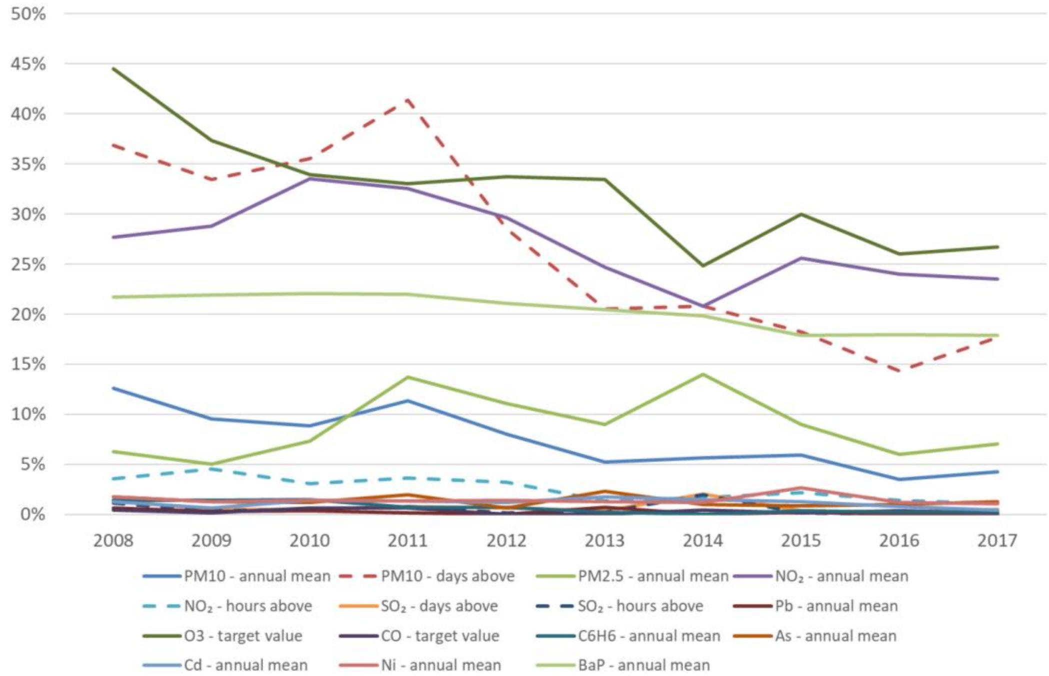
Overall, the number of *zones reporting exceedances of the target/limit values* provided has decreased over the period 2008 to 2017, The below figure shows that the decreases in the share of zones with exceedances for many of the pollutants have been fluctuating. For example, the slight decrease for NO_2 (annual mean) is a result of increases in the early years of the given time period and decreases – particularly between 2011 and 2014. Similarly, for PM_{10} (days above) the share of zones with exceedances rose between 2008 and 2011 – and decreased from that time only.

[4] AQUILA is the National Air Quality Reference Laboratories that are legally responsible for the quality assurance of air pollutant measurements in their respective Member States, which implies the organisation of national quality assurance and quality control (QA/QC) programmes and the participation in European QA/QC programmes. The Directive 2008/50/EC, Article 3 and Annex I, Section C provides for the national reference laboratory's responsibilities.

[5] FAIRMODE is the Forum for Air Quality Modelling which brings together air quality modellers and users in order to promote and support the harmonised use of modelling practices for the assessment of air quality by EU Member States.

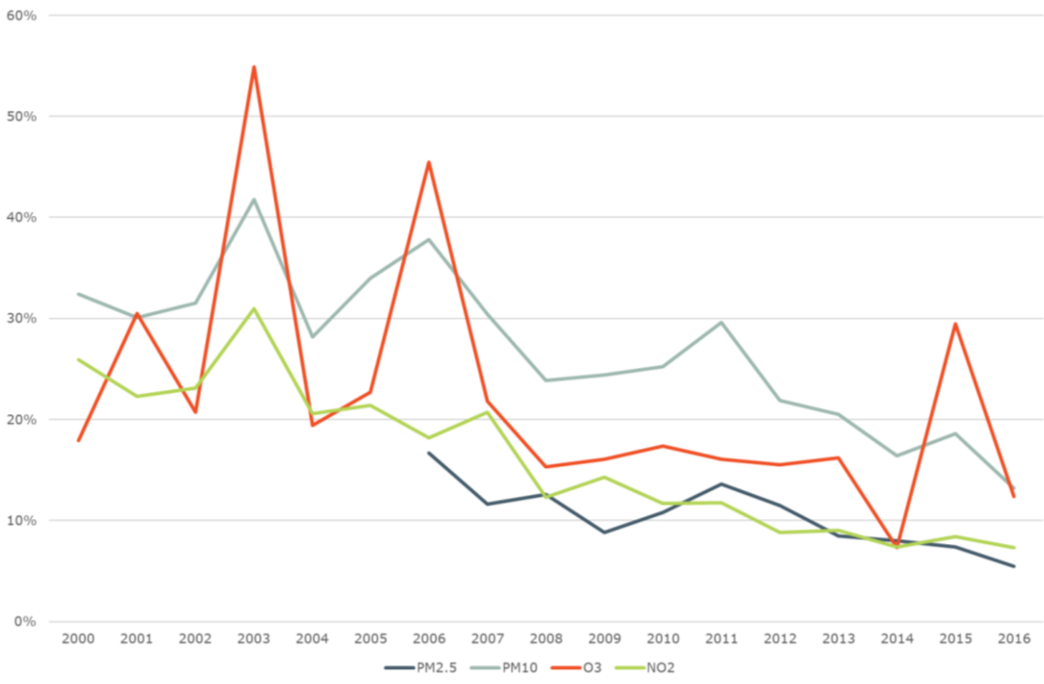
For the two other pollutants with relatively high shares of zones with exceedances, O_3 and BaP, the decreases between 2008 and 2017 have been smoother.

Figure 5-1 Share of zones in EU reporting exceedances above EU target/limit values, 2008-2017



Sources: 2008-2012: Annual ETC Technical Papers – Reporting on ambient air quality assessment, 2013-2017: COWI, based on data flow G

Figure 5-2 Share of EU urban population exposed to selected air pollution concentration above target/limit values, 2000-2016



Source: EEA, Exceedances of air quality standards in urban areas

Furthermore, air quality continues to remain an issue as evidenced by the share of urban population exposed to air pollutant concentrations above the target/limit values. The figure above depicts the trends in terms of exposure of EU urban population to concentrations above standards and illustrates a declining trend of the share of EU urban population exposed to $PM_{2.5}$, PM_{10}, O_3 and NO_2.

Time extensions

The Directive 2008/50/EC recognised the difficulties that Member States had in achieving compliance with the limit values for PM_{10}, NO_2 and C_6H_6 and included provisions that allowed for extensions of the deadline for achieving compliance under certain conditions. Based on Article 22 of the Directive Member States had the option to notify the European Commission and request for a time-extension of the attainment deadline. The Commission published guidance to the Member States on the information to be provided and the scope of the conditions and subsequently published a Staff Working Paper SEC(2011) 300 providing further guidelines for the notification of postponements of the deadline to apply the NO_2 limit values.

As evidenced by the notifications for time extension submitted by the Member States, the majority of Member States[6] notified the European Commission of cases where they assessed that the conditions were met in a given zone or agglomeration requiring the postponement of the attainment deadline for the limit values for NO_2 and Benzene or for a time-limited exemption from applying the limit values for PM_{10}. Member States applied for more than a third of the zones for a time-limited exemption to apply the limit values of PM_{10}, and requested a postponement of the attainment deadline for the limit values of NO_2 for almost a quarter of the zones where NO_2 is monitored. No notification for time extension was received from the Member States for Benzene.

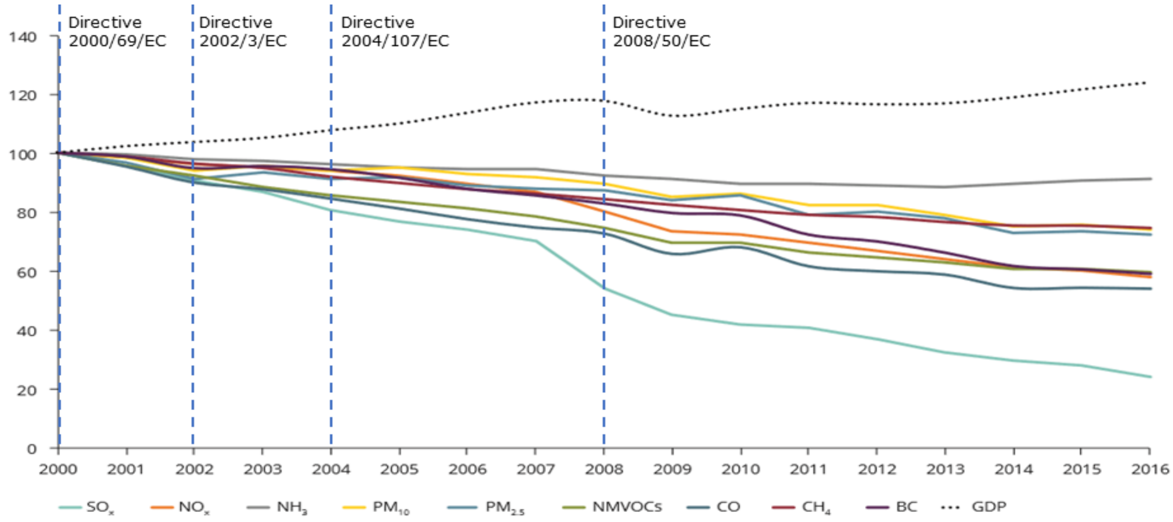
Air pollutant emissions

Trends over time show that emissions of all primary and precursor pollutants contributing to ambient air concentrations of PM, O_3 and NO_2, as well as As, Cd, Ni, Pb, Hg and BaP, decreased between 2000 and 2016. Substantive reductions have been reported in relation to SO_2 (76%) while NH_3 emissions have exhibited the smallest reductions (9%) (Figure 5-3 and Figure 5-4). Ammonia is a precursor of PM and is seen to contribute to episodes of high PM concentrations experienced across regions in Europe leading to a breach of the PM limit values [R53, P91]. Reductions in overall emissions have been achieved in spite of an increase in EU-28 GDP which is a clear sign of a significant decoupling from economic activity [R61].

The main sectors contributing to air to emissions of air pollutants in Europe, as per the most recent EEA report, are transport (road and non-road), the commercial, institutional and households sector, energy production and distribution, energy use in industry, industrial processes and product use, agriculture and waste.

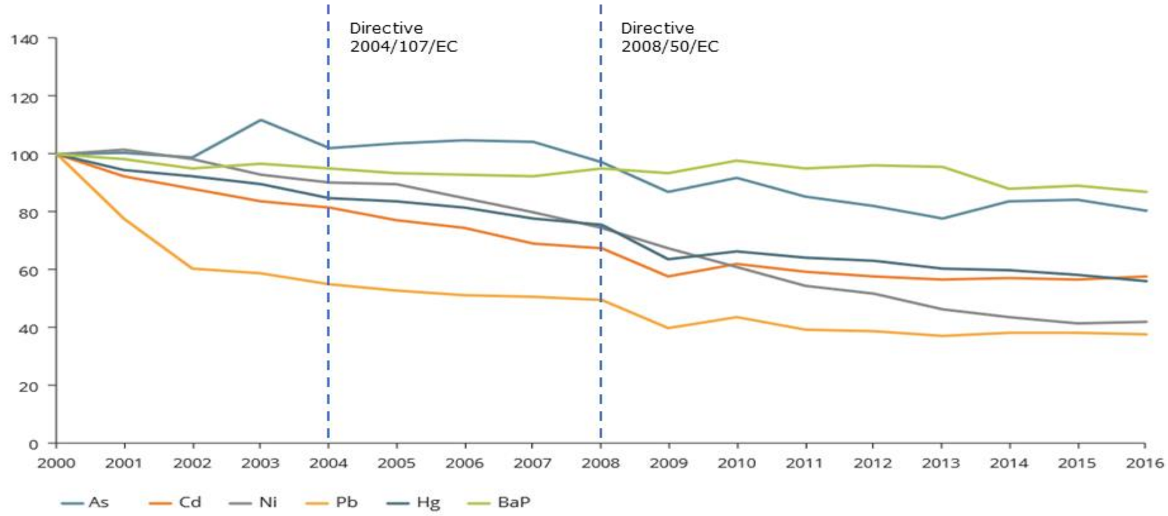
[6] Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, United Kingdom.

Figure 5-3 Emissions in EU by air pollutant, 2000-2016 (index 2000 = 100)



Source: EEA Air Quality in Europe 2018 Report

Figure 5-4 Emissions in EU by air pollutant, 2000-2016 (index 2000 = 100)



Source: EEA Air Quality in Europe 2018 Report

Harmful effect of air quality pollution

According to the World Health Organisation (WHO), air pollution continues to be the biggest environmental risk to human health in the European Union, causing premature deaths and with people living in urban areas particularly exposed [R189]. WHO identifies Particulate Matters (PM), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and ground-level ozone (O_3) as the air pollutants most harmful to human health [R191], e.g. causing heart disease and stroke, lung disease and lung cancer, respiratory disease, cardiovascular disease, liver and blood disease.

The European Environment Agency (EEA) has estimated in the 2018 Air Quality Report that, in 2015, 391,000 premature deaths are attributable to fine particulate matter ($PM_{2.5}$), 76,000 to NO_2 and 16,400 to O_3, warning that long-term exposure to air pollution poses a threat to human health [R61]. The economic costs of air pollution are estimates at well over EUR 20 billion in direct costs a year, and between EUR 330 to 940 billion per year in indirect costs [R87].

Infringements of air quality standards

Since 2008 until present, the European Commission has taken legal action against Member States to address the significant and persistent exceedances of air quality standards. Since 2008, the European Commission had infringement cases concerning PM_{10} against 22 Member States,[7] concerning NO_2 against 14 Member States[8], and concerning SO_2 against 10 Member States[9].

Initially, the European Commission focussed on infringements in relation to PM_{10} for which the compliance deadline was 2005, and NO_2 which the compliance deadline was 2010. Recently, the European Commission has stepped up its enforcement against Member States in particular for significant and persistent exceedances of limit values for nitrogen dioxide and particulate matters [D78]. In 2018, the Commission has thus referred France, Germany and the United Kingdom to the ECJ for failure to respect limit values for NO_2 and for failing to take appropriate measures to keep exceedance periods as short as possible as required by the case law of the ECJ. Hungary, Italy and Romania have been referred to ECJ over persistently high levels of $PM_{10.}$ The Member States had not presented credible and timely measures to reduce air pollution within the agreed time limits and as soon as possible as required by the legislation.

Some of the opened Court cases have already been closed. Most recently, the Court of Justice upheld the obligations emerging from the Directive 2008/50/EC in cases where Member States failed to fulfil its provisions. In the ECJ ruling of 5 April 2017 (C-488/15 European Commission v. Bulgaria), the Court found that Bulgaria failed to fulfil its obligations under the Directive 2008/50/EC related to keeping air pollution below the limits and its obligation to keep the period during which pollution levels exceed mandated norms as short as possible. The Court concluded that Bulgaria showed persistent non-compliance with the annual and/or daily limit values for PM_{10} in all of zones and agglomerations except for one.

In the ECJ ruling of 22 February 2018 (C-336/16, European Commission v. Poland) the Court found that Poland had regularly and persistently exceeded the daily limit values for PM_{10} concentrations in 35 zones, and also exceeded the annual limit values for such concentrations in 9 zones. Further, the Court stated that air quality plans must be adopted with due consideration to balancing the aim of minimising the risk of pollution and the various public and private interests. The obligation to establish air quality plans had been binding on Poland since 11 June 2010 but the country had adopted plans setting a deadline for putting an end to exceedances to 2020-2024 and indicating socio-economic difficulties and financial challenges. The Court concluded that while such factors may be taken into account, the deadlines imposed by Poland were not justified. Finally, the ECJ also said no appropriate measures had been adopted to ensure that the exceedance period of PM_{10} limit values was kept as short as possible, thus the second subparagraph of Article 23 (1) of the directive was not correctly implemented.

5.3 Reporting and public information

The AAQ Directives revised the provisions on reporting and dissemination of public information enabling the establishment of improved reporting systems. The EEA launched an upgraded air quality database (Air Quality e-Reporting) which follows the rules for reciprocal exchange of information and reporting on ambient air quality for Directive 2004/107/EC and Directive

[7] Active cases: Bulgaria; Hungary; Italy; Poland; Romania; Czech Republic; France; Germany; Greece; Latvia; Portugal; Slovakia; Spain; Sweden; Slovenia and Closed cases: Austria; Belgium; Cyprus; Denmark; Estonia; Malta; United Kingdom.

[8] Active cases: France; Germany; United Kingdom; Italy; Spain; Austria; Belgium; Czech Republic; Denmark; Hungary; Portugal; Poland, Luxembourg, Greece.

[9] Active cases: Bulgaria, Closed cases: France; Spain; Italy; Slovenia; United Kingdom; Czech Republic; Poland; Portugal; Romania.

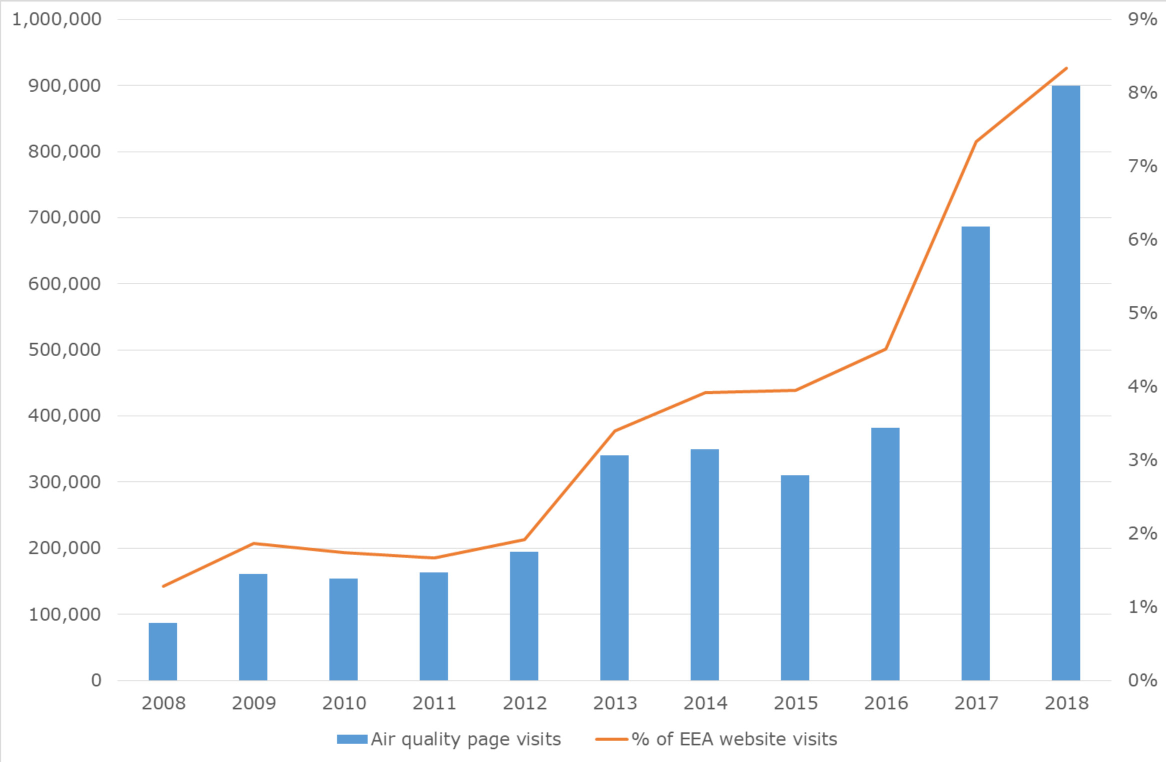
2008/50/EC and the rules set out in the Commission Implementing Decision 2011/850/EU and the Commission's guidance documents IPR Guidance Part I [D138] and IPR Guidance Part II [D139]. The Air Quality e-Reporting database contains current / live data on the status of air quality collected from the Member States.

Member States constantly send up-to-date air quality data to the EEA, for use in EEA's on-line information services and European Air Quality Index. Member States send validated data to the Commission once a year. Based on the Member State data, on an annual basis, the EEA provides air quality data, statistics and maps showing exceedances of thresholds in support of the AAQ Directives and Implementing Decision 2011/850/EU. Also, on a continuous basis, the EEA provides near-real-time air quality data in support of Implementing Decision 2011/850/EU. Member States are required to prepare Air Quality Plans when the validated data shows exceedances of the given limits. Reporting and data exchange obligations include monitoring data, information about zones, stations and assessment methods, the results of assessments, information about alerts, contributions from natural sources, road sanding and salting, air quality plans and measures and their implementation, and source apportionment. Most of these data are submitted through EEA's EIONET Reporting Obligation Database [D51] and e-Reporting [D42] data services. Member States shall also make this information available to the public.

Besides the periodic reporting by Member States, the Commission also have to rely on many other sources to identify and assess the level of compliance assurance in practice in the Member States. This include, but is not limited to, Member State reporting on the implementation of the AAQ Directives, specific air quality plans, country specific analyses through the Environmental Implementation Review (EIR) process and targeted EIR dialogues, Ambient Air Quality Expert Group meetings and package meetings and clean air summits in dialogue with Member States when the Commission considers actual infringement steps.

When it comes to the dissemination of information to the public, EEA website traffic monitoring data show (see Figure 5-5) shows that the number of visits to the EEA air quality website pages has increased substantively since 2008. This trend could be explained by the new and better digital data communication solutions and increased amount of data available but also by an increased interest of the public in the issues.

Figure 5-5 Visits to EEA air quality website pages, 2008-2018



Source: Data provided by the EEA on 9 May 2019.

5.4 Air quality plans

Under the AAQ Directives, Member States have to draft and implement air quality plans in areas where the limit and target values are exceeded. Given that Member States have recorded various exceedances in particular of the limit and target values for PM_{10} and NO_2, abatement measures had to be set in place and reported. As further presented in section 6.2, Member States that have reported exceedances generally have prepared and reported air quality plans as required by the Directive. Given that transport is a main source for exceedances, the majority of measures implemented by the Member States address this sector and include traffic-related measures to encourage less polluting types of transport and sustainable transport.

6 FINDINGS

The present chapter contains the findings of the support study for the fitness check of the AAQ Directives.

6.1 Relevance

The *relevance* criterion concerns the extent to which the objectives of the AAQ Directives are still relevant and whether the requirements of the legislation are still necessary and appropriate. This is assessed through one evaluation question.

Table 6-1 Evaluation questions and judgement criteria for Relevance

Evaluation questions and judgement criteria on Relevance
EQ 1: How relevant are the goals and objectives of the AAQ Directives to the needs of citizens; do the AAQ Directives still address the most relevant pollutants and set relevant standards and obligations to protect human health and the environment; are the AAQ Directives sufficiently adapted or adaptable to evolving technical and scientific progress, and which elements have become redundant in the light of key EU air quality priorities? • JC 1.1: The extent to which goals and objectives of the AAQ Directives correspond to the citizens' needs. • JC 1.2: The extent to which pollutants covered by the Directives remain relevant in the light of new scientific evidence regarding health and environmental impacts of air pollution and whether there is evidence of other pollutants, currently not addressed by the Directives, having significant adverse effects on health and/or environment. • JC 1.3: The extent to which standards and obligations for the pollutants currently covered are suitable to protecting the citizens from harmful effects of air pollution • JC 1.4: The extent to which standards, assessment methods and obligations have kept up with advances in technical and scientific progress. • JC 1.5: The extent to which elements of the Directives have become redundant in light of key EU air quality priorities.

6.1.1 Evaluation Question 1: Goals and objectives, pollutants and standards, adaptability

Question 1 sought to address the extent to which the AAQ Directives still set appropriate goals and objectives, address the most pressing air pollutants, and set meaningful air quality standards to protect human health and ecosystems in accordance with evolving scientific evidence. The question also assessed whether there is evidence of other pollutants having significant adverse effects on health and/or environment that are not currently addressed by the Directives. In addition, Question 1 assessed the extent to which the AAQ Directives are sufficiently adapted/adaptable to technical and scientific progress*, and which elements have become redundant* in the light of key EU air quality priorities.

Text box 6-1 Key findings on Relevance

The analysis shows that air quality is a major health and environmental concern for EU citizens. Despite improvements over the last decade, a substantial share of the EU population continues to be exposed to air pollution at levels deemed unhealthy by scientific standards, especially in cities. Stakeholders generally find that the AAQ Directives still address the current needs of the citizens across the EU.

Scientific evidence has grown on the harmful effects of the pollutants currently regulated by the AAQ Directives. In contrast, no evidence that any of the pollutants covered have only a limited adverse effect on human health/environment has been identified. Furthermore, there is a growing body of scientific research which indicates without being conclusive that there may be additional harmful effects, including caused by pollutants that are not currently regulated by the AAQ Directives, such as black carbon, ultrafine particles and ammonia. There is also further evidence of environmental implications of ammonia due to its important role in ecosystems and the global nitrogen cycle, as well as its contribution to secondary particle formation.

The AAQ Directives have stimulated Member State action on air quality and they still represent a key tool to improve air quality. However, a review of recent research indicates that the standards laid down by the AAQ Directives are not fully reflective of the recent and robust scientific evidence suggesting serious adverse health effects at lower concentration levels, including $PM_{2.5}$, PM_{10} and SO_2. The AAQ Directives do not set short-term standards for $PM_{2.5}$, to protect against peaks of pollution that would otherwise lead to substantial excess morbidity or mortality.

The AAQ Directives provide a degree of flexibility in relation to amending non-essential elements of the Directives and this opportunity has been used to account for the experience gained in implementing the Directives and the most recent standards for the sampling and measurement of different pollutants. Furthermore, the AAQ Directives envisaged a review of some of their essential elements as well, in 2013 for Directive 2008/50/EC and by the end of 2010 for Directive 2004/107/EC, but this did not lead to modifications of those essential elements. Moreover, there are no specific mechanisms in the AAQ Directives laying down an obligation to carry out a periodic review of the AAQ Directives with a view of adapting them to the latest technical and scientific progress.

The review found three articles that deal with provisions that have expired and are thus redundant: Postponement of attainment deadlines up to five years, the 2013 review of $PM_{2.5}$ provisions, and the 2010 review of Directive 2004/107/EC.

6.1.1.1 Goals and objectives

Judgement criterion 1.1: The extent to which goals and objectives of the AAQ Directives correspond to the citizens' needs.

Assessment summary: Based on the evidence collected, it appears that the goals and objectives of the AAQ Directives still correspond to EU citizens' needs to a large extent.

Air quality needs and citizens perception of air quality

It is a basic need of EU citizens to be protected from adverse health impacts and damage to the environment from air pollution. This need is reflected in the Treaty on the Functioning of the European Union (TFEU) [P137] Article 191(1) states that objectives of Union environmental policy include *preserving, protecting and improving the quality of the environment,* and *protecting human health*. The fundamental right of a high level of human health protection and a high level of environmental protection as well as the improvement of the quality of the environment are laid down in the Charter of Fundamental Rights of the European Union. The European Court of Justice has in its rulings given rise to the principle of right to clean air in EU as well as the right to a plan, referring in a number of Court cases to that limit values confer certain rights on EU citizens as they are imposed specifically to protect human health and are thus enforceable before national courts.

The 2002 6th EAP [P93] Article 7(1) states the objective of *achieving levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment*, which is continued in the 2013 7th EAP [P106]. The 7th EAP does not specify the levels of air pollution to be achieved to avoid significant negative impacts on and risks to human health and the environment, but – as far as protection of human health is concerned – sets the general objective to move closer to the World Health Organisation (WHO) recommended levels [P106].[10]

An additional citizens' need is to receive timely and useful information and advice when levels of air pollution exceed or are predicted to exceed information or alert thresholds.

[10] The WHO global air quality guidelines are designed to offer guidance in reducing the health impacts of air pollution [P134]. As discussed under EQE1.3, the WHO guideline values are generally stricter compared to the standards that have been politically agreed at EU level.

Citizen perception of air quality

The importance of air quality to EU citizens is reflected by two Eurobarometer surveys [D83, D84] and this study's open public consultation and stakeholder surveys (for details see Text box 6-2 and Appendix D).

Air quality has improved in most areas in the EU over the last 10 years [R53, D3, R61], but many people have the perception that air quality has deteriorated over the past 10 years (56 % in 2013, 47 % in 2017). While the perception of deterioration is declining, the percentage perceiving deterioration in air quality remains over 50 % in seven Member States, mostly in the south. This may indicate that air quality information is not readily available or not clear to the public [P91].

The findings of the case studies confirm that from the citizens' perspective, all of the AAQ Directives objectives are relevant (see details in Appendix D). This corresponds well to the current situation in the EU-28 where all Member States have exceedances at least in one zone, and 11 out of 12 pollutants had exceedances in at least one Member State each (all pollutants except for Pb), indicating continued relevance of the pollutants in place.

Common methods to monitor and assess air quality

The AAQ Directives are essential to ensure common methods to monitor and assess air quality across the EU. Without the AAQ Directives, each Member State would be free to adopt different methods, which would make it difficult to compare the air quality status between Member States. Comparability of air quality monitoring has been key to ensure better public information, and to enable enforcement of the air quality standards.

The data collected from the case studies and the stakeholder consultation indicates that certain aspects of the AAQ Directives leave Member States some margin of discretion which hampers comparability (see case studies and Appendix D elaborating this aspect further). The use of air quality modelling techniques is highly variable, and less than half of the Member States report the results of modelling in their assessments (see Table 6-5 in section 6.2.1.1). There are also inconsistencies in the use of indicative measurements, and the selection of monitoring station types (traffic, background) to be installed to achieve the minimum number of sampling points in a zone or agglomeration.

Public information

The AAQ Directives provisions on public information are important and clearly defined, and Member States and the EEA have established extensive public information systems. As pointed out by the ECA [P91, no. 76-81] and stakeholders, the quality of public information services varies considerably, and information is sometimes unclear, and can be inconsistent across the EU. For example, EEA and Member States have established different air quality indices which vary considerably.

Air quality plans

The requirement to prepare air quality plans when limit or target values are exceeded is one of the most fundamental provisions of the AAQ Directives. As pointed out by the ECA [P91, no. 37-47] the continuing, although decreasing, high levels of air pollution shows that air quality plans have not been sufficient to ensure compliance with limit and target values as soon as possible. Articles 13 and 23 set a clear obligation for competent authorities to take action to achieve compliance “as soon as possible”. This obligation of result has been key for actions to improve air quality in the EU, including enforcement and legal actions initiated by individuals, NGOs and the Commission.

The ECA also notes that the AAQ Directives do not require Member States to report on the implementation of air quality plans, or to update them when new measures are adopted or when progress is insufficient – only to update plans at the end of the plan's period [P91, no. 43, R56]. This makes it difficult for the public and the Commission to verify compliance with the air quality plan provisions of the AAQ Directives.

Transboundary air pollution

Transboundary air pollution is addressed in the AAQ Directives, NEC Directive (Directive 2016/2284/EU) and the CLRTAP Gothenburg Protocol, reflecting the relevance of this aspect of air quality. Article 25 of the 2008 Directive provides a mechanism for joint cooperation between Member States on joint or coordinated air quality plans in case of transboundary air pollution. Article 25 (2) provides an option of inviting the Commission to present and assist in such cooperation. The use of this mechanism was invoked for a series of dialogue meetings between Poland and Czech Republic, thus only once since the introduction of the 2008 Directive. An operational mechanism targeted to the requirements of the AAQ Directives are still found to be lacking by a number of Member States facing intra-EU transboundary air pollution, even though it is also argued that the biggest challenge on transboundary air pollution is faced with non-EU member countries on EU external border areas. However as also addressed in the effectiveness chapter, despite the relevance of the provision in terms of the need for addressing transboundary issues in joint Air Quality Plans, the provision cannot be considered effective or serving its purpose when it is never brought into use.

6.1.1.2 Pollutants

Judgement criterion 1.2: The extent to which pollutants covered by the Directives remain relevant in the light of new scientific evidence regarding health and environmental impacts of air pollution and whether there is evidence of other pollutants, currently not addressed by the Directives, having significant adverse effects on health and/or environment.

Assessment summary: Scientific evidence has grown on the harmful effects of the pollutants currently regulated by the AAQ Directives. In contrast, no evidence that any of the pollutants covered have only a limited adverse effect on human health/environment has been identified. Furthermore, there is a growing body of scientific research which indicates without being conclusive that there may be additional harmful effects, including caused by pollutants that are not currently regulated by the AAQ Directives, such as black carbon, ultrafine particles and ammonia. In terms of negative impacts on biodiversity and ecosystems, there is evidence of environmental implications of ammonia due to its important role in ecosystem and global nitrogen cycle, as well as contribution to secondary particle formation.

The health relevance of the pollutants and standards of the original air policy was thoroughly reviewed and confirmed in the 2013 clean air policy review [R183, R184]. As compared with 2005, there was additional evidence on the chronic impacts of ozone and NO_2. This reinforced the rationale for the respective standards [P38].

Europe's most serious pollutants concerning effects on human health are currently PM, NO_2 and ground-level O_3 [R53, R61]. At the time of Directive 1999/30/EC, the first Daughter Directive, SO_2 and lead were also serious pollutants, but effective emission reductions have greatly reduced the concentrations and associated risks of these pollutants. The most harmful air pollutants in terms of damage to ecosystems are ozone (O_3), ammonia (NH_3) and nitrogen oxides (NO_x) [R53]. NO_x, SO_2 and NH_3 contribute to the acidification of soil, lakes and rivers, causing the loss of animal and plant life and biodiversity. Apart from causing acidification, NH_3 and NO_x emissions also disrupt land and water ecosystems by introducing excessive amounts of nutrient nitrogen [R53].

Section B of Annex XV in Directive 2008/50/EC presents a list of supplementary information on air pollution abatement measures at appropriate local, regional or national level to be provided as supplement to the air quality plan, such as reduction of emissions from stationary sources, and reduction of emissions from vehicles through retrofitting with emission control equipment. The following table shows additional examples of potential abatement measures relevant for the elaboration of air quality plans (Article 23) and for submitting information according to article 22 of the Directive where limit values cannot be achieved (Article 22).

Table 6-2 Pollutants relevance, sources and examples of abatement measures of different pollutants

Pollutant	Relevance	Main sources	Examples of abatement measures
Sulphur dioxide (SO_2)	Exposure to SO_2 can affect the respiratory system and the function of the lungs. SO_2 can aggravate asthma and chronic bronchitis as well as increase the risk of infection. In addition, sulphur compounds have acidifying effects on soil and freshwater damaging plant and animal life.	• Energy production and distribution (51%) • Energy use in industry (20%) • Industrial processes and product (17%)	• Installation of de-SO_2 technologies on power generation and industry. • BAT requirements for industrial processes • Increasing the use of renewable energy in power generation. • Fuel switching from high-sulphur to low-sulphur fuels.
Nitrogen dioxide (NO_2)	NO_2 can increase symptoms of bronchitis and asthma, as well as lead to respiratory infections and reduced lung function and growth. Nitrogen oxides are ozone precursors and affect ecosystems by causing acidification and eutrophication.	• Road transport (39%)[11][12] • Energy production and distribution (17%) • Commercial, institutional and households (14%)	• Better on-road engine technologies (including retrofitting of vehicles). • Reliable and clean public transport • Shift to walking and cycling (in cities) • Urban vehicle access regulations and low emission zones • Installation of de-NO_2 technologies for industry and power generation.
Particulate matter ($PM_{2.5}$)	$PM_{2.5}$ is capable of penetrating deep into lung passageways and entering the bloodstream causing cardiovascular, cerebrovascular and respiratory impacts.	• Commercial, institutional and households (56%) • Road transport (11%) • Industrial processes and product (10%) • In addition, SO_2, NO_x, NH_3 (ammonia)[13] and VOCs for secondary $PM_{2.5}$ in the atmosphere	• Substitution of dirty stoves and boilers • Increase energy efficiency (of buildings) • City or district heating • Use of cleaner fuels • Use particle filters • Shift to walking and cycling (in cities) • Installation of pollution abatement equipment at industrial facilities. • Measures to reduce the precursor emissions of SO_2, NO_x or NH_3.

[11] The relative contribution of traffic at ground-level is much higher.

[12] Of the total emitted NO_x from traffic, around 80% comes from diesel powered.

[13] The main source for ammonia emission is agriculture (92%).

Pollutant	Relevance	Main sources	Examples of abatement measures
Particulate matter (PM_{10})	Health effects of PM_{10} include respiratory and cardiovascular morbidity, such as aggravation of asthma, cardiovascular and respiratory diseases and lung cancer.	• Commercial, institutional and households (39 %) • Industrial processes and product (19%) • Agriculture (15%)	• All above measures to reduce $PM_{2.5}$ • BAT requirements for industrial processes • Ban of open burning of agricultural residuals
Lead (Pb)	Lead can damage the nervous system, memory and responsiveness. Toxic metals like As, Cd, Ni and Pb also have severe impacts on ecosystems by causing problems to animals and plants through bioaccumulation.	• Energy use in industry (32%) • Industrial processes and product (29%) • Road transport (17%)	• Phasing out / ban the use of leaded petrol. • Shifting to zero and low-emissions vehicles. • Restricting or closing older and more polluting industrial facilities.
Carbon monoxide (CO)	CO can be harmful to humans by impairing the amount of oxygen transported in the bloodstream to critical organs.	• Commercial, institutional and households (48%) • Road transport (20%) • Energy use in industry (12%)	• Euro vehicle standards. • Increasing the use of renewable energy in power generation.
Benzene (C_6H_6)	Benzene is carcinogenic in humans (IARC group 1) and has been associated with a range of acute and long-term adverse health effects and diseases.	• Road transport • Energy use in industry	• Shifting to cleaner vehicles and low-emissions vehicles.
Ozone (O_3)	Exposure to O_3 concentrations can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases. O_3 also affects ecosystems by damaging crops, forests and other vegetation.	Sources of O_3 precursors NO_x, CO and VOCs include: • Road transport • Energy production and distribution	• Reducing energy consumption through energy efficiency measures. • Reducing NO_x and particle concentrations (indirect effects) • Measures to reduce the precursor emissions of NO_x, CO or VOCs.
Arsenic (As)	As is carcinogenic in humans (IARC group 1) and causes damage to the kidneys and negatively affects foetal development and the immune system.	• Energy use in industry (40%) • Industrial processes and product (25%) • Energy production and distribution (22%)	• Restricting or closing older and more polluting industrial facilities.
Cadmium (Cd)	Cd is carcinogenic in humans (IARC group 1) and causes damage to the kidneys.	• Energy use in industry (29%) • Industrial processes and product (29%) • Commercial, institutional and households (21%)	• Use of abatement technologies in metal refining and smelting facilities. • Restricting or closing older and more polluting industrial facilities.
Nickel (Ni)	Nickel compounds are carcinogenic (IARC group 1) and cause damage to the kidneys and affecting foetal development and the immune system.	• Energy production and distribution (37%) • Energy use in industry (17%) • Commercial, institutional and households (16%)	• Restrict or close older and more polluting industrial facilities.
Benzo[*a*]pyrene (BaP, $C_{20}H_{12}$)	BaP is carcinogenic in humans (IARC Group 1) and	• Industrial processes and product use (77%)	• BAT for industrial plants.

Pollutant	Relevance	Main sources	Examples of abatement measures
	is an indicator of the carcinogenic effect of the total polycyclic aromatic hydrocarbons (PAH).	• Commercial, institutional and households (especially wood burning) (16%) • Agriculture (6%) • Energy production and distribution (1%)	• Reduce wood burning, e.g. reduce energy consumption, improve energy efficiency • Ban of open burning of agricultural residuals

Source: EEA Air Quality in Europe 2016, 2017 and 2018 Reports [R51, R53, R61]. WHO Ambient (outdoor) air quality and health 2018 [D156].

Note: The data on the main sources responsible for different pollutants is from 2016 and extracted from the EEA Air Quality in Europe – 2018 report [R61], and EEA 2018 report European Union emission inventory report 1990-2016 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP) [R199]. Data on the main sources responsible for NO_2 is based on the data concerning NOx in the reports.

Text box 6-2 Findings from stakeholder consultations (targeted consultation, open public consultation and workshops)

In the open public consultation, 94% of respondents indicated that air pollution poses a concern to public health either to a large or very large extent. 88% of respondents indicated that air pollution poses a concern to the environment to a large or very large extent. The findings of the open public consultation thus support the findings from the previous EU-wide and national surveys that air quality continues to be an issue of concern to public health and the environment. At the same time, there was a consensus among the stakeholders who have provided answers to the targeted questionnaire, that the AAQ Directives still address the current needs of citizens across the entire EU.

The findings from the open public consultation suggest that all the pollutants currently regulated by the AAQ Directives remain relevant. The greatest number of participants agreed either completely or somewhat to the importance of addressing nitrogen dioxide (94%) and fine particulate matter ($PM_{2.5}$) (93%).

Stakeholders answering the targeted questionnaire suggest that the pollutants regulated under the AAQ Directives are all still relevant and monitoring and regulating the concentrations of the pollutants addressed is warranted. It was also highlighted that the evidence about the health impacts of all the pollutants addressed by the AAQ Directives has further developed over the last 10 years and, as such, there is no reason for EU law to stop regulating any of the pollutants currently addressed. A single NGO suggested that SO_2 is no longer relevant due to the implementation of stricter coal combustion standards [Questionnaire, Answer 7]. A respondent notes that concentrations of Pb, Ni and CO seem to be steadily under the limit/target values in most Member States, so there is no need to monitor them as frequently as other pollutants, which would be a cost savings [Questionnaire, Answer 29].

There was some regional variation in the responses received. German respondents were less likely to indicate that air quality posed a concern to public health than those of the other countries where a significant number of responses were received – less than 60% of German respondents indicated it was a concern to a very large extent, whereas in Belgium, France and Spain, over 80% of respondents felt very concerned about the impact on public health. A similar trend was seen in respect of respondents' views on pollution and the environment, although the variation was less marked in this case (here a lower proportion of respondents felt the pollution posed concerns to the environment to a very large extent).

The findings of the case studies confirm that from the citizens' perspective all of the AAQ Directives objectives are relevant. This corresponds well to the current situation in the EU-28 where all Member State have exceedances at least in one zone, and 11 out of 12 pollutants had exceedances in at least one Member State each (all pollutants except for Pb), indicating continued relevance of the pollutants in place. The case studies nonetheless also indicate that a number of the more detailed provisions of the Directives that serve to fulfil these overarching objectives may not fully respond to citizens' needs. These provisions concern in particular the current air quality standards, the substances being monitored and the requirements for the location of the monitoring sites.

Approximately 24% of the respondents to the open public consultation found the air quality standards of the AAQ Directives at appropriate level. 61% found the standards either much too lenient (27%) or somewhat too lenient (34%). In contrast, only 1% found the standards far too strict and 8% too strict. 24% of the respondents found the standards to be at appropriate level.

The findings of the targeted questionnaire paint a similar picture. Out of the 19 respondents, who have answered the question on the level of the current standards, 14 respondents found the standards partly sufficient and identified specific pollutants with respect to which the standards provided by the AAQ Directives are presumably insufficient. The standards for $PM_{2.5}$ were among those most frequently mentioned. Seven respondents found the standards insufficient to protect human health and/or the environment, two respondents found the targets provided by the Directive generally sufficient but highlighted a need to ensure compliance with the existing standards. One respondent indicated that the current daily limit values for PM_{10} were too stringent. One respondent to the targeted questionnaire pointed out that a move to the WHO AIR QUALITY GUIDELINES across Europe would be more appropriate for communicating to the public the need for changes to improve air quality [Questionnaire, Answer 33].

One respondent noted that the short-term (hourly, daily) and annual PM_{10} and $PM_{2.5}$ data are highly correlated, and short-term limit values are more sensitive to data losses than annual limit values, so that lowering the $PM_{2.5}$ annual limit value (to 12-13 µg/m³) would make exceedance of the PM_{10} daily limit value unlikely, which could improve the efficiency of the monitoring system. [Questionnaire, Answer 31]. One respondent finds that due to the problems large cities have with compliance with the air quality standards, separate thresholds for NO_2, PM_{10} and $PM_{2.5}$ should be provided for urban areas [Questionnaire, Answer 17]. One respondent points out that the requirement for traffic measuring points to be within 10 m from the roadway (AAQ Directives Annex III) is not appropriate for motorways and highways where no one is living (due to noise), and that this makes it difficult to establish a business in these locations resulting in an undesirable shift of operating facilities into residential areas [Questionnaire, Answer 24].

As far as the standards for the individual pollutants are concerned, the target values for Lead, Arsenic, Cadmium and Nickel were among those pollutants for which the targets provided by the Directive 2004/107/EC were perceived as being set at an appropriate level by the highest share of respondents (41%, 41%, 41% and 42%, see Figure 10 in Appendix D). These were followed by the SO_2 for which 36% of respondents indicated that the standards were set at an appropriate level. In contrast, 38% and 30% of the respondents indicated that the limit values for $PM_{2.5}$ and $PM_{10,}$ respectively, are much too lenient. Particulate matter was followed by Polycyclic Aromatic Hydrocarbons, including BaP and NO_2 for which the existing standards were found much too lenient by respectively 23% and 22% of respondents.

Overall, there was a consensus among the respondents to the targeted questionnaire on that the current AAQ air quality standards have had the merit to enhance the integration of air quality issues into public policies, to increase public awareness and consequently to contribute to the air quality improvement observed in recent years. Still, a large share of stakeholders highlighted the need to reflect to most recent scientific evidence on the harmful effects of air pollution and sharpen the current standards at least to the levels recommended by the WHO air quality guidelines/update of the guidelines [see e.g. Questionnaire, Answers No 2, 3, 9, 11, 15, 19, 20, 22 and 25, and an NGO interviewed in the context of the Slovak case study].

On the other hand, a limited number of stakeholders also highlighted the issue of economic viability of following the WHO guidelines [Questionnaire, Answer no 16]. In general, industry associations highlighted the importance of the fact that the requirements in the framework for air quality protection are cost-effective, reachable by the industry with available technologies, and in line with the Best Available Techniques (BAT) as already defined in the Industrial Emissions Directive (Directive 2010/75/EU) [Questionnaire, Answers no 6 and 12, and the industry representative interviewed in the context of the Slovak case study].

Similar views were echoed in the workshop discussions. Participants noted that despite air pollution being the fifth most important risk factor for non-communicable diseases, current standards do not fully reflect scientific evidence suggesting health impacts at concentration levels below the current limit values. Particular concern was expressed regarding $PM_{2.5}$, where stakeholders noted the need for short-term limit values.

Regarding additional pollutants which are not addressed by the AAQ Directives, open public consultation respondents were given an open text field and were able to name multiple pollutants in their answers. The most commonly cited additional pollutant being ultrafine particles (UFP) (96 responses), black carbon (BC) (70 responses) and ammonia (45).

See Appendix D for additional details on stakeholder responses.

Based on the findings of the HRAPIE and REVIHAAP projects conducted in the context of the 2013 Clean Air Policy review [R183, R184], the European Commission concluded that it was not appropriate to revise Directive 2008/50/EC at the time (e.g. by including additional pollutants). Instead, the projects recommended to focus on achieving compliance with existing air quality standards by 2020 (at the latest), and on using a revised NEC Directive (Directive 2016/2284/EU) to bring down pollution emissions in the period to 2030. The different pollutants are described briefly below with additional detail in Appendix D.

Ultrafine particles (UFP): Ultrafine particles (UFP), i.e. particles less than 0.1 µm (100 nm) in diameter, vary largely in composition, particle number concentration (PNC), and over space and time as a result of variations in emission sources and formation processes [S114]. Numerous recent studies have shown high correlations between UFP and health effects, and UFP measurements are good indicators of the progress of local measures to improve air quality [S133, S134, S135, S136, S137, R145]. The possibility of introducing a self-standing air quality standard for UFP has been subject to extensive discussion, both in scientific and policy circles. In 2006, the WHO concluded at the time that it could not recommend a guideline value: "While there is considerable toxicological evidence of potential detrimental effects of UF particles on human health, the existing body of epidemiological evidence is insufficient to reach a conclusion on the exposure-response relationship of UF particles. Therefore, no recommendations can be provided as to guideline concentrations of UF particles at this point in time." [R202, page 14]. The REVIHAAP project highlighted that since the 2005 global update of the WHO air quality guidelines a considerable number of new studies has been published, providing evidence on the health effects of size fractions, components and sources of PM [R184]. Health effects are observed with short-term (such as hours or days) and long-term (such as years) exposures to airborne particles. In 2013, the WHO concluded "There is increasing, though as yet limited, epidemiological evidence on the association between short-term exposures to ultrafine (smaller than 0.1 µm) particles and cardiorespiratory health, as well as the health of the central nervous system. Clinical and toxicological studies have shown that ultrafine particles (in part) act through mechanisms not shared with larger particles that dominate mass-based metrics, such as $PM_{2.5}$ or PM_{10}." [R184, page 18].

"With regard to concentration-response functions, the richest set of studies provides quantitative information for $PM_{2.5}$, but many studies would also provide concentration response functions for PM_{10} (or coarse particles, specifically), and a recent review provides concentration-response functions for black carbon. For ultrafine particle numbers, no general risk functions have been published yet, and there are far fewer studies available. Therefore, at this time, a health impact assessment for ultrafine particles is not recommended." [R184, page 49]. The issue is expected to be dealt with as part of the ongoing WHO guideline update.

Black carbon (BC): BC is incorporated in the NECD and Gothenburg Protocol as a recommended pollutant to include in submitted national emission inventories. Monitoring of ambient concentrations of black carbon would contribute to monitoring of the progress of NECD and the national programmes, as well as providing valuable data for research and assessment of health impacts of BC, and the progress of local air quality plans. In REVIHAAP it was mentioned that, for example, new evidence has linked black carbon particles with cardiovascular health effects and premature mortality, for both short-term (24 hours) and long-term (annual) exposures.

Ammonia[14]: Ammonia (NH_3) emissions lead to a loss of biodiversity and also contribute significantly to the formation of particulate matter and the associated health risks. More than half of fine particulate matter concentrations is not emitted directly, but is formed in the air when ammonia reacts with nitrogen oxides and sulphur dioxide (called secondary particles) [S83, S10]. Ammonia is not included in the AAQ Directives, but it is addressed through national emission reduction targets in the NECD.

The existing AAQ Directives do not cover the issue of odour nuisance, but odour was mentioned in the open public consultation and stakeholder consultations. The WHO Air Quality Guidelines include guideline values for odour nuisance for six malodourous substances, at concentrations below those where toxic effects occur [P133].

[14] While ammonia is not addressed by the AAQ Directives, ammonia emissions are addressed by the NEC Directive.

6.1.1.3 Standards and obligations

Judgement criterion 1.3: The extent to which standards and obligations for the pollutants currently covered are suitable to protecting the citizens from harmful effects of air pollution.

Assessment summary: Based on the evidence collected, the targets, thresholds and obligations laid down by the AAQ Directive have been helpful from 2008 to 2018 in stimulating national action on air quality and that they still represent a key tool to improve air quality. Recent scientific evidence indicates that the air quality standards laid down by the AAQ Directives are not fully reflective of the most recent and robust evidence available suggesting serious adverse health effects at lower concentration levels. Several standards laid down by the AAQ Directives are less stringent than the current WHO Air Quality Guidelines for the protection of human health.

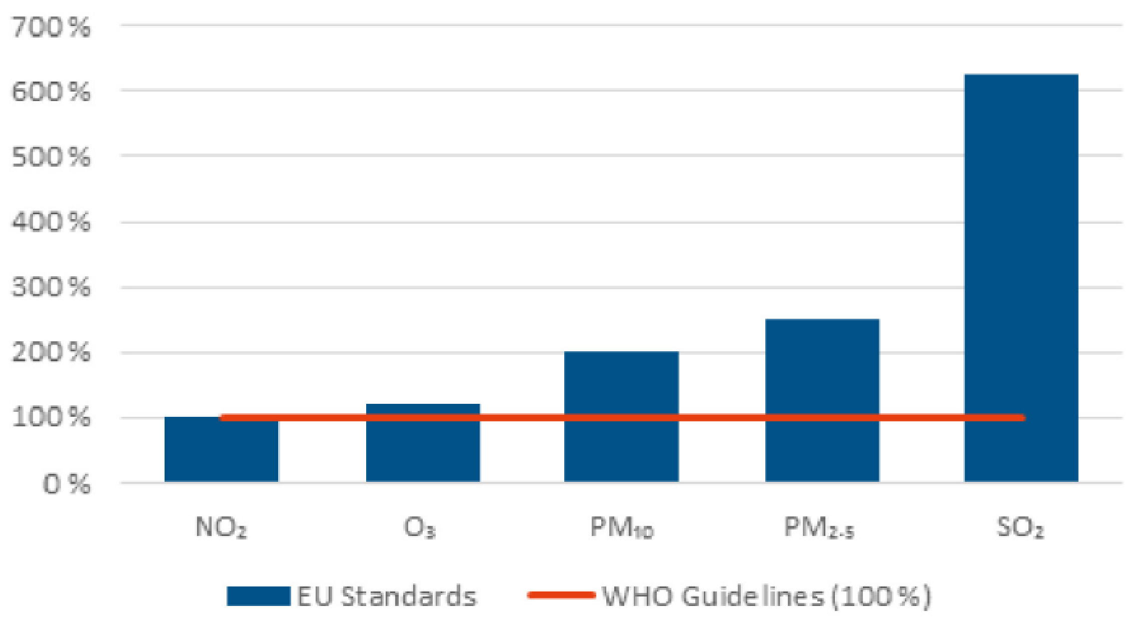
The air quality standards set in the AAQ Directives (Table 2-1) have been in place for almost two decades, and were last revised in 2005 in the context of the Thematic Strategy on Air Pollution [P14]. The TFEU [P137] Article 191 Article 3 states that EU environmental policy shall take account of available scientific and technical data. The 2002 6th EAP [P93] further states that the objective to achieve *levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment*, shall be pursued *taking into account relevant World Health Organisation (WHO) standards, guidelines and programmes*. With this policy background, and the WHO air quality guidelines existing at the time, and taking economic, social and cost-effectiveness aspects into account, the co-legislators (European Parliament and the Council) decided on the specific levels of the air quality standards in the AAQ Directives. In 2013, the 7th EAP [P106] item 54(a) introduced the goal that by 2020, *outdoor air quality in the Union has significantly improved, moving closer to WHO recommended levels, while indoor air quality has improved, informed by the relevant WHO guidelines*.

The WHO updated its air quality guidelines in 2005 for the four most common pollutants (PM, ozone, NO_2, SO_2) [P134]. The standards were examined in the context of the Commission's 2013 Clean Air Policy review. The findings of the review suggest that some of the existing standards were insufficient in relation to the WHO air quality guidelines on air pollution [R183, D57] and only provide incomplete protection for human health [P38]. A further tightening of the existing EU air quality standards was nonetheless considered to be not appropriate if introduced before substantial cuts in air pollution from the main sources: Instead a further reduction of air pollutants was proposed and adopted via the NEC Directive (Directive (EU) 2016/2284) which puts emissions on a trend to allow achieving WHO Guideline Values for $PM_{2.5}$ by 2030 in most parts of the EU [P59].

The WHO Air Quality Guidelines are designed to offer guidance in reducing the health impacts of air pollution [P134]. The WHO guideline values focus on health impacts and do not consider the technical feasibility or the economic, political and social aspects of the achievement of the recommended levels [P44]. The process of updating the WHO Air Quality Guidelines is currently under way and several systematic reviews of the evidence have been commissioned. This is not be expected to be concluded before the early 2020s.

Although WHO recommendations were taken into account in setting the air quality standards in the AAQ Directives, a number of the standards are higher than the values currently recommended by the WHO. As shown in Figure 6-1, there are discrepancies in particular with respect to the values SO_2, $PM_{2.5}$ and PM_{10}. In contrast NO_2 has an EU limit value that is in line with the WHO recommendation.[15] Moreover (not pictured in the figure), the EU target value for benzo[*a*]pyrene (BaP) is more than eight times higher than the WHO reference level.

Figure 6-1 Gap between EU standards and WHO guidelines



Source: European Court of Auditors [P91].

There is a body of evidence suggesting that several of the current EU air quality standards are insufficient for the protection of health and, to a limited extent, also for the protection of the environment. Most notably, the Impact Assessment underpinning the 2013 Clean Air Policy Package concluded that even if compliance with current legislation was reached, major health and environment impacts would remain [P38].

Recently, the Court of Auditors found that some of the standards of the Directive 2008/50/EC "*are much weaker than the World Health Organization guidelines. Furthermore, the standards allow limits to be exceeded frequently and do not include any short-term standard for $PM_{2.5}$, a very harmful air pollutant […] Health professionals support stricter standards in the EU […] Setting weak standards does not provide the right framework for protecting human health. It means that some locations with poor air quality are compliant with EU law*." [P91].

Information and alert thresholds

The AAQ Directives specifies information and alert thresholds for ozone, NO_2 and SO_2. These values trigger distribution of information to the public and initiation of measures in short-term action plans. These are highly relevant where high levels of SO_2 or NO_2 can occur. No information and alert thresholds are provided for particulate matter, although severe pollution episodes with high PM levels present a significant health risk to the public. Thirteen Member States have established national or municipal information and alert thresholds for PM_{10}, and two Member States have information and alert thresholds for $PM_{2.5}$ (Guiseppin (2017) [R105]). The levels of these thresholds vary considerably among these Member States, and even within Member States, which indicates varying levels of protection to the public. There is substantial evidence on the short-term acute health impacts of high levels of particulate matter, and establishment of information

[15] For a detailed comparison see Appendix D.

and alert thresholds for PM_{10} and $PM_{2.5}$ in the AAQ Directives would provide valuable protection to public health.

Upper and lower assessment thresholds

Upper and lower assessment thresholds determine the monitoring requirements for all of the pollutants in the AAQ Directives except ozone, and are thus a highly relevant aspect of unified assessment in the EU. For levels above the upper assessment threshold (UAT), fixed sampling points must be used. Between the upper and lower assessment thresholds, a smaller number of fixed sampling points may be used together with modelling and indicative monitoring. Below the lower assessment threshold (LAT), no fixed sampling points are required. The assessment thresholds are defined as fractions of the limit or target values, with UAT set at 60 to 80%, and LAT from 40 to 50% of the limit or target value.

Where a limit or target values is higher than the WHO guidelines, the assessment thresholds may be lenient compared to the WHO guideline. The lower assessment threshold for 24-hour SO_2 is 50 ug/m^3, while the WHO guideline is 20 ug/m^3. This means that no fixed monitoring stations would be required for SO_2 while SO_2 levels are more than twice the WHO guideline. The UAT and LAT for $PM_{2.5}$ are 17 and 12 ug/m^3, while the WHO guideline is 10 ug/m^3, allowing fixed sampling for $PM_{2.5}$ to be reduced or dropped while $PM_{2.5}$ levels remain above the WHO guideline. The UAT and LAT for lead and PM_{10} are also at or above the corresponding WHO guidelines.

6.1.1.4 Adaptation to technical and scientific progress

Judgement criterion 1.4: The extent to which standards, assessment methods and obligations have kept up with advances in technical and scientific progress.

Assessment summary: Based on the evidence collected, the findings of the evaluation show that the AAQ Directives have provided a degree of flexibility over time in relation to amending non-essential elements of the Directives and this opportunity has been used at one occasion to, among other things, account for the experience gained in implementing the Directive and the most recent standards for the sampling and measurement of different pollutants. Moreover, the Directives provided for a review of some of their essential elements in 2013 and by the end of 2010 (for the respective Directives). However, there are no specific mechanisms integrated in the Directives laying down an obligation to carry out a periodic review of the Directives with the view of adapting the Directives to the latest technical and scientific progress.

Pursuant to Article 28 (1) of Directive 2008/50/EC measures designed to amend the *non-essential elements* of the Directive (i.e. Annexes I to VI, Annexes VIII to X and Annex XV) shall be adopted through a regulatory procedure with scrutiny by a Scrutiny Committee composed of the representatives of the Member States,[16] as described in the Council Decision 1999/468/EC. As shown in Appendix D, in 2015 several annexes to Directive 2008/50/EC were amended by Commission Directive (EU) 2015/1480 of 28 August 2015. Directive 2015/1480/EU laid down rules concerning reference methods, data validation and the location of sampling points for the assessment of ambient air quality. As provided in the recitals to Directive 2015/1480/EU, amendments were needed partly in order to clarify the existing criteria, but also to complement the criteria taking into account, among other things, the experience gained in implementing the Directive and "*most recent standards for the sampling and measurement of particulate matter*".

[16] Note that the procedure can no longer be used in new legislation, but will continue to apply until the Directive is formally amended.

Article 32(2) provided specifically, that the Commission shall take into account the feasibility of adopting a more ambitious limit value for $PM_{2.5}$, review the indicative limit value of the second stage for $PM_{2.5}$.[17] Finally, Article 32(3) stipulated that as part of the review and, of appropriate, new reference methods for the measurement of PM_{10} and $PM_{2.5}$ shall be proposed.

The regulatory procedure with scrutiny, as described above, does not apply to the revision of *essential elements* of the Directive, including the limit values, exposure reduction targets, critical levels, target values, information or alert thresholds or long-term objectives specified in Annex VII and Annexes XI to XIV. Such provisions can only be amended following the ordinary legislative procedure as described in Article 192 of the TFEU.

As presented in Appendix D, Directive 2004/107/EC, was amended in 2009 and 2015. The 2009 amendments related to the possibility to adapt certain (non-essential) provisions and Annexes of the Directive to scientific and technical progress in accordance with the regulatory procedure with scrutiny.[18]

Reference methods
The reference methods for air quality measurements have been essential to provide comparable data on pollutant levels across the EU, but some technical issues have arisen. One national air quality authority pointed out that the current reference method for NO_2 is not suitable for regional background measurements, because the levels of NO_2 are very low. The reference method for PM_{10} and $PM_{2.5}$ is a 24-hour filter measurement, requiring laboratory processing that delays the results. There is a strong need for real-time measurements of PM_{10} and $PM_{2.5}$ for information to the public, which requires alternate methods (that must be shown to be equivalent). Stakeholders in Germany indicate that the procedure to demonstrate equivalence to the reference method is very complicated. This may hinder the adoption of new and alternative methods.

Modelling
The AAQ Directives provides the option (but not the obligation) to use modelling to supplement information from fixed sampling points. The AAQ Directives provides that "The results of modelling and/or indicative measurements shall be taken into account for the assessment of air quality with respect to the limit values." Although many Member States use modelling, until recently very few Member States have regularly submitted modelling results as part of the assessment documentation (see Table 6-5 in section 6.2.1.1), which indicates that the AAQ Directives is not sufficiently clear about the use of modelling and the need to report modelling results.

There has been extensive progress on modelling through FAIRMODE, but the AAQ Directives has not been updated regarding reference methods or clarifications of requirements for modelling. Inter-comparison exercises [R129] have for example shown that for modelling to be effective, an adequate number of background monitoring stations are needed. Flexibility on the choice of station types to meet the minimum number of stations in a zone (AAQ Directives Article 7.1 and Annex III) does not reflect modelling requirements and can lead to Member States having an inadequate number of background stations for effective use of modelling.

Emission inventories are essential to air quality planning, source apportionment, and as input to modelling, but the AAQ Directives does not mention emission inventories. Although there is extensive guidance available on emission inventories (including for NECD and GHG inventories), the

[17] Annex XIV of Directive 2008/50/EC provided an indicative limit value for $PM_{2.5}$ to be met by 1 January 2020. With respect to this value a review by the Commission in 2013 was foreseen "*in the light of further information on health and environmental effects, technical feasibility and experience of the target value in Member States*".
[18] As above.

AAQ Directives provides no standards or data quality objectives for this essential aspect of local air quality management.

Indicative measurements

Similar to modelling, the AAQ Directives provides the option to use indicative measurements to supplement data from fixed sampling points (Article 6). Indicative measurements are valuable to provide information about the spatial variation of pollutant concentrations and human exposure, but each Member State applies a different approach, making it difficult to compare the supplementary information provided.

Guidance

The Commission has provided guidance documents for monitoring, reporting and assessment, as shown in Table 5-1. Some of the guidance is carried over from the former 96/62/EC air quality framework directive, and has not been updated after 2008/50/EC came into force.

An area where guidance has been lacking until recently is on modelling and the representativeness of the siting of monitoring stations. Modelling approaches have been developed over the past 10 years by the FAIRMODE forum. FAIRMODE and AQUILA have collaborated on inter-comparison studies to improve knowledge of the representativeness of monitoring stations [R129]. This exchange and related recommendations emerging from these networks is highly relevant to the effective implementation of monitoring, modelling and assessment.

Few stakeholder comments have been received regarding guidance. In the Slovak Republic case study, a regional air quality authority indicated that there was a need for guidance and sharing of best practices on air quality plans. Since guidance and best practices are available for air quality plans and measures, this may reflect a language barrier, where technical documents and Internet resources in English may not be sufficiently accessible to local officials responsible for air quality planning.

6.1.1.5 Redundant provisions with respect to EU air quality priorities

Judgement criterion 1.5: The extent to which elements of the Directives have become redundant in light of key EU air quality priorities.

Assessment summary: The review found three articles that deal with provisions that have expired and are thus redundant: Postponement of attainment deadlines up to five years, the 2013 review of $PM_{2.5}$ provisions, and the 2010 review of Directive 2004/107/EC.

The review of the AAQ Directives identified several provisions that may be considered to have become redundant. Article 22 of Directive deals with postponement of attainment deadlines by up to five years and exception from the obligation to apply certain limit values until June 2011. Both time periods have passed, and this article can no longer be applied.

Article 32 of Directive 2008/50/EC concerns the 2013 review of provisions related to $PM_{2.5}$ and, as appropriate, other pollutants. This review was made [P142], supported by a consultancy report [R171], and the article has no further application.

Article 8 of Directive 2004/107/EC requires the Commission to report by the end of 2010 on experience with the Directive. The above mentioned corresponding consultant analysis [R171] served as input to the air policy review initiated in 2011. The article has no further application.

6.2 Effectiveness

Effectiveness analysis considers how successful the AAQ Directives have been in providing for the implementation of measures to improve air quality in the Member States, and thus to reduce the adverse impact of air pollution. It also seeks to identify the internal and external factors driving or hindering the progress towards achieving the objectives of the AAQ Directives. The analysis of effectiveness seeks to provide an answer to the evaluation question. Evidence collected in the context of the evaluation has been assessed against a set of a judgement criteria presented inTable 6-3.

Table 6-3 Evaluation question and judgement criteria for effectiveness

Evaluation question and judgement criteria on effectiveness
EQ 2: What factors have contributed to meeting the objectives of the AAQ Directives or to failing to meet these objectives, in terms of: 1) defining common methods to monitor and assess air quality, and assessing ambient air quality in order to monitor trends; 2) establishing standards of air quality to achieve across the EU; 3) ensuring that information on air quality is made public; 4) maintaining good air quality, improving it where it is not good; to what level can these factors be attributed to provisions of the AAQ Directives? • JC 2.1: Internal or external factors are identified that influenced the extent to which comparable monitoring and assessment of air quality has been ensured by competent authorities and representative, high quality monitoring of air quality has been achieved in all Member States. • JC 2.2: Internal or external factors are identified that influenced the extent to which the standards on air quality to achieve across the EU established by the AAQ Directives have been clear, actionable and complied with for all the EU (as reported based on the information gathered via the monitoring and assessment). • JC 2.3: Internal or external factors are identified that influenced availability of reliable, objective and comparable information across the EU. • JC 2.4: Internal or external factors are identified that influenced the extent to which coherent action has been taken to avoid, prevent or reduce effect of poor air quality.

6.2.1 Evaluation Question 2: Effectiveness

To assess the effectiveness of the AAQ Directives, the study investigated the implementation of the AAQ Directives in terms of achieving each of the four set objectives (as illustrated in the intervention logic, see section 2.2). Hence, firstly, the study analyses whether sufficient and comparable data are gathered to assess air quality in the Member States in view of enabling the design of the right actions to maintain or improve air quality. Secondly, the study investigates whether the set air quality target/limit values are achieved by the Member States. Thirdly, the study looks into the extent to which information on air quality is made public so that people and organisations can act on adverse air pollution concentration values. Fourthly, the study performs an assessment of the extent to which air quality plans were drafted by relevant stakeholders and measures were implemented accordingly in the Member States to avoid, prevent or reduce the effects of poor air quality. Text box 6-3 contains an assessment of the overall findings concerning the effectiveness of the AAQ Directives.

Text box 6-3 Key findings on the effectiveness of AAQ Directives

The extent to which the AAQ Directives have achieved the four objectives varies.

Regarding the first objective of the AAQ Directives, namely monitoring and assessing air quality, most zones in the Member States have the required minimum number of sampling points. Flexibility and ambiguity of criteria for classifying measurement stations are identified as possible factors that have led to differences in the way this has been done in the Member States. Furthermore, a lack of guidance may have limited the use of modelling in air quality assessment. In contrast, there is much EU guidance to assessment and reporting activities. The overall conclusion is that the AAQ Directives have encouraged the availability of reliable and comparable data, as such, enabling the monitoring of trends.

Regarding the second objective of the AAQ Directives, i.e. establishing air quality standards and achieving these in the Member States, the overall observation is that exceedances of targets/limits have decreased over time for most pollutants. Hence, it is concluded that the actions provided for by the AAQ Directives have been effective. The mandatory nature of the air quality standards has been identified as an important positive driver in achieving the standards.

Regarding the third objective that information on air quality is made public so that people, organisations and others can act on adverse air pollution concentration values, the conclusion is that information is indeed being made available for use by the public. However, the information is of mixed quality in different Member States, partly because Member States have taken varied approaches, both to the dissemination itself, but also to the collection, assessment and reporting of data at national level. The approach towards dissemination at EU level reporting is harmonised and the AAQ Directives have led to an enhanced clarity and transparency of information related to air quality.

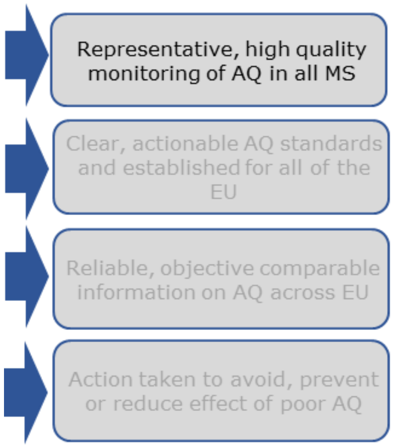
Regarding the fourth objective of preparing air quality plans and implementing measures accordingly to avoid, prevent or reduce the effects of poor air quality, a first conclusion is that all Member States have prepared air quality plans as required by the AAQ Directives. A second conclusion is that road transport is one of the main sources for the exceedances of NO_2 and, to a lesser degree also of PM_{10} (for particulate matter other combustion sources, such heating and energy play a bigger role in most instances). Many measures to reduce such emissions therefore focus on the transport sector – e.g. congestion charges, speed limits, the promotion of cleaner vehicles and public transport. A main source for PM_{10}, and also for NO_2, emissions is that of industrial, commercial and residential combustion. Measures here include the promotion of shifts towards low-emission fuels, retrofitting, green public procurement as well as public information services. A third conclusion is that Member States differ somewhat in their choice of measures. Effectiveness is encouraged by the flexibility for the Member States, hereunder regions and municipalities, to choose the measures that best fit their local conditions – i.e. the most cost-effective measures. This said, insufficient coordination between authorities in the Member States is pointed out by some as a hindering factor for reaping all the benefits from the flexible provisions.

6.2.1.1 Monitoring and assessment of air quality

Judgement criterion 2.1: Internal or external factors are identified that influenced the extent to which comparable monitoring and assessment of air quality has been ensured by competent authorities and representative, high quality monitoring of air quality has been achieved in all Member States

Indicator 1: The extent of achievement of expected outputs

Assessment summary: Most zones in the Member States have the minimum number of sampling points required by the AAQ Directives. Compliance has in general increased for the different air pollution types since the start of the implementation of the AAQ Directives. Hence, on average the assessment is that the AAQ Directives have encouraged the availability of reliable and comparable data, as such, enabling the monitoring of trends.



The objectives and associated outputs are provided for by Articles 1(2) and 1(3) in Directive 2008/50/EC. The articles are interlinked in the sense that common methods to monitor and assess air quality enable comparable air quality assessments. With respect to defining common methods, the Directive provides for rules to assess ambient air quality, including how, when, and where to assess air quality. This includes provisions related to fixed measurements of air pollutant concentrations, and when and how it is appropriate to supplement fixed measurements of pollutant concentrations with other assessment methods (modelling, objective estimation, indicative measurements). Directive 2008/50/EC also includes definitions of data quality objectives for the different methods. In terms of fixed measurements of pollutant concentrations, the provisions include: minimum numbers of sampling points for each pollutant, criteria for siting of these sampling points, and the reference methods for assessment of pollutant concentrations.

Table 6-4 shows via data from the data repository Central Data Repository (CDR)[19] that in 2016[20] most zones in the Member States had the minimum number of sampling points required by the AAQ Directives. Compliance has in general increased for the different air pollution types included in the table since the start of the implementation of Directive 2008/50/EC. It should, however, be underlined that in 2008 there was a lack of information for some Member States and zones, and so the information may not be fully comparable with that for 2016. Furthermore, it should be underlined that the 2016 share estimates are based on information only for the (sub-set of) zones for which the number of sampling points has been reported in that year. Hence, the share estimates are as a result connected with uncertainty and should be used with this in mind. For example, for BaP the still high estimate for 2016 of the share of zones without the required minimum number of sampling points is based on information available for 235 zones, i.e for less than half of 507 zones in the EU where BaP emissions were monitored.

Table 6-4 Share of zones without the required minimum number of sampling points, 2008 and 2016

	PM	NO_2	SO_2	CO	C_6H_6	Pb	O_3	As	Cd	Ni	BaP
2008	32%	7%	3%	1%	6%	2%	20%	4%	4%	2%	17%
2016	5%	2%	0%	1%	3%	0%	1%	4%	3%	2%	16%

Sources: 2008: Figure 10 in "Reporting on ambient air quality assessment in the EU Member States, 2008 - ETC/ACC Technical Paper 2010/11"
2016: COWI calculations based on CDR (data flows B, C, D)

Note: The share estimates are based on the information for the (sub-set of) zones for which the number of sampling points has been reported. Hence, the estimates are uncertain and should be used with this in mind.
$PM= PM_{10}+PM_{2.5}$

This study did not carry out a detailed assessment of the siting or classification of fixed measurement sampling points. However, previous studies indicate that there are some limitations to comparability stemming from varied approaches to assessing the representativeness of measurement station locations. For example, studies by JRC [R129] and ClientEarth [R1] argue that in some instances it is questionable whether monitoring is done in line with the requirements of the AAQ

[19] http://cdr.eionet.europa.eu/
[20] The latest year of data availability (January 2019).

Directives with respect to measuring the highest concentrations. JRC [R129] also describes that spatial representativeness is not clearly defined in the EU legislation and that the approaches thus vary among the different Member States.

As indicated by Table 6-5, there are also some differences in the approach taken by Member States in relation to supplementing fixed concentration measurements with other methods such as modelling techniques and indicative measurements. This possibility is provided for by the AAQ Directives when certain requirements are met, and an associated reporting requirement is defined in the Commission Implementing Decision 2011/850/EU (Reporting Obligation Database). A limited number of Member States have reported on this since the introduction of the EEA data flow for this purpose[21], while FAIRMODE suggests more use of modelling tools in the air quality assessment [R98].

The table shows that there has been an increase in the use of modelling techniques or indicative measurements for the assessment of air quality in the period for which consistent data is available (2013-2017).

Table 6-5 Number of Member States reporting use of modelling techniques or indicative measurements for assessment of air quality, 2013-17

	2013	2014	2015	2016	2017
Number of Member States	4[22]	5[23]	5[24]	8[25]	12[26]

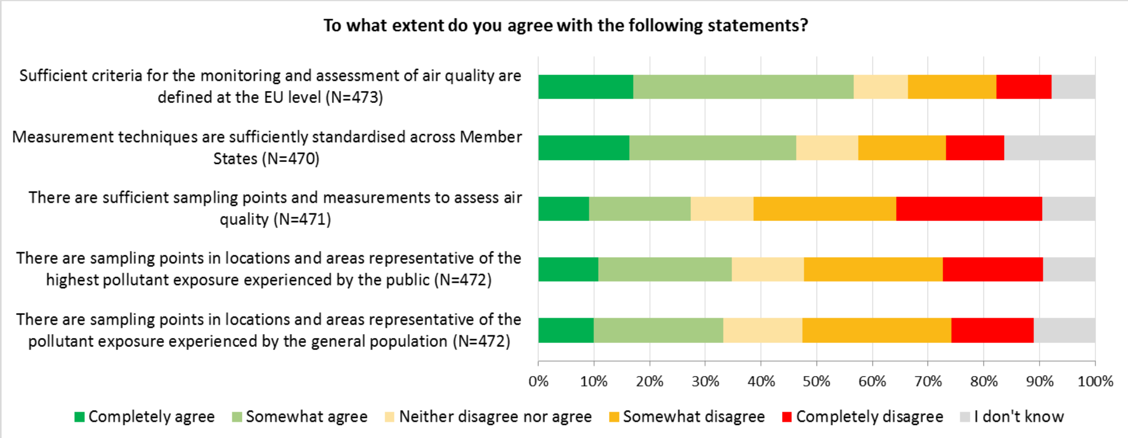
Source: Data provided by the EEA on 7 May 2019 – based on: http://aqportal.discomap.eea.europa.eu/products/submission-monitoring/data-monitor-all-except-e2a

While monitoring and assessment arrangements overall are in place in the Member States, the question is then their degree of commonality. The key findings from the stakeholder consultations are presented below.

[21] Current reporting arrangements in place since Implementing Decision 2011/850/EU (entry into force: 1 Jan 2014).
[22] Spain, Netherlands, Poland, United Kingdom
[23] Spain, Germany, Netherlands, Poland, United Kingdom
[24] Spain, Germany, Netherlands, Poland, United Kingdom
[25] Spain, Germany, Netherlands, Poland, United Kingdom, Denmark, Portugal, Romania
[26] Belgium, Spain, Germany, Netherlands, United Kingdom, Portugal, Romania, Croatia, Latvia, Lithuania, Sweden. And for objective estimation only: Denmark, Austria, Malta, and Slovenia.

Text box 6-4 Key findings from stakeholder consultation (open public consultation, targeted consultation, workshops)

The online public consultation asked the public about their views on the achievement of the objectives related to air quality monitoring and assessment. It shows that more that around half of the respondents are satisfied with the applied criteria and measurement techniques for monitoring and assessment of air quality. However, less than half of the respondents disagree with the statement that there are enough sampling points in the right locations.



Source: Open public consultation. Q7.6: To what extent do you agree with the following statements? N – varies per sub-question, see chart.

The majority (60%) of the respondents to the targeted questionnaire survey[27] carried out as part of this study state that the AAQ Directives have achieved the objective of defining common methods to monitor and assess air quality to a large or a very large extent, while 80%[28] thought the same about the achievement of the objective of actually monitoring and assessing ambient air quality.

Hence, on average their assessment is that the Directives have encouraged availability of reliable and comparable data, as such, enabling the monitoring of trends. However, this is not unanimous, as some stakeholders noted areas of further improvement of comparability/reliability of data – e.g. due to potential for different interpretations by the Member States.[29]

Indicator 2: The contribution of relevant AAQ Directives provisions (internal factors) and other (external) factors to the level of achievement

Assessment summary: Flexibility and ambiguity of criteria for classifying measurement stations are identified as possible factors that have led to differences in the way this has been done in the Member States. Regarding external factors, resource constraints (costs, qualified staff) may have led to a varied coverage or qualities of the EU territory with monitoring networks. In terms of other possible external factors, no firm conclusions can be drawn from the analysis.

The desk research carried out with the study has identified some challenges or areas for improvement both with respect to monitoring network designs and with respect to the use of modelling to supplement measurement data. These include missing definitions, criteria not being sufficiency clear, and the availability of guidance.

[27] Based on 26 responses.
[28] Based on 25 responses.
[29] This is further discussed below.

Regarding monitoring networks, the challenges identified mostly relate to the classification of the measurement stations. A number of studies have looked into the criteria for classifying measurement stations and pointed to that some of these criteria are rather generic and have suggested possible improvements to the classification [e.g. P121, S39]. Stricter and clearer criteria for micro-scale siting, macro-scale siting and representativeness of stations are suggested to improve comparability of measurements across cities [R44, R32]. Similarly, the JRC-Aquila position paper [P121] notes that the spatial representativeness of measuring sites is not defined in the legislation, which can hinder the effectiveness of the monitoring network design and suitability to assess exposures and model performances. This position paper further notes that guidance that is more "detailed and practical" is needed for the monitoring network to be effective.

On the other hand, many respondents to this study's targeted questionnaire survey suggest that effectiveness of the monitoring networks has been encouraged by the common methods defined by the Directives, i.e. they have played a central role in ensuring reliable and comparable data in the EU. Furthermore, the general provisions for fixed measurements were considered both detailed and clear by some of the Member State respondents and NGOs. Also, the work of the Commission, the EEA, and the networks such as FAIRMODE and AQUILA was commended as supportive of objective achievement. Hence, guidelines such as that on e-reporting[30] and on air quality assessments[31] are much appreciated.

However, provisions and guidelines on modelling were noted as areas where harmonisation is lacking (large degree of agreement among respondents, mentioned by the highest number of responses i.e. 47%[32]). In addition, some of the Member State respondents considered that there has been insufficient detail and guidance on site locations and classification (25% of responses, including national and local authorities and NGOs) and raised the issue of representativeness, guidance on how to monitor trends, or other areas they perceive guidance as insufficient. The perceived ambiguity or lack of clarity reported by the Member State respondents means that they may have been interpreting the same provisions differently, which in the view of some stakeholders may adversely have influenced comparability of the air quality assessment in between Member States (issue reported by national, local and regional authorities, NGOs).

Regarding the option to use modelling to supplement measurement data, the Directives do not specify exactly how models should be used. FAIRMODE [R98] has proposed how models could be used – and defined in the AAQ Directives – to assess air quality levels, for forecasting, source allocation, development and assessment of measures and plans, as well as monitoring network design. This would, however, require clearer definitions of data quality objectives for the models [R98, R40]. A survey among FAIRMODE network National contact points (NCPs) [R14] also found that the majority of respondents agreed that the "lack of clarity in the legislation and the lack of clear guidelines" are factors behind the limited reporting by Member States of air quality modelling results [R14].

In addition to elements related to the provisions in the Directives, some external factors, that have affected monitoring and assessment achievements, have been mentioned by the respondents to the targeted consultation. Among these, the strongest agreement was on costs and other resources as a hindering factor, mentioned by a quarter of respondents. These differences in

[30] http://ec.europa.eu/environment/air/quality/legislation/pdf/IPR_guidance1.pdf and https://www.eionet.europa.eu/aqportal/doc/IPR%20guidance_2.0.1_final.pdf
[31] http://ec.europa.eu/environment/air/quality/assessment.htm
[32] Of those that contributed qualitative answers to Objectives 1-2.

resource and funding availability may mean that some regions or Member States have less developed networks than others. No other (supporting or hindering) external factors were found to have a wider agreement, as they were mentioned by a small number of responses, indicating that they reflect individual circumstances[33]. Among the case studies, a notable example was provided by Germany: in terms of use of modelling, a political decision was made not to use it for compliance assessment, which has hampered the development and use of modelling for planning and exposure assessment in Germany. The methodology for the assessment of the population exposed to pollutant levels exceeding the limit values varies considerably from Member State to Member State, and there is no guidance on the approach to apply.

6.2.1.2 Air quality standards

Judgement criterion 2.2: Internal or external factors are identified that influenced the extent to which the standards on air quality to achieve across the EU established by the AAQ Directives have been clear, actionable and complied with.

Indicator 1: The extent of achievement of expected outputs

Assessment summary: The overall observation is that exceedances of targets/limits have decreased over time for most pollutants – both when measuring via the number of Member States experiencing exceedances and via the share of zones in the EU reporting exceedances. Several Member States have made use of the opportunity to apply for a time extension to comply with the targets/limits for PM_{10} and NO_2. While the zones with PM_{10} time extension grants given have led to above-average performance of the zones, the zones with granted NO_2 time extensions have done worse than average. However, the overall conclusion is that the actions provided for by the AAQ Directives have been effective.

The second objective and associated output relate to Article 1(1) in the Directive 2008/50/EC. It covers the provisions of the AAQ Directives defining the environmental objectives to be achieved by the Member States for the covered pollutants. The AAQ Directives establish air quality standards to be achieved throughout all Member States[34]. The Directives define limit values for particulate matter below 10 µm in diameter (PM_{10}), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), benzene (C_6H_6) and lead (Pb), target values for arsenic (As), cadmium (Cd), nickel (Ni), and benzo[a]pyrene (BaP), and an exposure concentration obligation for fine particulate matter of under 2.5 µm in diameter.

The first part of the judgement criterion concerns the question of whether the levels of the air quality standards are considered to be appropriate. The German case study, for example, suggests that the current focus on NO_2 in air quality plans is disproportionate with the impact, compared to the impact of $PM_{2.5}$ and to a lesser extent with PM_{10}. One reason is that the NO_2 annual limit value is equal to the WHO guideline, while the $PM_{2.5}$ annual limit value is 2.5 times higher than the WHO guideline.

The Swedish authorities consulted for that case study consider that the air quality standards and limits set by the AAQ Directives are not sufficiently strict. The limits could, for example, be reinforced through the implementation of a binding $PM_{2.5}$ daily limit value. The Swedish regulatory framework even goes beyond the requirements of the AAQ Directives by setting even stricter

[33] An overview is available in Appendix F.
[34] Established in Articles 12, 12, 14(1), 15, 16, 17(1), Annex VII, XI, XIII, XIV in Directive 2008/50/EC and Article 3(1), Annex I in Directive 2004/107/EC.

values for NO_2, SO_2 and O_3. The stricter standards, however, impose difficulties in enforcing them on a national level – i.e. Sweden is struggling with reaching the Swedish value for NO_2 and, in some cases, the EU limit value.

Regarding the compliance part of the judgement criterion, Table 6-6 shows that many Member States still in 2017 experience exceedances of the environmental targets/limits. PM_{10}, NO_2, O_3 and BaP are the air pollutants for which the highest number of Member States have reported exceedances. In turn, only a few Member States reported air pollutant values higher than the target values for the heavy metals. Compared with 2008, there has for almost air all pollutant types been a decrease in the number of Member States experiencing exceedances. Only, $PM_{2.5}$ has seen an increase.

A similar trend is found when analysing the alternative indicator of the share of zones in EU reporting exceedances – i.e. only $PM_{2.5}$ has seen a slight increase. The share of zones with exceedances remains particularly high regarding O_3, while some of the exceedances of PM_{10} and NO_2 remain together with that of BaP persistent and widespread. For NO_2 this is likely a reflection of difficulties to cope with an increasing road traffic in urban areas. The overall finding is thus that exceedances of targets/limits have decreased over time, indicating the pollution reduction measures provided for by the AAQ Directives have been effective.

Table 6-6 Exceedances of targets/limits, 2008 and 2017

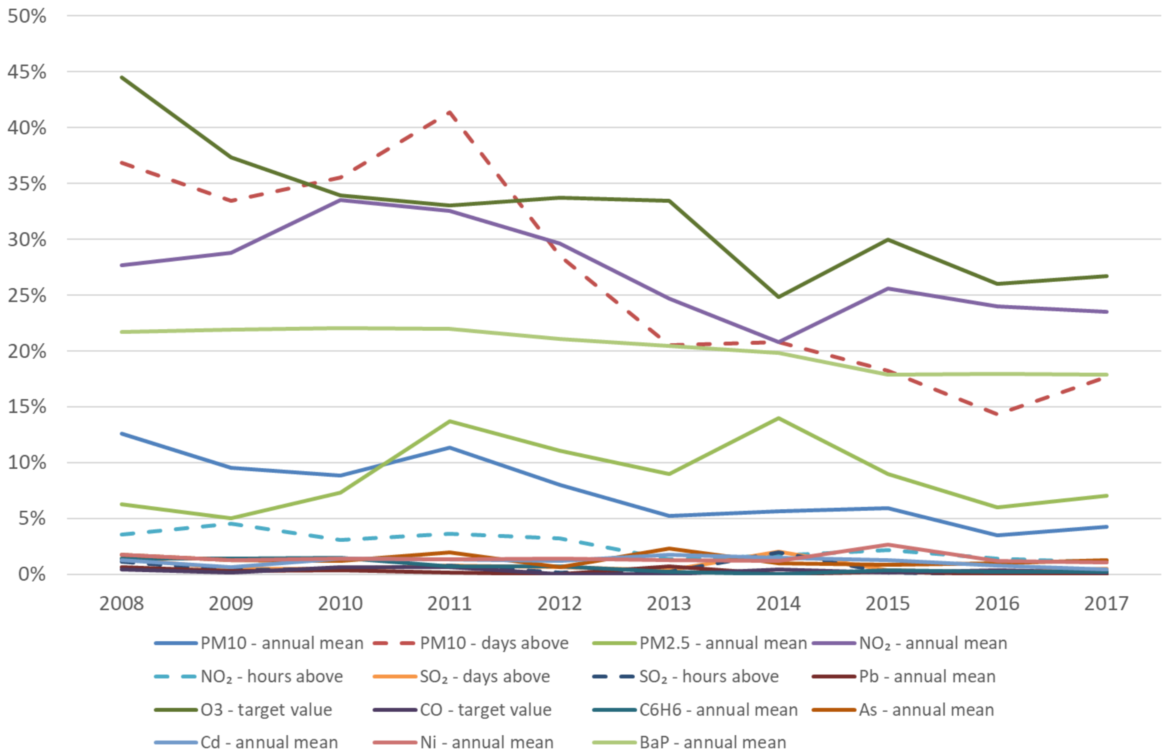
Pollutant	**Objective**	**Parameter value**	**Number of Member States reporting exceedances**		**Direction**	**Share of zones in EU reporting exceedances**		**Direction**
			2008	2017		2008	2017	
PM_{10}	Limit value	Annual mean	16	10	↓	13%	4%	↓
PM_{10}	Limit value	Days above	22	14	↓	37%	18%	↓
NO_2	Limit value	Annual mean	22	16	↓	28%	23%	↓
NO_2	Limit value	Hours above	10	6	↓	4%	1%	↓
SO_2	Limit value	Days above	5	2	↓	1%	0.5%	↓
SO_2	Limit value	Hours above	5	1	↓	1%	0.2%	↓
CO	Limit value	Maximum daily 8 hour mean	2	1	↓	0.4%	0.2%	↓
C_6H_6	Limit value	Annual mean	5	1	↓	1%	0.2%	↓
Pb	Limit value	Annual mean	3	0	↓	0.6%	0.0%	↓
O_3	Target value	Maximum daily 8 hour mean	18	14	↓	45%	28%	↓
$PM_{2.5}$	Target and limit value	Annual mean	4	8	↑	6%	7%	↑
As	Target value	Annual mean	8	4	↓	2%	1%	↓
Cd	Target value	Annual mean	5	2	↓	1%	0.4%	↓

Pollu-tant	Objective	Parameter value	Number of Member States reporting ex-ceedances		Direc-tion	Share of zones in EU reporting exceedances		Direc-tion
Ni	Target value	Annual mean	5	4	↓	2%	1%	↓
BaP	Target value	Annual mean	12	10	↓	22%	18%	↓

Sources: 2008: "Reporting on ambient air quality assessment in the EU Member States, 2008 - ETC/ACC Technical Paper 2010/11", 2017: COWI, based on data flow G
Legend: ↑ increase, ↕ unchanged, ↓ decrease

Figure 6-2 provides more detailed annual data per pollutant over the time period 2008 to 2017. It reveals that the decreases in the share of zones with exceedances for many of the pollutants have been fluctuating. For example, the slight decrease for NO_2 (annual mean) is a result of increases in the early years of the given time period and decreases – particularly between 2011 and 2014. Similarly, for PM_{10} (days above) the share of zones with exceedances rose between 2008 and 2011 – and decreased from that time only. For the two other pollutants with relatively high shares of zones with exceedances, O_3 and BaP, the decreases between 2008 and 2017 have been smoother.

Figure 6-2 Share of zones in the EU reporting exceedances, by pollutant, 2008-2017



Sources: 2008-2012: ETC Technical Papers
2013-2017: COWI, based on data flow G

Notes: The data series contain a few exceedance data gaps (e.g. for Italy 2013-2014) or wrong entries (e.g. Romania 2014). In these cases, both the data on the number of zones and of those with exceedances have been excluded from the calculation of shares.

For three pollutants, Member States had the option to request time extensions as per Article 22 of the Directive 2008/50/EC with respect to complying with the targets/limits for, i.e. PM_{10} – up to three years, and for NO_2 and C_6H_6 - up to five years. Due to expected difficulties with meeting the targets/limits several Member States have made use of the opportunity to apply for this. For the former two pollutants, Table 6-7 shows that time extension was applied for in a substantial number of zones – i.e. for more than a third of the zones where PM_{10} is monitored, and for almost a quarter of the zones where NO_2 is monitored. However, the European Commission has not objected to more NO_2 time extensions (than PM_{10} time extensions), both in absolute terms but so obviously in relative term – with 37% of the NO_2 zone applications being granted against 19% for the PM_{10} applications.

Some zones that have been granted time extensions in order to deal with the given air pollutant problems have not succeeded in avoiding exceedances at the time of the expiry of the time extension. This goes for 18% of the granted zones for PM_{10} and 39% for NO_2. For PM_{10} this is below the average of 23% for 2013 (see Table 6-7), while it for NO_2 is above the average of 28% for 2015. The tendency seems thus to be that the relatively fewer PM_{10} time extension grants given have led to better performance of the zones overall. The below performance of the zones with granted NO_2 time extensions might, however, be explained that the granting is given to zones with particular difficulties in dealing with NO_2 emissions.

Table 6-7 Zones with time extensions for PM_{10} (days above) and for NO_2 (annual mean)

	PM_{10}	NO_2
Number of zones in EU for which time extension was applied for	297	199
Number of zones in EU granted time extension by the EC	56	74
Number of zones in EU granted time extension but still had exceedances by 2013* (PM_{10}) and 2015 (NO_2)	10	29
Share of zones granted time extension	19%	37%
Share of zones granted time extension but still had exceedances by 2013* (PM_{10}) and 2015 (NO_2)	18%	39%

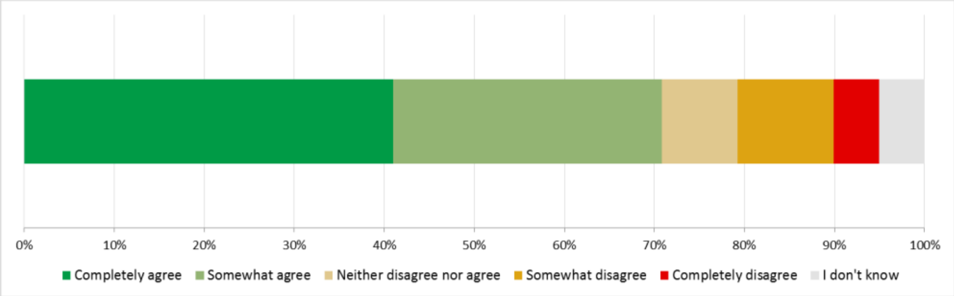
Sources: Time extensions: http://ec.europa.eu/environment/air/quality/time_extensions.htm
Exceedances: http://ec.europa.eu/environment/air/quality/time_extensions.htm

Note: * Since exceedance data were not available by zone for 2013 for a few Member States, data for 2014 were used for Hungary, Poland and Slovakia, and data for 2015 for Austria.

Text box 6-5 Findings from stakeholder consultation (open public consultation, targeted consultation, workshop)

The above observed trends are also appreciated by the respondents to the study's targeted questionnaire survey. 18 out of 26 respondents positively rates "the extent to which the established standards of air quality to achieve across the EU has been achieved". Respondents have exemplified the success by describing that the common standards and associated framework provide a "push" to resolve it, by urging authorities to act. However, it was also remarked that the standards are not fully actionable. The open public consultation question 7.1.2 asked "*to what extent have the Ambient Air Quality Directives been effective in achieving the following outputs: Clean air quality standards established across the European Union?*" The open public consultation responses to the question were largely positive. The vast majority of respondents (a little over 70% of the 476 respondents) agreed somewhat or completely that the Directives have achieved the aim to establish clean air standards.

Figure 6-3 Stakeholder responses regarding the extent to which the AAQ Directives have been effective in establishing clean air quality standards



Source: Open public consultation. N=476

Indicator 2: The contribution of relevant AAQ Directive provisions (internal factors) and other (external) factors to the level of achievement

Assessment summary: The mandatory nature of the air quality standards has been identified as an important positive element in achieving the standards. However, despite their mandatory nature, some Member States struggle, as shown above, to comply with limit/target values of key pollutants. The assessment of factors behind the non-achievement of the standards also points to linkages between the different objectives of the AAQ Directives. Effectiveness of air quality plans and measures (Objective 4) appears to influence the achievement of the environmental objectives. The correct siting of sampling points, on the other hand, is a prerequisite for correct monitoring and assessment of air quality, and thereby for effective plans and measures. Furthermore, external factors such as geography and meteorological conditions, socio-economic conditions, public awareness and other EU policies have played a role in how air quality objectives are being achieved.

Several factors influencing the objective achievement have been identified through desk study analysis and the targeted consultation. More hindering than driving factors have been identified. For some pollutants, in particular PM_{10}, more information is available, partly because limit values have been in force for a comparatively long time, and there have been a number of infringement cases.

In terms of factors that contribute to pollutant concentrations, the EEA annual air quality reports ([R53], [R51], [R50], [R45]) describe that for PM, the most important driver is precursor emissions which can lead to high seasonal concentrations (due to, in particular the emissions of NH_3 from fertiliser use in agriculture). Meanwhile it is acknowledged that O_3 concentrations are highly influenced by meteorological conditions. The targeted stakeholder consultation reiterated some of these factors, namely, certain policies (e.g. climate change – promoting diesel cars, biomass as zero-emission fuel as hindering and source legislation such as IED as contributing factor) and socio-economic factors, or specific Member State circumstances. These were raised both in the AAQ Expert Group meeting[35] and in the replies to the targeted questionnaire. In addition, in both of these consultation exercises, siting of sampling points came up as a factor influencing varied compliance (link with Objective 1).

Fewer internal factors were identified via the targeted questionnaire. 6 out of 26 respondents raised comments on the possible hindering effect of the way the air quality standards are defined, while two respondents highlighted that the mandatory nature of the standards is a driving force for achieving the objective. One NGO questioned, as shown in Text box 6-6, the value of having a flexibility in the setting of air quality standards.

Text box 6-6 NGO response to targeted questionnaire on different types of air quality standards

"Contrary to the limit values, other types of air quality standards (such as the target values, under Article 17 Directive 2008/50/EC or Article 3 Directive 2004/107/EC, or the average exposure reduction target, under Article 15 Directive 2008/50/EC) do not provide certainty to the public. Several flexibilities, inherent to these standards, and the ability of Member States to balance the protection of health and the environment with other factors (such as the costs of measures), significantly weaken the ability of these obligations to deliver improvements of air quality."

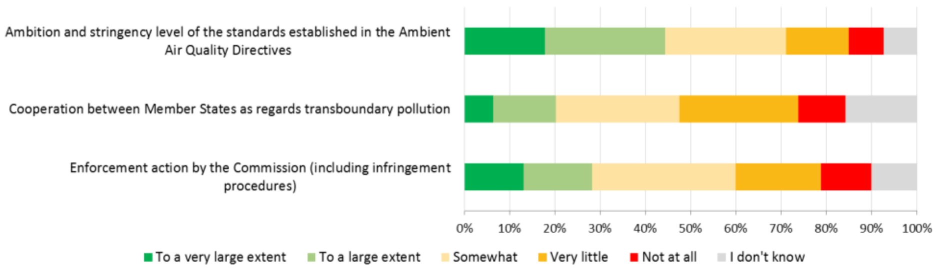
Source: Reply to targeted questionnaire

Furthermore, mostly linking to the relevance of the standards, some respondents considered the standards possibly too restrictive – e.g. same standards being applied in urban areas as elsewhere, while others thought that some of the air quality standards are "too weak". On the other hand, "strong" standards such as limit values were noted as a positive (internal) factor in driving compliance.

Text box 6-7 Open public consultation results: role of the provisions of the Directives in improving air quality

The open public consultation results put some of the factors that were named by stakeholders in the other consultation exercises (infringement procedures, ambition level and cooperation) into a wider perspective. The open public consultation asked stakeholders to provide their views on the extent to which certain provisions were factors in improved air quality in the Member States, namely: ambition and stringency level of the standards, cooperation between Member States on the issue of transboundary pollution, and enforcement action. The results are shown in the figures below. While the importance of these factors is acknowledged by a proportion of the respondents, this view is not unanimous. It is in particular noticeable that the ratings on enforcement action and cooperation are highly varied, indicating different experiences and perceptions.

Figure 6-4 Stakeholder responses regarding the extent to which the following factors related to the provisions of the Directives (at EU level) contributed to better air quality in the respondent's country



Source: Open public consultation. Question 7.2: To what extent have the following factors related to provisions of the Directives (at EU level) contributed to better air quality in your country? N=465.

[35] AAQEG meeting, January 2018.

In some cases where Member States have failed to comply with pollutant limits, they have been subject to infringement cases to force them to improve. Actually, Table 6-8shows that most Member States have faced Commission action related to failing to respect limit values since 2008. Overall, 23 of the 28 Member States have faced legal action: infringement cases against 20 Members States are ongoing for breaching one or several pollutant limits, while all infringement cases against 3 Member States are closed [D65]. Infringement cases are currently underway in 15 Member States regarding PM_{10}. There are active infringement cases related to NO_2 exceedances pending against 14 Member States. 10 Member States faced action on SO_2 exceedances, one of which remains active (see Table 6-8).

Table 6-8 Infringement cases against Member States since 2008 related to breach of pollutant limits

Pollutant	Active cases	Closed cases
PM_{10}	15 (Bulgaria, Czech Republic, France, Germany, Greece, Hungary, Italy*, Latvia, Poland, Portugal*, Romania, Slovakia, Slovenia*, Spain, Sweden*)	7 (Austria, Belgium, Cyprus, Denmark, Estonia, Malta, United Kingdom)
NO_2	14 (Austria, Belgium, Czech Republic, Denmark, France, Germany, Greece, Hungary, Italy, Luxembourg, Poland, Portugal, Spain, United Kingdom)	N/A
SO_2	1 (Bulgaria)	9 (Czech Republic, France, Italy, Poland, Portugal, Romania, Slovenia, Spain, United Kingdom)

Source: European Commission Infringement Decision Database as of April 2019 [D65].
Nagl et al. Air Quality and urban traffic in the EU: Best practices and possible solutions 2018 [R139].
Nagl et al. Implementation of the Ambient Air Quality Directive 2016 [S88].
Note: The active infringement cases include Member States, who received letter of formal notice, reasoned opinion or have been referred to the Court of Justice of the EU.
* These Member States have before faced infringement cases for the given pollutant since 2008, but they are now closed.

Furthermore, the analysis of selected court case documentation [L1, L2, L3][36] reveals differences between the reasons for failure to comply that are put forward by the claimants (the European Commission, as well as cases brought forward by NGOs such as ClientEarth) and that are put forward by the defendants (Member States). In particular, the defendants attribute failure to comply with natural sources, meteorological conditions, "too-strict" standards, and overall EU policy (in particular ineffective legislation of PM_{10} precursor emissions, weak link between air quality and climate mitigation policy). In addition, socio-economic conditions, cost and administrative difficulties are put forward as one of the factors in non-compliance. As such, the majority of factors put forward by the defendants are external to the AAQ Directives and often also outside of the defendants' direct influence. On the other hand, the claimants mainly referred to failure by the defendants to prepare appropriate air quality plans and adopt relevant measures to curb air pollution[37]. Other documents by NGOs ([R1], [R92]) complement this by referring to the other objectives of the AAQ Directives, namely, access to information and adequacy of plans and measures.

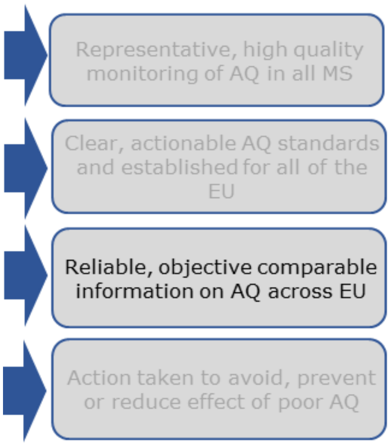
[36] The majority of the court case documentation available relates to PM_{10}, and NO_2.
[37] Appendix F provides details on the data identified in these documents.

6.2.1.3 Air quality information

Judgement criterion 2.3: Internal or external factors are identified that influenced availability of reliable, objective and comparable information across the EU

Indicator 1: The extent of achievement of the expected outputs

Assessment summary: The analysis finds that the information on air quality is made available to the public at the EU and Member State level. However, the information was assessed to be of mixed quality, level of detail and accessibility (to citizens) among Member State responsible authorities. The finding is based on the analysis of information on responsible authority websites, stakeholder consultation and case studies.



The third objective and associated output relate to Article 1(4) in Directive 2008/50/EC. The AAQ Directives require that the information regarding air quality is provided to the public and stipulate a set of rules on how that is to be done. This covers Articles 26 and 20 in the 2008 Directive and Article 7 in the Directive 2004/107/EC[38]. According to these, the Member States shall ensure that the public (and relevant organisations) are informed "adequately and in good time" on: 1) air quality, 2) time extensions or exemptions, 3) and air quality plans. This information must be free of charge and available on easily accessible media (e.g. Internet). In addition, Directive 2008/50/EC specifies that Member States must publish annual reports that summarise exceedances of environmental objectives, as well as the effects on those exceedances on health and the environment. Furthermore, the Commission Implementing Decision[39] from 2011 provides the rules for the reciprocal exchange of information and reporting on ambient air quality.

The assessment conducted for this Fitness Check found that air quality information is available to the public across the EU Member States – both via the EEA websites, as well as via national, regional, or local information sources. Most of the national[40] designated authorities in the Member States publish air quality information by making it available on their website. The results varied among the Member States in terms of the degree to which the information was easy to find, user-friendly and up-to-date. In terms of accessibility of annual reports of the national designated authority websites, 11 of the 28 assessed websites were found to provide easily accessible annual reports, the latest of which contained information on both exceedances and their effects.

As shown in the above section on air quality standards, most EU Member States reported exceedances for at least one pollutant in 2008 and 2017, which means that according to the Directives, most Member States can be expected to have prepared air quality plans, which also need to be available to the public.

A comprehensive assessment of the availability of information on the responsible Member State authority websites was carried out. The overall finding was that for 11 out of the 28 Member States, air quality information was easily accessible, user-friendly and up-to-date. For 15 Member

[38] In addition, Articles 27 and 20 in the 2008 Directive and Article 5 in the 2004 Directive relate to transmission of information to the Commission. This is done via the Eionet, and the predefined Reporting Obligations as outlined in the Commission Implementing Decision 2011/850/EU.
[39] See https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:335:0086:0106:EN:PDF and http://ec.europa.eu/environment/air/quality/legislation/pdf/IPR_guidance1.pdf
[40] For France, Italy and Spain the study also assessed the websites of regional designated authorities for capital regions.

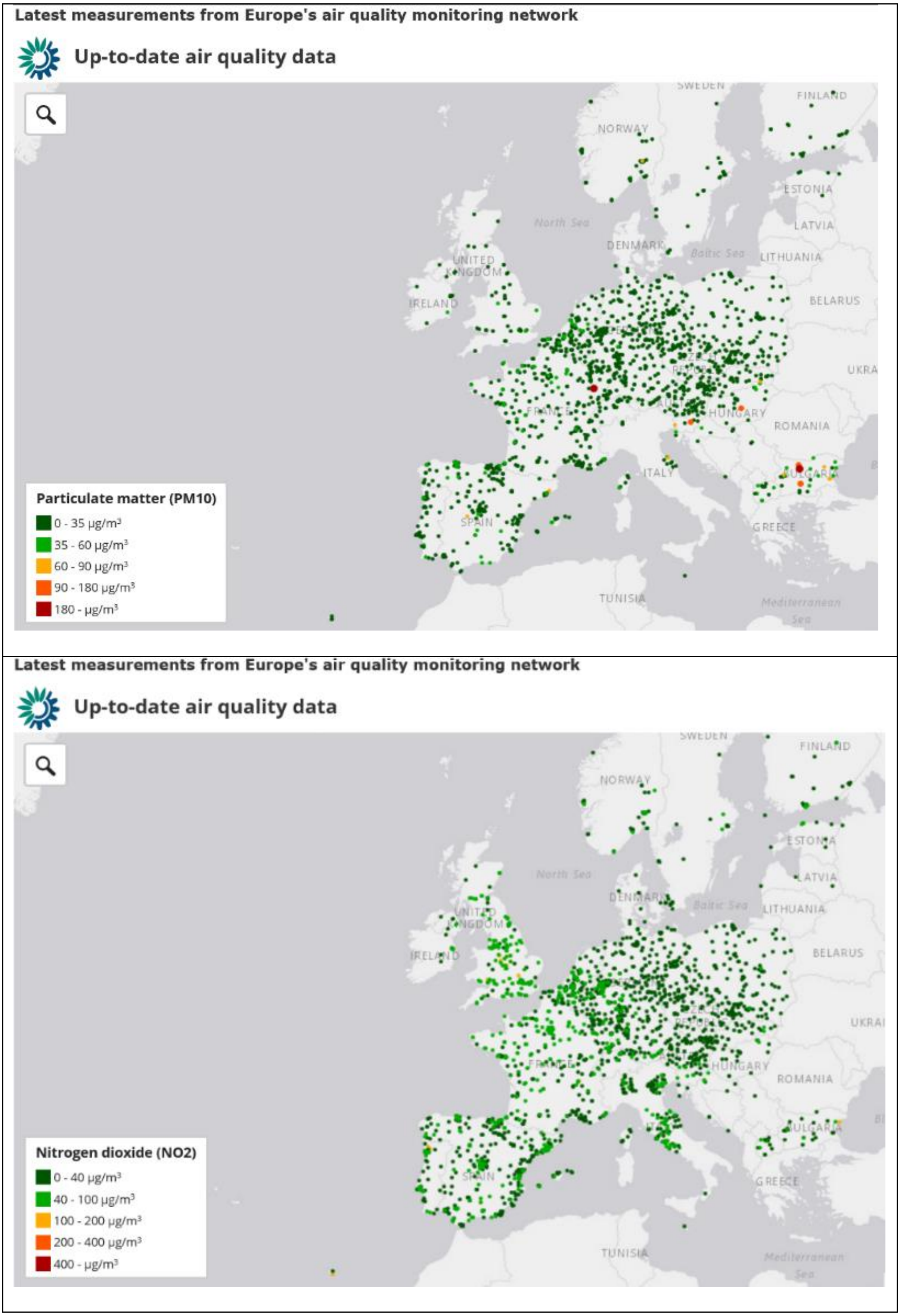
States, websites with relevant information was found, but it was either difficult to access (took a long time to locate), out of date or hard to understand. Furthermore, the availability in the Member States of annual reports on air quality was assessed. The finding is that for 12 Member States annual reports are accessible and contain both information on exceedances and their effects, for 4 Member States annual reports are accessible, but contain no information about exceedances or their effects, and for 12 Member States no annual reports were identified on the competent authority website.

Furthermore, most stakeholders who responded to the targeted questionnaire have positively assessed the achievement of the objective of making air quality information available to the public (70% of valid targeted questionnaire responses had positive ratings). Examples provided in terms of availability of information included EEA Air Quality Reports, availability of air quality information at the EU but also Member State level (authority websites). This said, some stakeholders noted that the information provided may not be clear to "an average citizen".

The case studies support the above finding by exemplifying that although information is published, there are still challenges in terms of public awareness (for example, noted by stakeholders in Slovakia and Spain). In some Member States information is provided both at national (federal) and regional (state) level, and there are selected regions which have not yet fulfilled the obligation to provide information to the public (Sicily, Italy case study). Similarly, around 60% of the open public consultation respondents agreed "completely" or "somewhat" that the AAQ Directives have been effective in achieving its objective of "Relevant information on air quality made available across the European Union".

To complement the Member State-level public information, air quality information is available at EU level on the EEA website, including up-to-date air quality data (as shown in Figure 6-5), historical statistical viewers, and other detail for each air pollutant covered by the AAQ Directives. This facility helps the fulfilment of the Commission Implementing Decision that "Member States shall make available to the data repository the information required by this Decision in accordance with the data requirements set out in Part A of Annex I. That information shall be automatically processed by an electronic tool". In this context, a recent evaluation of the EEA found that it is effective in providing reliable, objective and comparable information to the public – with air quality being noted as one of the most successful examples [P73].

Figure 6-5 Example of EEA air quality information dissemination



Source: EEA

Indicator 2: The contribution of relevant AAQ Directive provisions (internal factors) and other (external) factors to the level of achievement

Assessment summary: A driving factor influencing the achievement of the objective of making information on air quality available to the public is that there actually is a public demand for information. A factor which may hinder the achievement of this objective is found to be that Member States have taken varied approaches, both to the dissemination itself, but also to the collection, assessment and reporting of data. The evidence here is, however, "relatively weak" as it is based largely on examples provided in case study and targeted questionnaire responses.

Over a quarter[41] of respondents to the targeted questionnaire highlighted the provisions on information availability as an important positive factor in ensuring information being available to the public. On the other hand, 30% of the respondents[42] pointed to accessibility of information to the general public as hindering to objective achievement. In this regard, stakeholders noted that information is often not provided in a form that is clear to an "average citizen". Some noted this as being the result of the Directives themselves, while others raised it as an issue of varied implementation by Member States.

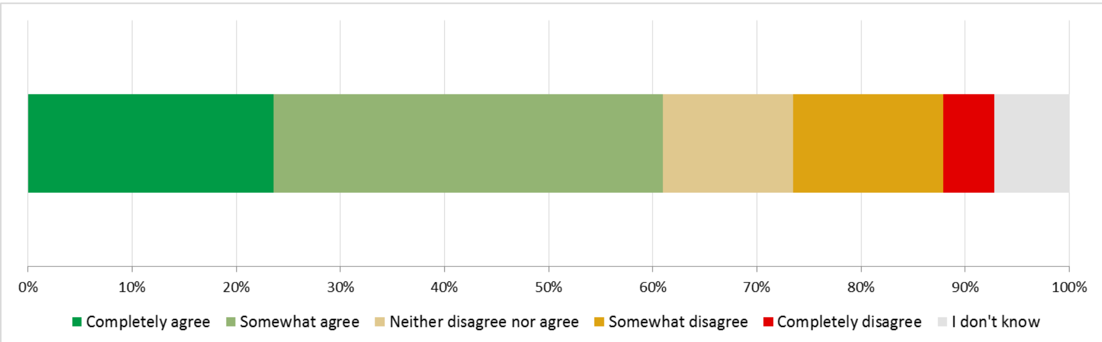
As an external factor contributing to public access to information, Directive 2003/4/EC on public access to environmental information was highlighted. Furthermore, the case studies indicate that some Member States had no prior information systems, and as such, the AAQ Directives have provided the required incentive to develop such systems (source: Bulgarian case study). However, national legal frameworks for handling this as well as responsibility division between national and regional levels have been found to be different. This may be another factor influencing the level/quality of information, but no direct evidence was identified.

Finally, as shown in Text box 6-8, the stakeholders that participated in the consultation overall appreciate the efforts made to improve the availability of air quality information.

Text box 6-8 Findings from the stakeholder consultation (open public consultation, targeted consultation, workshops)

In the open public consultation, the majority (60%) of stakeholders consulted have positively assessed the achievement of the objective of making air quality information available to the public, as shown in the figure below.

Figure 6-6 Stakeholder responses regarding effectiveness of the AAQ Directives in terms of making information on air quality available across the EU

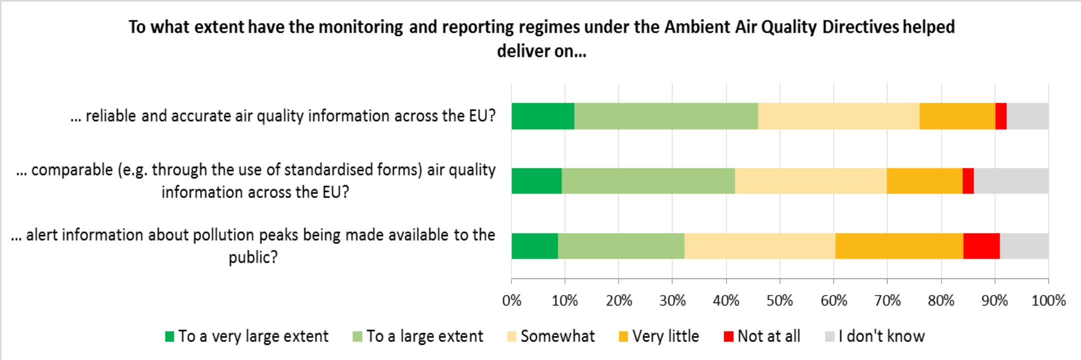


Source: Open public consultation Q7.1.3 to what extent have the Ambient Air Quality Directives been effective in achieving the following outputs: relevant information on air quality made available across the European Union?

[41] 8 out of 30.
[42] 9 out of 30.

The open public consultation also sought to understand the role of the AAQ Directives' monitoring and reporting regimes in delivering reliable, accurate, comparable information on air quality across the EU, as well as alert information being available. The responses are shown in the figure below. They indicate that the highest proportion of respondents (ca. 46%) consider that the provisions in the AAQ Directives have helped deliver reliable and accurate information (to a large or very large extent). Somewhat fewer (around 41%) think the same about comparability of information across the EU (reiterating some examples indicated under the other objectives analysed that Member States are able to interpret the Directives differently, leading to potentially different assessment). Finally, fewest considered that the AAQ Directives provisions contributed to making alert information available to the public.

Figure 6-7 Stakeholder views on role of the AAQ Directives regimes on information availability, reliability and comparability



Source: open public consultation Q7.7 To what extent have the monitoring and reporting regimes under the Ambient Air Quality Directives helped deliver on (elements in chart)

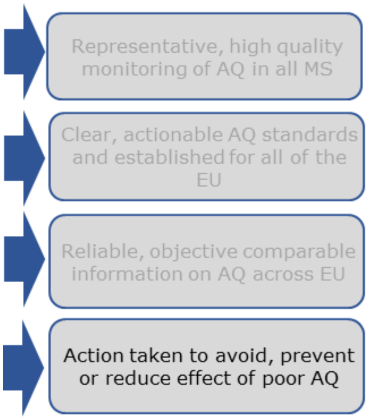
The respondents that commented on the achievement of the objective related to access to information to the public in the targeted consultation similarly assessed that, in general, the AAQ Directives have contributed to the availability of information about air quality. However, some limitations were noted. Most notably, 9 respondents (4 NGOs, 3 national authorities, 2 local or regional authorities) found that certain limitations existed in terms of how clear and understandable the information made available to citizens was and 2 NGOs raised concerns about the existence of different approaches in relation to information and alert thresholds.

6.2.1.4 Actions to avoid, prevent or reduce effects of poor air quality

Judgement criterion 3.3: Internal or external factors are identified that influenced the extent to which coherent action has been taken to avoid, prevent or reduce effects of poor air quality

Indicator 1: The extent of achievement of the expected outputs

Assessment summary: Almost all Member States reporting exceedances have also prepared air quality plans as required by the AAQ Directives. Road transport is one of the main sources for the exceedances of NO_2 and to a lesser degree also of PM_{10}. Many measures to reduce such emissions therefore focus on this sector – e.g. congestion charges, speed limits, the promotion of cleaner vehicles and public transport. A main source for PM_{10}, and also for NO_2, emissions is that of domestic heating. Measures here include the promotion of shifts towards low-emission fuels, retrofitting, green public procurement as well as public information services. Effectiveness is encouraged by the flexibility for the Member States, hereunder regions and municipalities, to choose the measures that best fit their local conditions – i.e. the most cost-effective measures. This is an issue that is analysed in more detail under the efficiency evaluation criterion within this study. This said, insufficient coordination between authorities in the Member States is pointed out as a hindering factor for reaping all the benefits from the flexible provisions.



The fourth objective and associated output relate to Article 1(5) in Directive 2008/50/EC, with Member State cooperation described in Article 1(6) being an important input. It concerns the provisions for actions by the Member States when air quality standards are not met. This covers the extent to which air quality plans have been made – hereunder short-term action plans triggered by the risk of exceedances, and the extent to which measures accordingly have been implemented in the Member States to avoid, prevent or reduce the effects of poor air quality. With the objective aiming to "maintain" or "improve" air quality it is closely linked to the other objectives (especially as related to air quality standards).

As found in the analysis above, most Member States have reported exceedances of limit and target values of at least one pollutant in the period 2008 to 2017. A review of the reporting of air quality plans by the Member States reveal that most have entered their plans into the CDR[43]. In this context it should be noted that air quality plans are only required within two years of the observed exceedance. Hence, it must be concluded that the AAQ Directives have been successful in encouraging the development of air quality plans. Furthermore, the Commission has provided best practices to support the development of short-term action plans.[44]

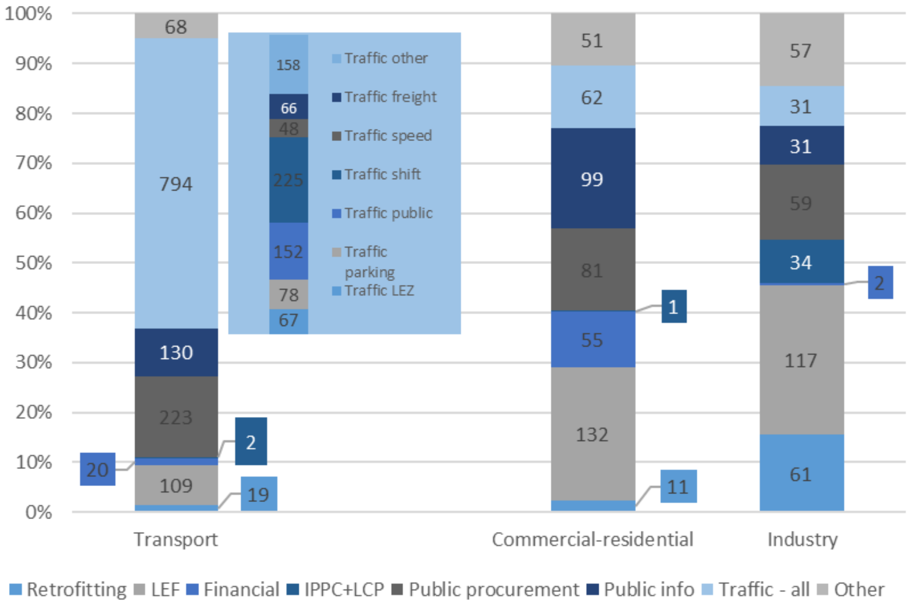
As already mentioned, the air quality plans provide for measures to be implemented in the Member States to avoid, prevent or reduce the effects of poor air quality. Effectiveness is here encouraged by the flexibility for the Member States, hereunder regions and municipalities, to choose the measures that best fit their local conditions – i.e. the most cost-effective measures, rather than prescribing measures. This is an issue that is analysed in more detail under the efficiency evaluation criterion within this study.

The EEA has in 2018[45], as shown in Figure 6-8, assessed the number of measures implemented in the EU by type of measure in the road transport (mainly urban, but also suburban and rural areas), commercial-residential (mainly urban areas) and industry sectors (mainly suburban and rural areas) to deal with NO_2 and PM_{10} exceedances. It covers the years 2014-16 and includes information on stated reasons for the exceedances. The EEA thus emphasises that road transport is one of the main sources for the exceedances of NO_2 and also of PM_{10}. For both pollutants, "proximity to a major road" and "heavily trafficked urban centre" were among the most common reasons cited. The measures identified include congestion charges, speed limits, the promotion of cleaner vehicles and public transport.

Furthermore, a main source for PM_{10}, and also for NO_2, emissions is pointed out to be that of industrial, commercial and residential combustion. Measures here include the promotion of shifts towards low-emission fuels, retrofitting, green public procurement as well as public information services.

[43] Only Luxembourg, Cyprus, Greece and Malta still have to do this. Source: Eionet submissions on CDR data set H.
[44] http://ec.europa.eu/environment/air/quality/legislation/pdf/SC5_Task%201_report.pdf
[45] EEA Briefing no 9/2018 [D41]; assessment includes Norway.

Figure 6-8 *Number of measures by type in the road transport, commercial-residential and industry sectors for NO_2 and PM_{10}*



Source: Figure provided by EEA (7 November 2018) – based in air quality measures data flow K. See also EEA: https://www.eea.europa.eu/themes/air/improving-europe-s-air-quality

Note: LEF – low emission fuels, IPPC - Integrated Pollution Prevention and Control (industry) measures, LCP – large combustion plants

As summarised in Table 6-9, a number of specific measures have been implemented in the Member States analysed in further detail in this study's case studies to deal with air pollution exceedances. The table reveals that the case studies have focused on urban area measures to deal with road traffic-related air pollutants such as NO_2, PM_{10}, CO and O_3, and on measures to dealt with pollution from domestic heating e.g. PM_{10}, $PM_{2.5}$ and CO.

The table shows that the measures differ in between Member States. This underpins the usability of the flexibility provided for by the AAQ Directives. This said, there are also a number of similarities between the Member States. For example, most Member States have found the establishment of low emission zones an effective way of reducing air pollution from road traffic in urban areas. Other common road traffic measures include traffic regulation and speed limits, cleaner public transport, and the promotion of cycling. Other measures, that are often used in the case study Member States, include the promotion of cleaner domestic heating, and in general the use of renewable energy sources.

The case studies have, however, also revealed that there in several Member States is insufficient coordination between authorities which is a hindering factor for reaping all the benefits from the flexible provisions. In some Member States it is a result of the division of responsibilities between the different levels of authorities, e.g. there are situations where cities do not have the legal authority to sufficiently regulate the emission sources contributing to exceedances. In other situations, there is a lack of competences among those being given the task to e.g. establish low emission zones or to regulate the traffic. Furthermore, at the strategic level, the air quality plans are not always coordinated with other sectoral plans. And, if responsibility is not clear and if money is short, air quality might not be a priority.

Table 6-9 Measures implemented in case study Member States to avoid, prevent or reduce the effects of poor air quality

Member State	Road traffic measures	Domestic heating measures	Other measures
Bulgaria	• Low emission zones • Congestion charges • Speed reductions • Promoting cycling • Modernisation of public bus fleet	• Ban on bituminous coal for household use • Fuel conversion in domestic heating • Promoting clean stoves and boilers • Installation of air filters on chimneys • Energy-efficient building insulation	• Use of renewable energy sources
Germany	• Low emission zones • Incentive programmes for taxis • e-mobility • Public transport • Promotion of cycling • Electrification of car-sharing offers		• Upgrading industrial installations
Ireland	• Investment in high-quality public transport • Dublin bike rental scheme • Ban on heave vehicles	• Bituminous coal restricted areas	• Agricultural and industrial measures will, together with transport and domestic heating measures, be integrated into the National Clean Air Strategy (NCAS) – that is under development
Italy	• Low emission zones • Initiatives to promote less-polluting vehicles • Traffic restrictions • Bike-sharing schemes • Ban on diesel and commercial vehicles at lower Euro standards in winter months	• Tax reductions when purchasing certified wood stoves • Stringent standards for household biomass burners	• Lower emission limits for refineries, chemical and cement plants • Increase in urban green areas • A ban for the more polluting stoves in order to reduce emissions from domestic heating
Slovakia	• Low emission zones • Traffic regulation	• Information to public about clean domestic heating	• Smog warning system • Working group for agricultural measures established
Spain	• Low emission zones (central zero emission zone) • Specific access roads for public transport • Tax incentives for less-polluting cars • Car parking restrictions • Traffic reductions and speed limits	• Renewable energy and energy efficiency in buildings	• Plan Aire 2017-2019 also includes agricultural measures
Sweden	• Low emission zones • Congestion charges • Speed reductions	• Temporary ban on small-scale solid fuel burning	• Sulphur control Area • Sulphur tax • Control of sulphur in fuel

Member State	Road traffic measures	Domestic heating measures	Other measures
	• Restriction on the use of studded tires • Dust binding to reduce particulate levels • Improved weather cleaning after winter season	• Information about emissions and hazards from burning wood • Extension of district heating	• Rural Development Programme (envisaged to reduce GHG and ammonia) • Environmental differentiated shipping tax

Source: Case studies

The differences in measures taken by the different Member States may have been reduced with more guidance to best practice measures. This said, there exist a number of guides for Member State authorities to make use of. These include management practices in the Member States analysed and disseminated by the European Topic Centre [S129, S130], that both cover urban areas measures as well as suburban measures such as those to increase the efficiency of power plant and the voluntary reduction of emission at specific refineries, and rural area measures such as a ban of waste burning or the implementation of technological measures to eliminate agricultural waste. Furthermore, there is useful guidance from the AIRUSE LIFE project [R200], that focuses on measures to be implemented in cities in Southern Europe – hereunder measures targeted at the construction and industrial sectors. Finally, more sector-specific guides are available. These include measures to address air pollution from small combustion sources [R12], from agricultural sources [S66] and from transport sources [S131, S132, R201].

Hence, while the case studies focused on measures targeted at urban and suburban areas, non-urban measures such as those targeting the agricultural sector are mentioned. Furthermore, the above guidance material shows that efforts are also made to implement measures targeted at rural areas – e.g. pollutants from the agricultural sector. This takes mainly the form of ammonia (NH_3), which enters the air as a gas from heavily fertilized fields and livestock waste. It also reacts with NO_x and SO_2 from road transport and industry and so also contributes to urban air pollution. Agricultural sector measures are considered to be most effective if they are integrated into production process decisions such as the possible use of low-emission fertiliser, better livestock, and manure management practices. Hence, there will also be benefits at the policy level between environmental (air quality) policies and agricultural policies.

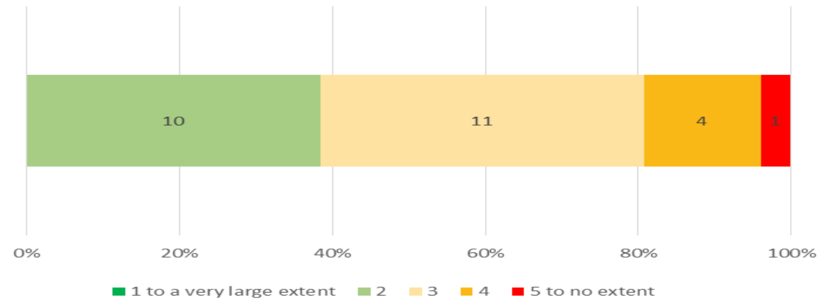
Similarly, suburban/rural measures target at reducing air pollution is often most efficiently carried out in coordination with industrial production process decisions and industrial policies. For example, the promotion of best available techniques many both be to the benefit of the companies' bottom lines as resource use may become more efficient and to the benefit of the environment.

Finally, wider policy decisions made may also be considered as measures contributing to the achievement of the objectives of the AAQ Directives. For example, taxation policies often comprise energy/fuel taxes that affect air pollution condition in both urban and rural areas, while urban policies may cover investments in cleaner mobility and public transport.

Text box 6-9 Findings from the stakeholder consultation (open public consultation, targeted consultation, workshops)

In the open public consultation, less than 40% of the respondents gave a positive evaluation of the AAQ Directives success in achieving the objective of maintaining good air quality and improving it where it is not so good. Compared with the similar stakeholder assessment of the other objectives of the AAQ Directives, this fifth objective scores the lowest with respect to achievement. The reasons given for this lower score include the continued exceedances of the target/limit values and the ongoing enforcement actions. However, the fact that target/limit values are set, and that enforcement actions are possible, is considered to be positive.

Figure 6-9 Stakeholder assessment of the extent to which the AAQ Directives achieved the objective of "maintaining good air quality, improving it where it is not good"



Source: Targeted questionnaire; Effectiveness question 1: To what extent have the AAQ Directives achieved their objectives? (1= to a very large extent; note inverted scale); Objective 5 Maintaining good air quality, improving it where it is not good. Expected output: coherent action taken to avoid, prevent or reduce effect of poor air quality. N=26

The stakeholders that commented on the provisions for maintaining good ait quality provided varying and sometimes discrepant assessments. The obligation to comply with the standards was broadly positively perceived by stakeholders. When it comes to the requirement to set up AQP discrepancies in views between stakeholder categories and within stakeholder categories were noted. Overall, 3 respondents (2 NGO, 1 national authority) positively assessed the provisions on air quality plans of the AAQ Directives. In contrast, 6 respondents flagged limitations in relation to the provisions, including: the issue of timing when air quality plans are required (1 national authority), ambiguity of air quality plans (1 scientific institution, 1 NGO), time taken to draw up the air quality plans (2 NGOs) and the ineffectiveness of the plans (1 national authority and 1 NGO). Another limitation raised by stakeholders was the fact that the AAQ Directives do not tackle air pollution (4 respondents – NGOs, business associations, national authorities). Other limitations of the AAQ Directives flagged by respondents included the limited action concerning the cross-border issues (6 respondents - NGOs, national authorities) and the lack of follow up (3 respondents – NGOs, local and regional authorities).

Indicator 2: The contribution of relevant AAQ Directives provisions (internal factors) and other (external) factors to the level of achievement

Assessment summary: An external factor such as public awareness has influenced the choice of measures resulting from the air quality plans. Furthermore, measures to improve air quality is not solely steered by the air quality plans but also influenced by other EU legislation as well as other Member State actions. Regarding internal factors, for example, the guidance from the EU to implementing measures is by some stakeholder considered not to have been sufficient, while it by others (in particular NGOs) is considered to be key in facilitating enforcement action.

Several factors related to the Directives have contributed to or hindered the achievement of the objective of avoiding, preventing or reducing the effects of poor air quality. Actually, the provision on air quality plans, hereunder the guidance provided in Annex XV of Directive 2008/50/EC, has been noted as both a contributing and a hindering factor. Article 23 is highlighted as a key provision by setting a clear obligation to take action, and it has been referred to effectively in enforcement actions. On the other hand, 6 respondents out of 26 to the targeted questionnaire survey pointed out a number of shortcomings of the AAQ Directives provisions. These include: too late timing of requirements to implement measures, a lack of clarity – e.g. no specific provisions for air quality plans in Directive 2004/107/EC, and insufficient clarity of guidance in Annex XV.

Enforcement actions themselves have also affected objective achievement. However, there is some disagreement on this account with two respondents (out of 26) to the targeted questionnaire noting that they have encouraged objective achievement, while three noted that pursuing such action has been difficult or lengthy.

No evidence has been identified with respect to the ease of application of Article 25 of Directive 2008/50/EC regarding cross-border issues. This said, six respondents out of 26 to the targeted questionnaire explicitly pointed to issues of with transboundary pollution and to a lack of measures in this regard. Reasons mentioned for not initiating Article 25 discussions in the strict sense of the 2008 Directive included lack of resources at local authority level to solve issues with air pollution in neighboring Member States close to common borders, lack of guidance on how Article 25 should be implemented in practice given different legislative settings across Member States, or perceptions that Article 25(2) should only be called upon when Member States were not able to solve a dispute by themselves.

The lack of a requirement in the Directive for (joint) national action plans to address cases of transboundary air pollution and the lack of coordination may also hamper the understanding of which measures may prove most useful and effective in the concrete context. The findings of the 2018 Court of Auditors Special Report [P91] further confirms the problem and points to that the Court of Auditors case studies did not find any evidence of coordinated actions on transboundary pollution in the air quality plans assessed under the study. The Court of Auditors thus provides a recommendation to the Commission to assist the Member States most affected by intra EU transboundary air pollution in their cooperation and joint activities, including introducing relevant measures in their air quality plans.

Five respondents suggested that maintaining good air quality is less prioritised compared to improving it. Hence, when air quality is or becomes good – i.e. complying with target/limit values, efforts and resources are redirected towards areas where air quality still is poor. Two of the respondents (out of 26) noted that hot-spot management stemming from focus on achieving limit values may distort the picture of the level of improvement achieved. Furthermore, four respondents emphasised that the AAQ Directives do not provide for sufficient measures to tackle air pollution on their own but also rely on other legislation to be effective.

In addition to the above factors related to the provisions of the AAQ Directives, a wide variety of external factors were mentioned by the respondents to the targeted questionnaire. Among these, two main areas affecting objective achievement were related to public awareness and to sectoral issues. The latter includes factors related to sectoral legislation, industry actions, and more specific measures being targeted to certain areas.

Public awareness, interest and action was mentioned as a factor by five Member State authorities. Eight of these respondents (out of 26) suggested that increasing public awareness – hereunder among public officials – helps to drive action for better air quality, while one respondent noted the lack of public awareness as an issue.

Other EU legislation was raised by four respondents as a supporting factor and by eight as a hindering factor. The positive responses include the general synergies between the other EU legislation and the AAQ Directives as well as specific legislation, such as the Industrial Emissions Directive, having contributed directly to the achievement of the objectives of the AAQ Directives. Among the eight respondents suggesting a negative contribution, two Member State authorities mentioned an overall conflict with other policy areas, while the others noted incoherence between policy goals or failure of other policies. Climate policy was, for example, pointed out by Member State authorities as having negatively contributed in two ways. Firstly, biomass is being considered as a zero-CO_2 fuel. However, burning organic material emits – like burning other solid fuels as coal – PM, NO_x, CO and SO_2. Secondly, the promotion of diesel cars has had adverse effects not least in urban areas. Respondents from NGOs and municipal authorities have mentioned negative contributions from agriculture, waste, urban energy use, industry policies, climate policies, and emission sources not controlled at EU level, such as small combustion sources (heating), small diesel engines, certain construction sites, etc.[46]

The capacity of an actions by Member State authorities are other widely mentioned factors. These include political will to implement measures which by one Member State authority/agency is regarded as lacking. Furthermore, the complexity of governance structures in terms of responsibility division is sometimes a barrier for decision-making and may exacerbate situations where political will is lacking. For example, in Member States such as Belgium and Germany, the responsibility for air quality management lies with regional (and local) governments, while the Federal Governments can pass or block relevant taxation or traffic management legislation. Finally, failure by Member State authorities to implement the AAQ Directives, e.g. to include all possible and necessary measures to achieve target/limit values within the shortest time possible, is of course a hindering factor.

Another hindering factor pointed out by five Member State authorities/agencies is a lack of awareness across the institutions – e.g. among those responsible for transport planning or spatial development, short-term thinking, or delayed national action. An example of a contributing factor is that of the introduction of official guidelines on the treatment of air quality in spatial planning in Norway that forces businesses and planners to consider air quality and to introduce measures when preparing projects affecting local air quality.

Limited financial resources were also noted as one of the hindering factors by Member State authorities/agencies and by some NGOs. A specific example provided by a Member State authority relates to difficulties in the residential sector where financial support programmes not always allow for the possibility for projects to be implemented.

Another source of evidence is the recent EUROSAI Joint report on air quality [R95] that points to a general problem of a lack of national plans for measuring ambient air policy effectiveness. The supreme audit institutions highlight that only a few EU Member States, i.e. Bulgaria, Hungary, Spain and the Netherlands, have adopted indicators for measuring policy effectiveness. The absence of a national plan and absence of performance indicators, or if such exists but were not properly implemented in other countries (e.g. Estonia, Poland, Romania, Slovakia), makes it very difficult to form an opinion on the effectiveness of measures taken by governments to combating air pollution.

Factors influencing achievement of the AAQ Directives objectives have also been identified through the case studies. In particular, the most common underlying factors can be listed as

[46] See Coherence chapter for more detail on this element.

coordination among different actors and sectors (Germany, Italy, Slovakia, Spain), harmonized methods and regular/precise data (Germany, Ireland, Slovakia, Spain), public and political attention (Bulgaria, Ireland, Italy), consequences for non-compliance /enforcement, e.g. elaboration of a dedicated strategy to tackle the PM_{10} problem as a result of the infringement proceeding (Slovakia, Spain, Sweden).

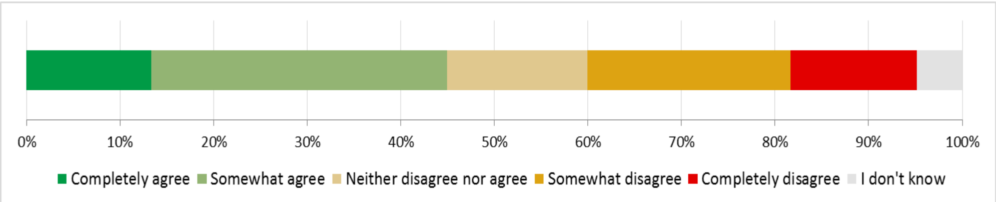
In terms of hindering factors, the most mentioned factors are lack of resources and staff (Ireland, Italy, Slovakia, Sweden), lack of coordination especially across different levels of government and sectoral actors, e.g. between local, regional and federal authorities on measures due to separation of legal authority (Bulgaria, Germany, Slovakia, Spain), lack of information e.g. information sharing among Member State and in a country; for the preparation of the air quality plans (Bulgaria, Slovakia). The findings of the case studies also suggest that despite some improvements, there is still a lack of motivation to improve air quality, both among different actors and public authorities (Germany, Ireland, Slovakia, and Spain).

Finally, the open public consultation, as shown in Text box 6-10, asked the public about their views on the achievement of the objective related to action taken to avoid, prevent, or reduce the effect of poor air quality.

Text box 6-10 Open public consultation results: effectiveness of the Directives to achieve coherent action to avoid, prevent, or reduce the effect of poor air quality

The open public consultation question 7.1.4 asked "to what extent have the Ambient Air Quality Directives been effective in achieving the following outputs: Coherent action taken to avoid, prevent, or reduce the effect of poor air quality?" As shown in the figure below, compared with the other objectives, the outputs required to achieve this objective are seen less positively. Less than half of the respondents "agreed" or "completely agreed" that the AAQ Directives have been effective in achieving this output (compared with 60-70% for the outputs related to setting up air quality monitoring network, establishing standards and providing information).

Stakeholder responses regarding the extent to which the AAQ Directives have been effective in achieving coherent action to avoid, prevent, or reduce the effect of poor air quality?



Source: open public consultation. Question 7.1.4 "to what extent have the Ambient Air Quality Directives been effective in achieving the following outputs: Coherent action taken to avoid, prevent, or reduce the effect of poor air quality?" N=474

6.3 Efficiency

Efficiency analysis considered information on the costs and benefits of measures introduced in response to the AAQ Directives. These fell into two categories, the first dealing with monitoring and reporting systems (direct costs) and the second with the measures designed to reduce emissions and exposure to air pollutants (indirect costs). Consideration is given to how impacts are distributed across stakeholders, including Member States, the public and the sectors that have needed to undertake action, and to the effects of the Directives on EU competitiveness.

Evaluation Questions 3 and 4 concern assessment of the measures implemented at the local, regional or national level to attain or maintain air quality within the AAQ Directive limit values. Costs associated with monitoring, reporting and assessment regimes are considered separately under Evaluation Question 5. Evaluation Question 6 then deals with effects of the AAQ Directives on EU competitiveness in the global economy and on economic, social and environmental sustainability.

Table 6-10 Evaluation questions and judgement criteria for Efficiency

Evaluation questions and judgement criteria on Efficiency
EQ 3: What are the costs and benefits (monetary and non-monetary) associated with implementation of the AAQ Directives in the Member States, and in the EU; have the benefits (improved air quality) been achieved in a cost-effective manner and to what extent have costs been equitably distributed across different sectors? • JC3.1 Quantification of the costs of measures and observations on synergies with other environmental and social policies where appropriate. • JC3.2 Estimates of the health benefits of measures introduced under the AAQ Directives in economic and non-economic terms, qualitative assessment of other benefits. • JC3.3 Are the benefits of action likely to exceed costs or vice versa. • JC3.4 Consideration of how actions have been targeted on the sectors.
EQ 4: Where there are significant cost differences between Member States and/or between different sectors and/or as regards costs to stakeholders (including social costs as a consequences of poor implementation), what is causing them; and are the costs of compliance proportionate to the benefits brought by the Directives? • JC4.1 Identification of costs at Member State level, and appraisal of the reason for cost differences. • JC4.2 Identification of reasons for cost differences between Member States, based on available data, and the sources affected. • JC4.3 Magnitude of health costs in economic and non-economic terms resulting from non-compliance with the limit values. • JC4.4 Comparison of costs and benefits of action.
EQ 5: How efficient are monitoring, reporting and assessment regimes, what are the administrative costs to the Member States and to the Commission; taking account of the objectives and benefits of the Directives is there evidence that they have caused unnecessary or excessive administrative burden? • JC5.1 Data on costs of implementing the requirements of the AAQ Directives for monitoring, reporting and assessment. • JC5.2 - Variability in costs, extent of devolution and availability of guidance • JC5.3 - Evaluation of the costs of action relative to the benefits brought by the AAQ Directives.
EQ 6: Has the implementation of the AAQ Directives supported or hampered EU competitiveness in the global economy; has the implementation of the AAQ Directives improved or been detrimental to economic, social and environmental sustainability? • JC6.1 Assessment of the evidence for transmission of effects of environmental legislation on competitiveness, evidence of impacts on a sectoral basis. • JC6.2 Effects of measures introduced under the AAQ Directives on economic, social and environmental sustainability.

6.3.1 Evaluation Question 3: Costs and benefits of the pollution control measures put in place in response to the AAQ Directives

This question assesses the costs and benefits (monetary and non-monetary) associated with implementation of the AAQ Directives in the Member States, and in the EU as a whole. It focuses on the pollutant control measures introduced to reduce exceedance of the air quality limit values, including the introduction of low emission zones and modal shift in transport, boiler replacements and industrial renovation. It continues by considering whether the benefits (improved air quality) have been achieved in a cost-effective manner and to what extent have costs been equitably distributed across different sectors. The main sources of evidence used to answer Question 3 are literature review, responses to the targeted questionnaires to Member States and original analysis. Little information of relevance to this question could be derived from the open public consultation and the case studies.

Text box 6-11 Key findings on efficiency of AAQ Directives

Costs have been quantified for some measures, though much of the reported costs are only partly associated with the AAQ Directives specifically, appearing to be linked more closely to other environmental and social legislation and action. The benefits of action are substantial, in the order of tens of billions of EUR since 2008, though precise attribution of benefits to the AAQ Directives is not possible given other legislation on air quality that has been implemented over the same period. Benefits seem to be achieved cost-effectively and equitably, with countries designing control strategies in a way that recognises the sources chiefly responsible for exceedance at a local level. Synergies with other policies are recognised in the development of local action plans bringing co-benefits particularly for transport and climate.

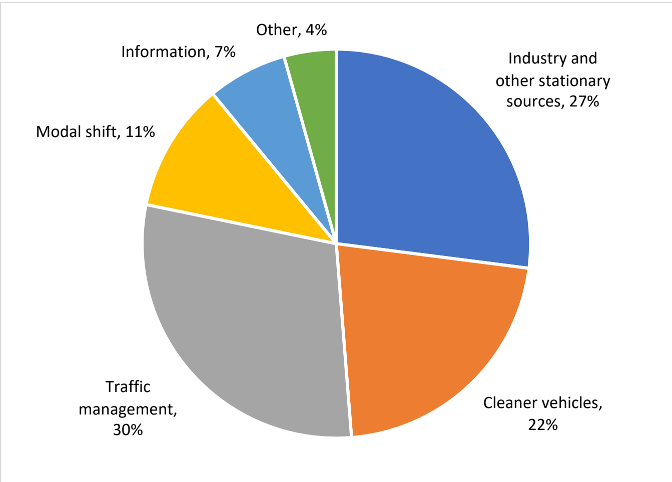
6.3.1.1 Costs of implementing the AAQ Directives

Judgement criterion: Quantification of the costs of measures and observations on synergies with other environmental and social policies where appropriate.

Assessment summary: Information on the costs of the measures introduced to improve air quality are available, however for many measures attributing the full cost of these programmes to air quality improvement is likely to result in double counting and there is little information available on measures that are very specific to air quality.

The EEA holds a database [D44] of measures introduced to improve air quality, covering most Member States. A wide range of measures are employed, relating to cleaner vehicles, traffic controls, modal shift in transport, fuel switching, stationary emission controls, public procurement, fiscal measures and information exchange (see Appendix F, F1.2). The breadth of measures considered, and variation in measures between countries, indicates that air quality management plans are tailored to local circumstance. It also highlights a role for subsidiarity, enabling Member States and their local authorities to

Figure 6-10 Measures adopted in air quality management plans



Source: Author calculations based on data from [D44] assess what is likely to work best on a case by case basis.

Measures are put in place in key sectors associated with exceedance of limit values such as transport and domestic heating (e.g. boilers -included in the figure under 'industry and other stationary sources'). For some countries, there are also a significant number of measures relating to information provision.

The types of measures for which costs are most readily available typically concern large infrastructure projects, such as development of new tram or train lines, roads or cycle routes, or congestion/Low emission zones, and major investments in certain cities (such as the Paris bike hire scheme). Associated costs in these cases will only be partly attributable to air quality improvement: indeed, the role of air quality in deciding to go ahead with new transport infrastructure may be small as compared to congestion-reduction objectives. In contrast, the rationale for implementing a low emission zone (LEZ) or expanding use of more sustainable transport modes, seems likely in many cases to rest entirely with air quality concerns.

Analysis of transport-related measures focused on research on air quality improvements in the Netherlands [R158] identified several measures involving subsidy schemes for vehicle replacement as cost effective, with costs lower than average damage costs for the Netherlands for $PM_{2.5}$. A scrappage scheme, and subsidies for retrofitting vehicles with particle traps were not effective when compared to national damage costs but would be for vehicles being driven to a large extent in urban areas where damage costs are higher (as a function of population density). The most cost-effective scheme – a subsidy scheme for new Euro V/EEV HGVs and buses – delivered benefits more than nine times the level of the costs. This highlights the potential for misallocating financial resources through inappropriate choice of measures, and in turn emphasises the need for data on cost-effectiveness of measures.

The Dutch study [R158] did not consider LEZs. Review of schemes in Berlin, Stockholm, Lisbon, Milan, Amsterdam and Copenhagen demonstrated that the benefits of schemes varied according to the area covered and population exposed, the vehicles targeted and the level of fees or fines. Significant reductions in roadside concentrations of NO_2 and PM_{10} were identified in several schemes (see Appendix F, F.1.4.1).

The EEA database [D44] demonstrates that measures addressing stationary combustion were important for several countries including Poland, Czech Republic, Denmark, Romania and Germany. Data for Poland and Denmark indicate higher cost-effectiveness for the boiler improvements than for the transport measures set out in the Dutch study that focussed on scrappage schemes and upgrading of vehicle technologies. It is also noted that the boiler improvements are not solely being undertaken to reduce air emissions but also to reduce greenhouse gas emissions, through integrated investments that also aim at increasing the proportion of renewable energy and at increasing energy efficiency. Attributing the full cost of these programmes to air quality improvement is thus likely to be incorrect in many cases: correct attribution to avoid double counting costs (or benefits, as discussed below) would need to be based on data describing the decision-making process, and the weight given to different objectives. Further discussion on co-benefits is provided in Appendix F (F.1.7.3).

The collated consultation responses contained little data on the costs and benefits of actions undertaken in the context of the two Directives. The national case studies similarly provide little data on this, although some estimates of cost are given for individual measures. For benefits, reference is made to impacts quantified typically by the EEA, but no further detail on the benefits arising from the implementation of the AAQ Directives is provided. Some data on costs has been identified from other sources, albeit, not always with the nature of costs (capital, operating, etc.) being clear. Similar conclusions on data availability have been reached elsewhere [R154, S52]. Whist preference was given to sources providing ex-post estimates, demonstrating costs and/or benefits once measures were complete, consideration has also gone to ex-ante forecasts of costs and benefits and theoretical studies. The lack of ex-post data on cost-effectiveness for many of the measures being adopted in air quality management plans can be a limitation to the efficient introduction of new measures, as it is hard to predict the performance of measures and to understand why a measure may work well in one location but less so in another. Reasons for the lack of data on costs include that many measures that are linked to air quality may have been adopted primarily for other purposes, such as congestion reduction, and are often introduced by institutions that are separate from those responsible for air quality. In such cases it may be impossible to allocate costs to air quality improvement specifically. That said, there is little information available on measures that are very specific to air quality, such as the implementation of low emission zones. The EUROSAI report [R95] comes to similar conclusions (see Appendix F, F.1.1).

6.3.1.2 Benefits of implementing the AAQ Directives

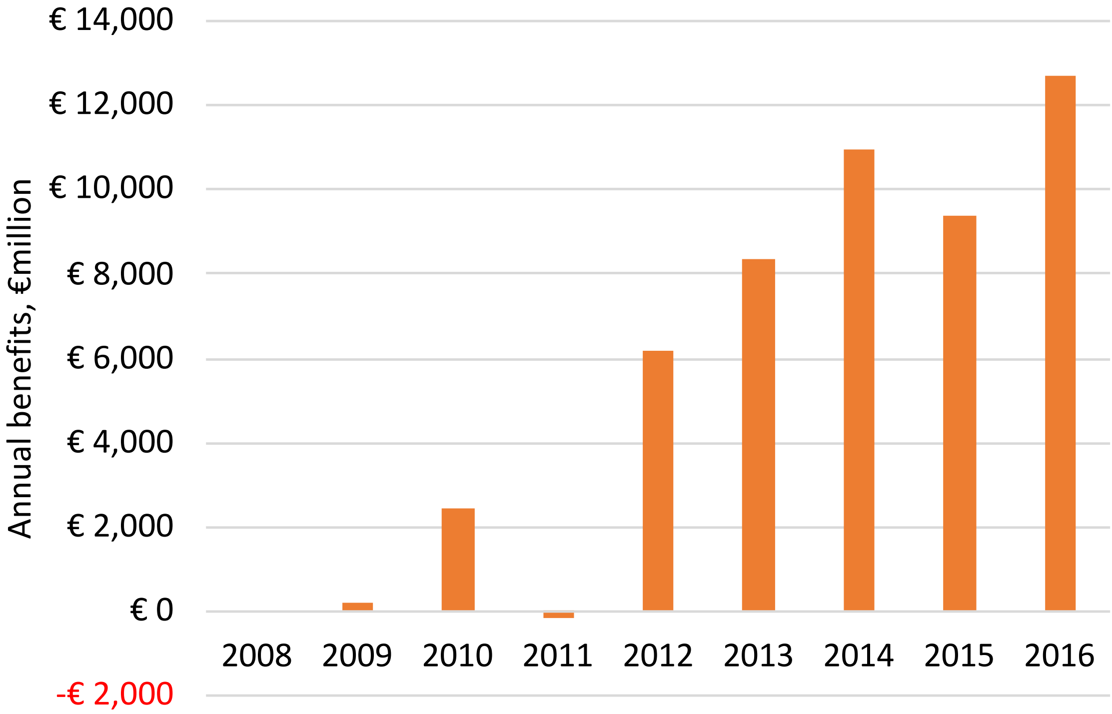
Judgement criterion: Estimates of the health benefits of measures introduced under the AAQ Directives in economic and non-economic terms, qualitative assessment of other benefits.

Assessment summary: The health benefits of complying with the limit values of the AAQ Directives from 2008 to 2016 are estimated to be in the order of EUR 50 billion, representing an estimate of 31,000 avoided premature deaths, 23,000 avoided hospital admissions and 100,000 avoided cases of childhood bronchitis over the period, together with other health effects and co-benefits through reduction in greenhouse gas emissions, congestion, etc. There is a strong trend to increasing benefits over time as compliance with the Directives increases. There is however significant uncertainty in the exact value of this estimate and it only provides an estimate of benefits of having reduced exposure of citizens from being above the limit values to below them.

Through the consultation process, information was received on the health costs of air pollution from a number of organisations, indicating that costs are substantial, in the order of hundreds of millions or billions of Euro for each country (Appendix F, F.2.4). Much of the variation is related to differences in the size of the population assessed. The data received show total estimates of air pollution impact, rather than the benefits attributable to actions taken under the AAQ Directives, though they are useful here for indicating a wide recognition that the health costs of poor air quality are substantial. Very little or no information was received on the co-benefits of actions which for many types of measure may provide a significant part of the rationale for adoption (Appendix F, F.1.4, F.1.7.3).

Calculations have been made to describe the order of magnitude for the benefits that have been attained by meeting the limit values for particles and NO_2 and the target value for ozone (Appendix F, F.1.7.1). An estimate of EUR 50 billion is provided for the period 2008 to 2016, equivalent to a saving of 31,000 equivalent attributable deaths over the period, increasing year on year to 7,700 in 2016. Further benefits include 23,000 avoided hospital admissions and 100,000 avoided cases of childhood bronchitis over the period, together with co-benefits through reduction in greenhouse gas emissions, congestion, etc. (see Appendix F, F.1.7.3). Details of the underlying calculations are provided in Appendix F, F.1.7. Figure 6-11 shows that benefits have increased steadily over the period as the area over which there is compliance with limit values has increased.

Figure 6-11. Annual benefits of the AAQ Directive relating to reduction in exposure to NO_2, ozone and PM_{10}



Source: Authors own calculations

The methods used to quantify these benefits are simplified, reflecting limitations in data availability. Benefits are only quantified for areas that have moved from non-compliance in 2008 to compliance in a later year. The following, in particular, should be noted:

- A conservative estimate of exposure above the limit values has been adopted based on data from 2015 [R53].
- Benefits of reducing exposure are not quantified if the limit value is not achieved.
- Benefits of reducing exposure below limit values are not quantified. This will underestimate benefit in areas where limit values have been achieved and further reductions are made, and in surrounding areas that were not in exceedance but have benefited from actions.
- There is potential for the AAQ Directives to have accelerated other legislation in terms of timing and ambition.
- No economic benefit is linked to equity considerations. The AAQ Directives focus attention very specifically on the areas where pollutant concentrations are highest. Analysis by the EEA [S128] has found that higher pollutant levels are often present in areas where incomes and education are lower and unemployment rates higher than European averages. This applies both at European and local scales.

Overall, these factors indicate that the EUR 50 billion estimate made here of the benefits of compliance with the limit values is an underestimate of actual benefit. It is plausible that benefits could be perhaps 2 to 4 times higher than indicated here if account were taken of exposure reduction in areas where compliance is yet to be achieved, in areas where there was no exceedance but actions linked to the Directives have reduced exposure, and so on. Set against this, however, are the benefits of other legislation targeted at air quality improvement (the National Emission Ceilings Directive (Directive 2016/2284/EU), Industrial Emissions Directive (Directive

2010/75/EU), etc., see Appendix F, F.1.8). It is noted that separation of the benefits of the AAQ Directives and National Emission Ceilings Directive was not provided in the impact assessments to the Thematic Strategy on Air Pollution in 2005 [P3], or its revision in 2013 [P41]. It is clear, however, that the Directives work in concert, so separation of benefits could be considered artificial. Actions taken for reasons such as climate mitigation are also relevant.

Information on effects that have been omitted from the analysis is provided in Appendix F, F.1.7.2. Notable amongst these are effects on ecosystems [R110], for which there is widespread risk through exceedance of the critical load for nitrogen across Europe and effects of ozone on crops and forests. Quantification of ecosystem impacts would require further data on emission reductions linked to air quality action plan measures (Appendix F, F.1.7.2). Equity considerations, with the AAQ Directives seeking to limit the extent of peak exposure levels, are also of note. Although these benefits are important, available evidence indicates that health benefits would still dominate the economic analysis [R110], especially as action plan measures tend to be focused on cities. A further source of bias relates to the omission of potential co-benefits and trade-offs of air quality actions that are not directly related to air quality improvement (e.g. reductions in greenhouse gas emissions, reduced congestion and noise from transport). The strength of these horizontal links to other policies is demonstrated, for example, in assessments of climate and energy policies for which some assessments indicate that air quality benefits may be sufficient to account for climate mitigation costs [P46]. These are explored in Appendix F, F.1.7.3. Research in the field of climate change assessment has demonstrated that co-benefits of the actions taken to reduce local air pollutants, as well as greenhouse gases, can be substantial [S113]. Trade-offs, however, are less common and typically much smaller [S113], although bioenergy is an area with important trade-offs. Justification for action for some of the transport measures that are included in air quality action plans may be linked mainly to congestion or mobility improvement (e.g. through upgrading and expansion of public transport provision). It is valid to include such measures in air quality action plans to ensure that synergies between policies (co-benefits) are exploited, and trade-offs are mitigated as appropriate.

6.3.1.3 Comparison of costs and benefits

Judgement criterion: Are the benefits of action likely to exceed costs or vice versa.

Assessment summary: There is a lack of availability of data on the costs and benefits of actions, as demonstrated by the limited amount of information identified in this report through the literature review, public consultation and national case studies. Assessment of technical measures with data available has demonstrated net benefits, but is limited in scope. The need for improved guidance on this matter has been recognised under the Convention on Long Range Transboundary Air Pollution.

Response to this question is hampered by a lack of data, particularly on costs and the effectiveness of actions in reducing emissions. Data already discussed for the Netherlands (Appendix F, F.1.4.2) provides evidence that some significant actions on transport, costing government EUR 383 million, have generated net benefits. In European Commission previous analysis, air quality improvement measures have repeatedly been estimated to generate net benefits (as in the review of the Thematic Strategy on Air Pollution [e.g. R7]).

In the absence of an extensive body of evidence on the costs and benefits of many of the actions adopted in air quality action plans, the assessment of cost-effectiveness is based on alternative considerations:

1. Are the main sources of emissions associated with exceedance of the limit values being targeted?

2. Are links to other policy priorities explored?
3. Is guidance available to assist local planners in identification of the most cost-effective actions?
4. Are the measures dealt with at the most appropriate level of governance?

1- A wide range of measures are being used (Appendix F.1.1), including measures in the transport sector (covering technical specifications, financial incentive for cleaner technologies, access reductions and encouragement for modal shift to public and active transport modes), and on stationary sources ranging from households to large industry. There is evidence that measures are targeting the sources that locally have most impact on exceedance of the limit values, which will be beneficial for cost-effectiveness. The interpretation of 'equitable' distribution of costs across sectors needs to consider which sectors are most responsible for exceedance of the limit values, rather than assume that all sectors should bear an equal cost burden. Analysis by Kieswetter and Amann [R128] provides a breakdown of different sources of $PM_{2.5}$ at monitoring stations in 20 EU Member States (see Appendix F1.10). In most cases the dominant sources associated with exceedance are traffic and fuel use by households/commercial/institutional sectors. Comparison with measures listed by country in the EEA database demonstrates good evidence that action plans are focusing on the main sources of exceedances that are controllable at a local level where they exist. This observation is further supported by evidence from the Czech Republic and Poland submitted in response to the targeted questionnaire, and information from the case study on Bulgaria (Appendix F1.10). From this perspective, costs seem to be equitably distributed across sectors. Although this statement has to be qualified against the limited availability of data on costs, no information has been collected that would support the opposite view.

2- There is also evidence that air quality planners are working with colleagues in other areas, notably climate and transport, in the development of policies, recognising that there are efficiencies to be gained with respect to the numerous co-benefits that exist between these areas. Ignoring the linkages that exist would risk not exploiting the true potential for co-benefits and potentially being exposed to trade-offs (negative side-effects of policies) that are unexpected. These factors are suggestive of measures being properly targeted, though the lack of data on cost-effectiveness of local measures to assist in the precise design of actions is problematic.

3- The availability of guidance provides opportunity for experience and data to be shared, with respect to numerous factors, from the simple identification of measures that are available to information on effectiveness and cost-efficiency. In itself, the availability of guidance does not indicate that public bodies and others are acting efficiently: the existence of guidance, however, indicates that competent authorities have mechanisms in place to enable the sharing of experience. The case studies revealed that guidance is available to assist planners with the development of air quality action plans for some countries such as Sweden but not others, such as Slovakia (Appendix F.2.1). There is little reason to believe that guidance from one Member State will not apply to others, so further consideration could be given to the sharing of guidance, noting of course the need to account for local circumstances. More efficient planning can be done if such data are routinely reported in a consistent manner. The need for improved guidance on this matter has been recognised at the Saltsjöbaden 6 workshop in March 2018 in relation to the Convention on Long Range Transboundary Air Pollution where it was recommended that an Expert Panel for Clean Air in Cities be established under the Task Force on Integrated Assessment Modelling [R142]. The remit of this Panel is to develop methods for identifying cost-effective actions at each policy level focussed on the reduction of health damage in urban areas.

4- It is noted that the efficiency of measures will be influenced by governance level. The setting of emission standards for mobile and stationary sources for the mass market is clearly most appropriate at a higher level (EU or national) than local, to ensure that there is adequate supply of products meeting the standard and avoiding unnecessary trade barriers. Other measures, particularly for very localised exceedances, such as around specific road junctions, are clearly appropriate for local decision making. The same may apply also to schemes covering larger areas, such as low emission zones. However, here it is noted as an example that the Dutch Government has taken a role in setting common practice for LEZs across the country which will strengthen implementation of LEZs nationally and avoid potential confusion between different schemes.

6.3.2 Evaluation Question 4: Cost variations across Member States and stakeholders

This question considers whether there are significant cost differences between Member States and/or between different sectors and/or as regards costs to stakeholders. For the general public a particular concern relates to the social costs of poor implementation of the AAQ Directives, interpreted here as a failure to meet the limit values by the specified dates. The question continues by considering what causes these differences and whether the costs of compliance are proportionate to the benefits brought by the Directives?

Text box 6-12 Findings on cost differences

It is observed that there are significant differences in cost between Member States and sectors, though these reflect the extent and primary source of exceedances at a local level. A lack of full compliance means that there are significant costs arising from poor implementation in terms of the health of the population. As under Evaluation Question 3, it is concluded that there is evidence to indicate that the costs of compliance are proportionate to the benefits achieved, though limited availability of data on costs is problematic for the assessment.

6.3.2.1 Causes of cost differences between Member States and between stakeholders

Judgement criterion: Identification of costs at Member State level, and appraisal of the reasons for cost differences.

Assessment summary: The availability of data on costs on a consistent basis across Member States is poor which naturally limits appraisal of cost differences. It is clear, however, that there are numerous reasons for differences in overall cost between Member States, relating, e.g. to the types of fuel used, the age of equipment, levels of industrial and other activities, variation in the cost-effectiveness of measures adopted, individual behaviour (for example with respect to walking, cycling and use of public transport), etc.

There is no collated body of data on costs incurred by Member States in implementing action plans introduced under the AAQ Directives. Neither the case studies nor the open public consultation have been successful in identifying such data. The situation is further complicated by many measures listed in air quality action plans being taken primarily for other reasons, such as congestion relief, mobility enhancement and climate mitigation. Data have, however, been received from some Member States in response to the questionnaire and from literature review (Appendix F, F.1.3 - F.1.6).

There are many reasons why the costs of pollution controls vary across Member States. Some factors relate to the baseline position for Member States in relation to differences in fuels used, age of equipment, transport systems, geography, public attitudes to walking and cycling and so on (Appendix F, F.2.1). Others relate to factors linked to the implementation of the AAQ Directives, such as provision of guidance, coordination of policies across regions and government departments, and actions taken to influence behaviour.

In the absence of the ideal data set for comparison of cost burdens across countries, data derived by the GAINS model is useful, as it is based on real data and expert judgment, while acknowledging the limitations of modelling for the current assessment. GAINS has been used extensively for analysis of European air quality policies [see, e.g. R11]. Consideration of data from previous analysis using GAINS demonstrates that there will be variation in costs per capita across Member States of the order of a factor of 2.5 due to differences in technical measures such as end of pipe controls (Appendix F, F.2.1, Table 27). The GAINS model does not, unfortunately, extend to non-technical measures such as LEZs.

As noted already, the availability of guidance on air quality management is variable, which will in turn lead to variation in costs between Member States. The provision of such guidance could improve future implementation and avoid inefficiencies through the sharing of experience, both in relation to measures that are effective and those that are ineffective.

The devolution of action to a local level including via subsidiarity recognises variability between locations, and ought to mean that the choice of measures is more efficient and targeted for local circumstances. In practice, one cannot be so confident because of limitations in information available to those working at a local level. There is relatively little in the available literature to inform decisions regarding the costs and benefits of measures to address poor air quality. The figures from the CE Delft study [R133] – indicating measures with cost effectiveness ratios ranging from 9:1 to 1:3 - highlighting potential for high variability (Appendix F, F.2.2).

The lack of direct evidence has necessitated the use of alternative sources of data such as information on the range of measures used by Member States assembled under Evaluation Question 3 (e.g. using the EEA database [D44] and discussed in Appendix F, F1.2 – 1.4). Whilst the EEA database only indicates the number of measures which Member States implement to address specific sources, it provides some insight on the way in which associated costs are spread across stakeholders and sectors within Member States. By way of example, in countries where most measures are focused on traffic and modal shift, such as Austria, Slovakia or the UK, the costs could be expected to be concentrated on government, on the businesses affected by the traffic measures and on citizens. On the other hand, the response from the Czech Republic (Appendix F, F.1.10, Table 25) is representative of a Member State where the contribution to poor air quality comes, more evenly, from a wide range of sources: industry, households and transport, with costs spread across these sectors along 35%, 37% and 27% respectively.

Results of the open public consultation reflect the position drawn from the assessment that the transport sector, particularly, has been affected by actions to tackle poor air quality. This is a widely held view, not only by the industry itself but also by those from professional, scientific and technical activities and from public administration. It is, however, notable that some of the measures listed for this sector within air quality management plans would have been introduced primarily to limit congestion or improve mobility rather than improve air quality, through the provision of alternatives in the form of improved public transport and by various infrastructure developments. This is however not the case for all measures, such as LEZs. Energy providers are also regarded by a significant share of respondents to the open public consultation as experiencing costs from the Directives.

As with the variation in costs by sector, the variation in costs affecting stakeholders depends upon the choice of measures, and the manner of their implementation. Citizens would be affected differently by, for example, a measure aimed at supporting scrappage of old vehicles, as opposed to one that charges them to access a city centre by car. Similarly, measures to upgrade boilers might have different profiles of cost for citizens: some will benefit from installation of more efficient boilers, especially if replacement is supported by capital grants. The exact effect on different stakeholders, therefore, relates to the source of the emissions, the choice of measure used to address that source of emissions, and the financial profile of the measure (including the extent of grant funding, for example).

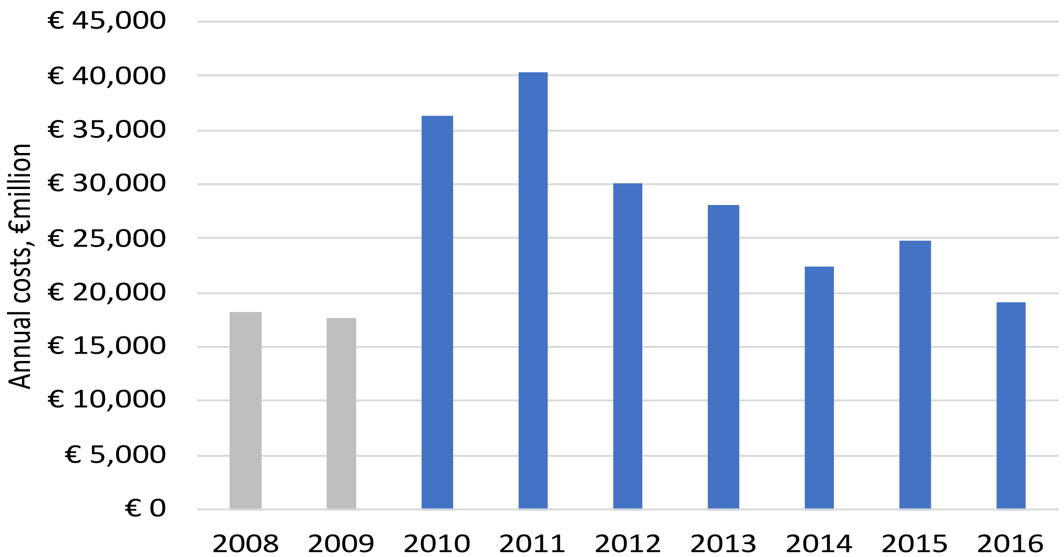
6.3.2.2 Cost of poor implementation

Judgement criterion: Magnitude of health costs in economic and non-economic terms resulting from non-compliance with the limit values.

Assessment summary: The data collected here indicate that the costs of compliance are low relative to the benefits of compliance with the air quality limit values.

Effects linked to poor implementation of the limit values are long-lasting, as highlighted by work by the Royal Colleges of Physicians of Paediatrics and Child Health in the UK, which discusses the life-long consequences of exposure to air pollution [S103]. The costs of poor implementation, defined as failure to meet the limit values by the dates specified in the Directives, are shown in Figure 6-12, with costs coming to a total of EUR 240 billion over the period 2008 to 2016. This definition leads to significant costs of poor implementation being present from the first year, given that earlier legislation required the limit for PM_{10} to have been achieved in 2005. This is a different situation to other environmental legislation, where compliance is required at a possibly much later date. For the National Emission Ceilings Directive, for example, legislation may be introduced a period of 10 years or more in advance of the date set for compliance. Costs are shown to decline steadily since 2010. Further details, including a breakdown of costs and impacts by Member State, are provided in Appendix F, F2.4.

Figure 6-12 Annual costs of poor implementation of the AAQ Directive of 2008. The years 2008 and 2009 are distinguished from other years as results for these years do not include exceedance of the NO_2 limit as this did not come into force until 2010.



Source: Authors' estimate

Direct comparison of our estimates of the benefits of actions taken under the AAQ Directives and the costs of poor implementation is problematic: the quantification of 'poor implementation' is relatively straightforward, relating to the extent of non-compliance. The quantification of benefits, in contrast is more complex and prone to a different set of biases, for example in understanding, the extent to which benefits can be specifically attributed to actions undertaken in response to the AAQ Directives. A robust conclusion can however be made: that the costs of poor implementation and the benefits of action are both substantial with estimates for the period 2008 to 2016 in the order of tens of billions of Euro and higher.

The costs of poor implementation can also be compared with the estimates for the baseline analysis done for the Clean Air For Europe (CAFE) programme which indicated total annual impacts of exposure to ozone and fine particles to be valued between EUR 190 and 705 billion per year in 2000 and EUR 130 to 550 billion per year by 2020 [R179] (the range given reflects uncertainty in the approach taken to valuation of mortality). More recent estimates, for example informing the Clean Air Outlook, are broadly comparable [R10]. This indicates that the overall cost of poor air quality is, naturally, higher than the costs of poor implementation. Uncertainties in these estimates are acknowledged, though it is to be noted that the methods used for quantification are consistent with the approach used in other policy assessment work carried out for DG Environment [R111, S108, R46, R108 and others]. Against this background, the broad ranges identified indicate that the societal impact of poor implementation is substantial.

6.3.2.3 Proportionality of costs with benefits

Judgement criterion: Comparison of costs and benefits of action.

Assessment summary: Assessment of this question is limited by the availability of data on costs of local measures. It is further complicated by the rationale for adoption of some measures, which may not be related primarily to air quality improvement, but instead to reducing greenhouse gas emissions or reducing congestion, or improving mobility.

Response to this question is hampered by the very limited availability of data on costs of local measures particularly, and a lack of clarity on the main objectives for introducing some measures (Appendix F, F.2.5). For abatement measures mandated at the EU level this is less of a problem as these tend to concern technical measures applied to technologies for which there is a good data availability. Returning to the issue of co-benefits (see Appendix F, F.1.7.3), for some measures put in place to fulfil AAQ Directives, the effects of reduced congestion, noise, accidents and greenhouse gas emissions are likely greater and possibly far greater than the air quality benefits. Inclusion of such measures in air quality action plans could be questioned (Appendix F, F.1.8), but recognition that measures adopted for other reasons can be beneficial for air quality is important for efficiency, as it indicates connectivity in decision making.

Indirect costs of the AAQ Directives (those associated with the measures put in place to reduce emissions, as opposed to costs of activities specifically mandated by the Directives on monitoring, reporting, etc.) are largely experienced where exceedances occur, through the implementation of measures designed to address more or less localised exceedances of the limit values. Whether the costs of addressing exceedances are proportionate to the associated benefits is determined by the choice of measures adopted. This is made clear in the cost-effectiveness analysis undertaken, for example, by CE Delft in the Netherlands [R158], which highlights that, of a range of different measures which can be used to address particulate matters emissions from transport, some measures deliver benefits far in excess of their costs, whilst for others, the opposite is the case. Unfortunately, given that clear information on the relative costs and benefits of different measures is lacking, there is a clear need for more empirical studies on the measures that are being used. There is also a need for systematic reporting and collation of costs, in order that air quality managers can make more informed decisions about the cost-effectiveness of different actions and criteria that influence their success or failure. This reporting would need to recognise the co-benefits and trade-offs involved in many actions that are justified only in part on air quality grounds.

The direct costs of compliance with the AAQ Directives – as measured by the administrative costs quantified under Evaluation Question 5 – are estimated to be low relative to the benefits of compliance with the air quality limit values (Section 6.3.3).

6.3.3 Evaluation Question 5: Efficiency of monitoring, reporting and assessment

Question 5 considers the efficiency of monitoring, reporting and assessment regimes and the administrative costs borne by Member States. It continues by considering, where there is evidence, whether the AAQ Directives have caused unnecessary or excessive administrative burden (additional administrative costs – on top of business as usual ones – imposed by the additional AAQ Directive requirements to monitoring, reporting and assessment) taking into account the objectives and benefits of the Directives.

Text box 6-13 Findings on efficiency of the monitoring, reporting and assessment in the AAQ Directives

It is estimated that, based on data provided by nine Member States, administrative **costs** per capita are between EUR 0.14 and 0.98 per year. Based on a smaller sample of four Member States, due to response rate of authorities to the targeted questionnaires, administrative **burden** per capita are estimated between EUR 0.12 and 0.38 per year. It is concluded that the benefits achieved by the Directives (see Evaluation Question 3), and the costs of poor implementation (Evaluation Question 4), are high enough to justify the administrative costs and/ burdens. However, there are areas where efficiency could be improved which relate to the extent that devolution of the requirements of the AAQ Directives to local level is supported by funding and a facilitative role being adopted by national institutions, variation in the availability of guidance between Member States and greater use of modern media technology. Costs of reporting to the public varied significantly, however this is likely underlaid by variation in the activities undertaken and unavailability of cost data for the full range of authorities undertaking information provision. Regarding variation in the costs between countries in reporting to the Commission, a lack of data specific to the reporting requirements of the AAQ Directives under consideration prevented clear conclusions being drawn on this point. Regarding the necessity of administrative burden imposed, it appears the EEA uses data reported by Member State on measures included in Air Quality Plans in activities which contribute to achieving the objectives of the Directive.

6.3.3.1 Administrative costs to Member States

Judgement criterion: Data on costs of implementing the requirements of the AAQ Directives for monitoring, reporting and assessment.

Assessment summary: Per capita administrative costs to Member States, where reporting appears to be comprehensive, appear to be in the region of €0.14 to €0.98 per capita. Although the upper-end value represents the reported cost for France including some activities which are not within the scope of the AAQ Directives, it feels inappropriate to seek to narrow this range on the basis of the data available. The cost of reporting to the Commission per Member State appears to vary considerably, from between tens of thousands of Euro to over EUR 100,000 a year. Reasons for difference in costs borne are unclear but may be underlain in part by the extent to which Member States have invested in updated electronic systems for reporting. Regarding costs of reporting to the public, the public information provision activities adopted by Member States and the related costs vary significantly.

Part of the administrative costs from monitoring, assessment and reporting tasks would have been incurred in the absence of the AAQ Directive requirements. They are the so-called business-as-usual (BAU) costs. The other part of the administrative costs is then the (additional) costs of having to comply with the (additional) AAQ Directives' requirements related to monitoring, reporting and assessment. They are the so-called administrative burdens. Further detail on this distinction can be found in Appendix F, F.3.1.

A significant part of the costs for monitoring, reporting and assessment are business-as-usual (BAU) costs, which follow on from earlier legislation and also national and local initiatives on air quality. Some additional cost has been incurred particularly with respect to calibration requirements and informing the public about ambient air quality levels and their effects.

Data on the administrative costs of the monitoring and assessment regimes were obtained from the targeted questionnaire and national case studies and are shown in the table below. In all cases these data refer to the overall cost of the monitoring and assessment and not specifically to the additional costs of the Directives. Disaggregation by cost element (approval of measurement systems, etc.) was limited in the data received by Member State.

Table 6-11 Annual administrative cost data provided by Member States divided by cost area.

Cost area Member State	**Monitoring infrastructure**	**Approval of measurement systems**	**Ensuring the accuracy of measurements**	**Data analysis and assessment methods**
Bulgaria	EUR 1.89 million in 2017			
Estonia	EUR 400,000	EUR 40,000	Included in "*Approval of measurement systems*"	EUR 25,000
France	EUR 65.6 million	EUR 5.2 million in 2016		
Netherlands	EUR 3.9 million in 2018			
Croatia	EUR 1.3 million	EUR 43,662		EUR 392,958
Poland	EUR 12.7 million	EUR 4,656	EUR 69,840	EUR 972,060
Slovakia	EUR 1 – 1.2 million			
Spain	EUR 5.6 million for maintenance of monitoring stations EUR 1.3 million for acquisition of new equipment			EUR 1.7 million
Sweden	EUR 2,459,490 in 2018	EUR 150 000 in 2018	EUR 200,000 in 2018	EUR 65,000 in 2018
Denmark	EUR 1.7 million	c. EUR 800,000	Included in	Included in

			"Approval of measurement systems"	*"Approval of measurement systems"*

Source: Appendix F, F.3.2

There are concerns over the comparability of data between countries. The Bulgarian data, for example cover all national environmental monitoring, whilst the data for France includes activities that are outside the scope of the AAQ Directives. Accepting the limitations of the data, recognising that, overall, these costs are expected to overestimate the assessment requirements of the AAQ Directives, they provide an indication of administrative costs per capita of EUR 0.14 to 0.98 per year.

Four Member States provided relatively complete estimates of the administrative burden related to monitoring and assessment incurred in complying with the AAQ Directives via the targeted questionnaire and case study interviews. These data were however not sufficiently disaggregated by cost element to present a breakdown. These data are presented in Table 6-12.

Table 6-12: Administrative Burden Cost data provided by Member States

Member State	Known administrative burden	Administrative burden per capita
Sweden	EUR 1,150,000	EUR 0.12
Croatia	EUR 1,344,000	EUR 0.32
Ireland	EUR 1,831,735	EUR 0.38
Denmark	EUR 670,000	EUR 0.29

Source: Appendix F, Section F.3.4

Some of these data however are incomplete: the Swedish data include only monitoring network costs at the national level and do not account for activities delegated regionally, the Croatian costs lack utility and maintenance costs for monitoring stations and also reference laboratory staff costs and the Irish data lack the cost of 2 full-time equivalent staff involved in local monitoring activity. The Denmark cost represents the complete costs of monitoring for the AAQ Directives.

In March 2017, the Commission published a study supporting a Fitness Check of monitoring and reporting obligations arising from EU environmental legislation [R83]. As part of this, the annual costs to Member States, to the Commission and to the European Environment Agency that arise from complying with reporting environmental obligations were estimated at EUR 22.4 million. The fraction of this total cost attributable to reporting under the AAQ Directives was not stated. However, the AAQ Directives were noted as legislative items which were responsible for "fairly large" administrative burdens in the order of EUR 100,000 to 1,000,000 per year per Member State. Other directives with reporting obligations related to release of air pollutants were also noted as making fairly large contributions to total Member State reporting costs.

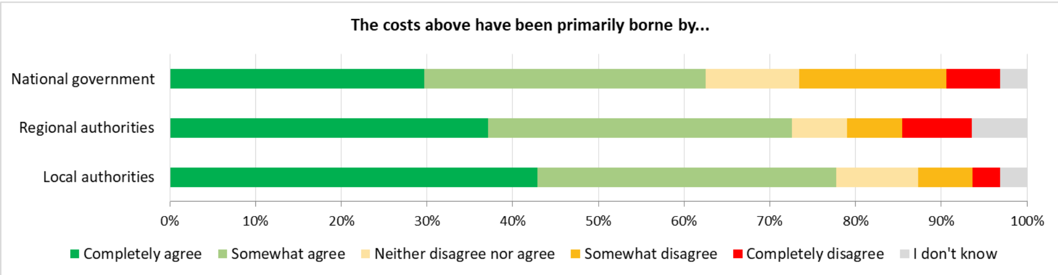
The annual cost incurred by the European Environment Agency for dealing with all reporting in the air quality topic area was estimated at EUR 760,000 based on the average budget and costed FTEs dedicated to air quality reporting by the EEA from 2014 – 2016. No data from earlier periods was available. Air quality reporting has involved large investment in new reporting systems, including the Air Quality E-Reporting Database, with most of this cost arising through software development by contractors.

Regarding the cost of providing information to the public, only three Member States (Estonia, France and Poland) provided estimates which amounted annually to EUR 0.0027, 0.0053 and 0.0006 per capita respectively. The reason for the large variation is likely due to the very different nature of the information activities undertaken by each Member State and the degree of devolution to local authorities for whom comprehensive data could not be collated.

Text box 6-14 Key findings from stakeholder consultation (open public consultation, targeted consultation, workshops)

As is explained in 6.3.3.1, the analysis undertaken in this chapter relies on responses to the targeted questionnaire and interviews conducted to inform the national case studies. The results of this consultation are not therefore repeated here as they are discussed throughout the chapter.

Question 8.20 of the online public consultation (open public consultation) asked respondents about the distribution of administrative costs.



Source: Question 8.20: To what extent do you agree with the following statement? “The costs above have been primarily borne by…” (responses from Public Administration and Defence sector, N=62-64 – different numbers of respondents for each statement)

Generally, the number of respondents believing each level of government to be primarily bearing costs followed the order (from highest to the lowest number):

- Local authorities;
- Regional authorities;
- National government.

6.3.3.2 Efficiency of monitoring and assessment regimes

Judgement criterion: Variability in costs, extent of devolution and changes to reporting requirements.

Assessment summary: Devolution of responsibilities, if not supported by funding and facilitation of collaboration, is thought to hamper efficiency. Additionally, the extent to which Member State adopt modern public information methods may be impacting the efficiency of reporting. Changes to the reporting requirements for air quality information are thought to have a bearing on the efficiency of reporting though it is intended that these will provide efficiencies in the long term.

Evaluation of the efficiency of the monitoring, reporting and assessment regimes identified four issues. The first concerned variation in the costs between countries, reported above. Unfortunately, variation in the extent of reporting in each country and the lack of data specific to the requirements of the AAQ Directives under consideration prevented conclusions being drawn on this point. The second issue concerned variation in the extent of devolution of the requirements of the AAQ Directives to local level. This may be positive or negative for efficiency, depending on the situation in each country, the extent to which it is appropriate for action to be driven nationally rather than locally, and the degree to which there is good communication across different tiers of government. Overall, there was a lack of information provided to indicate why countries had decided on a particular level of centralisation or decentralisation in their systems. There was limited evidence to indicate that decisions on this aspect that were made when air quality standards were first adopted had been reviewed, meaning that it is possible that systems that were once efficient are no longer efficient. The third issue concerned degree of uptake of modern communication methods. The extent to which Member State authorities choose more or less varied media, and take advantage of modern platforms and new technology, such as social media and smartphone apps, to communicate with the public, will dictate the efficiency of reporting regimes. The fourth issue concerned changes to requirements related to reporting and exchange of information, which applied from 1 January 2014 based on Commission Implementing Decision 2011/850/EC. Several Member States reported administrative burden incurred as a result of these changes, however it is noted that the intention of these changes is to introduce efficiencies in the long term.

6.3.3.3 Is Administrative burden resulting from monitoring, reporting and assessment requirements excessive?

Judgement criterion: Evaluation of the costs of the AAQ Directives relative to the benefits brought.

Assessment summary: It appears that taking into account the objectives of the Directives with regards to monitoring and reporting, and the potential benefits of actions taken as a result of this monitoring and reporting, administrative costs are not excessive.

Response to this question is against a background where data on administrative costs overall are relatively limited, from a minority of Member States. Of those countries that did provide data, the majority were able to make some estimate of the administrative costs related to monitoring, but few provided estimates of costs of other assessment methods and reporting. The Swedish respondent noted that the majority of the requirements that dictate the number of fixed measurements that are required in Sweden were present in previous EU directives and hence that the 2008 Directive in itself has likely led to only a relatively small increase in costs.

Some areas where efficiency could be improved were noted. In particular, the criteria for classifying measurement stations are described as rather generic (in particular urban background and suburban background). Stricter and clearer criteria for micro-scale siting, macro-scale siting and representativeness of stations are suggested to improve comparability of measurements across cities [R44, R32]. The JRC-Aquila position paper [P121] in addition notes that the spatial representativeness of measuring sites is not defined in the legislation, which can hinder the effectiveness of the monitoring network design and suitability to assess exposures and model performances. These ambiguities could represent an unnecessary burden when they result in either the installation of expensive monitoring stations and subsequent reporting of data that do not meet the goals of the Directive. Furthermore, as regards reporting obligations, based on uses to which data reported by Member State is applied by the EEA, it appears that the administrative burden incurred is necessary for the achievement of the objectives of the Directives.

It can be stated with reasonable certainty that the benefits achieved by the Directives (see Evaluation Question 3), and the costs of poor implementation (Evaluation Question 4), are high enough to justify the administrative burden. Based on the data collected, it is estimated that the total administrative burden of the AAQ Directives is of the order of EUR 300 million per year. In contrast, the annual benefits of current levels of compliance with the Directives are estimated to be in the order of EUR 50 billion per year, whilst the social costs of continued exceedance are around EUR 24 billion for the year 2016 (see Sections 6.3.1). Although a clear identification of the total administrative burden was not possible, the potential benefits are estimated to be substantially higher.

Further detail on this Evaluation Question can be found in Appendix F, F.3.4.

6.3.4 Evaluation Question 6: Competitiveness, economic, social and environmental sustainability

Question 6 considers whether the implementation of the AAQ Directives has supported or hampered EU competitiveness in the global economy and whether the implementation of the AAQ Directives has improved or been detrimental to economic, social and environmental sustainability?

Text box 6-15 Findings on efficiency of AAQ Directives

> The information reviewed here indicates that the impacts of the AAQ Directives on EU competitiveness are likely to be small, although these Directives may have stimulated innovation in some industries. It is also concluded that the AAQ Directives have enhanced economic, social and environmental sustainability.

6.3.4.1 Influence of AAQ Directives on EU's global competitiveness

Judgement criterion: Assessment of the evidence for transmission of effects of environmental legislation on competitiveness, evidence of impacts on a sectoral basis.

Assessment summary: Some economic sectors might have received a positive impact through spur in innovation, whereas, some sectors might have observed a short term negative impact. However, the overall impact of AAQ Directives on EU competitiveness appears to be small.

Given that European regulations for air quality and air pollutant emissions have existed in some form or another since the 1970s, and the stringency of these regulations displayed a very slow gradual increase over the years, it may be expected that the short term indirect impacts of increased compliance costs should have been largely internalised by industry, and offset by the longer term benefits of cost-efficiency in production and innovation. It is difficult therefore to disentangle and attribute a marginal competitiveness impact solely to the AAQ Directives, independent of this wider body of regulations.

In the impact analysis carried out on the EU Clean Air Policy Package in 2013 using the GEM-E3 general equilibrium model [R124], it is shown that there will be some loss of EU competitiveness for the sectors required to undertake abatement activities. However, after taking into account the increase in production of abatement technologies, and the increase in labour productivity due to reduced morbidity, the net effect on EU competitiveness was found to be negligible. Moreover, the stimulation of innovation in industries producing compliant products and technologies could result in an additional gain in global market share and hence increased EU competitiveness.

The actual effect on competitiveness *in the global economy* of the AAQ Directives depends on the extent to which the affected sectors are exposed to international trade. Although a range of measures have been implemented affecting a wide range of sectors, some sectors are affected more than others. The measures broadly concern industry, transport and traffic, fuel switching and energy use in buildings.

For actions concerning transport and traffic – which account for the majority of the measures identified in the EEA database – international competitiveness is not a relevant issue. It is unlikely that major logistics businesses would be affected significantly by transport measures for air pollution improvement, as these companies tend to operate modern vehicles for fuel efficiency reasons that are able to meet emission standards. Moreover, given that logistics businesses tend to be located outside of urban centres because of the implications for the efficiency of their logistics, the impacts of urban vehicle access restriction (UVAR) measures should be limited.

For distribution of final goods, all hauliers, whether from inside or outside Europe, are affected equally by UVAR measures that restrict or charge all heavy goods vehicles (HGVs) in the same way, irrespective of their country of origin. The same applies for transport services. To the extent that the measures relate to charges and restrictions applied to a given zone, the only thing that matters within that zone is whether a vehicle of a given type seeks access to it: that is not an activity which is readily 'tradeable'. Reduced congestion (linked to enhanced provision of public transport) will also facilitate efficiency of vehicle movements.

There will be some impact on the market shares of vehicle manufacturers linked to the range of vehicles that they supply. Companies focused on electric vehicles will benefit, whilst those more oriented to the diesel market may lose market share (as shown by analysis carried out by the International Council on Clean Transport [R119]). It can be expected that there will be winners and losers, in the short-term, from the measures implemented. The effects on the competitiveness of industry globally, however, may be considered relatively slight, other than to the extent that some additional stimulus will be given to developing the e-mobility sector.

It is difficult to ascertain the marginal effects of the AAQ Directives on the competitiveness of EU industry given that other measures (National Emission Ceilings Directive (Directive 2016/2284/EU), Industrial Emissions Directive (Directive 2010/75/EU), etc.) undertaken at the same time might also have affected the competitiveness of the industrial sector. However, some countries have had a stronger focus on reducing air pollutants emissions from industry than other Member States. In terms of global competitiveness, only those installations which are both a) affected by such measures, and b) engaged in tradable good sectors, will be negatively affected. Some of the investments required for the industry are partially met by funding from the European Structural and Investment Funds, as indicated in recent investigations undertaken by the Court of Auditors. This will reduce any competitiveness impacts. Response from the Czech Republic and the Netherlands indicated that competitiveness impacts, to the extent that they are negative, are quite targeted, whilst the benefits are widely distributed across the population, potentially improving productivity across sectors.

The buildings sector will be little affected by the AAQ Directives directly, given that construction activities are not exposed to significant international competition, although there could be some indirect effects. Providers of non-combustible renewable and low emission heating systems will benefit, whilst those dealing exclusively with coal or oil systems will be adversely affected, though market trends have been clear for some time giving such companies time to adapt.

Text box 6-16 Findings from the open public consultation

This analysis of competitiveness was generally supported by the views expressed in the open public consultation. Slightly over 50% of respondents felt competitiveness and innovation had been boosted to at least some extent as a consequence of the Directives' implementation, with just under 30% believing that competitiveness had not been boosted to any significant extent. Similar conclusions can be drawn when analysing the responses from individual sectors, such as, the public administration and defence sector, professional, scientific and technical activities sector, manufacturing sector, electricity and gas supply sector, transportation and storage sector, etc. The sectors identified as benefitting from the AAQ Directives were innovative industries (all sectors), personal mobility service providers, energy providers, healthcare and competent public authorities. On the other hand, sectors identified as not benefitting from the AAQ Directives were agriculture, waste, construction, and mining and quarrying.

In summary, it would seem that there are few reasons to believe that the AAQ Directives have major implications for global competitiveness. There are reasons to believe that some sectors have received a spur to innovate from the AAQ Directive, but equally, there are some sectors that might have received a short-term negative impact, albeit, locally confined. Given that most measures undertaken to meet the AAQ Directives are targeted on specific local sources, the extent to which industries widely exposed to international competition are directly, and significantly, affected by the measures is likely to be limited. A positive feature of the AAQ Directives' implementation may be that the innovation towards low-emissions solutions, in transport and energy in particular, are likely to have positive spill-overs far beyond the local situations where they are applied under the AAQ Directives.

6.3.4.2 Influence of the AAQ Directives on economic, social and environmental sustainability

Judgement criterion: Effects of measures introduced under the AAQ Directives on economic, social and environmental sustainability.

Assessment summary: Based on the evidence reviewed it can be concluded that the measures introduced under AAQ Directives have net positive impacts on economic, social and environmental sustainability in the EU.

An analysis of the global competitiveness of EU industry resulting from environmental legislation (though not air pollution legislation specifically) was carried out in the World Economic Forum's Europe 2020 Competitiveness Report [R194]. The analysis revealed that, in terms of the economy-based averages the EU leads in the global index for environmental sustainability compared to BRICS, developed countries and candidate countries, though other developed economies are not significantly far behind.

In regards to economic sustainability, as noted above, analysis of the effects of the Clean Air Policy Package of 2013 [R124] found that the negative impact on GDP from higher abatement expenditure is offset by the benefits from avoided morbidity due to improved air quality, with resulting net positive impact on EU GDP (while overall increased labour productivity would also play a role). The same study identified a number of social benefits linked to health and employment. Moreover, as shown in Section 6.3.1, benefits of AAQ Directives seem to be achieved equitably as countries mainly implemented measures to control exceedance at a local level, although it is difficult to draw definitive conclusion in regards to equitable distribution of costs due to limited availability of data.

A study for the OECD [S91] found that costs arising from non-implementation of the AAQ Directives would reach approximately 2% of EU GDP in 2060, leading to a reduction in capital accumulation and a slowdown in economic growth. Another study for the European Climate Foundation [R17] identified large economic benefits with decarbonising passenger car transport in Europe through reduced use of oil products and net gains in value added and employment. Responding to concerns about supplying substantial amounts of electricity to the vehicle fleet, the study noted the potential for exploitation of synergies in the timing of car battery charging and times of low demand for electricity. Challenges in the transition to an electrified vehicle fleet were noted, relating to the need to roll out a rapid charging infrastructure, effects on employment through the automotive value chain and the challenge to European industry of remaining at the cutting edge of clean technology innovation.

Besides direct impacts on air quality, some of the urban traffic related measures such as congestion charging, restriction of passenger vehicles in parts of city centre and speed restrictions in residential zones could generate wider social benefits in terms of reduction in traffic related accidents, congestion and noise. Rotaris et al. [S104] assessed the initial impacts of the Ecopass scheme in Milan which introduced a charging scheme to enter an 8 km2 area of the Milan city centre from January 2008. Besides the benefits from air quality improvements and reduction in travel time, the study also estimated a benefit of EUR 8 million from reduction in accidents during the first 11 months of operation of the scheme.

However, there could be negative distributional impacts associated with some of the urban traffic related measures introduced under the AAQ Directives, as these measures could have adverse cost impacts on the poorer fraction of the society due to an increase in transport costs and requirements to upgrade older non-compliant vehicles. However, a recent EEA report [S128] also noted that air pollution affects more intensively the most vulnerable socio-economic groups while at the same time noting that EU policies tend not to explicitly include actions targeting these socioeconomically vulnerable groups.

In regards to environmental sustainability, there are strong synergies between most air quality policies and climate action, though also some conflicts (such as the promotion of diesel vehicles in preference to petrol).

Text box 6-17 Findings from the open public consultation

Considering influence of the AAQ Directives on environmental sustainability, the majority of respondents to the open public consultation either completely agreed or somewhat agreed that EU policies and legislation had helped prevent worsening of air quality: the respondents felt this most strongly in relation to Europe as a whole, though were slightly less positive about the effects in their city or region. Even so, more than 75% expressed agreement that in the absence of the policies and legislation, matters would be worse at region or country level. Similar conclusions can be drawn when analysing the responses from individual sectors with at least 10 responses.

6.4 Coherence

Evaluation questions 7 and 8 seek to assess the coherence of the AAQ Directives, both internally and with other EU interventions. Question 7 considers the extent to which the Directives are coherent internally with other EU and Member State environmental policy, including other EU air quality interventions. Question 8 considers the coherence of the Directives with EU and Member State legislation and policy in other sectors, including transport, energy and agriculture, and co-ordination mechanism that seek to support policy coherence.

Table 6-13 Evaluation questions and judgement criteria for Coherence

Evaluation questions and judgement criteria on Coherence
EQ 7: To what extent do the AAQ Directives complement or interact with other environmental policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as the NEC Directive and IED Directive as well as EU climate legislation and policy); and how do these policies and legislation support or hamper the implementation of the EU air quality legislation? • JC 7.1: The extent to which AAQ Directives are coherent internally and with each other. • JC 7.2: The extent to which AAQ Directives are coherent with other air pollution legislation and policy including overarching EU Clean Air Policy, and the EU's international commitments • JC 7.3: The extent to which AAQ Directives are coherent with other EU environmental legislation. • JC 7.4: The extent to which the AAQ Directives are coherent with EU climate policy and legislation (including international commitments). • JC 7.5: The extent to which Member States have put in place an integrated approach to the implementation of the AAQ Directives and other environment and climate legislation and policy. EQ 8: To what extent do the AAQ Directives complement or interact with sectoral policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as energy, transport, agriculture, cohesion, taxation policies); and how do these policies support or hamper the implementation of the EU air quality legislation? • JC 8.1: The extent to which key EU sectoral policies support AAQ objectives, including public information. • JC 8.2: The extent to which EU funding instruments support Member State actions to improve air quality. • JC 8.3: The extent to which EU/national taxation policies or measures support Member State actions to improve air quality. • JC 8.4: The extent to which EU-level coordination mechanisms support a coherent approach to achieving AAQ objectives. • JC 8.5: The extent to which Member State air quality plans are coordinated with planning initiatives promoted by EU sectoral legislation and policy, Member State air quality plans are integrated or linked with spatial planning, Member State E coordination mechanisms support a coherent approach to achieving AAQ objectives.

6.4.1 *Evaluation Question 7: Coherence with environmental and climate policies*

Question 7 assesses the coherence of the AAQ Directives in the following dimensions: within each piece of legislation and between the AAQ Directives; within the overarching EU policy framework for air pollution and emissions; with the EU's international commitments on air pollution; and with other EU policy and legislation on environment and climate.

Text box 6-18 Key findings on the coherence of the AAQ Directives with environmental and climate policies

The analysis shows that the AAQ Directives form a coherent regulatory system to improve air quality in the EU. Several issues with their internal coherence were found, however: for example, Directive 2008/50/EC sets both limit and target values, while Directive 2004/107/EC only sets target values.

The AAQ Directives are coherent with the 2013 Clean Air Policy Package and with EU legislation on air pollutant emissions; coherence has grown over the evaluation period, for example with the 2016 revision of the NEC Directive. The Directives are also coherent with the EU's international commitments on air pollution.

A review of key environmental legislation and policy documents found mutual coherence; however, gaps were identified – for example, the Nitrates Directive (Directive 91/676/EEC) can support reductions in agricultural air emissions, but this legislation does not identify air quality as a goal.

Studies have shown that action for climate mitigation and air pollution should, overall, be mutually supportive, and has been a growing recognition of these links in EU policy documents.

6.4.1.1 Internal coherence of the AAQ Directives

Judgement criterion 7.1: The extent to which AAQ Directives are coherent internally and with each other.

Assessment summary: Based on the evidence collected, the AAQ Directives form a coherent regulatory system to improve air quality in the EU. Several specific issues were identified, for example regarding monitoring provisions in Directive 2008/50/EC. Also, this Directive sets limit values and calls for air quality plans; Directive 2004/107/EC does not require full air quality plans.

The review found that overall, each of the Directives is *internally coherent*: each set ambient air standards to be attained, assessment requirements and methods to determine ambient air quality levels, public information provisions and requirements to take action to reach and maintain good air quality levels. The Directives thus each put in place a holistic system (at the same time, the assessments of relevance and effectiveness, presented in sections 7.1 and 7.2, have identified issues with specific elements of the system such as current standards). Several specific issues were, however, identified regarding provisions of Directive 2008/50/EC (see the table below).

Table 6-14 Internal coherence issues identified in Directive 2008/50/EC

Topic	Brief overview	Source
Air quality plans	Annex XV of Directive 2008/50/EC calls for the plans to indicate the 'observed effects' of measures that existed prior to June 2008; no similar requirement for later measures	Comment at 2nd stakeholder workshop
Alert thresholds	Alert thresholds are set for SO_2 and NO_2; not for PM_{10} or $PM_{2.5}$ - (Arts. 13 and 19 and Annex XII of Directive 2008/50/EC)	ClientEarth, et al
Limit values	Directive 2008/50/EC sets annual and short-term limit values for SO_2, NO_2 and PM_{10}; but only an annual limit value for $PM_{2.5}$	ClientEarth, et al
Monitoring	Minimum number of monitoring stations set by zone/agglomeration, but it is the view of ClientEarth et al. that the ratio of urban background to traffic-oriented stations is determined across whole Member State (Annex V, Directive 2008/50/EC)	ClientEarth, et al
	Sampling points for PM_{10} required where there has been an exceedance in last three years (Annex V, Directive 2008/50/EC); a similar time period is not set for other pollutants such as NO_2	ClientEarth, et al, ECA [P91]
	Reference methods provided for fixed sampling points (monitoring) but not for modelling (Annex IV, Directive 2008/50/EC)	ClientEarth et al

With regard to coherence between the AAQ Directives, the two Directives largely share their *overall objectives* (their 'aims' are in Article 1 of each Directive and presented in section 2.1 above).

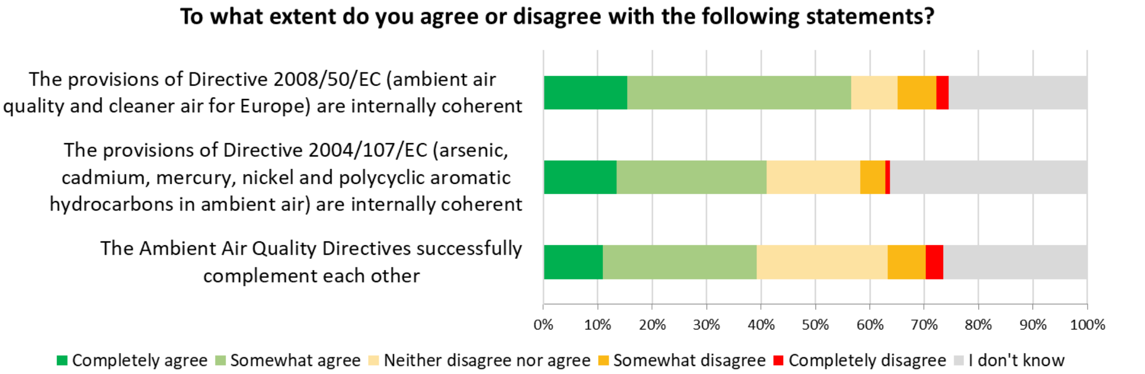
In terms of *provisions*, Directive 2008/50/EC includes both limit and target values, while Directive 2004/107/EC only includes target values (which are 'to be attained where possible over a given period', as per Art. 2 of each Directive). According to Art. 3 of Directive 2004/107/EC and Article 17 of Directive 2008/50/EC, national measures to implement target values should not entail disproportionate costs. The Directive 2008/50/EC moreover requires Member States to put in place the necessary plans and programmes when any limit value or target value is exceeded, and it sets out information to be included in air quality plans (Annex XV); Directive 2004/107/EC does not call for full air quality plans, but it requires Member States to submit the measures taken, not entailing disproportionate costs, in order to attain the target values.

Specific provisions for the implementation of the AAQ Directives are set out in Implementing Decision 2011/850/EC on the reciprocal exchange of information and reporting on ambient air quality. In addition, Directive 2015/1480 amended the 2004 and 2008 AAQ Directives, laying down rules concerning reference methods, data validation and location of sampling points. These two acts strengthen monitoring and reporting and are coherent with the AAQ Directives.

Text box 6-19 Stakeholder responses concerning internal coherence of the AAQ Directives

In the open public consultation, a majority of respondents responded that they either 'completely agree' or 'somewhat agree' that each of the two AAQ Directives are internally coherent and also that the two Directives complement each other (see the figure below).

Figure 6-13 Open public consultation responses on internal coherence



6.4.1.2 Coherence with other air pollution legislation

Judgement criterion 7.2: The extent to which AAQ Directives are coherent with other air pollution legislation and policy including overarching EU Clean Air Policy and EU international commitments.

Assessment summary: Based on the evidence collected, the AAQ Directives and EU legislation regulating air emissions from key facilities – the revised NEC Directive, the 2015 Medium Combustion Plants (MCP) Directive and the 2010 Industrial Emissions Directive – are strongly coherent. The 2013 Clean Air Policy Package introduced the MCP Directive and revisions to the NEC Directive, addressing gaps in coherence that existed earlier in the evaluation period. The AAQ Directives are also coherent with key EU international commitments related to air pollution.

This section first considers the following key EU policy and legislative documents addressing air pollution: the 2013 *Clean Air Programme*; the *National Emissions Ceilings (NEC) Directive* (Directive 2016/2284/EU), revised as part of the *Clean Air Policy Package* that also introduced the Clean Air Programme; the *Medium Combustion Plants (MCP) Directive* (Directive 2015/2193/EU), also introduced with the Programme; and the *Industrial Emissions Directive* (Directive 2010/75/EU). In each case, the assessment considers coherence between the *objectives* of the documents and those of the AAQ Directives; and then coherence between main *provisions.* The last part of this section considers the EU's international commitments related to air pollution.

The 2013 *Clean Air Policy Package* sets out objectives for reducing the health and environmental impacts of air pollution. One part of the Package, the *Clean Air Programme for Europe* [P37], calls in its *objectives* for achieving compliance with air quality targets by 2020 and sets 2030 objectives to further reduce health and ecosystem impacts. The Programme supports the implementation and enforcement of the AAQ Directives, and there is a strong coherence with them. The impact assessment for Clean Air Policy Package [P41] highlights the need for 'greater coherence' across EU policy and legal instruments addressing air pollution, including those for pollutant emissions: thus, in the first part of the 2008 to 2018 period for this evaluation of the AAQ Directives, it was considered that coherence could be increased.

In turn, the AAQ Directives are aligned with the key EU air policy priorities in the Clean Air Programme for Europe. In order to achieve the short-term priority of the Clean Air Programme for Europe, three elements in the AAQ Directives are considered essential: 1) the requirement to draw up air quality plans and short-term action plans, 2) assessing ambient air quality in order to monitor trends, and 3) laying down air quality standards.

The long-term priority of the Clean Air Programme for Europe of ensuring no exceedances of WHO guideline levels for human health and tolerance limits for ecosystems (critical levels) is aligned with the objectives of the AAQ Directives, but no elements of the AAQ Directives were identified as specifically contributing to achieving this priority.

The Package included a revision of the *National Emissions Ceilings (NEC) Directive* and the introduction of a directive on emissions from medium combustion plants. The impact assessment for Clean Air Policy Package refers to 'untapped synergies between the AAQ Directives and NECD'. The revised NEC Directive (Directive 2016/2284/EU) calls for achieving the air quality objectives set in EU legislation, and thus its *objectives* are strongly coherent with those of AAQ Directives. The *provisions* of the revised Directive are also strongly coherent: already before the revision, the Directive set national ceilings for five key air pollutants; among provisions introduced in the revision, the Directive requires Member States to prepare National air pollution control programmes (NAPCPs) which should assess the national emission sources likely to have an impact on air quality; another is the establishment of a ceiling on emissions of $PM_{2.5}$, a pollutant whose ambient concentrations are addressed by Directive 2008/50/EC. The revised Directive also includes an obligation that Member States coordinate monitoring with other EU legislation, including the AAQ Directives. In turn, the *provisions* of Directive 2008/50/EC refer to the NEC Directive, stating for example that air quality plans should be consistent with and integrated with plans prepared under it.

The implementation of the NEC Directive should moreover lead to improvements in air quality. The recent Clean Air Outlook [P59] estimates that the NEC Directive will by 2030 bring a total 54% reduction in negative health impacts compared to 2005 and a 27% reduction in the ecosystem areas exceeding eutrophication limits. The preparation of the first NAPCPs under the revised NEC Directive was still underway in 2018, the end of the evaluation period, and thus their results are still to come. In integrating their NAPCPs and air quality plans, Member States will need to address differences in geographical scales, as the former are at national level while the latter are commonly at a zone/agglomeration level.

The *Medium Combustion Plants (MCP) Directive* (Directive 2015/2193/EU) introduced emissions limits for facilities between 1 megawatt (MW) and 50 MW, thus covering plants not previously covered by the other EU legislation. Its *objectives* call for the protection of human health and the environment, and its *provisions* include emissions limits on key air pollutants: SO_2, NOx, CO and dust. These limits are to be implemented via permits, which for existing plants are to be introduced by 2024 and 2029 (depending on their capacity): consequently, key results of the MCP in terms of emissions reductions are likely only after the evaluation period. (The AAQ Directives do not refer to the MCP Directive, which was introduced afterwards.)

The *Industrial Emissions Directive* (Directive 2010/75/EU) sets rules on the prevention and control of pollution arising from industrial activities, as well as certain large agricultural enterprises such as pig and poultry raising. Its *objective* is to achieve a high level of protection of human health and of the environment, and its *provisions* include emission limit values for large combustion plants (50 MW and larger) for a number of pollutants, most but not all of which are included in the AAQ Directives and the requirement that permits must be based on the Best Available Techniques (BAT), in turn based on BAT reference documents (BREFs) prepared at EU level. Directive 2008/50/EC refers to the Large Combustion Plant (LCP) Directive (Directive 2001/80/EC), which was incorporated into the IED, and calls for air quality plans to be consistent and integrated with plans and programmes prepared under it. The 2013 Clean Air Programme noted the importance of the IED's implementation for achieving air quality objectives, but also noted that the review of BAT reference documents was underway and moreover that the IED's effectiveness also depends on Member State application of these documents. The recent Clean Air Outlook [P59] states that the 2017 BREF on large combustion plants will reduce further the emissions of NOx, SO_2 and particulates.

Together, the NEC Directive, MCP Directive and IED cover most of the pollutants addressed by the AAQ Directives, as well as key precursors; the main exceptions are Benzene, which arises from vehicle emissions and also industry, and BaP, mainly from vehicle emissions and domestic solid fuel combustion. (See Table 2 in Appendix G for further details.)

The European Court of Auditors [P91] has noted that the IED still 'allows Member States to set less stringent emission limit values' if they determine that BAT would lead to 'disproportionately higher costs' than environmental benefits, and allows 'flexibility instruments', under which some Member States have less stringent standards for certain plants such as district heating.

Stakeholder responses to the open public consultation support the conclusion that the NEC Directive, the MCP Directive and the IED are strongly coherent with the AAQ Directives.

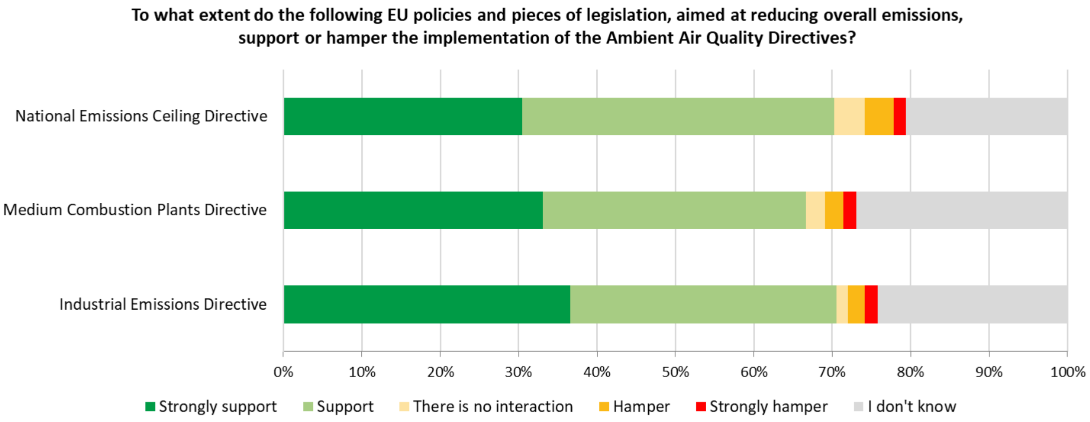
The assessment of the EU's *international commitments* has focused on two international agreements. In 2008, the International Maritime Organisation (IMO) adopted amendments to Annex VI to the International Convention for the Prevention of Pollution from Ships (the *revised MARPOL Annex VI*) sets rules for the progressive reduction in SO_X, NO_x and PM emissions from ships, as well as the introduction of emission control areas for stricter requirements near cities and coastal areas. The Preamble of Directive 2008/50/EC refers to the *Convention on Long-Range Transboundary Air Pollution* (CLRTAP), and the 2013 Clean Air Policy Package included legislation to accept an Amendment to Abate Acidification, Eutrophication and Ground-level Ozone under the

Convention. Overall, the *objectives* and *provisions* of these two international agreements are assessed as strongly coherent with those of the AAQ Directives. Coherence grew stronger over the evaluation period, in particular with the introduction of Revised MARPOL Annex VI.

Text box 6-20 Open public consultation results: coherence of the AAQ Directives with key EU legislation on air pollutant emissions and with EU international commitments

Over 60% of respondents to the Open Consultation indicated that the NEC Directive, MCP Directive and IED 'strongly support' or 'support' implementation of the AAQ Directives.

Figure 6-14 Open public consultation responses on coherence with the NEC Directive, MCP Directive and IED



The open public consultation also had a question on the CLRTAP: over 40% of the respondents felt that the AAQ Directives contributed to the Convention's objectives 'to a very large extent' or to 'to a large extent' (see Appendix G, section G.1.2, for further details, including an overview of the targeted questionnaire responses).

6.4.1.3 Coherence with other environmental legislation

Judgement criterion 7.3: The extent to which AAQ Directives are coherent with other EU environmental legislation.

Assessment summary: A review of selected environmental policy and legislative documents showed that these are coherent with the AAQ Directives: coherence is strong, including with the overarching 6th and 7th EAPs, though specific gaps in coherence were identified.

The assessment considered a set of key policy and legislative documents for environmental policy with potentially important interactions with the AAQ Directives. It considered the two overarching environmental policy documents in place during the evaluation period: both the *6th and 7th Environmental Action Programmes* (EAPs) contain objectives to improve air quality, and both Directive 2004/107/EC and Directive 2008/50/EC refer to the 6th EAP in their initial recitals: consequently, there is strong coherence between the AAQ Directives and the EAPs. The 7th EAP also refers to 'moving closer to WHO recommended levels', an objective set in the 2013 Clean Air Policy Package but not explicitly set out in the AAQ Directives.

The analysis considered two cross-cutting policy initiatives. The 2015 *Circular Economy Package* sets out actions for the transition to a circular economy. The Commission's Communication for the Package [P42] refers to air quality. Measures taken for the circular economy, such as improved resource efficiency of industrial process and reduced landfilling, are likely to contribute to improved air quality. The initiative for *Green Public Procurement* [P19] sets an overall objective to reduce environmental impacts; its criteria for key sectors such as transport address air pollution.

The review also considered six Directives whose fields of action can interact with air quality. In all cases, synergies were identified, though gaps were noted for the Nitrates and Noise Directives (see Appendix G for further details).

Table 6-15 Coherence with key environmental legislation

Legislation	Key synergies	Key gaps
SEA and EIA Directives **(Directives 2001/42/EC and Directive 2011/92/EU)**	SEA mandatory for many types of plans and programmes that could affect air quality; EIA mandatory for many projects that can emit air pollutants	No major gaps identified
Nitrates Directive **(Directive 91/676/EEC)**	By addressing practices that can lead to nitrate pollution of waters, the Directive should reduce agricultural emissions of ammonia and NOx	No reference to air pollution in the Directive
Noise Directive **(Directive 2002/49/EC)**	Industry and traffic are key sources of both noise and air pollutant emissions, especially in urban areas Directive 2008/50/EC: air quality plans should be consistent/integrated with noise plans	Noise Directive does not refer to potential links with air pollution issues
Habitats and Birds Directives **(Directives 92/43/EEC and 2009/147/EC)**	Directive 2008/50/EC sets target values and long-term objectives for ozone, and critical levels of SO_2 and NOx concentrations, for protection of vegetation	No major gaps identified

6.4.1.4 Coherence with EU climate policy and legislation (including international commitments)

Judgement criterion 7.4: The extent to which the AAQ Directives are coherent with EU climate policy and legislation (including international commitments).

Assessment summary: Based on the evidence collected, there are broad synergies between EU climate policy and the AAQ Directives, as measures to significantly reduce GHG emissions are also likely to reduce emissions of ambient air pollutants. The AAQ Directives may also have contributed to climate goals, for example via measures that reduce air pollutants and also GHG emissions.

Given the close links between climate and air quality policy, detailed in Appendix G, and the need to ensure coordinated policy action in each to build synergies and avoid unintended negative consequences, this judgement criterion assesses the coherence of EU climate policy and legislation with the AAQ Directives[47].

Broadly speaking, the GHG emissions reduction targets set out in EU climate policy and legislation – including the 2020 Climate and Energy Package of legislation [P18, adopted in 2008], the 2030 Climate and Energy Framework [P45, adopted 2014], the 2050 Low Carbon Roadmap [P28, adopted 2011] and the Long-Term Emissions Reduction Strategy [P71, adopted 2018] – are coherent with the objectives of the AAQ Directives. Modelling of the impacts of EU climate policy on air quality suggests that emissions of key air pollutants – NO_x, SO_2 and $PM_{2.5}$ – will decrease as the EU's GHG emissions reduction targets are achieved [S65, S18, P72]. Over the evaluation period, EU climate policy documents appeared to increasingly recognise the links between climate policy and air quality. The 2020 Package and 2030 Framework do not make specific reference to links with air objectives, whereas the 2050 Roadmap and the Long-Term Emissions Reduction Strategy specifically note the synergies that can be achieved when climate and air quality policies are well coordinated.

Looking at specific EU climate policy instruments, there appear to be synergies between EU action on climate protection and air quality. The EU-ETS Directive (Directive 2003/87/EC, as amended) is largely coherent with the AAQ Directives in that there are no direct conflicts or overlaps between the pieces of legislation. Similarly, the Effort Sharing Decision (Decision 406/2009/EC) and Regulation (Regulation 2018/842/EU) are consistent with the goals of the AAQ Directives. The 2008 AAQ Directive complements the goals of the EU-ETS Directive and the Effort Sharing Decision by addressing atmospheric concentrations of ambient pollutants that also have a climate impact but are not directly regulated by the EU-ETS Directive (e.g. the black carbon component of particulate matter, ozone and its precursors). Actions taken under the Effort Sharing Decision to reduce emissions of methane – an ozone precursor – can also improve air quality.

However, in the open public consultation, stakeholders noted concerns about the coherence of these two instruments with the objectives of the AAQ Directives, with 17% of respondents (for the ETS Directive) and 13% (for the Effort Sharing Decision) replying that they hamper the Directives. This may relate to broader concerns about the coherence between climate policy measures taken in relation to specific emission sources and air quality. For example, the policies implemented by Member States to achieve the targets in the Effort Sharing Decision may complement or impede the achievement of air quality objective, depending on the specific measures taken. The coherence of sectoral climate measures with the AAQ Directives is discussed in Question 8 below.

It is useful to look at whether EU climate change adaptation responses consider air quality, given the likelihood that climate change will adversely impact air quality. The EU Adaptation Strategy (COM(2013)0216) makes limited direct references to air quality; however a number of actions outlined by the Strategy (e.g. Action 1 supporting Member State adaptation action and Action 3 supporting adaptation in cities) could support EU air quality policy goals. The AAQ Directives could also support adaptation policy goals (for example, through ozone alert thresholds).

[47] Sectoral climate policy instruments, such as energy or transport policy measures, are addressed under question 8 below.

Text box 6-21 Stakeholder perceptions on coherence with EU climate policy and legislation

In responses to the open public consultation, stakeholders generally perceived that the EU-ETS Directive and the Effort Sharing Decision support EU air quality policy; however, a significant minority (17% of respondents for the ETS Directive and 13% for the Effort Sharing Decision) reported that they hamper the AAQ Directives. These responses may reflect broader concerns about the impact of sectoral measures taken to address greenhouse gas emissions. In the targeted questionnaire, when addressing coherence between the AAQ Directives and climate policy, respondents expressed concern about tensions between these policy areas. However, responses focused particularly on sectoral climate change policy responses, with sectoral policies on transport (support to diesel vehicles, particularly at Member State-level) and energy (inclusion of biomass energy generation under the Renewable Energy Directive) attracting the most concern.

6.4.1.5 An integrated approach at Member State level

Judgement criterion 7.5: The extent to which Member States have put in place an integrated approach to the implementation of the AAQ Directives and other environment and climate legislation and policy.

Assessment summary: Based on the evidence collected, Member State integration with environment and climate actions has not been a major issue; however, coordination with key sectors, including those closely related to climate, was a concern in the evaluation period (see JC 8.5 below).

The case studies and stakeholder comments identified few issues concerning integration with other environment and climate actions at Member State level: more generally, however, sectoral integration – for example with energy and transport policies – is a concern in many Member States (see JC 8.4 below). Moreover, it can be difficult to separate these policy areas from climate policy.

As noted in under JC7.2, one issue related to environmental policy concerns the flexibility mechanisms under the Industrial Emissions Directive (Directive 2010/75/EU): several Member States have used these to postpone the introduction of more stringent BAT requirements. Stakeholder comments raised concerns about climate policies, in particular in the areas of energy and transport.

Text box 6-22 Stakeholder responses concerning coordination with environment and climate policies at Member State level

In the responses to the targeted questionnaire, one national authority response to the targeted questionnaire states that national climate policies promoted biomass for heating and diesel over petrol vehicles, actions that can increase air pollutant emissions. Two local authorities expressed concerns about Member States climate measures that have promoted diesel vehicles through tax incentives, with potential negative impacts on air quality; and a large number of other respondents (11) expressed broad concerns about the coherence of climate policies in the transport and energy sectors with air quality goals, without specifically identifying whether these issues arise at the EU or Member State level.

6.4.2 *Evaluation Question* 8: Coherence with sectoral policies

Question 8 asks to what extent the AAQ Directives complement or interact with sectoral policies that affect air quality (or are affected by air quality), at both EU and Member State levels: these include transport, energy, agriculture, health and urban, cohesion and taxation policies.

Text box 6-23 Key findings on the coherence of the AAQ Directives with sectoral policies

The analysis shows that there are many synergies, as well as some contrasts, with EU sectoral policies. The EU legislation governing the Common Agricultural Policy recognises the need for environmental protection and its rural development funding can support actions to reduce agricultural emissions; but air emissions are not addressed under the direct payments to farmers, unlike impacts on water. EU transport legislation and policy documents set air quality among their goals, limit vehicle emissions and promote alternatives to road transport. However, during the evaluation period, EU provisions for controlling vehicle emissions in the Type Approval Framework had shortcomings, which the EU has sought to address since 2015. Nonetheless, less stringent NOx emissions limits for diesel vehicles may mean that the Type Approval Framework continues to be at odds with EU air quality goals. In EU energy policy, measures supporting increased energy efficiency are likely to support better air quality; however, the inclusion of biomass as a renewable energy source to meet targets under the Renewable Energy Directive (Directive 2018/2001/EU) may weaken the contribution of that Directive to EU air quality goals. EU taxation legislation allows Member States to tax diesel fuel at a lower rate than petrol, which can create obstacles for achieving air quality objectives.

EU funding has supported Member State action on air quality: Member States have allocated over EUR 150 billion from EU funds in the current programming period for investments potentially relevant to the AAQ Directives: the great majority of this funding is for investments that indirectly support air quality objectives, such as those for energy efficiency and public transport. A much lower level of EU funding has, however, supported investments – for example, for roads and biomass energy – that may hinder air quality objectives.

EU-level coordination mechanisms have supported policy coherence at EU level and at Member State level, and the role of these mechanisms has grown over the evaluation period. The analysis found that the level of sectoral coordination within Member States varies: although the evidence shows that coordination has improved in some Member States, gaps remain an obstacle to achieving the AAQ Directives' objectives, as does coordination between national and sub-national bodies.

6.4.2.1 Coherence with key EU sectoral policies

Judgement criterion 8.1: The extent to which key EU sectoral policies support AAQ objectives, including public information.

Assessment summary: The EU's broad transport policy goals are consistent with EU air quality objectives. However, weaknesses in the EU Type Approval Framework, and higher NO_x emissions limits for diesel cars, undermined air quality protection during the evaluation period. Legislative changes since 2015 – particularly the introduction of the Real Driving Emissions test and a stronger role for the Commission in enforcement – address many of the weaknesses in the Type Approval Framework. Synergies exist between EU energy efficiency policies and air quality goals; however, the inclusion of biomass under the Renewable Energy Directive may weaken the contribution of that Directive to EU air quality goals. Over the evaluation period, the Common Agricultural Policy has increased attention to environmental issues. The second pillar includes ammonia emissions among its priorities. EU health policy is found to be broadly aligned with air quality policy and synergies with EU air quality goals can be found in EU urban policy.

In considering how key EU policies – in particular those for the transport, energy, agriculture, urban and health sectors[48] - support AAQ objectives, the evaluation reviewed their *objectives* and, for many policy and legislative documents, also their *provisions*.

Transport

As transport, and in particular road transport, is a significant source of NO_x and other emissions, coherence between the EU's air quality and transport policy objectives is of great relevance for achieving the AAQ Directives' objectives of achieving and maintaining good air quality.

[48] EU climate policy was reviewed together with other EU environment policy in Question 7 above.

The transport policy goals as set out by the EU in policy statements are broadly coherent with EU air quality objectives. The Transport White Paper specifically includes 'clean urban transport and commuting' as part of its vision and adopts 'phasing out conventionally-fuelled cars in cities by 2050' as one of its ten goals. The 2016 Low-Emission Mobility Strategy and the Mobility Packages published in 2017 and 2018 explicitly recognise the need to address the impacts of transport on air quality and set out specific actions to support improved air quality, such as the Cleaner Transport Facility. The objective of the Trans-European Transport Network (TEN-T) policy is primarily to establish a single EU transport area through a trans-European transport infrastructure network, and the TEN-T Regulation makes limited reference to air quality. Nonetheless, it includes an objective to contribute to the 'reduction of external costs and environmental protection', broadly in line with EU air quality goals.

EU legislation on fuel quality – the Fuel Quality Directive (Directive 98/70/EC, as amended) and the Sulphur Directive (Directive 2016/802/EU) – is strongly coherent with the goals of the AAQ Directives, given its emphasis on protecting health and the environment through fuel standards. EU air quality goals were also supported by other EU transport legislation, including the Non-Road Mobile Machinery Regulation (Regulation 2016/1628/EU), the Eurovignette Directive (Directive 1999/62/EC, as amended) and the Alternative Fuels Infrastructure Directive (Directive 2014/94/EU).

The overall objective of the European Type Approval Framework (as established by Directive 2007/46/EC; Regulation 715/2007/EC (Euro 5 and Euro 6); Regulation 595/2009/EC (Euro VI), inter alia) is to support the internal market by establishing harmonised standards for vehicles[49]. Nonetheless, the recitals note that the 'main objective of the legislation on the approval of vehicles is to ensure that new vehicles, components and separate technical units put on the market provide a high level of safety and environmental protection' (Recital 14). This objective is clearly coherent with EU air quality objectives.

In terms of provisions, the Euro emission limits also support improved air quality. Nonetheless, the Euro 5 and 6 emissions limits set out in Regulation 715/2007/EC differentiate between petrol and diesel vehicles, with petrol-fuelled cars required to meet more stringent NO_x limits than diesel cars under both Euro 5 and 6. Article 5 of the Regulation provides for a general prohibition of defeat devices, including their use during vehicle testing. The prohibition however does not apply in exempted cases, e.g. where such devices are justified to protect the engine against damage. Such exemptions may undermine the contribution of Euro emissions limits to air quality protection.

In addition, implementation and enforcement of the Type Approval Framework may have undermined air quality objectives during the evaluation period. According to the evidence reviewed, together with input from stakeholders, the implementation of the Framework failed to ensure vehicles met emissions limits (particularly for NO_x). The European Parliament Inquiry into Emission Measurements in the Automotive Sector [R94] found that the failure to ensure that vehicle real driving emissions conformed with Euro 5 and 6 limits contributed, 'to a large extent', to Member States' infringements of the 2008 AAQ Directive. Weaknesses identified in the Type Approval Framework include the failure of laboratory test procedures (called the New European Driving Cycle - NEDC) to reflect NO_x emissions during real driving conditions and the failure to detect prohibited uses of defeat devices [D89]. During the evaluation period, from 2016 to 2018, legislation was adopted to strengthen the Commission's powers in the implementation and en-

[49] Article 1, Directive 2007/46/EC.

forcement of the Type Approval Framework (Regulation 2018/858), replace the previous laboratory test procedure (the NEDC) with the newer Worldwide Harmonised Light Vehicle Test Procedure (WLTP), and progressively introduce the Real Driving Emissions (RDE) test from 2016 to 2020. However, the inclusion of conformity factors, allowing vehicles to exceed the Euro 6 NO_x emission limits during RDE tests, led to criticisms that this package has undermined the effectiveness of the Framework in protecting air quality [R94], and in December 2018 the first instance of the Court of Justice of the European Union annulled this specific provision (subject to a 12-month transition period) [L5].

Text box 6-24 Stakeholder responses concerning coherence between the AAQ Directives and key EU transport legislation

> Respondents to the open public consultation generally agree that EU transport legislation supports EU air quality goals. Nonetheless, 12% of respondents reported concerns that the CO2 emissions standards for new cars and vans hamper air quality objectives and 11% of respondents stated Euro 5 and 6 standards for cars and vans hamper the AAQ Directives. Responses to the targeted questionnaire reported similar views. Respondents acknowledged that the Euro 5 and 6 vehicle standards overall support the objectives of the AAQ Directives, particularly in relation to particulate matter concentrations, but weaknesses in the implementation of the standards undermined their effectiveness in limiting NO_x emissions. Respondents also expressed concerns about the coherence of measures at the Member State level to reduce vehicle CO_2 emissions with EU air quality objectives.

Energy

The energy sector – energy production and distribution – is a significant contributor to concentrations of ambient air pollutants in Europe, particular SO_x concentrations. Energy use in industry and fuel combustion in commercial and domestic buildings for space heating also emit air pollutants, particularly PM_{10} and $PM_{2.5}$, SO_x, CO and black carbon. In addition, policy measures intended to reduce greenhouse gas emissions from energy generation are expected to lead to overall air quality benefits, but the impact of individual renewable energy sources differ. As such, it is important to take the interactions between EU energy policy and EU air quality goals into account.

The 2020 Climate and Energy Package (COM/2008/30)[50] includes two targets relevant to the energy sector: a 20% share of renewable energies in EU energy consumption by 2020; and a 20% energy efficiency target (i.e. energy consumption in 2020 is 20% below projected energy use). The energy efficiency target is likely to positively impact air quality, due to reduced air pollutant emission from energy generation. The impacts of the renewable energy target are overall likely to be positive for air quality, but the impacts depend on the sources of renewable energy that ultimately displace conventional energy generation. Some sources (e.g. solar, wind) are having a positive impact on air quality, while the air quality benefits of other sources (e.g. biomass) are less clear and depend to a large extent on the combustion technology used.

There are synergies between the objectives and provisions of the Energy Efficiency Directive (Directive 2012/27/EU, as amended) and air quality goals. As noted above, the 2020 and 2030 energy efficiency targets set out in the Directive likely to contribute to air quality goals through decreased energy generation. The objectives of the Renewable Energy Directive (Directive 2009/28/EC) and its 2018 recast (Directive 2018/2001/EU) are not directly in conflict with EU air quality goals, and the provisions may support improved air quality by reducing energy generation from fossil fuels. Regarding Stakeholders raised concerns that the inclusion of biomass as a renewable energy source in the Directive may undermine air quality goals. Similarly, literature,

[50] The coherence of broader climate policy is evaluated under Question 7 above.

including the 2018 European Court of Auditors report [P91, see also R38], expressed concern about the impact of biomass energy generation under the Directive on air quality. The inclusion of biomass as a renewable energy source under the Directive may have weakened the contribution of the Directive to improved air quality. The increased use of certain types of biomass technology under the Directive may also have negatively impacted air quality in specific locations.

The Energy Union Governance Regulation (Regulation 2018/1999/EU) links between climate, energy and air quality policy are recognised in the proposed Regulation's recitals and provisions. Integrated National Energy and Climate Progress Reports must include information on the impacts of climate and energy policies on air quality (Art. 17); and reporting on renewable energy must include information on estimated impacts of biomass fuels on air quality (Art. 20 and Annex IX).

The Ecodesign Directive (Directive 2009/125/EC) does not specifically set out an air quality objective, but Article 1 includes reference to the Directive's contributions 'to sustainable development by increasing energy efficiency and the level of protection of the environment'. Air emissions are included among the ecodesign parameters for products listed in Annex I of the Directive. The implementing regulations setting out ecodesign requirements solid fuel heaters (Commission Regulation 2015/1185/EU) and solid fuel boilers (Commission Regulation 2015/1189/EU) are clearly intended to support air quality objectives. However, the long transition period for these measures have been noted in the literature [S88, P91] and in some stakeholder submissions. The Commission has noted this reflects a balance of environmental objectives with the need to allow consumers and industry time to adjust to the change [P91].

Text box 6-25 Stakeholder responses concerning coherence between the AAQ Directives and key EU energy legislation

When asked about the coherence between key EU energy sector legislation and the AAQ Directives, a majority of respondents to the open public consultation agreed that EU legislation on energy overall supported the implementation of the AAQ Directives, as indicated in the figure below. When concerns were expressed, they tended to focus more on the Renewable Energy Directive, with 8% of respondents reporting that the Directive hampered the implementation of the AAQ Directives.

Agriculture

Agriculture is a source of ammonia emissions, which is a PM and ozone precursor. In recent years, the EU Common Agricultural Policy (CAP) has undergone a series of reforms that have improved its environmental sustainability. In particular, the 2013 reform aimed at finding a balance between agricultural production, rural development and the environment [D63]. Under direct payments to farmers (the main part of 'Pillar I' of the CAP), payments for implementing compulsory 'green' measures were introduced to support basic environmental management on all agricultural land in the EU-28 [R115]. The cross-compliance rules refer to soil management and ban the burning of arable stubble, a provision that should reduce air emissions of particulates. The cross-compliance rules also include the Nitrates Directive (Directive 91/676/EEC), whose measures can reduce air emissions (see JC7.3 above).

The second pillar of the CAP supports rural development: the European Agricultural Fund for Rural Development [P109] includes among its objectives ensuring the sustainable management of natural resources and addressing climate change. Among the priorities of this Fund there are measures to reduce GHG and ammonia emissions from agriculture (see section on EU funding instruments below for further information)[51].

Text box 6-26 Stakeholder responses concerning coherence between the AAQ Directives and the CAP

Respondents to the open public consultation were divided on the role of the CAP: just over 20% perceived that the CAP supports or strongly supports implementation of the AAQ Directives, while close to 30% perceived that it hampers or strongly hampers their implementation (and the largest share, over 40%, responded 'don't know'). Divisions were also seen in responses to the targeted questionnaire: several NGOs stated that the CAP is not meeting its environmental objectives in general and thus is not supporting the AAQ Directives; a public authority said that manure management requirements will reduce air pollutant emissions from agriculture. This is in line with the results of the targeted questionnaire, where respondents who expressed concerns about the coherence between EU energy and air quality policy objectives tended to focus on the impacts of the inclusion of biomass in the Renewable Energy Directive.

Health and urban policies

Human health impacts are a central rationale for air pollution policy. Under the EU Treaties, Member States are primarily responsible for health policy. EU health policy has emphasised that health considerations should be mainstreamed across EU policies: the EU's Second Health Programme (2008-13) called for addressing the health effects of environmental determinants, and the Third Health Programme (2014-2020) [P40] calls for promoting 'health in all policies'. The AAQ Directives, in turn, identify the protection of human health as a central objective. Given the alignment between the objectives of the AAQ Directives and EU health policy, these two areas are broadly coherent; the EU Health Programmes, however, only briefly refer to environmental and climate impacts on health.

In the targeted questionnaire as well as in the second stakeholder workshop, health NGOs called for greater attention to health in the AAQ Directives, in particular in terms of their standards (see also section 6.1.1.3 on the relevance of the standards in the AAQ Directives).

Regarding *urban policy*, the Urban Agenda for the EU, launched in 2016, is a key EU-level policy initiative for urban policy. As the Urban Agenda focuses on setting up a multi-level dialogue among government actors and stakeholders at different levels, it is covered below in section 6.1.1.4 on EU-level coordination.

6.4.2.2 Coherence with EU funding instruments

Judgement criterion 8.2: The extent to which EU funding instruments support Member State actions to improve air quality.

Assessment summary: Based on the evidence collected, EU funding instruments have provided significant resources: in the 2014-2020 period, Member States allocated about EUR 2 billion from the cohesion policy funds in direct support for air quality measures and about EUR 166 billion for investments that can potentially indirectly contribute to better air quality, such as those for energy efficiency and public transport. Other EU funding instruments, including research programmes, have also provided significant resources for projects that can support air quality objectives. Coherence strengthened over the evaluation period as EU funding instruments devoted greater attention to sustainable and low-carbon investments. Member States have directed a much smaller

[51] In addition to measures under the CAP, certain large agriculture enterprises, including intensive pig and poultry facilities, come within the scope of the Industrial Emissions Directive, the 2017 Best available techniques Reference document (BREF) includes techniques to reduce air emissions from this sector.

amount of EU funding to investments in areas such as roads and biomass; some of these may hinder air quality objectives.

This section reviews the objectives and provisions for key EU funding instruments, as well as information available on their spending related to air quality objectives. The AAQ Directives do not, however, refer to these funding instruments.

Legislation governing cohesion policy funds (Regulation 1303/2013/EU) includes thematic objectives supporting air quality. Among the cohesion policy funds, the European Regional Development Fund (ERDF) and the Cohesion Fund (CF) together provided about EUR 1.22 billion for air quality investments[52] in the 2007-2013 programming period [D161]; in the current, 2014-2020 period Member States have allocated about EUR 2 billion [R30, D161] (a third fund, the European Agricultural Fund for Rural Development, EAFRD, is discussed separately below; the European Social Fund and the European Maritime and Fisheries Fund were not analysed as strong links to air quality were not foreseen). Member States are using these resources for pollution control at large industrial facilities, for the reconstruction of building heating systems, for public transport improvements, for air quality monitoring stations and in some cases, for air emissions from the agriculture sector [R30]. The case studies for this report provide examples of these air quality investments.

In addition, much larger cohesion policy allocations in other areas support actions that can improve air quality. These include, as reported by the European Commission, allocations in the 2014-2020 period for: 'the low-carbon economy (EUR 45 billion), environmental protection and resource efficiency (EUR 63 billion) and network infrastructure (EUR 58 billion)' [P69].

Several studies indicate, however, that Member States did not use the full potential of ERDF and CF funding for air quality. The Partnership on Air Quality [R146] finds that few Operational Programmes explicitly allocate funding to air pollution reduction projects. The European Court of Auditors [P91] indicates that in some of its case studies, ERDF and CF resources were not used to tackle known air pollution sources. EUROSAI [R95] finds that EU funding for air quality was not always well-targeted by Member States in the countries it reviewed.

Investments, including those supported by EU funds, can also support projects that may negatively affect air quality [R146]. Operational Programmes (OPs) provided EUR 42.6 billion of cohesion policy funds for road investments in the 2007-13 period; in the 2014-2020 period, Member States have allocated a lower amount, EUR 30 billion [D161]. OPs made expenditures of EUR 690 million for biomass projects in the 2007-2013 period; in the 2014-2020 period, allocations of EUR 1.6 billion were made for biomass contributing to cohesion policy's objective of supporting the shift to a low-carbon economy, for which allocations were earmarked. ECA [P91] raises concerns about the coherence of biomass investments with air quality objectives. The impacts on air quality of spending in these areas will, however, depend on the specific projects and contexts.

The *Connecting Europe Facility (CEF)* provides finance for investments in transport, energy and telecommunications infrastructure in Europe. During the 2007-2013 funding period, approximately EUR 8 billion was allocated to the TEN-T network. Most of this funding went to developing an interoperable railway network [R160]: rail investments can reduce air pollutant emissions by supporting a shift away from road transport. CEF also provided direct benefits for air quality by funding projects that support the deployment of alternative fuels. For instance, under the CEF funding objective ensuring sustainable and efficient transport systems (155 actions with EUR

[52] See Appendix G for the spending category used for this calculation and further details.

~930 million) many projects concern the deployment of alternative fuels such as LNG and electricity, both in vehicles and for infrastructure. For the 2014-2020 period, there is a stronger focus on supporting low-carbon and sustainable modes of transport [D68]. The total budget for CEF in the 2014-2020 period is EUR 32 billion, with CEF-Transport accounting for most of this budget (EUR 24 billion). About EUR 9 billion of CEF is to be invested in infrastructure projects that have some benefit for air quality, with the majority of CEF investments in the railway sector [P59] (approximately 70% of total funding) expected to benefit air quality to the extent that these investments support modal shift from road transport. Moreover, the European Commission is supporting projects for cleaner mobility and alternative fuels infrastructure: in 2018, funding of EUR 1 billion for 39 clean transport projects was proposed for upgrading Europe's rail network, further developing alternative fuels infrastructure and promoting zero emission water transport [P69]. CEF can also support investments in transport infrastructure that may have negative impacts on air quality, such as roads or waterborne transport, but this appears to be small share of overall funding.

The *European Fund for Strategic Investment (EFSI)* is aimed at mobilising EUR 315 billion[53] in private investments; its key areas include infrastructure, and climate and environment. EFSI includes the CEF debt instrument, which financing for energy and transport investments in the Member States. There is no explicit mention of air quality in the EFSI Regulation (Regulation 2015/1017); however, there is a strong focus on investments that align with EU policies that can benefit air quality, such as Horizon 2020 and TEN-T. It is estimated that approximately EUR 95 billion of the EUR 315 billion in investments mobilised under EFSI will have been allocated for projects that can have an air quality dimension, such as energy and transport projects [P59].

The *European Agricultural Fund for Rural Development (EAFRD)* has a spending focus area (5D) in the 2014-2020 period tackling GHG and ammonia emissions: Member States can use resources to finance investments such as ammonia abatement measures, installation of air washers and coverage of storage manure facility and to support more sustainable farming practices. The target is to mobilise EUR 2 billion of public spending. Out of the 112 RDPs, however, only about half included spending under this focus area [D53].

The EU's *research and innovation programmes* have supported investments for air quality. An estimated combined total of EUR 13 billion in funding has been provided in the 2007-2013 and 2014-2020 framework programmes for projects that directly or indirectly contributed to improving air quality [D58, P91]. Projects have addressed a range of topics including the long-term health effects of air pollution and technologies for air quality monitoring in urban areas [D70]. Other research has focused on innovative greener technologies, including EUR 420 million for 107 research and innovation projects under the umbrella of the European Green Cars Initiative [D47]. In addition, the CIVITAS Initiative (supported by the European Commission's DG for Mobility and Transport) provides a network of European cities to test innovative measures for urban transport [D17].

The *EU LIFE Programme* aims to improve the quality of the environment, notably via funding for innovative pilot projects. LIFE projects have supported projects for air quality planning, capacity building, monitoring and modelling, sustainable urban mobility and pilot pollution control investments. In the period 2014-2020, 51 projects and about EUR 300 million has been allocated to projects with a direct or indirect impact in terms of improving air quality [D61, D29]. For examples of LIFE projects for air quality, see Appendix G, G.2.2.

[53] Recently increased to EUR 500 million.

Text box 6-27 Stakeholder perceptions of the coherence of EU funds with the AAQ Directives

In the open public consultation, a large share of respondents perceived that EU funding supports the AAQ Directives' objectives, as did targeted questionnaire responses (see Appendix G for details). In the second stakeholder workshop, however, some participants raised concerns about the coherence of EU financing to support investments in biomass, which has the potential to increase air pollutant emissions in local areas.

6.4.2.3 Coherence with EU and Member State taxation policies

Judgement criterion 8.3: The extent to which EU/national taxation policies or measures support Member State actions to improve air quality.

Assessment summary: Based on the analysis of available evidence, EU energy taxation legislation setting lower minimum tax rates for diesel fuel than for petrol may not have aligned with air quality objectives. In addition, Member State tax levels often favoured diesel over petrol and incentivised the ownership and use of private cars. Such taxation policies at EU and Member State level (together with weaknesses in the Type Approval Framework described under JC8.2) may have led to higher emissions of air pollutants, in conflict with the objectives of the AAQ Directives.

The evidence suggests that EU provisions on the taxation of transport fuels may not fully support the objectives of the AAQ Directives. Per litre, diesel results in higher NO_x and PM (as well as CO_2) emissions than petrol. The minimum levels of taxation for transport fuels set out in the Energy Taxation Directive (Directive 2003/96/EC) (in Article 7 and Annex I) set lower minimum tax rates per litre for diesel than for petrol[54]. In addition, Article 18 and Annex II set out the derogations allowing Member States to apply tax rates below the minimum level of taxation for certain products. These derogations include reduced rates of taxation for diesel fuel. In 2011, the European Commission proposed amendments to the Directive that would remove the favourable tax treatment of diesel (COM (2011) 169); however, this proposal failed to secure the support of the Parliament or Council [P92] and was subsequently withdrawn by the Commission.

Member State policies on the taxation of transport fuels and of vehicles are often at odds with EU air quality objectives. Most Member States have diesel taxes between 10% and 40% lower than petrol in 2017 [R166]. As of 1 January 2018, all but two Member States (the United Kingdom and Hungary) taxed diesel fuel at a lower rate than petrol [D66][55], which can incentivise the purchase and use of diesel-fuelled vehicles, potentially leading to increased ambient air pollution. In addition, Member State tax settings often incentivise vehicle ownership (and, therefore, road transport) through favourable tax treatment of company vehicles. The 2018 European Semester Country Reports have, for example, noted the issue of company car tax treatment in Belgium and Germany. In general, these incentives allow tax advantages for employers that offer employees cars as in-kind benefit. These incentives reduce the costs of road transport for employees, encouraging them to use cars over other modes of transport [R29]. In Member States with lower fuel taxes on diesel and other measures that support vehicles with lower CO_2 emissions (e.g. reduced registration or circulation taxes), these measures also have the potential to increase the share of diesel cars. These two potential effects of favourable tax treatment of company vehicles combine to increase emissions of NO_x and PM. This suggests that in many Member States, tax treatment of fuel and vehicles is not in line with the objectives of the AAQ Directives.

[54] The minimum level of taxation for diesel (EUR 330 per 1,000 litres) is around 8% lower than the level for unleaded petrol (EUR 359).
[55] In recent years, countries such as Belgium [D136], France [P122] and Portugal [R167] have taken measures to reduce the tax gap between diesel and petrol fuel.

6.4.2.4 EU-level coordination mechanisms

Judgement criterion 8.4: The extent to which EU-level coordination mechanisms support a coherent approach to achieving AAQ objectives.

Assessment summary: Coordination mechanisms at EU level have supported, on the one hand, coherence in EU policy-making related to air quality and, on the other hand, coherence in Member State actions. Based on the evidence collected, the role of coordination mechanisms has grown over the evaluation period.

Several mechanisms have supported coordination for EU policy making in key sectors for air pollutant emissions. Mechanisms that have supported coordination in key policy areas for air quality include the following (see Appendix G for further details):

- The *Energy Union Project Team*, composed of representatives of relevant Commission services, supported the integration of air quality into the Energy Union legislative package of 2018, as seen in the inclusion of reporting requirements on air quality under the Energy Governance Regulation (Regulation 2018/1999/EU), noted above (JC8.1).

- The *Technical Committee for Motor Vehicles (TCMV)*, the comitology committee for Type Approval legislation, and the Working Group on Motor Vehicles expert group and its sub-groups, supported the improvements to the Type Approval Framework for vehicle emissions, including the development of the Real Driving Emission (RDE) test (the Type Approval Framework is covered under JC8.1). The participation of DG Environment, together with other Commission services, in the TCMV means that air quality considerations can be factored into discussions. However, the European Parliament's EMIS inquiry raised concerns that the effectiveness of the TCMV and the Working Group and sub-groups in addressing air quality issues has been weak, due to over-representation of industry, lack of transparency, and slow progress in adopting improved vehicle test procedures such as the RED. It also found that new rules for Commission expert groups adopted in 2016 (C(2016) 3301 final) should better balance the representation of stakeholders in expert groups and improve the transparency of proceedings [R94].

- The preparation of Best Available Techniques (BAT) Reference Documents (BREFs) under the *Industrial Emissions Directive* (Directive 2010/75/EU) is supported by technical working groups, which include 100 to 200 experts from Member States, industry and NGOs; draft BREFs are reviewed by the IED Article 13 Forum, with representatives from Member States, industry and NGOs [D86] (see JC7.2 above for further information on coherence with the IED).

- The *European Sustainable Shipping Forum*, established in 2013, has in its work supported implementation of rules on the sulphur content of marine fuels [D82]. The Forum brings together industry and NGOs and includes a sub-group on air emissions that has addressed topics including sulphur, NOx and particulate emissions from ships (coordination with IMO rules on the sulphur content of marine fuels is addressed under JC7.2).

Several mechanisms are in place at EU level that can support coherent Member State approaches in addressing air quality, including the integration of air quality in sectoral policies at Member State level. Particularly important are the *Clean Air Dialogues*, bilateral dialogues between the Commission and Member States facing implementation challenges. Key objectives are 'promoting clean air policy in other sectoral areas' and promoting 'synergies and avoid policy tensions' [D74]. These dialogues were introduced in the last two years of the evaluation period. A review of the outcomes of the meetings held in 2017 and 2018 show that the Dialogues focus in large part on sectoral policies impacting on air quality objectives (see Appendix G for details). These Dialogues thus support better coordination at Member State level.

The *Urban Agenda for the EU* promotes an integrated and coordinated approach for the urban dimension of EU and national policies and legislation, with the aim to improve the quality of life in urban areas (see also JC 8.1). Work under the Urban Agenda includes the establishment of 'partnerships', bringing together authorities at different levels of government as well as key stakeholders, to address specific areas of concern: air quality was one of the first Partnerships, launched in 2016. Under the Partnership's Action Plan, released in 2018, partners will undertake a series of activities such as the preparation of good practices for city air quality action plans and the mapping of tools such as health impact assessments to better address air pollution impacts on health [R177]. The Urban Agenda thus supports better coordination at local level.

In addition, EU environmental initiatives that can support Member State coordination include the Environmental Implementation Review [D76], the Action Plan on environmental compliance and governance [D75], and IMPEL, the EU Network for the Implementation and Enforcement of Environmental Law (IMPEL): these are described in Appendix G.

Text box 6-28 Stakeholder responses concerning EU-level coordination mechanisms

Most stakeholders responding to the open public consultation perceived that mechanisms in place to promote coordinated action between the EU level and Member States in implementing the AAQ Directives had a positive role: about 30% of respondents perceived that mechanisms to support coordination between the EU and the Member States are 'somewhat' adequate and a further 30% found them adequate 'to a large extent' or 'to a very large extent'. See Appendix G for further details.

6.4.2.5 An integrated approach at Member State level

Judgement criterion 8.5: The extent to which Member State air quality plans are coordinated with planning initiatives promoted by EU sectoral legislation and policy, Member State air quality plans are integrated with spatial planning, and Member State coordination mechanisms support a coherent approach to achieving the objectives of the AAQ Directives.

Assessment summary: Based on the evidence collected, both horizontal coordination with sectoral authorities and vertical coordination across levels of government remain major challenges in many Member States. The case studies identified examples where implementation of the AAQ Directives has improved coordination in the evaluation period.

Policy coordination within Member States is critical to the successful implementation of the Directives. Coordination is important across two dimensions – horizontally, in policies across sectors; and vertically, among different levels of government – to ensure that air quality objectives are addressed in policy-making affecting emission sources [S48].

Several case studies identify issues concerning *horizontal coordination*: in Germany, for example, with agriculture in Lower Saxony; in Bulgaria, between air quality, climate and energy strategies at both national and municipal levels. The final action plan of the Air Quality Partnership [P8] identified, as one of its two main areas of concern, coordination at city level, for example, between actions for air, health, energy, transport and urban planning. Studies have found that air quality planning and spatial planning jurisdictions are often not aligned [S48, D9]; moreover, only a few Member States, such as the Netherlands, have embedded air quality considerations in spatial planning [S14].

The case studies also indicate recent improvements. In Ireland, for example, coordination among government departments was in place for the preparation of the first National Clean Air Strategy (NCAS). In Italy, the preparation of the 2013 Po Basin Action Plan brought together five national ministries with the regions of the Po Valley, which have had repeated exceedances of EU limit values; this plan then stimulated greater coordination on air quality among national ministries.

As noted under JC8.4, EU initiatives have strengthened Member State policy coordination. The Clean Air Dialogues have addressed coordination issues. Hundreds of urban areas have prepared *Sustainable Urban Mobility Plans*, an initiative of the EU's 2013 Urban Mobility Package [D77] (see Appendix G for further details).

In terms of *vertical coordination*, the action plan of the air quality partnership under the EU Urban Agenda [P8] highlights that coordination between different levels of governance (national, regional, local) is a key challenge. The European Court of Auditors found that Air Quality Plans 'could not deliver significant results in the short term because they went beyond the powers of the local authorities responsible for implementing them'; lack of necessary funding from the national level can also hinder local actions [P91]. Some Member States have complex governance systems, making coordination more difficult: EUROSAI [R95] found that this was the case in Poland, where there are multiple government bodies across national, regional and local levels.

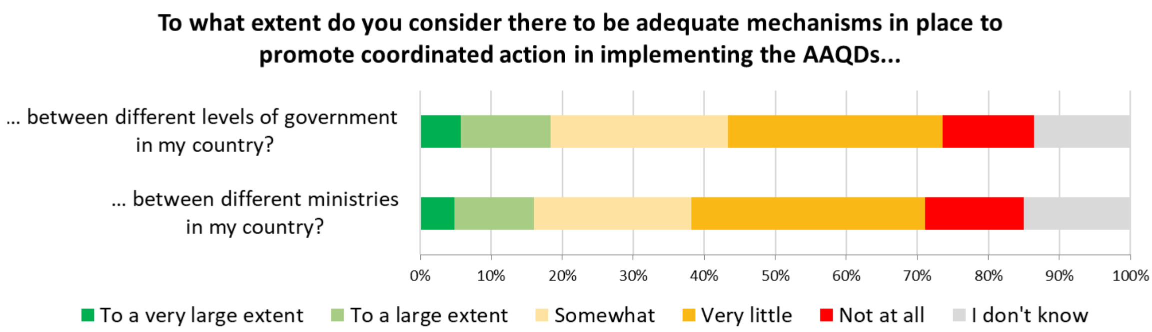
The case studies identified examples of these problems and good practices. In Sweden, for example, municipalities, county administrative boards and transport authorities have worked together on air quality plans (see Appendix G for further details).

Stakeholders raised concerns about coordination within Member States (see the box below).

Text box 6-29 Stakeholder responses concerning coordination within Member States

More than twice as many respondents to the open public consultation indicated that adequate mechanisms for coordination were in place to a 'very little' extent or 'not at all' than those who felt that they were in place to a 'large' or 'very large' extent, both for horizontal and for vertical coordination (see the figure below).

Figure 6-15 Open public consultation responses concerning mechanisms for coordination within Member States



Open public consultation respondents moreover indicated negative perceptions of coordination across all eight sectors indicated in the questionnaire: taxation, health, energy, mobility/transport, public procurement, urban development, climate change and industrial policy. Respondents also perceived that the objectives of the AAQ Directives were not coordinated with those for spatial planning. Moreover, comments to an open question about coordination within Member States were largely negative and position papers submitted by respondents to the open public consultation noted concerns about inadequate vertical coordination in the Member States (see Appendix G for details).

6.5 EU added value

EU added value brings together the findings from all other evaluation criteria, looking for benefits and changes resulting from the AAQ Directives that are additional to those that would have resulted from action at local, regional or national level alone. Under the principle of subsidiarity, "in areas which do not fall within its exclusive competence, the Union shall act only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States, either at central level or at regional and local level, but can rather, by reason of the scale or effects of the proposed action, be better achieved at Union level"[56].

The key evaluation questions that were addressed as part of the study and concern EU added value are presented in the table below.

Table 6-16 Evaluation questions and judgement criteria for EU added value

Evaluation questions and judgement criteria on EU added value
EQ 9: To which degree have the AAQ Directives, including common EU air quality standards and comparable air quality assessment, management and information approaches enabled Member States and their competent authorities to take successful action to improve beyond what would have been possible without EU action? • JC 9.1: The extent to which the AAQ Directives have brought added value by triggering changes to national and local legislation, thus improving air quality beyond what would have been achieved without EU action. • JC 9.2: The extent to which the AAQ Directives brought added value by setting up comparable air quality assessment and information approaches enabling Member States and their competent authorities to take successful action, thus improving air quality beyond what would have been achieved without EU action. EQ 10: What has been the EU added value of the AAQ Directives, do the Directives and their means of implementation create synergies or overlaps with other Community objectives, and how has the distribution of responsibilities between EU, Member State, regional and local level impacted on air quality management? • JC 10.1: The extent to which the AAQ Directives have brought added value by creating synergies and avoiding overlaps with Community objectives. • JC 10.2: The extent to which the AAQ Directives have brought added value by ensuring a more appropriate distribution of responsibilities between EU, Member States, regional and local air quality management.

6.5.1 *Evaluation Question 9: Added value of common air quality framework*

Question 9 assessed "to which degree have the AAQ Directives, including common EU air quality standards and comparable air quality assessment, management and information approaches enabled Member States and their competent authorities to take successful action to improve beyond what would have been possible without EU action?".

Text box 6-30 Key findings on EU added value of the AAQ Directives

Overall, evidence shows that the AAQ Directives have brought added value by setting up a common air quality standards framework, harmonised rules for air quality monitoring and assessment, increasing the availability of good quality information which enabled action by the authorities to improve air quality.

The AAQ Directives jointly introduced air quality standards for five additional pollutants, i.e. $PM_{2.5}$ (limit and target values), As, Cd, Ni, PAH (target values), and reinforced previously existing standards for other pollutants. Prior to the implementation of the Directives, Member States had different approaches to regulating pollutants in terms of the level of protection (weaker or stricter limits) and the legal nature of the regulations (binding or voluntary, limit values or guidelines, obligation of results or obligation of means). The Directives harmonised the approach to air quality standards. In line with the principle of subsidiarity,

[56] Article 5 of the Treaty on European Union.

the EU intervention to harmonise standards is justified to prevent different and changing requirements in individual jurisdictions from negatively affecting the creation of a level playing field in addressing air quality challenges. Furthermore, the transboundary nature of air pollution further warrants the need for EU action. The measures to harmonise the standards are also proportionate, aligning the standards across EU Member States and their implementation did not impose disproportionate costs on the Member States.

The AAQ Directives introduced a common framework for assessment and monitoring which led to the availability of better quality and more comparable information to the public. In addition to the common framework set out by the provisions of the AAQ Directives, the European Commission also provided various guideline documents (e.g. guidelines on setting up common measuring stations for $PM_{2.5}$) as well as networks to ensure the quality of assessment information generated through monitoring, modelling or objective estimation (FAIRMODE, AQUILA). However, as evidenced by findings from the case studies and stakeholder consultations, certain provisions (e.g. siting of monitoring stations) offer a certain degree of flexibility to the Member States which may, within the boundaries of this flexibility, lead to limited differences in monitoring and assessment. Under the principle of subsidiarity, the EU intervention is warranted to ensure the application of a common methodology for monitoring and assessment across Member States in view of enabling the systematic and rigorous compilation of data and assessment of air quality across Member States.

The AAQ Directives have also been important in ensuring a higher level of access to information to the public on air quality which led to (legal) action by public authorities, the general public and other organisations, as evidenced by the number of infringement proceedings and the amount of court cases pursued by citizens and organisations such as ClientEarth.

6.5.1.1 Added value in terms of common air quality standards

Judgement criterion 9.1: The extent to which the AAQ Directives have brought added value by triggering changes to national and local legislation, thus improving air quality beyond what would have been achieved without EU action.

Assessment summary: Evidence collected in the context of the study to support the fitness check indicates that the AAQ Directives have brought added value in terms of introducing air quality standards for additional specific pollutants and assessment approaches across EU Member States. The common standards introduced by the Directives led to an increased harmonisation of air quality standards applied by the Member States and, thus, a reduction of discrepancies in air quality standards. In line with the principle of subsidiarity, the harmonisation of the air quality standards appears to be justified in view of ensuring a uniform approach to addressing air quality issues. Although there is some evidence to suggest a contribution made by the AAQ Directives to decreasing trends of air pollution over the past decade, the precise added value of the harmonised rules on declining air pollution cannot be quantified.

The EU added value of Directive 2008/50/EC and Directive 2004/107/EC has been significant and manifold when it comes to setting up a harmonised air quality standards framework at European level as well as to setting up comparable air quality assessment approaches across Member States.

In terms of setting up a common air quality standards framework and triggering changes to the national and local legislation, the analysis indicates that, as a result of the AAQ Directives a more balanced level-playing field for dealing with air pollution has been achieved across Member States as a result of the increased harmonisation of air quality standards. Given the transboundary nature of air pollution and in line with the principle of subsidiarity, the measures to harmonise the air quality standards are warranted to prevent different and changing requirements in individual jurisdictions from negatively affecting the creation of a level playing field in addressing air quality challenges. Furthermore, the adoption of uniform air quality standards mitigates the risk of fragmentation in dealing with air pollution as a consequence of uncoordinated measures taken at

Member State level. The EU intervention had the added value of setting the level of ambition and providing a focussed and complementary approach in dealing with pollutant concentrations.

The AAQ Directives (Directive 2008/50/EC and Directive 2004/107/EC) had varying levels of effect on applicable national and local legislation depending on the type of pollutant regulated and the limits imposed. The AAQ Directives brought most added value when it comes to the harmonisation of concentrations for $PM_{2.5}$, As, Cd, Ni, PAH. At EU level, Directive 2008/50/EC was the first to introduce air quality objectives for fine particles ($PM_{2.5}$) including a limit value and objectives targeting exposure of the population to fine particles, thus contributing to the harmonisation of the approach towards dealing with fine particles concentrations across Member States. In addition, Directive 2004/107/EC introduced target values for arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons.

Standards for concentrations for other pollutants (PM_{10}, NO_2, NO_x, SO_2, O_3, CO, Benzene) were in place at EU level prior to the Directive 2008/50/EC and Directive 2004/107/EC. Thus, for these pollutants the two directives brought added value only to the extent that they reinforced pre-existent values, but did not introduce standards for previously un-regulated pollutants. The currently applicable limit values for concentrations of SO_2, NO_2, NO_x, PM_{10}, Pb were introduced by the First Daughter Directive almost 20 years ago, whereas the limit values for concentrations of CO and Benzene were introduced by the Second Daughter Directive and are almost 18 years old. Similarly, the target value of O_3 is over 15 years old and the target currently in force is less strict than in the past.

Prior to the introduction of the AAQ Directives and their predecessors[57], air quality standards varied considerably across Member States in terms of the type of pollutants that were regulated, the level of protection (weaker or stricter limits) and the legal nature of the regulations (binding or voluntary, limit values or guidelines, obligation of results or obligation of means). The overview below in Table 6-17 provides a mapping of the situation in terms of standards for specific pollutants at Member State level prior to the adoption of the AAQ Directives. The table is supported by additional evidence that can be found in Appendix H.

In the absence of uniform air quality standards, it is likely that Member States would have continued with the same or similar practices in terms of air quality standards. Thus, the AAQ Directive had an important contribution in terms of harmonisation.

[57] Council Directive 1999/30/EC (First Daughter Directive) regulating limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead, Directive 2000/69/EC (Second Daughter Directive) introducing limit values for benzene and carbon monoxide and Directive 2002/3/EC (Third Daughter Directive) relating to ozone

Table 6-17 Comprehensive mapping of standards for specific pollutants in the majority of the Member States prior to the AAQ Directives[58]

Pollutant	Member States with standards in place prior to the AAQ Directives	Member States without standards in place prior to the AAQ Directives
Current standards for $PM_{2.5}$ introduced by Directive 2008/50/EC.		
$PM_{2.5}$[59]	Bulgaria, France	Belgium, Czech Republic, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Sweden, United Kingdom
Current standards introduced by Directive 2004/107/EC (Fourth Daughter Directive)		
As[60]	Belgium, Germany, Netherlands,	Austria, Denmark, Finland, France, Ireland, Italy, Luxembourg, Portugal, Spain, Sweden, United Kingdom
Cd[61]	Austria, Belgium, Germany, Netherlands	Denmark, Finland, France, Ireland, Italy, Luxembourg, Portugal, Spain, Sweden, United Kingdom
Ni[62]	Belgium, Netherlands	Austria, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Portugal, Spain, Sweden, United Kingdom
PAH[63]	Belgium, Croatia, France, Germany, Italy, Netherlands, Sweden, United Kingdom	Austria, Denmark, Ireland, Luxembourg, Portugal
Current standards introduced by Directive 2002/3/EC (Third Daughter Directive)		
O_3[64]	Austria, Germany, Italy, Netherlands, Sweden, United Kingdom	Belgium, Denmark, Finland, France, Greece, Ireland, Luxembourg, Portugal, Spain
Current standards introduced by Directive 2000/69/EC (Second Daughter Directive)		
CO[65]	Austria, Finland, Germany, Italy, Netherlands, Portugal, Sweden, United Kingdom	

[58] The table (and supplementary tables in Appendix I) have been compiled on the basis of desk research of existent literature and national legislation, data gathered through the 7 case studies and contacts (email exchanges and phone calls) with relevant national authorities in the 7 case study Member States. In cases of Member States where no information was found via desk research or via contacts with the national authorities, this is indicated in footnotes. No information means that in the sources consulted and via the contacts with the national authorities, no information was retrieved. A comprehensive overview of the data sources used to compile the table is presented in Appendix I.
[59] For $PM_{2.5}$ no information in the consulted sources was found for: Austria, Croatia, Cyprus, Denmark, Estonia, Finland, Germany, Greece, Hungary, Latvia, Lithuania, Malta, Slovenia, and Spain.
[60] For As no information in the consulted sources was found for: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.
[61] For Cd no information in the consulted sources was found for: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.
[62] For Ni no information in the consulted sources was found for: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.
[63] For PAH no information in the consulted sources was found for: Bulgaria, Cyprus, Czech Republic, Estonia, Finland, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Romania, and Slovenia.
[64] For O_3 no information in the consulted sources was found for: Bulgaria, Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.
[65] For CO no information in the consulted sources was found for: Belgium, Bulgaria, Czech Republic, Croatia, Denmark, Estonia, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Poland, Romania, Slovakia, Slovenia, and Spain.

Pollutant	Member States with standards in place prior to the AAQ Directives	Member States without standards in place prior to the AAQ Directives
Benzene[66]	Austria, Germany, Italy, Netherlands, Portugal, Sweden, United Kingdom	Belgium, Denmark, Finland, France, Greece, Luxembourg
Current standards introduced by Council Directive 1999/30/EC (First Daughter Directive)		
PM_{10}[67]	Bulgaria, Italy, Sweden	NA
SO_2[68]	Austria, Finland, Germany, Italy, Netherlands, Sweden, United Kingdom	NA
NO_2 and NO_x[69]	Austria, Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Hungary, Italy, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden	NA
Pb[70]	Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Spain, Sweden, United Kingdom	Austria

Source: Desk research and exchanges with national authorities. Precise references can be found in Appendix H containing more comprehensive tables with overviews of standards per type of pollutants.

While having had a positive added value in terms of creating a common framework for standards for pollutants across Member States, the introduction of harmonised values has not fully had the expected effect in terms of ensuring compliance with the standards established by the AAQ Directives. As highlighted in the section on the effectiveness of the AAQ Directives (see section on effectiveness), instances of non-compliance with the EU air quality standards and exceedances of limit values have been registered in various Member States. As presented under effectiveness, over the period 2008 to 2017 the majority of Member States reported exceedances of some of some of the pollutants (see section 6.2).

The AAQ Directives set standards for the concentration of pollutants in ambient air but they do not regulate emissions. Nevertheless, actions to achieve pollutant concentration standards can somewhat decrease emissions. However, a clear correlation between the two may nevertheless not be visible, and could not be observed in this case. As presented in Figure 5-3 and Figure 5-4 (in the implementation state of play section), trends over the past decade (2000-2016) show a decline in total emissions levels across all types of pollutants, although variations in terms of the level of reductions per type of pollutants and across Member States exist. When comparing historical trends of emissions with the temporal milestones of the adoption and implementation of the AAQ Directives, no notable changes can be observed in terms of trends of emissions.

[66] For Benzene no information in the consulted sources was found for: Bulgaria, Czech Republic, Croatia, Estonia, Hungary, Ireland, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia, and Spain.
[67] For PM_{10} no information in the consulted sources was found for: Austria, Belgium, Czech Republic, Croatia, Denmark, Finland, Estonia, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain and United Kingdom.
[68] For SO_2 no information in the consulted sources was found for: Belgium, Bulgaria, Czech Republic, Croatia, Denmark, Estonia, France, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Poland, Romania, Slovakia, Slovenia, and Spain.
[69] For NO_2 and NO_x no information in the consulted sources was found for: Croatia, Denmark, Estonia, Greece, Ireland, Latvia, Lithuania, Malta, and United Kingdom.
[70] For Pb no information in the consulted sources was found for: Bulgaria, Czech Republic, Croatia, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Romania, Slovakia, and Slovenia.

Despite declining trends, including across pollutants introduced specifically by Directive 2008/50/EC and Directive 2004/107/EC, i.e. $PM_{2.5}$, As, Ni, Cd, PAH, as mentioned above it is difficult to ensure a precise attribution of these developments to the enforcement of AAQ Directives standards due to the presence of confounding factors that may have also impacted these trends (e.g. source emission legislation, the National Emission Ceilings Directive (Directive 2016/2284/EU), pre-existent national legislation in place, prevalence of activity in certain sectors in specific Member States).

While the effect and added value of the AAQ Directives in terms of declining trends in emissions and concentrations of pollutants cannot be precisely quantified, it can be concluded that the effect the AAQ Directives had on the harmonisation of air quality standards and on incentivising action at Member State level made an important contribution to declining trends, notably of pollutant concentrations.

Text box 6-31 Findings from stakeholder consultations (targeted consultation, open public consultation and workshops)

Stakeholders consulted through targeted consultation, open public consultation and stakeholder workshops generally agreed that the AAQ Directives resulted in consistent rules across Europe on the maximum level of air pollution that citizens are exposed to. In the open public consultation, more than half of the respondents consulted (i.e. 60% of 483) indicated that the AAQ Directives provided for consistent rules across Europe on maximum levels of air pollution citizens are exposed to. In the targeted consultation, amongst the 43 responses received, the most commonly mentioned aspect of added value of the AAQ Directives was in terms of common air quality standards (16 respondents covering national authorities, local and regional authorities, NGOs, scientific or research organisations, industry). Generally, there was agreement in terms of the added value that the AAQ Directives brought amongst stakeholders that commented on this issue (national authorities, local and regional authorities, NGOs, scientific or research organisations, industry). Differences arose only limitedly in relation to the respondent representing the industry that indicated that the standards are "politically motivated (unrealistic and not science-based) measures."

6.5.1.2 Added value in terms of assessment, monitoring and information

Judgement criterion 9.2: The extent to which the AAQ Directives brought added value by setting up comparable air quality assessment and information approaches enabling Member States and their competent authorities to take successful action, thus improving air quality beyond what would have been achieved without EU action.

Assessment summary: The evidence collected suggests that the AAQ Directives have brought EU added value by enshrining common rules for assessment and monitoring of air quality across Member States. This has had positive effects in terms of enabling Member States to set up comparable and effective monitoring networks. The EU action was warranted under the principle of subsidiarity as action taken at national level would have likely continued to be fragmented, thus, imposing challenges in ensuring comparable monitoring and assessment systems. The provisions on monitoring and assessment were clear and guidelines provided by the European Commission, as well as networks to ensure the quality of assessment information generated through monitoring, modelling or objective estimation (FAIRMODE, AQUILA) are positively regarded by stakeholders. Nevertheless, the legal provisions on siting of monitoring stations offer some flexibility for interpretation which means that monitoring may not be always performed in areas with likely high concentrations of pollution. The data collected through the monitoring networks is disseminated by the EEA as well as by national level authorities. This leads to a high level of information and awareness of the public and other relevant organisations to the issues of air quality, which enables more effective (including legal) action.

The findings show that the AAQ Directives have contributed to increasing the harmonisation and consistency of the assessment and monitoring approaches of air quality across Member States. The AAQ Directives provide a common framework and common rules on how, when, and where to assess air quality and under what conditions it is appropriate to supplement the measurement of concentrations with other assessment methods (modelling, objective estimation) (Articles 5, 6, 7, 8 Directive 2008/50/EC). As further elaborated in the section on effectiveness (see section on effectiveness and Appendix E), the AAQ Directives provide common rules on minimum numbers of fixed measurement monitoring stations for each pollutant, depending *inter alia* on pollutant type and population; criteria for siting of these monitoring stations; and the reference methods for assessment of pollution concentrations, as well as data quality objectives. The Directives also define rules and responsibilities for assessment regime and criteria, including assessment thresholds that determine the requirements in each zone or agglomeration. Furthermore, the European Commission complemented the provisions of the AAQ Directives with guidelines for example on setting up common measuring stations for $PM_{2.5}$ under Directive 2008/50/EC. The European Commission also supported the set-up of networks and forums to ensure the quality of assessment information generated through monitoring, modelling or objective estimation (e.g. FAIRMODE, AQUILA).

Although Member States had in place their own assessment regimes of air pollutant concentrations prior to the AAQ Directives, the adoption of the common rules led to increased harmonisation in monitoring and more uniform quality checks of data, which in turn also means more comparable and consistent data across the Member States on air quality. Although there is insufficient evidence on how and whether Member States would have changed their monitoring systems in the absence of the AAQ Directives, it is likely that the differences in monitoring systems would have remained, imposing challenges in terms of data quality and comparability across Member States. In line with the principle of subsidiarity, the need for comparable data on air quality across Member States warranted action at EU level to ensure a more uniform approach to the assessment and monitoring of air quality.

All seven Member States (Bulgaria, Ireland, Italy, Germany, Spain, Slovakia, Sweden) that were subject of the case studies, as well as five other Member States that were subject of a recent audit by the EUROSAI Working Group on Environmental Auditing (Estonia, Hungary, Netherlands, Poland, Romania) currently had operational monitoring systems in place. Furthermore, the case studies confirmed that in the absence of the AAQ Directives, the Member States would not have had similarly comprehensive monitoring networks and comparable data. The absence of a harmonised approach across Member States in terms of monitoring and the need for a good EU-level understanding of air quality legitimised action at EU-level in relation to air quality assessment and monitoring.

Table 6-18 EU Added value of AAQ Directives in terms of monitoring and assessment in selected Member States

Member State	EU Added value of AAQ Directives
Bulgaria	• No air quality monitoring system in place prior to the AAQ Directives • Set up of air quality monitoring systems according to the AAQ Directives
Germany	• Improvement of the monitoring network and more comparable monitoring
Ireland	• Definition of a new network for air quality monitoring
Italy	• Upgrading and integration of monitoring stations in the monitoring network
Slovakia	• Increased focus on monitoring of pollutant concentrations in areas with high population exposure
Sweden	• Reinforced focus on PM_{10} levels and traffic measurements • Establishment of a Reference Laboratory for Urban Air Measurement (Reflab) • Definition of detailed quality procedures for monitoring (Manual for Quality Assurance / Quality Control[71])
Spain	• Increased focus on monitoring of pollutant concentrations in areas with high population exposure

Source: case studies

Nevertheless, despite the high EU added value that the AAQ Directives have in terms of ensuring a harmonised approach to monitoring and assessment, findings from the analysis under effectiveness, case studies and recent reports (e.g. the European Court of Auditors, EUROSAI) conclude that air quality monitoring and assessment can be further improved (e.g. in terms of number and siting of monitoring stations, coverage of types of pollutants, maintenance of monitoring systems). Furthermore, although the AAQ Directives set a minimum number of sampling points and define criteria for siting sampling points, the provisions on siting offer some degree of flexibility. As a consequence, this can lead to situations whereby Member States do not measure air quality near major industries or main urban traffic routes [P91].

At the same time, recent studies such as the EEA report on urban air quality [R63] suggest that cities across Member States increased the number of sampling points over the past 5 years as a result of the AAQ Directives and recognise the beneficial effect of this increase (e.g. Belgium – Antwerp, Ireland – Dublin, Spain – Madrid, Czech Republic – Prague). Furthermore, the report found that stakeholders in a number of cities (Belgium – Antwerp, Germany – Berlin, Sweden – Malmo, Italy – Milan, France – Paris, Austria – Vienna) expressed interest in monitoring emerging and non-regulated parameters (particulate number, black carbon, ozone precursors, which are not regulated in Annex X of Directive 2008/50/EC, ammonia, visibility, pesticides, ultrafine particles, nitrogen and metals, which are not currently regulated by Directive 2004/107/EC [R63]. This is likely also due to the public and political awareness and more attention to the issue of air quality

[71] Reference Laboratory for Urban Air Measurement (2018), Harmonisation of QA / QC for air quality measurement in Sweden.

brought about by the adoption of the AAQ Directives. However, according to the EEA report, cities request clear guidance on a common method for measuring these pollutants.

Effective monitoring and assessment of air quality and collection and dissemination of comparable data is of key importance in ensuring awareness and access to information on air quality to the wider public. Beyond ensuring a more structured approach towards monitoring and assessment, the Directives also contributed to a more systematic data collection and dissemination of information to the wider public.

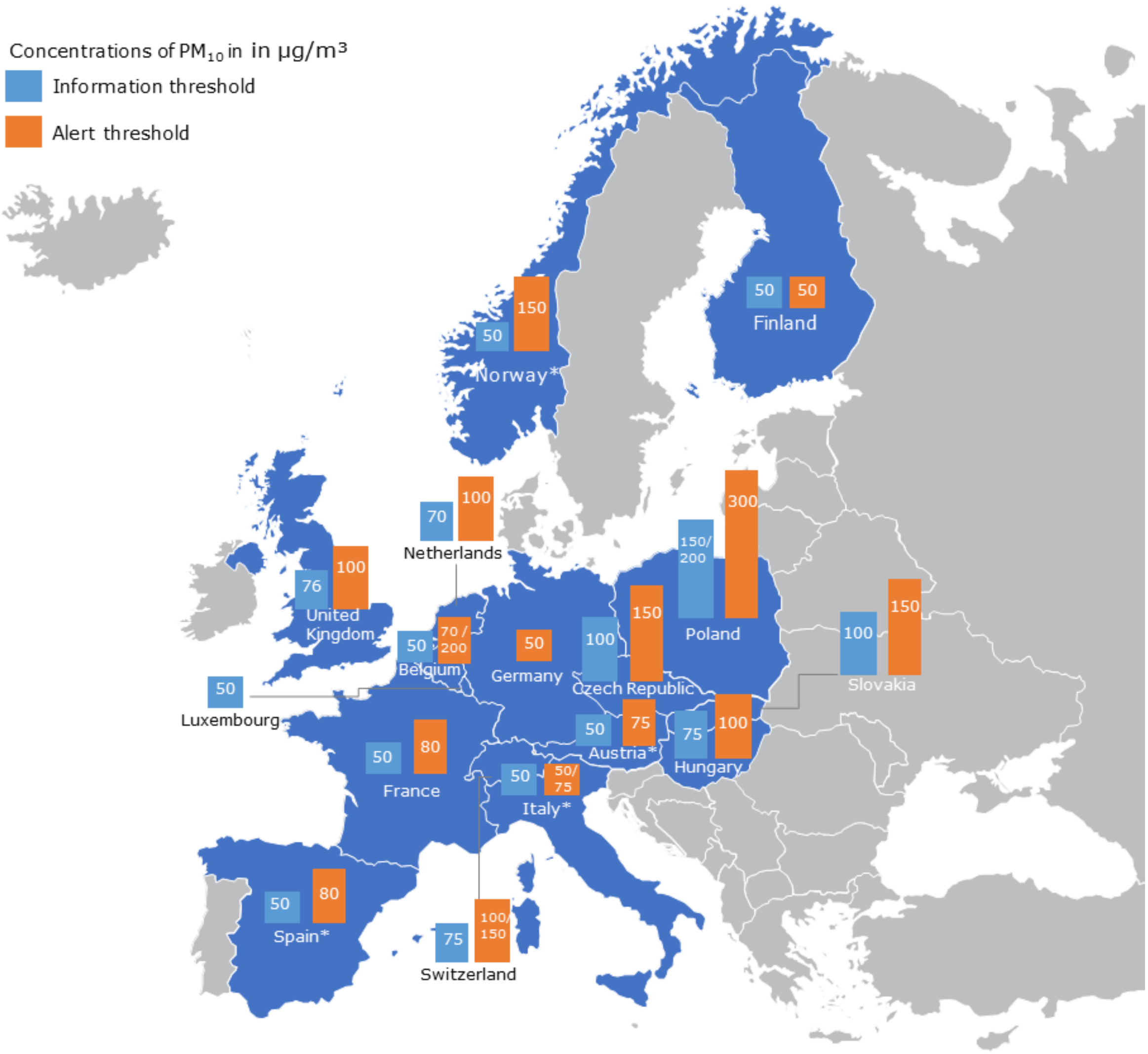
At EU level, the European Environment Agency plays an important role by ensuring the compilation of data and its dissemination, including in near-real-time, to the European public via the Air Quality e-Reporting database and the Air Quality Index. The outreach of the Air Quality Index has been considerable and has substantively increased over time as presented in Figure 5-5 above. In its first year of publication, the Air Quality Index was the most consulted publication of the EEA, and was visited 518,016 times over 2017. In addition, the EEA regularly publishes reports such as the Air Quality in Europe report, which are also amongst the most consulted publications of the EEA. For example, the Air Quality in Europe – 2017 Report has been visited 70,092 times in 2017, which amounts to 7.7% of the EEA web visits registered in 2017.[72]

At national level, the AAQ Directives have also incentivised the dissemination of near real-time data on air quality via amongst other websites, regular reports and mobile phone apps. The AAQ Directives also set information and alert thresholds for sulphur dioxide, nitrogen dioxide and ozone. The alert and information thresholds have been important in ensuring a uniform approach to informing the population in all Member States about concentrations of SO_2, NO_2, and O_3 in ambient air.

In contrast, the AAQ Directives do not set an alert and information threshold for PM_{10}, which is therefore based on national regulation. As further substantiated in the figure below, in the absence of harmonised alert and information thresholds, the requirements at national level are not unified and, as a consequence, there is a risk that in cases where the same level of air pollution will occur, citizens in different countries may or may not be warned by the authorities in spite of the harmful effect of high concentrations on human health [R95].

[72] Data received from EEA in interview.

Figure 6-16 Map information and alert thresholds across Member States μg/m³



Notes: The thresholds for countries with * are applicable for specific regions: Austria (Graz); Germany (Stuttgart); Italy (Piermont, Lombardy); Norway (Bergen); Poland (national); Spain (Catalonia)

For Belgium: The alert threshold is between 70 μg/m³ - 200 μg/m³ depending on the stage

For Italy: The alert threshold for Piermont is between 50 μg/m³ - 180 μg/m³ depending on the stage, whereas for Lombardy the alert threshold is 75 μg/m³.

For Poland: The information threshold in Krakow is 150 μg/m³ whereas at national level is 200 μg/m³

Source: COWI based on Wiesen (2017), Air Pollution Emergency schemes and EUROSAI Working Group on Environmental Auditing (2019), Joint Report on air quality

Furthermore, the AAQ Directives do not set information and alert thresholds for $PM_{2.5}$, which are also regulated in some Member States at national level. This means that different Member States have different approaches to inform their population when it comes to air pollution from fine particles.

Table 6-19 Examples of Member States with information and alert thresholds for $PM_{2.5}$

$PM_{2.5}$	Information threshold	Alert threshold
Finland	40 µg/m³/3h	
United Kingdom	54 µg/m³	71 µg/m³

Source: COWI based on Wiesen (2017), Air Pollution Emergency schemes

Access to information on and awareness of the issue of air quality are important precursors to enable effective action on enforcement by the relevant authorities (including the European Commission) and citizens.

At EU level, the European Commission has taken action against non-compliance with the requirements of the AAQ Directives and as of January 2019, the European Commission was pursuing 15 ongoing infringement proceedings due to PM pollution[73], 14 due to NO_2[74] and one due to SO_2[75] and two other infringement proceedings regarding air pollution monitoring[76]. At the moment of drafting this report, there was no ongoing infringement procedure on ozone or other pollutants covered by the AAQ Directives.

At national level, the provisions of the AAQ Directives, in particular those related to the air quality standards, the requirements to draft and enforce air quality plans in situations of exceedances and provisions on information to the public, have led to the pursuance of actions in courts by citizens and other organisations.

Although the right of access to justice is not explicitly protected by the AAQ Directives as in other environmental legislation (e.g. waste) [P91, R63] (the right is provided for in the Aarhus Convention), the level of legal action taken by citizens and other organisations indicates a high level of awareness to the issue of air pollution. However, the absence of common provisions on access to justice means that the national access to justice rules may vary between different Member States and it is not always clear whether the air quality plans can be challenged in court under the provisions of the AAQ Directives.

Until presently, in the Czech Republic, Germany, France, Italy, Belgium and the United Kingdom, national courts (usually the competent administrative courts) have ruled in favour of citizen's right to clean air and required the Member State concerned to take further action to tackle air pollution [P91]. Notably, some organisations such as ClientEarth have played an important role in ensuring enforcement of the AAQ Directives at national level. For example, after the ruling of the CJEU in Case C-404/13 *ClientEarth v Secretary of State for the Environment*, *Food and Rural Affairs*, which set an important precedent for the right to clean air across Europe, ClientEarth rolled out a litigation campaign to replicate its legal action in the UK in other European countries (currently, 10 EU countries: Belgium, Bulgaria, the Czech Republic, France, Germany, Hungary, Italy, Poland, Slovakia and the United Kingdom). The availability of public and comparable information on air quality in EU Member States, promoted by the AAQ Directives, was essential in order to identify the

[73] Belgium; Bulgaria; Hungary; Italy; Poland; Romania; Czech Republic; France; Germany; Greece; Latvia; Portugal; Slovakia; Spain; Sweden; Slovenia
[74] France, Germany, United Kingdom; Italy, Spain; Austria, Belgium, Czech Republic, Denmark, Hungary, Luxembourg, Poland, Portugal
[75] Bulgaria
[76] Romania and Slovakia.

cities where air pollution levels were particularly high and, as a result, the risks to the health of the population particularly serious.

Table 6-20 Examples of national-level court cases on air quality

Member State	Court cases concerning clean air
Austria	In October 2017, a lawsuit in the Higher Administrative Court gave citizens a sound legal basis to demand measures to protect them from health hazards arising from air pollutants. The Higher Administrative Court with jurisdiction, ruled on 19 February 2018 that environmental NGOs can order a review of compliance with the legal provisions arising from EU environmental law.
Bulgaria	In Bulgaria, municipal air quality plans cannot be challenged in court. While a possible remedy could be class actions in civil courts, administrative courts are of the opinion that these plans are internal administrative documents and cannot be challenged as judged in several recent cases[77]. The AAQ Directives are not very clear about the access to justice requirements in terms of air quality plans, which leads Bulgarian courts to refrain from action. The provisions of the Aarhus Convention, while providing for access to justice, do not provide a clear picture on whether air quality plans can be challenged in court.
Czech Republic	Two citizens, a local NGO and the Frank Bold society filed an administrative complaint against the air quality management plan in Ostrava in 2016. In December 2017, the Supreme Administrative Court rejected the air quality plan for Ostrava as not being appropriate. The ruling may have set a precedent for three other ongoing cases of complaints against air quality plans.
France	After several setbacks, Les Amis de la Terre with support of ClientEarth brought a new case against the French Government. In its judgment of 11 July 2017 (n° 394254), the Conseil d'État departed sharply from its previous decisions stating that the AAQ Directives set an obligation of results and ordered the adoption of new and more effective air quality plans by 31 March 2018.
Germany	The first court case was the Janecek case but based on Directive 96/62/EC. Since then, there have been 28 cases brought to court by Deutsche Umwelthilfe. Most recently the Federal Administrative Court ruled that health protection takes precedence over economic interest and thus cleared the way for diesel bans.
Hungary	Local residents of road no. 86 in western Hungary sued the road operator and maintenance company in 2007 for failing to implement measures to prevent heavy duty road traffic causing health and property damages. This test case was successful and the verdict was affirmed by the Hungarian Supreme Court.
Netherlands	In September 2017, the Court of the Hague ordered in a lawsuit initiated by the environmental protection organisation Milieudefensie that action must be taken immediately in terms of air pollution. The state was sentenced to concrete measures to comply with all European limit values in a "foreseeable and demonstrable" manner.
Poland	In Poland, residents, supported by the Frank Bold society, were, at the time of research, claiming their right to challenge air quality plans at the Constitutional Court. Although the ruling was not expected until the end of 2018, the increased pressure on the authorities had already led to considerably improved air quality plans.

[77] See Administrative Court Sofia city ruling 6541/25.09.2017 court case 7190/2017; Supreme administrative court ruling 13138/01.11.2017 court case 12064/2017; Supreme administrative court ruling 890/23.01.2018 court case 14145/2017.

Member State	Court cases concerning clean air
Slovakia	In 2017, a group of citizens in Bratislava together with the NGOs CEPTA, ClientEarth and Cyklokoalícia brought a claim against the Slovak Government for insufficient protection of air quality in Bratislava to the district court of Bratislava. The claim suggested that the air quality plan for Bratislava was not sufficient, lacked concrete measures and targets and was not compliant with the Slovak and European legislation. The district office in Bratislava that drafted the plan argued that, pursuant to current laws, it is not competent to require other subjects to implement measures to improve air quality and to enforce such measures / impose sanctions in case of non-compliance. The district office further argued that the public was consulted and had the opportunity to comment on the proposed air quality plan. No court decision has been published on the matter until the time of writing of this report.
Sweden	In 2008, the Swedish Society for Nature Conservation (SSNC) brought a case against the city of Stockholm for failing to take measures included in its air quality plan. Despite a 2012 court ruling in SSNC's favour, the lack of any effective remedy has allowed the city to continue to delay taking action.
UK	In February 2018 the High Court ruled that the court should have effective oversight of the UK Government's next air quality plans. This meant that for the first time, an NGO would be able to immediately bring the government back to court if it prepares an air quality plan which is unlawful.

Source: DUH (2018), Environmental Action Germany. Legal Actions for Clean Air. Case Studies.

6.5.2 *Evaluation Question 10: Added value in creating synergies and clarity of responsibilities*

Question 10 assessed "What has been the EU added value of the AAQ Directives, do the Directives and their means of implementation create synergies or overlaps with other Community objectives, and how has the distribution of responsibilities between EU, Member State, regional and local level impacted on air quality management?"

Text box 6-32 Findings on EU added value of AAQ Directives

Overall the findings suggest that the AAQ Directives have brought added value by ensuring synergies with broader Community objectives and sector-specific objectives (transport, energy, health and common agricultural policy). However, there is some evidence to suggest that there is a need to ensure a stronger link between the air quality framework and common agricultural policy.

Furthermore, the findings suggest that the AAQ Directives have had an effect on the division of responsibilities at national level as a result of the provisions on monitoring and assessment, requirements for reporting and information and to set up air quality plans. Findings suggest that improved coordination and cooperation between public-sector institutions is necessary in complex air quality governance systems, in particular when it comes to the implementation of air quality plans and in relation to coordination between central government authorities and local authorities as well as between central government and regional authorities.

6.5.2.1 Added value in terms of synergies with other Community objectives

Judgement criterion 10.1: The extent to which the AAQ Directives have brought added value by creating synergies and avoiding overlaps with Community objectives.

Assessment summary: The AAQ Directives have brought added value in terms of ensuring synergies with other Community objectives such as transport and energy. However, there is room for further improvement in terms of synergies between the AAQ Directives and agriculture policy. At national level, further synergies can be sought in terms of the air quality legislation translating the AAQ Directives into national legislation and other related national legislation (e.g. transport).

The AAQ Directives have brought added value by reinforcing the commitment of the EU and Member States to ensure good air quality and mitigate the negative effects of air pollution across Member States. The AAQ Directives reinforce the commitment made by the European Union in the (6th and 7th) Environmental Action Programmes to reduce pollutant emissions significantly (Directive 2008/50/EC, Preamble 1).

The AAQ Directives are part of a wider body of legislation aimed at tackling air pollution. As presented under coherence (see section 0), the AAQ Directives are supportive of and coherent with the objectives and provisions of related air pollution legislation, such as the National Emission Ceiling Directive (Directive 2016/2284/EU) and source-related legislation as the Medium Combustion Plant Directive (Directive 2015/2193/EU) and Industrial Emissions Directive (Directive 2010/75/EU).

The AAQ Directives ensure synergies with higher Community environmental objectives. They are supportive of other environmental legislation, in particular the Environmental Impact Assessment Directive (Directive 2011/92/EU) and the Strategic Environmental Assessment Directive (Directive 2001/42/EC). Synergies between the AAQ Directives and other environment-related legislation can be considered to add value at EU level in addressing environmental issues.

As presented under the section on coherence, the AAQ Directives have been broadly consistent and ensured synergies with relevant sectoral policies and legislation – with some caveats outlined above.

The evidence collected also indicates that, in the absence of action at EU level, consistency and synergies of national air quality legislation with other sectoral policy objectives would have been challenged. This is further substantiated by the fact that, at national level, in some instances (e.g. Bulgaria, Germany, and Spain), there is still room for further improvement of coordination of air quality frameworks in particular with transport policies (e.g. diesel cars legislative frameworks, low emission zones frameworks) as well as energy policies. Further details and examples are provided in Appendix H.

Stakeholders consulted also broadly assessed that the AAQ Directives' objectives were consistent with other legislation at EU level. In particular, stakeholders were asked to assess the extent to which EU legislation concerning vehicles emissions and fuel quality hampered the implementation of the AAQ Directives. The stakeholders broadly assessed that such EU legislation supports the AAQ Directives. The results are further elaborated in Appendix H.

6.5.2.2 Added value in terms of appropriate distribution of responsibilities

Judgement criterion 10.2: The extent to which the AAQ Directives have brought added value by ensuring a more appropriate distribution of responsibilities between EU, Member States, regional and local air quality management.

Assessment summary: The AAQ Directives have brought some changes in relation to the distribution of responsibilities as a result of, for example, the requirements to set up monitoring and assessment systems, requirements to set up air quality plans and to inform the public. Action at EU level is warranted under the principle of subsidiarity to ensure a uniform approach to tackling air quality issues and improve consistency of the results. However, the extent to which these changes have brought added value at national level in comparison to previous governance frameworks is not clear. Some improvements are still necessary in relation to coordination between national, regional and local authorities in particular when it comes to the implementation of air *quality measures that involve different levels of governance (e.g. local – central, regional – central).*

The division of responsibilities between the EU and national level is fairly clear for relevant stakeholders, with the EU setting the overall steering and regulatory framework for air quality and the EEA supporting Member States by gathering data and disseminating it to the wider public, and the national level being engaged in the implementation of the requirements of the AAQ Directives including ensuring air quality within set limits, monitoring and assessing air quality and disseminating information about air quality at national level.

At national level, the distribution of responsibilities is generally clear with specific authorities tasked with different areas of responsibility in relation to air quality. It is notable that all the selected Member States have complex systems in place for managing air quality with multiple stakeholders being involved. Member States had in place governance systems even before the AAQ Directives and changes in their governance systems for air quality ensued only as a result of the requirements to monitor, assess, report and draft air quality plans.

In complex air quality management systems with a high number of authorities involved and in systems where air quality management is decentralised whereas the central government still maintains steering over regulating adjacent sectors that are the source of pollution (e.g. transport) (e.g. Slovakia, Sweden, Germany), difficulties in effective coordination and implementation of air quality measures were found. A particular case is coordination between public-sector institutions in relation to the implementation air quality plans, which appears to be challenging in almost all selected Member States. The issue of coordination seems to arise especially when different levels of governance are involved (e.g. local-central, local-regional). This is due to the fact that in some instances, the air quality plans contain measures that fall in the remit of responsibility of other national or regional authorities. Such situations can lead to a decreased effectiveness and added value of air quality plans.

Text box 6-33 Findings from stakeholder consultations (targeted consultation, open public consultation and workshops)

Approximately half of the stakeholders consulted via the open public consultation generally assessed that the AAQ Directives had at least a 'somewhat' positive effect on the coordination between different governance levels at national, regional and local levels. However, the issues regarding coordination were also evident from the responses of the stakeholders as 37% (of 438) stakeholders considered the AAQ Directives to have had little or no effect on coordination. One respondent in the targeted consultation (local authority) commented on the clarity of allocations of responsibilities between and across different levels of governance at national level. The respondent highlighted that the AAD Directives should be revised to improve governance elements, in particular to allocate more flexibility to the Member States to allocate responsibilities for the assessment and to establish zones and agglomerations.

6.6 Overview

The present section offers an overview of selected specific issues identified in terms of the implementation of the AAQ Directives over the period reviewed in the scope of this study. The issues have been mapped per 'thematic areas' and against the evaluation criteria and evaluation questions.

Table 6-21 Overview of selected issues identified by the support study in relation to the implementation of the AAQ Directives

Area	Relevance	Effectiveness	Efficiency	Coherence	EU added value
Air quality standards	Harmful pollutants identified by scientific literature are not addressed (e.g. black carbon, ultrafine particles) The air quality limits for pollutants do not sufficiently reflect most recent scientific evidence on adverse effects of lower concentration levels No short-term standard for $PM_{2.5}$	Exceedances of air quality limits still exist in a high number of Member States in particular for PM_{10}, NO_2, O_3 and BaP	No issues identified	Directive 2008/50/EC sets both limit and target values; Directive 2004/107/EC only sets target values.	As per relevance and effectiveness
Monitoring and assessment	Are all potentially harmful substances not addressed by AAQ Directives sufficiently monitored (ammonia, ultrafine particles, black carbon)	Discrepancies in the approach taken by Member States for supplementing fixed measurements with other methods leads to shortcomings with continuous (reliable) monitoring of trends Need for additional more detailed guidance on the monitoring assessment regimes (e.g. siting methods, use of modelling)	Where devolution of responsibilities is not supported by funding and facilitation of collaboration this is thought to be hampering efficiency. Changes to the reporting requirements for air quality information are thought to have a bearing on the efficiency of reporting though it is intended that these will provide efficiencies in the long term.	Directive 2008/50/EC provides reference methods for monitoring but not modelling.	Discrepancies in the approach of Member States to siting of monitoring stations
Information and reporting	No issues identified	Discrepancies in the level of information of the public in relation to air quality levels	Efficiency influenced by the extent to which Member States adopt modern public information methods	No issues identified	Lack of a harmonised approach in terms of information to the public for some pollutants (e.g. lack of PM_{10} information and alert thresholds) leads to different approaches across Member States

Area	Relevance	Effectiveness	Efficiency	Coherence	EU added value
Air Quality Plans and measures (including links with other policies)	No issues identified	Lack of effectiveness of air quality plans and measures appear to influence the achievement of environmental objectives Art. 25 mechanism is not effective Plans do not include cost and benefit assessments of measures, and set no verifiable implementation timelines	No practice to assess cost-effectiveness, or costs and benefits, of measures as part of air quality plans. Recognising connectivity between policies in different fields (primarily climate, energy and transport) provides a mechanism for exploiting potential co-benefits and minimising trade-offs, in turn, improving environmental sustainability.	Specified under Directive 2008/50/EC but not Directive 2004/107/EC Coherence could be strengthened for some EU environmental legislation (e.g. nitrates and noise) Synergies with climate, energy and transport policies have been strengthened but could be further improved The CAP includes agricultural emissions among the priorities of the second pillar. Member States could better target funding for air quality EU taxation policy allows Member States to tax diesel lower than petrol, and many do. Member States also promote use of company vehicles Coordination among sectors and across levels of government could be strengthened in many Member States	Lack of harmonised approach in terms of air quality plans implementation leads to discrepancies in approaches and instances of discoordination between public authorities

7 CONCLUSIONS

The following section presents the final conclusions of the study to support the fitness check.

7.1 Relevance

The study to support the fitness check of the AAQ Directives found that the Directives remain broadly relevant in addressing needs at EU level. However, the adaptability of the AAQ Directives to scientific developments and results can be further enhanced.

The relevance of the AAQ Directives continues to be high but the provisions of the Directives in respect to regulated pollutants and air quality standards are not aligned with new scientific and technical evidence.

The analysis shows that air quality is a major health and environmental concern for EU citizens. Despite improvements over the last decade, a substantial share of the EU population continues to be exposed to air pollution at levels deemed unhealthy by scientific standards, especially in cities. The goals and objectives of the AAQ Directives still address the needs of EU citizens to a large extent.

Scientific evidence has grown on the harmful effects of the pollutants currently regulated by the AAQ Directives. In contrast, no evidence that any of the pollutants covered have only a limited adverse effect on human health/environment has been identified. There is a growing body of research suggesting relevance of various components of particulate matter, such as black carbon or ultrafine particles. There is evidence of environmental implications of ammonia due to its important role in ecosystems and the global nitrogen cycle, as well as its contribution to secondary particle formation.

The AAQ Directives have stimulated Member State action on air quality from 2008 to 2018 and they still represent a key tool to improve air quality. However, a review of recent scientific evidence indicates that the standards laid down by the AAQ Directives are not fully aligned with recent and robust scientific evidence suggesting serious adverse health effects at lower concentration levels, including for $PM_{2.5}$, PM_{10} and SO_2 and thus *less stringent than the current WHO Air Quality Guidelines for the protection of human health.* The AAQ Directives do not set short-term standards for $PM_{2.5}$, to protect against peaks of pollution that would otherwise lead to substantial excess morbidity or mortality.

The AAQ Directives provide a degree of flexibility in relation to amending non-essential elements of the Directives and this opportunity has been used to account for the experience gained in implementing the Directives and the most recent standards for the sampling and measurement of different pollutants. Furthermore, the AAQ Directives envisaged a review of some of their essential elements as well, in 2013 for Directive 2008/50/EC and by the end of 2010 for Directive 2004/107/EC, but this did not lead to modifications of those essential elements. There are no specific mechanisms in the AAQ Directives laying down an obligation to carry out a periodic review of the AAQ Directives with a view of adapting them to the latest technical and scientific progress.

The review found three articles that deal with provisions that have expired and are thus redundant: Postponement of attainment deadlines up to five years, the 2013 review of $PM_{2.5}$ provisions, and the 2010 review of Directive 2004/107/EC.

Strength of the conclusion	
Data sources:	Desk research (literature review), Targeted questionnaire, Open public consultation, Case studies, interviews
Strength of evidence:	**High**: The conclusion relies on extensive desk research, interviews with national authorities and has been corroborated with evidence from the stakeholder consultation.
Data gaps:	The *WHO Air Quality Guidelines* are currently under revision with an expected publication date in 2020. [R156, D162]

7.2 Effectiveness

The study to support the regulatory fitness check finds that the extent to which the AAQ Directives have achieved the four objectives vary.

Regarding the objective related to monitoring and assessment of air quality the achievements of most Member States have been in line with the AAQ Directives, which have encouraged the availability of reliable and comparable data, as such, enabling the monitoring of trends.

Most zones in the Member States have the minimum number of sampling points required by the AAQ Directives. Compliance has in general increased for the different air pollution types since the start of the implementation of the AAQ Directives. Hence, in general the assessment is that the AAQ Directives have encouraged the availability of reliable and comparable data, as such, enabling the monitoring of trends.

Flexibility and ambiguity of criteria for classifying measurement stations have been identified by stakeholders as possible factors that have led to differences in the way this has been done in the Member States and so may have led to limitations in comparability of data. Regarding external factors, resource constraints (costs, qualified staff) may have led to a varied coverage or qualities of the EU territory with monitoring networks. In terms of other possible external factors, no firm conclusions can be drawn from the analysis.

Strength of the conclusion	
Data sources:	Desk research (literature review and data analysis of air quality reporting), targeted questionnaire, open public consultation, case studies, interviews.
Strength of evidence:	**High**: The conclusion relies on extensive desk research, interviews with national authorities and has been corroborated with evidence from the stakeholder consultation.
Data gaps:	Data on sampling points are not available for all zones for all years. Data analysis conducted on Member State reporting does not provide sufficient level of details to further substantiate the external factors. No clear picture in terms of some external factors being more predominant than others.

Regarding the objective of establishing air quality standards and achieving these in the Member States, the overall observation is that exceedances of targets/limits have decreased over time for most pollutants. Hence, it is here concluded that the actions provided for by the AAQ Directives have been effective.

The overall observation is that exceedances of targets/limits have decreased over time for most pollutants – both when measuring via the number of Member States experiencing exceedances and via the share of zones in the EU reporting exceedances. Several Member States have made use of the opportunity to apply for a time extension to comply with the targets/limits for PM_{10} and

NO_2. While the zones with PM_{10} time extension grants given have led to above-average performance of the zones, the zones with granted NO_2 time extensions have done worse than average. However, the overall conclusion here is that the actions provided for by the AAQ Directives have been effective.

The mandatory nature of the air quality standards has been identified as an important positive element in achieving the standards. However, despite their mandatory nature, some Member States struggle, as shown above, to comply with limit/target values of key pollutants. The assessment of factors behind the non-achievement of the standards also points to linkages between the different objectives of the Directives. Effectiveness of air quality plans and measures appears to influence the achievement of the environmental objectives. The correct siting of sampling points, on the other hand, is a prerequisite for correct monitoring and assessment of air quality, and thereby for effective plans and measures. Furthermore, external factors such as geography and meteorological conditions, socio-economic conditions, public awareness and other EU policies have played a role in how air quality objectives are being achieved.

Strength of the conclusion	
Data sources:	Desk research (literature review and data analysis of air quality reporting), targeted questionnaire, open public consultation, case studies, interviews.
Strength of evidence:	**High**: The conclusion relies on extensive desk research, interviews with national authorities and has been corroborated with evidence from the stakeholder consultation.
Data gaps:	None

Regarding the objective that information on air quality is made public so that people, organisations and others can act on adverse air pollution concentration values, the conclusion is that information is made available for use by the public

However, the information is of mixed quality, partly because Member States have taken varied approaches, both to the dissemination itself, but also to the collection, assessment and reporting of data. The finding is based on the analysis of information on responsible authority websites, stakeholder consultation and case studies.

A driving factor influencing the achievement of the objective of making information on air quality available to the public is that there actually is a public demand for information. A factor which may hinder the achievement of this objective is found to be that Member States have taken varied approaches, both to the dissemination itself, but also to the collection, assessment and reporting of data. The evidence here is, however, "relatively weak" as it is based largely on examples provided in case study and targeted questionnaire responses.

Strength of the conclusion	
Data sources:	Desk research, targeted questionnaire, open public consultation, case studies, interviews
Strength of evidence:	**Medium**: The conclusion relies on extensive desk research analysis of responsible authorities' websites, interviews with national authorities and has been corroborated with evidence from the stakeholder consultation.
Data gaps:	Some information in Member States is only available in the national languages, limiting cross-border analysis/comparison.

Regarding the objective of preparing air quality plans and implementing measures accordingly to avoid, prevent or reduce the effects of poor air quality, the conclusion is that Member States reporting exceedances have also prepared air quality plans as required by the AAQ Directives

Member States reporting exceedances have prepared air quality plans as required by the AAQ Directives. Road transport is one of the main sources for the exceedances of NO_2 and also of PM_{10}. Many measures to reduce such emissions therefore focus on this sector – e.g. congestion charges, speed limits, the promotion of cleaner vehicles and public transport. A main source for PM_{10}, and also for NO_2, emissions is that of domestic heating. Measures here include the promotion of shifts towards low-emission fuels, retrofitting, green public procurement as well as public information services. Effectiveness is encouraged by the flexibility for the Member States, hereunder regions and municipalities, to choose the measures that best fit their local conditions – i.e. the most cost-effective measures. This is an issue that is analysed in more detail under the efficiency evaluation criterion within this study.

An external factor such as public awareness has influenced the choice of measures resulting from the air quality plans. Furthermore, measures to improve air quality is not solely steered by the air quality plans but also influenced by other EU legislation as well as other Member State actions. Regarding internal factors, for example, the guidance from the EU to implementing measures is by some stakeholder considered not to have been sufficient, while it by others (in particular NGOs) is considered to be key in facilitating enforcement action.

Strength of the conclusion	
Data sources:	Desk research (literature review, data analysis of air quality reporting), targeted questionnaire, open public consultation, case studies, interviews
Strength of evidence:	**Medium**: The conclusion relies on extensive desk research, interviews with national authorities and has been corroborated with evidence from the stakeholder consultation.
Data gaps:	The flexibility of measure choice limits the attribution of measures adopted in the Member States to the AAQ Directives (and other initiatives, respectively).

7.3 Efficiency

Variation in actions taken to improve air quality is reflective of differences in pollution sources and local conditions. This indicates that measures are being efficiently targeted, although there is not a strong body of data on measured costs and benefits.

A range of abatement measures are used in Member States to comply with the AAQ Directives. These include actions to reduce traffic, promote cleaner vehicles, reduce domestic emissions and additional actions beyond Best Available Techniques (BAT) for industrial facilities. The cost of measures varies significantly between countries for a variety of reasons, ranging from geographical differences to the fuels used and age of polluting equipment. Some factors also relate to the air quality management process, for example whether guidance is provided by Member States. Observed variation in costs appears justifiable against variation in local conditions. Similarly, the costs of meeting the requirements of the Directives vary between stakeholders within countries depending on the sources of pollution primarily linked to exceedance. In some cases, costs are imposed locally and on the specific sectors contributing most to the local level to exceedance, whilst in others, costs may be spread more broadly across society through using central government or European funds, for example to finance scrappage schemes for vehicles or boiler replacement programmes.

Strength of the conclusion	
Data sources:	Desk research (literature review, data analysis of AQ reporting), Targeted questionnaire, Open public consultation, Case studies, interviews
Strength of evidence:	**High with respect to the variation in the measures introduced and cost differences between Member States and between sectors**: The conclusion relies on extensive desk research, interviews with national authorities and has been corroborated with evidence from the stakeholder consultation. **Low with respect to the exact magnitude of costs,** given data limitations and the potential for double counting of costs between different policy areas, most notably air quality, transport and climate and energy.
Data gaps:	There is very limited data, especially ex-post data, available on the costs and effectiveness of many measures that are introduced to improve air quality, especially for those with some behavioural aspect such as modal shift in transport.

Health effects of poor air quality, and therefore the benefits of action, are substantial

There is widespread acceptance that the health costs of poor air quality are high. Indicative estimates generated for this study indicate accrued health benefits of complying with the AAQ limit values from 2008 to 2016 of EUR 50 billion. These benefits are building steadily over time as the area facing exceedance of the limit values is reduced. There are good grounds for regarding this figure as a lower bound estimate. Contrasted with the benefits of action are the costs of poor implementation, considered here in relation to the degree of non-compliance with limit values for PM, NO_2 and O_3. The economic value of health impacts associated with limit values exceedance is estimated to be in the order of EUR 240 billion for the EU for the period 2008 to 2016. The annual costs of poor implementation started at a high level, given that compliance with limit values was not achieved by legislated dates that were either before or shortly after the introduction of the current directive for NO_2 and PM_{10}. However, the annual costs of poor implementation have fallen steadily since 2010. The estimates are not of high accuracy but provide an order of magnitude estimate of the damage associated with non-compliance that can be compared with cost data.

There is some evidence that the benefits of measures contained in air quality action plans exceed costs, but there is too little data available to conclude this with certainty. Many of the more expensive measures linked to air quality action plans, including expansion of public transport fleets, development of transport infrastructure and replacement of inefficient boilers, are typically taken with other objectives to the fore, such as reducing congestion, improving mobility or reducing greenhouse gases. Many of these measures have further co-benefits, with promotion of cycling and walking having significant public health benefits, and renewal of public transport fleets leading to reductions in noise. A full cost-benefit analysis of such measures would therefore need to account for significant benefits unrelated to air quality improvement. Recognition of the links between policy in different areas is beneficial for efficiency.

Strength of the conclusion	
Data sources:	Desk research (literature review, data analysis of AQ reporting), Targeted questionnaire, Open public consultation, Case studies, interviews, original analysis.
Strength of evidence:	**Medium**: The conclusion relies on extensive desk research, interviews with national authorities and has been corroborated with evidence from the stakeholder consultation and original analysis using tools consistent with recommendations from WHO and models used by the EEA and to inform policy development within the European Commission. However, modeling results are based on assumptions that necessarily involve simplification.
Data gaps:	Some impacts of air pollutants are unquantified, for example concerning benefits to ecosystems and from increased equity. It is unlikely that these would change the order of magnitude of estimates of impact and benefit. Information on co-benefits via reduced congestion, etc. is also lacking and will be of prime importance where measures are not introduced primarily in response to air quality.

Administrative costs of monitoring appear to range from EUR 0.14 to 0.98 per capita. The total annual administrative burden is estimated at EUR 300 million. The AAQ Directives are likely to have led to only a small increase in total costs for monitoring and reporting, and the benefits achieved by the Directives far outweigh the administrative burdens.

Assessment of monitoring costs finds a range of EUR 0.14 to 0.98 per capita between Member States having provided data. Regarding the efficiency of monitoring it is noted that some Member States have centralised responsibilities, whilst others have devolved them. There are arguments to support both approaches, the former concerning potential for economies of scale, and the latter offering the potential for greater local understanding of the nature of pollution problems. The total annual administrative burden for monitoring and reporting borne by Member States is estimated at EUR 300 million though the AAQ Directives are likely to have led to only a small increase in total costs for monitoring and reporting. The benefits achieved by the AAQ Directives far outweigh the administrative burdens. Some stakeholders have identified possible actions for improving efficiency of monitoring systems to avoid incurring unnecessary burden, for example by providing further guidance on the use of indicative measurement and modelling.

Strength of the conclusion	
Data sources:	Desk research, Targeted questionnaire, Follow up consultation with civil servants, Open public consultation, Case studies
Strength of evidence:	**Low - Medium**: Only Member State Authorities, at whatever geographic level, with responsibility for implementing air quality assessment, monitoring and reporting regimes can provide accurate estimates of administrative costs and burdens. As such, an extensive effort was made to gather information directly from Member State authorities. The reliability of the data gathered from Member State authorities, through targeted questionnaires and case study interviews and follow up correspondence, is likely to be very high. However, overall, only limited relevant cost data were made available through these means. This reduces the reliability of conclusions drawn.
Data gaps:	The cost area for which the most reliable data covering the largest number of Member States was available was monitoring network infrastructure and operation. However, information regarding costs of approval of measurement systems, ensuring the accuracy of measurements and analysis and other assessment methods was limited. Regarding costs of reporting, relevant data was made available by six Member States, however comparability of data provided was low in many cases. Three Member States provided comparable data on costs of reporting to the commission and to the public.

Impacts of AAQ Directives on EU competitiveness are likely to be low and the AAQ Directives have the potential of enhancing economic, social and environmental sustainability.

The impacts of the AAQ Directives (distinct from legislation on air pollution more generally) on competitiveness are likely to be very low, given that these Directives mainly trigger measures targeted at local sources of air pollution, such as traffic and domestic heating. For some industries, the legislation may have acted as a spur for innovation, opening up new market opportunities. It is also concluded that the AAQ Directives have enhanced economic, social and environmental sustainability.

Strength of the conclusion	
Data sources:	Desk research, Targeted questionnaire, Open public consultation
Strength of evidence:	**Low - Medium:** The conclusion relies on extensive desk research and has been corroborated with evidence from the stakeholder consultation. However, there was a lack of primary data focused specifically on this question. There were some data related to impacts of air quality regulations in general on EU competitiveness, and on economic, social and environmental sustainability. However, no data were found in relation to direct impacts of the AAQ Directives alone. In the open public consultation, respondents (including industry specific respondents) in general agreed that competitiveness and innovation had been boosted to at least some extent from the implementation of the AAQ Directives. There were a couple of responses to the targeted questionnaire which stated that AAQ Directives had short-term negative impacts on competitiveness for some sectors in their countries, but few other respondents also provided examples of boosting competitiveness through product/technological innovation.
Data gaps:	Primary research specifically targeted at the competitiveness effects of the AAQ Directives.

7.4 Coherence

Overall, the analysis has found good internal coherence of the AAQ Directives, strong coherence with related air pollution legislation and pollution (after the release of the 2013 Clean Air Policy Package), and good coherence with environmental and climate policy. There has been good coherence with EU funding and with EU sectoral policies – though gaps were identified. Issues were seen notably with EU and Member State taxation policies for fuels and Member State vehicles taxes. EU mechanisms have supported policy coherence at both EU and Member State levels – coherence and coordination within many Member States has been an important gap, however.

The AAQ Directive provide a coherent regulatory system to improve air quality in the EU

The AAQ Directives form a coherent regulatory system to improve air quality in the EU, though specific issues (concerning monitoring, air quality standards and air quality plans) with their internal coherence were identified. The AAQ Directives are coherent with the 2013 Clean Air Policy Package and with EU legislation on air pollutant emissions; this coherence has grown over the evaluation period, for example with the 2016 revision of the NEC Directive (Directive 2016/2284/EU). The Directives are also coherent with the EU's international commitments on air pollution.

The AAQ Directives are coherent with the overarching EU environmental objectives set out in the 6th and 7th EAPs, though a gap is seen regarding the 7th EAP's long-term objective of implementing WHO standards. While broadly coherent with the environmental legislation reviewed, gaps were identified – for example, the Nitrates Directive (Directive 91/676/EEC) can support reductions in agricultural air emissions, but this legislation does not identify air quality as a goal. Studies have shown that action for climate mitigation and air pollution should, overall, be mutually supportive, and there has been a growing recognition of these links in EU policy documents.

Strength of the conclusion	
Data sources:	Desk research (literature review), targeted questionnaire, open public consultation, case studies
Strength of evidence:	**High**: The conclusion relies on extensive desk research and has been corroborated with evidence from the stakeholder consultation.
Data gaps:	NA

Synergies between the AAQ Directives with other EU sectoral policies, EU funding instruments and EU and Member States taxation policies were found but some gaps were identified

There are many synergies, as well as some contrasts, with EU sectoral policies. The CAP's rural development funding can support actions to reduce agricultural emissions, but air emissions are not addressed under the direct payments to farmers. EU legislation and policy documents for transport set air quality among their goals, limit vehicle emissions and promote alternatives to road transport; however, during the evaluation period, EU provisions for controlling vehicle emissions in the Type Approval Framework have had shortcomings (which the EU has sought to address since 2015). EU energy efficiency and renewable energy policies are likely to have supported better air quality – however, concerns remain about the inclusion of biomass to meet targets under the Renewable Energy Directive (2018/2001/EU), where the benefits for air quality are less clear.

EU funding has supported Member State action on air quality: Member States have allocated over EUR 150 billion from EU funds in the current programming period for investments (directly and/or indirectly) relevant to the AAQ Directives: the great majority of this funding is for investments that indirectly support air quality objectives, such as those for energy efficiency and public transport. EU funding has, however, supported investments that may hinder air quality objectives, though in the current funding period this appears to be lower than the funding for investments supporting air quality objectives.

EU taxation legislation allows Member States to tax diesel fuel at a lower rate than petrol, which can create obstacles for achieving air quality objectives. In many Member States, fuel taxes and tax treatment of company cars do not support air quality objectives.

Strength of the conclusion	
Data sources:	Desk research (literature review), targeted questionnaire, open public consultation, case studies
Strength of evidence:	**High**: The conclusion relies on extensive desk research and has been corroborated with evidence from the stakeholder consultation.
Data gaps:	Data was not found on the impacts of EU investments in terms of air pollutant emissions or air quality; this is a gap in particular for the high amounts of funding identified as either indirectly supporting air quality objectives as well as potentially negative investments for air quality objectives.

Coordination mechanisms have supported policy coherence at EU and Member State level but coordination in some Member States can be improved.

EU-level coordination mechanisms have supported policy coherence at EU level and at Member State level, and the role of these mechanisms has grown over the evaluation period. The level of sectoral coordination within Member States varies: although the evidence shows that coordination has improved in some Member States, gaps in coordination in many Member States remain an obstacle to achieving the AAQ Directives' objectives, as does coordination between national and sub-national authorities.

Strength of the conclusion	
Data sources:	Desk research (literature review), targeted questionnaire, open public consultation, case studies
Strength of evidence:	**High**: The conclusion relies on extensive desk research and has been corroborated with evidence from the stakeholder consultation.
Data gaps:	Detailed country-level information is not available for all Member States

7.5 EU added value

The fitness check found that the AAQ Directives brought EU added value in several manners as elaborated below.

The AAQ Directives provided a harmonised framework for air quality standards and EU-level regulation of 5 additional pollutants.

The AAQ Directives (Directives 2008/50/EC, 2004/107/EC) brought EU added value by ensuring a more harmonised and coordinated approach towards the regulation of air quality standards for pollutants compared to what Member States could have achieved through single national regulations. Furthermore, the AAQ Directives introduced limit and target values for 5 pollutants that previously had not been regulated at EU level, i.e. $PM_{2.5}$, As, Cd, Ni, PAH. Prior to the introduction of the AAQ Directives, air quality standards varied considerably across Member States in terms of the type of pollutants that were regulated, the level of protection (weaker or stricter limits) and the legal nature of the regulations (binding or voluntary, limit values or guidelines, obligation of results or obligation of means). Despite the high EU added value in terms of creating a common framework for standards for pollutants across Member States, the introduction of harmonised values has not fully had the expected results in terms of compliance of Member States with the standards as illustrated by exceedances of some of the limit values for PM_{10}, NO_2, the target value for O_3 as well as the target value for BaP. The evidence supporting this conclusion is further elaborated in section 6.5.1.

Strength of the conclusion	
Data sources:	Desk research, Targeted questionnaire, Open public consultation, Case studies
Strength of evidence:	**High**: The conclusion relies on extensive desk research, interviews with national authorities and has been corroborated with evidence from the stakeholder consultation. More than 60% of the 483 respondents considered AAQ Directives to have a positive effect on ensuring consistent rules across Europe.
Data gaps:	Some data gaps remain in terms of the mapping of the situation of the air quality standards prior to the AAQ Directives. However, sufficient data was collected to allow for drawing the above conclusion with a high degree of reliability. To fill in the data gaps, the team contacted the Member States national authorities to obtain more information.

The AAQ Directives provided a harmonised framework for air quality assessment and monitoring which resulted in higher quality and availability of information on air quality incentivising action by citizens and authorities.

Added value in relation to the AAQ Directives also resulted from the establishment of a harmonised framework for air quality assessment and monitoring. Despite there being differences in terms of monitoring systems and some challenges related to the provisions on siting, the AAQ Directives had a positive effect of Member States air quality monitoring systems. The AAQ Directives also resulted in a higher level of available information to the public and wider dissemination of information on air quality which raised further awareness and potentially incentivised (enforcement) action by citizens, authorities and relevant organisations, as evidenced by the high number of court cases. However, some difficulties were reported by stakeholders consulted in relation to the fact that the AAQ Directives do not explicitly provide for the right to access to justice which basically entails that Member States have different approaches to enforcement.

Strength of the conclusion	
Data sources:	Desk research, Targeted questionnaire, Open public consultation, Case studies
Strength of evidence:	**High**. The conclusion relies on evidence collected via desk research complemented with stakeholders' assessments. 68% (of 446) respondents to the open public consultation assessed that the AAQ Directives had at least somewhat of an effect on enforcement at EU level, and 62% (of 441) assessed the same but at national level.
Data gaps:	NA

Added value in terms of synergies with Community objectives can be found both at EU and Member State level but further national coordination between authorities within Member States and exploration of possible synergies can be sought.

The AAQ Directives have been coherent with other Community objectives both at EU and Member State level (when it comes to how Community objectives are translated in national legislation) but some possibilities for further exploration of synergies at national level have been found. The AAQ Directives have brought some EU added value in terms of improving coordination at EU and national level. At EU level, the AAQ Directives provide for a clear definition of roles. At national level, the AAQ Directives' requirements to set up air quality plans, monitor and assess air quality and provide information to the public had an effect on the governance systems of some Member States but this varied depending on what the Member State had previously in place. Nevertheless, evidence suggests that coordination between public-sector authorities can be further improved at national level, in particular in relation to the responsibilities and coordination in the implementation of the air quality plans and coordination between local-central and local-regional authorities.

Strength of the conclusion	
Data sources:	Desk research, Targeted questionnaire, Open public consultation, Case studies
Strength of evidence:	**High**. The conclusion relies on evidence from desk research (in particular the case studies) complemented with stakeholder assessments. More than half of consulted stakeholders (of 438) considered that the AAQ Directives had a positive effect on coordination between different levels of governance in the Member States.
Data gaps:	Some data gaps in terms of the situation prior to the AAQ Directives in terms of governance systems. Contacts with authorities in the Member States were made to fill in any data gaps.

APPENDIX A PROCEDURAL INFORMATION

Separate document attached.

APPENDIX B CONSULTATION SYNOPSIS

Separate document attached.

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APPENDIX D DETAILED EVIDENCE - RELEVANCE

Separate document attached.

APPENDIX E DETAILED EVIDENCE - EFFECTIVENESS

Separate document attached.

APPENDIX F DETAILED EVIDENCE - EFFICIENCY

Separate document attached.

APPENDIX G DETAILED EVIDENCE - COHERENCE

Separate document attached.

APPENDIX H DETAILED EVIDENCE – EU ADDED VALUE

Separate document attached.

APPENDIX I CASE STUDY SUMMARY

Separate document attached.

APPENDIX J CASE STUDIES

Separate documents attached.

- Case study Report – Bulgaria
- Case study Report – Germany
- Case study Report – Italy
- Case study Report – Ireland
- Case study Report – Slovakia
- Case study Report – Spain
- Case study Report – Sweden

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APPENDIX A
PROCEDURAL INFORMATION
METHODS AND ANALYTICAL TOOLS

Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

COWI

1 PROCEDURAL INFORMATION

The first part of the appendix presents step-by-step the process for the delivery of the support study for the fitness check of the AAQ Directives. This is presented task by task. The tasks have been defined on the basis of the requirements of the Tender Specifications of the study.

1.1 Task 1 - Development of methodology and work plan

Rationale: The purpose of Task 1 was to define and fine-tune the methodology to address the issues under examination. Furthermore, Task 1 focussed on drafting a detailed work plan for the implementation of the study.

Process: The overview of the process regarding Task 1 is presented in the table below.

Activity	Description
Kick off meeting	The purpose of the kick off meeting was to discuss the proposed methodology and ensure alignment of expectations. The kick off meeting with the Commission was held on 31 January 2018. Prior to the kick-off meeting a draft Inception Report was submitted on 25 January 2018. Minutes of meetings from the two kick off session were provided as a follow up to the meetings.
ISSG Meeting	The purpose of the meeting with the ISSG was to inform the members of the ISSG of the scope and purpose of the study and to receive initial feedback and reflections. The first ISSG meeting was held on 1 February 2018. The meeting discussed the draft Inception Report and the proposed evaluation questions. Comments from the ISSG members made at the meeting and in written comments following the meeting (Comments received from DG CLIMA, DG RTD, DG MOVE and ECFIN via DG ENV on 9 February 2018) were incorporated into the Final Inception Report.
Developing the methodology (including intervention logic, evaluation questions matrix, open public consultation questionnaire)	Following the discussion and comments received at the kick-off meeting and the ISSG meeting, the IL was revised and finalised. Furthermore, the evaluation questions matrix was updated on the basis of the comments for each of the evaluation questions.
Prepare the Inception Report	The Final Inception Report submitted on 2 March 2018 included the final Intervention Logic (chapter 2) as well as the final Evaluation Questions (chapter 3), and the final open public consultation questionnaire.

Timeline: The implementation of Task 1 ran from contract signature to mid-April 2018. The key milestones were:

- 25 January 2018: Submission of Draft Inception Report
- 31 January 2018: Kick-off meeting
- 1 February 2018: ISSG Meeting
- 2 March 2018: Submission of Final Inception Report
- April 2018: Submission of Final Inception Report (rev.1) that included a revised version of the Evaluation Criteria and questions integrating DG ENV comments
- April 2018: Approval of Final Inception Report by DG ENV

Output: The output of Task 1 included the Inception Report containing a clearly defined work plan and the methodology for the implementation of the study. The Inception Report also contained the refined intervention logic and the updated evaluation questions matrix on the basis of the comments from DG ENV and the ISSG.

1.2 Task 2 – Review of information and establishment of evidence base

Rationale: The main aim of the task was to establish a comprehensive evidence base for answering the evaluation questions. For this purpose, secondary evidence was collected and analysed including existing evaluations, studies, reports, audits, information on infringements, complaints, court rulings, information and recommendations from stakeholders, position papers, peer reviewed articles from scientific and technical journals. This included information both at EU and Member State level.

Process: The process of collecting and analysing the data is presented in the table below highlighting the main activities undertaken. A total of 537 references covering different types of studies, reports, legislation, journal articles were reviewed as part of the evidence base.

Activity	Description
Developing evidence database on data sources and tools	The research team set up a comprehensive evidence database comprising data sources received from DG ENV, ISSG members, EEA, national level authorities and other relevant stakeholders as well as data sources found by team members via desk research. The database consisted of: a shared folder containing all literature / data sources identified and a common spreadsheet cataloguing all data sources. The data sources were catalogued using a spreadsheet data review tracker which served 2 purposes: first, it was used as a reference list, complemented with the information on specific evaluation criteria for which different sources were used; secondly, it was used to exchange information between team members and to track which information sources have been reviewed.
Evidence Report	The data sources identified were reviewed by the team members and the key findings were summarised in an Evidence Report. The report was submitted to DG ENV on 19 June 2018, serving the purpose of identifying early gaps in evidence and how to address these through other data collection methods. Comments on the draft were received from DG ENV on the 2 July 2018 (relevance), on 6 of July 2018 (efficiency, EU added value) and 13 July 2018 (in particular on effectiveness). Additional dialogue with DG ENV followed, based on the comments, and main responses to points raised were included as part of the monthly progress reporting. The comments have been taken into account in the preparation of the draft interim report.
Continuous updating of the evidence base throughout the	Throughout the implementation of the study (not only as part of Task 2), the evidence base that was collected as part of Task 2 was continuously expanded as new data sources were identified. This meant that the database of sources (spreadsheet) was regularly updated with new data sources and the team members updated their respective sections of the analysis per evaluation criteria with the new information coming from the new data sources.

Timeline: The implementation of Task 2 ran from mid-January 2018 to September 2018. The key milestones were:

- 19 June 2018: Evidence Report submitted to the European Commission
- 2-13 July 2018: Comments on the evidence collected were received from the EC and subsequently integrated in the Interim Report

Evidence and Output: The evidence collected via the review of secondary data sources served as basis for the analysis performed under each of the evaluation criteria. The initial output of Task 2 was an Evidence Report presenting the findings of the desk based review per evaluation question. This was used as a basis later on for triangulation and for complementing data coming from other data collection streams (e.g. stakeholder consultation, analysis of database data).

1.3 Task 3 – Consultation with stakeholders and assessment of stakeholder feedback

Rationale: The main rationale for the task was to conduct a comprehensive stakeholder consultation in line with the Better Regulation Guidelines to (a) confirm the topics covered by the fitness check, (b) gather factual information, data and knowledge about the implementation of the AAQ Directives, (c) to solicit views and opinions of stakeholders on the extent to which the AAQ Directives have successfully met their different objectives.

Process: The stakeholder consultation process included an online public consultation, two stakeholder workshops and a targeted questionnaire.

Activity	Description
Development of Consultation Strategy	The Stakeholder Consultation Strategy has been further developed on the basis of DG ENV comments received and in line with the Better Regulation Guidelines and integrated in the Inception Report.
Development of open public consultation (open public consultation)	Based on an initial outline of questions made by DG ENV, a fully-fledged Open Public Consultation (open public consultation) questionnaire was elaborated and submitted to DG ENV. Several iterations were made in close cooperation with DG ENV, the relevant DGs and the ISSG. The Consultant received final approved open public consultation questionnaire on 9 April 2018. The same week the open public consultation was built in EUSurvey, and tested by the Consultant and Commission representatives. The open public consultation in EUSurvey was sent to Commission for translation on 13 April 2018. The final open public consultation as received from the Commission was attached to the final Inception Report. The questionnaire was made available in 23 official EU languages (excluding Irish) and uploaded to the EU survey tool on 8 of May 2018. After the closing of the open public consultation on 31 of July 2018 (a total of 12 weeks), a short factual summary of the results of the open public consultation has been submitted to the Commission for upload, and a draft Full Summary Report is submitted as Appendix B of the draft Interim Report. A total of 489 responses to the open public consultation were received. Additional contributions to the open public consultation in the form of further comments and position papers by existing stakeholders responding to the open public consultation (received from DG ENV on 14 September 2018) were integrated as part of the final Interim Report.
Development of Targeted Questionnaire	A draft questionnaire was prepared and submitted to the Commission, with the purpose of using it to obtain evidence on all criteria from targeted stakeholders, including public authorities, NGOs, industry, and the research community, and to complement the responses received from the open public consultation. The evidence gathering questionnaire was launched beginning of June 2018 with a submission deadline end of July 2018.
Stakeholder Workshops	Two stakeholder workshops were organised on 18 June 2018 and 15 January 2019. The aim of the stakeholder workshops was to gather stakeholders' perception and validate findings coming out of the analysis. Minutes from the workshop were drafted and made public by the European Commission on the workshop website.
Ambient Air Quality Expert Group meetings	The team participated in 3 air quality expert group meetings: Ambient Air Quality Expert Group (1) on 29 and 30 January 2018, Ambient Air Quality Expert Group (2) on 11 and 12 March 2019, Ambient Air Quality Expert Group (3) on 5 July 2018.

Timeline: The key milestones were:

- 9 April 2018: Approval of the open public consultation questionnaire
- 8 May 2018: Opening of the open public consultation
- 31 July 2018: Closing of the open public consultation
- June – July 2018: Targeted questionnaire

- 18 June 2018: First stakeholder workshop
- 15 January 2019: Second stakeholder workshop

Evidence and Output: The evidence collected from the consultation activities encompasses both objective evidence (contained in position papers) as well as perceptions / opinions of stakeholders. The evidence collected through the various stakeholder consultation activities have been used and integrated in the analysis under the various criteria. The main outputs of the stakeholder consultation processes is the Synopsis Report (Appendix B) and the evidence that is integrated in the report and evidence appendices as part of the different evaluation criteria.

1.4 Task 4 – Case studies

Rationale: The aim of the case studies was to complement evidence coming out of Task 2 and 3 with more detail and granular information on the situation regarding the experience and lessons learned in the implementation of the air quality legislation in seven representative Member States.

Process: The task included the development of 7 case studies. The selected case studies were:

- Slovakia: focus on Košický kraj
- Germany: focus on Berlin
- Spain: focus on Madrid
- Sweden: focus on rural environment, ecosystem impacts
- Ireland: focus on public information provisions
- Bulgaria: focus on Plovdiv
- Italy: focus on Sicily and the shortcomings in reporting obligations

The overview of the process for developing the case studies and implementing Task 4 is outlined in the table below.

Activity	Description
Selection of case studies	The case study selection criteria were agreed upon jointly with DG ENV in the inception period of the study. The selection of the 7 case studies was made by DG ENV in March 2018.
Piloting the case study approach	A case study pilot was conducted (Slovakia) and finalised in September 2018. This included conducting the field visit, interviews, doing desk research and drafting the case study report.
Conducting the remaining case studies	The remaining case studies (6) were conducted over the course of September to December 2018. This process included conducting field visits and interviews, doing desk research and drafting the case study reports.
Feedback from DG ENV	In the process of drafting the case study reports, the case studies were shared gradually with DG ENV and comments / feedback was received on them. The comments and feedback have been integrated in the case study reports.
Validating the results of the case studies	The interviews minutes and the draft case study reports were shared and validated with the national level interviewees consulted in the context of the case studies. The case study reports were shared with the interviewees in January 2019 and feedback was received from the majority interviewees until the end of February 2019. The information was integrated in the reports by the month of March 2019.
Case study report and summary of case studies	The case study reports (7) together with the summary of the case studies was submitted to DG ENV together with the Draft Final Report in March

Activity	Description
	2019. As highlighted above, prior to the submission of the case studies together with the Draft Final Report, the case study reports had already been shared with the European Commission and feedback on them had been received and integrated.

Timeline: Task 4 was implemented over the course of September – March 2018. The key milestones were:

- September 2018: Pilot case study
- September – December 2018: Drafting the case studies
- January – March 2019: Validation and finalisation of case studies

Evidence and Output: The evidence collected in the context of the case studies covers the situation of the implementation and the effects of the AAQ Directives in different national context. The evidence was used to supplement findings coming from the desk review and the stakeholder consultation in answering the evaluation questions. The output of the task are 7 case study reports (Appendix J) as well as a summary report presenting the findings across all case studies (Appendix I).

1.5 Task 5 – Preparation of analytical documents, Interim Report and Final Report

Rationale: The aim of this task was to focus on the production of the Interim Report and the Final Report presenting the findings of the study.

Process: The overview of the process regarding Task 5 is presented in the table below.

Activity	Description
Inception Report	A draft inception report containing the methodological approach and the work plan was used as basis for the work done in the context of the study.
Interim Report	An interim report containing emerging findings across all evaluation criteria was drafted by the team. This served as basis for discussion with DG ENV and for development of the Draft Final Report.
Final Report	A final report will be submitted to the European Commission in May 2019. The report integrates all the findings as well as comments and reflections from DG ENV and the ISSG.
Monthly Progress Reports	Monthly Progress reports have been submitted to DG ENV at the end of each month during project implementation.

Timeline: The key milestones of Task 5 are:

- April 2018: Approval of the Inception Report
- March 2019: Approval of the Interim Report
- May 2019: Submission of the Final Report
- June 2019: Final submission

Output: The output of the task are the different reports, culminating with the Final Report.

2 METHODS AND ANALYTICAL TOOLS

2.1 Analysis of e-Reporting data

European air quality information, as reported by all EU Member States is collected, managed and made available via the European Environment Agency website, on the Air Quality e-Reporting database (previously AirBase)[1]. Information in this database is based on national reports from the Member States, based on the relevant reporting obligations. A quantitative and qualitative assessment was conducted using data reported on: assessment regimes, attainment of environmental objectives and air quality plans and measures. This informed assessment of effectiveness and efficiency.

Table 2-1 Summary of data used for the quantitative assessment

Data inputs	Source
Minimum number of sampling points for fixed measurements	Annex V in 2008/50/EC [14] Annex III in 2004/107/EC [16]
Zone population and zone type	Data flow B - Downloaded from the EEA/Eionet e-Reporting database on 23/05/2018 [74]
Exceedance attainment status (assessment thresholds)	Data flow C - Downloaded from the EEA/Eionet e-Reporting database on 23/05/2018 [74]
Sampling points used in the assessment (fixed and indicative measurements)	Data flow C - Downloaded from the EEA/Eionet e-Reporting database on 23/05/2018 [74]
Information on the assessment methods - for models and objective estimation	Data flow D1b deliveries – as identified on the Eionet Reportnet 01/10/2018 (reporting deadline 30/09/2018)
Information on the attainment of environmental objectives	Data flow G – Downloaded from the EEA/Eionet e-Reporting database on 28/11/2018 [74]
Information on Air Quality Plans	Data flow H deliveries as identified on the Eionet Reportnet 01/10/2018
Information on measures	Data flow K Downloaded from the EEA/Eionet e-Reporting database on 03/11/2018 [74]

Source: Authors

Data reliability and limitations: The tools to conduct the quantitative analysis were based on a reliable and quality assured data set, namely e-reporting data compiled from Member State reporting by the EEA. As such, the data provides a valuable snapshot of the situation based solely on Member State own reporting. Despite that, some limitations should be noted:

[1] https://www.eea.europa.eu/data-and-maps/data/aqereporting-8 [74]. The database also includes information from non-EU countries that are member and cooperating countries of the EEA and EIONET.

- Data currently available in this form (i.e. aggregated and collated by the EEA) covers 2013-17. Information in the same form is not available for earlier years, which would enable assessment of longer term trends in a comparable manner.
- Reporting format has changed over the evaluation period, due to IPR. This means that for some datasets the timeline is interrupted (in particular, data flow D1b).
- Data submitted by Member States is updated on a regular basis and new submissions are added. The study noted this where possible after the analysis has been done. However, some submissions since the date of download of specific datasets may not be reflected.

It is to be noted that the study did not conduct a full compliance check based on this data. The data was used to gauge an overview of the status for the different elements of the fitness check. More detail of the approach and data used is available in Appendix E.

2.2 Efficiency analysis and modelling

Efficiency analysis considered information on the costs and benefits of measures introduced in response to the AAQ DIRECTIVESs. These fell into two categories, the first dealing with monitoring and reporting systems and the second with the measures designed to reduce emissions and exposure to air pollutants. Consideration is given to how impacts are distributed across stakeholders, including Member States, the public and the sectors that have needed to undertake action, and to the effects of the Directives on EU competitiveness.

A variety of data were used in the assessment, including review of the literature, data collection from stakeholders including Member States and information from the open public consultation. Original analysis was undertaken for assessment of the health benefits of complying with the legislation and the social costs of poor implementation. Ex-post data gathered on the costs and benefits of actions that have been taken was preferred to ex-ante or theoretical forecasts.

In the absence of the ideal data set for comparison of cost burdens across countries, data derived by the GAINS model is useful, as it is based on real data and expert judgment, while acknowledging the limitations of modelling for the current assessment. GAINS has been used extensively for analysis of European air quality policies [see, e.g. 552]. Consideration of data from previous analysis using GAINS demonstrates that there will be variation in costs per capita across Member States of the order of a factor of 2.5 for technical measures such as end of pipe controls (Appendix F2.1, Table 27). The reasons for these differences relate to the issues already identified, including the age of equipment and the types of fuel used. The GAINS model does not, unfortunately, extend to non-technical measures such as LEZs.

For quantification of health impacts (for assessment of benefits of the AAQ DIRECTIVESs and the social costs of poor implementation) the ALPHA-RiskPoll (ARP) model has been used. ARP was developed by Mike Holland (EMRC). ALPHA-Riskpoll was specifically developed for use in assessment of scenarios for air quality policy development. The model is privately owned, though full details of the inputs have been provided in earlier reports to the European Commission [285, 286, 287, 289], for which it and earlier versions have been used in assessment of many air pollution policies since the late 1990s [e.g. 558]. It has also been used in analysis for the European Environment Agency [545] and OECD [111], and also under licence in France and Sweden.

The model is structured around application of the impact pathway approach first developed in the early 1990s for EC DG Research under the ExternE Project [382], providing a logical and sequential path from exposure to benefits assessment. It can be applied at any scale for which exposure (population x concentration) data are available. The main external inputs are data on pollution concentration, derived either from the use of models such as EMEP [68] and CHIMERE [544] or from monitored data.

A major part of the model concerns the response functions for health impact assessment. These apply the recommendations of the HRAPIE (Health Response to Air Pollutants in Europe) study carried out by WHO-Europe on behalf of DG Environment and published in 2013 [568], which involved 100 experts from Europe and North America. Alternative assumptions and functions can be introduced. Background data on incidence and prevalence of healthy conditions are taken from WHO sources [see 289]. Key parameters concern the functions used for quantification of mortality impacts and their valuation. Alternative positions on mortality assessment are available in the literature, but the HRAPIE position remains robust from a European perspective: the global burden of disease study, for example, involves extrapolation of available data from a variety of sources to account for impacts in regions where epidemiological data are either absent or limited, whereas HRAPIE considered various studies carried out in the European region. Recognising uncertainty in mortality valuation, ALPHA-Riskpoll values both in terms of the value of statistical life (VSL) and the value of a life year (VOLY) with ranges for both, based on earlier European research [see 287]. Subsequent meta-analysis by OECD suggests that the unit values adopted for the analysis here are more likely to underestimate benefits than not, but they have been retained for consistency with earlier assessments. For European analysis the model uses uniform valuations across the EU: an alternative approach based on country-specific valuations would change the results in individual countries, but (noting the spread of exceedances identified here) is expected to have little impact on the overall results.

The model has been extensively reviewed and debated during the development of European air quality policies, as it has been used repeatedly to provide benefits assessment alongside the cost-effectiveness analysis of the GAINS model [291]. Peer reviewed studies in the academic literature include, for example, analysis of the air quality benefits of climate policies [554]. Steps taken to assure the quality of the results of the modelling in the present study (in addition to use of the already validated model) include comparison with results of earlier modelling, and consideration of the extent to which benefits of actions under the AAQ DIRECTIVESs specifically may be reflected in results of assessments of the benefits of declining exposure to air pollutants more generally.

The scenarios considered here are based on pollution monitoring data reported by the European Environment Agency, indicating the fraction of the population exposed in excess of limit values and the average amount of exceedance. Of these two components, the fraction of the population exposed in excess of the limits is better characterised, with more limited data availability on the extent of exposures under exceedance (discussed further in Appendix F.1.7.1). The modelling does not account for improvements in health that would be expected from reducing pollutant exposure levels below the limit values, recognising that these do not equate to no-effect thresholds. Dealing with existing conditions there is no use of additional data to describe socio-economic or macro-economic state.

Precise accounting for the benefits attributable to other legislation on air such as the Industrial Emissions Directive and directives on vehicle emissions, and on sustainable development more generally, was not possible within the context of the present study. Results of the modelling should thus be interpreted as providing an indication of the overall scale of benefits and social costs of poor implementation, rather than precise estimates.

Further details on the application of the model in the present study are provided in Appendix F.1.7.1.

Data reliability and limitations: There are a number of problems in characterising the efficiency of the AAQ DIRECTIVESs. First, there is limited data availability on the costs and benefits of actions that have been undertaken to comply with the AAQ DIRECTIVESs, particularly with respect to ex-post information. Second, many estimates of cost and benefit are incomplete. Third, the effects of the AAQ DIRECTIVESs are part of a much larger body of legislation on air quality and environment more generally. This includes the Industrial Emissions Directive, Directives on vehicle emissions and fuel quality, the Climate and Energy Package and the Circular Economy Package. There are then transport measures that have some air quality benefit but are instigated primarily on the basis of other pressures, for improved mobility or reduced congestion. The prime driver for many measures reported as being undertaken in response to the AAQ DIRECTIVESs frequently lies with other legislation. A further complication is that many of the actions undertaken to improve air quality have additional co-benefits, reducing emissions of greenhouse gases, congestion and so on (there are occasionally also trade-offs, but these are less significant). Assessment has thus needed to consider these issues when coming to conclusions on efficiency.

2.3 Literature review

The aim of the literature review was threefold, i.e. to gain a deep understanding of the AAQ Directives, to establish the baseline and the implementation state of play and, most importantly, to collect secondary data on the main evaluation questions.

The support study for the fitness check relied on an extensive literature review of relevant reports and studies, academic literature, position papers published by experts, stakeholder opinions, legislation at Member State level and other relevant literature. The approach towards the literature review has been done in a systematic manner with the use of a comprehensive reference database in an Excel sheet with ID numbers. The ID numbers have been used throughout the report when referencing specific sources. The comprehensive list of literature reviewed for the purpose of this support study is presented in Appendix C of the report.

Data reliability and limitations: An extensive body of literature has been published on the topic of air quality and AAQ Directives treating to some extent the evaluation questions. The data reliability is high as the studies and reports used were peer reviewed. However, analysis made it clear that certain evaluation questions were treated more in-depth than others in the previously written literature. For example, evidence regarding the efficiency of the AAQ Directives has been particularly difficult to find in the literature whereas evidence to support the analysis of the relevance questions was more readily available. Furthermore, another limitation was related to the fact that analyses related to the situation prior to the AAQ Directives in the Member States were limited, and thus data gaps in terms of setting the baseline and making an exhaustive mapping of the situation ex-ante exist.

2.4 Legal analysis

As a basis for the assessment of relevance and coherence in particular, the study included a legal analysis of the AAQ Directives provisions as well as the relation between the AAQ Directives and other policies or legislation at EU (and national level). Legal analysis has been carried out to assess whether there are any instances of redundancy / irrelevance of the provisions of the AAQ Directives (for relevance), and comparative legal analysis has been carried out to ascertain whether there are any instances of coherence, incoherence and gaps between obligations arising from the relevant AAQ Directives and other EU level legislation or policies.

Furthermore, the study encompassed an analysis of case law at EU and national level in relation to the AAQ Directives, as well as infringement procedures by the European Commission for non-compliance with the requirements of the AAQ Directives.

Data reliability and limitations: The reliability of the data and analysis is high given that it relies primarily on EU legislation, including the AAQ Directives, case law, infringement cases as well as secondary literature (e.g. reports or academic literature) analysing these aspects.

2.5 Consultation

The consultation processes involved several data collection activities, namely: (a) a targeted consultation, (b) an open public consultation, (c) seven case studies, (d) two workshops and the participation in three ambient air quality expert groups. These are further elaborated below. A more detailed account of the approach to the consultation of key stakeholders and results from the consultation process are presented in the Consultation Synopsis Report (Appendix B).

Targeted consultation

A targeted questionnaire was sent to approximately 160 representatives of public institutions at national, regional and local level; 100 representatives of NGOs at national and EU level; 80 representatives of industry and trade at national (including national chambers of commerce) and EU level; and 90 research institutes or universities in EU Member States and 90 research institutes or universities in EU Member States covering environmental, health and industry sectors. The associations at EU level were selected in order to ensure a multiplier effect. The initial deadline for responses was 24 July 2018, which was then extended to 15 September 2018.

In total, 41 responses were received. Of these, 2 organisations submitted position papers in lieu of completing the questionnaire. Respondents included 15 public authorities and 5 municipal and regional authorities in Member States, 5 Environmental NGOs and 5 non-Environmental NGOs, 6 educational or scientific organisations, 1 association of local governments and 4 business associations.

Data reliability and limitations: A key limitation of the questionnaire is the quality of the data received which varied across submissions. Some questionnaires submissions contained well substantiated argumentation and answers to all questions, whereas others only briefly noted the position of stakeholders with little or no elaboration of the rationales behind.

Open public consultation

A public EU stakeholder consultation was conducted in the period 08 May 2018 – 31 June 2018 and targeted all interested parties, including citizens, companies, organisations, public authorities, etc.

The questionnaire was structured in two parts. The first part concerned background information about the respondent and general questions on views and concerns of air quality, awareness of Directives, and effects of EU policy and legislation on air quality. The second part consisted of specific related to the effectiveness, relevance, efficiency, coherence and EU added value of the Ambient Air Quality Directives. Participants could provide additional statements by uploading submission papers at the end of the questionnaire.

The open public consultation generated a total of 489 responses. The majority (51%, 248 responses) of respondents replied as individuals, followed by representatives in the Public Administration and Defence sector (64 responses, 40%) and Professions, Scientific and Technical Activities (33 responses, 14%). In addition, there were 29 responses (12%) representing Other Service Activities, which includes activities of professional membership organisations, trade unions, lobbyists and support groups, environmental and ecological groups, etc., with specific interests in issues related to air quality. Respondents came from 27 of the 28 EU Member States with the largest share from Belgium (21%), Germany (17%) and Italy (15%). The larger share of respondents from Belgium can be explained by a presence of EU-level and industry/civil society entities with headquarters in Brussels, Belgium. Furthermore, the large number of responses from Germany and Italy could be due to a prominence of specific types of industries directly or indirectly impacted by measures to improve air quality (e.g. energy production and supply).

Data reliability and limitations: A key limitation in relation to open public consultations is that, while such consultations invite responses from a broad range of stakeholders, including private citizens, they cannot be taken to be representative of the general population. This is because respondents are self-selecting and may not be unbiased. Therefore, care has been taken to ensure that results from the open public consultation are not presented as representing the population at large.

Case studies

The study encompassed seven case studies covering different Member States, namely: Bulgaria, Germany, Ireland, Italy, Spain, Slovakia, and Sweden.

The case studies investigated more in depth several essential dimensions which fed into the analysis of this report, in particular:

- Levels of compliance with the requirements of the AAQ Directives, including improvements (or lack thereof) in terms of pollutant concentrations and/or exceedances;
- Governance systems for air quality including for air quality monitoring and assessment, as well as any issues or good practices related to implementation of air quality monitoring requirements and coordination between relevant authorities;
- Implementation successes and implementation challenges in terms of enforcing the provisions of the AAQ Directives in the Member States;
- Factors underlying or hindering the compliance with the AAQ Directives at national level;
- Costs of implementation and non-implementation of the AAQ Directives and benefits;
- Assessments of the effectiveness, efficiency, relevance, coherence and EU added value of the AAQ Directives in the Member States.

The case studies generated in-depth knowledge concerning the implementation of the AAQ Directives in the seven Member States. The case studies relied on: extensive desk research[2] and interviews with relevant authorities.

Data reliability and limitations: While the case studies provide in-depth examples of the implementation of the AAQ Directives in Member States, they are not a sufficient basis for generalisation to all EU Member States. Thus, the evidence from the case studies has been used in particular for the purpose of exemplification, whereas analysis of trends and patterns across Member States uses more comprehensive datasets, e.g. EEA dataset.

The case studies focus on gathering information ex-ante and ex-post the implementation of the AAQ Directives. Given the lack of a comprehensive review of the situation prior and after the AAQ Directives in the Member States, some data gaps still remain, which are highlighted throughout

[2] Including amongst others the EUROSAI Joint Report on Air Quality, the Court of Auditors Special Report on Air Pollution: Our health is still insufficiently protected, EEA Report on Europe's Urban Air Quality.

the report. In the analysis performed in the present report, the data from the case studies was further complemented with data from desk research and data from consultation activities.

Workshops and expert groups

The study also included several interactions in meetings and workshops with experts in the field of air quality as well as other key stakeholders. This included two stakeholder workshops and the participation to three Ambient Air Quality Expert Groups throughout the project:

- Stakeholder Workshop (1) on 18 June 2018
- Stakeholder Workshop (2) on 15 January 2019
- Ambient Air Quality Expert Group (1) on 29 and 30 January 2018
- Ambient Air Quality Expert Group (2) on 11 and 12 March 2019
- Ambient Air Quality Expert Group (3) on 5 July 2018

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Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

Appendix B: Synopsis of consultation results

1 INTRODUCTION

This report presents a summary of the results of consultation activities carried out by the European Commission in preparation for the Fitness Check of the EU Ambient Air Quality (AAQ) Directives.

The Fitness Check examined the implementation of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC). These Directives set air quality standards and requirements to ensure that Member States monitor and assess air quality on their territory, in a harmonised and comparable manner. The fitness check also considers the corresponding Implementing Decision 2011/850/EC and Commission Directive EU/2015/1480 and builds on the extensive analysis developed as part of the 2013 EU air policy review[1].

The overall purpose of the Fitness Check is to assess the extent to which AAQ Directives are fit for purpose and continue to provide the appropriate legislative framework for ensuring protection from adverse impacts on, and risks to, human health and the environment. As part of this exercise, Member States and other relevant stakeholders were consulted to collect supporting information, data and knowledge on the implementation of various aspects of the AAQ Directives, with a view to fill any potential information/data gaps in the course of the Fitness Check and inform analysis of evaluation questions. Consultation activities also aimed at gathering stakeholders' views and opinions on the extent to which AAQ Directives have successfully met their objectives.

2 CONSULTATION STRATEGY

The consultation focused on gathering stakeholders' responses on the following aspects:

- awareness of the air quality issues in general and knowledge of the Directives' provisions;
- views regarding the contribution of the Directives to improved air quality;
- whether the provisions of the AAQ Directives continue to be relevant, effective, efficient, and coherent with other EU and national policies, as well as the extent to which an EU-level approach to air quality has added value.

A broad range of stakeholders were consulted for the Fitness Check, including Member State competent authorities at all relevant levels (e.g. national, regional and local), civil society and non-governmental organisations, organisations representing industry and trade, researchers and the scientific community, international organisations (such as WHO), as well as citizens.

The consultation process included a strong representation of scientific and technical expertise from both public and private sectors as well as adequate representation from civil society organisations, including NGOs. Care was taken to ensure that, in each Member State, stakeholders representing government, civil society and industry were provided the opportunity to provide input. Particular attention was paid to consulting stakeholders in territorial levels and areas where air quality problems were problematic.

To account for different information needs, consultation activities included:

[1] COM/2013/0918 final

- an **open public consultation (OPC)** allowing the interested public and stakeholders to express their views;
- a **targeted stakeholder consultation** focusing on selected stakeholders in all Member States and at EU level organisations; and
- two **stakeholder workshops** with stakeholders.

3 CONSULTATION ACTIVITIES

3.1 Feedback on the Fitness Check Roadmap

The public consultation on the Fitness Check Roadmap was open from 26 July to 23 August 2017. It resulted in 13 responses online and one additional response was received via email. Five replies were received at the EU-level and nine at Member state level.[2] By stakeholder group, two replies were received from business organisations, four from business associations, five from NGO/civil society, one from public authorities, one from a private citizen and one from a city. The full responses are available online and were considered in the analysis underpinning this fitness check.[3]

3.2 Targeted questionnaire

The targeted questionnaire was aimed at collecting evidence and information relevant to answer the evaluation questions from a selected number of stakeholders at national and EU level.

The targeted questionnaire was sent to approximately 160 representatives of public institutions at national, regional and local level; 100 representatives of NGOs at national and EU level; 80 representatives of industry and trade at national (including national chambers of commerce) and EU level; and 90 research institutes or universities in EU Member States covering environmental, health and industry sectors. The associations at EU level were selected in order to ensure a multiplier effect. The deadline for responses was 24 July 2018, which was then extended to 15 September 2018.

In total, 43 responses were received. Of these, two organisations submitted position papers in lieu of completing the questionnaire and one provided feedback in email form. A number of respondents provided documents in addition to completed questionnaires. Respondents included 16 national authorities and five local or regional authorities (or associations of local governments) in Member States, ten NGOs, six educational or scientific organisations, five industry associations and one local authority employee responding in an individual capacity. A table outlining the respondents is provided in Annex 1.

The 43 responses represented around 10% of stakeholders approached. This response rate reflects the fact that the team deliberately cast a wide net, approaching a broad range of stakeholders to try to maximise the number of respondents. This approach was considered necessary, given the questionnaire had both a consultation and a data collection purpose – approaching a large number of respondents would support the collection of the necessary data (e.g. cost data for the evaluation of efficiency). All major stakeholder groups were represented in the responses,

[2] Germany (3), Austria (1), Denmark (1), Italy (1), Hungary (1), Netherlands (1), United Kingdom (1).

[3] https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2017-3763998/feedback_en

except for EU and international organisations who nonetheless participated in other consultation activities (e.g. the stakeholder workshops). The relatively high representation of national authorities (16 out of 43 responses) may suggest that these respondents were more likely to contribute due to their awareness of the Fitness Check via the Air Quality Expert Group.

The responses were shared with the study team and the Commission. Each criterion lead in the study team carried out a qualitative text analysis, reviewing the documents and identifying key themes in each response. Where a significant number of responses was received on one criterion or issue, qualitative analysis software was used (Nvivo, Dedoose) to allow for efficient coding of responses and identification of common themes.

3.3 Open public consultation

The aim of the open public consultation was to gather views from citizens and stakeholders on general awareness of air quality issues and the Directives, and opinions on the implementation of AAQ Directives according to five evaluation criteria (relevance, effectiveness, efficiency, coherence and EU value-added).

The questionnaire was open to any interested party, including private citizens, companies, civil society organisations, researchers and public authorities. The open public consultation questionnaire was accessible in 23 official EU languages (excluding Irish) and published online from the European Commission's public consultation portal website. Supporting documentation in any of the EU official languages were also accepted. The public consultation was opened on EU Survey on 8 May 2018 and remained open to responses until 31 July 2018.

The questionnaire was structured into two parts: background information about the respondent and general questions on views and concerns of air quality, awareness of the Directives, and effects of EU policy and legislation on air quality. The second part consisted of specific questions related to the effectiveness, relevance, efficiency, coherence and EU added value of the AAQ Directives. Participants could provide additional statements by uploading submission papers at the end of the questionnaire.

The open public consultation generated a total of **489 responses**. The responses were exported to Excel directly from the EU Survey platform. Questions with answers on a Likert scale were recoded using a set of common response scales. Then sub-questions were grouped together for generating visual representations using bar charts. For questions with open-ended answers, answers were grouped together based on common themes. Then qualitative analysis was undertaken based on these themes, along with visual representation using pie or column charts where relevant.

The majority (51%, 248 responses) of respondents replied as **individuals**, followed by representatives in the **Public Administration and Defence sector** (64 responses, 27%) and **Professions, Scientific and Technical Activities** (33 responses, 14%). In addition, there were 29 responses (12%) representing **Other Service Activities**, which includes activities of professional membership organisations, trade unions, lobbyists and support groups, environmental and ecological groups, etc., with specific interests in issues related to air quality. Respondents came from 27 of the 28 EU Member States with the **largest share from Belgium** (21%, 102 responses), Germany (17%, 81 responses) and Italy (15%, 71 responses). The larger share of respondents from Belgium can be explained by a presence of EU-level and industry/civil society entities with headquarters in Brussels, Belgium. Furthermore, the large number of responses from Germany and Italy could be due to a prominence of specific types of industries directly or indirectly impacted by measures to improve air quality (e.g. energy production and supply).

Figure 1: Type of Organisation or Institutions (n=240)

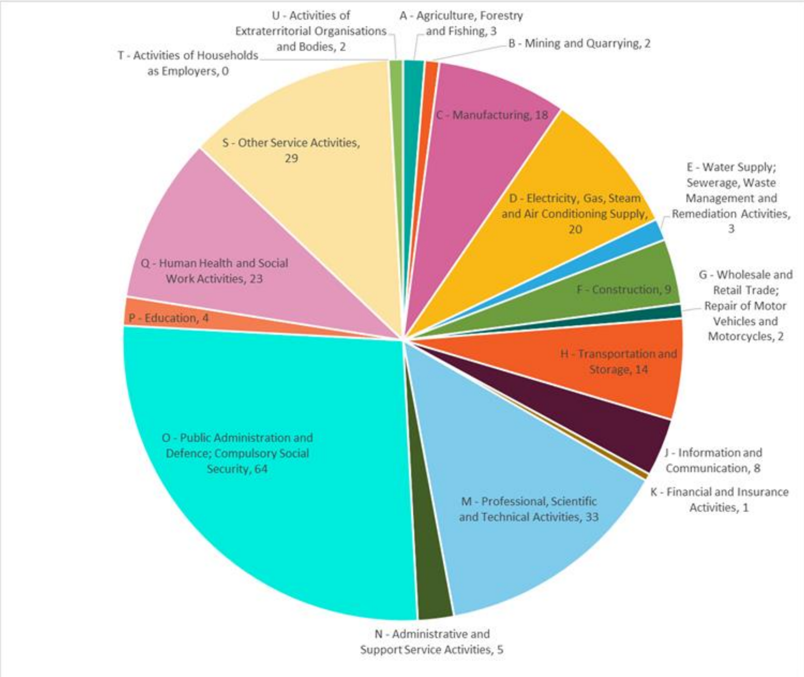
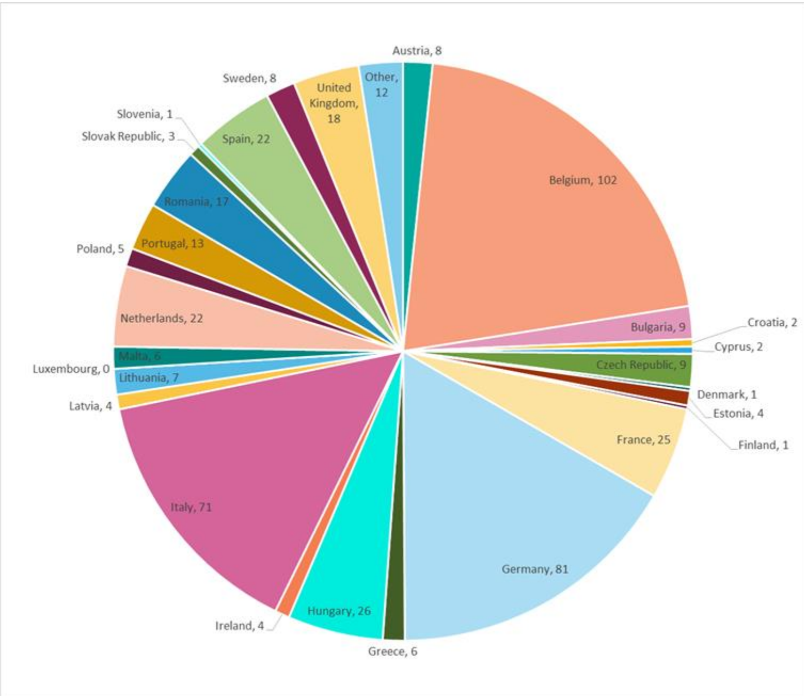


Figure 2: Geographic Distribution of Respondents (n=241)



In addition to completing the questionnaire, seven respondents (two industry stakeholders, two local or regional authorities, two NGOs, and one partnership of local, national and EU stakeholders) provided position papers by email. These were subsequently reviewed and taken into account in the supporting study.

3.3.1 Responses to general questions on awareness and effects

As much as **90% of respondents** either completely agreed or somewhat agreed with the statement that **poor air quality is an issue of concern in Europe**. Underlying these concerns were 75% or more who completely agreed that poor quality has negative impacts on individual health, wellbeing of the population, the health of the overall population in the EU and the environment. More than 60% of respondents reported feeling either very well informed or moderately informed about EU clean air policies, the EU AAQ Directives, national level air quality policy and plans and local and/or regional-level air quality plans.

Respondents as a whole felt the issue of air quality should be tackled more or less equally at all levels of governments, with slightly more respondents (28%, 370 responses) indicating the EU as most appropriate. In thinking about how EU policy and legislation on air quality has helped to improve a number of objectives, the largest share of respondents (60%) agreed either somewhat or completely on the objective for ensuring consistent rules on the levels of air pollution to which citizens were exposed. The weakest level of agreement related to the question regarding the provision of comparable information to citizens on air pollution levels. Just under 40% agreed that EU policies and legislation on air quality helped to achieve this objective (see Figure 4).

Figure 3: Question 4.4: Which level of government is the most appropriate to address air quality problems?

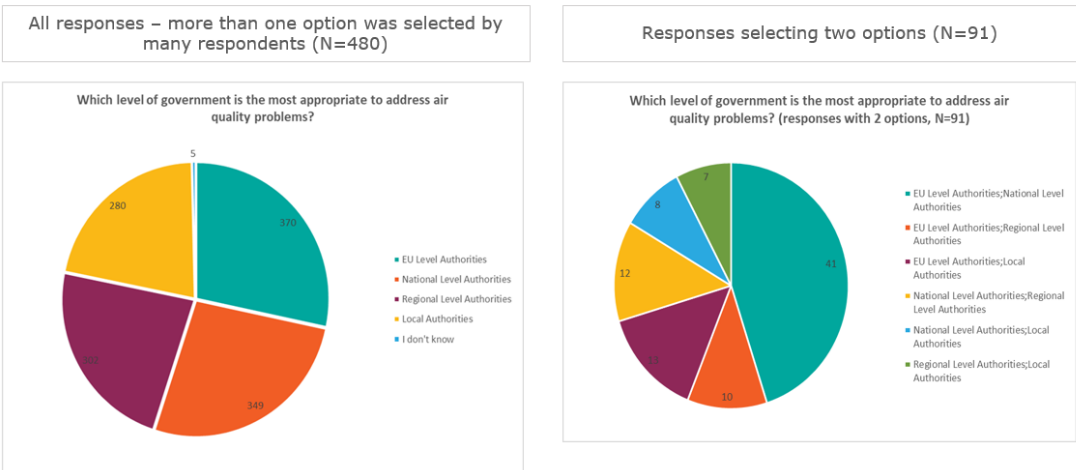
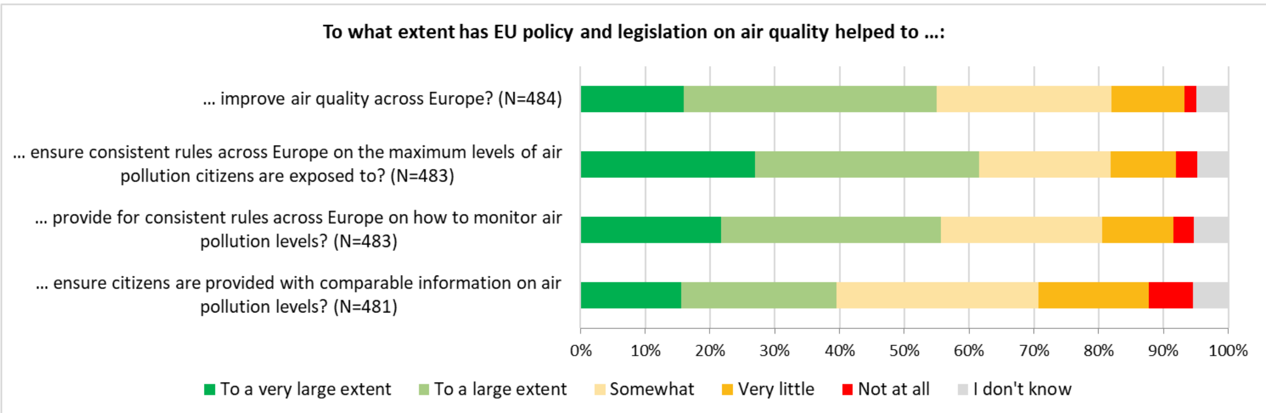
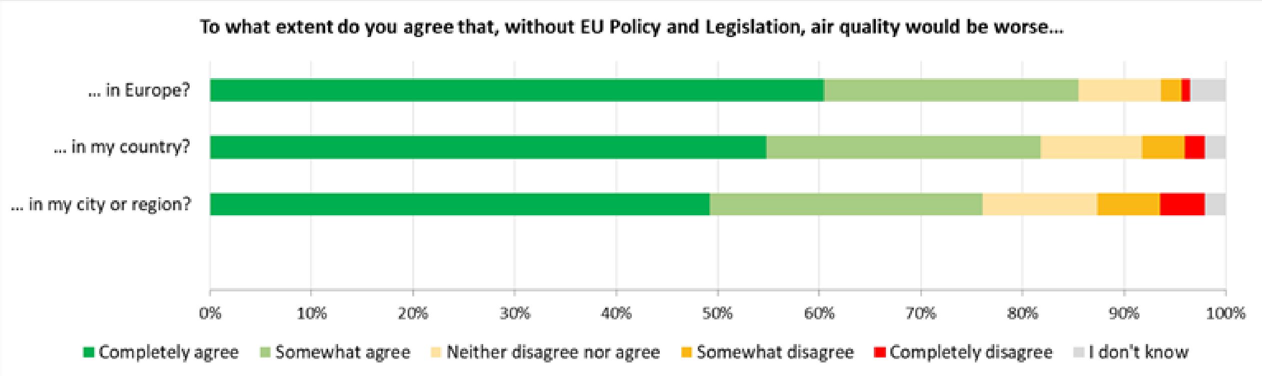


Figure 4: Question 4.5: To what extent has EU policy and legislation on air quality helped to… (n=481-484 – different numbers of respondents for each statement)



The majority of respondents agreed either completely or somewhat that EU policies and legislation have helped prevent worsening off air quality in Europe (86%), in the respondent's country (82%), and in the respondent's city or region (76%).

Figure 5: Question 4.6: To what extent do you agree that, without EU policy and legislation, air quality would be worse… (N=473-483 – different numbers of respondents for each statement)



3.4 Workshops

Two workshops with stakeholders were held in June 2018 and January 2018. The purpose of the workshops was to gather evidence, confirm issues for the evaluation, solicit views on the performance and implementation of the AAQ Directives and seek feedback on emerging findings. Participants included representatives from national, regional and local governments in the EU, environmental and other public bodies, business and trade organisations, civil society, international bodies (WHO), academia and the research community.

Approximately 100 participants attended the June 2018 workshop 150 participants attended the January 2019 workshop from national, regional and local governments, environmental and other public bodies, representatives of business and trade organisations, civil society, international organisations, academia and the research community. The main themes raised by stakeholders are summarised by evaluation criterion in Section 4.

Stakeholder interventions during the workshop were noted, with at least two team members taking notes during each session. These notes were compiled and used to develop draft meeting minutes, with cross-checking across the multiple sets of notes to ensure accuracy. The Draft minutes were shared with the Commission, which reviewed and revised the minutes. The final set of minutes was published on the Commission website for each workshop and shared across the team responsible for the supporting study to ensure that stakeholder views from the workshops could be considered in the study.

3.5 Ad hoc contributions

During the Fitness Check, stakeholders made a number of ad hoc contributions to the process. These included a meeting between Commission staff and a port authority, where the port authority emphasised the need to ensure alignment between the AAQ Directives and source legislation and to support effective multi-level governance. An industry stakeholder also provided input in late-2018 in a position paper which noted concerns about the challenges faced by Member States in meeting the limit values in the 2008 Directive and the need for a supporting regulatory framework addressing all relevant emission sources.

Following the workshops, a small number of ad hoc contributions were made to the Commission and/or the team carrying out the supporting study:

- One industry stakeholder resubmitted their targeted questionnaire response following the second stakeholder workshop and asked that the study team ensure that it is taken into account in the evaluation of relevance. The study team subsequently reviewed the response to ensure that it was appropriately reflected in the study's analysis.

- One environmental NGO representative followed-up on the second stakeholder workshop providing documentation and further details regarding comments on coherence made during the workshop. This information related to coherence between EU climate and air quality objectives. The study team reviewed the documentation provided to identify information relevant to the analysis and incorporated this information into the analysis.

3.6 Other activities

Other stakeholder consultation activities included a workshop at Green Week 2018 and follow-up with individual stakeholders in response to direct inquiries with the Fitness Check team and/or the consultants carrying out the supporting study.

3.6.1 Ambient Air Quality Expert Group

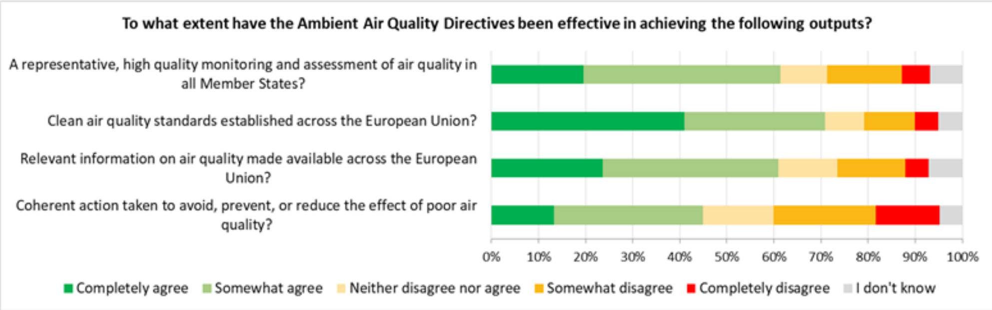
In addition, the European Commission's Ambient Air Quality Expert Group was consulted throughout the Fitness Check. Members of the supporting study team attended three meetings of the Expert Group in 2018 and 2019. At the January 2018 meeting, the roadmap and intervention logic were presented to the Expert Group, and the specific sessions focused on each criterion, where Expert Group members provided their preliminary views on the criteria and the data available for the supporting study. The July 2019 meeting was dedicated to the Fitness Check. Discussions were structured around key issues emerging in the analysis: methods for monitoring air quality and reporting of information; standards and ambition levels; measures for protecting air quality and Air Quality Plans; and policy coherence. The preliminary study findings were presented to the Expert Group at the March 2019 meeting and members were invited to provide their comments.

4 RESULTS OF THE STAKEHOLDER CONSULTATION

4.1 Effectiveness

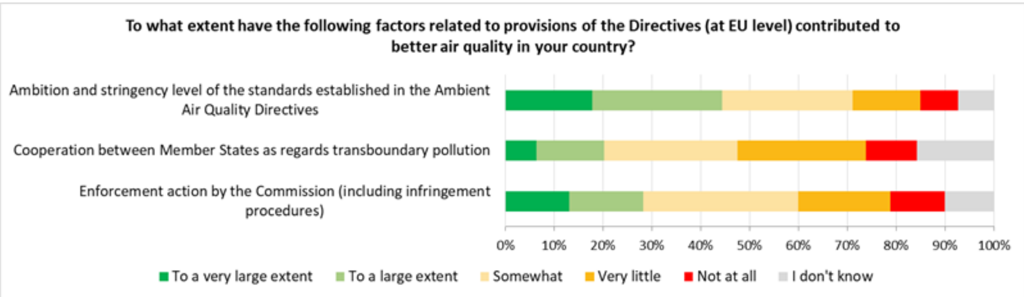
In general, respondents from the OPC perceived the AAQDs to be effective in achieving their objectives. Most respondents agreed either completely or somewhat that standards are well-established (71%), monitoring is in place (61%), and information is being made available (61%). There was less agreement in respect to the objective of taking coherent action to avoid, prevent or reduce the effect of poor air quality, with only 45% of respondents indicating that they completely or somewhat agreed that the Directives have been effective.

Figure 6: Question 7.1: To what extent have the Ambient Air Quality Directives been effective in achieving the following outputs? (N=471-477 – different numbers of respondents for each statement)



Regarding the factors contributing to better air quality, respondents from the OPC perceived the ambition and stringency levels of the AAQDs had made the most significant contribution (44%)[4], while the cooperation between the MSs was felt to have contributed the least (20%). A significant minority of respondents (32%) felt much less enthusiastic about enforcement action by the Commission contributing to better air quality in their countries.

Figure 7: Question 7.2: To what extent have the following factors related to provision of the Directives (at EU level) contributed to better air quality in your country? (N=465-467 – different numbers of respondents for each statement)



With regards to the factors contributing to better air quality at the MS level, most OPC respondents (38%) believed that national air quality plans and/or measures had contributed to improving air quality to a very large or large extent. However, 51% of respondents were keen to highlight the limited extent of the effect of penalties put in place by Member States. Legal authority at the different governance levels in Member States was also a factor deemed important, though there were concerns regarding the availability of adequate national funding for air quality, with only 22% of respondents rating this aspect as having a very large or large contribution (see Figure 9).

[4] Either to a very large or large extent.

Figure 8: Question 7.3: To what extent have the following factors related to provision of the Directives (at a Member State Level) contributed to better air quality in your country? (N=465-470 – different numbers of respondents for each statement)

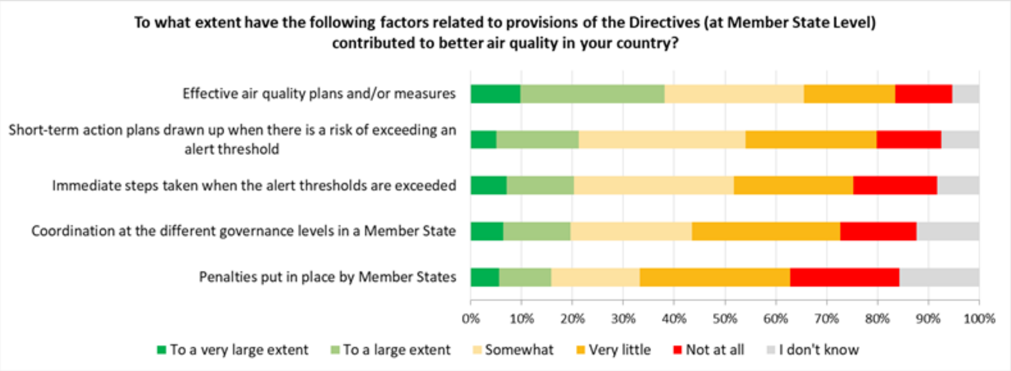
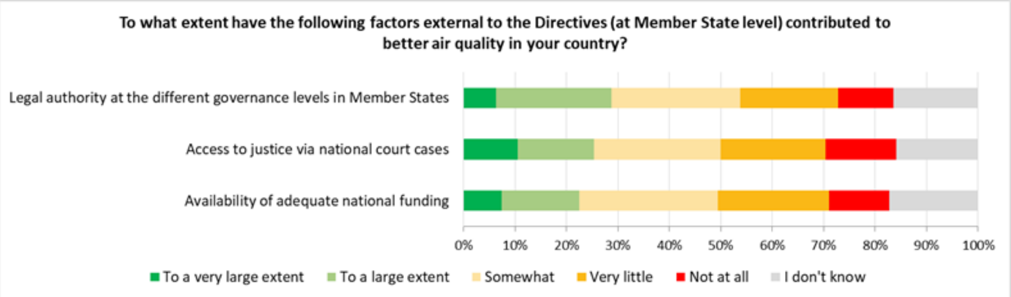
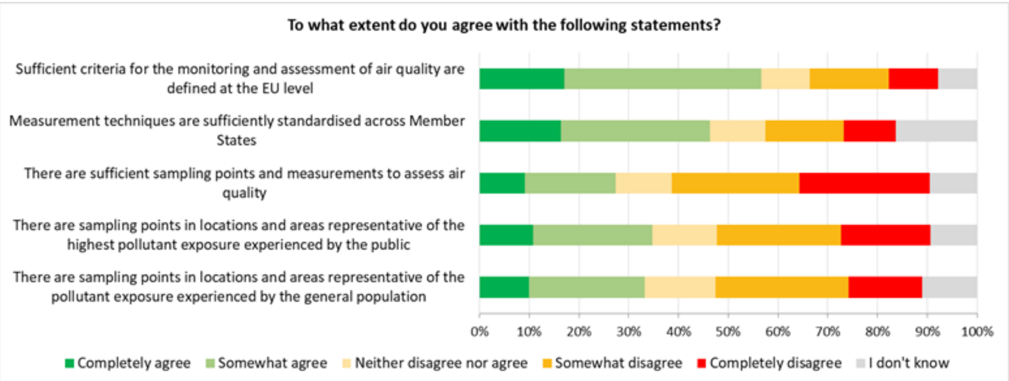


Figure 9: Question 7.4: To what extent have the following factors external to the Directives (at a Member State Level) contributed to better air quality in your country? (N=459-463 – different numbers of respondents for each statement)



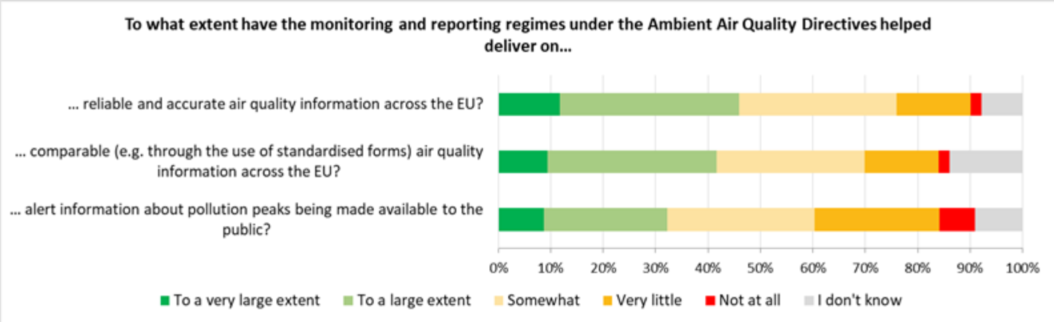
Regarding the effectiveness of the monitoring and assessment of air quality, 58% of OPC respondents agreed completely or somewhat that sufficient criteria are defined at the EU level for monitoring and assessment, and the measurement techniques are sufficiently standardised across the MS (46%). However, respondents were more likely to disagree that there are sufficient sampling points and measurements to assess air quality (52%) and on the location of sampling points both in terms of areas representative of the highest pollutant exposure experienced by the public (43%) and areas representative of the pollutant exposure experienced by the general population (42%).

Figure 10: Question 7.6: To what extent do you agree with the following statements? (N=470-473 – different numbers of respondents for each statement)



Finally, 88% of OPC respondents believed that monitoring and reporting regimes under the AAQDs has helped deliver reliable, accurate and comparable air quality information across the EU to a very large or large extent. At the same time, respondents also felt that it had helped very little or not at all in this regard (86%). The view was less positive in respect of alert information about pollution being made available to the public, with 31% of respondents rating this aspect as having helped very little or not at all.

Figure 11: Question 7.7: To what extent have the monitoring and reporting regimes under the Ambient Air Quality Directives helped deliver on… (N=469-475 – different numbers of respondents for each statement)



Similar findings were echoed in the workshops, with participants identifying several factors that may limit the effectiveness of air quality objectives. Representatives from national authorities and NGOs raised the issues of widespread exceedances of air quality standards as an issue limiting the effectiveness of the Directives.

Comments from NGOs and local and regional governments also focused on the lack of clear provisions and guidance on modelling. NGOs and local experts also raised the issue of unclear distribution of responsibilities within Member States for the implementation of air quality plans which contributes to reduced effectiveness of the Directives.

National officials also emphasised that more attention should be given to measuring emissions in areas where vulnerable populations are present, with consideration given to applying more stringent limit values in these areas. A number of comments were raised by representatives of authorities, industry and NGOs on the siting of monitoring stations: some stakeholders suggested the Directives' criteria on siting is too flexible, while some suggested that it was too restrictive.

Participants also raised aspects where the Directives have made progress. These focused on:

- Improvements in publicly available information and data on air quality and on the accessibility, timeliness and user-friendliness of information on air quality assessment under reporting obligations in the IPR decision 2011/850/EU. However, stakeholders reported their views that the availability of information to the public differs significantly between Member States.
- The effectiveness of limit values in driving pollutant reductions and harmonising air quality standards across Member States.
- The obligation to adopt Air Quality Plans which have ensured exceedances of air quality standards are kept as short as possible.

In the targeted questionnaire, of the 43 respondents to the targeted questionnaire, 35 respondents had provided contributions on effectiveness, and 26 of these provided a quantitative estimate on their perceptions regarding the effectiveness of the AAQ Directives. In achieving objectives 1 (defining common methods to monitor and assess air quality) and 2 (assessing ambient air quality in order to monitor trends), most commonly mentioned positive examples were the common methods for measuring and assessing air quality established by the Directives allowing for comparison of information between different cities and countries in Europe (Objective 1); that provisions for fixed measurements are clear and detailed (Objective 1); and that the Directives have encouraged availability of reliable and comparable data, thus enabling assessment of trends (Objective 1+2). Common examples on difficulties included the room for interpretation in the Directives regarding criteria for siting of stations, in particular traffic stations (e.g. how close to the road, what is a junction), zone definitions, and definitions of background/traffic sites, which leads to possibly incomparable data depending on the specific approach taken in each Member State (Objective 1); and representativeness with regards to the extent to which the measured concentrations reflect human exposure to pollutants, based on the current provisions. The three lowest scores explained their score by the fact that it is difficult and expensive to get a measurement method approved (two business associations and an educational/scientific organisation).

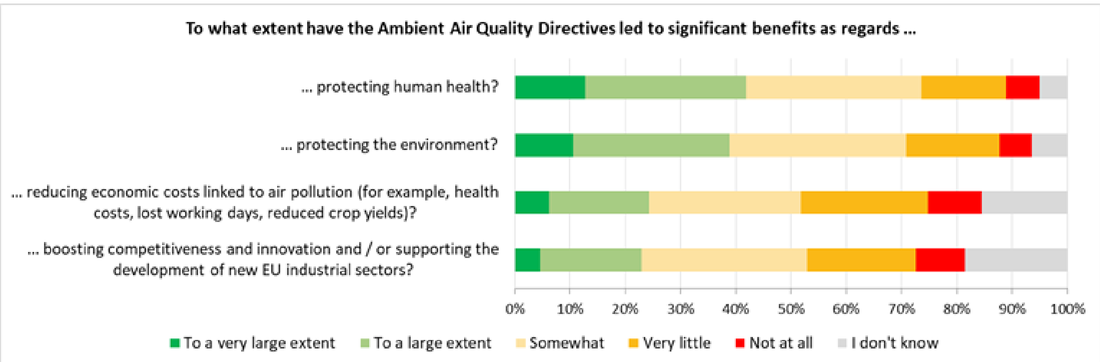
As to objective 3 (establishing standards of air quality to achieve across the EU; role of the Directives), most common positive responses were that mandatory AQ standards has been a driving force for MS to ensure that the necessary policies and measures are put in place" (MS authority/agency), whereas negative responses pointed to shortcomings in the definition of standards (municipal authority, NGOs and business community).

For objective 4 (ensuring that information on air quality is made public) most common positive factors mentioned were that the Directives provisions on information availability, monitoring and reporting along with the EEA reports and the Air Quality Index had facilitated public awareness (MS authorities, scientific institutions, business organisations, NGOs), however on the question of accessibility, it was also flagged as negative factors that the information provided is not necessarily understandable to citizens if not followed by further interpretation (MS authorities, NGOs). As to objective 5 (maintaining good air quality, improving it where it is not good), common positive responses contained general statements that air quality has improved, and that AAQDs have contributed to maintaining or improving air quality. Common areas of concern or shortcomings pointed to continued exceedances, ongoing enforcement action, and action plans or measures considered ineffective (MS authorities, NGOs).

4.2 Efficiency

A greater proportion of OPC respondents believed that AAQDs have delivered significant benefits for protecting human health (42%) and the environment (39%) either to a very large or large extent. Views were less positive for the AAQDs' effects on reducing economic costs linked to air pollution, and boosting competitiveness and innovation, or supporting the development of new industrial sectors.

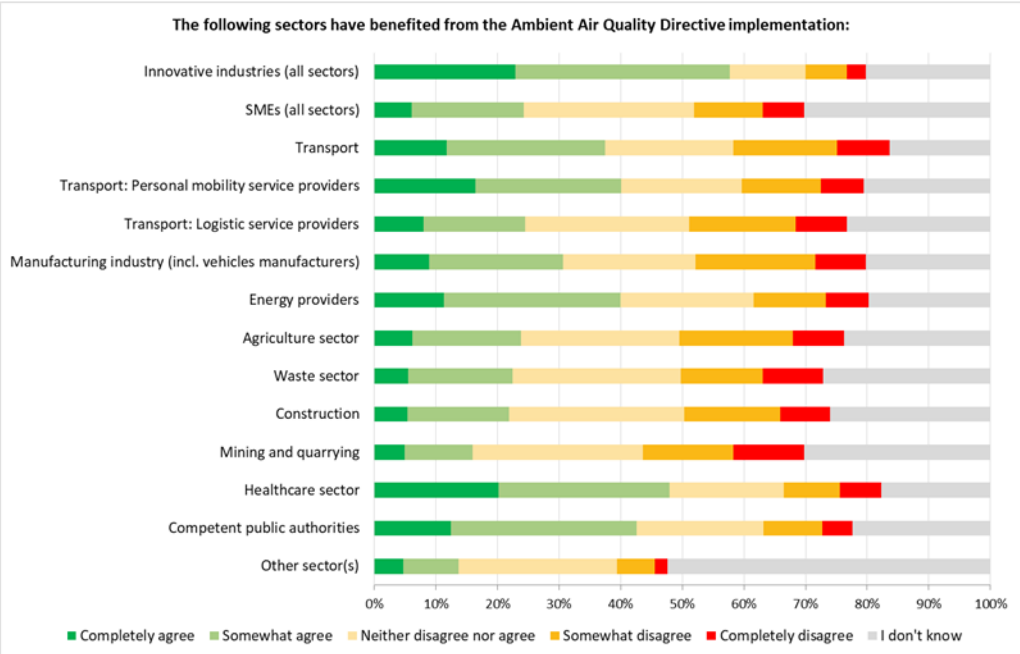
Figure 12: Question 8.1: To what extent have the Ambient Air Quality Directives led to significant benefits as regards… (N=465-473 – different numbers of respondents for each statement)



OPC respondents agreed most strongly that the implementation of AAQDs benefited all citizens (67%) and citizens living in urban areas (65%). This was very closely followed by 59% who believed it benefited citizens deemed to be vulnerable or sensitive in health terms. Fewer respondents believed AAQDs benefited citizens living in rural areas (43%) and vulnerable citizens in socio-economic terms (47%).

The sectors considered to provide the most sectoral benefits of AAQD implementation were innovative industries (all sectors) (58%), healthcare (48%), competent public authorities (43%), transport (personal mobility service providers) (40%) and energy providers (40%). While the sectors considered to have benefitted the least from AAQDs implementation were transport (logistic service providers) (24%), agriculture sector (24%), waste sector (22%), construction (22%), and mining and quarrying (16%). Responses from Public Administration and defence sector and from the Professional, Scientific and Technical Activities sector showed similar patterns to the responses from all respondents.

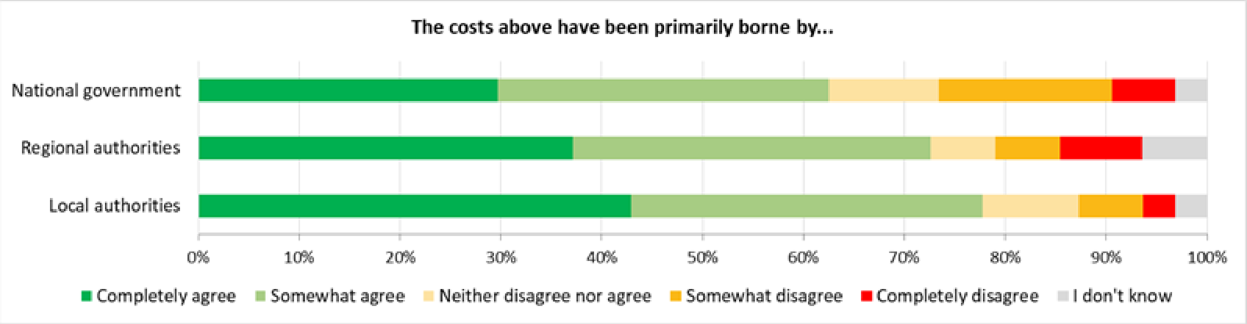
Figure 13: Question 8.3: To what extent do you agree with the following statement? "The following sectors have benefitted from the Ambient Air Quality Directive Implementation." (N=424-454 – different numbers of respondents for each statement)



Some analysis was undertaken of the responses received from the different sectors. The data does not appear to support the assertion that respondents felt other sectors had benefitted, whilst they had not; however, it is noted that the number of responses received from the specific sectors is, in most cases, relatively small.

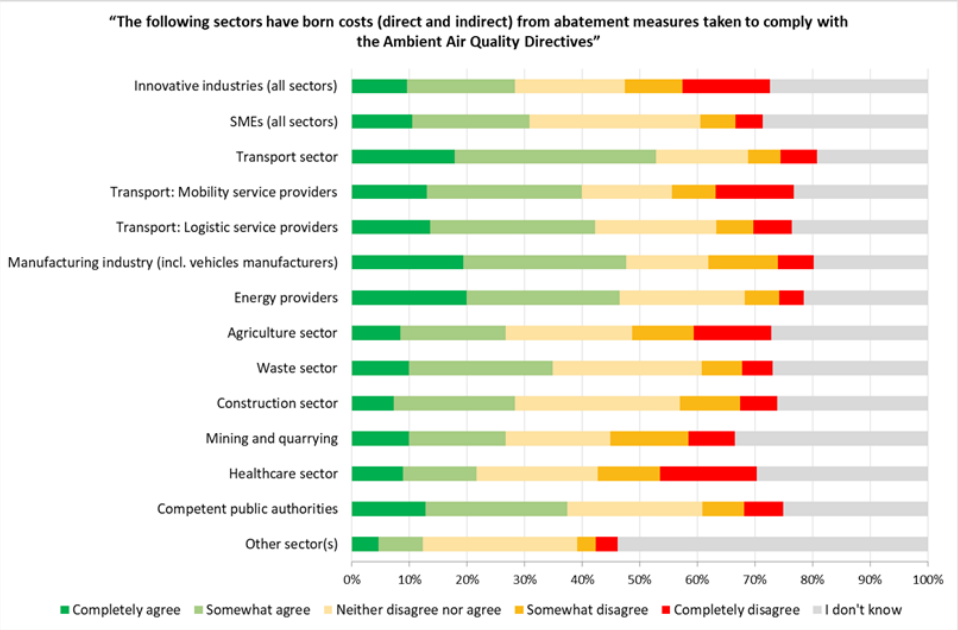
Regarding monitoring, reporting and assessment costs associated with AAQDs, a larger share of respondents agreed somewhat or completely that significant costs were associated with monitoring equipment (46%), as well as the costs of developing and adopting air quality plans (42.5%). While responses from all respondents did not clearly identify which level of government had borne the costs, respondents from the public administration and defence sector were most likely to indicate the costs had been borne by local (77%) and regional authorities (73%).

Figure 14: Question 8.20: To what extent do you agree with the following statement? "The costs above have been primarily borne by…" (responses from Public Administration and Defence sector) (responses from Public Administration and Defence sector, N=62-64 – different numbers of respondents for each statement)



Finally, OPC respondents indicated stronger levels of agreement for 'all citizens' (59%) and 'citizens living in urban areas' (47%) as most likely to bear the costs arising from abatement measures. Just over 50% of respondents indicated that they 'completely agree' or 'somewhat agree' with the view that the Transport sector (all types) had borne costs to comply with the AAQ Directives, with the closely related sectors, Mobility Service Providers (and Logistic Service Providers) also receiving a high proportion of responses of this nature. Manufacturing industries (47%) and energy producers (46%) were most frequently identified as bearing the costs, along with the competent public authorities (37%).

Figure 15: Question 8.23: To what extent do you agree with the following statement? "The following sectors have borne costs (direct and indirect) from abatement measures taken to comply with the Ambient Air Quality Directives." (N=373-426 – different numbers of respondents for each statement)



Rather than simply quantifying the costs of complying with the Directives, comments in workshops focused on how to quantify the costs of measures taken to improve air quality in line with the limit values in the Directives, and quantifying benefits other than health benefits. Specifically, the costs of air quality measures were viewed as being more important than those of complying with other requirements in the Directives (e.g. costs of establishing monitoring networks, administrative costs such as reporting, etc). Whether to consider the costs of health impacts associated with low concentrations of pollutants (i.e. below the limit values in the Directives) was also discussed.

Other issues raised focused on the importance of capturing costs by key sectors contributing to air pollution. In this regard, participants suggested developing a common methodology to quantify the costs of air pollution not only on health but also on agriculture and ecosystems, as this would help to show the value of addressing air pollution. Others pointed to the difficulty in attributing costs (and benefits) of improved air quality to the AAQ Directives, due to the interactions between the Directives and other policy interventions, e.g. in sectors such as transport. For example, some transport measures are taken in response to the AAQ Directives, but other high-cost measures are taken primarily for other reasons, to reduce congestion and improve mobility. Finally, it was also noted the majority of action plans do not have a cost-effectiveness analysis despite there being many low-costs measures available at the local level.

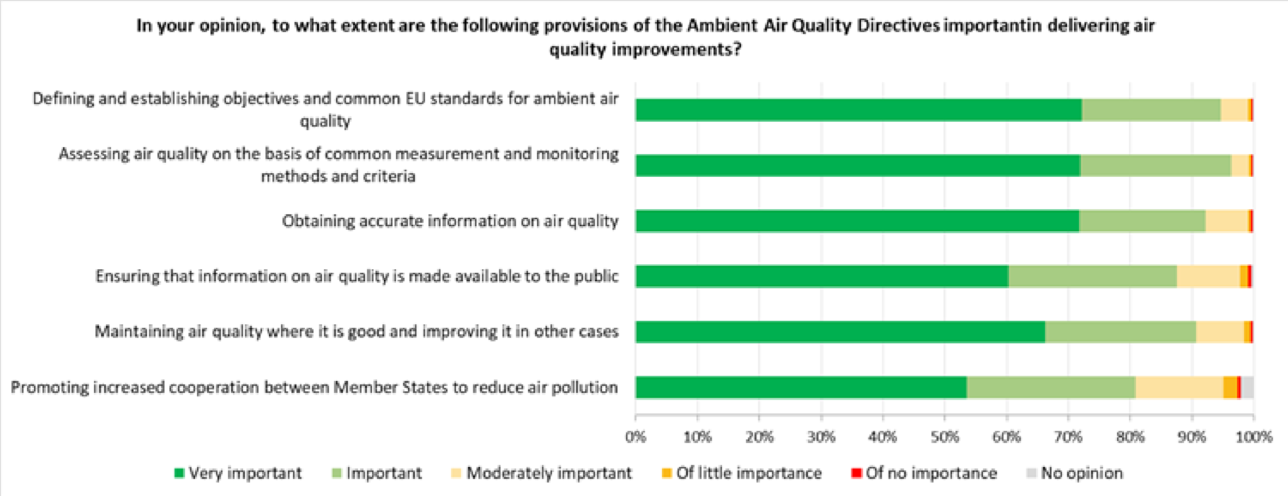
The evaluation of efficiency relied heavily upon the input of stakeholders via the Targeted Questionnaire, which included questions focused on the administrative costs and burdens associated with the AAQDs. This is because only Member State Authorities, at the relevant governance level, with responsibility for implementing air quality assessment, monitoring and reporting regimes can provide accurate estimates of administrative costs and burdens. Much of the analysis in Evaluation Question 6 is therefore underpinned by the cost data returned via part of the consultation exercise. For Evaluation Question 7 responses to the targeted questionnaire provided evidence of innovations that are likely to be triggered by the implementation of the AAQDs, as well as examples of sectors that might have been adversely affected by the AAQDs.

In addition to providing data, questionnaire respondents commented on the challenges of quantifying the costs and benefits associated with the Directives. While national authorities provided significant useful information, they also commented on the data limitations. NGOs provided useful information on the benefits of the Directives and the costs of non-implementation, while also noting the challenges of quantifying benefits, particularly in relation to non-health benefits. NGOs were significantly more likely to express concerns about the costs of non-implementation. Responses by local authorities tended to note they bear a disproportionate share of the costs of implementing measures needed to ensure compliance with the Directive. Industry stakeholders provided very little comment on the topic of efficiency, making general statements about the need to ensure the efficient implementation of the Directive.

4.3 Relevance

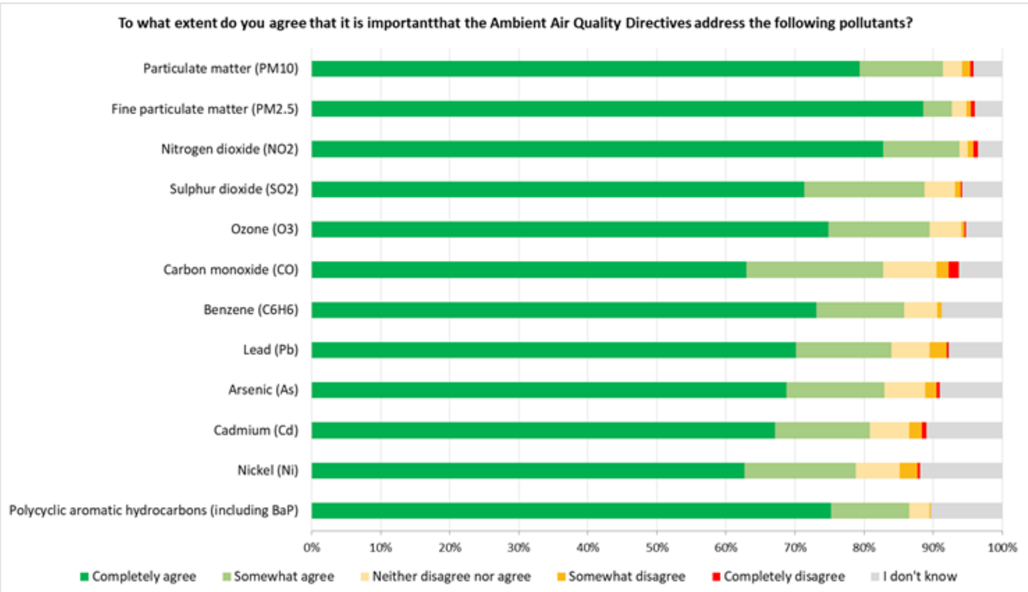
An overwhelming majority of OPC respondents agreed either to a large or very large extent that air pollution poses a major concern to public health (94%) and the environment (88%). Respondents considered these four provisions of the AAQD as the most important in delivering air quality improvements: 'defining and establishing objectives and common EU standards for ambient air quality' (95%); 'assessing air quality on the basis of common measurement and monitoring methods and criteria' (96%); 'obtaining accurate information on air quality' (92%); and 'maintaining air quality where it is good and improving it in other cases' (91%).

Figure 16: Question 6.2: In your opinion, to what extent are the following provisions of the Ambient Air Quality Directive important in delivering air quality improvements? (N=480-485 – different numbers of respondents for each statement)



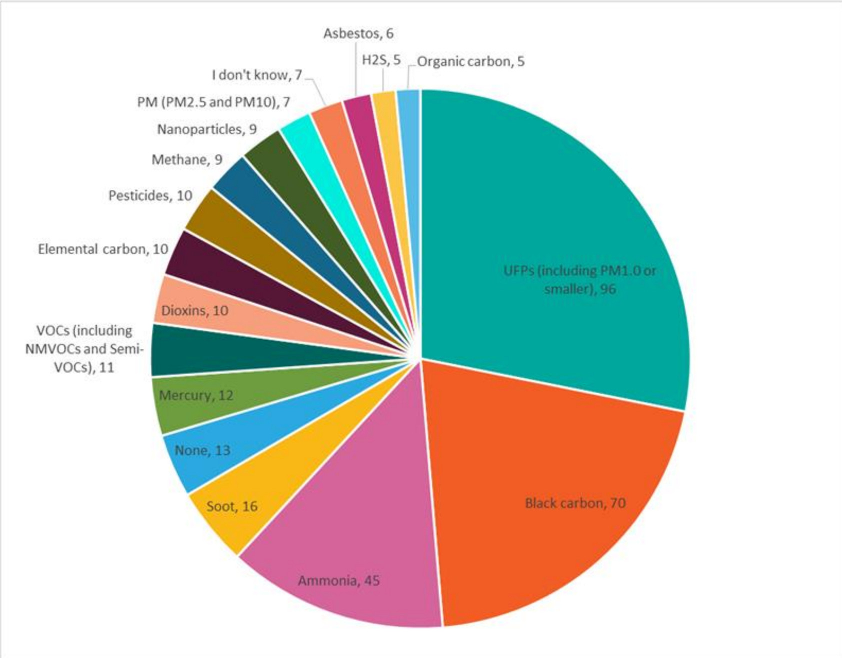
Respondents felt strongly that all pollutants should be addressed by the AAQDs, however a greater number of participants agreed either completely or somewhat to the importance of addressing nitrogen dioxide (94%) and fine particulate matter ($PM_{2.5}$) (93%).

Figure 17: Question 6.3: To what extent do you agree that it is important that the Ambient Air Quality Directives address the following pollutants? (N=472-483 – different numbers of respondents for each statement)



OPC respondents also proposed additional pollutants for inclusion in the AADQs, the most commonly cited being Ultra Fine Particles (UFPs) (96 responses), black carbon (70 responses) and ammonia (45).

Figure 18: Question 6.4: Which pollutants not currently addressed by the AAQDs would you suggest be included within their scope? (Pollutants mentioned in 5 or more responses) (n=237)



With regard to the stringency of the limit values for pollutants under the AAQ Directives, respondents mostly felt that standards were set at about the right level for pollutants concerning carbon monoxide (CO), lead (Pb), arsenic (As), cadmium (Cd) and Nickel (Ni). On the other hand, limits were considered far too lenient or somewhat too lenient for particulate matter (PM10), fine particulate matter (PM2.5), nitrogen dioxide (NO2) and polycyclic aromatic hydrocarbons, including Benzo(a)pyrene (BaP) (see Figure 19).

Finally, there was some support for the view that the AAQDs could be more adaptable to new circumstances, although the most common response was that the AAQDs were 'somewhat adaptable' to scientific knowledge (29%) and technical capacities (33.5%).

Figure 19: Question 6.7: To what extent have the Ambient Air Quality Directives been flexible to adapt to new circumstances as regards? (N=477-478 – different numbers of respondents for each statement)

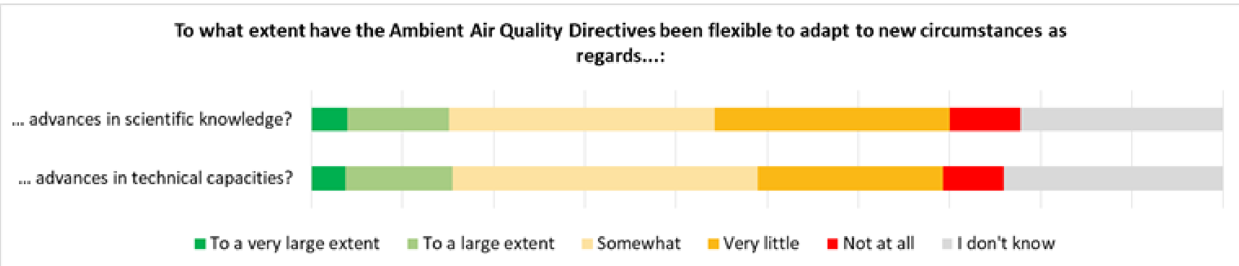
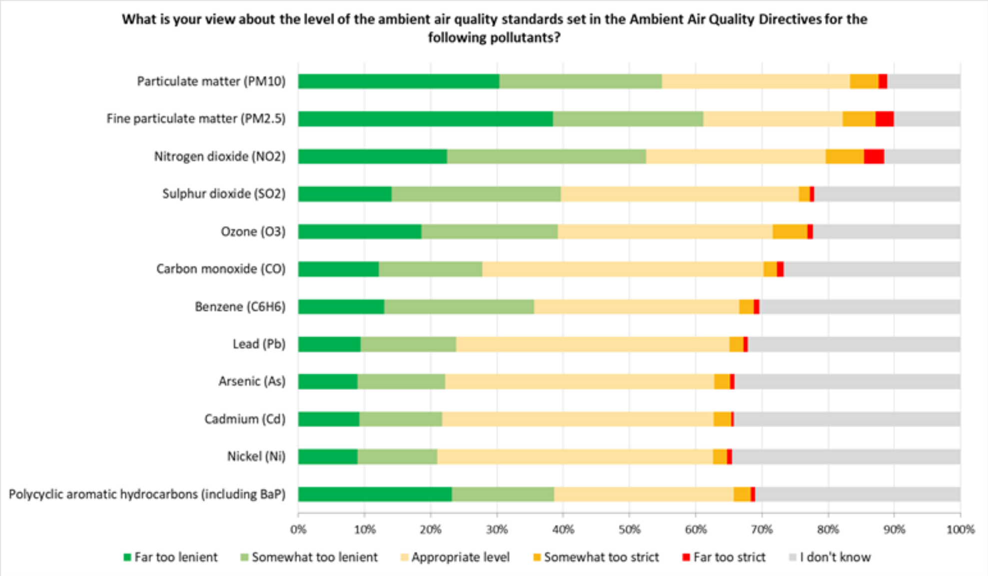


Figure 20: Question 6.6: What is your view about the level of the ambient air quality standards set in the Ambient Air Quality Directives for the following pollutants? (N=456-468 – different numbers of respondents for each statement)



Similar views were echoed in the workshop discussions. Participants noted that despite air pollution being the fifth most important risk factor for non-communicable diseases, current standards do not fully reflect scientific evidence suggesting health impacts at concentration levels below the current limit values. Particular concern was expressed regarding $PM_{2.5}$, where stakeholders noted the need for short-term limit values. Others pointed to the limitations of EU legislation in reacting swiftly to evolving knowledge about pollutants and their effects. In this regard, the need for specific measures on microparticles was mentioned and greater alignment of standards with WHO Guidelines was sought, especially in the case of SO_2, where EU limit values are significantly higher than WHO recommendations.

Other comments focused on the need for the air quality legal framework to be adaptable to new approaches to measure air quality, such as citizen science methods, which can help raise awareness but is not suitable for assessing compliance with air quality standards as the of precision of data is lacking.

In responses to relevance questions of the targeted questionnaire, most responses indicated that the AAQD were still relevant and address important citizens' needs.

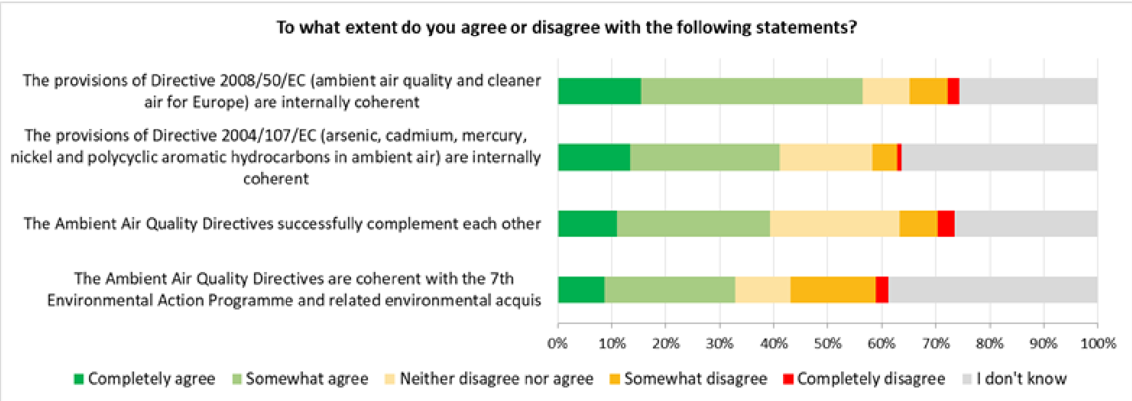
The need to consider regulation of black carbon (BC) was mentioned by 42% (18 of 43) and UFP, nanoparticles or $PM_{1.0}$ by 42% (18 of 43). Other pollutants mentioned more than once included long-term or background ozone (SOMO35), NH_3, pesticides, other PAH than B(a)P. Only Member State national organisations (5 of 16) mentioned pollutants that were less relevant, in particular SO_2 and CO. PM_{10} was not relevant to one Member State national organisation due to climate, and PM_{10} and $PM_{2.5}$ were not relevant to one other Member State national organisation since levels were already below the lower assessment threshold.

Except for industry, most respondents observed that one or more limit values were less strict than WHO guidelines and should approach the WHO guidelines (53%, 23 of 43), in particular for PM_{10} and $PM_{2.5}$, but also SO_2, O_3, and B(a)P. Several mentioned the need for 24-hour limit value for PM2.5, and information and alert thresholds for PM_{10} and $PM_{2.5}$. Most responses from Industry and industry associations (4 of 5) indicated that the current limit values were either sufficient or too stringent. Single responses from industry associations indicated that the WHO guidelines do not take societal and practical implementation factors into account, or that focus should be on achieving the existing standards.

4.4 Coherence

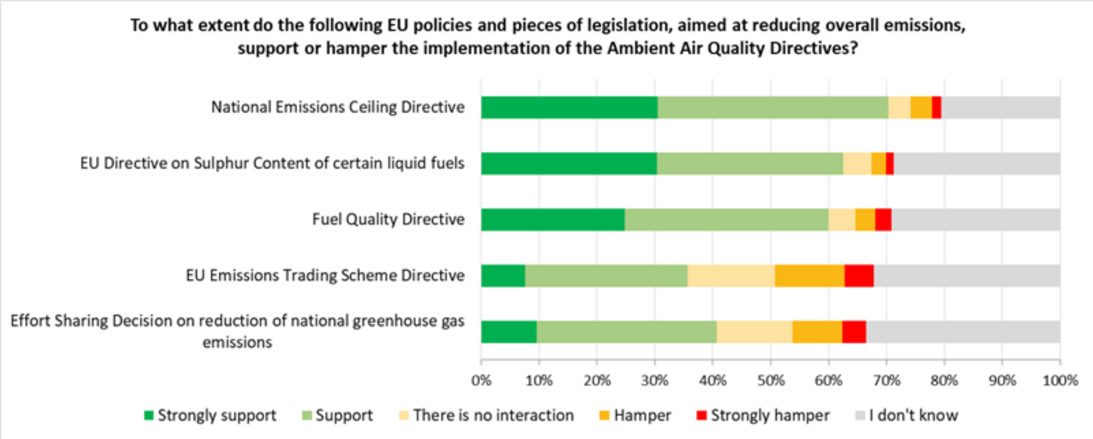
Regarding the coherence of the AAQDs, a higher number of respondents to the OPC (57%) indicated the Directive 2008/50/EC to be internally coherent than was the case for the Directive 2004/107/EC (41%). Only 33% agreed completely or somewhat with the statement that the AAQ Directives are coherent with the 7th Environmental Action Programme and related environmental acquis. Workshop participants also highlighted several areas where there is a lack of internal coherence between the two AAQ Directives. One concerns the provisions on the minimum number of monitoring stations (e.g. under Annex V of Directive 2008/50/EC), making it difficult to understand whether each zone or agglomeration has the right mix of sites. A second issue concerns an absence of reference methods for modelling in Annex VI of Directive 2008/50/EC. Finally, Annex XV of Directive 2008/50/EC on air quality plans is outdated, as information on the effects of measures is only required for those measures adopted prior to June 2008.

Figure 21: Question 9.1: To what extent do you agree or disagree with the following statements? (N=438-442 – different numbers of respondents for each statement)



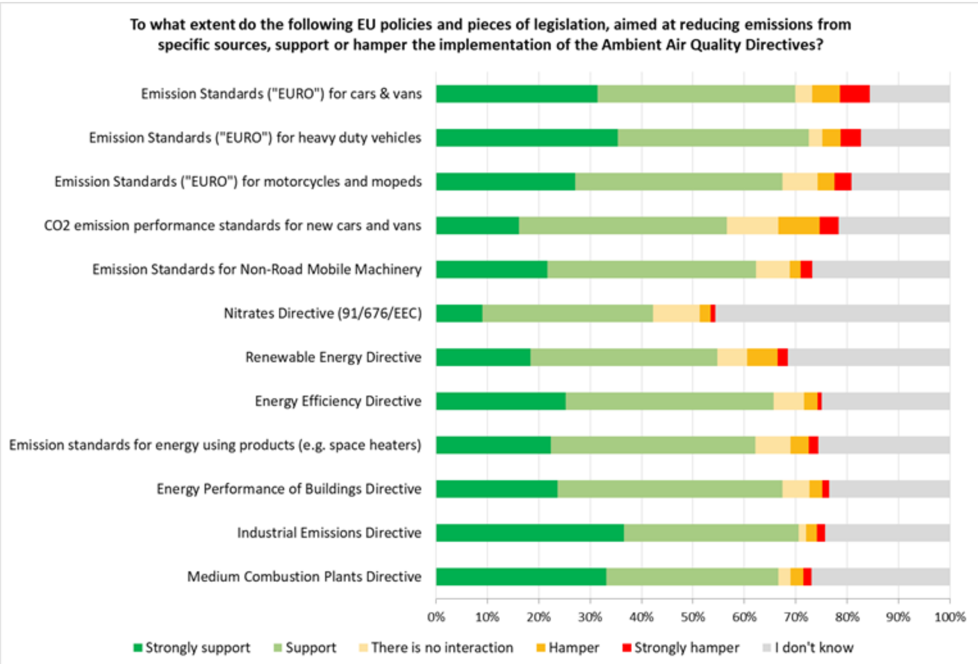
On EU policies and legislation, respondents considered the National Emissions Ceiling Directive (Directive 2016/2284/EU) to be strongly coherent with the AAQ Directives, with 70% indicating that it either strongly supports or supports the implementation of AAQDs. This was closely followed by the Sulphur Directive 2016/802/EU (62%) and the Fuel Quality Directive 98/70/EC (60%). OPC respondents were less likely to indicate that policies targeting greenhouse gases as being supportive to the AAQDs, and the EU Emissions Trading Scheme, in particular, attracted a significant number of respondents (17%) who felt the scheme hampered the AAQDs' implementation.

Figure 22: Question 9.2: To what extent do the following EU policies and pieces of legislation, aimed at reducing overall emissions, support or hamper the implementation of the Ambient Air Quality Directives? (N=430-437 – different numbers of respondents for each statement)



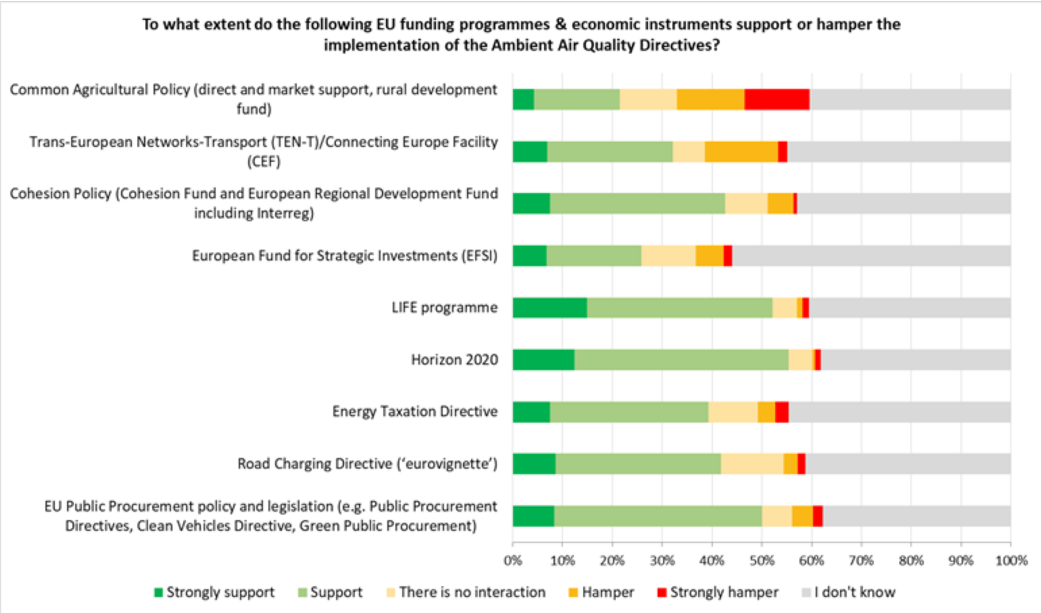
In regard to policies/legislations aimed at reducing emissions from specific sources, the highest proportion of respondents (73%) indicated the emission standards for heavy goods vehicles either strongly support or support the implementation of AAQDs compared to other policies. This was closely followed by emission standards for cars and vans (70%), and the Industrial Emissions Directive 2010/75/EU (71%).

Figure 23: Question 9.3: To what extent do the following EU policies and pieces of legislation, aimed at reducing emissions from specific sources, support or hamper the implementation of the Ambient Air Quality Directives? (N=428-429 – different numbers of respondents for each statement)



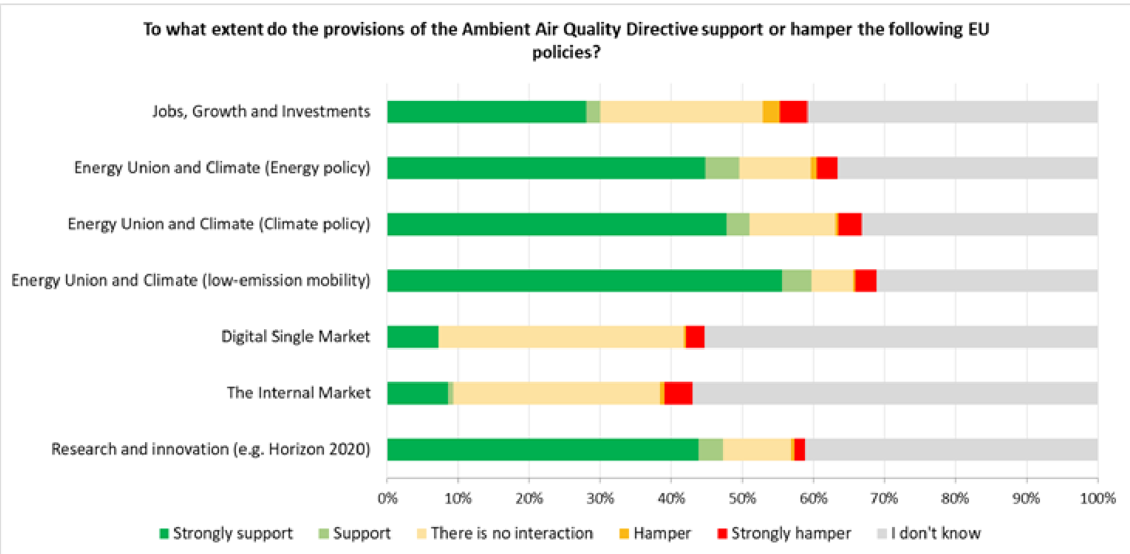
A large portion of OPC respondents answered 'I don't know' to the question on the coherence of AAQDs with funding programmes and economic instruments. Of those who offered a different response, the proportion indicating that they felt the programmes and instruments supported the implementation of the AAQ Directives was highest for Horizon 2020 (55%), the LIFE programme (51%), and EU Public Procurement Policy (50%). The Common Agricultural Policy, on the other hand, was deemed to hamper implementation of the AAQDs (see Figure 24). This issue was also raised in the workshops with a representative of a national NGO noting EU funding schemes such as biomass and the Common Agricultural Policy supporting various measures that in-crease air pollution. These have in turn made it difficult to obtain EU funding mechanisms that support actions for air quality at national level – including under the CAP's rural development funding.

Figure 24: Question 9.4: To what extent do the following funding programmes and economic instruments support or hamper the implementation of the Ambient Air Quality Directives? (N=410-417 – different numbers of respondents for each statement)



On coherence with other EU policies, OPC respondents believed the AAQDs support the EU Energy Union and Climate (low-emission mobility), the Energy Union and Climate (climate policy), the Energy Union and Climate (Energy policy) and Research and Innovation (Horizon 2020).

Figure 25: Question 9.5: To what extent do the provisions of the Ambient Air Quality Directive support or hamper the following EU policies? (N=230-279 – different numbers of respondents for each statement)



Regarding the contribution of AAQDs to global/international initiatives, respondents were most positive regarding contributions made to the UNECE Convention on Long Range Transboundary Air Pollution, the UN Framework Convention on Climate Change and related agreements, the UN Montreal Protocol on substances that deplete the ozone layer, and the Sustainable Development Goals. A representative from a national NGO in the workshops also raised the issue of whether AAQ Directives' goals should be brought in line with the Paris Agreement goal of limiting global climate change to well below 2 degrees Celsius, which would require significant cuts to GHG emissions and imply concurrent cuts to emissions of ambient air pollutants.

In terms of the coherence with planning efforts at the local level, OPC respondents felt that the objectives of the AAQDs were not well integrated within different urban planning efforts in their city/region. They also felt that the implementation of AAQDs were not coherent with a number of national policies, notably, taxation policy, public procurement policy, urban development policy and industrial policy. The extent of alignment was considered better, though still not good, with mobility / transport policy and energy policy. Similar views were mirrored in the workshops with participants pointing to gaps in the coherence of the AAQ Directives and EU transport policy, which focuses on emission limits for new vehicles, but does relatively little the existing vehicle fleet. On this issue, an official of a regional government noted the EU should consider adopting requirements applying to existing cars. According to stakeholder comments at the workshops, t Member States have struggled to meet air quality standards due to weaknesses in the EU legal framework for vehicle emissions.

Finally, OPC respondents were much more positive about mechanisms to promote coordinated action between the EU and MS than between levels of government, or ministries, within their country. The most common responses in explaining the perceived inadequacy of mechanisms to promote coordination was simply 'lack of cooperation' (36 responses), followed by a lack of implementation of the Directives in their Member State (35 respondents) or a lack of action taken to implement them. In the workshop, a representative of a government health institute noted that permitting and spatial planning decisions in stakeholder's Member State consider whether new activities are aligned with air quality limit values, but this is not the case across the EU.

In responses to the targeted questionnaire, a relatively significant number of respondents commented on issues relating to the internal coherence of the Directives (e.g. consistent approaches in setting limit values, consistency in the requirements of siting of monitoring stations, coherence of alert thresholds). Respondents across all stakeholder groups expressed concerns about the coherence between air quality goals and transport, energy and climate policy. Comments on the coherence of the AAQ Directives with other sectoral policy areas were very much focused on transport, with 21 respondents commenting on this. Many of these responses focused on climate measures taken in the transport sector, usually at the national or local level, to reduce GHG emissions and were concerned with the potential for such measures to undermine air quality. Other comments on transport raised concerns about the effectiveness of the Euro vehicle emissions standards in protecting air quality. Other comments on sectoral policy focused on the treatment of biomass under the Renewable Energy Directive (Directive 2018/2001/EU), emissions standards for boilers under the Ecodesign Directive (Directive 2009/125/EC), and emissions from agricultural activities.

In terms of differences between stakeholder groups, NGO and national authority respondents to the targeted questionnaire were more likely to cite concerns about the coherence between air quality, climate policy and transport policy (particularly support for diesel vehicles in Member State responses to climate change and the impact of the Euro standards for vehicles on air quality). Concerns about emissions from biomass-generated heat and energy tended to be raised by government authorities: of the nine responses on this topic, seven were from national or local government authorities. Of the small number of industry respondents, most (4 out of 5) emphasised the need to ensure coherence between the AAQ Directives and other legislation relevant to air quality, notably the NEC Directive (Directive 2016/2284/EU) and the Industrial Emissions Directives (Directive 2010/75/EU) – two commented that air quality standards should be informed by what is feasible within the framework of the Industrial Emissions Directive. While NGOs and government authorities often raised concerns about specific issues in transport and energy policy, industry stakeholders also made broad comments on the need to address emissions from other sectors, such as transport (2 responses), energy (2) and agriculture (2).

4.5 EU added value

OPC respondents were generally positive about the added value of the AAQDs. Just over 50% felt that the influence of the AAQDs had been strongest in increasing public awareness of air quality. On the other hand, a significant share (37%) of respondents believed the implementation of AAQDs had very little or no effect on the positive coordination at different governance levels within the respondents' countries (see Figure 27).

A significant majority of respondents also agreed that EU level legislation is necessary to improve air quality at national, regional and local level (94%), as well as to address transboundary air pollution across different Member States (91%). On the other hand, the majority (54%) disagreed that national legislation could have achieved the same results as the Air Quality Directives in reducing air pollution. However, stakeholders from the workshops considered a lack of coordination between different levels of governance, the distribution of responsibilities between national, regional and local authorities and a lack of guidance on air quality modelling as factors that hampered the ability of the Directives to deliver EU added-value.

Overall, the respondents to the targeted questionnaire commented on a number of aspects of EU added value of the AAQ Directives, including amongst others the added value brought by the introduction of common air quality standards, the requirements for monitoring and assessment, the requirements for setting up air quality plans. Most commonly mentioned the added value of the AAQ Directives was in terms of common air quality standards (16 respondents covering national authorities, local and regional authorities, NGOs, scientific or research organisations, industry), monitoring and assessment (8 respondents covering national authorities, local and regional authorities, NGOs), air quality plans (7 respondents covering national authorities, NGOs), information and awareness raising (6 respondents covering national authorities, NGOs).

Generally, there was agreement in terms of the added value that the AAQ Directives brought at added value amongst stakeholders that commented on this issue (national authorities, local and regional authorities, NGOs, scientific or research organisations, industry). Differences in views were most notable when it comes to the added value of air quality standards and (legal) action taken by the EC. More specifically, while national authorities, local and regional authorities, NGOs and scientific organisations broadly commended the added value of the Directives in setting air quality standards and incentivising (legal) action which led to improvements in pollution levels, one industry representative raised concerns about EU infringement procedures and the fact that these were causing "politically motivated (unrealistic and not science-based) measures."

Another notable aspect raised by one respondent (local authority) was related to the clarity of allocations of responsibilities between and across different levels of governance at national level. The respondent highlighted that the AAD Directives should be revised to improve governance elements, in particular to allocate more flexibility to the Member States to allocate responsibilities for the assessment and to establish zones and agglomerations.

Figure 26: Question 10.2: To what extent do you agree or disagree with the following statements? (N=451-455 – different numbers of respondents for each statement)

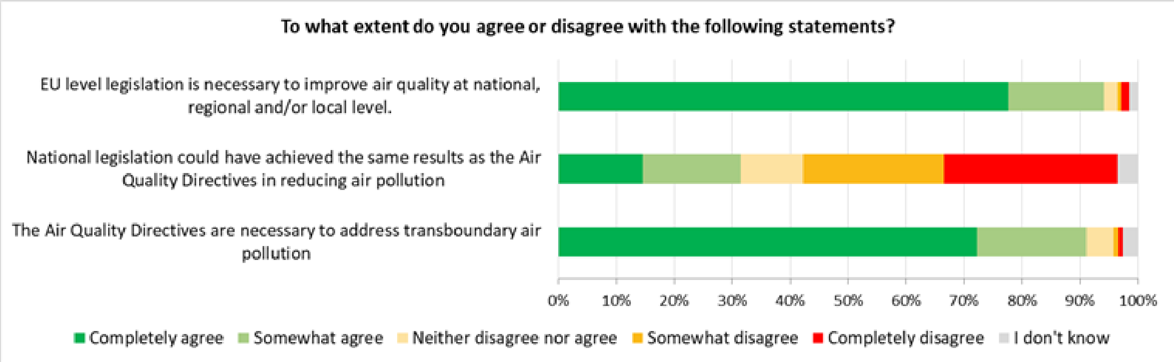
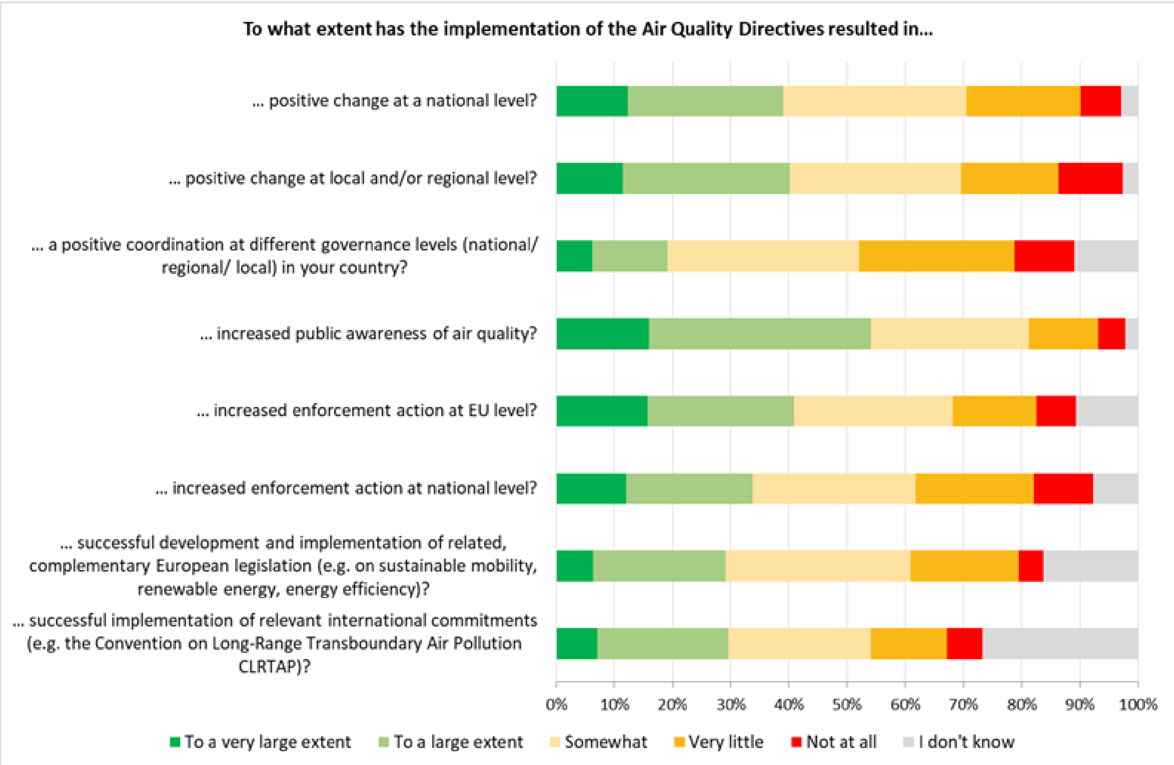
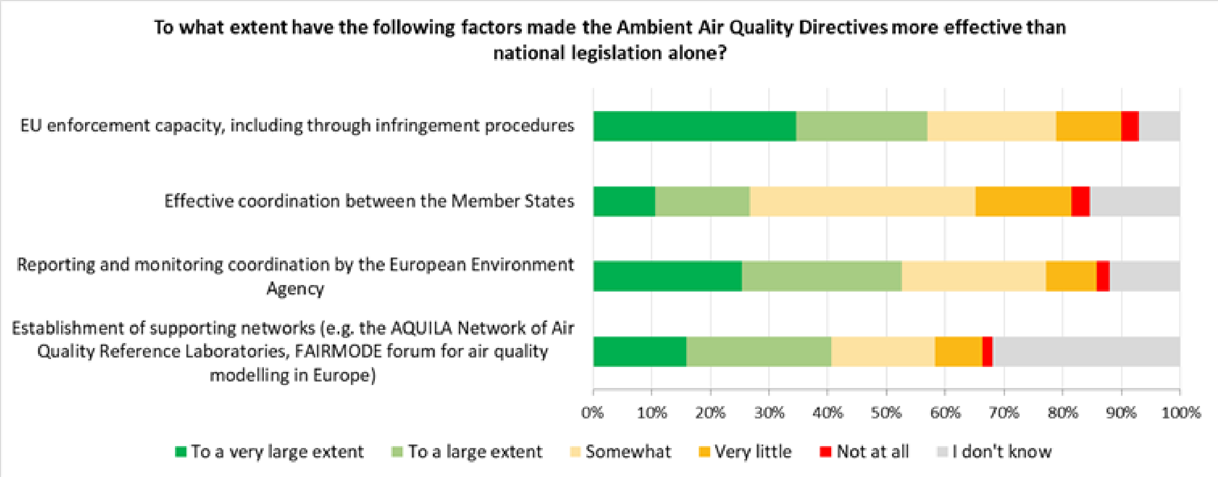


Figure 27: Question 10.1: To what extent has the implementation of the Air Quality Directives resulted in the following? (N=438-450 – different numbers of respondents for each statement)



Most respondents (56%) agreed that EU enforcement capacity (e.g. infringement procedures), reporting and monitoring coordination by the European Environment Agency (52%) and establishment of supporting networks (41%) were key factors in making AAQDs more effective than national legislation alone. However, the contribution of "Effective coordination between the Member States" was rated positively by a lower number of respondents (excluding ‘I don’t know’ responses, 45% respondents answered ‘Somewhat’ for this factor).

Figure 28: Question 10.3: To what extent have the following factors made the Ambient Air Quality Directives more effective than national legislation alone? (N=434-446 – different numbers of respondents for each statement)



OPC respondents were mixed in their views on the AAQDs being fit for purpose on protecting citizen's health and the environment from the harmful effects of air pollution. Some 25% answered 'yes' in addition to 22% who answered 'no', while a notable proportion (35%) didn't answer and 17% were neutral. The reasons provided in support of Directives being fit for purpose ranged from contributions in terms of increased awareness of air pollution, positive impacts on transboundary air pollution, contributions to improvements in health and better protection of the environment. Other respondents believed air quality would be worse in Europe without the Directives and that the Directives had set clear and binding objectives and defined Member State responsibilities.

Comments from the workshops focused on areas where the Directives were considered to be more effective than national legislation alone. For example, a representative from an NGO emphasised the importance of Article 23 of Directive 2008/50/EC, which introduced the obligation to adopt air quality plans to keep exceedances of air quality standards as short as possible, and as a result provided EU added value driving local and national action for air quality. However, the same NGO noted that Annex XV of the same Directive is not sufficiently clear in relation to public participation and that AAQ Directives do not provide explicit access to justice for challenging authorities in court when air quality standards are breached.

A significant share of OPC respondents (93 respondents) described the Directives as not being fit for purpose on the basis of not being strict enough. Of those, a notable share (45 respondents) mentioned the WHO guidelines and the fact that the limits set in the Directives are lower than those recommended by the WHO. This comment was also raised by NGO representatives in the Workshops who called for better alignment of limit values with WHO guidelines. Other comments from OPC respondents focused on a lack of enforcement or penalties and Member State compliance, leniency towards industry (in particular to the automobile industry) and a lack of ambitiousness in scope.

5 INCLUSION OF THE CONSULTATION RESULTS IN THE STUDY TO SUPPORT THE FITNESS CHECK

Contributions made by stakeholders during the consultation activities have been an important input into the study supporting the Fitness Check. All stakeholder contributions have been analysed by the study team and taken into account in evaluation of each criterion in the supporting study to the extent possible.

In general, the stakeholder comments broadly support the conclusion that the AAQ Directives continue to be relevant, are effective, efficient, coherent and bring EU-added value; nonetheless, there are issues that require attention. These themes were taken into account in the support study and are broadly in line with the study's conclusions that the AAQ Directives are fit for purpose.

6 ANNEX 1

Table 1 Respondents to targeted questionnaire

Organisation name	Member State	Organisation type
WKO Austrian Federal Economic Chamber	Austria	Industry
IRCEL-CELINE Belgian Interregional Environment Agency	Belgium	National authority
Executive Environment Agency	Bulgaria	National authority
Ministry of Environment and Energy	Croatia	National authority
Ministry of the Environment	Czech Republic	National authority
Industrial Minerals Association Europe	EU	Industry
EPHA European Public Health Alliance	EU	NGO
CEMBUREAU - European Cement Association	EU	Industry
EUROFER	EU	Industry
ISEE International Society for Environmental Epidemiology - European Chapter	EU	Scientific or research organisation
EFANET European Federation of Allergy and Airways Disease Patients' Associations	EU	NGO
CONCAWE	EU	Industry

ClientEarth, EEB, AirClim, HEAL and T&E (joint response)	EU	NGO
European Respiratory Society	EU	Scientific or research organisation
HSY Helsinki Region Environmental Services and City of Helsinki (joint response)	Finland	Local or regional authority
ATMO France	France	NGO
Airparif	France	NGO
Atmo Grand Est	France	NGO
City of Munich	Germany	Local or regional authority
Local authority employee responding in individual capacity	Germany	Citizen or individual expert
Clean Air Action Group	Hungary	NGO
Environmental Protection Agency	Ireland	National authority
Environmental Sustainability Lab University of Brescia	Italy	Scientific or research organisation
Riga City Council	Latvia	Local or regional authority
Ministry of Environment Protection	Latvia	National authority
Administration de l’environnement	Luxembourg	National authority

Environment and Resources Authority	Malta	National authority
VNG Association of Netherlands Municipalities	Netherlands	Local or regional authority association
Ministry of Infrastructure and Water Management	Netherlands	National authority
RIVM	Netherlands	Scientific or research organisation
Environment Agency	Norway	National authority
Norwegian Institute for Air Research	Norway	Scientific or research organisation
Polish environmental authorities (joint response)	Poland	National authority
Romanian environmental authorities (joint response)	Romania	National authority
Ministry of Environment	Slovakia	National authority
Ecologistas en Accion	Spain	NGO
Ministry for the Ecological Transition	Spain	National authority
Environmental Protection Agency	Sweden	National authority
IVL Swedish Environmental Research Institute	Sweden	Scientific or research organisation
British Heart Foundation	United Kingdom	NGO

Department for Environment, Food and Rural Affairs	United Kingdom	National authority
Greater London Authority	United Kingdom	Local or regional authority
Clean Air London	United Kingdom	NGO

Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

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Appendix C: References

APPENDIX C REFERENCES

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Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

Final Report

Appendix D: Detailed Evidence for Relevance

APPENDIX D DETAILED EVIDENCE FOR RELEVANCE

This appendix provides detailed information supporting the assessment of relevance under the study supporting the Fitness Check of the EU Ambient Air Quality Directives. This accompanies the assessment provided in the final study report.

The evaluation of relevance included one question and five judgement criteria. An overview of the question, judgement criteria and main data sources is presented below.

Evaluation Question (EQ)	Judgement Criteria (JC)	Sources
EQ 1: How relevant are the goals and objectives of the AAQ Directives to the needs of citizens; do the AAQ Directives still address the most relevant pollutants and set relevant standards and obligations to protect human health and the environment; and are the AAQ Directives sufficiently adapted or adaptable to evolving technical and scientific progress; and which elements in the Directives are essential to deliver on these priorities, have elements become redundant?	JC 1.1: The extent to which goals and objectives of the AAQ Directives correspond to the citizens' needs. JC 1.2: The extent to which pollutants covered by the Directives remain relevant in the light of new scientific evidence regarding health and environmental impacts of air pollution and whether there is evidence of other pollutants, currently not addressed by the Directives, having significant adverse effects on health and/or environment. JC 1.3: The extent to which standards and obligations for the pollutants currently covered are suitable to protecting the citizens from harmful effects of air pollution. JC 1.4: The extent to which standards, assessment methods and obligations have kept up with advances in technical and scientific progress. JC 1.5: The extent to which elements of the Directives have become redundant in light of key EU air quality priorities.	Literature review Stakeholder consultation (open public consultation, targeted questionnaire, workshops) Case studies

D.1 Evaluation question 1: Relevance of objectives and obligations of AAQ and adaptability to technical and scientific progress

Evaluation Question 1 assessed *"How relevant are the goals and objectives of the AAQ Directives to the needs of citizens; do the AAQ Directives still address the most relevant pollutants and set relevant standards and obligations to protect human health and the environment; and are the AAQ Directives sufficiently adapted or adaptable to evolving technical and scientific progress; and which elements in the Directives are essential to deliver on these priorities, have elements become redundant?"*

This section provides further detail on the approach and evidence linked to the following judgement criteria:

- *JC 1.1: The extent to which goals and objectives of the AAQ Directives correspond to the citizens' needs.*
- *JC 1.2: The extent to which pollutants covered by the Directives remain relevant in the light of new scientific evidence regarding health and environmental impacts of air pollution and whether there is evidence of other pollutants, currently not addressed by the Directives, having significant adverse effects on health and/or environment.*

- *JC 1.3: The extent to which standards and obligations for the pollutants currently covered are suitable to protecting the citizens from harmful effects of air pollution.*
- *JC 1.4: The extent to which standards, assessment methods and obligations have kept up with advances in technical and scientific progress.*
- *JC 1.5: The extent to which elements of the Directives have become redundant in light of key EU air quality priorities.*

D.1.1 JC 1.1: Relevance of goals and objectives for citizens

This section provides further detail on the approach and evidence linked to *JC 1.1: The extent to which goals and objectives of the AAQ Directives correspond to the citizens' needs.*

Approach

The objectives of the AAQ Directives are compared against the needs of citizens.

For the purpose of the assessment of the relevance, the objectives of the AAQ Directives are summarised as follows:

- Define common methods to monitor and assess air quality;
- Assess ambient air quality in order to monitor trends;
- Establish standards of air quality to achieve across the EU;
- Ensure that information on air quality is made available to the public;
- Maintain good air quality, improve it where it is not good.

As regards the third objective, while detailed air quality standards are provided in Annexes VII (ozone), Annex XI (limit values for pollutants other than ozone), XIII (critical levels) and XIV (exposure targets for $PM_{2.5}$) of Directive 2008/50/EC, recital 2 to the Directive specifies that in order to protect human health and the environment as a whole "*emissions of harmful air pollutants should be avoided, prevented or reduced and appropriate objectives set for ambient air quality taking into account relevant World Health Organisation standards, guidelines and programmes*."

The fifth objective includes situations where significant transboundary transport of air pollutants or their precursors requires cooperation and joint action among Member States. This includes cooperation on transboundary transport between neighbouring Member States, regional initiatives led by the Commission, and international commitments on long-range transboundary air pollution, such as the CLRTAP Gothenburg Protocol.

It is a basic need of EU citizens to be protected from adverse health impacts and damage to the environment from air pollution. This need is reflected in the Treaty on the Functioning of the European Union (TFEU) [P137] Article 191 item 1. that objectives of Union environmental policy include preserving, protecting and improving the quality of the environment, and protecting human health. This is further expressed in 2002 6th EAP [P93] Art. 7 1. objective of *achieving levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment*, which is continued in the 2013 7th EAP [P106].

The 7th EAP, as cited above, does not specify the levels of air pollution to be achieved to avoid significant negative impacts on and risks to human health and the environment, but – as far as protection of human health is concerned – sets the general objective to move closer to the World Health Organisation (WHO) recommended levels [P106].[1]

To assess whether the objectives of the AAQ still correspond to the citizens' needs, the study explores citizens' perception of air quality and the extent to what air quality continues to pose a concern to citizens' health and/or the environment. This assessment is supplemented by a review of the information on the current exposure to air pollution.

Limitations to the approach

Citizens' needs are not explicitly defined in the AAQ Directives, so it is necessary to assume a limited scope for citizens' needs based on policy documents.

Although an extensive body of literature has been published on the AAQ Directives and air quality management in the EU, few directly address the more abstract question of meeting citizens' needs. Data reliability is high for peer reviewed studies and reports subject to professional review and quality assurance. However, analysis made it clear that certain evaluation questions were treated more in-depth than others in the previously written literature. Another limitation was related to the fact that analyses related to the situation prior to the AAQ Directives in the Member States were limited, and thus there are data gaps in terms of setting the baseline and making an exhaustive mapping of the situation ex-ante.

The reliability of the legal analysis is high given that it relies primarily on EU legislation, including the AAQ Directives, case law, infringement cases as well as secondary literature (e.g. reports or academic literature) analysing these aspects.

A key limitation of the targeted questionnaire is the quality of the data received which varied across submissions. A few questionnaire submissions contained well substantiated argumentation and answers to all questions, whereas others only briefly noted the position of stakeholders with little or no elaboration of the rationales behind.

A key limitation of the open public consultation is that, while such consultations invite responses from a broad range of stakeholders, including private citizens, they cannot be taken to be representative of the general population. This is because respondents are self-selecting and the resulting sample may not be unbiased. Therefore, care has been taken to ensure that results from the open public consultation are not presented as representing the population at large.

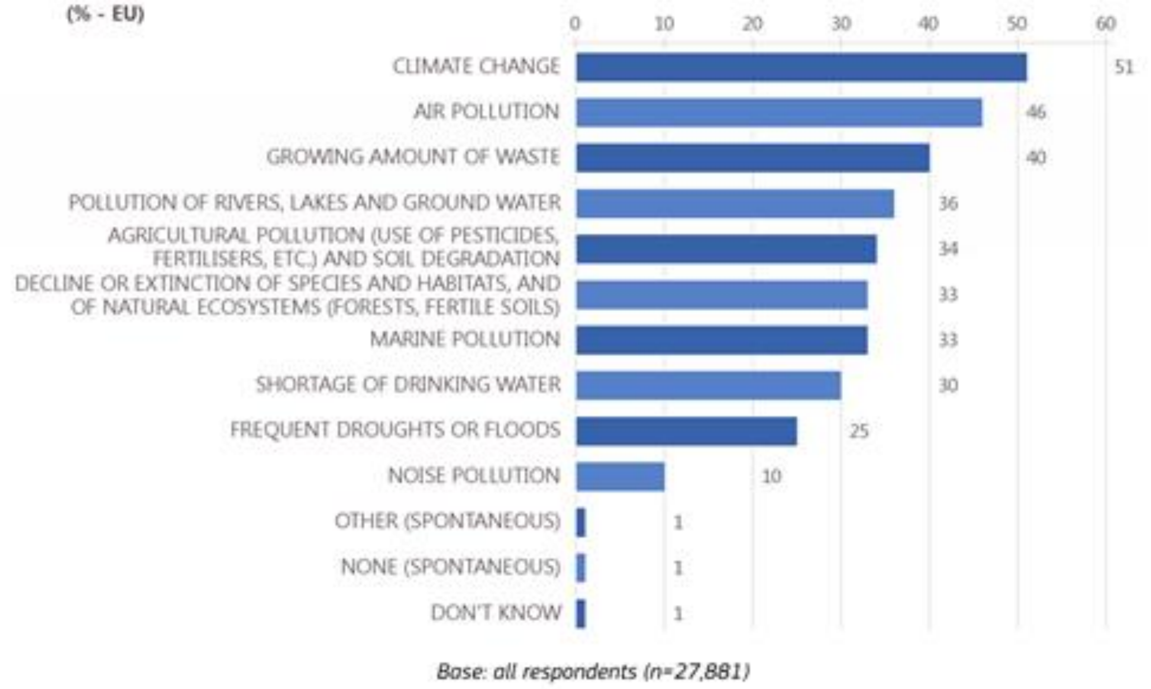
Results

(a) Citizens' perception of air quality

EU wide and national surveys indicate that air quality continues to be an issue of concern to the citizens in the EU. Air pollution has been identified as the second most important environmental issue in the 2017 Eurobarometer survey [D84] (see Figure 1). Air pollution was the most frequently chosen issue in eight countries.

[1] The WHO global air quality guidelines (hereafter WHO Air Quality Guidelines) are designed to offer guidance in reducing the health impacts of air pollution [P134]. As discussed under EQE1.3, the WHO guideline values are generally stricter compared to the standards that have been politically agreed at EU level.

Figure 1 From the following list, please pick the four environmental issues which you consider the most important (MAX. 4 ANSWERS) (% - EU)



Source: [D84].

Similarly, a recent survey of British Heart Foundation supporters found that 65% of the respondents were concerned about the impact of outdoor air pollution on their health. Just under a quarter of respondents felt that air pollution had affected their health in the last couple of years, with 40% of those affected stating they have had to change their way of life to avoid outdoor air pollution [Not published, referred to in Questionnaire, Answer no 5].

At city level, a recent study conducted under the EU-funded PASTA project[2] analysed the link between the level of concern over health effects of air pollution and personal and environmental factors. The study covered seven European cities of different size, geographical region and air-pollution levels. Overall, 58 % of participants were worried over health effects of air pollution, with large differences between the seven cities. Average levels of concern were found to have a good correlation with average NO_2 levels and a lower correlation with average $PM_{2.5}$ levels. The study also concluded that there may be benefits to considering subjective perceptions of air pollution in addition to objective air pollution measures, as subjective perception of air pollution can have important implications in terms of health-protective behaviours and citizen and stakeholder engagement in cleaner air policies and those findings can be used to inform future policy making [S31].

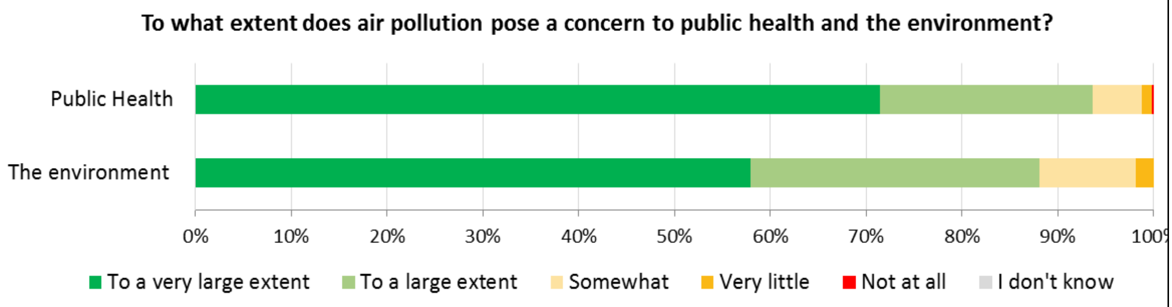
Air quality was also a major concern for stakeholders in the open public consultation (see Text box 1).

[2] Dons, E.; Laeremans, M. Anaya-Boig, E. et al.(2018). Concern over health effects of air pollution is associated to NO_2 in seven European cities, Physical Activity through Sustainable Transport Approaches (PASTA) project funded by the 7th Framework Programme of the European Commission. [S31]

Text box 1 Stakeholder concern regarding air pollution.

As shown in **Error! Reference source not found.**Figure 2, 94% of respondents to the open public consultation indicated that air pollutions poses a concern to public health either to a very large (72%) or to a large extent (22%). 88% of respondents indicated that air pollution poses a concern to the environment to a very large (58%) or to a large extent (30%).

Figure 2 Air pollution as a concern to public health and the environment

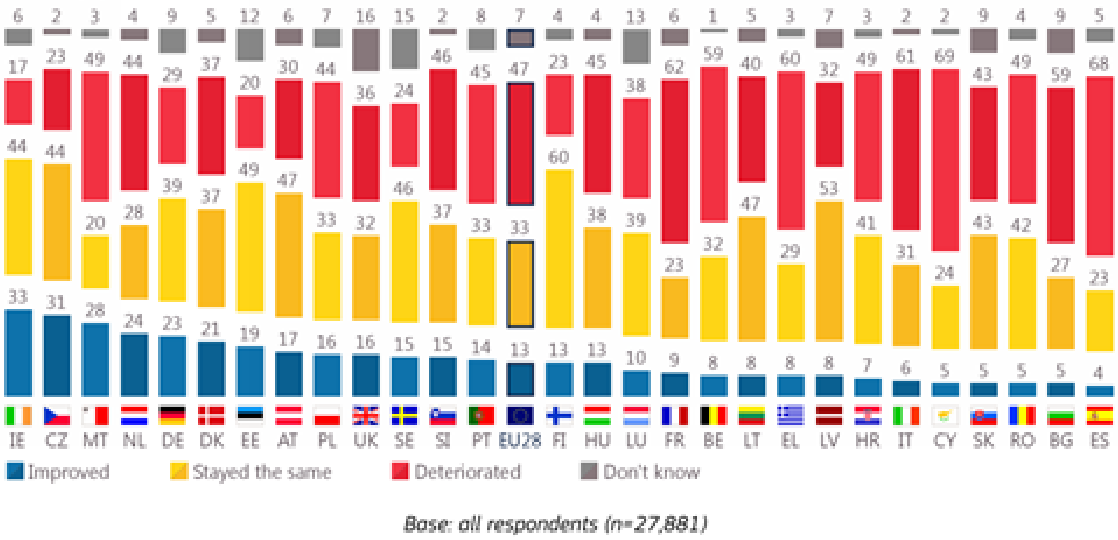


Source: open public consultation, Question 6.1: To what extent does air pollution pose a concern to public health? N=483.

Citizen perception of trend in air quality over the last 10 years

Citizens perception of trend in their surrounding air quality is included in both the 2013 and 2017 Eurobarometer surveys [D83, D84], allowing a four-year comparison of citizen perception. 56% of the respondents to the 2013 Eurobarometer indicated that air quality in their country has deteriorated in the last 10 years, 24% indicated it has stayed the same and 16% said it has improved [D83]. In comparison, in 2017, 47 % of respondents to the Eurobarometer indicated that air quality has deteriorated over the last 10 years, 33 % indicated it had remained the same, while only 13% indicated that the air quality has improved [D84] (see Figure 3). The percentage indicating that air quality has deteriorated has declined (56 % to 47 %), but so has the percentage indicating that air quality has improved (16 % to 13 %). The percentage indicating air quality has stayed the same has risen (24 % to 33 %).

Figure 3 *Do you think that, over the last 10 years, air quality in (your country) has improved, stayed the same, deteriorated, or don't know? (%); n=27,881*



Source: [D84].

There are few areas where air quality has actually deteriorated over the past 10 years. In Madrid, many stations show declines in NO_2 levels, but some stations have shown an increasing trend, and ozone levels do not show a clear trend [R139, p. 16]. Stakeholders in Spain also point to increasing trends at some locations in Valencia.

At most locations, air quality has substantially improved throughout most of the EU over the last 10 years [R53], so the citizen perception of deterioration is contrary to the overall trends in most places. There are locations where declining (or steady) levels have not reached the limit values. Continued exceedances and delayed compliance receive increasing coverage by the press and NGOs, and resulting court cases are often highly visible to the public. Severe air pollution episodes, such as the December 2016 and March 2014 PM and NO_2 episodes in Paris[3], initiating dramatic but ineffective emergency measures (traffic restrictions, ban of wood burning, industry production cuts, etc.) could also give an impression of deterioration. Despite the existence of extensive on-line air quality information systems (EEA and Member States) showing broad improvements in air quality, public concern focuses on hot spots and exceedances, where improvement is lacking.

Overall, the public perception may therefore be a result of better public and political awareness of the air quality challenges in general. It may however also indicate that it is difficult for the citizens to find comparable information within the publicly accessible air quality information and available air quality indices. As recently pointed to by the European Court of Auditors, though flagging some good practices in this regard, the quality and availability of public information on air quality in Member States is not always found to be clear or useful for the citizens regarding the health impacts and measures to take to mitigate risks. Also, the study found that Member States, regions and cities defined air quality indices differently, resulting in different assessment of the same air quality, somewhat compromising the credibility of the information provided [P91][4]

[3] Guiseppin (2017) [R105]

[4] European Court of Auditors, Air Pollution: Our health still insufficiently protected, Special Report 2018/No 23 [P91].

The EEA Air Quality Index[5] is a recent tool for providing better comparability across MS on air quality.

The findings of the open public consultation thus support the findings from the previous EU-wide and national surveys that air quality continues to be an issue of concern to public health and the environment. At the same time, there was a general consensus among the stakeholders, who have provided answers to the targeted questionnaire, on that the AAQ Directives still address the current needs of citizens across the entire EU.

There was some regional variation in the responses received. German respondents were less likely to indicate that air quality posed a concern to public health than those of the other countries where a significant number of responses were received – less than 60% of German respondents indicated it was a concern to a very large extent, whereas in Belgium, France and Spain, over 80% of respondents felt very concerned about the impact on public health. A similar trend was seen in respect of respondents' views on pollution and the environment, although the variation was less marked in this case (here a lower proportion of respondents felt the pollution posed concerns to the environment to a very large extent).

The findings of the case studies confirm that from the citizens' perspective all of the AAQ Directives objectives are relevant. This corresponds well to the current situation in the EU-28 where all MS have exceedances at least in one zone, and 11 out of 12 pollutants had exceedances (all pollutants except for Pb), indicating continued relevance of the pollutants in place. The case studies nonetheless also indicate that a number of the more detailed provisions of the Directives that serve to fulfil these overarching objectives may not fully respond to citizens' needs. These provisions concern in particular the current air quality standards (see EQ1.3), the substances being monitored (see EQ1.2) and the requirements for the location of the monitoring sites (see EQ2: effectiveness, in the main report and Appendix E).

The following table sums up the findings across the case studies, focusing on the relevance of 1) objectives of the AAQ Directives, 2) AAQ Directives pollutants and 3) AAED standards/target values.

Table 1 Findings from the case studies

Relevance of/Case study	AAQ Directives objectives	AAQ Directives pollutants	AAQ Directives standards	Comments
Bulgaria	+++	++	++	Relevance of target values are questioned by national and regional authorities as not sufficiently reflecting local climate, economic or social conditions
Germany	+++	++	++	As to other pollutants, stakeholders point to that adding BC and UFP would be useful. In terms of standards, stakeholders point to that more attention needs to be put on the impact of $PM_{2.5}$

[5] http://airindex.eea.europa.eu/.

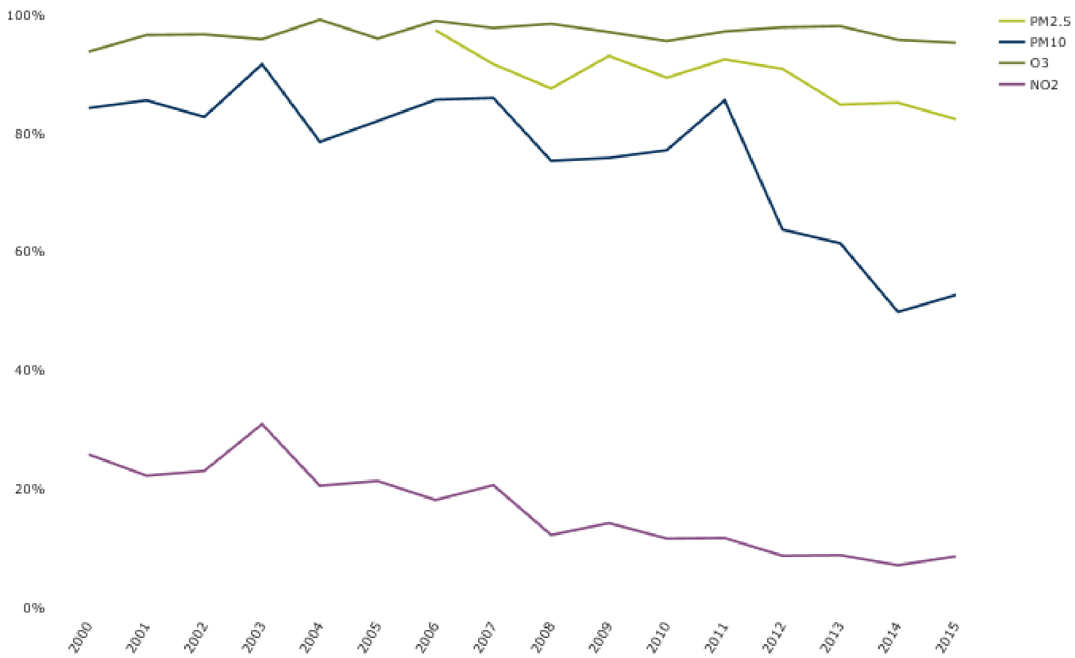
Ireland	+++	++	++	National authorities state that the limit values for NO_2, ozone and PAH are still highly relevant, whereas $PM_{2.5}$ and PM_{10} are less relevant as national authorities now refer to the WHO Air Quality Guidelines values due to their stringency. SO_2 and CO are not so relevant in a national context.
Italy	+++	++	++	Different stakeholder views as to whether the current limit values are appropriate or should be more stringent. The AAQ Directives does not fully address the concerns of citizens near industrial areas (Sicily)
Slovak Republic	+++	++	++	Different stakeholder views as to whether existing AAQ standards are appropriate or should be more stringent. Relevance of AAQ Directives standards are in particular questioned by NGOs as not reflecting the needs of the citizens.
Spain	+++	++	++	Agreement among key stakeholders that the scientific evidence behind the WHO recommendations to ensure human health requires the limit levels of the AAQ Directives to be increased to similar ambitious levels.
Sweden	+++	++	++	National authorities consider AAQ standards and limits relevant, but not sufficiently strict. Point to a need for a binding $PM_{2.5}$ daily limit value.

+) = less relevant; ++) = somewhat relevant; +++) = highly relevant

(b) Air pollution in the EU

The WHO has identified air pollution as the single largest environmental health risk in Europe, linked to a substantial disease burden [R190, also cited in R53 and S1]. The information on the concentrations of different pollutants in the ambient air suggests that while emissions of many pollutants have decreased substantially in Europe over the past decades [R53], resulting in improved air quality across Europe [D3], a substantial proportion of the Union's population remains exposed to levels of air pollution, including indoor air pollution, exceeding WHO Air Quality Guidelines [R49]. Figure 4 below shows the share of urban population exposed to air pollutant concentrations above the WHO Air Quality Guidelines.

Figure 4 Urban population exposed to air pollutant concentrations above WHO air quality guidelines



Source: [R58].

Thus, while European status shows that emissions are being reduced, the reviewed literature indicates that additional measures still need to be applied in order to achieve the long-term target of moving closer to the WHO recommended levels [see also S25]. The 7th EAP highlights that action is especially needed in areas, such as in cities, where people, particularly sensitive or vulnerable groups of society, and ecosystems, are exposed to high levels of pollutants [R106].

(c) Common methods to monitor and assess air quality

Stakeholders concur that the AAQ Directives are essential to ensure common methods to monitor and assess air quality across the EU. Without the AAQ Directives, each Member State would be free to adopt different methods, which would make it difficult to compare the air quality status between Member States. Comparability of air quality monitoring has been key to ensure better public information, and to enable enforcement of the air quality standards. The recent Air Quality in Europe 2018 report [R61] from the EEA included for the first time updated data *inter alia* on exposure of population in urban and suburban areas to exceedances of the EU air quality standards and WHO Air Quality Guidelines, and provided extended country scope in the analysis of concentrations including information on the status of reporting on $PM_{2.5.,}$ which facilitates actual comparison across countries.[6]

An important aspect of the AAQ Directives is the provision of guidance on monitoring, assessment and reporting provided by the Commission, EEA and their supporting institutions. An overview of guidance documents is provided in the main report section 5.2 Monitoring and assessment.

(d) Air quality modelling

Data collected from case studies and the stakeholder consultations have pointed to certain aspects of the AAQ Directives where Member States have a wide margin of discretion which hampers comparability. In particular the use of air quality modelling techniques is highly variable, and less

[6] Air Quality in Europe – 2018 report, EEA Report/No 12/2018 [R61]

than half of the Member States report the results of modelling in their assessments (table 6-5). There are also inconsistencies in the use of indicative measurements, and the selection of monitoring station types (traffic, background) to be installed to achieve the minimum number of sampling points in a zone or agglomeration.

(e) Air quality plans

The requirement to prepare air quality plans when limit or target values are exceeded is one of the most fundamental provisions of the AAQ Directives. As pointed out by the EQA [385, no. 37-47] the continuing, although decreasing, high levels of air pollution shows that air quality plans have not been sufficient to ensure compliance with limit and target values as soon as possible. Articles 13 and 23 set a clear obligation for competent authorities to take action to achieve compliance "as soon as possible". This obligation of result has been key for actions to improve air quality in the EU, including enforcement actions from individuals, NGOs and the Commission.

The EQA also notes that the AAQ Directives do not require Member States to report on the implementation of air quality plans, or to update them when new measures are adopted or when progress is insufficient – only to update plans at the end of the plan's period [385, no. 43, 48]. This makes it difficult for the public and the Commission to verify compliance with the air quality plan provisions of the AAQ Directives.

(f) Public information

Providing information on air quality to the public is essential to ensure protection of public health, raise awareness of the health and environmental effects, and inform the public of actions taken to improve air quality. The AAQ provisions on public information are good and clear, and Member States and the EEA have established extensive public information systems. As pointed out by the EQA [P91, no. 76-81] and stakeholders, the quality of public information services varies considerably, and information is sometimes unclear, and can be inconsistent across the EU. For example, EEA and Member States have established different air quality indices which vary considerably. Air quality levels which are poor in one Member State may be registered as good in another. The provision of health information during air quality alerts is also highly variable, or not provided. There is a need to further harmonise the provision of public information under the AAQ Directives, including provision of guidance and best practices. One respondent to the targeted questionnaire pointed out that the WHO Air Quality Guidelines facilitate communication to the public regarding changes needed to improve air quality [Questionnaire, Answer 33].

(g) Transboundary air pollution

Transboundary air pollution is addressed in the AAQ Directives, NECD and the CLRTAP Gothenburg Protocol, reflecting the relevance of this aspect of air quality. Article 25 of the AAQ Directives obligates Member States to cooperate when exceedances are due to transboundary transport of pollutants or their precursors, and to invite the Commission to be present and assist in the cooperation. Cooperation includes, where appropriate, drawing up joint or coordinated air quality plans, short-term action plans, exchange of information, and informing the public. The AAQ Directives do not require any specific monitoring or assessment in problematic boarder areas. De facto there has only been one instance where the Commission had been invited for intervention, which may question the relevance of this provision from the outset, despite a number of regions facing challenges on cross-border air pollution. The transboundary obligation cannot be considered effective or serving its purpose when it is never brought into use. Also, when Member States do not establish joint Air Quality Plans in those regions, the Commission has no possibility of facilitating or following the issue. Several Member States have called for more clear provisions in the AAQ Directives on this aspect [AAQEG meeting 5 July]. The current situation has been confirmed by the ECA [P91, no. 34].

To sum up, the findings from the desk research and stakeholder consultation indicate that air quality is a major health and environmental concern for EU citizens. Despite improvements over the last decade, a substantial share of the EU population continues to be exposed to air pollution at levels deemed unhealthy by scientific standards, especially in cities. There was a general consensus among the stakeholders, who have provided answers to the targeted questionnaire, that the AAQ Directives still address the current needs of citizens across the EU. Based on the evidence collected it can thus be concluded that from 2008 to 2018 the AAQ Directives have continued to address one of the key health and environmental hazards for EU citizens.

D.1.2 JC 1.2: Pollutants addressed by the AAQ Directives

This section provides further detail on the approach and evidence linked to *JC 1.2: The extent to which pollutants covered by the Directives remain relevant in the light of new scientific evidence regarding health and environmental impacts of air pollution and whether there is evidence of other pollutants, currently not addressed by the Directives, having significant adverse effects on health and/or environment.*

Approach

The analysis relied on extensive review of scientific literature on pollutants and their health impact as well as case studies results and interviews with relevant authorities.

Limitations to the approach

There is extensive peer reviewed scientific literature on pollutants and their health impacts. Data reliability is high for peer reviewed studies and reports subject to professional review and quality assurance. However, research on health impacts of pollutants and PM components that are not already included in the AAQ Directives is more limited, since measurement datasets are limited in time and spatial coverage. This increases the uncertainty associated with relating new pollutants to health outcomes.

The literature reviews carried out in the major reviews of the health impact of air pollutants are time-consuming, several year projects, and must have a time cut-off for the literature included. They may not reflect results obtained in newer research.

Limitations of the targeted questionnaire and open public consultation are discussed in the previous section and also apply here.

Results

(a) Pollutants addressed in the AAQ Directives

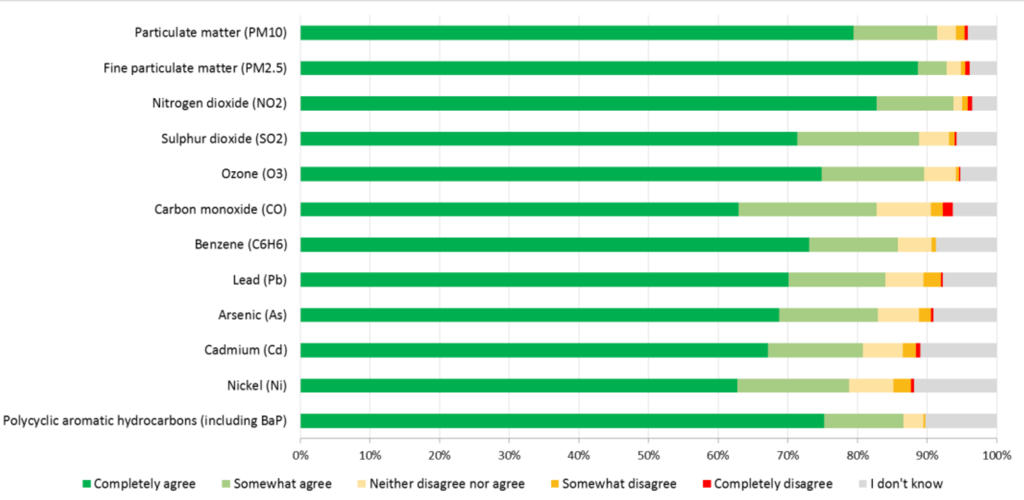
The air quality standards set in the Directives have been in place for almost two decades, and were last revised in 2005 in the context of the Thematic Strategy on Air Pollution [P14]. The WHO updated its air quality guidelines in 2005 for the four most common pollutants (PM, ozone, NO_2, SO_2) [P134]. The health relevance of the pollutants and standards of the original air policy was reviewed and confirmed in the 2011-2013 air quality review. As compared with 2005, there was additional evidence on the chronic impacts of ozone and NO_2. This reinforced the rationale for the respective standards [P38].

Europe's most serious pollutants concerning effects on human health are currently PM, NO_2 and ground-level O_3[R53]. At the time of the original AAQ Directives (1999), SO_2 and lead were also serious pollutants, but effective emission reductions have greatly reduced the concentrations and associated risks of these pollutants. The most harmful air pollutants in terms of damage to ecosystems are ozone (O_3), ammonia (NH_3) and nitrogen oxides (NOx) [R53]. NOx, SO_2 and NH_3 contribute to the acidification of soil, lakes and rivers, causing the loss of animal and plant life and biodiversity. Apart from causing acidification, NH_3 and NOx emissions also disrupt land and water ecosystems by introducing excessive amounts of nutrient nitrogen [R53].

Text box 2 Open public consultation results: Importance of the pollutants addressed

The findings from the open public consultation suggest that all the pollutants currently regulated by the AAQ Directives remain relevant. The greatest number of participants agreed either completely or somewhat to the importance of addressing nitrogen dioxide (94%) and fine particulate matter ($PM_{2.5}$) (93%).

Figure 5 Importance of the pollutants addressed



Source: Open public consultation, Question 6.3: To what extent do you agree that it is important that the Ambient Air Quality Directives address the following pollutants? N=480.

Similarly, stakeholders who have provided answers to the targeted questionnaire, suggest that the pollutants regulated under the AAQ Directives are all still relevant and monitoring and regulating the concentrations of the pollutants addressed is warranted. It was furthermore highlighted that the evidence about the health impacts of all the pollutants addressed by the AAQ Directives has further developed over the last 10 years and, as such, there is no reason for EU law to stop regulating any of the pollutants currently addressed. It was further highlighted as particularly essential that the Directives address the four most common air pollutants – particulate matter (PM), ozone (O_3), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) – i.e. the pollutants regulated under the WHO Air Quality Guidelines Global Update 2005 [Questionnaire, Answer no 20]. A single NGO suggested that SO_2 is no longer relevant due to the implementation of stricter coal combustion standards [Questionnaire, Answer 7]. A respondent notes that concentrations of Pb, Ni and CO seem to be steadily under the limit/target values in most Member States, so there is no need to monitor them as frequently as other pollutants, which would be a cost savings [Questionnaire, Answer 29].

In the sections below, the various pollutants are addressed individually.

Particulate matter

PM is a mixture with physical and chemical characteristics varying by location. Chemical constituents of PM include sulphates, nitrates, ammonium, other inorganic ions (e.g. ions of sodium, potassium, calcium, magnesium and chloride), organic and elemental carbon, crustal material, particle-bound water, metals (including cadmium, copper, nickel, vanadium and zinc) and polycyclic aromatic hydrocarbons (PAH). Moreover, biological components such as allergens and microbial compounds are found in PM [R185].

Health effects of PM are well documented and include respiratory and cardiovascular morbidity, such as aggravation of asthma, respiratory symptoms and an increase in hospital admissions and mortality from cardiovascular and respiratory diseases and from lung cancer [R185].

As for $PM_{2.5}$ the REVIHAAP project concluded that the scientific conclusions of the 2005 WHO Guidelines on the evidence for a causal link between $PM_{2.5}$ and adverse health outcomes in humans have been confirmed and strengthened and, thus, clearly remain valid [R184]. The UK medical effects committee COMEAP has reviewed more recent research and confirmed that there is good evidence that $PM_{2.5}$ plays a causal role in shortening life. They reconfirm the previous value of the $PM_{2.5}$ relative risk coefficient for mortality, with less statistical uncertainty than previously [R27].

Nitrogen dioxide

Regarding NO_2 and O_3 the estimated impacts on the population of exposure to NO_2 and O_3 concentrations in 2014 were around 75 000 and 13 600 premature deaths in the EU-28 per year, respectively [R53]. A number of studies published in the recent years have studied the association of exposure and adverse health effects and confirm the harmful effects of NO_2, for example in relation to non-accidental and cause-specific mortality. COMEAP recently reviewed epidemiological evidence on the health effects of long-term exposure to NO_2, finding increased evidence of a causal effect for NO_2, although there is an overlap between the health associations for NO_2 and $PM_{2.5}$ [R28]. COMEAP also found that the available evidence does not suggest a threshold for effects at the population level (safe level for NO_2 below which there are no significant health effects).

Ozone

Similarly, there is a substantial amount of evidence on the health effects of ozone for example as with respect to airway inflammation and the frequency of respiratory symptoms.

(b) Pollutants currently not addressed in the AAQ Directives

Based on the findings of the HRAPIE and REVIHAAP project conducted in the context of the 2011-2013 air quality review, the Commission concluded that it was not appropriate to revise Directive 2008/50/EC (e.g. by including additional pollutants). Instead, the projects recommended to focus on achieving compliance with existing air quality standards by 2020 (at the latest), and on using a revised NEC Directive to bring down pollution emissions in the period to 2030 [P37].

The results of the HRAPIE project nonetheless highlighted that experts did not perceive current air quality standards to be "safe" since adverse impacts on human health from air pollutants emitted by various sources were still observed and pollution concentrations were still too high and affected human health. The study also concluded that important gaps in knowledge existed as regards air pollution-related health impacts, and more research was thus needed to fill in the knowledge gaps [R183].

The HRAPIE project identified a number of ambient air pollutants that pose a health risk. The combined results revealed a strong signal for finer PM components, especially for $PM_{2.5}$ and ultra-fine particles (UFPs) from combustion and non-combustion processes emitted by a variety of source categories. A strong signal also emerged in responses to metal components of PM for a number of source categories, especially in responses to finer PM components, such as $PM_{2.5}$ and UFPs [R183]. Moreover, bioaerosols were identified by the HRAPIE experts as an emerging risk. However, as there is not a dose–response relationship for bioaerosols, implementation of a limit value was not considered feasible [D142]. However, with reference at the time to the upcoming NEC Directive, the AAQ Directives revision did not address these air pollutants despite the emerging knowledge base, nor did it establish monitoring requirements that could allow for monitoring of substances of increasing importance despite the potential relevance of such provisions.

Generally, the findings from the targeted questionnaire indicate that new scientific evidence exists suggesting that there are others pollutants – currently not addressed by the Directives – that are of concern, either in terms of their potential for direct impacts upon human health, or because of their interactions with other mechanisms. Black carbon and ultrafine particles were the two pollutants most frequently mentioned (by 15 and 13 respondents respectively). The different pollutants are described in detail below.

Ultrafine particles (UFP)

UFPs, i.e. particles less than 0.1 µm (100 nm) in diameter, vary largely in composition, particle number concentration (PNC), and over space and time as a result of variations in emission sources and formation processes [S114]. UFPs in the atmosphere derive from a number of different sources – both natural and anthropogenic. This includes both primary emissions and secondary aerosol formation [S114]. Combustion sources – and motor vehicles emissions in particular – are frequently dominant, in particular in urban areas [S81, S114]. Research indicates that ongoing trends towards urbanisation and expansion of road traffic are likely to further increase population exposure to UFPs [S81] and that increasing applications of man-made nanomaterials add to the problem, e.g. after incineration at the end of their lifetime [R93]. The possibility of introducing a self-standing air quality standard for UFP has been subject to extensive discussion, both in scientific and policy circles.

As far as health effects of UFP are concerned, research indicates that the size of particles is directly linked to their potential for causing health problems and suggests that the smaller particles with the PM metric are the most significant in relation to health outcomes [R3]. A discussion of whether the small size is the *decisive* property for UFPs' toxicity is nonetheless still ongoing [e.g. R75] and there are views suggesting that the current policies that make use of the mass-based metrics PM_{10} and $PM_{2.5}$ do not properly represent all risks for human health [See e.g. European Federation of Clean Air and Environmental Protection Associations (EFCA), R93].

The WHO in 2006 [P134] declined to recommend a guideline value for UFP, since the existing body of epidemiological evidence was insufficient to reach a conclusion on the exposure–response relationship to ultrafine particles. While a number of experimental and numerical studies has advanced understanding of UFPs, the desk review indicates that the evidence remains inconclusive or insufficient [R145] and there is need for further research [D158]. Issues which contribute to uncertainty on the health effects of UFP include that UFP can be a surrogate for other pollutants in the urban pollutant mixture, there are limited long-term and comparable data on UFP concentrations across the EU, and the high spatial and temporal variability of UFP requires advanced modelling techniques to estimate exposure levels [R145].

Ultrafine particles were the second most frequently mentioned pollutant in the targeted questionnaire. For example, an environmental NGO suggested that $PM_{1.0}$ should also be measured and obligatory limit values should be applied for the maximum number of ultrafine particles in ambient air [Questionnaire, Answer no 7]. A Member State authority highlighted that exceptionally small particles form an insignificant contribution to the mass concentration of $PM_{2.5}$, however their abundance has a significant impact on these concentrations [Questionnaire, Answer No 16].

Ultrafine particles are incorporated into EURO 5 and EURO 6 vehicle emission standards, as emission limits in terms of the number of particles per kilometre. Monitoring of ambient UFP near roadways would complement the implementation of these vehicle standards, as well as reflect the progress of local measures to reduce traffic emissions, and provide valuable data for health impact research and assessments.

Black carbon (BC) and other components of particulate matter

The REVIHAAP project highlighted that since the 2005 global update of the WHO air quality guidelines a considerable number of new studies has been published, providing evidence on the health effects of size fractions, components and sources of PM. Health effects are observed with short-term (such as hours or days) and long-term (such as years) exposures to airborne particles. It was mentioned that, for example, new evidence has linked black carbon particles with cardiovascular health effects and premature mortality, for both short-term (24 hours) and long-term (annual) exposures.

In studies taking black carbon and $PM_{2.5}$ into account simultaneously, associations remained robust for black carbon. Even when black carbon may not be the causal agent, black carbon particles were found to be a valuable additional air quality metric for evaluating the health risks of primary combustion particles from traffic, including organic particles, not fully taken into account with $PM_{2.5}$ mass [R184]. Accordingly, a number of sources suggest to introduce regulation of various components of PM (e.g. black carbon). For example, Janssen et al suggested to introduce black carbon particles as an additional air quality indicator to evaluate the health risks of air quality dominated by primary combustion emissions, as well as benefits of traffic abatement measures [S71, see also the recommendation by the European Federation of Clean Air and Environmental Protection Associations (EFCA) [R75]].

Similarly, a number of stakeholders highlight that the balance of evidence currently available suggests that the (combustion-derived) components of PM are principally responsible for the effects on human health, but there is very little regulation of such components [e.g. Questionnaire, Answer no 19, no 16 and no 20].

Black carbon (BC) is incorporated in the NECD and Gothenburg Protocol as a recommended pollutant to include in submitted national emission inventories. The NECD requires Member States to prioritise reductions of black carbon in their national air pollution control programmes. Monitoring of ambient concentrations of black carbon would contribute to monitoring of the progress of NECD and the national programmes, as well as providing valuable data for research and assessment of health impacts of BC, and the progress of local air quality plans.

Metals

Metals such as aluminium, arsenic, lead, iron, cadmium, copper, chromium, manganese, nickel, zinc and vanadium are found in the air bound to particulate matter. Arsenic, cadmium, chromium and nickel are considered to be carcinogenic in humans and cause damage to the kidneys. As far as lead, mercury, manganese and arsenic are concerned, effects include damage to nervous system, reduced concentration, memory and responsiveness. Furthermore, mercury, arsenic and nickel can affect foetal development and the immune system. Effects of are also documented for cardiovascular system (mainly based on studies in the working environment) [P128].

Directive 2004/107/EC regulates four heavy metals: arsenic (As), cadmium (Cd), mercury (Hg) and nickel (Ni), although no limit value or target value is set for mercury.

Taking into account their adverse health effects the Norwegian Institute of Public Health has established Air Quality Criteria (corresponding to WHO's Air Quality Guidelines) for a number of additional metals than those that are currently included in the AAQ Directives [P128]. This includes Chromium, Manganese and Vanadium. On the other hand, no air quality criteria have been set for aluminium, iron, copper or zinc, as there is a lack of knowledge about health effects at the concentrations found in outdoor air [P128].

Similarly, a French report from the national health organisation (ANSES) provided recommendations for the pollutants that should be monitored in the ambient air. The suggestions, in addition to ultrafine particles and carbon soot, various organic compounds (see below) includes a number of metals (e.g. manganese, copper, cobalt, vanadium) and semi-metallic chemical elements (antimony) [S4].

Ammonia[7]

Ammonia (NH_3) emissions lead to a loss of biodiversity and also contribute significantly to the formation of particulate matter and the associated health risks. More than half of fine particulate matter concentrations is not emitted directly, but is formed in the air when ammonia reacts with nitrogen oxides and sulphur dioxide (called secondary particles) [S83, S10].

Ammonia is not included in the AAQ Directives, but it is addressed through national emission reduction targets in the NECD. Although ammonia is a precursor for formation of secondary particles, which are a significant share of $PM_{2.5}$ in cities, there are no requirements to monitor background ambient concentrations of ammonia as there are for precursors of ozone. Standardised and widespread monitoring of ammonia in the EU would provide valuable data for calculation of secondary particulate formation, and serve to monitor the performance of national emission reductions.

In the recent report from the Commission on the First Clean Air Outlook[8] targets originally set in the Clean Air Programme, based at the time on the proposal for the NECD[9], have been updated as to the expected reductions in negative health impacts and expected reduction in ecosystem areas exceeding eutrophication limits, compared to 2005. Figures for projected air policy benefits for 2030 based on the adopted NECD and impact of source legislation adopted since 2014 point to a larger expected reduction in negative health impacts compared to 2005 (54%). provided full

[7] While ammonia is not addressed by the AAQ Directives, ammonia emissions are addressed by the NEC Directive.

8 COM(2018)446 final

9 COM (2013)920 final

compliance with all legislative requirements. However, the expected reduction in ecosystem areas exceeding eutrophication limits has fallen (from 35% to 27 %) leading to lower ecosystem improvements since none of the additional pieces of EU source legislation adopted since 2014 tackles ammonia (NH_3). The NH_3 is thus still highly relevant under the AAQ Directives both for reducing ecosystem and health impacts.

A group of NGOs suggested that the introduction of a new air quality standard for ammonia should be considered. It was highlighted that ammonia has negative impacts on biodiversity and ecosystems and is a precursor of particulate matter (PM) which has harmful effects on health [Questionnaire, no 20]. Accordingly, it was suggested that the monitoring of secondary particle precursors such as ammonia should be extended in both urban and rural areas [Questionnaire, Answers no 3 and 10]. The AAQ Directives requires measurements of ozone precursor substances (Article 10, 6 and Annex I). Although NH_3 is a significant precursor – along with NO_X and SO_2 - to formation of secondary particles with significant health impacts, there is no requirement in the AAQ Directives to measure NH_3 as a precursor substance. NH_3 measurements would provide useful data to modelling of both particle formation and eutrophication, and compliment emission inventories for NH_3 required by NECD.

Odours

The existing AAQ Directives do not cover the issue of odour nuisance. WHO's 2000 air quality guidelines include guideline values for odour nuisance for six malodourous substances, at concentrations below those where toxic effects occur [P133].

Smells of economic activity in enterprises were mentioned (by 2 out of 19 respondents that have provided answers to the targeted questionnaire and by one stakeholder consulted for the Slovak case study) as an example of needs currently not addressed by the AAQ Directives [Questionnaire, Answer no 17 and also the NGO interviewed in the context of the Slovak case study]. Specifically, stakeholders suggested that unpleasant odours are a frequent cause of citizens' complaints, lower the quality of life and have an adverse effect on the citizens' attitudes and their confidence in available air quality data. It was mentioned that complaints concerning unpleasant odours are very frequent and there is a need for a better definition of odours and separation of the terms air pollutants for which the limit or target value is prescribed and substances that cause unpleasant odours. It was highlighted that Member States currently have different approaches to this issue with regard to responsibility, measurement methods and prescribed standards, and there is therefore a need to regulate the issue at the EU level [Questionnaire, Answer no 16].

(c) Other pollutants recommended for monitoring

As mentioned above, the ANSES report [S4] provided recommendations for the pollutants that should be monitored in the ambient air. The suggestions, in addition to ultrafine particles and carbon soot, and a number of metals and semi-metallic chemical elements include a number of organic compounds, such as 1,3-Butadiene, hydrogen sulphide, Acrylonitrile, 1,1,2-Trichloroethane, naphthalene). The report highlights that the pollutants identified could be monitored even if, in the first stage, no limit value is set [S4].

Other pollutants mentioned as potentially relevant to address during the stakeholder consultation include pesticides, heavy pollutants (such as dioxin) [Questionnaire, Answer no 7], emission sources such as tyre and brake wear, non-exhaust traffic related particles, heavy goods vehicle refrigeration units, heating and power emissions [Questionnaire, Answer no 2]. Finally, a health NGO suggested that one of the most important agents provoking allergic symptoms, not yet addressed by the AAQ Directives, are pollen grains from plants. To address this substance it was proposed to reduce the use of the plant species with demonstrated allergenicity for human health in city planning and establish a public aerobiological network to provide EU citizens with a real-time pollen monitoring system [Questionnaire, Answer no 9].

To sum up, as far as pollutants currently regulated by the Directives, the body of evidence on the harmful effects of the pollutants has grown. In contrast, no evidence that would suggest that any of the pollutants covered have a limited adverse effect on human health/environment has been identified.

As for pollutants currently not covered, there is growing evidence suggesting relevance of various components of particulate matter, or ultrafine particles (measured as number of particles).

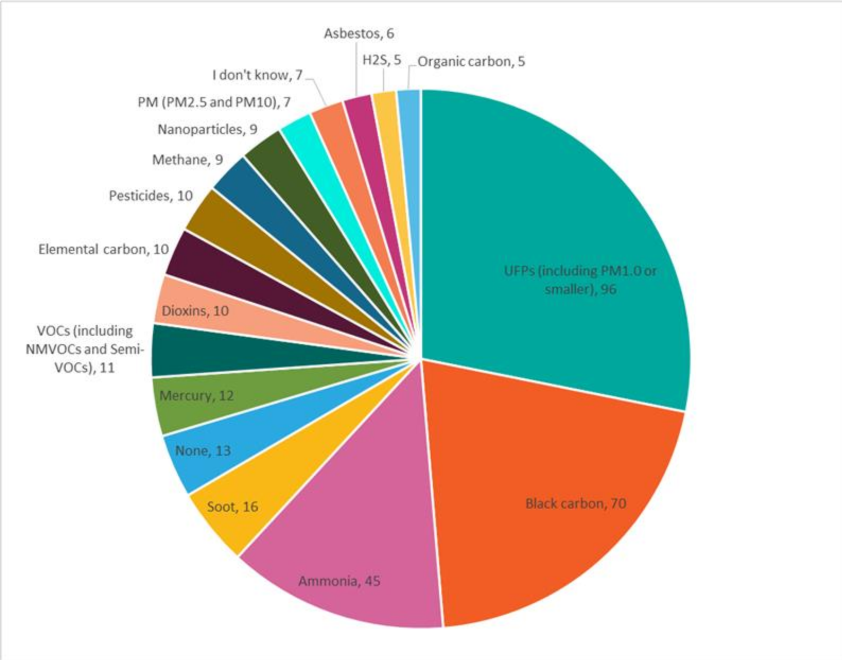
The major components of particulate matter include metals, organic compounds (measured as organic carbon [OC]) including materials of biological origin, inorganic carbonaceous material (including black carbon [BC] and elemental carbon [EC]), and sulphate, nitrate, ammonium, and other ions [S1]. There is growing evidence that black carbon (BC)/elemental carbon (EC) and ultrafine particles (UFP) are better associated with health impacts than $PM_{2.5}$ mass concentration. These parameters are also better associated with local emission sources (transport, domestic heating) than $PM_{2.5}$, making them better suited to monitor the progress of measures in air quality plans. The uncertainty of health impacts has been too high to establish a limit value or target value for BC/EC or UFP, but standardised monitoring of one or both of these parameters throughout the EU would provide significant comparable information about air quality to the public, and support continued research on their impacts.

The open public consultation results regarding additional pollutants is shown in Text box 3.

Text box 3 Stakeholder responses regarding the relevance of pollutants addressed by the AAQ Directives, and additional pollutants which should be added to the AAQ Directives.

Open public consultation respondents were given an open text field and were able to name multiple pollutants in their answers. The most often cited pollutants are shown in Figure 6. The most commonly cited additional pollutant being ultrafine particles (UFP) (96 responses), black carbon (BC) (70 responses) and ammonia (45).

Figure 6: Question 6.4: Which pollutants not currently addressed by the AAQ Directives would you suggest be included within their scope? (Pollutants mentioned in 5 or more responses) (n=237)



In terms of negative impacts on biodiversity and ecosystems, there is evidence of environmental implications of ammonia due to its important role in ecosystem and global nitrogen cycle, as well as contribution to secondary particle formation.

D.1.3 JC 1.3: Standards and obligations

This section provides further detail on the approach and evidence linked to *JC 1.3: The extent to which standards and obligations for the pollutants currently covered are suitable to protecting the citizens from harmful effects of air pollution*

Approach

As outlined above, the pollutants covered by the AAQ Directives include twelve pollutants. The evaluation question focuses in particular on the limit and target values and the critical levels for the protection of vegetation set by the AAQ Directives.

The permissible levels provided in the AAQ Directives represent minimum harmonisation. As such, Member States may introduce – and as will be elaborated below some already has - more demanding standards within their territories.

To answer the evaluation sub-question, the documents underpinning the 2013 air policy review were reviewed, the newly available evidence of adverse effects of various pollutants examined and stakeholder views on the level of the current standards explored. Moreover, the currently applicable EU air quality standards were compared with other existing standards/guidelines, including the WHO Air Quality Guidelines.

Limitations to the approach

Limitations discussed in the previous sections also apply here.

Results

A. Results: Desk research, targeted questionnaire, case studies

The table below provides a comparison of a number of selected EU standards and WHO guidelines.

Table 2 Comparison of selected EU standards and WHO guidelines

Air Quality Directive				WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	One day	**No limit value**		25 µg/m³ (*)	99th percentile (3 days/year)
	Calendar year	**Limit value, 25 µg/m³**	The target value has become a limit value since 1 January 2015	10 µg/m³	
PM_{10}	One day	**Limit value, 50 µg/m³**	**Not to be exceeded on more than 35 days per year**	50 µg/m³ (*)	99th percentile (3 days/year)
	Calendar year	**Limit value, 40 µg/m³**		20 µg/m³	
O_3	Maximum daily 8-hour mean	**Target value, 120 µg/m³**	**Not to be exceeded on more than 25 days per year, averaged over three years**	100 µg/m³	
NO_2	One hour	Limit value, 200 µg/m³ (*)	**Not to be exceeded more than 18 times a calendar year**	200 µg/m³ (*)	
	Calendar year	Limit value, 40 µg/m³		40 µg/m³	

Source: [D30] and own assessment.

Note: Instances in which the standards provided in the Directive 2008/50/EC are less stringent than the WHO guideline values are highlighted in bold.

As mentioned above, the air quality standards set in the Directives have been in place for almost two decades. The TFEU [P137] Article 191 Article 3 states that EU environmental policy shall take account of available scientific and technical data. The 2002 6th EAP [P93] further states that the objective to achieve *levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment*, shall be pursued *taking into account relevant World Health Organisation (WHO) standards, guidelines and programmes*. With this policy background, and the WHO air quality guidelines existing at the time, and taking economic, social and cost-effectiveness aspects into account, the co-legislators (European Parliament and the Council) decided on the specific levels of the air quality standards in the AAQ Directives. The 2013 7th EAP [P106] item 54(a) introduced the goal that by 2020, *outdoor air quality in the Union has significantly improved, moving closer to WHO recommended levels, while indoor air quality has improved, informed by the relevant WHO guidelines*.

The standards were examined in the context of the Commission's 2013 air policy review. The findings of the review suggest that the existing standards were insufficient in relation to the WHO air quality guidelines on air pollution [P183, D57] and only provide incomplete protection for human health [P38]. A further tightening of the existing EU air quality standards was nonetheless considered to be not appropriate if introduced before substantial cuts in air pollution from the main sources.

Instead, the 2013 Clean Air Programme for Europe (which was adopted based on the 2013 air policy review) proposed stricter emission ceilings via a revised NEC Directive and recommended to, in the short term (that is until 2020 at the latest), focus on achieving compliance with the existing standards. At the same time, the Commission indicated that the AAQ Directive will be kept under review with a view to revision once the NEC Directive has set background concentrations on the right downwards track [P37].

EU standards for health protection set out in the Directives address both short and long-term health impacts [S1]. There is a body of evidence suggesting that the current EU air quality standards are insufficient for the protection of health and, to a limited extent, also for the protection of the environment. Most notably, the Impact Assessment underpinning the 2013 Clean Air Policy Package concluded that while compliance would bring significant health and environmental benefits, it would not solve the substantial outstanding health and environmental problems beyond 2020, because the standards were set as interim objectives rather than at the low impact levels recommended by the WHO and other scientific bodies [P38]. As such, the Impact Assessment concluded that even if compliance with current legislation was reached, major health and environment impacts would remain [P38].

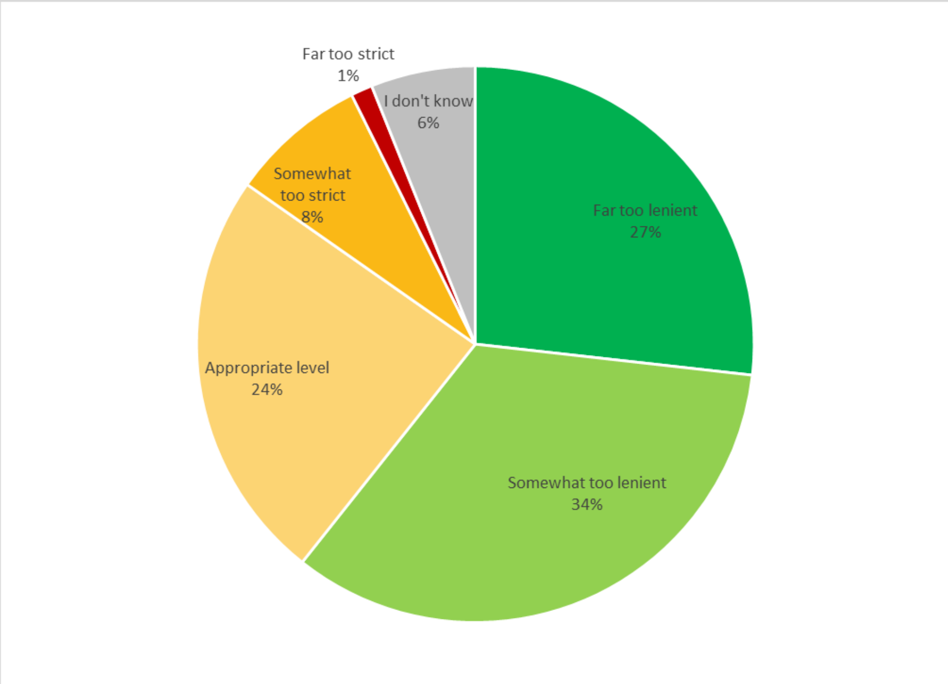
Recently, the Court of Auditors found that some of the standards of the Directive 2008/50/EC "*are much weaker than the World Health Organization guidelines. Furthermore, the standards allow limits to be exceeded frequently and do not include any short-term standard for $PM_{2.5}$, a very harmful air pollutant […] Health professionals support stricter standards in the EU […] Setting weak standards does not provide the right framework for protecting human health. It means that some locations with poor air quality are compliant with EU law*." [S1].

Similarly, Yamineva [S126] presented a number of arguments to the effect that – despite the positive achievements of the 2013 Clean Air Policy Package – EU air policy remained inefficient and unsatisfactory in relation to impacts on air quality. In this connection, it was also put forward that even if the existing legislation was to be implemented in full, significant negative impacts on public health and the environment would continue to be suffered within the EU.

Text box 4 Stakeholders' views on the level of standards

Approximately 24% of the respondents to the open public consultation found the air quality standards of the AAQ Directives at appropriate level. 61% found the standards either much too lenient (27%) or somewhat too lenient (34%). In contrast, only 1% found the standards far too strict and 8% too strict. 24% of the respondents found the standards to be at appropriate level.

Figure 7 Stakeholders' views on the standards provided by the AAQ Directives



Source: Open public consultation Question 6.5: What is your view on the level of the air quality standards set in the Ambient Air Quality Directives? N=478.

The findings of the targeted questionnaire paint a similar picture. Out of the 19 respondents, who have answered the question on the level of the current standards, 14 respondents found the standards partly sufficient and identified specific pollutants with respect to which the standards provided by the AAQ Directives are presumably insufficient. The standards for $PM_{2.5}$ were among those most frequently mentioned. Seven respondents found the standards insufficient to protect human health and/or the environment, two respondents found the targets provided by the Directive generally sufficient but highlighted a need to ensure compliance with the existing standards. One respondent indicated that the current daily limit values for PM_{10} were too stringent. One respondent to the targeted questionnaire pointed out that a move to the WHO Air Quality Guidelines across Europe would be more appropriate for communicating to the public the need for changes to improve air quality [Questionnaire, Answer 33].

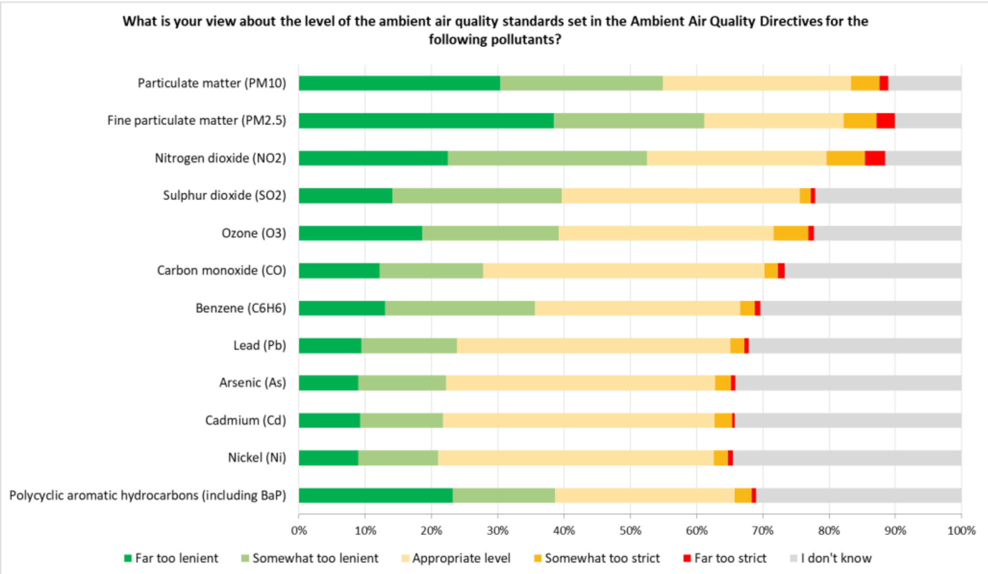
One respondent noted that the short-term (hourly, daily) and annual PM_{10} and $PM_{2.5}$ data are highly correlated, and short-term limit values are more sensitive to data losses than annual limit values, so that lowering the $PM_{2.5}$ annual limit value (to 12-13 µg/m³) would make exceedance of the PM_{10} daily limit value unlikely, which could improve the efficiency of the monitoring system. [Questionnaire, Answer 31]. One respondent finds that due to the problems large cities have with compliance with the air quality standards, separate thresholds for NO_2, PM_{10} and $PM_{2.5}$ should be provided for urban areas [Questionnaire, Answer 17]. One respondent points out that the requirement for traffic measuring points to be within 10 m from the roadway

(AAQ Directives Annex III) is not appropriate for motorways and highways where no one is living (due to noise), and that this makes it difficult to establish a business in these locations resulting in an undesirable shift of operating facilities into residential areas [Questionnaire, Answer 24].

Text box 5 Stakeholders' views on the level of standards set for individual pollutants in the AAQ Directives.

With regard to the stringency of the limit values for pollutants under the AAQ Directives, open public consultation respondents mostly felt that the target values for Lead, Arsenic, Cadmium and Nickel were among those pollutants for which the targets provided by the Directive 2004/107/EC were perceived as being set at an appropriate level by the highest share of respondents (41%, 41%, 41% and 42%) (see Figure 8). These were followed by the SO_2 for which 36% of respondents indicated that the standards were set at an appropriate level. In contrast, 38% and 30% of the respondents indicated that the limit values for $PM_{2.5}$ and PM_{10}, respectively, are much too lenient. The standard for polycyclic aromatic hydrocarbons including benzo[*a*]pyrene (BaP) was found much too lenient by 23% of the respondents. The existing standards for NO_2 were found far too lenient by 22% of respondents, although the NO_2 limit values correspond to the WHO guidelines for NO_2. $PM_{2.5}$ and NO_2 had the highest number of respondents indicating the standards were somewhat strict or far too strict.

Figure 8 Stakeholders' views on the standards provided by the AAQ Directives (individual pollutants)



Source: Open public consultation, Question 6.6: What is your view about the level of the ambient air quality standards set in the Ambient Air Quality Directives for the following pollutants? N=468; 466; 467; 462; 462; 461; 461; 458; 460; 456; 457; 458 (for the different pollutants).

Overall, there was a consensus among the respondents to the targeted questionnaire on that the current AAQ air quality standards have had the merit to enhance the integration of air quality issues into public policies, to increase public awareness and consequently to contribute to the air quality improvement observed in recent years. Still, a large share of stakeholders highlighted the need to reflect to most recent scientific evidence on the harmful effects of air pollution and sharpen the current standards at least to the levels recommended by the WHO air quality guidelines/update of the guidelines [see e.g. Questionnaire, Answers No 2, 3, 9, 11, 15, 19, 20, 22 and 25, and an NGO interviewed in the context of the Slovak case study].

On the other hand, a limited number of stakeholders also highlighted the issue of economic viability of following the WHO guidelines [Questionnaire, Answer no 16]. In general, industry associations highlighted the importance of the fact that the requirements in the framework for air quality protection are cost-effective, reachable by the industry with available technologies, and in line with the Best Available Techniques (BAT) as already defined in the Industrial Emissions Directive (IED) [Questionnaire, Answers no 6 and 12, and the industry representative interviewed in the context of the Slovak case study].

Similar views were echoed in the workshop discussions. Participants noted that despite air pollution being the fifth most important risk factor for non-communicable diseases, current standards do not fully reflect scientific evidence suggesting health impacts at concentration levels below the current limit values. Particular concern was expressed regarding $PM_{2.5}$, where stakeholders noted the need for short-term limit values.

(a) Comparison with other existing standards/guidelines

The following sections present the findings of the comparison of the standards set for the protection of human health in the AAQ Directives, the WHO Air Quality Guidelines and air quality standards in a number of selected countries.[10]

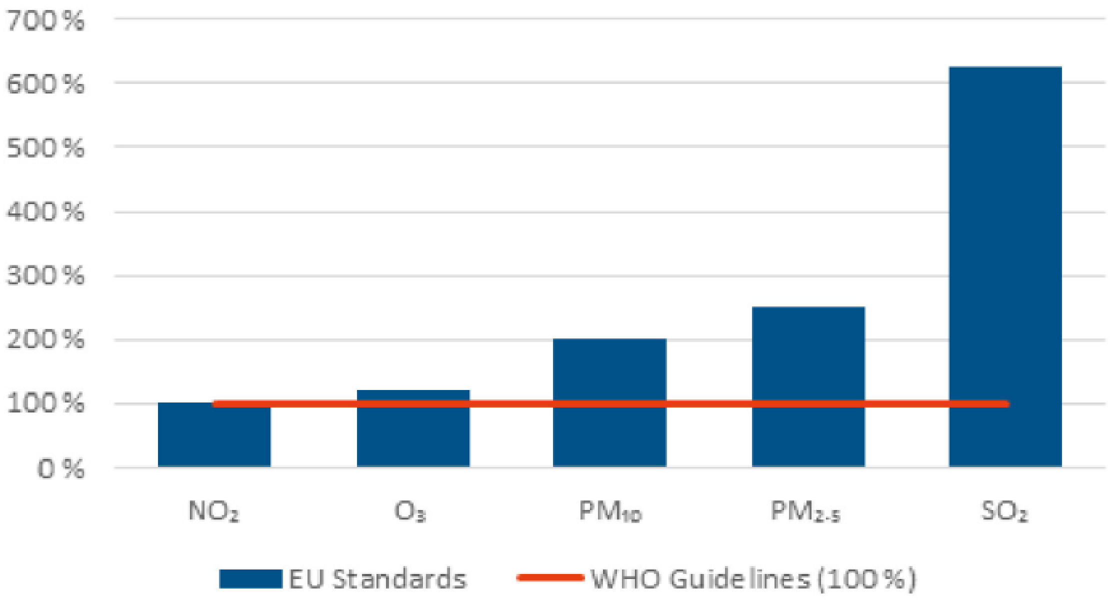
The WHO Air Quality Guidelines are designed to offer guidance in reducing the health impacts of air pollution [P134]. The WHO guideline values focus on health impacts and do not consider the technical feasibility or the economic, political and social aspects of the achievement of the recommended levels [P44]. The process of updating the WHO Air Quality Guidelines is currently under way and a number of systematic reviews of the evidence have been commissioned [Stakeholder workshop]. At the time of writing of this reports the results of the review are not yet available. It is nonetheless possible that the review may result in further tightening of the existing recommendations.

As shown in Figure 9, although based on the WHO recommendations, a number of EU air quality standards are higher than the values currently recommended by the WHO.[11]

[10] It should be highlighted that when comparing various standards in addition to the differences in the level, the averaging period and statistical indicator, the application area and the differences between the implementation of the standards according to the national legislation and the EU legislation also have to be considered [See, e.g. S25].

[11] The process of updating the WHO Air Quality Guidelines is currently under way and a number of systematic reviews of the evidence have been commissioned [Stakeholder workshop].

Figure 9 Gap between EU standards and WHO guidelines



Source: Court of European auditors [P91].

As shown in the figure above, there is a rather discrepancy in particular with respect to the values SO_2, $PM_{2.5}$ and PM_{10}. In contrast NO_2 has an EU limit value that is in line with the WHO recommendation. Moreover (not pictured in the above figure), the EU target value for benzo(a)pyrene (BaP) is more than eight times higher than the WHO reference level.

Throughout the EU more demanding standards have been adopted, for example, by Austria (NO_2 and PM_{10}), the United Kingdom (ozone) [S80] and Sweden (most notably for NO_2).

In non-EU European countries, Norway has since 2016 had more stringent limit values for both $PM_{2.5}$ and PM_{10} (see below in the section dedicated to particulate matter). In Switzerland the Clean Air Ordinance (LRV) has been recently revised. The revisions include the introduction of an annual limit value for $PM_{2.5}$ that is in line with the WHO recommendations (see below).

In the developing world, most of the countries have evolved their own air quality standards. However, there are also countries that follow the WHO air quality guidelines and adopted these guidelines as standards [S55].

Finally, De Leeuw et al compared standards set for the protection of human health from a selected number of countries (Australia, Canada, China, India, New Zealand and United States), with the guidelines set by WHO, and the EU limit and target values [S25].[12] A more detailed comparison is provided in the sections addressing each of the individual pollutants below.

Particulate matter

[12] A more detailed overview is provided by Joss et al [S72], who compiled national short- and long-term ambient air quality standards of the classical ambient air pollutants and CO in relation to the WHO guidelines in the 194 WHO member states. The study for each country tabulated ambient air quality standards for different averaging times: $PM_{2.5}$ (24-h and annual average), PM_{10} (24-h and annual average), O_3 (1-h mean and 8-h average), NO_2 (1- and 24-h average), SO2 (10-min, 24-h and annual average), and CO (15-min, 1-, 8- and 24-h average).

Standards are set both for PM_{10} and for fine particulate matter $PM_{2.5}$. As for PM_{10} the Directive sets two limit values: for daily average and for annual mean concentration. Pursuant to Annex XI of the Directive the PM_{10} daily mean value may not exceed 50 µg/m³ more than 35 times a year and the PM_{10} annual mean value may not exceed 40 µg/m³.

For $PM_{2.5}$ Directive 2008/50/EC currently sets a yearly limit value of 25 µg/m³. This value was initially set as a target value to be met by 2010 and as a limit value to be met by 2015.[13] Moreover, additional $PM_{2.5}$ objectives targeting exposure of the population to fine particles were set by the Directive 2008/50/EC. These objectives are set at a national level and are based on the average exposure indicator (AEI) determined as a 3-year running annual mean $PM_{2.5}$ concentration averaged over selected monitoring stations. They include an exposure reduction target and an exposure concentration obligation (ECO) of 20 µg/m³ AEI measured at urban background stations as a three year average. As far as $PM_{2.5}$ is concerned Directive 2008/50/EC thus focuses on limiting long-term exposure through the use of annual standards.

Recent studies elaborate on the health effects of e.g. long-term exposure to low concentrations of fine particulate matter [S21]. It has been estimated that a reduction in the annual average ambient air concentration of $PM_{2.5}$ from 35 µg/m³ to 10 µg/m³ would reduce mortality caused by air quality by 15% [D156]. Similarly, a recent research from Public Health England estimated that just a 1 µg/m³ reduction in $PM_{2.5}$ concentrations this year could prevent over 50,000 new cases of coronary heart disease by 2035[R148, referred to in Questionnaire, Answer no 5].

Comparing the current PM_{10} and $PM_{2.5}$ limit values, the current PM_{10} limit value gives a higher level of health protection than the $PM_{2.5}$ limit value. The ratio of the 2005 WHO PM_{10} guideline (annual) to EU PM_{10} limit value is 20/40 = 0.5, whereas ratio of WHO $PM_{2.5}$ guideline to EU $PM_{2.5}$ LV is 10/25 = 0.4. Moreover, the WHO air quality guidelines provide a guideline both for the annual mean and the 24-hour mean concentration of $PM_{2.5}$. In this respect the WHO air quality guidelines specify that meeting the guideline values for the 24-hour mean will "*protect against peaks of pollution that would otherwise lead to substantial excess morbidity or mortality. It is recommended that countries with areas not meeting the 24-hour guideline values undertake immediate action to achieve these levels in the shortest possible time.*" [P134]. Finally, the WHO guideline values for the yearly concentrations of both PM_{10} and $PM_{2.5}$ are more stringent compared to the limit values provided by Directive 2008/50/EC (20/40 µg/m³ and 10/25 µg/m³ for PM_{10} and $PM_{2.5}$ respectively.

From a comparative perspective, the annual limit value for $PM_{2.5}$ laid down Directive 2008/50/EC is significantly higher than the standards applied in other developed countries (e.g. US, Australia and Canada) and in some developing countries (e.g. Mexico) [S55]. The Swedish (non-binding) environmental objectives both for PM_{10} and $PM_{2.5}$ are more ambitious compared to the EU standards (30 µg/m³ and 15 µg/m³ for daily concentrations and yearly concentrations, respectively, for PM_{10} and 25 µg/m³ and 10 µg/m³ for $PM_{2.5)}$. In Norway the annual limit value for $PM_{2.5}$ is 15 µg/m³ and for PM_{10} 25 µg/m³. The number of allowed exceedances of the daily limit value of 50 µg/m³ for PM_{10} is reduced to 30 (whereas the Directive allows 35). A study to evaluate further reductions of the limit values has been initiated [Targeted questionnaire, Answer No. 21 and §7-6 of the Norwegian Pollution Regulation]. In Switzerland the Clean Air Ordinance (LRV) has been recently revised. As mentioned above, the Swiss limit values for particulate matter have been

[13] Moreover, Annex XIV of the Directive provides an indicative limit value for $PM_{2.5}$ to be met by 1 January 2020. As specified in the Annex, the limit value was to be reviewed by the Commission in 2013 "*in the light of further information on health and environmental effects, technical feasibility and experience of the target value in Member States*".

recently revised in line with the WHO recommendations. The Swiss limit values for PM_{10} (annual and 24-hour) and the limit value for $PM_{2.5}$ are more stringent compared to the EU standards.

38% and 30% of the respondents to the open public consultation indicated that the limit values for $PM_{2.5}$ and PM_{10}, respectively, are much too lenient. Similarly, a number of respondents to the targeted questionnaire suggested that the limit values for particulate matter in Directive 2008/50/EC are too lenient for sufficient protection of human health. Specifically, stakeholders suggested $PM_{2.5}$ deserves reinforced measurements and more emphasis in Europe [Questionnaire, Answers no 1 and 19] and – considering the WHO guidelines as a benchmark – the current $PM_{2.5}$ limit value needs to be more ambitious [see e.g. Questionnaire, Answers no 1, 5, 12, 21]. In addition to strengthening the current (yearly) $PM_{2.5}$ limit values, it was also suggested to introduce limit values for $PM_{2.5}$ 24-hour average, based on WHO guidelines [Questionnaire, Answer no 16].

Nitrogen dioxide

For nitrogen dioxide (NO_2), two limit values for protection of human health are set in Directive 2008/50/EC: NO_2 hourly mean values may not exceed 200 µg/m³ more than 18 times in a year and the NO_2 annual mean value may not exceed 40 µg/m³. The Directive also sets a critical level for the annual mean concentration of nitrogen oxides (NO_X) of 30 µg/m³, for the protection of ecosystems.

The annual limit value for NO_2 in Directive 2008/50/EC is identical to the WHO Air Quality Guidelines value. However, as indicated in the ANSES report [S4] "*For long term effects, experts agree to update the current WHO guideline regarding new data from cohort studies, which could lead to the recommendation of a guide value of less than 40 µg.m³*." The hourly limit value for NO_2 in Directive 2008/50/EC is somewhat less stringent in terms of statistical indicators as Directive 2008/50/EC allows 18 exceedances per year.

In Sweden, more ambitious objectives have been set both as binding national standards and as guiding environmental objectives ("Miljömål") for the protection of human health. Most notably, a more demanding national limit value has been set for NO_2: one hour average 90 µg/m³ not to be exceeded for more than 175 hours (compared to 200 µg/m³ at EU level to be exceeded for the maximum of 18 hours) and one day 60 µg/m³ not to be exceeded for more than 7 days (no daily limit value set at EU level). The non-binding environmental objectives for NO_2 are even more ambitious: one hour average 60 µg/m³ not to be exceeded for more than 175 hours and one year average of 20 µg/m³ (compared to 40 µg/m³ at EU level) [Miljömål and Swedish case study]. Looking at other countries, the various NO_2 standards show a large uniformity with respect to the level. In the countries compared by De Leeuw et al in 4 out of 6 hourly standards at level of 200 µg/m³ were defined; equal levels (80 µg/m³) were set for the two daily standards (China, India) and for 4 out of the 6 annual standards a level of 40 µg/m³ was defined. However, it was also emphasised that the statistical indicators differ strongly (for example, 0, 1, 9 or 18 allowable exceedance of the hourly concentration of 200 µg/m³) [S25].

For NO_2 existing standards were found much too lenient by 22% of respondents to the open public consultation. An environmental NGO suggested that the hourly limit value was not representative of the situation. As an example, the annual limit values of 40 µg/m³ was said to be largely exceeded in the Greater Paris Area with level that can be more than twice higher. However, it was noted that the information and alert value are very rarely reached. This was said to create a confusion and misunderstanding for the authorities, the citizens and the media: whereas NO_2 is the most important issue regarding air pollution in Paris Region, there are almost no pollution episodes associated with it. This was said to give the impression that every day the situation is fine, whereas the annual summary shows strong exceedances and several millions of people exposed to level higher than the annual limit value [Targeted questionnaire, Answer no 1].

Sulphur dioxide

As for sulphur dioxide (SO_2) two limit values for protection of human health and two critical levels for the protection of vegetation have been set in Directive 2008/50/EC. As far as protection of human health is concerned the hourly limit value has been set at 350 µg/m³ and may not be exceeded more than 24 times a calendar year. The daily target value was set at 125 µg/m³ a may not be exceeded more than 3 times a calendar year.

A comparison between the standards set for the protection of human health with other standards showed that the most stringent EU daily limit value was weaker than the corresponding standards in a number of other countries [R33]. Moreover, the EU standard (24-hour mean) is approximately 6.25 less stringent compared to the WHO Air Quality Guidelines.

Ozone

For ozone (O_3) target values are set for the protection of human health and for the protection of vegetation. As far as protection of human health is concerned, a maximum daily eight-hour mean target value has been set at 120 µg/m³. This value may not be exceeded on more than 25 days per calendar year averaged over three years. Moreover, Directive 2008/50/EC defines long-term objectives both for the protection of human health and for protection of vegetation.

The maximum daily 8-hour mean value at 120 µg/m³ is higher compared to the value recommended by the WHO guidelines is 100 µg/m_3. The EU standard is also less stringent than the value set by the UK the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (100 µgm^{-3} (8-hour) which may not to be exceeded more than 10 times a year). Moreover, the EU standard appears to be one of the weakest standards compared in De Leeuw et al. However, in terms of exposure reduction by full implementation the EU standard ranks as number 4 after the WHO standard, Indian 8-hour and Canadian 8-hour [S25].

In relation to the standards provided for ozone a Member State authority put forward that the target values and long-term objectives for ozone are defined in such a way that geographical and climatological differences between Member States are not taken into account. It was argued that this was not optimal since there is a pronounced difference in levels between, for example, the Mediterranean countries and other EU Member States, which is not caused by human activities and direct discharge into the air of pollutants from known emission sources [Questionnaire, Answer no 16].

Arsenic, Cadmium, Nickel and Polycyclic Aromatic Hydrocarbons, including Benzo(a)pyrene (BaP)

Unlike the AAQ Directive, which sets both target and limit values, Directive 2004/107/EC establishes (only) *target values* for the concentration of arsenic, cadmium, nickel and benzo(a)pyrene in ambient air.

The 2001 Position paper on arsenic, cadmium and nickel compounds in ambient air compiled the available knowledge and proposed limit values on the basis of risk assessments [P79]. The 2004 Directive, however, chose not to set limit values as it was concluded that there were no cost-effective measures to attain everywhere the concentration levels that would give rise to harmful effects on human health [P11]. With regard to mercury, Directive 2004/107/EC and Directive

2015/1480/EC prescribes a mandatory measurement of mercury in ambient air and reference measurement methods, however, no target values have been prescribed like it was done for other metals (As, Cd, Ni).

The target values for Lead, Arsenic, Cadmium and Nickel were among those pollutants for which the targets provided by the Directive 2004/107/EC were perceived as being set at an appropriate level by the highest share of respondents to the open public consultation (41%, 41%, 41% and 42%). In contrast for Polycyclic Aromatic Hydrocarbons, including BaP, the existing standards were found much too lenient by 23% of the respondents.

From a comparative perspective for Benzo[a]pyrene there is a rather large discrepancy between the WHO reference level[14] and the target values of the Directive. The Swedish environmental objective for BaP is 0,1 ng/m³. Similarly, the Norwegian Institute of Public Health recommended an annual value of 0.1 ng/m³. These recommendations are significantly lower compared to the target value in Directive 2004/107/EC is 1 ng/m³.

A number of stakeholders suggested that – given their important impact on human health - it may be appropriate to revise the limit and target values and corresponding threshold values for other components included in the Directives as well, e.g. benzo[a]pyrene [Questionnaire, Answers no 21 and 22]. Some stakeholders also suggest to change from target values to limit values both for b(a)p and for heavy metals (As, Cd and Ni) [Questionnaire, Answer no 21] and to introduce a target value for mercury on the basis of the WHO guidelines [Questionnaire, Answer no 16].

Information and alert thresholds

The AAQ Directives specifies information and alert thresholds for ozone, NO_2 and SO_2. These values trigger distribution of information to the public and initiation of measures in short-term action plans. These are highly relevant where high levels of SO_2 or NO_2 can occur. No information and alert thresholds are provided for particulate matter, although severe pollution episodes with high PM levels present a significant health risk to the public. Thirteen Member States have established national or municipal information and alert thresholds for PM_{10}, and two Member States have information and alert thresholds for $PM_{2.5}$ (Guiseppin (2017) [R105]). The levels of these thresholds vary considerably among these Member States, and even within Member States, which indicates varying levels of protection to the public. There is substantial evidence on the short-term acute health impacts of high levels of particulate matter, and establishment of information and alert thresholds for PM_{10} and $PM_{2.5}$ in the AAQ Directives would provide valuable protection to public health.

Upper and lower assessment thresholds

Upper and lower assessment thresholds determine the monitoring requirements for all of the pollutants in the AAQ Directives except ozone, and are thus a highly relevant aspect of unified assessment in the EU. For levels above the upper assessment threshold (UAT), fixed sampling points must be used. Between the upper and lower assessment thresholds, a smaller number of fixed sampling points may be used together with modelling and indicative monitoring. Below the lower assessment threshold (LAT), no fixed sampling points are required. The assessment thresholds are defined as fractions of the limit or target values, with UAT set at 60 to 80%, and LAT from 40 to 50% of the limit or target value. Where a limit or target values is higher than the WHO guidelines, the assessment thresholds may be too lenient compared to the WHO guideline.

[14] According to WHO the concentrations of BaP producing excess lifetime cancer risks are of 0.012 ng/m³.

The lower assessment threshold for 24-hour SO_2 is 50 ug/m³, while the WHO guideline is 20 ug/m³. This means that no fixed monitoring stations would be required for SO_2 while SO_2 levels are more than twice the WHO guideline. The UAT and LAT for $PM_{2.5}$ are 17 and 12 ug/m³, while the WHO guideline is 10 ug/m³, allowing fixed sampling for $PM_{2.5}$ to be reduced or dropped while $PM_{2.5}$ levels are remain above the WHO guideline. The UAT and LAT for lead and PM_{10} are also at or above the corresponding WHO guidelines. The assessment thresholds should take the WHO guidelines into consideration, to ensure that adequate monitoring is maintained as long as levels exceed the WHO guidelines.

Summary of the main findings

Evidence of improved air quality in the EU over the past few decades as regards several pollutants show that the targets, thresholds and obligations laid down by the AAQ Directive have been helpful from 2008 to 2018 in stimulating national action on air quality and that they still represent a key tool to improve air quality.

The Impact Assessment underpinning the 2013 Clean Air Policy Package recognised that the various ambient air quality standards were set as interim objectives rather than at the low impact levels recommended by the WHO and other scientific bodies and, as such do not solve the substantial outstanding health and environmental problems [P38]. Furthermore, the review of recent scientific evidence indicates that the air quality standards laid down by the AAQ Directives are not fully reflective of the most recent and robust evidence available suggesting serious adverse health effects at lower concentration levels.

The findings of the evaluation also show that a number of standards laid down by the AAQ Directives is less stringent compared to the current WHO Air Quality Guidelines for the protection of human health. This is the case in particular for $PM_{2.5}$ (yearly mean concentration), PM_{10} (yearly mean concentration and, looking at the statistical indicator, also the daily mean concentration), SO_2 (daily mean concentration). In addition, the AAQ Directives do not set short-term standards for $PM_{2.5}$, which are considered important in order to protect against the peaks of pollution that would otherwise lead to substantial excess morbidity or mortality.

Table 3 *Definitions of thresholds used in the AAQ Directives.*

Limit values	Limit values are that shall be attained within a given period and not be exceeded once attained, are set for all regulated pollutants in Directive 2008/50/EC except ozone (see Article 13(1) of the Directive 2008/50/EC). Limit values are the strictest type of objective because they impose an absolute, unqualified duty on the Member States to achieve them by a given deadline, regardless of the cost.	In case that the values are exceeded, Member States are required to develop and implement air quality plans to achieve the relevant limit or target value. Moreover, short-term action plans may be produced to address the risk of exceeding one or more limit or target values (Article 24(1) AAQ).
Target values	Target values are averaged over a fixed period, checked annually, and are set for $PM_{2.5}$, O_3 and all regulated pollutants in Directive 2004/107/EC. Pursuant to Article 17 of the Directive 2008/50/EC, target values need to be achieved where possible, without incurring disproportionate costs.	
Long-term objectives	*Long-term objectives* are the levels to be attained in the long term with the aim of providing effective protection of human	

	health and of the environment. Long-term objectives for ozone are specified in Annex VII of the Directive 2008/50/EC.
Critical levels	*Critical levels* for the protection of vegetation are specified in Annex XIII of the Directive 2008/50/EC. Critical levels are set for sulphur dioxide and oxides of nitrogen.
Alert thresh-olds	A*lert thresholds* mark the levels beyond which there is a risk to human health from brief exposure of the population as whole and at which immediate steps are to be taken by the Member States.
Information thresholds	*Information thresholds* mark the levels beyond which there is a risk to human health from brief exposure for particularly sensi-tive sections of the population and for which immediate and ap-propriate information is necessary. Information and alert thresholds are specified in Annex XII of the Directive 2008/50/EC

Source: Directive 2008/50/EC and [S48].

The current limit and target values for the protection of human health as laid down by the AAQ Directives are summarised in the Table below.

Table 4 Current EU limit and target values for the protection of human health

	Substance	One hour	One day	Annual mean	Comments
Limit values	SO_2	350 µg/m³	125 µg/m³		Exceedances allowed on 24 hours/ 3 days per year
	Pb			0.5 µg/m³	Measured as content in PM_{10}
	PM_{10}		50 µg/m³	40 µg/m³	Exceedances allowed on 35 days per year
	$PM_{2.5}$			25 µg/m³	
	NO_2	200 µg/m³		40 µg/m³	Exceedances allowed on 18 hours per year
	C_6H_6			5 µg/m³	

	Substance	One hour	One day	Annual mean	Comments
	CO		10 mg/m³ (8 hour)		
Target values	O_3		120 µg/m³ (8 hour)		Exceedances allowed on 18 hours per year
	As			6 ng/m³	Measured as content in PM_{10}
	Cd			5 ng/m³	Measured as content in PM_{10}
	Ni			20 ng/m³	Measured as content in PM_{10}
	BaP			1 ng/m³	Measured as content in PM_{10}

Source: AAQ Directives.

WHO Air Quality Guidelines

The table below provides a comparison of a number of selected EU standards and WHO guidelines.

Table 5 Comparison of selected EU standards and WHO guidelines

Air Quality Directive				WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	One day	**No limit value**		25 µg/m³ (*)	99th percentile (3 days/year)
	Calendar year	**Limit value, 25 µg/m³**	The target value has become a limit value since 1 January 2015	10 µg/m³	
PM_{10}	One day	**Limit value, 50 µg/m³**	**Not to be exceeded on more than 35 days per year**	50 µg/m³ (*)	99th percentile (3 days/year)

	Calendar year	**Limit value, 40 μg/m³**		20 μg/m³	
O_3	Maximum daily 8-hour mean	**Target value, 120 μg/m³**	**Not to be exceeded on more than 25 days per year, averaged over three years**	100 μg/m³	
NO_2	One hour	Limit value, 200 μg/m³ (*)	**Not to be exceeded more than 18 times a calendar year**	200 μg/m³ (*)	
	Calendar year	Limit value, 40 μg/m³		40 μg/m³	

Source: [D30] and own assessment.
Note: Instances in which the standards provided in the Directive 2008/50/EC are less stringent than the WHO guideline values are highlighted in bold.

The table below shows the substances covered by the AAQ Directives with limit values exceeding WHO guidelines. It illustrates the relationship between the limit values in the AAQ Directives and the WHO guidelines. A figure of 1 in the right-hand column illustrates that the limit value is the same. A figure higher than 1 indicates the factor by which limit value in the Directives is higher than given in the WHO guidelines [R20].

Table 6 EU limit values in correspondence to WHO guidelines/reference levels

Substance	EU/WHO
BaP [year] (T, RL)	8.33
SO_2 [day]	6.25
C_6H_6 [year] (RL)	2.94
$PM_{2.5}$ [year]	2.5
PM_{10} [day]	1
PM_{10} [year]	2
NO_2 [hour]	1

NO_2 [year]	1
O_3 [8 hours] (T)	1.2

Note: T: target value; RL: reference level.
Source: Adapted from R20].

US NAAQS

National air quality standards

In the United States, air quality standards are categorised for ambient and hazardous pollutants [S55]. The ambient standards are set by the US EPA pursuant to the Clean Air Act (40 CFR part 50) for six principal pollutants (the so called "criteria air pollutants"). These include O_3, CO, SO_2, NO_2, PM and Lead. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings [D54]. As shown in the table below, a number of the current EU standards is more restrictive compared to those adopted in the U.S (e.g. for PM_{10}) and a larger number of chemical compounds is being monitored [see also S80]. In contrast for $PM_{2.5}$ both a yearly and daily standard is provided in the US and the allowed yearly concentration for $PM_{2.5}$ in the US (12 and 15 µg/m³) is considerably lower than the current EU standard (of 25 µg/m³).

Table 7 US standards for criteria air pollutants

Pollutant		Primary/secondary	Averaging time	Level	Form
Particulate matter (PM)	$PM_{2.5}$	Primary	1 year	12.0 µg/m³	Annual mean, averaged over 3 years
		Secondary	1 year	15.0 µg/m³	Annual mean, averaged over 3 years
		Primary and secondary	24 hours	35 µg/m³	98th percentile, averaged over 3 years
	PM_{10}	Primary and secondary	24 hours	150 µg/m³	Not to be exceeded more than once per year on average over 3 years
Nitrogen dioxide (NO_2)		Primary	1 hour	100 ppb*	98th percentile of 1-hour daily maximum concentrations
		Primary and secondary	1 year	53 ppb	Annual mean

Sulfur dioxide (SO_2)	Primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year
Ozone (O_3)	Primary and secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Carbon monoxide (CO)	Primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead (Pb)	Primary and secondary	Rolling 3 month av-erage	0.15 µg/m³	Not to be exceeded

Source: [D54].
* ppm = parts per million; ppb = parts per billion.

China

Zhao et al. described and compared the China AQ standards to the US, the EU, Japan and the WHO's air quality guidelines [S127]. As shown in the table below the comparison focused on the primary pollutants in the US's National Ambient Air Quality Standards (NAAQS), the EU Air Quality Framework Directive (i.e. the predecessor of the AAQ), the Japan's environmental Quality Standards (eQSs) and the WHO’s Air Quality Guidelines.

Table 8 Comparison of the China's AAQS with other national and organisational standards

		Threshold concentration (µg/m³)					
Pollutant	Average period	China's AAQS Grade-I	China's AAQS Grade-II	US's NAAQS (Primary)	EU's AQFD	Japan's EQSs	WHO's AQGs
SO_2	10 min						500
	1 h	150	500	214	350	261.6	
	24 h	50	150		125	104.6	20
	1 year	20	60				
CO	1 h	10 000	10 000	40 000			
	8 h			10 000	10 000	22 900	
	24 h	4 000	4 000			11 400	
SPM	1 h					200	
	24 h					100	
PM_{10}	24 h	50	150	150[a]	50[e]		50
	1 year	40	70		40		20
$PM_{2.5}$	24 h	35	75	35[b]	25[e]	35[f]	25
	1 year	15	35	12[c]	20	15	10
NO_2	1 h	200	200	205.3[d]	200		200
	24 h	80	80			75–113	
	1 year	40	40	108(53 ppb)	40		40
O_3	1 h	160	200			118(O_x)	
	8 h	100	160	160.7(75 ppb)	120		100

Notes: [a]Not to be exceeded more than once per year.
[b]To attain this standard, the 3-year average of the 98th percentile of 24-h concentrations at each population-oriented monitor within an area must not exceed 35 µg/m³.
[c]To attain this standard, the 3-year average of the weighted yearly mean PM2.5 concentrations from single or multiple community-oriented monitors must not exceed 15 µg/m³.
[d]With 98th percentile.
[e]EU target value; will be limit value to be met by 1 January 2015.
[f]Not to be exceeded more than once a calendar year.

Source: [S127].

Zhao et al concluded that – comparing the EU's standards and China's AAQS, EU had a "moderate" standard for SO_2 (1-hour average), but the same standard for CO (8- hour average) for both Grade-I and II.[15] It was also found that the EU standard for PM_{10} (24-hour average) was the same as the Chinese AAQS Grade I, but more stringent compared to that of China's AAQS Grade-II. Similarly, the yearly average standard for $PM_{2.5}$ was found "relatively loose" compared with China's AAQS Grade-I, but slightly more stringent compared to China's AAQS Grade-II. The standard for NO_2 (yearly average) was found to be essentially the same. Finally, the EU standard for ozone (8-hour average) was found to lie in between China's AAQS Grade-I and II.

Switzerland

In Switzerland the Clean Air Ordinance (LRV) has been recently revised. The revisions include the introduction of an annual limit value for $PM_{2.5}$ that is in line with the WHO recommendations.

[15] Grade I is applicable to natural reserves, scenic areas and other specially protected areas in China. Grade II is applicable to residential areas, commercial-traffic-residential areas, cultural areas, industrial areas and rural areas in China.

Table 9 Comparison between Swiss air quality standards, the WHO air quality guidelines and Directive 2008/50/EC

	Switzerland		WHO		EU	
Pollutant	Concentration	Statistical indicator	Concentration	Statistical indicator	Concentration	Statistical indicator
PM_{10}	20 µg / m³	Annual mean	20 µg/m³		**Limit value, 40 µg/m³**	
PM_{10}	50 µg / m³	24-hour average value; may not be exceeded more than three times a year	50 µg/m³ (*)	99th percentile (3 days/year)	Limit value, 50 µg/m³	**Not to be exceeded on more than 35 days per year**
$PM_{2.5}$	10 µg / m3	Annual mean (arithmetic mean)	10 µg/m³		**Limit value, 25 µg/m³**	

Source: [L7].

Particulate matter

Table 10 Comparing of $PM_{2.5}$ standards in different countries

***Table 3.** Comparative analysis of NAAQS for criteria pollutants*

Pollutants	Developed Countries				Developing Countries							International
	UK/EU 2005 [a]	US [b]	Australia [c]	British Columbia [d]	South Africa [e]	Mexico [f]	China I [g]	China II [g]	China III [g]	India I [h]	India II [h]	WHO [i]
SO_2 (µg/m³)												
1 hr	350, 24/year [j]		200	900	350, 88/year		150	500	700			
24 hr	125, 3/year	365, 1/year	80	260	120, 4/year	0.13 ppm 1/year	50	150	250	80	80	125
Annual	20		20	50	50	0.03 ppm	20	50	100	50	20	50
NO_2 (µg/m³)												
1 hr	200, 18/year, (EU 2010)		120	400	200, 88/year	0.21ppm, 1/year	120	120	240			200
24 hr				200			80	80	120	80	80	
Annual	40 (EU, 2010)	100	30	60	40		40	40	80	40	30	40
PM_{10} (µg/m³)												
24 hr	50, 35/year	150, 1/year	50	50	120, 4/year	120	50	150	250	100	100	50
Annual	40	50			50	50	40	100	150	60	60	20
$PM_{2.5}$ (µg/m³)												
24 hr		35, 98%	25	25		65	50	150	250	60	60	25
Annual	25	15	8	8		15	40	100	150	40	40	10
CO (µg/m³)												
1 hr		40 000, 1/year		28 000	30 000, 88/year		10 000	10 000	10 000	4 000	4 000	30 000
8 hr	10 000	10 000, 1/year	9 000	11 000	10 000, 11/year	11 ppm 1/year				2 000	2 000	10 000
24 hr							4 000	4000	4 000			

[a] Source: http://uk-air.defra.gov.uk/documents/National_air_quality_objectives.pdf
[b] Source: http://www.epa.gov/air/criteria.html
[c] Source: http://www.environment.gov.au/topics/environment-protection/air-quality/air-quality-standards#air
[d] http://www.bcairquality.ca/reports/pdfs/aqotable.pdf
[e] DEA (2009)
[f] http://transportpolicy.net/index.php?title=Mexico:_Air_Quality_Standards (PM_{10} and $PM_{2.5}$ value should be met at 98% of the time in a year)
[g] China: Zone I: Residential areas; Zone II: Commercial areas; Zone III: Industrial areas (http://www.vecc-sepa.org.cn/eng/news/news_detail.jsp?newsid=e00397)
[h] India I -Industrial, Residential, Rural and other area, India II -Ecological sensitive area, 98 % of the time in year
[i] WHO-AQG (WHO, 2005)
[j] 24 per year means 24 exceedances per year are permitted

Source: [S55].

The target values are outlined in the table below.

Arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons

Table 11 Target values for arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons

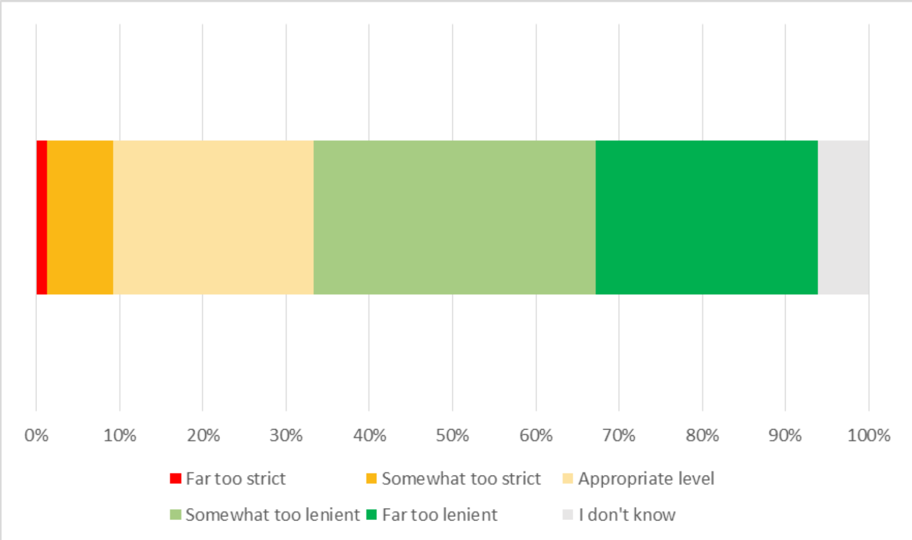
Pollutant	Concentration	Averaging period	Legal nature
Arsenic	6 µg/m³	1 year	Target value
Cadmium	5 µg/m³	1 year	Target value
Nickel	20 µg/m³	1 year	Target value
Polycyclic Aromatic Hydrocarbons	1 µg/m³/m₃ (expressed as concentration of Benzo(a)pyrene)	1 year	Target value

Source: Directive 2004/107/EC.

B. Results: Open public consultation

A majority of the 478 respondents to the open public consultation question 4.1.5 felt that the standards in the AAQ are somewhat lenient or far too lenient (Figure 10).

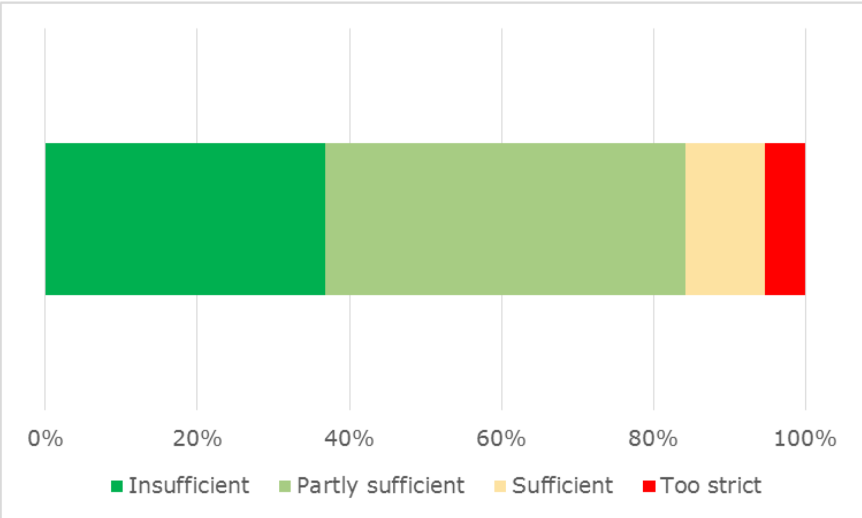
Figure 10 Stakeholders' views on the standards provided by the AAQ Directives



Source: Open public consultation Question 4.1.5: What is your view on the level of the air quality standards set in the Ambient Air Quality Directives? N=478.

19 respondents to the targeted questionnaire provided an answer to the question regarding whether the targets, thresholds and obligations set out by the AAQ Directives are set at such a level so as to protect human health and environment. Out of these two respondents found the targets provided by the Directive generally sufficient but highlighted a need to ensure compliance with the existing standards, among other things, by laying down an obligatory roadmap to compliance. One respondent indicated that the current daily limit values for PM_{10} were too stringent. Seven respondents found the standards insufficient to protect human health and/or the environment taking into account the current WHO air quality guidelines or their update. 14 respondents found the standards partly sufficient and identified specific pollutants with respect to which the standards provided by the AAQ Directives are presumably insufficient. The standards for $PM_{2.5}$ were among those most frequently mentioned.

Figure 11 Stakeholders views on the standards provided by the AAQ Directives



Source: Targeted questionnaire, Question 3: Are the targets, thresholds and obligations set out in the AAQ Directive set at as such a level so as to protect human health and environment? N=19.

For example, an environmental NGO put forward that while the AAQ Directives have been helpful in stimulating national action on air quality, they are not yet fully protecting the health of citizens since the World Health Organisation (WHO) states that particulate matter (PM) is harmful to health at levels well below the limits currently set out in the EU Directive. This means that citizens across the EU, particularly those with heart and circulatory conditions, are still being exposed to levels of air pollution that put their health at risk [Questionnaire, Answer no 5].

An environmental NGO suggested that the limit values need to be consistent with the WHO recommendations. It was noted that this would, among other things motivate areas complying with the current regulation to pursue their efforts in favour of public health [Questionnaire, Answer no 3].

Similarly, an educational/scientific organisation suggested that the AAQ Directives directive has been a step in the right direction for the improvement of air quality and protection of public health in urban European centres, based on the epidemiological evidence at the time of its issue. Nevertheless, enhancement of knowledge supports strengthening the standards as results point to effects at low levels below the current standards. In addition, considering pollutants not monitored until now is necessary to address the changing profile of air pollution mixture and it associated health effects, especially among susceptible groups such as the elderly, children and people with pre-existing diseases." [Questionnaire, Answer no 14].

Similarly, a health NGO put forward that while the AAQ Directives set the provisions to improve the air quality in Europe, there is a room to better address the current need of people to actually breathe healthy air by 1) further restricting air pollution levels and 2) by increasing the information on the health and environmental consequences of air pollution and health protection of EU citizens, especially for the more vulnerable ones such as patients with allergy and airways diseases [Questionnaire, Answer no 9 and similarly the answer provided by the NGO interviewed in the context of the Slovak case study]. As far as information to the public is concerned, it was highlighted by a Member State authority that there was an increasing public demand towards having more restrictive limit values (in line with the ones set by WHO) [Questionnaire, Answer no 22].

A Member State authority has pointed out that there are some discrepancies between the emissions levels set by WHO recommendations and AAQ Directives for some of the pollutants. It was put forward that the WHO recommendations are set in order to ensure human health, therefore the levels set by AAQ Directives should as ambitious as the WHO ones. This was highlighted as especially relevant taking into account that in many countries administrations only take actions when is required by a legal act [Questionnaire, Answer no 22].

A group of NGOs suggest that the targets, thresholds and obligations set out in the AAQ Directives represent a useful interim target towards achieving "levels of air quality that do not give rise to significant negative impacts on, and risks to human health and environment", the objective stated in the 7th and previous EU Environmental Action Programmes. However, it was also highlighted that the targets currently set out in the AAQ Directives, in most cases, do not reflect the latest scientific evidence about the harmful effects of air pollution on human health and the environment. It was put forward that the EU air quality standards were the result of political compromise and not science-based, as in the case of the possibility of having 35 days of exceedances for the daily mean PM_{10} [Questionnaire, Answer no 20 and an NGO interviewed in the context of the Slovak case study].

A number of stakeholders also highlighted the issue of economic viability of following the WHO guidelines [Questionnaire, Answer no 16]. An industry association suggested that emphasis should be on addressing an efficient and better implementation of the targets already fixed, before considering any changes [Questionnaire, Answer no 13]. In general, industry associations highlighted the importance of the fact that the requirements in the framework for air quality protection are cost-effective, reachable by the industry with available technologies, and in line with the Best Available Techniques (BAT) as already defined in the Industrial Emissions Directive (IED) [Questionnaire, Answers no 6 and 12, and the industry representative interviewed in the context of the Slovak case study]. Another industry association noted that concerning current and future limit values more time and flexibilities for the implementation in the Member States is required [Questionnaire, Answer no 24].

Finally, a business association suggested that the daily maximum values for PM_{10} from has become obsolete. It was argued that the daily mean value (DMV 50 µg/m³ with a maximum of 35 days of exceedance days/year) is far too strict in relation to the yearly mean value (YMV 40 µg/m³) and should be increased to about 55 permitted exceedance days so as to correlate with the YMV. It was highlighted that for health protection the yearly mean value is significantly more relevant than the daily mean value [Questionnaire, Answer no 24]. This view has not been shared by any of the other stakeholders consulted.

Summary of the main findings

Evidence of improved air quality in the EU over the past few decades as regards several pollutants show that the targets, thresholds and obligations laid down by the AAQ Directive have been helpful from 2008 to 2018 in stimulating national action on air quality and that they still represent a key tool to improve air quality.

The Impact Assessment underpinning the 2013 Clean Air Policy Package recognised that the various ambient air quality standards were set as interim objectives rather than at the low impact levels recommended by the WHO and other scientific bodies and, as such do not solve the substantial outstanding health and environmental problems [P38]. Furthermore, the review of recent scientific evidence indicates that the air quality standards laid down by the AAQ Directives are not fully reflective of the most recent and robust evidence available suggesting serious adverse health effects at lower concentration levels.

The findings of the evaluation also show that a number of standards laid down by the AAQ Directives is less stringent compared to the current WHO Air Quality Guidelines for the protection of human health. This is the case in particular for $PM_{2.5}$ (yearly mean concentration), PM_{10} (yearly mean concentration and, looking at the statistical indicator, also the daily mean concentration), SO_2 (daily mean concentration). In addition, the AAQ Directives do not set short-term standards for $PM_{2.5,}$ which are considered important in order to protect against the peaks of pollution that would otherwise lead to substantial excess morbidity or mortality.

A group of NGOs suggest that the targets, thresholds and obligations set out in the AAQ Directives represent a useful interim target towards achieving "levels of air quality that do not give rise to significant negative impacts on, and risks to human health and environment", the objective stated in the 7th and previous EU Environmental Action Programmes. However, it was also highlighted that the targets currently set out in the AAQ Directives, in most cases, do not reflect the latest scientific evidence about the harmful effects of air pollution on human health and the environment. It was put forward that the EU air quality standards were the result of political compromise and not science-based, as in the case of the possibility of having 35 days of exceedances for the daily mean PM_{10} [Questionnaire, Answer no 20 and an NGO interviewed in the context of the Slovak case study].

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D.1.4 JC 1.4: Adaptability to technical and scientific progress

This section provides further detail on the approach and evidence linked to *JC 1.4: The extent to which standards, assessment methods and obligations have kept up with advances in technical and scientific progress.*

Approach

The approach to answer the evaluation sub-question is twofold. Firstly, to assess the extent to what the Directives are adaptable to technical and scientific progress the procedure applicable to revisions of the AAQ Directives is reviewed. Secondly, it is examined to what extent these procedures have been utilised and whether revisions were adopted with the view to adapt the Directives to advances in scientific knowledge and/or technical capacities.

Limitations to the approach

There is extensive scientific and grey literature with quantitative data on new techniques in air quality measurements and modelling, in comparison to techniques used operationally in the EU. There is much greater uncertainty in literature and reports dealing with the more subjective aspects of air quality management, such as development of air quality plans and programs. There are very few quantitative and peer-reviewed studies of the operational planning process, and implementation of new techniques for air quality planning, and the available studies only cover a small sample of EU cities or regions.

Results

Directive 2008/50/EC

Pursuant to Article 28 (1) of Directive 2008/50/EC measures designed to amend the *non-essential elements* of the Directive (i.e. Annexes I to VI, Annexes VIII to X and Annex XV) shall be adopted through a regulatory procedure with scrutiny by a Scrutiny Committee composed of the representatives of the Member States,[16] as described in the Council Decision 1999/468/EC.

In 2015 several annexes to Directive 2008/50/EC were amended by Commission Directive (EU) 2015/1480 of 28 August 2015. Directive 2015/1480/EU laid down rules concerning reference methods, data validation and the location of sampling points for the assessment of ambient air quality. Specifically, the Directive amended certain provisions of Annexes I (laying down criteria for quality assurance for the for ambient air quality assessment), Annex III (laying down criteria for the siting of sampling points), Annex VI (laying down reference method for the measurement of certain pollutants) and Annex IX concerning the minimum number of sampling points for fixed measurements of concentrations of ozone. As provided in the recitals to Directive 2015/1480/EU, amendments were needed partly in order to clarify the existing criteria, but also to complement the criteria taking into account, among other things, the experience gained in implementing the Directive and "*most recent standards for the sampling and measurement of particulate matter*".

In addition to establishing a specific procedure for the amendment of certain non-essential elements of the Directive, Article 32 of Directive 2008/50/EC called for a review of the provisions related to $PM_{2,5}$ and, as appropriate, other pollutants in 2013. As specified in Article 32, as regards $PM_{2.5}$ the review shall be undertaken "*with a view to establishing a legally binding national exposure reduction obligation in order to replace the national exposure reduction target and to review the exposure concentration obligation laid down in Article 15, taking into account, inter alia, the*

[16] Note that the procedure can no longer be used in new legislation, but will continue to apply until the Directive is formally amended.

following elements: latest scientific information from WHO and other relevant organisations, air quality situations and reduction potentials in the Member States, the revision of Directive 2001/81/EC, progress made in implementing Community reduction measures for air pollutants."

Article 32(2) provided specifically, that the Commission shall take into account the feasibility of adopting a more ambitious limit value for $PM_{2.5}$, review the indicative limit value of the second stage for $PM_{2.5}$.[17] Finally, Article 32(3) stipulated that as part of the review and, of appropriate, new reference methods for the measurement of PM_{10} and $PM_{2.5}$ shall be proposed.

As elaborated on above in EQ1.3, the air policy review did not consider further tightening of the existing EU air quality standards appropriate, and, as such has not resulted in amendments of the air quality standards laid down in Directive 2008/50/EC. As far as reference methods for PM_{10} and $PM_{2.5}$, these were, as presented above, amended by Directive 2015/1480/EU.

The regulatory procedure with scrutiny, as described above, does not apply to the revision of *essential elements* of the Directive, including the limit values, exposure reduction targets, critical levels, target values, information or alert thresholds or long-term objectives specified in Annex VII and Annexes XI to XIV. Such provisions can only be amended following the ordinary legislative procedure as described in Article 192 of the TFEU.

One respondent to the targeted questionnaire replied that 2008/50/EC Article 32 expressly re-quested the Commission to review the standard for $PM_{2.5}$ by 2013 and present a proposal to the European Parliament and the Council, but even though it was clear in 2013 that the annual limit value for $PM_{2.5}$ was too weak to protect human health, the Commission has not presented any proposal to adapt the standard in light of the growing scientific evidence [Questionnaire, Answer 20].

One respondent emphasised the importance of a solid scientific basis when establishing standards, and that when the PM_{10} was established, important factors such as resuspension on road surfaces or natural sources were not adequately taken into account, which has continuing consequences for Member States [Questionnaire, Answer 24].

Reference methods

The reference methods for air quality measurements have been essential to provide comparable data on pollutant levels across the EU, but some technical issues have arisen. Stakeholders in Germany have pointed out that the current reference method for NO_2 is not suitable for regional background measurements, because the levels of NO_2 are very low. The reference method for PM_{10} and $PM_{2.5}$ is a 24-hour filter measurement, requiring laboratory processing that delays the results. There is a strong need for real-time measurements of PM_{10} and $PM_{2.5}$ for information to the public, which requires alternate methods (that must be shown to be equivalent). Stakeholders in Germany indicate that the procedure to demonstrate equivalence to the reference method is very complicated. This may hinder the adoption of new and alternative methods.

Modelling

The AAQ Directives provides the option (but not the obligation) to use modelling to supplement information from fixed sampling points. The AAQ Directives provides that "The results of modelling and/or indicative measurements shall be taken into account for the assessment of air quality with respect to the limit values." Although many Member States use modelling, few Member State

[17] Annex XIV of Directive 2008/50/EC provided an indicative limit value for $PM_{2.5}$ to be met by 1 January 2020. With respect to this value a review by the Commission in 2013 was foreseen "*in the light of further information on health and environmental effects, technical feasibility and experience of the target value in Member States*".

have regularly submitted modelling results as part of the assessment documentation, which indicates that the AAQ Directives is not sufficiently clear about the use of modelling and the need to report modelling results. (see main report section 6.2.1.1 and Table 6-5 for additional information on modelling).

There has been extensive progress on modelling through FAIRMODE, but the AAQ Directives has not been updated regarding reference methods or clarifications of requirements for modelling. Intercomparison exercises under FAIRMODE and AQUILA [R129] have for example shown that for modelling to be effective, an adequate number of background monitoring stations are needed. Flexibility on the choice of station types to meet the minimum number of stations in a zone (AAQ Directives Article 7.1 and Annex III) does not reflect is need and can lead to Member States having an inadequate number of background stations for effective use of modelling.

Emission inventories are essential to air quality planning, source apportionment, and as input to modelling, but the AAQ Directives does not mention emission inventories. Although there is extensive guidance available on emission inventories (including for NECD and GHG inventories), the AAQ Directives provides no standards or data quality objectives for this essential aspect of local air quality management.

Indicative measurements

Similar to modelling, the AAQ Directives provides the option to use indicative measurements to supplement data from fixed sampling points. Although data quality objectives and minimum data and time coverage are specified in the AAQ Directives, there are no reference methods. Indicative measurements are valuable to provide information about the spatial variation of pollutant concentrations and human exposure, but each Member State applies a different approach, making it difficult to compare the supplementary information provided. There is also no obligation to report indicative monitoring to the Commission.

One respondent to the targeted questionnaire noted that greater flexibility in the AAQ Directives would have allowed Member States to make better use of emerging technologies like the use of satellite data, optical path technologies and electro-chemical sensor technologies in the assessment process - even if not permissible for compliance testing - but these are not able to be used in a reporting context, which inhibits their more widespread use [Questionnaire, Answer 38].

Directive 2004/107/EC

Directive 2004/107/EC, was amended in 2009 and 2015. The 2009 amendments related to the possibility to adapt certain (non-essential) provisions and Annexes of the Directive to scientific and technical progress in accordance with the regulatory procedure with scrutiny.[18]

As such, Article 4 of the Directive, addressing the assessment of ambient air concentrations and deposition rates, and section II of Annex II and of Annexes III to V can be adapted to scientific and technical progress in accordance with the regulatory procedure with scrutiny. Similarly as in the case of Directive 2008/50/EC this procedure cannot be used in order amend, directly or indirectly, the target values laid down by the Directive.

The 2015 Directive amended a number of the Annexes to the Directive 2004/107/EC in relation to the data quality objectives and the reference methods for assessment of concentrations of various pollutants.

Moreover, Article 8(2) of the Directive calls for the examination – by 31 December 2010 - of the effect of arsenic, cadmium and nickel on human health in the light of the latest scientific and

[18] As above.

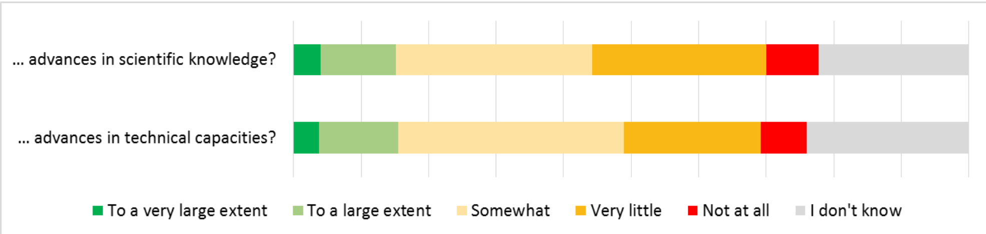
technological developments and for the Commission to consider further action in relation to mercury, taking account of "*technical feasibility and cost-effectiveness and any significant additional health and environmental protection that this would provide*". Finally, Article 8(3) foresees that the review, finalised in 2013 [R171], carried out pursuant to Article 8 may be accompanied, if appropriate, by proposals for amendments to this Directive.

Text box 6 Open public consultation results: Stakeholders' views on flexibility of Directives to adapt

The results of the open public consultation show diverse views with respect to the flexibility of the AAQ Directives to adapt to advances in scientific knowledge. Approximately 4% of the respondents to the open public consultation indicated that the AAQ Directives have been flexible to adapt to new circumstances as regards advances in scientific knowledge to a very large, while 11% indicated that they have been flexible to a large extent. On the other hand, 8% of the respondents indicated that the Directives have not at all been flexible to adapt to new circumstances, 26% indicated that they have been very little flexible and 29% indicated that they have been somewhat flexible.

As far as flexibility to adapt to advances in technical capacities, the picture looks similar. 5% of the respondents indicated that the Directives have been flexible to adapt to new circumstance to a very large and 15% indicated that the Directives have been flexible to a large extent. 7% of the respondents suggested that the Directives have not been flexible at all, 20% suggested that the Directives have been very little flexible and 34% indicated that the Directives have been somewhat flexible to adapt to advances in technical capacities.

Figure 12 Flexibility of the Directives to adapt



Source: Open public consultation, Question 6.7: To what extent have the Ambient Air Quality Directives been flexible to adapt to new circumstances as regards advances in scientific knowledge and advances in technical capacities? N=477, 478.

Summary of the main findings

The findings of the evaluation show that the AAQ Directives have provided a degree of flexibility over time in relation to amending non-essential elements of the Directives and this opportunity has been used at one occasion to, among other things, account for the experience gained in implementing the Directive and the most recent standards for the sampling and measurement of different pollutants. Moreover, the Directives provided for a review of some of their essential elements, in 2013 and by the end of 2010 (for the respective Directives). However, there are no specific mechanisms integrated in the Directives laying down an obligation to carry out a periodic review of the Directives with the view of adapting the Directives to the latest technical and scientific progress.

Table 12 Amendments to Directive 2008/50/EC

Act	Comment	Sub-division concerned	From
32015L1480	Replacement	Annex III SECTION C Paragraph 1 TIRE 1	18/09/2015
32015L1480	Replacement	Annex III SECTION D	18/09/2015
32015L1480	Deletion	Annex VI SECTION D	18/09/2015
32015L1480	Replacement	Annex VI SECTION E	18/09/2015
32015L1480	Replacement	Annex III SECTION C Paragraph 1 TIRE 5	18/09/2015
32015L1480	Replacement	Annex III SECTION C Paragraph 1 TIRE 2	18/09/2015
32015L1480	Replacement	Annex IX SECTION A	18/09/2015
32015L1480	Replacement	Annex I SECTION C	18/09/2015
32015L1480	Completion	Annex III SECTION C Text	18/09/2015
32015L1480	Replacement	Annex VI SECTION A	18/09/2015

Source: Eurlex.

Table 13 Amendments to the Directive 2004/107/EC

Act	Comment	Sub-division concerned	From
32009R0219	Amendment	Article 4	20/04/2009
32009R0219	Replacement	Article 5.4	20/04/2009
32009R0219	Replacement	Article 6.3	20/04/2009
32015L1480	Replacement	Annex V SECTION I	18/09/2015
32015L1480	Deletion	Annex IV SECTION I Paragraph 3 Sentence	18/09/2015
32015L1480	Replacement	Annex IV SECTION I TABL	18/09/2015
32015L1480	Replacement	Annex V SECTION II	18/09/2015
32015L1480	Replacement	Annex V SECTION III	18/09/2015
32015L1480	Completion	Annex IV SECTION I Text	18/09/2015
32015L1480	Replacement	Annex V SECTION IV	18/09/2015

Source: Eurlex.

D.1.5 JC 1.5: Essential and non-essential elements of the AAQ Directive

This section provides further detail on the approach and evidence linked to *JC 2.2: The extent to which elements of the Directives have become redundant in light of key EU air quality priorities.*

Approach

The analysis relied on the review of the AAQ Directives as well as results from the targeted consultation and the case studies.

Limitations to the approach

Given that the results rely primarily on desk research, no limitations to the approach are identified.

Results

Essential elements of the AAQ Directives

Short-term priority

The review of the provisions of the AAQ Directives show that the Directives set a wholesome system to monitor and manage air quality. To improve air quality and, in this connection, achieve full compliance with the existing air quality standards, three elements within the air quality monitoring and management system established by the AAQ Directives have been identified as essential.

Firstly, the requirement to draw up air quality plans (Article 23 of Directive 2008/50/EC) and short term action plans (Article 24 of Directive 2008/50/EC) ensure that appropriate plans are drafted in case of an exceedance of a limit or target value with the view to "*achieve the related limit or target value*", but also in case of a risk of exceedance of one or more alert threshold "*to reduce the risk or duration of such an exceedance*". The obligation to adopt air quality plans under Article 23 has been one of the cornerstones of the AAQ Directives and one of the most effective provisions to ensure the improvement of air quality across the EU. It sets an obligation of result "as soon as possible". Legal actions by individuals and NGOs would not have been possible without the obligation to adopt air quality plans that set out appropriate measures to achieve compliance as soon as possible.

Secondly, the elements of the Directive concerning assessing ambient air quality in order to monitor trends (Articles 3, 4, 5, 6, and 9 of Directive 2008/50/EC and Articles 4 (1), (2), (3), (4), (5), (6), (7), (8), (9), (11),(12) and (13) of Directive 2004/107/EC and the relevant Annexes) ensure the availability of information on exceedances or risk thereof so that appropriate action, as described above, can be taken to achieve the applicable standards. The AAQ Directives have ensured a high level of harmonisation for monitoring and assessment of air pollution across the EU, especially in relation to fixed monitoring stations. All of the provisions regarding monitoring and assessment are important to ensure the achievement of Objective 1. The availability of comparable air quality data across the EU has been essential to ensure better public information, raising public awareness and enabling citizens and NGOs to identify areas of poor air quality and to take legal action to enforce air quality standards. The availability of comparable air quality data has also enabled research on the health and environmental impacts of air pollutants across the EU, which is essential for establishment and revision of air quality standards.

Finally, the elements of the Directives laying down air quality standards (Articles 12, 13, 14(1), 15, 16, 17(1) of Directive 2008/50/EC and Article 3 (1) of Directive 2004/107/EC and the respective Annexes) are essential as these elements set binding obligations to guide Member States' actions to improve air quality. Similarly, the Court of Auditors found that the 2008 Directive is the cornerstone of the EU's clean air policy, as it *"sets concentration limits for pollutants in the air we breathe.*"[P91] Binding and enforceable air quality standards have allowed the development of the right to clean air in Europe, and to ensure that national and local authorities are committed to improve air quality – through legal action if necessary. Without these standards, each Member State would be free to set its own air quality standards, based on different levels of protection of human health and the environment.

To maintain air quality (where it is good) Articles 12 and 18 are key. Article 12 of Directive 2008/50/EC lays done the requirement that for zones and agglomerations where the levels of SO_2, NO_2, PM_{10}, $PM_{2.5}$, lead, benzene and CO in the ambient air are below the respective limit values, Member States "*shall maintain the levels of those pollutants below the limit values and shall endeavour to preserve the best ambient air quality, compatible with sustainable development.*" Within this requirement, it is possible that an air quality plan to comply with limit values in one area could result in raising concentrations in another area, for example by traffic diversion away from a hot spot to other cleaner areas of a city – as long as the limit value was not exceeded in the other area. For limit values greater than the WHO guidelines, this requirement allows spatial shifting of the pollutant burden on health, as long as the limit value is complied with. A stronger requirement here would prohibit measures that lead to increases in pollutant concentrations in other areas.

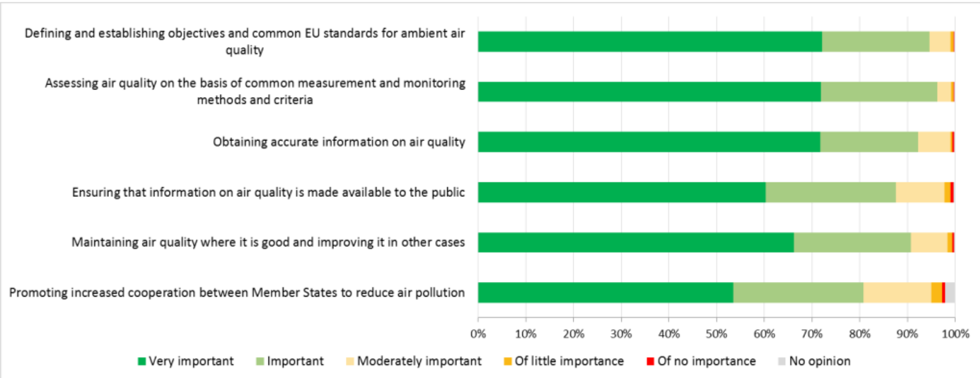
Regarding ozone, Article 18 requires Member States, in so far as factors including the transboundary nature of ozone pollution and meteorological conditions permit, to "*maintain those levels* *below the long-term objectives and shall preserve through proportionate measures the best ambient air quality compatible with sustainable development and a high level of environmental and human health protection*."

There was a general consensus among stakeholders who have provided answers to the targeted questionnaire that the AAQ Directives have a key role in driving action to reduce concentrations of pollutants in ambient air (at least) below the existing limit values. Binding enforceable rules on air quality objectives, air quality plans, monitoring and information to public and were among those provisions of the AAQ Directives most frequently cited as essential to deliver air quality improvements.

Text box 7 Open public consultation results: Stakeholders' views on importance of objectives/elements

Each of the objectives/elements of the Directives has been has been considered as important in delivering air quality improvements by the respondents to the open public consultation. The three provisions of the AAQ Directives with highest importance (important or very important) for delivering air quality improvements were: 'assessing air quality on the basis of common measurement and monitoring methods and criteria' (96%); 'defining and establishing objectives and common EU standards for ambient air quality' (95%); and 'obtaining accurate information on air quality' (92%).

Figure 13 Importance of the AAQ Directives' objectives/elements



Source: Open public consultation, Question 6.2: In your opinion, to what extent are the following provisions of the Ambient Air Quality Directives important in delivering air quality improvements? N=481; 483; 485; 481; 483; 480 (for the different objectives).

Long-term priority

As for the long-term strategic priority to ensure no exceedance of the WHO guideline levels for human health and of the critical loads and levels which mark the limits of ecosystem tolerance, preamble 2 of Directive 2008/50/EC suggests that appropriate objectives for ambient air quality should be set "*taking into account relevant World Health Organisation standards, guidelines and programmes*". The objectives of Directive 2008/50/EC thus in principle coincide with the long-term priority of moving closer/ensuring no exceedance of the WHO Air Quality Guidelines.

The review of the AAQ Directives nonetheless showed that a number of the air quality standards set by the Directive is less stringent compared to the guideline values recommended by the WHO for the protection of human health (see EQ1.3 above) and the Directive itself lacks any specific tools/incentives for further improvement of local air quality beyond the limit and target values. As such, while, as discussed above, a number of elements was identified as essential to improve air quality, no elements were identified as specifically contributing to ensuring no exceedances of the WHO guideline levels for human health and of the critical loads and levels which mark the limits of ecosystem tolerance in the long term. This finding is supported by the Clean Air Programme for Europe. The Clean Air Programme envisages that the revised NEC Directive will be the *main tool* to drive down background concentrations across Europe, "*bringing major benefits for public health and ecosystems.*" [P37].

It was also the prevailing view among the respondents to the targeted questionnaire that the long-term priority of ensuring no exceedance of the WHO recommended levels and tolerance limits and critical levels which mark the limits of ecosystem tolerance is not well served by the current Directives. Though the AAQ Directives Annex provides for SO_2 and NO_x critical levels (Art. 14 of Annex XIII), exceedance of critical levels does not require development of a plan to achieve the critical levels as quickly as possible as is the case for limit values, making these provisions less effective and relevant as if these had been limit values.

Non-essential elements of the AAQ Directives

The assessment of the provisions of the Directives against the key priorities of EU air policy showed that in order to achieve the short-term priority of achieving full compliance with the existing air quality standards, three elements within the air quality monitoring and management system established by the AAQ Directives are essential: the requirement to draw up air quality plans (Article 23 of the Directive) and short term action plans (Article 24), the elements of the Directive concerning assessing ambient air quality in order to monitor trends (Articles 3, 4, 5, 6 and 9 of Directive 2008/50/EC and Articles 4 (1), (2), (3), (4), (5), (6),(7), (8), (9), (11), (12) and (13) of Directive 2008/50/EC and the relevant Annexes) and the elements of the Directives laying down air quality standards (Articles 12, 13, 14(1), 15, 16, 17(1) of Directive 2008/50/EC and Article 3 (1) of Directive 2004/107/EC and the respective Annexes).

As far as the long-term priority of ensuring no exceedances of the WHO guideline levels for human health and of the critical loads and levels which mark the limits of ecosystem tolerance, the objectives of the AAQ Directives are aligned with the priorities, but no elements of the Directives were identified as specifically contributing to achieving the priorities.

The review of the Directive also identified three provisions that may be considered to have become redundant. This is the case for Article 22 of Directive 2008/50/EC regarding postponement of attainment deadlines and exception from the obligation to apply certain limit values. This is also the case for the review provisions in Article 32 concerning the 2013 review of provisions related to $PM_{2.5}$ and, as appropriate, other pollutants and the review provision in Article 8 of Directive 2004/107/EC (see EQ1.3).

For example, a group of NGOs has put forward that in order to improve air quality in Europe and reach the clean air objective of the 7th EU Environment Action Programme, it is key to have binding and enforceable rules on air quality objectives (such as the limit values), assessment of air quality, information gathering and publication, air quality plans and transboundary cooperation between authorities [Questionnaire, Answer no 20]. Similarly, an environmental NGO noted that the monitoring and information requirements, as well as the limit values, of the AAQ Directives have allowed for a strong decrease of several primary pollutants as well as enhanced stakeholders' awareness [Questionnaire, Answers no 1 and 4].

Another environmental NGO suggested that measuring, informing and acting, prescribed by the AAQ Directives, are essential to improve air quality in the member states [Questionnaire, Answer no 1]. A health NGO suggested that another key element essential to deliver on the policy priorities is the information to the population, whether it is via emission footprint of products public information in the form of an air quality and health index or promoting active transport options such as cycling [Questionnaire, Answer no 9]. The existence of clear and binding obligations about air quality has also been highlighted key in raising awareness in the public [Questionnaire, Answer no 20].

A regional authority pointed out that in order to "achieve full compliance with existing air quality standards in the short term" the essential element of the Directive to deliver this is the requirement of member states to provide action plans for zones and agglomerations with areas of exceedance (Article 23) [Questionnaire, Answer no 19]. Similarly, an environmental NGO suggested that air quality plans are key elements [Questionnaire, Answer no 7].

Some stakeholders even suggested that all provisions of the Directives are essential. For example, a group of NGOs put forward that in order to achieve reductions of levels of pollutants in ambient air, all the elements of the AAQ Directives are essential since the AAQ Directives have set out a coherent, effective and efficient system to monitor and manage air quality. It was put forward that the weakening of any element of the directives would impact their effectiveness and hinder the achievement of the short-term and long-term objectives [Questionnaire, Answer no 20].

An environmental NGO suggested that the AAQ Directive is not delivering on the Communication for Clean Air in Europe's aims of full compliance with WHO air quality guidelines [Questionnaire, Answer no 5]. Similarly, an environmental NGO highlighted that given that a substantial proportion of the Union's population remains exposed to levels of air pollution, exceeding WHO recommended standards, it's unlikely, based on current trends and on the high and widespread levels of exceedances that the EU air quality standards will be met by 2020 [Questionnaire, Answer no 9].

Similar to the views presented above, the regional authority suggests that the priority "to ensure no exceedance of the WHO guideline levels for human health" is not well served by the AAQ Directives in their current form e.g. because the EU limit for $PM_{2.5}$ exceeds the WHO health-based guideline limit [Questionnaire, Answer no 19]. A group of NGO suggested that while the AAQ Directives are fit to enable compliance with the short-term objective (i.e. full compliance with existing air quality standards), it is clear that in order to achieve the long-term objective (i.e. no exceedance of the WHO guideline levels for human health and of the critical loads and levels which mark the limits of ecosystem tolerance), the current air quality standards will need to be revised and strengthened in line with the growing scientific evidence about health impacts of air pollution [Questionnaire, Answer no 20].

Finally, as regards no exceedance of the critical loads and levels which mark the limits of ecosystem tolerance in the long term a regional authority suggested that the priority is served in the current provisions. However, the authority also noted that the statement in 2008/50/EC that "T*he risk posed by air pollution to vegetation and natural ecosystems is most important in places away from urban areas. The assessment of such risks and the compliance with critical levels for the protection of vegetation should therefore focus on places away from built-up areas*" does not reflect the growing importance of urban green infrastructure [Questionnaire, Answer no 19].

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Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

Final Report

Appendix E: Detailed Evidence for Effectiveness

APPENDIX E DETAILED EVIDENCE FOR EFFECTIVENESS

This appendix provides detailed information supporting the assessment of effectiveness under the study supporting the fitness check of the AAQ Directives. Hence, it complements the evidence presented in the final study report which is used when assessing the effectiveness of the AAQ Directives.

E.1 JC 2.1: Monitoring and assessment of air quality

This section provides further evidence regarding the judgement criterion for the effectiveness of the monitoring and assessment of air quality. It thus covers the first objective of the AAQ Directives, i.e. that sufficient and comparable evidence is gathered to enable the design of actions to maintain or improve air quality.

Objective: Define common methods to monitor and assess air quality and assess ambient air quality in order to monitor trends
Output: Representative, high quality monitoring of air quality in all Member States and competent authorities ensure monitoring and assessment of air quality

JC 2.1: Internal or external factors are identified that influenced the extent to which comparable monitoring and assessment of air quality have been ensured by competent authorities and representative, high quality monitoring of air quality has been achieved in all Member States

The effectiveness of the following Articles and related Annexes in the AAQ Directives are considered under this criterion:

Table 1 Articles and related Annexes: Objective 1

Articles in 2008/50/EC	Annexes in 2008/50/EC	Articles in 2004/107/EC	Annexes in 2004/107/EC
3, 4, 5, 6, 7, 8, 9, 10, 11, 14(2)	Annex I (data quality objectives), Annex II (assessment requirements), III-IV (sampling point locations), V (number of sampling points), VI (reference methods), VIII-X (sampling ozone concentrations+ precursors)	4 ((1), (2), (3), (4), (5), (6), (7), (8), (9), (11), (12), (13))	Annex II, Annex III, Annex IV

Source: COWI, based on the AAQ Directives [P98], [P96].

E.1.1 Approach

This section describes the approach to assess the first indicator, namely the extent to which Member State reporting indicates that competent authorities ensure monitoring and assessment of air quality as stipulated in the AAQ Directives.

The extent to which EU Member States complied with the requirements for fixed measurements was assessed quantitatively by the study team, supplemented by additional sources containing qualitative information. A quantitative assessment was conducted using data from the Air Quality e-Reporting database [D38]. This was supplemented with information from previous air quality reports and infringement cases against Member States on the relevant articles[1], both for additional data (EEA reports), and general descriptions of the assessment situation and shortcomings in the Member States (e.g. infringements). The information was further supplemented by asking targeted stakeholders about their experiences in terms of appropriate implementation of air quality assessment and trend monitoring in the Member States.

Quantitative analysis approach

The assessment of air quality as defined by the AAQ Directives covers a number of methods. In the zones where the concentration of a specific pollutant is above a given threshold (upper assessment threshold - UAT, as defined by the AAQ Directives), fixed measurements are required to assess ambient air quality (but may be complemented by other methods). Fixed measurements of pollutant concentrations are therefore a key assessment method, especially in areas (zones) with concentrations above the UAT. Good data from official Member State air quality reporting are available in terms of sampling points used for fixed measurements and was used to calculate the number of sampling points. Other sources of information were used to cross-check and supplement these, in particular the EEA air quality reports.

Other air quality assessment methods defined in the Directives are modelling, objective estimation and indicative measurements. These can be used to supplement fixed measurements, and, provided certain conditions are met, the requirement for number of sampling points can be decreased.

Member States also report information on these assessment methods as defined in the Commission Implementing Decision 2011/850/EU. Indicative measurements are reported together with the fixed measurements[2], while modelling and objective estimation are reported separately[3]. The period where reporting was migrated from previous spreadsheet-based questionnaires to e-Reporting was marked by low-reporting of the relevant data on use of modelling (see Section E.2.2 for details). For the purposes of this study, combined information on all the methods is used.[4]

The methodology used follows and builds upon that described in the EEA Air Implementation Pilot [R44]. All zones that reported on air quality have been assessed. For each pollutant and each zone, the following steps were taken:

1. Number of sampling points required based on the relevant annexes was calculated, based on population, zone type, and the exceedance attainment status (i.e. below lower assessment threshold, above upper assessment threshold, or between the two), using Air Quality e-Reporting data [D38]. The required number of sampling points is calculated assuming only fixed measurements are used (as defined in Annex IX in 2008/50/EC for O_3, and Annex V in 2008/50/EC for other pollutants covered by this Directive; Annex III in 2004/107/EC). For the pollutants, zones and Member States for which modelling/objective estimation or indicative measurements were reported in the years analysed, this requirement was adjusted depending on the provisions defined in the Directives for specific pollutants.

[1] [D59], [D60], [R86], [R44], [R155].

[2] Reporting Obligations as outlined in the Commission Implementing Decision 2011/850/EU, data flow C, data flow D

[3] Reporting Obligations as outlined in the Commission Implementing Decision 2011/850/EU, data flow D1b

[4] The Member State reporting on assessment methods (D1b) includes both models and objective estimation. Other sources reviewed discuss mainly modelling.

2. Number of sampling points in each zone defined for the specific pollutant was calculated, using information on sampling points reported by Member States (Air Quality e-Reporting data [D38] data flow C).

3. The two values were compared for each zone, to indicate whether the number of sampling points are sufficient.

4. The information was aggregated at Member State level to indicate how many zones were found to have insufficient number of sampling points for specific pollutants.

Table 2 lists the data sources for assessing the fulfilment of the monitoring network requirements for 2013-16. Data prior to 2013 stem from the annual ETC Technical Papers reporting on ambient air quality assessments in the Member States.

Table 2 *Summary of data used for the quantitative assessment of fulfilment of monitoring network requirements, 2013-16*

Data inputs	Source
Minimum number of sampling points for fixed measurements	Annex V in 2008/50/EC [98] Annex III in 2004/107/EC [P96]
Zone population and zone type	Data flow B - Downloaded from the EEA/Eionet e-Reporting database on 23/05/2018 [D38]
Exceedance attainment status (assessment thresholds)	Data flow C - Downloaded from the EEA/Eionet e-Reporting database on 23/05/2018 [D38]
Sampling points used in the assessment (fixed and indicative measurements)	Data flow C - Downloaded from the EEA/Eionet e-Reporting database on 23/05/2018 [D38]
MS deliveries for (D1b) Information on the assessment methods (Articles 8 and 9) - for models and objective estimation	Data flow D1b deliveries – as identified on the Eionet Reportnet 01/10/2018 (reporting deadline 30/09/2018)

Directive 2008/50/EC pollutants other than ozone

As stipulated in Article 7(3) of Directive 2008/50/EC, the number of sampling points listed above may be reduced by up to 50%, provided certain information quality conditions are met. This study did not make an assessment on whether these conditions were met at each location. Instead, it was assumed that those conditions were met, allowing the number of sampling points required by the Directive to be reduced by 50%.

Table 3 *Minimum number of sampling points for fixed measurement to assess compliance with limit values (where fixed measurement is the sole source of information): sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter (PM_{10} and $PM_{2.5}$), lead, benzene and carbon monoxide*

Population of zone (thousands)	If maximum concentrations exceed the Upper Assessment Threshold (UAT)		If maximum concentrations are between the upper and lower assessment thresholds (LAT-UAT)	
	Pollutants except PM	PM (sum of PM_{10} and $PM_{2.5}$)	Pollutants except PM	PM (sum of PM_{10} and $PM_{2.5}$)
0-249	1	2	1	1
250-499	2	3	1	2
500-749	2	3	1	2
750-999	3	4	1	2
1,000-1,499	4	6	2	3
1,500-1,999	5	7	2	3
2,000-2,749	6	8	3	4
2,750-3,749	7	10	3	4
3,750-4,749	8	11	3	6
4,750-5,999	9	13	4	6
≥6,000	10	15	4	7

Source: Directive 2008/50/EC Annex V.

Directive 2008/50/EC: ozone

Table 4 *Minimum number of sampling points for fixed measurement to assess compliance with limit values (where fixed measurement is the sole source of information): Ozone (O_3)*

Population of zone (thousands)	Agglomerations	Other zones
0-249		1
250-499	1	2
500-999	2	2
1,000-1,499	3	3
1,500-1,999	3	4
2,000-2,749	4	5
2,750-3,749	5	6
≥3,750	One additional station per 2 million inhabitants	

Source: Directive 2008/50/EC Annex IX.

As stipulated in Article 10(3) of Directive 2008/50/EC, the number of sampling points listed above may be reduced if certain conditions are met. The maximum reduction is not specified as it is in Article 7, but the number cannot be lower than one sampling per two million inhabitants or one sampling point per 50,000 km². This study did not make an assessment on whether the data quality objectives and other conditions were met. Instead, it was assumed that those conditions were met, and the maximum reduction is allowed (i.e. that the legal requirement for the number of sampling points is reduced to one sampling point per 50,000 km² or 2 million inhabitants and minimum one in each zone or agglomeration, as per Article 10(3c)).

Directive 2004/107/EC pollutants

Table 5 Minimum number of sampling points for fixed measurement to assess compliance with limit values (where fixed measurement is the sole source of information): arsenic, cadmium, nickel and benzo(a)pyrene

Population of zone (thousands)	If maximum concentrations exceed the upper assessment threshold		If maximum concentrations are between the upper and lower assessment thresholds	
	As, Cd, Ni	B(a)P	As, Cd, Ni	B(a)P
0-749	1	1	1	1
750-1,999	2	2	1	1
2000-3,749	2	3	1	1
3,750-4,749	3	4	2	2
4,749-5,999	4	5	2	2
≥6,000	5	5	2	1

Source: Directive 2004/107/EC Annex III.

Article 4 of Directive 2004/107/EC stipulates that the measurements may be supplemented by modelling techniques and a combination of assessment methods can be used, depending on concentrations. It does not specify a maximum reduction of sampling points if other techniques are used, but states that "one background sampling point shall be installed" every 100,000 km² for indicative measurement, and each Member State should set up at least one measuring station for the pollutants covered in this article. The placement of sampling points has to allow identification of geographical variation and long-term trends. This study did not assess whether the siting met these criteria. It was assumed that these criteria were met, and the requirements were thus minimum according to the Directive (i.e. one sampling point per 100,000 km²).

Limitations to the approach

The tools to conduct the quantitative analysis were built on a reliable and quality assured data set, namely e-reporting data compiled from Member State reporting by the EEA. As such, the data provides a valuable snapshot of the situation based solely on Member State own reporting. Despite that, some limitations should be noted:

- The study did not assess compliance in detail, namely, ratios of different types of sampling points, data quality objectives, locations, etc. Only the overall numbers of points were calculated.

- Information related to use of modelling/objective estimation is reported[5] by the Member States, and the analysis reflects this reporting, as the best and most reliable source of information. However, the change from pre-IPR reporting to e-Reporting has influenced the number of Member States reporting in the first few years of the e-Reporting. In particular, Member State reporting was reviewed for 2012 (last year where reporting was conducted in the spreadsheet format) and 2013-17 (years for which e-Reporting is available)[6]. The lower reporting used in the above-described method means that higher numbers of sampling points are considered "required". E.g. if a Member State reported in 2012 and 2016-17, but not in 2013-15, the numbers of sampling points required in the years 2013-15 are higher, if everything else stays the same.

- The assessment of reporting of data flow D1b (assessment methods - for models and objective estimation) did not consider the reporting pollutant by pollutant, only overall presence or absence of reporting.

- The information and analysis presented here does not intend to provide a full compliance assessment, but only an indicative overview of the situation. Other more detailed and targeted studies are conducted for this purpose and this fitness check does not intend to replace those.

E.1.2 Results: Objective achievement

A: Evidence from the desk study

Member State reporting of air quality assessment

According to the IPR, the Member States have the following reporting obligations related to air quality assessment:

(B): Information on zones and agglomerations (Article 6 in the IPR)
(C): Information on the assessment regime (Article 7 in the IPR)
(D): Information on the assessment methods (Articles 8 and 9) - for fixed and indicative measurements
(D1b): Information on the assessment methods (Articles 8 and 9) - for models and objective estimation

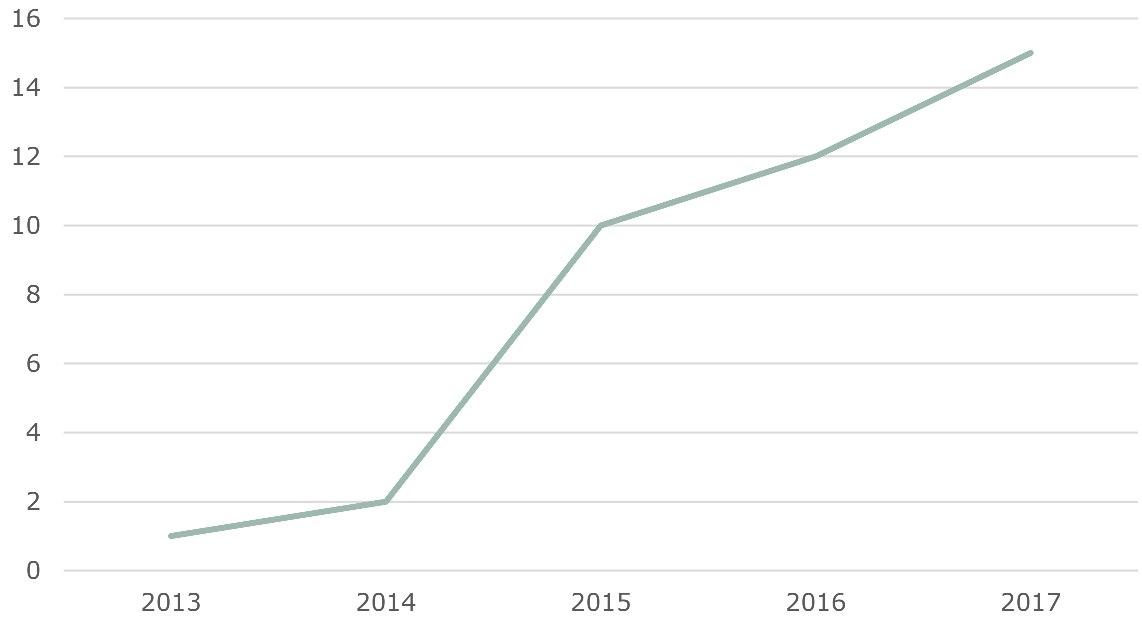
The reporting under (B), (C), and (D) above is collated by the EEA into pan-European datasets and made available on the Air Quality e-Reporting website. Data flow C includes information on fixed and indicative measurements at sampling points for each zone or agglomeration. Data flow D1b reporting includes information on use of models and objective estimation. Since the introduction of the EEA data flow for this purpose, the number of Member States reporting on the use of models and objective estimation has increased. Last year which was reported under the previous reporting arrangement was 2012.

[5] The level of reporting was analysed using the *Reporting obligation for: (D1b) Information on the assessment methods (Articles 8 and 9) - for models and objective estimation (ROD 742).*

[6] Presented in the next section

The figure below shows the number of Member States that reported on data flow D1b for years 2013-2017 (latest report deadline was 2018/09/30 for reporting 2017, and the figure includes data up to this deadline).

Figure 1 Number of Member States reporting in data flow D1b: Information on the assessment methods (Articles 8 and 9) - for models and objective estimation



Source: COWI calculations based on the Central Data Repository, Eionet, as of 2018/09/30 (deadline for reporting 2017)

The number of Member States reporting on this data flow has increased steadily, with 15 Member States reporting for 2017 (Romania, Germany, Poland, Malta, Netherlands, Italy, Croatia, United Kingdom, Spain, Denmark, Sweden, Portugal, Latvia, Lithuania, Slovenia) by the reporting deadline 30/09/2018[7]. However, not all the reports of data set D1b include modelling. Malta reports correction for Saharan dust in air quality measurements, while Sweden reports objective estimation.

As indicated by Table 6, there are also some differences in the approach taken by Member States in relation to supplementing fixed concentration measurements with other methods such as modelling techniques and indicative measurements. This possibility is provided for by the AAQ Directives when certain requirements are met, and an associated reporting requirement is defined in the Commission Implementing Decision 2011/850/EU (Reporting Obligation Database). A limited number of Member States have reported on this since the introduction of the EEA data flow for this purpose[8], while FAIRMODE, suggest more use of modelling tools in the air quality assessment [R98].

The table shows that there has been an increase in the use of modelling techniques or indicative measurements for the assessment of air quality in the period for which consistent data is available (2013-2017).

[7] As of 15 March 2019, Final Report version of this appendix, additional reports have been submitted by Belgium and Greece (modelling) and Hungary and Austria (objective estimation).
[8] Current reporting arrangements in place since 2011.

Table 6 Number of Member States reporting use of modelling techniques or indicative measurements for assessment of air quality, 2013-17

	2013	2014	2015	2016	2017
Number of Member States	4	5	5	8	12

Source: Data provided by the EEA on 7 May 2019 – based on: http://aqportal.discomap.eea.europa.eu/products/submission-monitoring/data-monitor-all-except-e2a

Data analysis results

Table 7 shows via data from the data repository CDR[9] that in 2016[10] most zones in the Member States have the minimum number of sampling points required by the AAQ Directives. It should, however, be underlined that in 2008 there was a lack of information for some Member States and zones, and so the information may not be fully comparable with that for 2016. Furthermore, it should be underlined that the 2016 share estimates are based on information only for the (sub-set of) zones for which the number of sampling points has been reported in that year. Hence, the share estimates are as a result connected with uncertainty and should be used with this in mind. For example, for BaP the still high estimate for 2016 of the share of zones without the required minimum number of sampling points is based on information available for 235 zones, i.e for less than half of 507 zones in the EU where BaP emissions were monitored.

Table 7 Share of zones without the required minimum number of sampling points, 2008 and 2016

	PM	NO_2	SO_2	CO	C_6H_6	Pb	O_3	As	Cd	Ni	BaP
2008	32%	7%	3%	1%	6%	2%	20%	4%	4%	2%	17%
2016	5%	2%	0%	1%	3%	0%	1%	4%	3%	2%	16%

Sources: 2008: Figure 10 in "Reporting on ambient air quality assessment in the EU Member States, 2008 - ETC/ACC Technical Paper 2010/11"
2016: COWI calculations based on CDR (data flows B, C, D)

Note: The share estimates are based on the information for the (sub-set of) zones for which the number of sampling points has been reported. Hence, the estimates are uncertain and should be used with this in mind.
$PM = PM_{10}+PM_{2.5}$

Commission action

In terms of breech of requirements in Articles related to monitoring network, the Commission has in 2017 taken action against Slovakia and Romania.

Romania has been issued a letter of formal notice, titled "AIR - Bad Application of Directives 2008/50/EC and 2004/107/EC and of the Commission Implementing Decision 2011/850/EU" [D65]. According to the relevant press release, Romania "has failed to establish a monitoring network compliant with EU standards and requirements to effectively assess and improve air quality".

[9] http://cdr.eionet.europa.eu/

[10] The latest year of data availability (January 2019).

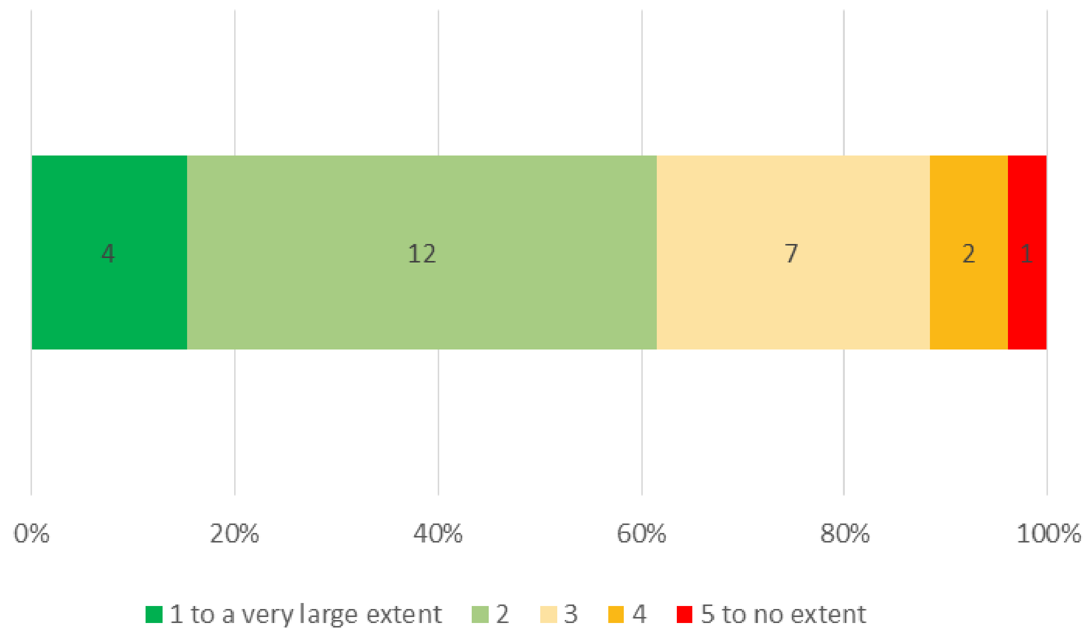
A similar letter was issued to Slovakia in October 2017 [D65]. A Clean Air Dialogue meeting was held between the Commission and Slovakia, to discuss approach to clean air policy in Slovakia [R86]. The conclusions from this meeting state that efforts to improve the monitoring network are underway, including adding 14 sampling points to the fixed measurement network. There is no information on the type of these additional sampling points, or about the pollutants that will be measured.

B: Evidence from the targeted consultation

Targeted questionnaire responses were analysed using the qualitative analysis software NVivo to extract common themes and semi-quantitative results.

Among the 43 responses to the questionnaire, 35 respondents have chosen to provide contributions on effectiveness, and 26 of these have provided a quantitative estimate on their perceptions regarding the effectiveness of the AAQ Directives in achieving the first objective. The results are shown in the following two figures.

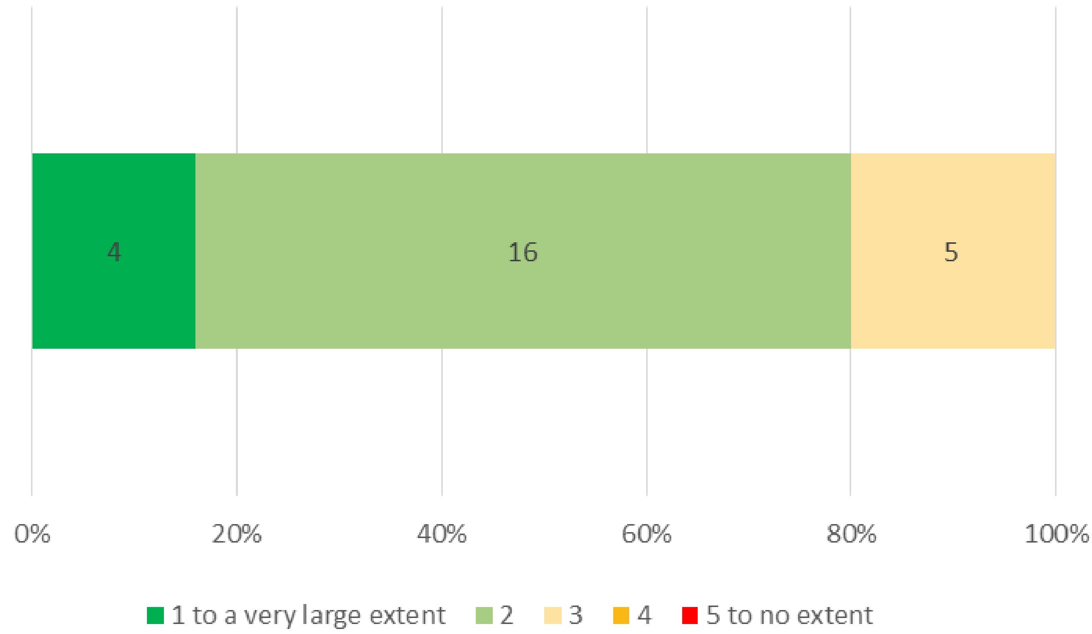
Figure 2 Stakeholder assessment of the extent to which the AAQ Directives achieved the objective of "Defining common methods to monitor and assess air quality"



Source: Targeted questionnaire; Effectiveness question 1: To what extent have the AAQ Directives achieved their objectives? (1= to a very large extent; Note inverted scale); Defining common methods to monitor and assess air quality. Expected output: representative, high quality monitoring of air quality in all MS. N=26

As the figure above indicates, 60% of the respondents assessed that the AAQ Directives have achieved defining common methods to monitor and assess air quality (score 1 or 2). The three lowest scores came from two business associations and an educational/scientific organisation (explaining the score given by the fact that it is difficult and expensive to get a measurement method approved). Meanwhile 80% of the respondents considered that the Directives have achieved the objective of "assessing ambient air quality in order to monitor trends" (score 1 or 2), as shown below.

Figure 3 *Stakeholder assessment of the extent to which the AAQ Directives achieved the objective of "assessing ambient air quality in order to monitor trends"*



Source: Targeted questionnaire; Effectiveness question 1: To what extent have the AAQ Directives achieved their objectives? (1= to a very large extent; note inverted scale); Assessing ambient air quality in order to monitor trends. Expected output: competent authorities ensure monitoring and assessment of air quality. N=25 (an additional 26th response provided a value equivalent to 1.75 on the inverted scale, presumably an average from values provided by different contributors).

The respondents provided several positive examples and indicated some difficulties. For Objective 1, overall 32 qualitative responses were provided. Among these, 21 exemplified or argued the positive aspects of achievement of relevant outputs, while 29 contained some shortcomings (the majority providing both).. Modelling-related issues were also raised under both. As such, both are presented together in this section.

The main positive examples that have come out from the responses are:

- The common methods for measuring and assessing air quality established by the Directives allow comparing information between different cities and countries in Europe
- In particular, provisions for fixed measurements are clear and detailed
- The Directives have encouraged availability of reliable and comparable data, thus enabling assessment of trends
- Work of the Commission (Clean Air Outlook), the EEA (Air Quality Reports) and various networks has supported this objective
- Density of the monitoring network is high compared to other parts of the world, and many stations have a long continuous history

However, some shortcomings and difficulties with applying the AAQ Directives have been identified by the stakeholders. The following examples have been provided:

- There is room for interpretation in the Directives regarding: criteria for siting of stations, in particular traffic stations (e.g. how close to the road, what is a junction), zone definitions, and definitions of background/traffic sites, which leads to possibly incomparable data depending on the specific approach taken in each Member State

- Representativeness is also questioned with regards to the extent to which the measured concentrations reflect human exposure to pollutants, based on the current provisions (note the link to the relevance evaluation questions). Moreover, it is not made clear in the Directives, how to evaluate representativeness

- While modelling is considered an important tool for assessing trends in a wider area, it is defined in the Directives as a "supplement" to the measurement results. Limited guidelines are available on how modelling should or could be used in assessment of air quality or the public policies. Hence this area is not harmonised across the EU

- Insufficient guidance for long-term monitoring of trends; insufficient guidance of assessment regimes

- There is no requirement to continue monitoring where there are no exceedances[11]. Monitoring site requirements indicate that "worst" locations are to be measured. To comply with this requirement, measurement stations may be relocated from areas where air quality has improved to even worse areas, removing the possibility to monitor trends in a specific location

- Due to limited funding availability, it is suggested by some stakeholders that only a minimum number of stations has been set-up in certain Member States. This is "risky" in terms of trend monitoring as it means missing data has a larger influence on availability of sufficient information for trend monitoring. Another related example suggests that where one station is required, this should be a traffic station, which has diminished the number of stations seen as most relevant for AQ trend monitoring (background stations).

- Minimum requirements for indicative measurements are provided in the amending Dir 2015/1480/EC, but the text does not provide clear guidance for interpretation of these results

Some of the above elements also contain factors influencing objective achievement and are further discussed in the following section.

C: Results of the open public consultation

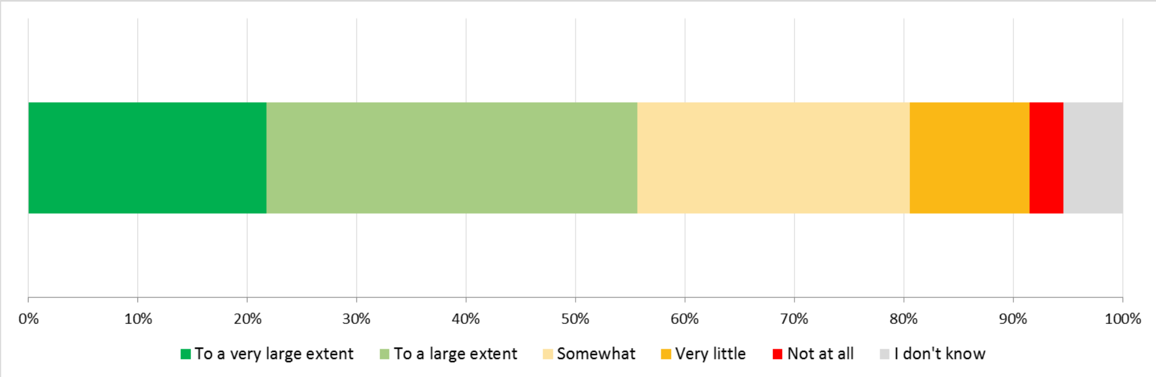
The open public consultation included items related to the effectiveness of air quality monitoring and assessment regimes setup in the Member States as well as factors influencing this in terms of provisions in the AAQ Directives or external factors.

In particular, the open public consultation question 4.5.3 asked "To what extent has EU policy and legislation on air quality helped to provide for consistent rules across Europe on how to monitor air pollution levels?" The responses shown in the figure below indicate that a slight majority (56%) of respondents answered positively (to a "large" or a "very large" extent). The rate was

[11] Note that sampling points with PM exceedances in the last three years shall be maintained.

78% among those who defined themselves as representatives of the public administration sector[12], 85% among respondents in the electricity and gas sector[13], and 88% among information and communication[14] sector respondents. On the other end of the spectrum, respondents from construction[15] (22%), and human health sectors[16] (35%) rated this lowest[17].

Figure 4 *Stakeholder responses regarding the extent to which the EU policy and legislation on air quality helped to provide for consistent rules across Europe on how to monitor air pollution levels*



Source: Open public consultation. Question 4.5.3: To what extent has EU policy and legislation on air quality helped to provide for consistent rules across Europe on how to monitor air pollution levels? N=483

This indicates general acknowledgement among these respondents that the EU air quality legislation has contributed to providing consistent rules on monitoring, thus indicating that the framework is considered effective by a small majority. However, more than one in six respondents (14%) consider the extent to be very little or none at all. This was supplemented by questions 7.1.1 and 7.6 in the open public consultation, which asked in more detail whether the application of the rules is effective. The results are shown in the two figures below.

[12] O - Public Administration and Defence; Compulsory Social Security

[13] D - Electricity, Gas, Steam and Air Conditioning Supply

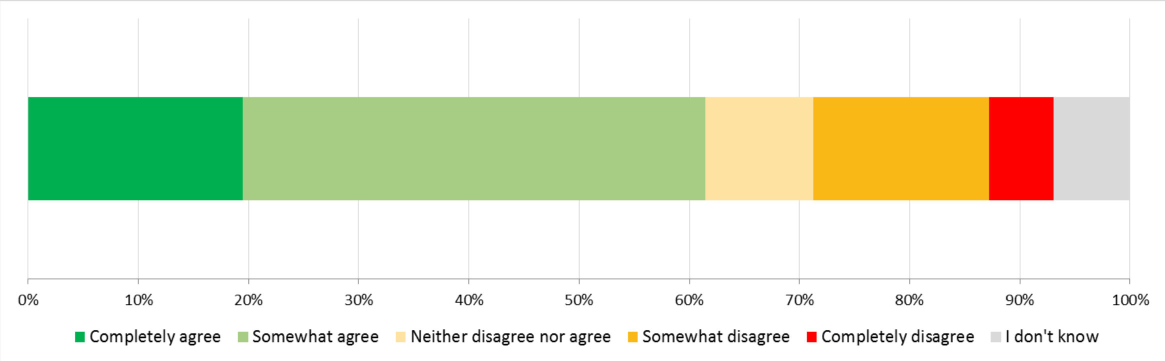
[14] J - Information and Communication

[15] F - Construction

[16] Q - Human Health and Social Work Activities

[17] Among sectors with at least five responses. Note that around half of all respondents did not select a sector

Figure 5 *Stakeholder responses regarding the extent to which the AAQ Directives have been effective in achieving a representative, high quality monitoring and assessment of air quality in all Member States*

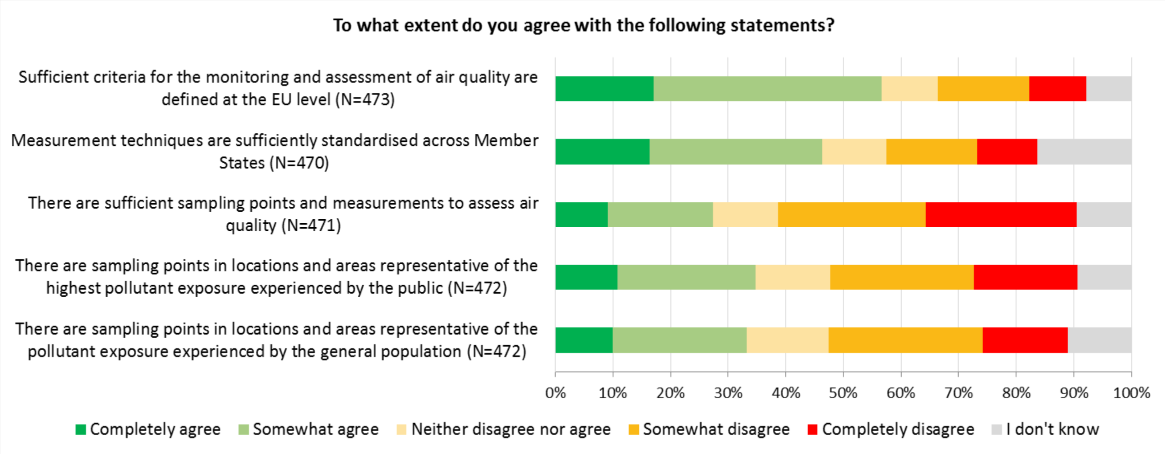


Source: Open public consultation. Q7.1.1: To what extent have the Ambient Air Quality Directives been effective in achieving the following outputs? - A representative, high quality monitoring and assessment of air quality in all Member States? N=477

As shown in the figure above, the majority (61%) of the respondents somewhat agreed or completely agreed that the AAQ Directives have been effective in achieving a representative, high quality monitoring and assessment of air quality in all Member States. Still, another 22% (more than one in five respondents) disagreed with the statement, indicating a substantial group of respondents considers the effectiveness as limited.

Looking in more detail, at a number of specific questions about the monitoring network, certain explanations for this appear. While 57% of the respondents agreed (somewhat or completely) that sufficient criteria are defined at the EU level for the monitoring and assessment of air quality, fewer (46%) consider that the measurement techniques are sufficiently standardised. Regarding the number of sampling points, only 33% expressed a positive view over sampling points being in locations representative of the pollutant exposure of the general population and 35% over sampling points being placed where the highest pollutant exposure occurs. More than 40% disagreed (somewhat or completely) with both of these statements. Finally, the majority (52%) of respondents *disagreed somewhat or disagreed completely* that sufficient sampling points are installed, as shown in the figure below.

Figure 6 Stakeholder responses regarding monitoring network in the EU



Source: Open public consultation. Q7.6: To what extent do you agree with the following statements? N – varies per sub-question, see chart.

E.1.3 Results: Factors influencing objective achievement

In the literature, little information has been identified on factors influencing the achievement in the Member States of representative, high quality monitoring and assessment of air quality, as the majority of literature focuses on attainment of standards or discusses theoretical aspects of monitoring networks. In the documents with relevant information, "factors" or "drivers" of compliance or non-compliance are not directly described, but rather presented as possible challenges or areas for improvement. In particular, the challenges refer to aspects of monitoring network design, mostly relating to siting of the measurement stations or using modelling to supplement measurement data.

In terms of the networks, the challenges identified mostly relate to the classification of the measurement stations. The criteria for classifying measurement stations are described in the literature as being rather generic (in particular urban background and suburban background). Stricter and clearer criteria for micro-scale siting, macro-scale siting and representativeness of stations are suggested to improve comparability of measurements across cities [R44,R32]. This may indicate that current criteria are not sufficient for this purpose, and as such that the provisions do not function as a supporting factor. The air implementation pilot study [R144] involved twelve cities overall, from various parts of Europe, but the number of city air quality experts raising the concern is not known. However, a number of studies have discussed the possible improvement to the classification [e.g. P121, S39], indicating this is a well-known factor.

The JRC-Aquila position paper [P121] in addition notes that the spatial representativeness of measuring sites is not defined in the legislation, which can hinder the effectiveness of the monitoring network design and suitability to assess exposures and model performances. This position paper further notes that guidance that is more "detailed and practical" is needed in order for the monitoring network to be effective. While modelling is defined in the AAQ Directives as a complementary tool to fixed measurement, it is not specified how exactly models should be used. FAIRMODE [R98] has proposed that models should be used (and defined in the AAQ Directives) to assess air quality levels, for forecasting, source allocation, development and assessment of measures and plans, as well as monitoring network design. This would require more clearly defined data quality objectives for models [R98, R40]. FAIRMODE also carried out a survey among

Member State contact points[18] with the aim to gauge the reasons behind limited reporting by Member States of air quality modelling results [R14]. This survey found that the majority of the respondents agreed that the "lack of clarity in the legislation and the lack of clear guidelines" is a limiting factor. Other factors (e.g. administrative, technical or resource limitations) drew varied opinions. This has also been raised in the consultation conducted under this fitness check.

Targeted questionnaire

As noted above, regarding the targeted questionnaire, there were 32 responses to this question that related to Objective 1. They varied in the level of detail and not each response contained factors. The table below lists examples where the respondents considered the provisions of the Directives contributed to the achievement of the objective (success areas) and areas where improvements may be needed in order to progress further towards fulfilling this objective.

[18] FAIRMODE network National contact points (NCPs).

Table 8 Stakeholder responses regarding the achievement of Objective 1: Defining common methods to monitor and assess air quality; and using these assessments to monitor trends; Role of the Directives (language in quotes unedited; spelling adjusted)

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
Common methods and clear definitions allowing harmonised assessment and data comparability	+	12 (3 of these likely coordinated)	"The common methods settled by the AAQ Directives to monitor air quality have a proven positive effect at the member state scale. As an example, in France, pollution levels in different cities can be compared without any doubt on the data quality and on their comparability." [NGO] "This situation enabled the implementation of the comparison of air quality and assessment of air quality in various cities/states across the EU through the utilisation of clearly defined criteria for the siting of air quality measurement stations, for air quality measurement methods and assessment of air quality according to limit values that are applicable across the entire EU territory." [Member State authority/agency] "The AAQ Directives are essential to ensure common methods to monitor and assess air quality across the EU 28 Member States. Without the AAQ Directives, each Member State would be free to follow different methods. Such situation would make it much more complex, if not impossible, to compare air quality status between different countries and cities in Europe. […] The AAQ Directives have ensured a high level of harmonisation for monitoring and assessment of air pollution across the EU. All of the provisions of the Directives mentioned in the question are key in ensuring the achievement of the objective." [NGO] "Having a legal instrument stabilising common methods for monitoring and for assessing AQ has been a trigger to MS for using the methods set by the Directive instead of using the ones they consider more appropriate, that differ from one country to the other, and therefore that could jeopardize the results' comparability." [Member State authority/agency] "The directives set very detailed requirements concerning the assessment of ambient air quality; these requirements are quite clear and easy to follow. This is especially true for the fixed measurement" [Member State authority/agency]
Standards regarding monitoring and measurement have contributed to time series/trend monitoring	+	9 (3 of these likely coordinated)	"The common methods settled by the AAQ Directives to monitor air quality make it possible to obtain reliable data and thus to evaluate the trends of the different pollutants over time." (NGO) "The standards regarding monitoring and measurement in the AAQ Directives have contributed to comparable measurements with long time series, making it possible to monitor trends in ambient air quality." (Member State authority/agency) "Regarding air quality assessment, the same comment applies than the question above. The European AAQ legislation has played an essential role to encourage MS to assess in a homogeneous way the AQ in their own territory in order to monitor the trends." (Member State authority/agency)

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
Additional work to support the Directive implementation by the EC, EEA, and various networks[19]	+	6	"The Commission's Clean Air Outlook and the European Environment Agency's air quality reports provide helpful data across member states and at a national level, the UK Government publishes data regularly." [NGO] "CEN-standards and AQUILA guidance" [Member State authority/agency] "There is generally excellent support through intercomparisons to establish common methods. These intercomparisons are essential for our use as the National Reference Laboratory as part of our quality system. We would very much hope that this type of work is continued if not expanded." [Member State authority/agency]
Reference methods	+-	5	"The obligation to apply the reference measurement methods and criteria specified in Annex VI has been fundamental in order to ensure consistency in the way national authorities monitor and assess air quality." (NGO) "Unfortunately it has been very difficult and expensive to get a measurement method approved as equivalent." (Educational or scientific organisation) "Reference methods are clearly defined by the AAQ Directives. However, the option of easier updating of regulations with new standards should be provided in case that new standardised methods are developed and accepted for certain pollutants (this does not apply to reviews of existing standards, only to the development of new ones), in particular in view of the rapid development of instrumental analytical techniques over the past several decades. The Directive should, besides the current list of reference methods, also allow for the possibility that the said list is updated on the basis of recommendations by AQUILA or another body." (Member State authority/agency) "Technologies are moving forward and it should be possible for the legislator and the stakeholder to determine PM real time measurement techniques that are compliant with the level of quality assurance that EU want for the Member States. This would avoid the heavy procedure to prove the equivalency with the gravimetric method. Indeed, to be successful in proven the equivalency, the Member States need invest money and recruit new collaborators what is more difficult for smaller countries." (Member State authority/agency)
Modelling provisions	-	15	*Further details below*
Insufficient clarity or guidance on siting and classification criteria	-	8	"the issue of the criteria for siting and classification of measurement stations has still not been fully resolved although there exist general guidelines and instructions. […]" (Member State authority/agency, see box below for details) "Criteria for e.g. traffic stations should be argumented better, why exactly max 10 metres from the road, regardless of the volume of traffic" (Municipal authority)

[19] Excluding FAIRMODE, which is described separately below

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
			"The Directives are quite good on establishing criteria for siting etc., however they possibly could be more prescriptive with some of the criteria to eliminate ambiguity. For example, with the siting of traffic stations – and what constitutes a junction etc." (Member State authority/agency) "The directive should be more clearly about the siting criteria for sampling points. […] Differences in the siting of monitoring stations and unclarity about the role of modelling leads to the standards not being applied in the same manner in all member states." (Member State authority/agency) "There are, however, still some uncertainties in the wording of the AAQ Directives. In particular, Annex V is not consistent, as it sets minimum numbers of sampling points for zones/agglomerations; however, the requirements for the proportion between total number of urban background and total number of traffic oriented station is set for the entire territory of a Member State (see Annex V, Section A(1), footnote (1)). Such a discrepancy between the different levels and the criteria, makes it very difficult for individuals and NGOs to assess compliance with the requirements. It also leads to inconsistent practices across the EU." (NGO) "Los criterios de ubicación de los puntos de muestreo son poco precisos." (NGO) "Improvements could be made to the Directive by specifying the definition of a background site, of a traffic site and by homogenizing the concept of zoning that could vary from a country to another." (NGO)
Guidance/provisions on trend monitoring	-	4	"Not clear from directive how to deal with stations which measures air quality in cities where problems doesn't exist anymore or in case if inhabitants in state have reduced during past years. Is it possible to stop measurements in these cities or to reduce total number of stations at national level if total population has reduced?" (Member State authority/agency) "Still, there is no clear guidance in the directive on how to ensure the long-term monitoring or on what is considered necessary for monitoring of trends. Only Ozone and PAHs trends are mentioned in the AAQDs, for other components, there is no mention of trend monitoring requirements in the AAQ directives. This is because the AAQD station network is designed primarily to support compliance, not trend analysis." (Educational or scientific organisation) "However, the AAQDs do not sufficiently describe how monitoring of trends is to be achieved. Only Ozone and PAHs trends are mentioned specifically in the AAQDs, and for other components, there is no mention of trend monitoring requirements. […] However, there are no requirements in the AAQDs to continue monitoring on sites where there are no exceedances of limit values." (Member State authority/agency)
Other guidance lacking	-	6	"In relation with 2011/850/EC decision, the Member States implement the eReporting mechanism. A documentation on how to calculate population and vegetation affected in case of ozone exceedance would be useful and even necessary to compare the situation between the countries." (Member State authority/agency)

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
			"Also not clear enough how to deal with measurements that are carried out with indicative methods (low cost sensors). Not clear enough provisions included in annex VI section E on how to deal with demonstration of equivalence (especially for PM)." (Member State authority/agency) "More work is need on providing practical guidance to member states on implementing air quality assessment." (Member State authority/agency) "In addition, it is not clear how representative the current monitoring network is, and additional guidance on how to evaluate the representativeness of monitoring stations is needed." (Member State authority/agency) "Defining representative measurement places in full compliance with the requirements laid down in the annexes of the AAQ directives, may not always be possible. In fact, according to annex III.B.1.a) of directive 2008/50/CE sampling points shall be sited in such a way as to provide data on the one hand on the areas where the highest concentrations occur an on the other hand on areas which are representative for the exposure of the population in general. These criteria do not match with the criteria of annex V.A.1 of the directive 2008/50/CE which requires only one sampling point for pollutants (except PM) for a zone with a population of 0 – 249000. Furthermore, in a zone there may be an isolated place where the highest concentrations occur but which is not at all representative for the exposure of the population in general of that zone. This measurement point would however trigger the necessity to establish an air quality plan for the whole zone in accordance to article 23 of directive 2008/50/CE and hence give a wrong image of the entire zone." (Member State authority/agency)

Source: COWI based on targeted questionnaire responses; Overall, 43 responses were assessed.
Note: +/- : positive factor or negative factor

The above table highlights some of the varied experiences among the stakeholders. 12 of 32 respondents exemplified the success of the AAQ Directives in ensuring data comparability, for example, due to the standard methods used for measuring concentrations of pollutants, clarity and usability of definitions. In addition, nine respondents considered that provisions on air quality assessment have allowed the creation of time series and trend monitoring. The work of the Commission, the EEA, and the various expert networks has been highlighted as an important contributor to the achievement of the objectives.

Despite these successes, it is evident from the responses that many key stakeholders have struggled with certain elements of the AAQ Directives. The perceived ambiguity or lack of clarity reported by the Member State respondents means that they may have been interpreting the same provisions differently, influencing the consistency of the outputs of the air quality assessment in the various Member States.

The two hindering factors mentioned by the highest number of responses are:

- provisions regarding modelling
- limited clarity of siting and classification criteria

Furthermore, as also shown in Text box 1, Member State authority/agency respondents highlighted several other areas where they could have benefited from more detailed guidance on e.g. representativeness of stations, and how to monitor trends.

Text box 1 Example response related to clarity/suitability of siting and classification criteria (response from Member State authority/agency)

"The issue of the criteria for siting and classification of measurement stations has still not been fully resolved although there exist general guidelines and instructions. Namely, the Directive was adopted after a great number of states have already set up their monitoring systems, and very often the locations were already determined in accordance with criteria different from those prescribed by the Directive. This led to "adjustment" of the requirements determined by the actual conditions at a location to the criteria for the classification of the sampling point under the Directive. In addition, the fact we often come across in practice is that it is very difficult to find a "clean" location that can be assigned an unequivocal classification. We are usually dealing with stations that are impacted by several factors at the same time or several factors that are significant but impossible to differentiate depending on the prevailing meteorological conditions. "

A more in-depth analysis of the responses mentioning modelling related provisions shows that 20 responses mentioned "models" or "modelling" in several contexts. Most of these responses noted that the AAQ Directives are not sufficiently "prescriptive" regarding use of modelling in air quality assessment, possibly leading to different approaches taken by the Member States (which in turn may impact comparability of data). Table 9 below summarises the numbers of responses related to this topic[20].

[20] The remaining four mentions not in the table contain: 1) suggestion for a specific modelling approach, 2) discussion on spatial representativeness of measurement stations, 3) increasing need for air quality maps based on measurements and modelling, and 4) a reference to EEA processing of Member State information.

Table 9 Responses related to modelling methods to assess air quality

	Number of responses containing …			
Type of stakeholder	…references to insufficient or ambiguous provisions related to AQ modelling	…references to varied approaches taken (without referring to lacking/ambiguous provisions)	…references to non-specific provisions, but considering that a suitable approach	Total effectiveness responses
NGOs	5[21]			7
Member State authorities or agencies	8			15
Educational or scientific organisation	1 (National Reference Laboratory)			4
Other (group of municipalities)	1			1
Municipal authorities		1		3
Business associations			1	3
Other categories				2
Total	**15**	**1**	**1**	**35**[22]

Source: COWI based on targeted questionnaire responses

Examples of responses are provided in Text box 2. Notably, while these respondents consider the provisions in the AAQ Directives lacking or ambiguous, many of them acknowledge the work of FAIRMODE. Overall FAIRMODE work is cited by 11 responses to effectiveness questions, acknowledging the importance and benefits of this work or quoting specific FAIRMODE reports.

Text box 2 Example extracts on references to modelling (language unedited)

"The obligation to apply the reference measurement methods and criteria specified in Annex VI has been fundamental in order to ensure consistency in the way national authorities monitor and assess air quality. At the moment, however, the AAQ Directives provide only limited guidance on modelling methods." (NGO)

"Moreover, some accurate requirement concerning the modelling tools and the quality of the output data should be added to the Directives to allow for the assessment of the public policies. No actions will be taken by the cities where the policies to improve air quality cannot be assess." (NGO, coordinated)

"Although modelling is specified in the Directive as one of the assessment methods, its application is defined as a “possibility” in the sense of it being a supplement to the measurement results when the values of measurement concentrations are below the upper assessment threshold. […] In view of the level of development of modelling tools and methods, we are of the opinion that, in accordance with FAIRMODE guidance document, it is necessary to include the use of models for the purpose of assessing air quality as a method equal in importance to the measurements, under the provision that, as measurement results have to meet prescribed standardised criteria so should modelling results also meet defined quality and uncertainty criteria for which methods and tools have already been elaborated within the framework of FAIRMODE." (Member State authority/agency)

[21] Three of those coordinated

[22] All effectiveness questions, not only those related to Objective 1.

"However, the AAQDs are insufficient in its descriptions on how to assess ambient air quality, where AQ modelling is required." (Member State authority/agency)

"There is still some ambiguity in modelling (Art. 7) of the air quality (the directive does not state which models should be used). This is however being solved outside the framework of the directives in the FAIRMODE initiative." (Member State authority/agency)

"There is currently limited guidance on how modelling should or can be incorporated into Member State compliance assessments. Despite positive engagement with the EEA and FAIRMODE, progress has been slow in developing modelling quality objectives." (Member State authority/agency)

"the use of models/objective estimations and sensors and their possible application for assessing the ambient air quality are marginally mentioned and worked out in the Directives […] The lack of regulation/legislation for models/objective estimations and eventually sensors is inconvenient because clear regulations and common understanding are needed in this area." (Member State authority/agency)

"The Directives are non-specific about modelling method and this should continue. Collaborative modelling exercises, such as those of EURODELTA, that arrive at similar results using different assumption sets add confidence to modelling results. Overall the AAQDs by themselves cannot set out how to do robust trend analysis but they can enable the necessary tools." (Business association)

Source: Targeted questionnaire

Some external factors have been described by the respondents, but these are more diverse. In terms of hindering factors, the most mentioned factors are costs and other resources (personnel with skills and knowledge) – mentioned by a quarter of respondents that contributed to Objective 1. Differences in capacity may mean that some regions or Member States may have less developed monitoring networks. Another recurrent theme is the different approaches taken by the competent authorities, e.g. due to some of the provisions mentioned above, that allow for some interpretation (or flexibility), the extent of network prior to the AAQ Directives. Finally, respondents in smaller Member States have noted that the market for technology/equipment and services is small inside the Member State, thus potentially creating a technological divide between Member States and/or difficulties obtaining equipment or services.

On the other hand, Member State cooperation has been exemplified as highly supportive of the objectives of the AAQ Directives, e.g. collaboration between competent authorities, national reference laboratories, or hiring consultants from abroad. EU funding, local or national initiatives, and technological development are some of the others that have been exemplified. However, these have all been noted by only 1-3 of the respondents, making it difficult to draw any conclusions.

E.2 JC 2.2: Air quality standards

This section provides further evidence regarding the judgement criterion for the effectiveness of establishing air quality standards and achieving these in the Member States, i.e. an analysis of whether air quality target/limit values are suitable and are met.

Objective: Establish standards of air quality to achieve across the EU
Output: Clear, actionable AQ standards are established and complied with for all of the EU

JC 2.2: Internal or external factors are identified that influenced the extent to which the standards on air quality to achieve across the EU established by the Ambient Air Quality Directives have been clear, actionable and complied with for all the EU

This criterion seeks to assess the extent which the specific provisions in the AAQ Directives and/or external factors have contributed to establishing and complying with the air quality standards. The effectiveness of the following Articles and related Annexes in the AAQ Directives are considered under this criterion:

Table 10 Articles and related Annexes: Objective 2

Articles in 2008/50/EC	Annexes in 2008/50/EC	Articles in 2004/107/EC	Annexes in 2004/107/EC
(12)[23], 13, 14(1), 15, 16, 17(1)	Annex VII (O_3 target values), Annex XI (limit values for pollutants other than O_3), XIII (critical levels), XIV (exposure targets for $PM_{2,5}$)	3 (1)	Annex I

Source: COWI, based on the AAQ Directives [P98], [P96].

E.2.1 Approach

The level of achievement of environmental objectives is one of the main items reported, assessed and scrutinised across the EU. The data sources used for this include a number of ETC Technical papers comprising data for 2008-2012, while data from 2013 are contained in the e-Reporting database, i.e. data flow G: "Information on the attainment of environmental objectives (Article 12)". This data flow contains status of attainment of the objectives set out in the AAQ Directives, for each pollutant, in each individual zone or agglomeration defined for that pollutant. The dataset was used to assess the levels of achievement of the air quality standards, defined in Annex XI, Annex VII and Annex XIV of Directive 2008/50/EC as well as Annex III of Directive 2004/107/EC.

Directive 2008/50/EC defines limit values for particulate matter below 10 µm in diameter (PM_{10}), below 2.5 µm in diameter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), benzene (C_6H_6) and lead (Pb) in Annex XI.

[23] Article 12 stipulates that air quality should be maintained where it is good, as such it is listed under sub-q 5. However, it is also relevant here, since it also introduces the limit values and is associated with the reporting obligation on attainment of environmental objectives (ROD679), as defined in the COMM Implementing Decision 2011/850/EC.

Table 11 Limit values defined in Directive 2008/50/EC

Pollutant	Averaging period	Limit value	Date by which limit value is to be met
PM_{10}	Calendar year	40 µg/m³	1 January 2005
	1 day	50 µg/m³ not to be exceeded on more than 35 days per year	1 January 2005
$PM_{2.5}$	Calendar year	Limit value: 25 µg/m³	1 January 2015 (target value until 1 January 2010)
	(calculated as Average Exposure Indicator, assessed as a 3-year running annual mean)	Exposure concentration obligation: 20 µg/m³	2015
NO_2	Calendar year	40 µg/m³	1 January 2010
	1 hour	200 µg/m³ not to be exceeded on more than 18 hours per year	1 January 2010
SO_2	1 day	125 µg/m³ not to be exceeded on more than 3 days per year	1 January 2005
	1 hour	350 µg/m³ not to be exceeded on more than 24 hours per year	1 January 2005
CO	Maximum daily 8-hour mean	10mg/m³	1 January 2005
C_6H_6	Calendar year	5 µg/m³	1 January 2010
Pb	Calendar year	0.5 µg/m³ (measured as content in PM_{10})	1 January 2005

Source: Directive 2008/50/EC, Annex XI [P98]

For ozone (O_3), Directive 2008/50/EC sets, as shown in Table 11, a set of environmental objectives to be achieved separately from the above pollutants.

Table 12 Environmental objective values defined for O_3 in Directive 2008/50/EC

Pollutant	Averaging period	Target value	Date by which target value is to be met
O_3	Maximum daily eight-hour mean	Target value: 120 µg/m³ not to be exceeded on more than 25 days per calendar year averaged over three years	1 January 2010
	Maximum daily eight-hour mean within a calendar year	Long-term objective: 120 µg/m³	Not defined

Source: Directive 2008/50/EC, Annex VII and XIV [P98]

Directive 2004/107/EC also defines target values for arsenic (As), cadmium (Cd), nickel (Ni), and benzo(a)pyrene (BaP).

Table 13 Limit values defined in Directive 2004/107/EC

Pollutant	Averaging period	Target value	Date by which target value is to be met
Arsenic (As)	Calendar year	6 ng/m³ (measured as content in PM_{10})	31 December 2012
Cadmium (Cd)	Calendar year	5 ng/m³ (measured as content in PM_{10})	31 December 2012
Nickel (Ni)	Calendar year	20 ng/m³ (measured as content in PM_{10})	31 December 2012
Benzo(a)pyrene (BaP)	Calendar year	1 ng/m³ (measured as content in PM_{10})	31 December 2012

Source: Directive 2004/107/EC, Annex I and Article 3 (date); [P96]

Limitations to the approach

The tools to conduct the quantitative analysis were built on a reliable and quality-assured data set, namely e-reporting data compiled from Member State reporting by the EEA, combined with ETC Technical Papers for data before 2012. As such, the data provides a valuable snapshot of the situation based solely on Member State own reporting.

E.2.2 Results: Objective achievement

A. Evidence from the desk study

Regarding the compliance part of the judgement criterion, Table 14**Error! Reference source not found.** shows that many Member States still in 2017 experience exceedances of the environmental targets/limits. PM_{10}, NO_2, O_3 and BaP are the air pollutants for which the highest number of Member States have reported exceedances. In turn, only a few Member States reported air pollutant values higher than the target values for the heavy metals. Compared with 2008, there has for almost air all pollutant types been a decrease in the number of Member States experiencing exceedances. Only, $PM_{2.5}$ has seen an increase.

A similar trend is found when analysing the alternative indicator of the share of zones in EU reporting exceedances – i.e. only $PM_{2.5}$ has seen a slight increase. The share of zones with exceedances remains particularly high regarding O_3, while some of the exceedances of PM_{10} and NO_2 remain together with that of BaP persistent and widespread. For NO_2 this is likely a reflection of difficulties to cope with an increasing road traffic in urban areas.

The overall finding is thus that exceedances of targets/limits have decreased over time, indicating the pollution reduction measures provided for by the AAQ Directives have been effective.

Table 14 Exceedances of targets/limits, 2008 and 2017

Pollutant	Objective	Parameter value	Number of Member States reporting exceedances		Direction	Share of zones in EU reporting exceedances		Direction
			2008	2017		2008	2017	
PM_{10}	Limit value	Annual mean	16	10	↓	13%	4%	↓
PM_{10}	Limit value	Days above	22	14	↓	37%	18%	↓
NO_2	Limit value	Annual mean	22	16	↓	28%	23%	↓
NO_2	Limit value	Hours above	10	6	↓	4%	1%	↓
SO_2	Limit value	Days above	5	2	↓	1%	0.5%	↓
SO_2	Limit value	Hours above	5	1	↓	1%	0.2%	↓
CO	Limit value	Maximum daily 8 hour mean	2	1	↓	0.4%	0.2%	↓
C_6H_6	Limit value	Annual mean	5	1	↓	1%	0.2%	↓
Pb	Limit value	Annual mean	3	0	↓	0.6%	0.0%	↓
O_3	Target value	Maximum daily 8 hour mean	18	14	↓	45%	28%	↓
$PM_{2.5}$	Target and limit value	Annual mean	4	8	↑	6%	7%	↑
As	Target value	Annual mean	8	4	↓	2%	1%	↓
Cd	Target value	Annual mean	5	2	↓	1%	0.4%	↓
Ni	Target value	Annual mean	5	4	↓	2%	1%	↓
BaP	Target value	Annual mean	12	10	↓	22%	18%	↓

Sources: 2008: "Reporting on ambient air quality assessment in the EU Member States, 2008 - ETC/ACC Technical Paper 2010/11"
2017: COWI, based on data flow G
Legend: ↑ increase, ↕ unchanged, ↓ decrease

Commission action

Particulate matter - PM_{10}

The compliance deadline for PM_{10} was set in the legislation preceding the AAQDs, hence the limit values described above have been in force since 2005. Legal action against 15 Member States in terms of PM_{10} is reported as ongoing by the Commission [D65] [24]: Bulgaria, the Czech Republic, Germany, Greece, Spain, France, Hungary, Italy, Latvia, Portugal, Poland, Romania, Sweden,

[24] http://ec.europa.eu/atwork/applying-eu-law/infringements-proceedings/infringement_decisions/?lang_code=en

Slovakia, and Slovenia. Seven additional countries have had infringement action against them since 2008 according to the infringement database [D65]: Austria (closed in 2015), Belgium (closed in 2018), Cyprus (closed in 2012), Denmark (closed in 2010), Estonia (closed in 2011), Malta (closed in 2010), and the UK (closed in 2013).[25]

Table 15 Status and number of cases against Member tates related to breach of PM_{10} limits

	Number of Member States	**Member States**
Referral to Court	5	Bulgaria, Poland, Hungary, Romania, Italy
Reasoned Opinion	9	Czech Republic, France, Germany, Greece, Latvia, Portugal, Slovakia, Spain, Sweden
Formal notice	1	Slovenia

Source: EC European Commission Infringement Decision Database as of April 2019 [D65]

Most recently, in May 2018, Hungary, Italy, and Romania were referred to the Court of Justice of the EU for "failing to respect agreed air quality limit values and for failing to take appropriate measures to keep exceedance periods as short as possible." [26] Italy, Portugal, Slovenia and Sweden have had two separate infringement cases on PM_{10} exceedances since 2008.

Nitrogen dioxide – NO_2

There are 13 infringement cases related to NO_2 exceedances pending against: Austria, Belgium, the Czech Republic, Denmark, France, Germany, Hungary, Italy, Luxembourg, Poland, Portugal, Spain and the United Kingdom, related to concentrations of nitrogen dioxide (NO_2).

Table 16 Status and number of cases against Member States related to breach of NO_2 limits

	Number of Member States	**Member States**
Referral to Court	4	France, Germany, Italy,United Kingdom
Reasoned Opinion	1	Spain
Formal notice	8	Austria, Belgium, Czech Republic, Denmark, Hungary, Luxembourg, Poland, Portugal

Source: EC European Commission Infringement Decision Database as of April 2019 [D65].

In May 2018 France, Germany and the UK were referred to the Court of Justice of the EU for "failure to respect limit values for nitrogen dioxide (NO_2), and for failing to take appropriate measures to keep exceedance periods as short as possible"[27]. Likewise, Italy was referred to the

[25] See below for information for NO_2 and other pollutants (fewer cases available)
[26] http://europa.eu/rapid/press-release_IP-18-3450_en.htm
[27] http://europa.eu/rapid/press-release_IP-18-3450_en.htm

Court of Justice of the EU in March 2019 for "failure to protect citizens against the effects of nitrogen dioxide".[28]

Other pollutants

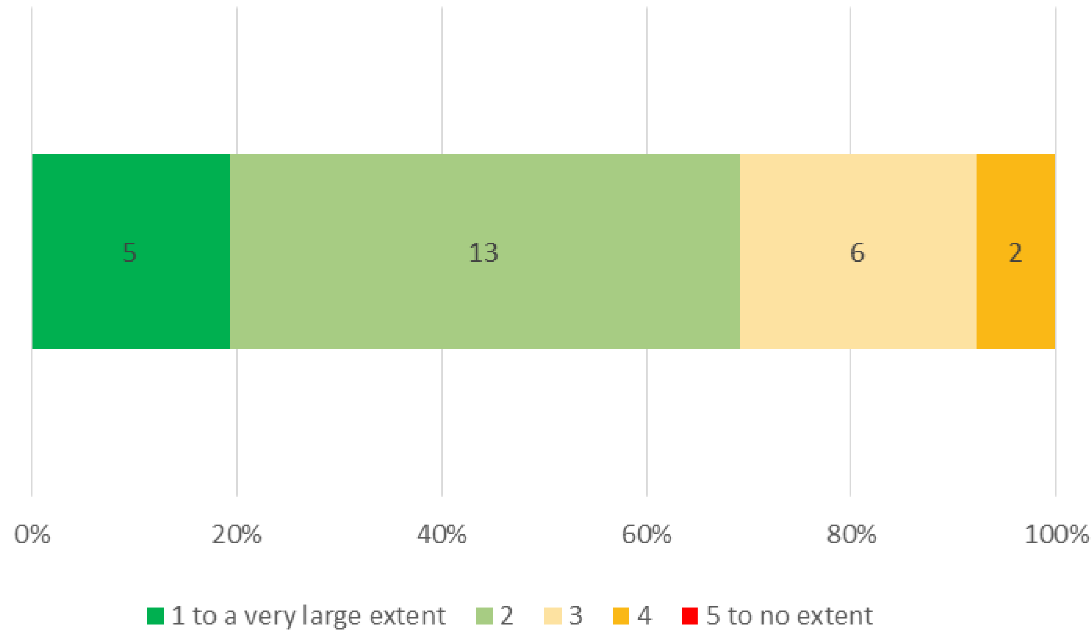
Both Bulgaria (reported exceedances every year from 2008 to 2017) and France (reported exceedance in 2008 and in 2015) have faced Commission action regarding SO_2: latest case with France closed in 2010, while Bulgaria received a reasoned opinion in 2014, and the case remains open. Cases against eight other Member States have been open: Spain, Italy, Slovenia, Czech Republic, Poland, Portugal, Romania and the United Kingdom (all closed between 2008 and 2013) [D65].

B. Evidence from the targeted consultation

The targeted questionnaire responses were analysed using qualitative analysis software NVivo to extract common themes and semi-quantitative results.

Among the 43 responses to the questionnaire, 35 respondents have chosen to provide contributions on effectiveness, and 27 of these have provided a quantitative estimate on their perceptions regarding the effectiveness of the AAQ Directives in achieving Objective 2.

Figure 7 Stakeholder assessment of the extent to which the AAQ Directives achieved the objective of "establishing standards of air quality to achieve across the EU"



Source: Targeted questionnaire; Effectiveness question 1: To what extent have the AAQ Directives achieved their objectives? (1= to a very large extent; note inverted scale); Objective 2 Establishing standards of air quality to achieve across the EU. Expected output: clear, actionable Air quality standards are stablished and complied with for all the EU. N=26 (an additional 27th response provided a value equivalent to 1.5 on the inverted scale, presumably an average from values provided by different contributors).

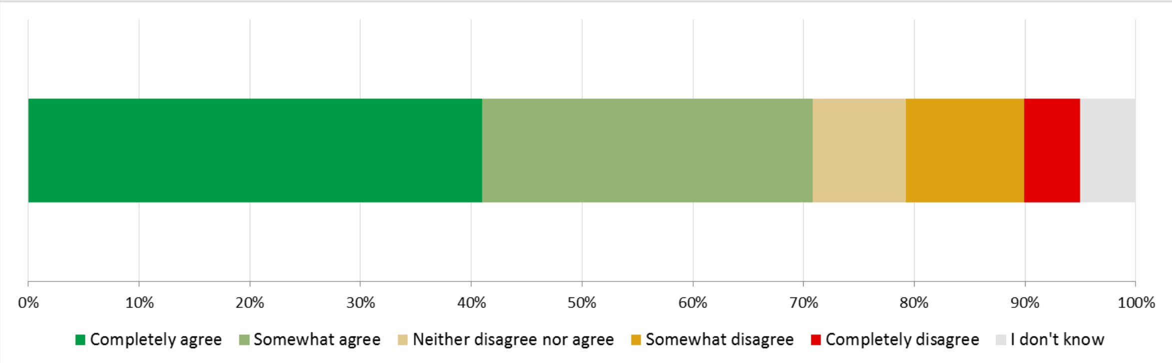
[28] http://europa.eu/rapid/press-release_MEMO-19-1472_en.htm

The respondents have exemplified the success by describing that the common standards and associated framework provide a "push" to resolve it, by urging authorities to act. However, it was also remarked that the standards are not fully actionable. Further examples were found to overlap with the factors that stakeholders named as influencing the achievement of the objective, thus they are discussed in the following section.

C. Results of the open public consultation

The open public consultation included items related to the establishment of the air quality standards. In particular, the open public consultation question open public consultation 7.1.2 asked "to what extent have the AAQ Directives been effective in achieving the following outputs: clean air quality standards established across the EU?" As shown in the figure below, most respondents (a little over 70%) agreed somewhat or strongly with this statement, indicating a high regard to the standards of the Directives.

Figure 8 Stakeholder responses regarding the extent to which the AAQ Directives have been effective in establishing clean air quality standards



Source: Open public consultation. Question 7.1.2 "to what extent have the Ambient Air Quality Directives been effective in achieving the following outputs: Clean air quality standards established across the European Union?" N=476

E.2.3 Results: Factors influencing objective achievement

Literature review

Compared to other objectives, compliance with the air quality standards, including relevant factors, has been relatively well-covered in literature. However, more hindering than positively driving factors have been identified in literature. The EEA Air Quality annual reports ([R53], [R51], [R50], [R45]) describe some factors contributing to developments of pollutant concentrations, and their extent

- For PM, precursor emissions are the most important driver for the decreasing concentrations, while meteorology plays a smaller role. In addition, NH_3 emissions from agriculture are contributing to high PM concentrations (seasonal, in some areas of Europe). A combination of weather-related factors and source-emissions (use of fertiliser and residential heating), can lead to particularly severe events, such as that observed in 2014 in France and other countries (UK, Belgium, Netherlands and Germany).

- For O_3, meteorological conditions are an important factor influencing its formation and degradation, and meteorological trends have led to some O_3 reduction in the 1990s. High solar radiation, and heatwaves are noted as important contributors to episodes of high O_3 concentrations.

The assessment of court cases[29] [L1-L3, L6] has identified various arguments put forward by defending parties and by claimants that may be considered as possible factors in compliance with air quality standards. In particular, the defending parties (Member States, UK Secretary of State for the Environment, Food and Rural Affairs) have put forward the following arguments to explain the non-compliance:

- Socio-economic situation (Bulgaria, PM_{10})
- Domestic heating by wood and coal (Bulgaria, PM_{10})
- Pollution from natural sources, such as volcanoes (Italy, PM_{10})
- Meteorological conditions and "rising of particulate matter deposited on the ground" (Italy, PM_{10})
- Limit values and time-limits imposed too strict ("due to insufficient technical knowledge of the process of PM_{10} formation") (Italy, PM_{10})
- EU policies to reduce PM_{10} precursors not delivering as expected (Italy, PM_{10})
- Insufficient link between EU air quality policy and, e.g. climate mitigation policy (Italy, PM_{10})
- Considerations of cost, political sensitivity and administrative difficulties (implicit, Defra case, NO_2)

Meanwhile the claimants (Commission, ClientEarth) and other interested parties have put forward the following as arguments:

- Failure to adopt appropriate measures and failure to submit a national air quality plan (Italy, PM_{10})
- Failure to consider measures that would be effective in "as short as possible" a time (UK, NO_2)
- Inadequate air quality plans (UK, NO_2)
- Usage of emission factors which substantially underestimate real-driving emissions, and subsequently leading to fewer clean air zones being established (UK, NO_2). This leads to a more general consideration of the effect that performance of emission standards can have on measures to reduce NO_2 concentrations)

In its Clean Air Handbook [R1], ClientEarth describes a questionnaire filled in by NGOs in ten Member States, asking about common problems related to citizens' "right to clean air". The problems identified related to several of the objectives of the AAQ Directives. Among those, some have a clear link to the non-attainment of air quality standards. In particular, the document highlights a lack of information (further discussed in the next section), difficulties accessing courts, and inadequate measures in air quality plans (to be further discussed under Objective 5). The latter may lead to persistent non-compliance with standards via delayed (or absent) implementation, inaccurate assessments of the measures' effectiveness and lacking updates despite continued problems. The EEB, in its recent assessment [R92] of national air quality proposals[30] sent to the Commission in 2018, also finds that most proposals are not concrete enough, lack detail,

[29] CJEU and High Court of the UK judgements and court proceedings.
[30] The Member States that were given warnings by the Commission for breaching EU air quality limits were requested in January this year to send concrete proposals of how they will tackle air quality issues. The EEB and partner organisations sought to gain access to these proposals (provided by the governments to the Commission), by submitting access to information requests to the relevant Ministries. https://eeb.org/national-air-pollution-plans-too-little-too-late-to-avoid-court/

or ambition, and in many cases, no concrete measures are proposed or they are generic and do not indicate "commitment".

Stakeholder consultation

At the start of the Fitness Check process, in January 2018, the Ambient Air Quality Expert Group meeting participants were asked to identify possible factors influencing compliance or non-compliance with the air quality standards[31]. It was noted that some drivers can contribute to both compliance and non-compliance, e.g. economic activity. With outset in these discussions, the following factors were identified as driving non-compliance:

- Real driving emissions
- Changes in policies to promote diesel cars (climate change)
- Changes in policies to promote biomass burning (climate change)
- Fiscal incentives promoting diesel/biomass burning
- Socio-economic factors – use of low-quality fuels and burners
- Real performance of burners
- Governance issues preventing adopting of measures at regional/local level
- Siting of sampling points – even if the sampling point is in compliance with the AAQ Directives
- Composition and number of vehicles
- Economic activity
- Source apportionment (no guidance available), sources not properly identified or only identified after exceedances are reported
- Significant sources not addressed at EU late or only very late
- Particular circumstances in Member States not reflected appropriately in the AAQ Directives nor in the 2013 review
- Lack of knowledge from sectors to air quality – lack of awareness
- No dialogue with transboundary countries, not part of EU
- Agricultural policy (ammonia emissions leading to increased $PM_{2.5}$)
- Length of infringement procedures
- Lack of awareness on low quality fuels

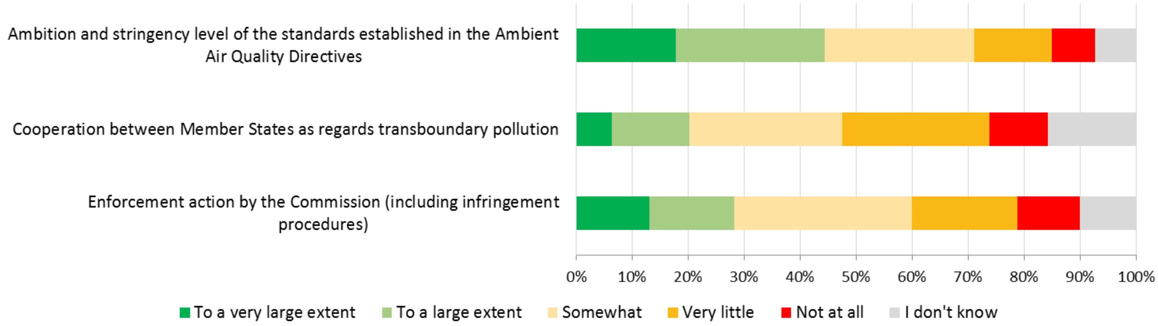
On the factors positively driving compliance the following were noted:

- Economic activity
- Binding limit values, risk of getting infringement procedures initiated
- Increased interest from the public, pressure from policy makers, better evidence on health effects
- Modelling results trigger additional action
- Source apportionment: sources targeted, when identified, Member States have been able to address them
- Source legislation, IED, Combustion Plants
- Raising of knowledge AQUILA; FAIRMODE; AAQEG; IPF meetings
- IPR: very effective in creating real-time networks in SE
- Dialogues involving stakeholders
- Centralized tools developed for reporting

[31] At the time of the meeting, the Evaluation Question for effectiveness was phrased focusing only on the air quality standards (and not the other objectives)

open public consultation question 7.2 asked stakeholders to provide their views on the extent to which certain provisions were factors in improved air quality in the Member States, namely: ambition and stringency level of the standards, cooperation between Member States on the issue of transboundary pollution, and enforcement action. The results are shown in the figure below.

Figure 9 Stakeholder responses regarding the extent to which the following factors related to the provisions of the AAQ Directives (at EU level) contributed to better air quality in the respondent's country



Source: Open public consultation. Question 7.2: To what extent have the following factors related to provisions of the Directives (at EU level) contributed to better air quality in your country? N=465.

Compared with over 70% of respondents who considered the AAQ Directives successful in establishing clean air standards (Section F.2.4), the level of ambition and stringency of these standards was positively assessed by around 45% of respondents. Enforcement actions by the Commission (e.g. infringement procedures) ware considered to contribute (to a large or very large extent) by under 30% of respondents. Finally, cooperation between Member States related to transboundary pollution was positively assessed by only 20% of respondents.

The targeted questionnaire gathered more detail on the factors influencing the achievement of the objective to establish standards to achieve across the EU (expected output: clear, actionable Air quality standards are stablished and complied with for all the EU). It asked the respondents to assess the role of the provisions in the AAQ Directives in the objective achievement as well as to provide examples of external factors that contribute or hinder the achievement of this objective. 17 responses were provided to the question on Directive provisions (internal factors), and 20 responses contained answers on external factors.

The relevant provisions listed in the questionnaire in terms of setting standards to be achieved across the EU were those that define limit/target values or other environmental objectives, including critical values. This covers Articles 13, 14(1), 15, 16, 17(1) and Annexes VII, XI, XII-XIV in Directive 2008/50/EC; Article 3 and Annex I in Directive 2004/107/EC.

Table 17 summarises the responses related to the provisions above, and how they influence the achievement of the objective. Overall, it is noted by the respondents that the mandatory nature of standards is an important factor in contributing to the achievement of air quality standards. On the other hand, non-mandatory standards are assessed to being weaker, and a number of other areas are highlighted in terms of where the standards are either too loose, too strict, or too uniform. These areas are closely related to the relevance evaluation questions and, as such, are not further analysed here. Furthermore, Table 18 lists the responses provided on possible external. The most mentioned positive driver named was WHO guidelines and other scientific evidence – found in around a quarter of responses. The most prominent hindering factor exemplified was the differing approaches and levels of implementation by Member States.

Table 17 Stakeholder responses regarding the achievement of Objective 2: Establishing standards of air quality to achieve across the EU; Role of the Directives (language in quotes unedited; spelling adjusted

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
Compulsory nature of standards	+	2	"mandatory AQ standards has been a driving force for MS to ensure that the necessary policies and measures are put in place" (Member State authority/agency) "Among the different air quality standards set under the AAQ Directives, limit values (Articles 13 and 16(2) and Annexes XI and XIV of Directive 2008/50/EC) provide the highest degree of clarity to the public and are the standards best fit for the purpose of driving action against air pollution." (NGOs)
Shortcomings in the definition of standards	-	6	"Contribution failed: should be separate standards for urban areas" (municipal authority) "Contrary to the limit values, other types of air quality standards (such as the target values, under Article 17 Directive 2008/50/EC or Article 3 Directive 2004/107/EC, or the average exposure reduction target, under Article 15 Directive 2008/50/EC) do not provide certainty to the public. Several flexibilities, inherent to these standards, and the ability of Member States to balance the protection of health and the environment with other factors (such as the costs of measures), significantly weaken the ability of these obligations to deliver improvements of air quality […] The target values and average exposure reduction target appear to be fit primarily to inform the public about the current air quality status in relation to the relevant pollutants and to monitor trends. However, given the lack of legal consequences in the event of breach of these standards, they have not been effective in forcing authorities to implement concrete measures to reduce concentrations of the relevant pollutants." (NGOs) "As it turned out, for example, when determining the limit value for PM_{10}, important factors, such as the effects caused by re-suspension on road surfaces (which account for 18% of fine particles pollution from traffic in Austria) or natural sources, were ignored. The consequences of the strict limit for particulate matter resulting thereof have to be borne by Member States to this day." (Business association)

Source: COWI based on targeted questionnaire responses; Overall, 43 responses were assessed, 16 of which contributed to effectiveness questions on Objective 2 (however not necessarily providing a detailed response to each question).
Note: +/- : positive factor or negative factor

Table 18 Stakeholder responses regarding the achievement of Objective 2: Establishing standards of air quality to achieve across the EU; Role of the Directives (language in quotes unedited; spelling adjusted)

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
WHO and other scientific evidence	+	8 (2 coordinated)	"Scientific evidence plays a key role in guiding the establishment of air quality standards. The Commission should continue to use the most recent scientific evidence on health impacts of air pollutants to guide the setting of binding air quality standards." (NGO) "The WHO Air Quality Guidelines, as well as the Norwegian Institute of Public Health's Air Quality Criteria are important health based standards" (Member State authority/agency)
Cooperation	+	3	"Establishing standards of air quality is necessary but not sufficient. Atmo Grand Est has been working with neighbouring member states to share methods, data and build a truly common technical base that permits a common vision of issues. Thanks to Interreg projects Atlmo idee and Atmo Vision [...] cooperation is effective and air quality issues can be introduced into development objectives in the main Eurodistricts." (NGO) "CEN groups and AQUILA have been working to provide guidance, answering the needs of the AAQD. This is in our opinion an appropriate approach due to the required specialist knowledge, amount of work and coordination effort required." (Educational or scientific organisation)
Public awareness	+	3	"[...] In addition, the increasing of awareness from the society has bring out the necessity of ensuring better air quality levels and therefore has force the administration to take actions for the improvement of the AAQ standards." (Member State authority/agency) "Public interest in their own health and environment, particularly during pollution/smog episodes." (Member State authority/agency)
Implementation (leading to different levels of achievement)	+ / -	8	"Member States implement measures with different speed, such as joint EU Best Available Techniques in industry (BAT) or the building sector" (Business association) "A special care might be needed to secure the existing monitoring stations and their location in areas of exceedances." (NGO) "Given that sites in exceedance is sometimes used as a metric for the scale of the air quality problem facing a Member State, the proportion of site types can clearly have a material impact on this picture." (Municipal authority) "The margin for interpretation for siting of sampling points and the unclarity about the role of modelling in assessing compliance with AQ standards." (Member State authority/agency)

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
Other policies	+ / -	4	"In the last years there some examples that has contributed to have better air quality standards (IPPCD, LCPD) and some others that has hindered the fulfilment of the AQ standards (Energy policies, CC policies)." (Member State authority/agency) "In the case of sector specific sources, decisions on Best Available Techniques (BAT) conclusions – out of the BREFs and this via the Industrial Emissions Directive (IED) – establish the legal reference for the Emission Limit Values in the permits of industrial installations. BREF are part of the EU air pollution policy, reducing emissions at source." (Business association)
Geography	+ / -	2	"For some pollutants there is a significant influence of the geographical position of certain countries / cities to the level of concentrations of certain pollutants." (Member State authority/agency) "Even at European levels, the geographic location of countries and the climate impact on air quality is so high that uniform thresholds become inapplicable or inaccessible" (municipal authority)
Other negative	-	1	"Evaluation of the national system to follow-up the AAQ Directive has indicated that there is a need to strengthen knowledge and tools, such as modelling and by guidance documents, in the local communities." "For PM10 the concern of traffic safety during the winter season has been a hinder to introduce prohibition of studded tyres in cities, because of the snow and slippery roads in the winter" (both from a single Member State authority/agency)
Other positive	+	1	"Regularly monitoring and access to updated information to the public" (Member State authority/agency)

Source: COWI based on targeted questionnaire responses; Overall, 43 responses were assessed, 16 of which contributed to effectiveness questions on Objective 2 (however not necessarily providing a detailed response to each question).

Note: +/- : positive factor or negative factor

E.3 JC 2.3: Air quality information

This section provides further evidence regarding the judgement criterion for the effectiveness of making air quality information public so that people, organisations and others can act on adverse air pollution concentration values (Objective 3).

Objective: Ensure that information on air quality is made public
Output: Reliable, objective, comparable information on air quality across the EU

JC2.3: Internal or external factors are identified that influenced availability of reliable, objective and comparable information across the EU

The effectiveness of the following Articles and related Annexes in the AAQ Directives are considered under this criterion:

Table 19 Articles and related Annexes: Objective 3

Articles in 2008/50/EC	Annexes in 2008/50/EC	Articles in 2004/107/EC	Annexes in 2004/107/EC
26, 27, 19, (20)	Annex XII (information and alert thresholds), XVI (public information)	5, 7	-

Source: COWI, based on the AAQ Directives [P98], [P96].

E.3.1 Approach

The AAQ Directives require that the information regarding air quality is provided to the public and stipulates a set of rules on how that is to be done. Articles 27 and 20 in the 2008 Directive and Article 5 in the 2004 Directive relate to transmission of information to the Commission. This is done via the Eionet, and the predefined Reporting Obligations as outlined in the Commission Implementing Decision 2011/850/EU.

The present assessment focuses on provisions related to making the information public, and as such relates to Articles 26, 20 in Directive 2008/50/EC and Article 7 in Directive 2004/107/EC. According to these articles, the public (and relevant organisations) should be informed "adequately and in good time" on: 1) air quality, 2) time extensions or exemptions, 3) and air quality plans. This information should be free of charge and available on easily accessible media (e.g. Internet). Furthermore, the articles require annual information to be published that summarises exceedances of limit and target values, as well as the effects on those exceedances on health and the environment. This should be in the form of an annual report. Finally, the provisions of Article 26 in Directive 2008/50/EC include a requirement to inform the public of the bodies designated to implement the tasks defined in Article 3.

To evaluate the level to which the objective (to ensure the public has access to air quality information) was achieved, the study assessed:

1) ease of accessing information on exceedances and air quality plans

2) availability of annual reports and whether their contents include items on both exceedances and effects of those exceedances

The first element was analysed by accessing the websites of the responsible competent authorities (as provided on the Air Quality e-reporting database). The general website of the authority responsible for air quality assessment was accessed with the view to evaluate the ease of finding relevant air quality information and air quality plans. The purpose of the exercise was not to locate and use air quality information, but rather "mimic" an interested citizen who is interested in accessibility, timeliness and user-friendliness of information. As such, the assessment may not have located all the detailed information if it was difficult to find from the front page of the website. In addition, this assessment involved checking if air quality plans are easily accessible.

The websites assessed are listed in the table below. In France, Italy and Spain, competent authorities are designated by city or region. For these Member States, the national level and the capital city or capital region authority website was assessed.

Table 20 Responsible competent authorities and their websites

Member State	Competent authority	Competent authority website given in dataflow B
Austria	Umweltbundesamt GmbH	http://www.umweltbundesamt.at
Belgium	IRCEL-CELINE	http://www.irceline.be
Bulgaria	Executive Environment Agency	http://www.eea.government.bg/
Czech Republic	CHMI Prague Komorany	http://www.chmi.cz
Croatia	Hrvatska agencija za okoliš i prirodu	not provided; located via search engine: http://www.haop.hr
Cyprus	Department of Labour Inspection - Ministry of Labour, Welfare and Social Insurance	www.mlsi.gov.cy/dli
Estonia	Estonian Environmental Research Centre	not provided; located via search engine: http://www.klab.ee
Denmark	Danish Environmental Agency	http://www.mst.dk
France	Defined by region/city. The responsible authority for the capital region: Airparif The responsible Ministry: Ministère de la Transition écologique et solidaire	Île-de-France: http://www.airparif.asso.fr/ Responsible Ministry: https://www.ecologique-solidaire.gouv.fr/
Finland	Ympäristöministeriö	http://ymparisto.fi
Germany	Federal Environment Agency	www.umweltbundesamt.de
Hungary	OMSZ - Hungarian Meteorological Service	http://www.met.hu
Greece	Ministry of Environment, Energy & Climate Change	http://www.ypeka.gr
Italy	Defined by region/city. The responsible authority for the capital region: Regione Lazio - Direzione Infrastrutture, Ambiente e	Capital region: www.regione.lazio.it Responsible Ministry:

Member State	Competent authority	Competent authority website given in dataflow B
	Politiche Abitative - Area Conservazione Qualità Ambiente e Bonifica Siti Inquinati. The responsible Ministry: Ministero dell'Ambiente e della Tutela del Territorio e del Mare	http://www.minambiente.it
Ireland	Environmental Protection Agency Ireland	http://www.epa.ie/air
Latvia	Latvian Environment, Geology and Meteorology Centre	http://www.meteo.lv http://www.lvgmc.lv
Luxembourg	Administration de l'environnement, division Air/Bruit	http://www.environnement.public.lu
Lithuania	Environmental Protection Agency	http://www.gamta.lt
Netherlands	Ministerie Infrastructuur en Milieu	http://www.rijksoverheid.nl/ministeries/ienm
Malta	Environment Resources Authority (ERA)	http://era.org.mt
Poland	Chief Inspectorate of Environmental Protection	www.gios.gov.pl
Portugal	Agencia Portuguesa do Ambiente	http://www.apambiente.pt
Romania	Agentia Nationala pentru Protectia Mediului	http://www.anpm.ro
Slovakia	SHMU	http://www.shmu.sk
Spain	Defined by region/city. The responsible authority for the capital city: Ayuntamiento de Madrid The responsible Ministry: Ministerio para la Transición Ecológica	Capital region: http://www.mambiente.munimadrid.es/opencms/opencms/calaire Responsible ministry: https://www.miteco.gob.es
Sweden	Swedish Environmental Protection Agency / Naturvårdsverket	https://www.naturvardsverket.se/Luft/
Slovenia	Slovenian Environment Agency	http://www.arso.gov.si
United Kingdom	The Department for Environment, Food and Rural Affairs, The Scottish Government, The Welsh Government and The Department of Environment - Northern Ireland	https://www.gov.uk/defra

Source: Air Quality e-Reporting [D38]; Note for Estonia and Croatia, websites were located using a search engine.

The second step of the analysis involved assessing the availability of annual air quality reports and checking whether their contents include items on both exceedances and effects of those exceedances. A similar approach to the first step was taken, in terms of "mimicking" an interested citizen (member of the public). As such, the results demonstrate, what information was accessible within a reasonable number of "clicks".

Limitations to the approach

The assessment was done in as short a time span as possible, by a small team, ensuring that the judgement providing is consistent and reflects the same snapshot in time. However, some limitations remain:

- Some of the websites were analysed at a later date (National websites for France, Italy, Spain and Croatia)
- Citizens may be interested in different parts of the information and have different levels of understanding: someone interested in air quality for health reasons, curiosity, school research, etc. The analysis imitates what a citizen may require, but it does not necessarily represent a likely response of the general population, or of a specific group to the information provided

E.3.2 Results

A. Evidence from the desk study

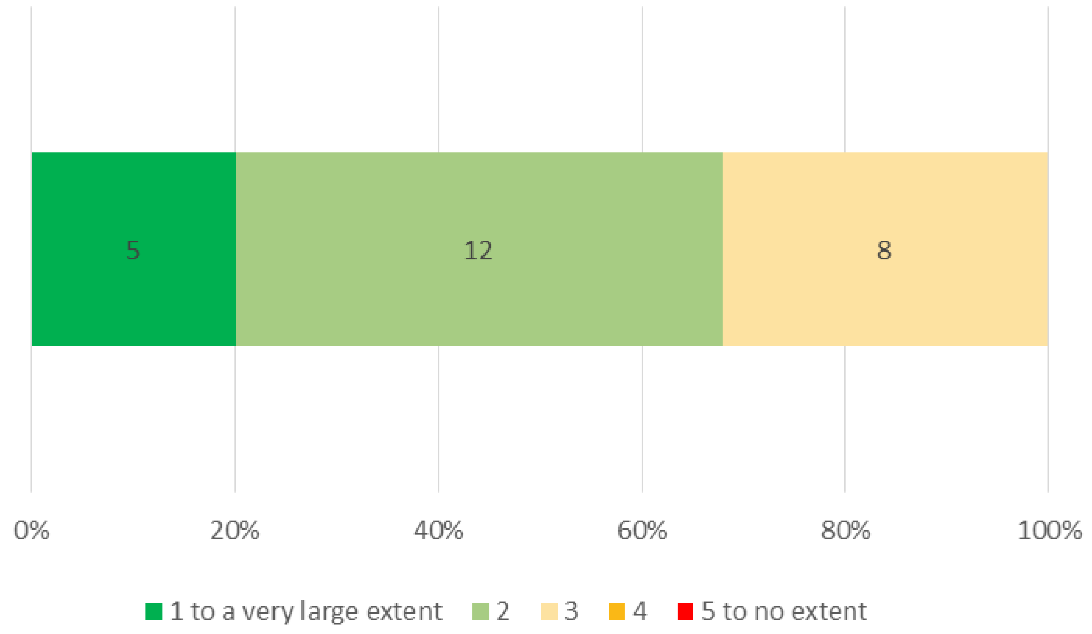
A comprehensive assessment of the availability of information on the responsible Member State authority websites was carried out. The overall finding was that for 11 out of the 28 Member States, air quality information was easily accessible, user-friendly and up-to-date. For 15 Member States, websites with relevant information was found, but it was either difficult to access (took a long time to locate), out of date or hard to understand. For the remaining 2 Member States no information was found.

B: Evidence from the targeted questionnaire

The targeted questionnaire responses were analysed using qualitative analysis software NVivo, to extract common themes and semi-quantitative results.

The targeted questionnaire aimed to attain more detail on the above issue. Among the 43 responses to the questionnaire, 35 respondents have chosen to provide contributions on effectiveness, and 26 of these have provided a quantitative estimate on their perceptions regarding the effectiveness of the AAQ Directives in achieving Objective 3. The majority (17 respondents) rated the achievement of this objective positively, and the rest chose the neutral rating (none provided negative rating).

Figure 10 *Stakeholder assessment of the extent to which the AAQ Directives achieved the objective of "ensuring that information on air quality is made public"*



Source: Targeted questionnaire; Effectiveness question 1: To what extent have the AAQ Directives achieved their objectives? (1= to a very large extent; Note inverted scale); Objective 3 Ensuring that information on air quality is made public. Expected output: Reliable, objective, comparable information on air quality across the EU. N=25 (a further response provided a rating equivalent to 2.15 on the inverted scale, presumably an average among respondents).

The main messages delivered by the questionnaire respondents are summarised in the table below. In general, while the AAQ Directives are noted as having contributed to the availability of information about air quality (in particular, specific requirements for information provision have been highlighted, as well as the EEA work including their Air Quality reports). However, some limitations have also been highlighted. Most notably, nine respondents found that there are limitations in terms of how clear and understandable the information is to the citizens. It was also noted that the Member States approach the task differently, including air quality index, and alert thresholds. However, some respondents noted that the possibility for the Member States to adapt the requirements for the specific needs of their citizens was welcome. The two main external factors named by the respondents were public demand for air quality data and contribution of other legislation, namely the legal framework on public access to environmental information.

Table 21 Stakeholder responses regarding the achievement of Objective 3: Ensuring that information on air quality is made public; Role of the Directives and external factors (language in quotes unedited; spelling adjusted)

Factor	(+)/ (-)	Internal/ external	Number of responses containing references to this element	Examples
Provisions on information availability, monitoring and reporting	+	Internal	8 (7 Member State authorities and 1 scientific institution)	"The fact that the AAQ Directives specifically ask Member State to provide information to the public has in our opinion led to awareness of the issues" (Scientific institution) "The provisions of Annex XVI of 2008/50/EC, along with the publishing of Air Quality in Europe-reports, contribute to the accessibility of public information regarding ambient air quality." (Member State authority/agency) "AAQ Directives implementation led to the development of the national air quality network website, that allows the public to access historical data from 2007 up to present." (Member State authority/agency)
EEA work and reports	+	Internal	3 (2 Member State authorities and 1 business association)	"The EEA do excellent work in making data available through their website etc. Also, publications such as Air Quality In Europe by the EEA are excellent in distilling the information on air quality available." (Member State authority/agency) " Air Quality in Europe reports, contribute to the accessibility of public information regarding ambient air quality." (Member State authority/agency)
Air Quality Index	+-	Internal	3 (NGO and 2 Member State authorities)	"The lack of a harmonized European air quality index makes it difficult to communicate on a cross-border basis." (NGO) "better interpretation of the results would be welcomed, to avoid widespread panic and reduce the number of unjustified inspections. It is expected that application of the European Air Quality Index will bring better comprehensiveness of the measurement results." (Member State authority/agency) "In addition, the very presentation of information, principally in case of current measurement results, may arouse a lot of controversy resulting from the lack of norms averaged up to an hour and the lack of standards for the presentation of current monitoring results, which is manifested in various types of air quality indices, either local or proposed by EEA." (Member State authority/agency)
Accessibility of information	-	Internal/external	9 (4 NGOs, 3 Member State authorities, 2 municipal authorities) -	"Education level of society very often is not enough to understand air quality monitoring information." (Municipal authority)

Factor	(+)/ (-)	Internal/ external	Number of responses containing references to this element	Examples
			3 of the NGO responses are coordinated	"Better interpretation of the results would be welcomed, to avoid widespread panic and reduce the number of unjustified inspections." (Member State authority/agency) "The published mass of monitoring data is often not understandable for an average citizen. The clear public summaries and local air quality descriptions are lacking." (NGO)
Different approaches in Member State	+-	Internal/external	4 (3 Member State authorities, 1 NGO)	"Authorities in EU Member States adopt significantly different practices in relation to public information, highlighting the need for further harmonisation." (NGO) "The methods of publicising air quality information by individual Member States could be more prescriptive. Perhaps some working groups should be established on the dissemination of air quality data and report production etc." (Member State authority/agency) "The AAQDs provide a clear framework for producing data on air quality with Member States having the flexibility to produce AQ data that is tailored to the needs of their populations." (Member State authority/agency) "the way information is published must meet social expectations, which cannot be directly regulated by regulations at the level of directive, because in different Member States the expectations of citizens will be different." (Member State authority/agency)
Alert thresholds	-	Internal	2 (NGOs)	"The existence of national initiatives like information and alert thresholds for PM10 in France and not included in the EU directives makes things difficult on a transboundary level." (NGO) "[Responding organisation] would like to see these provisions [Article 19 on alert thresholds] extended to particulate matter, which the Directive currently recognises is a threat to human health." (NGO)
Provisions in Annex XVI	+	Internal	2 (NGO and Member State authority/agency)	"The provisions of Annex XVI of 2008/50/EC, along with the publishing of Air Quality in Europe-reports, contribute to the accessibility of public information regarding ambient air quality." (Member State authority/agency) "The AAQ Directives require Member States to publish not only information about air quality, but also other key information. In particular, according Annex XVI, competent authorities must provide the following information during high pollution events: […]. Despite the clear wording of the directives, this additional information is rarely provided." (NGO)

Factor	(+)/ (-)	Internal/ external	Number of responses containing references to this element	Examples
Provisions on zones and assessment of air quality	-	Internal	2 (Member State authorities)	"the provisions regarding zones makes comparisons across countries more challenging and are also more challenging for the public to relate to." "In the annual Air Quality in Europe report, the EEA make use of graphical and spatial representations of the monitoring data across Europe. On maps within the document, the UK looks relatively sparse in terMS of monitoring points compared to most Member States and the comparison made between Member States is not adequately representative given that a large amount of UK data is not processed. […] Comparison between Member States will be difficult and inaccurate until methods for assessing compliance become more harmonised, where Member States choose to submit modelling data for the purposes of assessing compliance."
Public interest	+	External	6 (3 NGOs and 3 Member State authorities) – the 3 NGO responses are coordinated	"Citizen expectations on air quality issues have also pushed in the direction of more information using some new channels such as digital applications and e-learning platform settled in collaboration with universities." (NGO) "Public considers the air quality as a priority. The air quality data are in great demand." (Member State authority/agency) "Publicly available up-to-date AQ data intensified the demand from the public for getting the accurate up-to-date information everywhere across the country. It amplified even further efforts to ensure that information on air quality is made public." (Member State authority/agency)
Other legal acts and frameworks	+	External	3 (NGO, Member State authority/agency, scientific organisation)	"The implementation of the Public Access to environmental information Directives has help on ensuring that information on air quality is made public." (Member State authority/agency) "An external factor that can facilitate availability of information on air quality is Directive 2003/4/EC on public access to environmental information, which implements the Aarhus Convention." (NGO)

Source: COWI based on targeted questionnaire responses; Overall, 43 responses were assessed, 30 of which contributed to effectiveness questions on Objective 3 (however not necessarily providing a detailed response to each question).

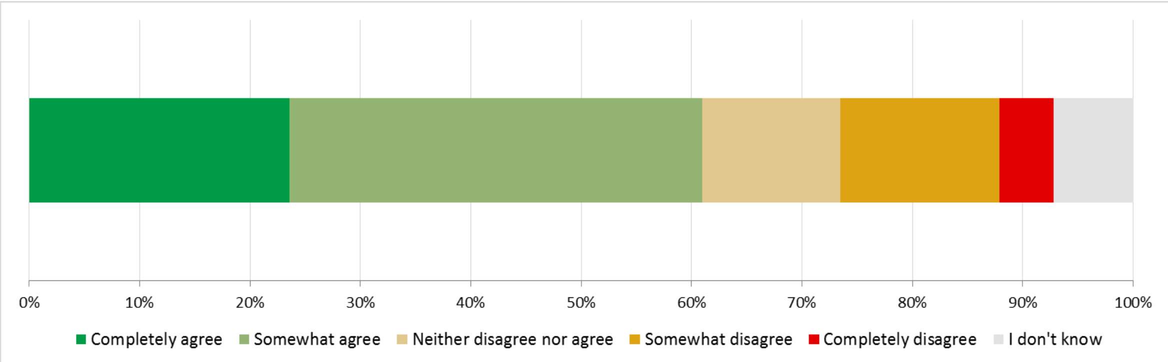
Note: +/- : positive factor or negative factor

C. Results of the open public consultation

The open public consultation question 7.1.3 asked "*to what extent have the Ambient Air Quality Directives been effective in achieving the output associated with this objective, namely, relevant information on air quality made available across the European Union?*"

The response distribution indicates that the majority of the respondents agree (somewhat or completely) that the AAQ Directives have been effective, as shown in the figure below.

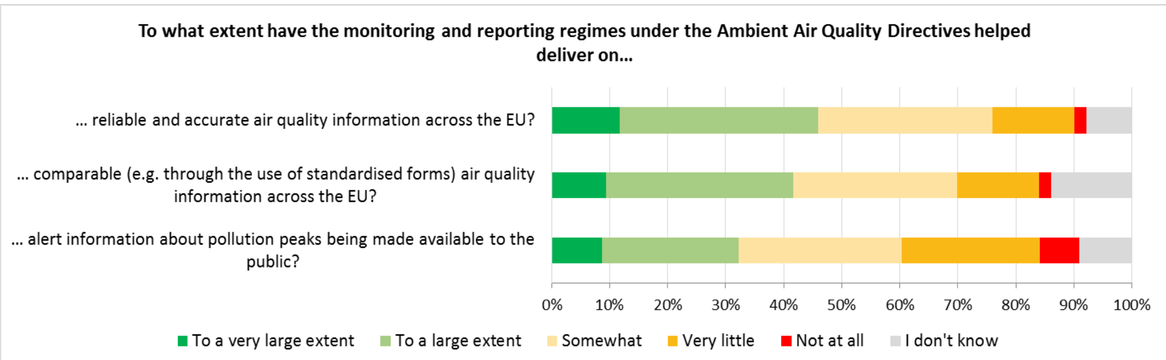
Figure 11 Stakeholder responses regarding effectiveness of the AAQ Directives in terms of making information on air quality available across the EU



Source: Ppen public consultation Q7.1.3 to what extent have the Ambient Air Quality Directives been effective in achieving the following outputs: relevant information on air quality made available across the European Union?

Meanwhile question 7.7 in the open public consultation seeks to understand the role of the AAQ Directives' monitoring and reporting regimes in delivering reliable, accurate, comparable information on air quality across the EU, as well as alert information being available. The responses are shown in Figure 12. They indicate that the highest proportion of respondents (46%) consider that the provisions in the AAQ Directives have helped deliver reliable and accurate information (to a large or very large extent). Somewhat fewer (41%) think the same about comparability of information across the EU (reiterating some examples indicated under the other objectives analysed that Member States are able to interpret the Directives differently, leading to potentially different assessment). Finally, fewest considered that the AAQ Directives' provisions contributed to making alert information available to the public.

Figure 12 Stakeholder views on role of the AAQ Directives' regimes on information availability, reliability and comparability



Source: Open public consultation Q7.7 To what extent have the monitoring and reporting regimes under the Ambient Air Quality Directives helped deliver on (elements in chart)

E.4 JC 2.4: Actions to avoid, prevent or reduce effect of poor air quality

This section provides further evidence regarding the judgement criterion for the effectiveness producing air quality plans by the Member States and accordingly to implement measures to avoid, prevent or reduce the effects of poor air quality (Objective 4).

Objective: Maintain good air quality, improve it where it is not good
Output: Coherent action taken to avoid, prevent, or reduce effect of poor air quality

JC2.4: Internal or external factors are identified that influenced the extent to which coherent action has been taken to avoid, prevent or reduce effect of poor air quality

The effectiveness of the following Articles and related Annexes in the AAQ Directives are considered under this criterion:

Table 22 Articles and related Annexes: Objective 4

Articles in 2008/50/EC	Annexes in 2008/50/EC	Articles in 2004/107/EC	Annexes in 2004/107/EC
12, 18 (maintain) 17 (2,3), 23, 24, 25	Annex XV	3 (2, 3)	-

Source: COWI, based on the AAQ Directives [P96], [P98].

E.4.1 Results: objective achievement

A: Evidence from the desk study

This section presents:

- Information on air quality plans, based on data flow H from Air Quality e-Reporting, compared with exceedances

- Information on measures based on an analysis done by the EEA (for PM_{10} and NO_2), supplemented by the measure catalogue (best-practices)

<u>Air quality plans</u>

The requirement to establish air quality plans is set out in Directive 2008/50/EC Article 23. According to this article, in zones or agglomerations where the levels of pollutants exceed limit or target value, Member States are required to establish air quality plans with the aim to achieve relevant limit or target values. The air quality plans have to set out measures such that the exceedance period is kept as short as possible, and the content is defined in Annex XV of the Directive. Meanwhile Directive 2004/107/EC does not have a specific provision for air quality plans, but requires, in Article 3, to "demonstrate the application of all necessary measures not entailing disproportionate costs, directed in particular at the predominant emission sources, in order to attain the target values" in the zones and agglomerations where target values are exceeded.

Annex XV of 2008/50/EC stipulates that an air quality plan should contain the following information:

1. Localisation of excess pollution (including the measuring station)
2. General information about the zone and polluted area
3. Responsible authorities (in charge of development and implementation of the plans)
4. Nature and assessment of pollution (before introduction of measures)
5. Origin of pollution (including that coming from other regions)
6. Analysis of the situation (factors behind exceedance, possible measures)
7. Measures or projects for improvement that existed prior to the Directive coming into force
8. Measures or projects adopted following the entry into force of the Directive (including description of all measures, timetable for implementation and estimate of improvement of air quality and time to achieve this improvement)
9. Measures or projects planned or researched for the long term
10. List of documents, publications etc. used to supplement information required above.

As per Article 13 of the Commission Implementing Decision 2011/850/EU, Member States are required to report air quality plans as set out by Article 23 of Directive 2008/50/EC, and the information has to be made available to the Commission "no later than 2 years after the end of the calendar year in which the first exceedance was observed"[32].

Table 23 below presents the number of air quality plans listed in data flow H, relevant pollutants and years covered.

Table 23 Member State reporting for: (H) Information on air quality plans (Article 13), 2013-16

	Number of submissions CDR	Years covered in CDR submissions	Number of plans in data flow H	Pollutants
Austria	3	2014, 2016	3	NO_2, PM_{10}
Belgium	7	2012, 2013, 2014, 2015	4	NO_2, PM_{10}, Pb
Bulgaria	4	2012, 2013, 2014, 2015	-	-
Croatia	4	2013, 2014, 2015	8	NO_2, O_3, BaP in PM_{10}, PM_{10}, $PM_{2.5}$
Cyprus	-	-	-	-

[32] Article 13 (2) of the AAQD IPR

Czech Republic	4	2012, 2013, 2014, 2015	78	NO_2, BaP, PM_{10}, SO_2, $PM_{2.5}$, Cd, C_6H_6, As
Denmark	1	2015	1	NO_2
Estonia	-	-	-	-
Finland	5	2012, 2013, 2014, 2015	1	NO_2
France	5	2012, 2013, 2014, 2015	75	NO_2, O_3, BaP in PM_{10}, Cd in PM_{10}, PM_{10}, CO, SO_2, $PM_{2.5}$, As in PM_{10}, Ni in PM_{10}, Pb in PM_{10}
Germany	41	2012, 2013, 2014, 2015	335	NO_2, PM_{10}, C_6H_6
Greece	-	-	-	-
Hungary	18	2016	18	-
Ireland	-	-	-	-
Italy	2	2012	30	NO_2, O_3, BaP in PM_{10}, PM_{10}, NH_3, CO, SO_2, $PM_{2.5}$, T-VOC, NO_x as NO_2, C_6H_6
Latvia	6	2012, 2013, 2014, 2015	10	NO_2, PM_{10}
Lithuania	1	2013	4	BaP in PM_{10}, PM_{10}
Luxembourg	-	-	-	-
Malta	-	-	-	-
Netherlands	1	2015	-	-
Poland	42	2012, 2013, 2014, 2015	9	BaP, PM_{10}, $PM_{2.5}$, C_6H_6
Portugal	3	2013, 2014, 2015	9	NO_2, PM_{10}
Romania	4	2012, 2013, 2014, 2015	-	-
Slovakia	2	2013, 2016	-	-
Slovenia	2	2014, 2016	2	PM_{10}
Spain	3	2013, 2014, 2015	41	NO_2, O_3, PM_{10}, NH_3, $PM_{2.5}$
Sweden	3	2014, 2015	3	NO_2, PM_{10}
United Kingdom	2	2013, 2015	2	NO_2

Source: COWI calculations based on data flow H http://aideh.apps.eea.europa.eu/ and Eionet Reporting Obligation Database https://rod.eionet.europa.eu/obligations/680

Measures introduced by the Member States

Member States are required to implement and report measures in areas where pollutant limit and target values are exceeded (Articles 13 and 14 of the IPR). The EEA has published an overview of measures that the Member States have reported under this provision [D41]. The EEA overview focuses on the two pollutants that have the highest number of reported exceedances, namely PM_{10} and NO_2 (and consequently most measures are reported that aim to reduce emissions of these pollutants). The briefing covers the years 2014-16 and includes information on stated reasons for exceedances, sectors targeted, and types of measures in the relevant sectors.

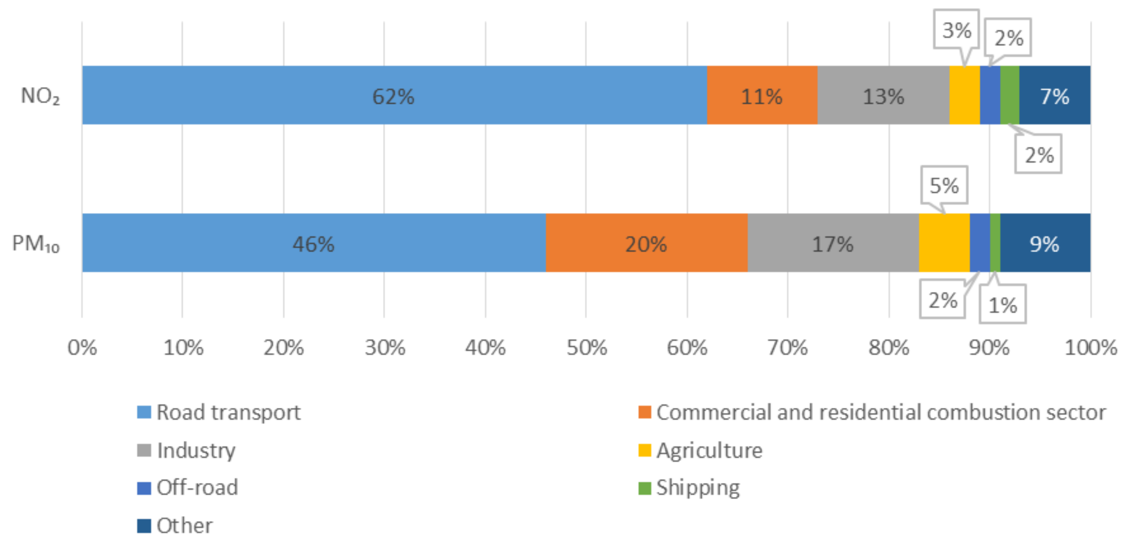
Table 24 Reasons provided in Member State reporting for exceedances of PM_{10} and NO_2

	PM_{10}	NO_2
% of reports which provided reason for exceedance	56%	90%
Most frequent reasons for exceedance (where a reason is given)	"other reasons" (41%)	"Proximity to a major road" (56%)
	Heavily trafficked urban centre (24%)	Heavily trafficked urban centre (37%)
	Proximity to a major road (21%)	NA

Source: [D41]

Sectors targeted are shown in the figure below, indicating that for both assessed pollutants road transport is the main sector targeted by the Member States, for NO_2 covering nearly 2/3 of the measures. This is followed by industry and commercial and residential sector, together accounting for 80% of measures for both pollutants.[33]

Figure 13 Sectors targeted by air quality measures, PM_{10} and NO_2

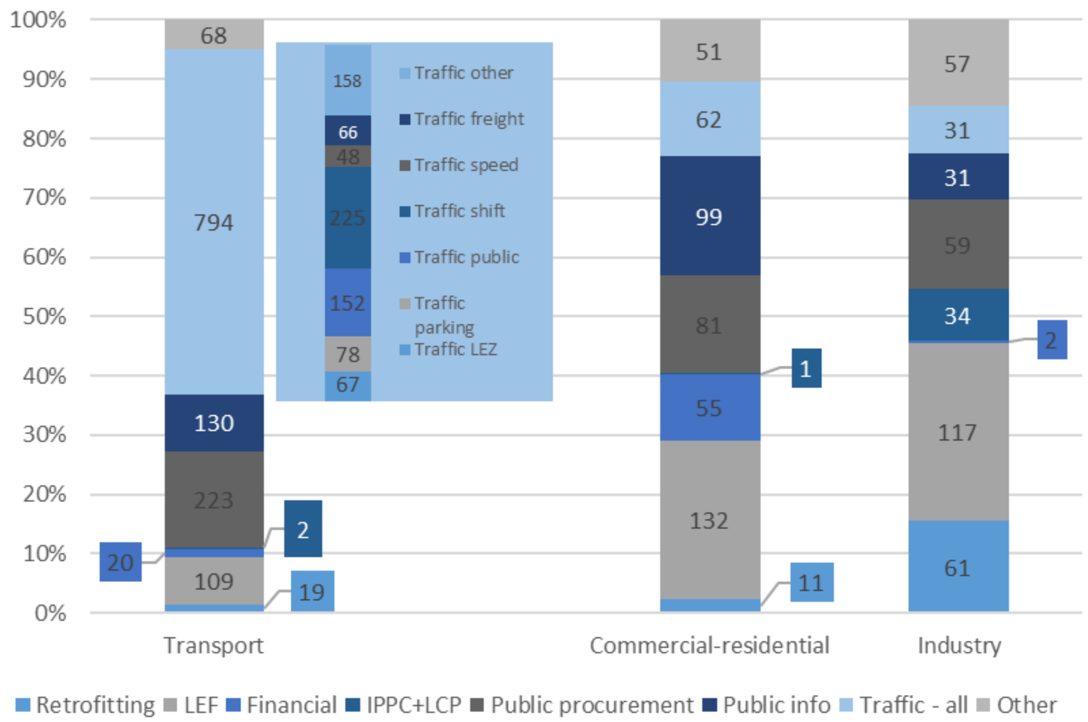


Source: COWI based on [D41]

[33] Note that the main support study report also covers non-urban area measures.

The measure types reported by the Member States in the three sectors with most reported measures – i.e. road transport (mainly areas), commercial and residential combustion and industry (mainly non-urban areas) – are shown in the figure below.

Figure 14 *Number measures by type in the road transport, commercial-residential and industry sectors for NO_2 and PM_{10}*



Source: Figure provided by EEA (7 November 2018) – based in air quality measures data flow K. See also EEA: https://www.eea.europa.eu/themes/air/improving-europe-s-air-quality

Note: LEF – low emission fuels, IPPC - Integrated Pollution Prevention and Control (industry) measures, LCP – large combustion plants

Across the different sectors, the most common measure reported was low emission fuels for PM_{10} and public procurement for NO_2, followed by traffic related measures such as modal shift, public transport and others.

Table 25 Distribution of reported measure types, PM_{10} and NO_2

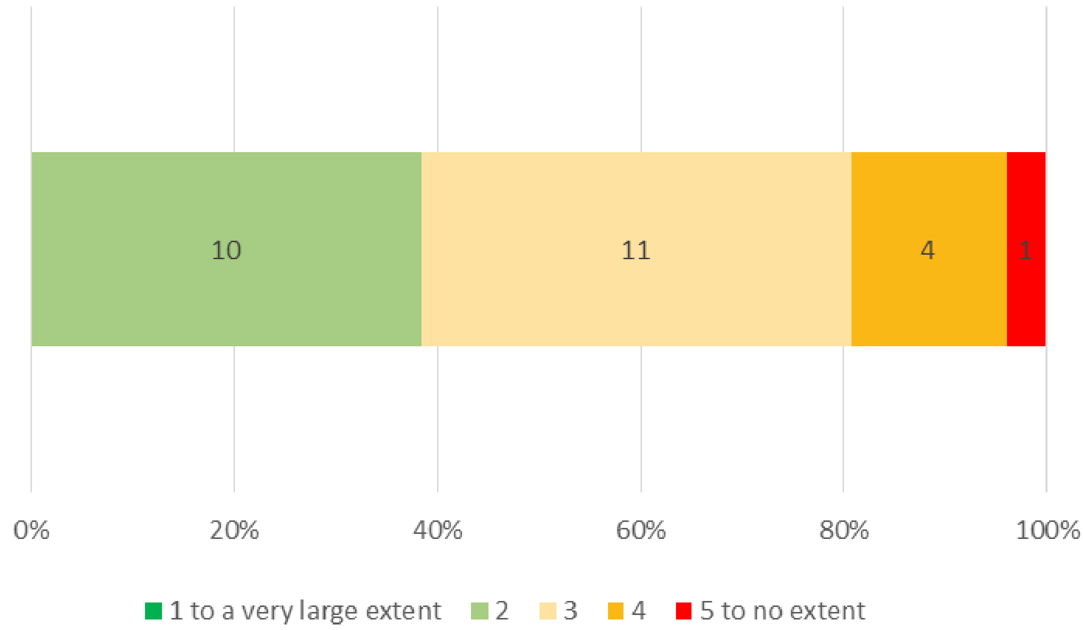
Classification	**PM_{10}**	**NO_2**
Low emission fuels	22%	9%
Public procurement	13%	17%
Public information	11%	10%
Traffic shift	9%	14%
Traffic other	8%	11%
Traffic public	6%	9%
Financial (taxes, charges etc.)	5%	2%
Retrofitting	4%	3%
Traffic low emission zones	3%	4%
Traffic freight	2%	4%
Traffic parking	2%	5%
Integrated Pollution Prevention and Control measures and large combustion plants	2%	1%
Traffic speed	2%	4%
Other	11%	6%

Source: [D41]

B: Evidence from the targeted consultation

The targeted questionnaire aimed to attain more detail on the issues above. It asked the respondents to provide their assessment of the extent to which the AAQ Directives have achieved Objective 5 (maintaining good air quality, improving where it is not good), and reasoning behind the score given. Among the 43 responses to the questionnaire, 27 quantitative estimates were available regarding the effectiveness of the AAQ Directives in achieving Objective 4.

Figure 15 *Stakeholder assessment of the extent to which the AAQ Directives achieved the objective of "maintaining good air quality, improving it where it is not good"*



Source: Targeted questionnaire; Effectiveness question 1: To what extent have the AAQ Directives achieved their objectives? (1= to a very large extent; note inverted scale); Objective 5 Maintaining good air quality, improving it where it is not good. Expected output: coherent action taken to avoid, prevent or reduce effect of poor air quality. N=26 (a further response indicated a rating in between, stating "3 or 4").

The results support the open public consultation result, with less than 40% of respondents positively evaluating the AAQ Directives' achievement of this output. Compared to the assessment provided for the other objectives, this objective also scored lowest among the targeted questionnaire respondents.

Among the 43 respondents, 32 provided answers to the question, one of which was only quantitative assessment (rating), the rest included some explanation. A further answer relevant for this topic was found in another part of the questionnaire. The contents of the responses are summarised in the table below.

Table 26 Targeted questionnaire responses on achievement of Objective 4

Responses contain	Number of responses	Summary of response content
Descriptions of reasoning for achievement of the objective	13 (4 + *9 that contain both positive and negative elements)*	13 responses provided either positive or both positive and negative descriptions. These responses contained general statements that air quality has improved, and that the AAQ Directives have contributed to maintaining or improving air quality. Five (5) of these responses elaborated that this is because Directives encourage action (e.g. via provision of limit values, possibility of enforcement action)
Descriptions of possible areas of concern / non-achievement of objective	23 (14 + *9 that contain both positive and negative elements)*	23 responses contained descriptions of areas of concern or shortcomings. The shortfall from achieving this objective is indicated by continued exceedances (7 responses), ongoing enforcement action (2 responses), and action plans or measures considered ineffective (4). The 10 remaining responses contained factors, shortcomings or suggestions.
Both	9	(described in the two rows above)
Neither	5	These responses provided statements that are not directly related to the question of objective achievement

Source: COWI based on targeted questionnaire responses; Overall, 43 responses were assessed, 32 of which contributed to this question (however not necessarily providing a detailed response).

All answers mentioning factors or shortcomings were analysed together with the questions that specifically asked to name factors hindering or supporting the achievement of the objective. This is presented in the section below.

The targeted questionnaire gathered more detail on the factors influencing the achievement of the objective to maintain good air quality or improve it where it is not good. It asked the respondents to assess the role of the provisions in the Directives in the objective achievement as well as to provide examples of external factors that contribute or hinder the achievement of this objective. 15 responses contained answers specifically on Directive provisions (internal factors), and 24 responses contained answers on external factors. Additional information on factors was found in other parts of the questionnaire.

Regarding internal factors (Table 27) - the relevant provisions listed in the questionnaire in terms of maintaining good air quality, improving it where it is not good were those that define how to act, what to do when standards are not met, and that aim to facilitate action to reduce transboundary pollution. This covers Articles 12, 17 (2,3), 18, 23, 24, 25 and Annex XV in Directive 2008/50/EC, Article 3(2,3) in Directive 2004/107/EC. The responses related to these provisions in the Directives are summarised in the table below. Notably, in addition to the listed provisions, some responses mention the provisions related to setting air quality standards, in particular limit values (Article 13) in combination with Article 23.

External factors (Table 28) – a wide variety were named by the respondents to the targeted questionnaire, but two main areas affecting objective achievement were related to public awareness and to sectoral issues. The latter includes factors related to sectoral legislation, industry actions, and more specific measures being targeted to certain areas. Overall, sector related issues were mentioned in 15 responses (some mentioning more than one type of factor). This count includes climate legislation elements, affecting transport and residential sectors.

Table 27 Stakeholder responses regarding the achievement of Objective 4 – internal factors (language in quotes unedited; spelling adjusted)

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
Obligation to comply with standards (Article 13)	+	2	"Having ambitious air quality standards set by the AAQ Directives has force Member State to implement the necessary measures to improve air quality." (Member State authority/agency) "Together with the obligation to comply with limit values pursuant to Article 13 Directive 2008/50/EC, the linked obligation to adopt air quality plans under Article 23 has been one of the cornerstones of the Air Quality Directive and one of the most effective provisions. This provision played a key role in ensuring the improvement of air quality across the EU. " (NGO)
Provisions on air quality plans (including guidance)	+	3	Article 23 is seen as key, because it sets a clear obligation to take action and has been used effectively in enforcement action (see also below). "The second subparagraph of Article 23(1) sets an obligation of result. The introduction of this new obligation in Directive 2008/50/EC represented a significant improvement of the previous regulatory framework and it has been key in driving actions against air pollution across Europe." (NGO) "Action Plans defined in Directives works excellent." (municipal authority) "The development of air quality plans according to Annex 15 of Directive 2008/50/EC led to the attainment of added knowledge regarding the regional background levels, especially the transboundary component of regional total background." (Member State authority/agency) "requirements of Annex XV provide essential guidance to competent authorities about the information that needs to be included in air quality plans. Accordingly, it also ensures coherence and comparability between air quality plans across the EU." (NGO)
Public awareness	-	6	Despite the importance of these provisions, a number of shortcomings were mentioned: - Timing when the AQP is required: only after exceedance, which is considered to go against Article 12 (2008/50/EC) and its aim to preserve the best ambient air quality (1 mention, Member State authority/agency - Article XV - Guidance on how to prepare and what should be contained in AQP is seen as difficult to interpret, unclear, and lacking specifics (4 mentions). NEC Directive related guidance is mentioned as a good example in 2 cases. - Ambiguity in terms of AQPs for pollutants with TVs (e.g. "2004/107/EC does not require the establishment of an Air Quality plan in case of exceedances of the target values"; " Por la ambigüedad de las Directivas AAQ sobre su obligatoriedad para los contaminantes sujetos a valores objetivo") (2 mentions, Scientific institution, NGO)

Factor	(+)/(-)	Number of responses containing references to this element	Examples
Enforcement action	+/-	5	- Time taken to draw up the plans (possibly an external factor to the extent that this depends on the authorities drafting them) (2 mentions, NGOs) Plans are ineffective, due to the time taken to prepare them, but also lack of concrete actions with SMART indicators (2 mentions, Member State authority/agency, NGO). This point possibly links to the shortcomings in available guidance. Enforcement action is seen as a positive contributor to achievement of the objective, in particular enabled by provisions in Article 23(1). "The introduction of this new obligation in Directive 2008/50/EC represented a significant improvement of the previous regulatory framework and it has been key in driving actions against air pollution across Europe. Enforcement actions from individuals, NGOs and the Commission have been one of the key drivers in relation to the recent developments and improvements in air quality in the EU. Legal actions would not have been possible, without the existence of the obligation to adopt air quality plans that set out appropriate measures to achieve compliance as soon as possible (Article 23(1), second subparagraph)." (NGO) However, two responses state that environmental crime is not yet sufficiently recognised in European law (and thus enforcement action has been difficult). (NGO, Member State authority/agency), and one response notes that infringement procedures are lengthy (Member State authority/agency)
Cross-border issues	-	6	Article 25 of Directive 2008/50/EC: no evidence has been provided on the application of this provision (or difficulties with applying it). However, 6 respondents explicitly pointed to issues with transboundary pollution (including specifically noting lack of action), but no mention of these being addressed (NGOs, Member State authorities).
AAQ Directivess do not tackle air pollution	-	4	The respondents noted that AAQ Directivess on their own do not provide instruments for improvement of air quality and, as such, rely on other legislation to be effective (links to external factor of source legislation, and coherence issues). Mentioned by NGO, business association, Member State authorities.
Lack of follow-up	-	3	Another element coming up in multiple answers was that follow-up and feedback on Member State actions is limited, e.g. whether different Member State have interpreted the Directives differently in terms of presenting relevant actions, how effective and efficient actions are. Mentioned by NGOs and a municipal authority. This indicates either lack of awareness or insufficiency of existing initiatives at EU level.
Maintaining good airquality essentially less prioritised	-	5	When air quality is or becomes good (achieved compliance), effort and resources are redirected. Therefore, in practice the provision to improve air quality where it is bad is prioritised compared to maintaining good AQ. Further, two of the responses noted that hot-spot management stemming from focus on achieving limit values

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
Others	-	1-2 each topic	may distort the picture of the level of improvement achieved. Focus on achievement of standards may result in improving AQ in problem areas at the expense of "maintaining" good air quality in other, broader areas or population exposure. Other issues mentioned include lack of hot-spot management, and insufficient training of national experts. These issues are related to type of action taken, as such, they can possibly be partly considered external factors. Notably, the response mentioning lack of hot-spot management contrasts those (above) that consider there is too much focus on hot-spot management.

Source: COWI based on targeted questionnaire responses; Overall, 43 responses were assessed, 32 of which contributed to effectiveness questions on Objective 4 (however not necessarily providing a detailed response to each question).
Note: +/- : positive factor or negative factor

Table 28 Stakeholder responses regarding the achievement of Objective 4 – external factors (language in quotes unedited; spelling adjusted)

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
Public interest, awareness and action	+/-	9 (8+, 1-)	Action, interest and awareness of the public was mentioned as a supporting factor by NGOs (4 responses) and Member State authorities (5 responses). Eight of these answers described that increasing public awareness (and also awareness among officials) drives action for better air quality, while one answer noted lack of public awareness as an issue.
Sectoral (and other) legislation	+	4	The answers noting positive contributions of source legislation contain two types of information: general acknowledgement of synergies to support improved AAQ Directives (2 responses from Member State authorities); naming specific legislation, in particular the Industrial Emissions Directive and IPPC which have contributed to achievement of AAQ Directives objectives (2 responses, Member State authority/agency and industry association)
Public awareness	-	8	Among the 8 responses noting negative contribution, two Member State authorities noted general conflict with other policy areas, while the others noted incoherence between policy goals or failure of other policies and provided examples.

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
			Climate policy was noted (by Member State authorities) as having negatively contributed in two ways: 1) biomass being considered a zero-emission fuel, which does not consider air pollution resulting from biomass burning in the residential sector. 2) promotion of diesel cars. Furthermore, Euro standards were noted to have failed to deliver real-world emission reductions, and insufficient follow-up by Member State and Commission was noted (NGO). *See also below on industry action.* Other NGO and municipal authority responses include mentions of: agriculture, waste, urban energy, industry policies, climate policies reflected in national fiscal policies (presumably linked to vehicles), emission sources not controlled at EU level, such as small combustion sources (heating), small diesel engines, certain construction sites, etc.
Industry action	-	5	These answers contain two main points: first, lobbying by industry to influence policy making, second, lack of willingness to take action and manipulation (2 NGO responses, 1 Member State, 1 municipal authority, 1 scientific institution).
Measures targeting certain sectors	+-	4	Respondents noted that the sector best addressed so far has been industry, while residential, transport and agriculture have not followed to the same level (2 business associations), possibly pointing to perceived unfair burden sharing. Further, it was remarked by city authority responses that measures in traffic (2 mentions) and residential sector (1 mention) are politically sensitive or there is lack of will to implement those.
Real-life not in line with the AAQ Directives provisions	-	5	These responses highlighted the discrepancy between standards and real-life emissions (already mentioned above), all of them remarking on difficulties with NO_2. Two of these responses raise the point that the AAQ Directives limit values for NO_2 were set based on assumptions that do not match real-life situation, leading to non-compliance. These responses came from a Member State authority/agency and a business association.
Performance and capacity of authorities in Member States	+-	8 (7-, 1+)	Answers from NGOs and municipal authorities indicated issues related to the capacities and action in the Member States: - Implementation of measures requires political will, which is regarded as lacking (also mentioned by a Member State authority/agency) - Complexity of governance structures – need for agreements among different levels may exacerbate the situations where political will is lacking, as it provides additional barriers, in terms of responsibility division. While in

Factor	(+)/ (-)	Number of responses containing references to this element	Examples
			countries like Belgium and Germany, responsibility for air quality management lies with regional (and local) governments, the Federal Governments can pass or block relevant fiscal or traffic management legislation. - Different implementation in the Member State (policies that are not EU-controlled, including fiscal, housing) - Failure of authorities to implement the Directives, e.g. failure to include all possible and necessary measures to achieve limit values within the shortest time possible, or including measures that are outside of their responsibility Further, Member State authority/agency responses raise issues with lack of awareness across the institutions (e.g. among those responsible for transport planning or spatial development), short-term thinking, or delayed national action (combined response from Member State and local governments). One positive example was provided in this regard, which acknowledges the importance of these actors: namely, Norway has introduced official guidelines on the treatment of air quality in spatial planning, which forces businesses and planners to consider AQ and introduce measures, when preparing projects affecting local AQ.
Funding	-	6	Limited financial resources are noted as one of the factors by Member State authorities/agencies (in particular among EU-13 countries) and some NGOs. A specific example is provided by a Member State authority relates to difficulties in the residential sector: financial support programmes do not always allow the possibility for projects to be implemented by natural persons, which limits implementation activities in the sector.
Other issues	+-	1-3 each	Other issues mentioned include: geography & meteorology, urbanisation/population growth/increased population density, economic development, local history, transboundary pollution (covered further in the section above on internal factors), need for improved models, long term nature of some measures (e.g. city planning), need for behaviour change, scale of the problem (e.g. residential sector heating). One response expressed appreciation for the national testing laboratories.

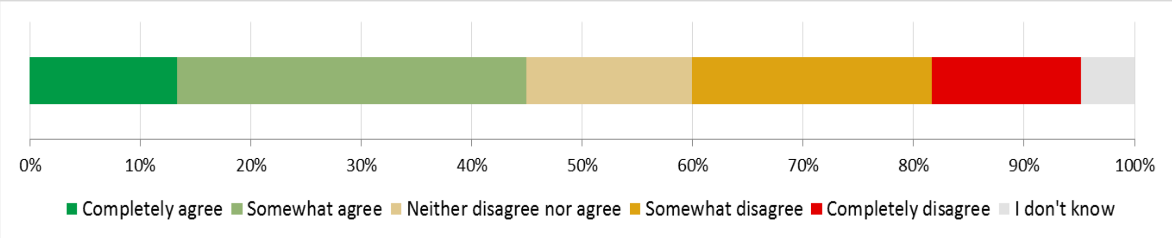
Source: COWI based on targeted questionnaire responses; Overall, 43 responses were assessed, 32 of which contributed to effectiveness questions on Objective 4 (however not necessarily providing a detailed response to each question).

Note: +/- : positive factor or negative factor

C: Results of the open public consultation

The Open Public Consultation included items related to action taken to avoid, prevent or reduce the effect of poor air quality. In particular, the open public consultation question open public consultation 7.1.4 asked "*to what extent have the Ambient Air Quality Directives been effective in achieving the following outputs: Coherent action taken to avoid, prevent, or reduce the effect of poor air quality?*" As shown in the figure below, compared with the other objectives, the outputs required to achieve this objective are seen less positively. Less than half of the respondents "agreed" or "completely agreed" that the AAQDs have been effective in achieving this output (compared with 60-70% for the outputs related to setting up air quality monitoring network, establishing standards and providing information).

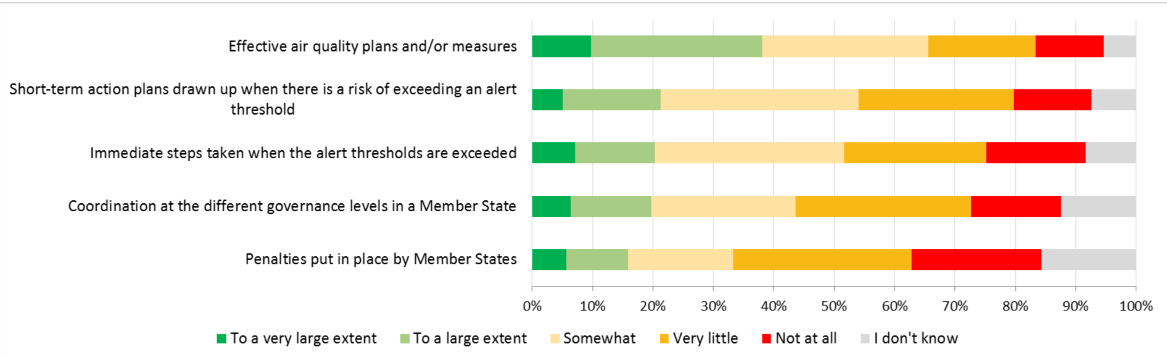
Figure 16 Stakeholder responses regarding the extent to which the AAQDs have been effective in achieving coherent action to avoid, prevent, or reduce the effect of poor air quality?



Source: Open public consultation. Question 7.1.4 "to what extent have the Ambient Air Quality Directives been effective in achieving the following outputs: Coherent action taken to avoid, prevent, or reduce the effect of poor air quality?" N=474

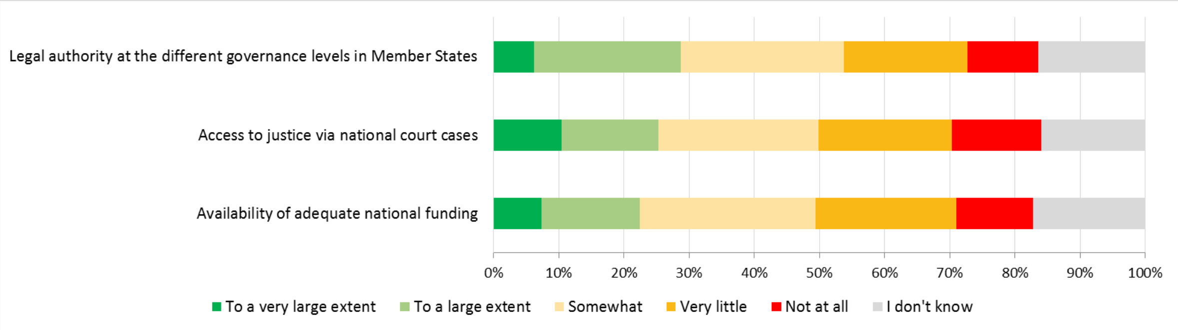
The responses to the open public consultation show that the factor scoring most positively is "effective air quality plans and/or measures", followed by "Legal authority at the different governance levels in Member States." However, the results indicate very mixed views among the respondents.

Figure 17 Stakeholder responses regarding the extent to which the following factors related to provisions of the Directives (at Member State Level) contributed to better air quality in [respondent's country]?



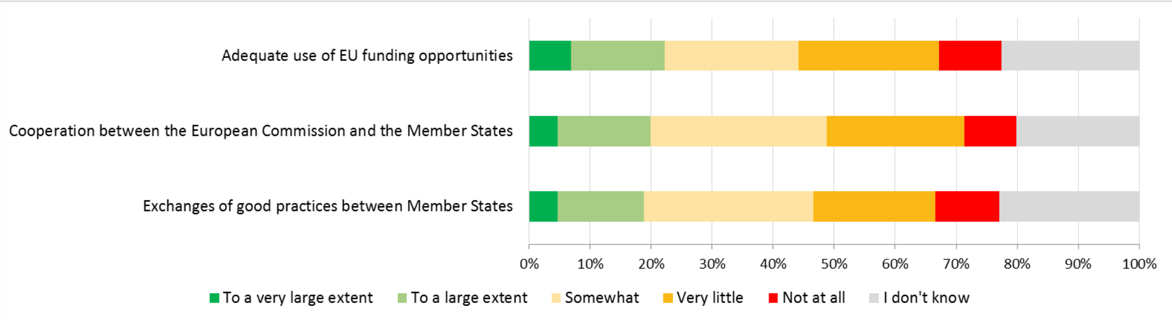
Source: Open public consultation. Question 7.3. To what extent have the following factors related to provisions of the Directives (at Member State level) contributed to better air quality in your country?

Figure 18 *Stakeholder responses regarding the extent to which the following factors external to the Directives (at Member State level) contributed to better air quality in [respondent's country]?*



Source: Open public consultation. Question 7.4 To what extent have the following factors external to the Directives (at Member State level) contributed to better air quality in your country?

Figure 19 *Stakeholder responses regarding the extent to which the following factors external to the Directives (at EU level) contributed to better air quality in [respondent's country]?*



Source: Open public consultation. Question 7.5 To what extent have the following factors external to the Directives (at EU level) contributed to better air quality in your country?

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Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

Final Report

Appendix F: Detailed Evidence for Efficiency

APPENDIX F DETAILED EVIDENCE FOR EFFICIENCY

This appendix provides detailed information supporting the assessment of efficiency under the study supporting the Fitness Check of the EU Ambient Air Quality Directives. This accompanies the assessment provided in the final study report.

F.1 Evaluation question 3: Costs and benefits of the AAQ Directives

The present section contains additional evidence concerning *EQ 3: What are the costs and benefits (monetary and non-monetary) associated with implementation of the AAQ Directives in the Member States, and in the EU; have the benefits (improved air quality) been achieved in a cost-effective manner and to what extent have costs been equitably distributed across different sectors?*

The question refers to costs and benefits associated with 'implementation of the AAQ Directives in the Member States, and in the EU', specifically in relation to local air quality management plans. Local plans are needed where measures taken at other levels have not delivered compliance with the limit values defined for air quality. Benefits here focus on the outcomes from implementation of the measures: these benefits may be monetised, but where no monetary values are available, non-monetary benefits (for example, the extent of pollution reduction) may be of use. The costs of monitoring and reporting of pollutant concentrations are dealt with separately under Question 5.

The Better Regulation Guidelines are clear that the answer to this question should provide evidence on the actual costs and benefits, showing what can be linked to the EU intervention and what cannot. Good evaluations should make strong efforts to go beyond a qualitative description of the different costs and benefits of the EU intervention and seek to quantify them. This creates a challenge for the current assessment, noting that cost data, particularly ex-post cost data, are limited: none of the national case studies undertaken for this assessment were able to reference national assessments of the costs or benefits of AAQ Directives' implementation, though some reference is made to the costs of specific measures. The EUROSAI report [R95] comes to a similar conclusion on data unavailability.

In many cases where air quality benefits are quantified for measures, the attribution of cost to air quality management can be questioned, as the reduction of pollution may be only one of a number of drivers behind implementation of a measure [e.g. D107]. Other reasons for introducing measures include congestion relief in the case of certain traffic measures and reduction of greenhouse gas emissions in the case of boiler replacement programmes. A more complete listing of co-benefits and trade-offs of actions is provided below. Knowledge of co-benefits and trade-offs is important in the design of efficient legislation, which should clearly recognise effects in other policy areas, allowing co-benefits to be strengthened and trade-offs to be mitigated to an appropriate degree.

The following indicators have been investigated:

- The types of measure adopted
- Sectors affected
- Change in public exposure to levels of pollution above limit values
- Associated changes in health impacts
- Qualitative review of other types of benefit or impact of the Directives
- Synergies with other policy areas, notably climate and transport

For some pollutants, such as $PM_{2.5}$ and NO_2 there are exceedances of the limit values in a large number of locations, whilst for some others, like CO, exceedance is very rare (the EEA's 2018 report on Air Quality in Europe [R61] identifies only one exceedance of the CO limit value in the EU). Limit values for most pollutants provide a point of reference for compliance. For $PM_{2.5}$ the approach is supplemented by the National Exposure Reduction Target recognising the evidence for the severity of its impacts and that it has no threshold for effect.

It is incorrect to regard limit values as thresholds for effect, in other words concentrations below which impacts do not occur and the population is fully protected [R192]. Some recommendations for quantification include a limit below which analysis is not recommended, but these typically relate to the lower bound for concentrations observed in the epidemiological studies from which response functions have been generated. An example is the recommendation by WHO-Europe to quantify NO_2 impacts only above a concentration of 20 $\mu g.m^{-3}$ [R192].

The analysis has considered the academic and non-academic literature, outputs from the targeted questionnaires.

F.1.1 The Eurosai assessment

The EUROSAI report [R95] reviewed the availability of information on cost effectiveness of measures to improve air quality in several countries, and provided useful background to the current assessment. A number of conclusions were reached in the report regarding cost-effectiveness of air quality interventions:

- Project funding was not always well-targeted, though the authors identified a number of successful projects, particularly those funded by the EU LIFE Programme, which was considered 'best ECA practice'.
- Funding sources were often varied, fragmented, and insufficient to deal with the problem.
- As in the present assessment, the authors concluded that data on costs were not systematically collected as the following examples (quoting from the report) indicate:
  - Netherlands: 'the Ministry of Infrastructure and the Environment does not keep annual accounts of expenditure on the various forms of action taken under the National Air Quality Cooperation Programme (NSL). In our 2016 audit, we concluded that the Minister did not have much information available on the funds spent in implementing the NSL. Funds were spent both by central government on national measures and by local authorities on local measures. The ministry does not ask for financial progress reports on the cost of local measures. We also concluded that the ministry had limited information on the cost-effectiveness of each of the four types of NSL measure. The financial accounts are not linked to the programme's results. There are no clear links between national and local measures; it is not clear whether and how they reinforce each other.'
  - Poland: 'there were no data on the cost of corrective action concerning air protection (including all sources of funding), nor a detailed projection of the future level of expenses that needed to be incurred in order to guarantee the requisite air quality. Also, no analysis had been made to establish the level of external cost stemming from poor air quality.'
  - Bulgaria: 'there are no financial statements quoting specific figures for the implementation of national and municipal strategies, programmes, plans and there is no link with national and local financial estimates and annual budgets.'
  - Switzerland: EUROSAI found that there is no overall picture for the costs of implementing legislation on control of particulate matter. Consequently, the Swiss Federal Audit

Office recommended that the government seek to achieve greater cost transparency in relation to air pollution control.

- Costs and benefits are not analysed or not fully analysed. Of the 15 countries considered only 5 reported some cost-benefit analysis. Some countries reported that the measures taken by their governments had not been effective in improving air quality (including Poland and Spain). The Netherlands reached a different conclusion, that their programme had been effective, though their own 2017 audit concluded that the same reduction in emissions could have been achieved at lower cost. This raises a question about the way that the Dutch audit was framed: whether to maximise emission reductions or minimise the population exposed to pollutant levels in excess of the limit values. For the latter, as discussed elsewhere here, there are additional benefits of equity to consider, with the AAQ Directives seeking to ensure that no individuals are exposed to levels of pollution that are considered excessive.

Table 1 EUROSAI conclusions on the cost-effectiveness of measures taken to improve air quality.

	How is budget allocated for the government's policy on air quality?	Does the (central) government have access to information on the costs and benefits of the policy?	Have the costs and benefits been analysed?	What are the result of this analysis? What is the known effectiveness of public funding or other incentives for helping to improve air quality?
EU Member States				
Bulgaria	Dark green	Light green	Light green	Not in scope
Estonia	Not in scope	Not in scope	Not in scope	Not in scope
Hungary	Dark green	Dark green	Medium green	Medium green
Poland	Medium green	Medium green	Light green	Light green
Romania	Dark green	Light green	Light green	Not in scope
Slovakia	Medium green	Dark green	Light green	Not in scope
Spain	Medium green	Dark green	Dark green	Light green
Netherlands	Dark green	Medium green	Medium green	Medium green
Non-EU countries				
Albania	Medium green	Dark green	Light green	Not in scope
Georgia	Not in scope	Not in scope	Not in scope	Not in scope
Israel	Dark green	Dark green	Dark green	Light green
Kosovo	Not in scope	Not in scope	Not in scope	Not in scope
Moldova	Medium green	Light green	Light green	Light green
Switzerland	Dark green	Dark green	Medium green	Medium green
FYR Macedonia	Medium green	Dark green	Light green	Not in scope

Dark green	Funding allocated/access to information/cost benefit analysis/ measures are effective
Medium green	Funding allocated but not adequate/no access to full information or no overall picture/incomplete cost-benefit analysis/ measures have only been partially effective
Light green	No funding allocated/no access to information/no cost-benefit analysis/ measures are not effective
Not in scope	Sub-audit question not in audit scope

In considering the relevance of the EUROSAI conclusions to the present assessment it is necessary to consider the remit of the analyses. EUROSAI considered not only local measures but also actions taken to reduce transboundary air pollution.

F.1.2 Types of measures introduced

EEA provides a database [D44] of 34 categories of possible action plan measures as shown in Table 2. The database includes measures for 20 member states, with no entries for Cyprus, Estonia, Greece, Hungary, Ireland, Luxembourg, Malta and the Netherlands.

The database provides an overview of the types of measure that are being adopted to meet the Directives and is far more extensive than other datasets. Unfortunately, for the evaluation of costs, benefits and efficiency, the database poses a number of difficulties:

- Only 3% of rows in the database contain entries for pollutant reduction, in some cases dealing with concentration and others emission;
- Based on the data vocabulary definitions on the Eionet website, it is understood that emission reductions cited in the database are annual rather than totalled over a period of years. However, units for emission changes are not specified and not always clear.
- There appears to be potential for cost data to be present in about 9% of rows given that currency is specified, but there are no data in the cost column (although in a few cases, cost data have been identified in the measure descriptions).
- The descriptions of costs (in the few cases where they are given) is incomplete, meaning that it is impossible to know whether they account for set-up costs, operation and maintenance and (where appropriate) any revenues earned (e.g. from fees for traffic access), or only part of the total cost (and revenue streams), or whether they are total costs or annualised.
- The number of rows where there is emission reduction data, and where there may be cost data available (if information on costs is indeed present in the system for those measures where a currency is specified but no data provided), accounts for only 2% of the database.
- A large number of measures are classified in the 'Other' category. Inspection of these entries indicates that many, and possibly most, would fit into the other categories listed. It follows that many measures appear to be wrongly classified.
- There is a lack of consistency in reporting between countries. In terms of numbers, the UK, for example, has as many entries as all other countries combined, having submitted details for each local authority in the country. Denmark, on the other hand, has submitted only 2 entries. Excluding the UK, the average number of measures taken by Member States is 73.

Table 2 Types of measures listed in the EEA database

Target	Categories of action plan measure
Industry	IPPC permits beyond BAT
	LCP permits and national plans going beyond BAT
Cleaner vehicles	Cleaner vehicle transport services
	New vehicles, including low emission vehicles
Traffic	Congestion pricing zones
	Differentiation of parking fees
	Speed limits
	Freight transport
	Land use planning for sustainable transport facilities
	Low emission zones
	Management of parking places
	Other (Traffic planning and management)
	Other measures not specified
Low emission fuels	Low emission fuels for stationary & mobile sources
	Other (Low Emission Fuels)
	Regulations for fuel quality
Stationary emission controls	Emission control equipment
	Low emission stationary combustion sources
	Retrofitting emission control equipment
Fuel switching - stationary sources	Shift to installations using low emission fuels
Information	INTERNET (Public information/Education)
	Leaflets (Public information/Education)
	other (Public information/Education)
	RADIO (Public information/Education)
	Television (Public information/Education)

Target	Categories of action plan measure
Fiscal	Introduction/increase of environment charges
	Introduction/increase of environment taxes
	Tradable permit system
	Introduction/increase of environmental funding
Modal shift	Slow modes (e.g. expansion of bicycle and pedestrian infrastructure)
	Effective improvement of public transport
	Encouragement of shift of transport modes
Public procurement	Other (Public procurement)
Other	Other

Source: [D44]

A summary of the data in the EEA database in terms of the % of measures for each country in each measure category is provided. The most common category is 'Traffic' measures, which includes low emission zones, parking controls, speed controls and various measures directed towards movements of freight. Clearly the measures included in this list will not all carry equal weight - some measures will require more substantive action than others, and may be associated with greater costs than others, whilst the benefits that accrue may also vary. Nonetheless this provides an indication of the order of magnitude in respect of the types of activities being undertaken by MS, as well as some indication of the extent to which this varies across Europe.

Despite being regarded by economists as being highly efficient [R144] given their inherent flexibility in contrast with command and control measures, fiscal measures outside the use of access charges as in congestion zones are not used to a great degree. Denmark cites the introduction of a tax on diesel vehicles. The relatively high number of fiscal measures identified for Romania appears mainly to be misclassification as the following example, listed against 'Introduction / increase of environmental taxes' shows: *The organization of the construction sites and the rehabilitation of roads in compliance with environmental legislation…. The measure will be imposed on contractors in the contracting phase of the work*.

Overall in the database most of the measures identified as fiscal are listed for the UK. However, classification in this category again appears misleading for some entries, such as "Ensure Taxi's comply with emission limits and consider EURO standards for fleet" or "*Testing Taxi's and private hire vehicles to continue and for vehicle inspectorate to be contacted for arrangements to be made for roadside testing for compliance with MOT emission standards*".

The table suggests that two key areas are the focus of much of the activity – measures tackling emissions from transport and those related to impacts associated boilers (noting that those categorised as low emissions fuels and stationary emission controls both relate to boilers). For some countries, there are also a number of measures relating to information provision. The following table summarises the data available corresponding to each of these sectors.

Table 3 % of measures for each country in each category. Green shaded cells indicate a share of 20% or more. Measures classified as 'Other' are not included.

	Industry	Stationary emission controls	Fuel switching - stationary sources	Cleaner vehicles	Traffic	Modal shift	Low emission fuels	Fiscal	Public procurement	Information
Austria	0%	0%	0%	18%	73%	9%	0%	0%	0%	0%
Belgium	0%	40%	0%	40%	20%	0%	0%	0%	0%	0%
Bulgaria	1%	6%	3%	9%	28%	16%	20%	0%	0%	16%
Croatia	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
Czech Rep.	1%	30%	0%	2%	25%	12%	26%	0%	0%	3%
Denmark	0%	50%	0%	0%	0%	0%	0%	50%	0%	0%
Finland	0%	0%	0%	20%	60%	0%	20%	0%	0%	0%
France	9%	18%	3%	9%	23%	14%	1%	0%	1%	23%
Germany	1%	6%	2%	26%	29%	24%	7%	1%	0%	5%
Italy	7%	5%	6%	11%	20%	14%	29%	1%	1%	7%
Latvia	0%	0%	0%	67%	33%	0%	0%	0%	0%	0%
Lithuania	5%	5%	5%	20%	10%	10%	15%	0%	5%	25%
Poland	3%	38%	0%	9%	12%	3%	26%	0%	0%	9%
Portugal	0%	0%	0%	50%	50%	0%	0%	0%	0%	0%
Romania	0%	26%	0%	29%	11%	3%	14%	14%	0%	3%
Slovakia	0%	0%	0%	0%	67%	0%	33%	0%	0%	0%
Slovenia	0%	2%	3%	5%	35%	26%	15%	0%	1%	13%
Spain	1%	19%	3%	14%	23%	12%	16%	3%	0%	10%
Sweden	0%	1%	0%	3%	38%	31%	16%	1%	1%	9%
UK	1%	2%	0%	3%	33%	42%	1%	1%	7%	10%

Source: [D44]

F.1.3 Data on measures from earlier reviews

Information from a number of reviews of measures is provided in this section. Ideally, these reviews would provide a precise description of the actions undertaken, together with data on costs and benefits (as emission reductions, change in pollutant levels, quantified health impacts) associated with each measure. However, this depth of information is available only very rarely. Ex-post data showing what actually happened as opposed to what was predicted to happen, are far rarer still: once policies have been agreed and initiated the need to revisit them to assess how successful they were is clearly not valued, as the authorities responsible move on to other concerns. This creates a barrier to learning from the experiences of others: certainly, lessons can be learned from the information that has been collated, but more could be. The data limitations are reflected in the conclusions of the Saltsjöbaden VI workshop of March 2018 which informs future activities under the UNECE Convention on Long Range Transboundary Air Pollution [P46]. Through those conclusions the Task Force on Integrated Assessment Modelling under the Convention has been requested to convene a working group to review what is available and what more could be done. A standardised system for reporting information would be a useful starting point.

A number of reviews have taken place of the cost effectiveness of measures covering the period of interest for this analysis. A study undertaken by Ricardo AEA on behalf of Defra in the UK sought data on the effectiveness of measures to tackle NO_2, reviewing over 400 studies as part of its work [R154]. Following on from this, work undertaken by the National Institute of Health and Care Excellence, with support from Eunomia and the University of the West of England, also undertook a comprehensive review of the literature, searching academic databases [R79]. Both studies established that data in respect of the costs and benefits of measures to tackle air pollution was generally limited, particularly in respect of studies which were based on ex-post information. A similar conclusion was reached by the University of Brescia, in a study outlining the use of the RIAT+ tool to assess the costs and benefits of the air quality plan for the Lombardy region. The latter study confirmed the lack of data evaluating the costs and benefits of air quality plans in particular: the tool was developed to allow for such evaluation to take place. It is noted that the tool makes use of ex-ante data in developing the assessments, and as such the related studies are of limited use in the current appraisal, which focuses on costs actually incurred, and the benefits which are actually realised as a result (rather than benefits which might occur under modelled scenarios).

Relevant data from a catalogue of measures presented on the JRC website [D114], which had been developed to provide guidance in air quality action plan development, is given in the table below, covering 73 measures. The list contains mainly transport measures (although emissions from stationary sources are also included). Data on the effectiveness of measures is only included for a small sub-set of measures, and measures have, in some cases, been classified as successful in the absence, apparently, of both cost data and data on the effectiveness of the measure (i.e., without supporting information on pollution reduction). It is also unclear whether data are ex-ante (showing forecast performance) or ex-post (representing actual performance).

Table 4 Summary data on costs and effectiveness from the JRC's catalogue of Air Quality Measures for cases where cost data are provided. Highlighted cells are those judged to be successful and where cost data were presented.

Measure	Pollutants	Success	Cost	Effectiveness
Air quality modelling to identify exceeded areas - example UK		Y	No data	Not applicable
Animal House Adaptation	PM_{10}, NH_3	Y	No data	30-80%
Austrian Action Programme for Mobility Management for communities	NO_2, PM_{10}	Y	No data	No data
Ban of fuel oil for residential heating - Lombardy	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	No data
Banning the marketing, sale and distribution of bituminous fuels - Dublin	BaP, PM_{10}, SO_2	Y	No data	Emission: -69% Concentration: - 35.6 ug.m-3 Pollutant not specified
Bicycle renting scheme - example Paris	NO_2, PM_{10}, $PM_{2.5}$	Y	€140M set-up offset by revenues	No data
Biotope Area Factor – Berlin	NO_2, O_3, PM_{10}, $PM_{2.5}$, SO_2	Y	No data	No data
Car sharing schemes -example Paris	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	No data
Central logistics (e.g. for construction) - Berlin, Vienna	NO_2, PM_{10}	Y	No data	No data
Cleaner Taxis - example London	NO_2, PM_{10}	Y	No data	No data

Measure	Pollutants	Success	Cost	Effectiveness
Cleaner vehicles for large private fleets - example US Postal Service	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	No data
Reducing emissions from public transport - example Berlin	NO_2, PM_{10}	Y	€10M particle filters in 1000 buses, €1.5M SCR retrofit	37 t/a soot 732 t/a NOx
Reducing emissions from public transport - example Madrid	NO_2, PM_{10}	Y	No data	Emission reductions per bus: PM 60-97% CO 52-84% NOx 25-86%
Congestion charge - Gothenburg	NO_2, PM_{10}	Y	No data	No data
Congestion charge - London	NO_2, PM_{10}	Y	No data£320M set up, £64M pa running costs, £105M pa revenue	Emission reduction 8% NOx, 6% PM_{10}
Congestion charge - Milan	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	No data
Congestion charge - Stockholm	NO_2, PM_{10}	Y	No data	Emission reduction in inner city 8.5% NOx, 613% PM_{10}
Construction sites guidance and restrictions	PM_{10}	Y	No data	No data
Covered storage of slurry and manure	PM_{10}, NH_3	Y	No data	40-80% NH_3
Cycle-to-work scheme - Ireland	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	No data
DPF retrofitting of trucks and buses - example Madrid	NO_2, PM_{10}	Y	Introduction: €6.1M	No data

Measure	Pollutants	Success	Cost	Effectiveness
Dry flue gas desulfurisation technology using magnesium oxide - Yerakini, Greece	SO_2	?	Set up: €1.5M for 1 large rotary kiln	45% SO_2
Ecodriving programs when fuel prices are low - Dublin	Not specified	N	No data	No data
Extension / Introduction of cycling networks, especially cycling highways	NO_2, PM_{10}, $PM_{2.5}$	Y	Set up: €21M, running costs €84k/y, total costs €55M	No data
Extension / introduction of tram lines - Nice	NO_2, PM_{10}, $PM_{2.5}$	Y	Setup: €650M	Forecast reduction around 16%. Reduction of 20k vehicles/day in Nice
Extension / introduction of tram lines - Paris	NO_2, PM_{10}, $PM_{2.5}$	Y	Setup: €400M	No data
Extension of district heating - example Vienna	NO_2, PM_{10}, BaP	Y	No data	No data
Extension of tram lines - Graz	PM_{10}	Y	Setup: €500M	No data
Fugitive dust measures	PM_{10}	Y	No data	No data
Idling reduction schemes - London and US	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	No data
Information to the public - example London	NO_2, PM_{10}, $PM_{2.5}$, O_3, SO_2	Y	No data	Not applicable
Integrated construction site traffic management - Vienna	NO_2, PM_{10}	Y	No data	No data
Intensive street cleaning	PM_{10}	N	No data	No data

Measure	Pollutants	Success	Cost	Effectiveness
Intermodality (e.g. park and ride)	NO_2, PM_{10}, $PM_{2.5}$, O_3, SO_2	Y	No data	No data
Job tickets	NO_2, PM_{10}	Y	No data	No data
Local air quality management support - UK	NO_2, PM_{10}	Y	No data	Not applicable
Low ammonia manure application methods	PM_{10}, $PM_{2.5}$, NH_3	Y	No data	NH3 40-80% reduction
Low emission zone - Berlin	NO_2, PM_{10}	Y	No data	Stage 1: -24% diesel PM, -14% NOx Stage 1: >-50% diesel PM, 20% NOx
Low emission zone - Lombardy and Milan	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	No data
Low emission zone - London	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	22t PM_{10}, 270 t NOx in 2011,
Low emission zones - Malmö, Stockholm	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	Estimated at 3-4% NOx, HC 16-21%, PM 13-19%
Lower speed limits on main roads - Berlin	NO_2, PM_{10}	Y	No data	-5 to 9ug/m^3 NO_2, -2 ug/m^3 PM_{10} No data
Moss meadows trials - Germany	PM_{10}	N	No data	No data
Motorway bypass - example Mühlhausen, Germany	NO_2, PM_{10}	Y	No data	-1.5 to 3.5 ug/m^3 NO_2

Measure	Pollutants	Success	Cost	Effectiveness
Noise barriers - Netherlands	NO_2, PM_{10}	Y	No data	Close behind barriers, NO_2 -14%, PM 34%
NOx bubble for airport - Zurich	NO_2	Y	No data	No data
NOx bubble steel plant – BAT frontrunner: SCR for sintering plant - Linz, Austria	NO_2, PM_{10}	Y	No data	No data
NOx charge for boilers generating >25GWh/y - Sweden	NO_2	Y	No data	50% of the overall reduction of specific NOx emissions, which was 65% between 1990 and 1992 was due to the NOx charge
Trading of industrial NOx emissions within the Netherlands	NO_2	☐	No data	No data
Obligatory district heating for new buildings - Upper Austria	NO_2, PM_{10}, BaP	Y	No data	No data
Onshore power supply - Antwerp	NO_2, PM_{10}	N	No data	No data
Onshore power supply - Gothenburg	NO_2, PM_{10}	Y	No data	97% emission reduction/ pollutant unspecified
Power plants permits beyond BAT - Lombardy	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	No data
Prohibit open field agricultural waste burning - example Austria	BaP, PM_{10}	Y	No data	No data

Measure	Pollutants	Success	Cost	Effectiveness
Public transport ticket schemes - example London	NO_2, PM_{10}	Y	No data	No data
Quality Bus Corridor (QBC) or Bus Rapid Transit (BRT) Ireland	NO_2, PM_{10}	Y	No data	No data
Redistribution of public space from passenger cars to slow modes - Paris	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	No data
Residential biomass combustion regulation - Lombardy	BaP, PM_{10}	Y	No data	No data
Restrictions to HDV through traffic - Stuttgart	NO_2, PM_{10}, $PM_{2.5}$	Y	No data	Emission reduction: -1% to -9% PM_{10}, -1% to -15% NOx. Concentration change: -1% to -8% PM_{10} exceedance days; -1% to -10% NO_2 annual mean
Sectoral ban of transport by trucks of specific goods - Tyrol	NO_2, PM_{10}	Y	No data	Emission reduction -2.5% NOx. concentration reduction 0.7ug/m^3 NOx. Expected 6.6% reduction in HDVs
SOx Emission Control Area (SECA) - North Sea, Baltic Sea	SO_2	Y	No data	70% emission reduction
Spatial planning: concentration at major axis of public transportation - example Salzburg	NO_2, PM_{10}	Y	No data	No data

Measure	Pollutants	Success	Cost	Effectiveness
Speed limit of 80km/h on motorway - Rotterdam	NO_2, PM_{10}	Y	Setup: €1.2M, Running costs €50k	Emission reduction -20% NOx, 30% PM_{10}. concentration reduction 3ug/m^3 NOx, 1 ug/m^3 PM_{10}.
Speed limits on motorways - Tyrol	NO_2, PM_{10}	Y	No data	Emission reduction -6.2% NOx. concentration reduction 3.7ug/m^3 NOx. Less benefit than permanent speed limit.
Speed reductions for (tug) ships - Antwerp	NO_2, PM_{10}	Y	No data	-10% reduction in fuel consumption
Stringent emission limit value for domestic heating in inner city areas - Aachen	PM_{10}	Y	No data	No data
Stringent emission limit value for domestic heating in inner city areas - Berlin	PM_{10}	Y	No data	No data
Subsidising alternative vehicles - Berlin	NO_2, PM_{10}, $PM_{2.5}$	N	No data	No data
Tackling fuel poverty - UK	PM_{10}	Y	No data	No data
The Big Tree Plant: urban street trees and community orchards - London and other communities in the UK	NO_2, PM_{10}, $PM_{2.5}$, O_3, SO_2	Y	Set up cost >£5M	No data
TiO_2 coatings trials to reduce NOx levels - several cities	NO_2	N	No data	No data

Measure	Pollutants	Success	Cost	Effectiveness
Traffic light management and optimization - Graz, Austria	PM_{10}	Y	No data	Up to 8.7% reduction in PM emissions
Urban ventilation - example Dresden	NO_2, PM_{10}	Y	No data	No data

Source: [D114]

The measures with the largest costs are not being introduced solely to tackle air pollution. Examples indicated in the table above include the introduction of public transport networks, and the introduction of the congestion charging zone. The latter is discussed in more detail later in the section, where it is considered alongside low emissions zones. It is worthy of note that the types of measures for which costs are most readily available from the JRC's database typically concern large infrastructure projects, such as development of new tram or train lines, roads or cycle routes, or congestion/Low emission zones, and major investments in particular cities (such as the Paris bike hire scheme).

Included in the table above and the JRC's catalogue of Air Quality Measures are some actions that are not primarily linked to air quality improvement. Examples include:

- Action to reduce fuel poverty in the UK, which is driven mainly by social concerns and action on climate; and
- Use of noise barriers in the Netherlands, which is clearly intended, primarily, to deal with noise.

However, recognition of the benefits of actions taken for one reason in terms of other policy priorities is beneficial and may increase the efficiency of public policy in general. A lack of data on impact on emissions, and on allocation of benefit to different policy objectives, however, makes it difficult to account for such measures in a truly meaningful way in assessment of the efficiency of air quality management plans, beyond (importantly) recognising that there are links between policies: this in itself is an indicator of efficiency in planning processes. It is then unclear to what extent the costs of these measures may be considered attributable to air quality improvement and the 2008 Directive. A conclusion that can be drawn immediately is that improved guidance on both the costs and effectiveness of actions could improve the efficiency of action plans.

Further information has been collated by EIONET [D50] and is presented in Table 5. The table again demonstrates the wide range of measures that are possible for air quality improvement. Costs for individual measures vary over orders of magnitude. Some of the measures are expressly for air quality improvement under the AAQ Directives, others may be driven by other legislation, for example, permitting required under the Industrial Emissions Directive.

Smeets et al [S111] evaluated the cost-effectiveness of policy options to improve the air quality in the Netherlands. They considered two ways to assess the cost-effectiveness of further policy actions. The first focused on the progress towards the legally binding EU air quality limit values for PM_{10} and NO_2 (specifically in relation to traffic-related hot-spots) and the second on health benefits via minimisation of overall population exposure to PM_{10}. Results showed that optimising air quality limit values in the Netherlands will, in general, also deliver cost-optimal solutions for the reduction of exposure to PM_{10}. The introduction of road use pricing schemes was found to be the most cost-effective measure, followed by technical measures directed at the reduction of primary PM_{10} emissions from storage and handling, shipping, industry and agriculture. The implementation of 'de-NOx' equipment on inland ships is also cost-effective. Other assessed abatement options were considered less cost-effective. These were measures to reduce the emissions of secondary particle precursors such as NH_3 emissions from agriculture, SO_2/NOx emissions from industry and NOx emissions from small combustion sources. Cleaner heavy-duty vehicles fitted with particle filters and advanced 'de-NOx' technology) formed a special case. Results indicate that cleaner heavy-duty vehicles are cost-effective (compared to other measures) to bring down the concentration of pollutants at traffic-related hotspots but are relatively costly for improving the exposure of the general population to PM_{10}. The conclusions on secondary particle formation are not borne out elsewhere: much of the benefit quantified by Amann et al. [R7] in EU policy assessment work is related to secondary aerosols. The difference in perspective is likely to be a function of the scale of analysis: a geographically small country like the Netherlands may see little benefit from its own reductions of the precursor pollutants, whilst others will benefit (though of course the opposite also applies, with the Netherlands benefiting from emission controls in surrounding countries).

Table 5 Data on measures collated from EIONET.

Country	Category	Measure	Description	Cost
Poland	Other (Low Emission Fuels)	Information system for residents	Continuation of the repair task, consisting in forecasting the state of pollution on the current day and two more	110,000 PLN
Spain	Other (Low Emission Fuels)	Execution of a prediction system of meteorological phenomena that hinder the dispersion and protocol of actions.	A weather forecast project will be developed in collaboration with the State Meteorological Agency (AEMET) in order to predict in advance enough the appearance of meteorological phenomena that prevent the dispersion of pollutants and contribute to the increase of the levels of particles in suspension in the area. A protocol of action will be drawn up, together with the Port Authority, the Town Councils involved, and the companies affected, that contemplates the notices to the population, the measures to be taken to reduce the industrial, port and traffic emissions during the climatological episodes of poor dispersion of pollutants	3,000 EUR
Transport				
Poland	Other (Low Emission Fuels) / Cleaner vehicle transport services (public procurement)	Low emission reduction program	Development and implementation of the Low Emission Reduction Program covering liquidation or replacement of heat sources using coal fuels for low-emission through connection to the heating network, replacement of coal boilers with gas fired devices or replacement for solid fuel powered appliances meeting the requirements of class 5 of PN-EN 303: 5/2012	338,318,000 PLN
Poland	Other (Low Emission Fuels) / Cleaner vehicle transport services	Improvement of energy efficiency of building objects	Implementation of energy efficiency principles in construction facilities, in particular in public buildings, including thermal modernization of construction works through renovation works leading to comprehensive	264,000,000 PLN

Country	Category	Measure	Description	Cost
	(public procurement)		thermo-modernization of the building and energy savings, thanks to the use of modern technical solutions and renewable energy sources.	
Poland	Cleaner vehicle transport services (public procurement)	Lowering transport emissions by creating low-traffic zones	Cleaning wet streets in the spring-autumn period with the frequency preferably once a week	800 PLN
Croatia	Low Emission Zones	Introduction of low-traffic road zones (the so-called Eco-zone) and the extension of the pedestrian zone in the city centre	The Eco-Zone covers an area of around 2 km2 in the centre of the city, where the congestion charge would be applied by applying a vignette for certain types of high-emission vehicles, which would discourage their entry into the Eco-Zone. According to the estimates from the Study, the expected decrease in vehicles in the Eco-Zone would be 10% would result in improved air quality.	300,000 HRK
Croatia	Land use planning to ensure sustainable transport facilities	Improvement of road traffic regulation for the dismantling of the suburbs Donji grad, Trnje, Tresnjevka - north, Novi Zagreb - west and Novi Zagreb - east	Introduction of new measures to prioritise public transport and improve traffic flows on busy roads.	1,000,000 HRK
Croatia	Management of parking spaces	Improving the public transport of the city with the emphasis on strengthening the role of the city rail transport	Upgrading existing public transport lines and introducing new lines in newly built urban areas	999 HRK (likely a typo/incorrect)

Country	Category	Measure	Description	Cost
Spain	Emission control equipment / reduction of traffic speed limits	Measures applicable to the industry	It is a series of measures aimed at improving the control of emissions in the industry, and therefore controlling the emissions of NO_2, and therefore O_3, as well as other pollutants. These measures are contemplated in the "Air Quality Improvement Plan for the Region of Murcia 2016-2018", and are called HOR 5.I, and IND 2.II.	61,250 EUR
Permit Systems				
France	IPPC Permits	Reduction of emissions of toxic compounds (BaP) from the Furnace sector of the Sérémange-Erzange coking plant	The following actions will be taken: replacement of the oven doors at the coking plant; improvement of the regulation and reduction of pressure of the ovens; decrease of benzene and PAH discharges in the gaseous effluents recovered during the charging process.	9,000,000 EUR
France	IPPC Permits	Reduction of emissions of toxic compounds (Benzene) from the Gas and Furnace treatment sectors of the Sérémange-Erzange coking plant	Actions taken: suppression of diffuse benzene emissions from the emissaries in the "Gas Treatment" zone (vents, pits, tanks, etc); reduction of benzene releases in the gaseous effluents recovered during charging.	6,000,000 EUR
Spain	Emission control equipment / IPPC Permits	Actions in the industrial sector	Reduction of NO_2 emissions through the implementation of selective catalytic reduction systems to a cogeneration plant, incorporation of environmental criteria to administrative authorizations, implementation of automatic systems for continuous measurement of pollutants and process improvements, treatments and technologies applied to the waste management. Measures from the 20 to the 23, and the 26 of the Strategy of Quality of the Air and Climatic Change of the Community of Madrid. Blue Plan + 2013-2020.	5,576,550 EUR

Country	Category	Measure	Description	Cost
Equipment Upgrades				
Spain	Emission control equipment	Reduction of diffuse emissions in the electric power industry	The electric power producing industry installs a system of adjustable sleeves in height to effect the unloading.	700 EUR
Spain	Emission control equipment	Monitoring the focus of the steam generation boiler of the electric power industry	The focus of the steam generation boiler is monitored with real-time transmission to the Ministry.	2,000 EUR
Spain	Emission control equipment / Introduction/increase of environmental charges	Preparation of technical document and implementation of improvements in handling and storage of bulk in the port of Aviles	Preparation of a technical reference document that analyses the Main movements of solid bulk, signal the best way to perform operations and indicate the equipment associated with each operation. The document has already been prepared during the processing of the Plan. Implementation of new screening systems in the different storage of solid bulk in the open air in the port of Aviles and construction of a closed warehouse for the storage of blende and ribbons for transport.	2,047,000 EUR
Poland	Other (Low Emission Fuels)	Reducing fugitive emissions	Reducing fugitive emissions by applying technical and organizational measures.	n/a
Poland	Other (Low Emission Fuels)	Extension of the heating and gas network	Providing access to the heating and gas network through expansion and modernization of the network in areas where access is lacking, especially in the areas of exceedances.	n/a

Country	Category	Measure	Description	Cost
Public Information				
Poland	Public internet/leaflet information	Ecological education	Educational campaigns aimed at making the society aware of: the harmfulness of waste incineration in household furnaces, the benefits of connecting to centralized heat sources, thermo-modernization, the promotion of modern low-emission heat sources and others.	300,000 PLN
Poland	Public internet information	Ecological education	Conducting educational campaigns aimed at raising awareness in the field of: - the impact of air pollution on human health; harmfulness of waste incineration in household furnaces; benefits of connecting to centralized heat sources; promotion of low-emission heat sources.	50,000 PLN

Allemand et al. [D1] provide analysis for Ile-de-France of 25 measures including actions on road traffic, industry, aviation, agriculture and residential, public and commercial sites. Measures were assessed using a multi-criteria framework that accounted for environmental (including health) impacts, economic efficiency, legal feasibility and social acceptability. The highest ranked measures were low emission zones, active travel, removal of old wood appliances, car sharing and reducing emissions from aircraft taxiing. The lowest ranked measures concerned a charter for clean work sites, stricter emission limits for waste incineration plant, promotion of low emission vehicles and mobility plans in enterprises. Each of the low ranked options scored poorly on costs and emission reductions, in part reflecting the current state of technologies (etc.) in use (in other words, the same ranking may not apply everywhere).

Guariso et al. [D107] also provide analysis for Lombardia, considering the region's air quality plan. The plan consists of 66 measures covering road transport and mobility (26 measures), point emissions and energy efficiency (27) and agriculture and forestry (13). Overall results are shown in Table 6. The information presented in the table demonstrates that measures are cost-effective, in the sense that benefits are greater than costs, but also that the air quality benefits are low compared to total benefits for the measures introduced. These results highlight that air quality – health benefits are only part of the picture for many of the measures that are included in air quality action plans, and that the wider co-benefits of action may well underpin the rationale for specific policies. At the same time, it is important not to lose sight of the air quality benefits in order that policies are introduced in a way that maximises the overall benefits of policies.

Table 6 Estimated costs and benefits of the Lombardia air quality plan. Units: EUR million/year.

	Costs	Total benefits	Air quality benefits
End-of-pipe measures	13	560	52
Efficiency measures	7,100	11,500	43
Scenario measures	30	760	26

Source: [D107]

F.1.4 Control measures

Many of the measures that are taken under the AAQ Directives concern transport. This section starts by considering Low Emission Zones specifically, for two reasons. First they are a widespread response to the need for air quality improvement in cities where traffic is the major local source of emissions. Second, they enable illustration of the differing factors that local authorities need to take into account when initiating measures: even when an option has been identified there are many issues that must be taken into account to adjust for local circumstance that will effect both costs and efficiency.

F.1.4.1 Low Emission Zones

LEZs are a widespread and growing mechanism for reducing traffic emissions in areas where pollutant concentrations exceed limit values. They are linked to a broader set of Urban Vehicle Access Restrictions (UVARs) including congestion zones and bans on specific vehicle types. The development of LEZs for road transport was facilitated by the introduction of the Euro vehicle emission standards in the early 1990s. These standards defined a means of distinguishing the environmental performance of vehicles in service.

Some emission control measures, such as some of those associated with end-of-pipe treatment of emissions from new industrial facilities, can be closely defined with respect to likely costs and benefits. In contrast, LEZs provide an example of a measure where costs and benefits are a function of a number of factors, local geography, street layout, age of the vehicle fleet, etc., an understanding of which is essential in order to take a position on the relative merits of different schemes and overall efficiency.

The first LEZs were declared in Sweden in 1996 in Stockholm, Goteborg and Malmö. By 2018, LEZs had been declared, or were in the process of being declared, in more than 220 towns and cities across Europe. This includes LEZs in 14 EU countries (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain, Sweden, and the UK), as well as Norway and Switzerland. Details of these zones and other access restrictions have been collated online [D55]. In some locations, LEZs have been declared in response to exceedance of limits for particulates (mainly PM_{10}), and in others, for NO_2: in some they have been declared in response to exceedances of both. They have often been introduced when other actions, individually or in combination, have not delivered necessary improvements.

A number of factors are considered in the declaration of an LEZ, each of which has a significant bearing on the likely success of the scheme, in terms of both efficiency and effectiveness:

- Emission sources
- The size of the LEZ
- Duration
- Types of vehicle affected
- Emission standards required
- Penalties for non-compliance
- Strategy for future tightening of standards
- Links to other policies
- Enforcement

Each is discussed below:

- **Emission sources:** Following the requirements of Annex A source apportionment exercise is typically carried out to understand what the major emission sources of pollution are [S73]. This will consider all sources (road and rail traffic, domestic, commercial, industrial, background and various others including aviation). Emissions are typically quantified from a knowledge of activity levels in an area, relating to the fuels used, traffic flows, housing density, etc., combined with information on emission factors (emission per unit of activity). For traffic, activity data are needed not only on the number of vehicles but also speed, and ideally additional flow characteristics, such as whether flow is continual or subject to frequent stopping and starting. Such analysis can highlight the contribution of different sources to specific exceedances.
- **The size of the LEZ:**
    - Larger LEZs will (obviously) reduce pollution over a greater area than a smaller LEZ, and avoid risk of displacing traffic from one part of a city to another.
    - All else being equal, large LEZs are likely to have a greater impact on concentrations of air pollutants particularly towards the centre of the zone, as the larger the LEZ, the more vehicles will be affected.
- **Duration:** Many LEZs are permanent, running 24 hours a day and 365 days a year. This is a distinguishing feature between LEZs and Congestion Zones, which typically only operate over peak hours. In Stockholm for example the Congestion Charge applies only from 6.30

am to 6.30 pm, and not at weekends, public holidays or the month of July, whilst the LEZ applies at all times. However, not all LEZs apply constantly: the Parisian scheme operates from 08.00 to 20.00 Monday to Friday for light vehicles, and the same times but every day for heavy duty vehicles; Lisbon's applies from 07.00 to 21.00 Monday to Saturday; whilst Athens' applies 07.00 to 20.00 Monday to Friday.

- **The types of vehicle or vehicles affected by the LEZ:** Almost all schemes target heavy goods vehicles. An increasing number of schemes are also targeting smaller vehicles: for example, Amsterdam extended its LEZ to cover mopeds, taxis and tour buses from the start of 2018. Specific exemptions may cover emergency services, historic vehicles, speciality vehicles such as mobile cranes, etc.
- **Emission standards to be met by vehicles, (Euro, 4, etc.)**: In addition to specification of Euro standards, some local authorities have declared additional measures, for example future bans on diesel vehicles, or actions to encourage uptake of electric vehicles. Amsterdam has declared its intention that public bus transport will be emission free from 2026. The authorities in Athens have stated they wish to remove diesel vehicles from the city by 2025. In some countries there is coordinated action such that the same Euro standards are applied in all zones: A National LEZ Covenant signed by the Dutch Government and stakeholders, for example, defines LEZ standards for lorries in excess of 3.5t.
- **Penalties for non-compliance:** The penalties for non-compliant vehicles are designed to be sufficiently significant as to influence behaviour, as the following examples show:
    - Paris: For cars, €68 (€180 if not paid in 45 days). For HGVs and buses, €135 (€375 if not paid in 45 days).
    - Eindhoven (NL): €230 for lorries, €95 for other vehicle types
    - Vienna, Niederosterreich (AT): Maximum penalty of €2,180.
    - Lund (SE): 1,000 SEK
    - German LEZs: €80+administration fee (this has more than doubled since the scheme was first introduced)
- **Strategy for future tightening of standards:** The trajectory of the LEZ in terms of strengthening restrictions over time, and dissemination of this information. Some schemes make no reference to the progress of the required standards over time, whilst others do. The Athens LEZ makes reference to an increase in the qualifying registration date of 1 year each year. Paris states that Euro standards will be gradually tightened. Oxford (UK) has declared its intent to introduce the world's first Zero Emission Zone, banning petrol and diesel vehicles from a small part of the city centre by 2020, and extending this to the whole of the city centre by 2035 [D128]. Publication of information on the future direction of LEZs provides opportunity for citizens and businesses to plan efficiently for the situation as it evolves.
- **Links to other local transport policies, such as Urban Vehicle Access Regulations (UVARs):** Such policies clearly need to work in harmony, or the good work done by one scheme could be undone by another, for example, if vehicles were diverted by an access restriction onto streets where a LEZ (or an air quality management area) is located. This emphasises the need for environment and transport departments to work together, ideally at all levels, from national to local government, as well as internationally.
- **Enforcement.** Many operate automatically using camera systems. Some (e.g. Athens, Lisbon) are manually operated with police enforcement. In some cases where a specific type of

vehicle is affected (e.g. buses in Brighton, UK) a major part of enforcement is through agreement with vehicle operators.

Some countries have developed national schemes, at least in outline. In Sweden, for example, the same standards apply for all LEZs, though with some variation in the details of local implementation. A similar situation applies to the Netherlands, where identical standards apply to heavy duty vehicles across the country. Germany, too, has a common framework established at national level [D110].

The response of vehicle operators may take different forms according to circumstance:

- Purchase of new vehicles that enable access to the LEZ.
- Deployment of non-conformant vehicles away from LEZs, which may have the disbenefit of prolonging poor air quality elsewhere.
- Retrofitting vehicles, which is permitted in some places (e.g. Lisbon, Hannover) but not in others (e.g. the Dutch LEZs).
- Using alternative transport modes where available, though this is most suitable for passenger transport rather than goods.
- Pay the charge. In many cases this is unlikely as an option for anything but the most occasional use, given the high level that the charge is set at.

A summary of evidence of the benefits from various LEZ schemes is shown in Table 7 below. The table also summarises some of the key characteristics of the schemes taken from the literature.

Reported percentage reductions in vehicle exhaust emissions can be relatively high, such as those from the Berlin and Stockholm zones in the table. Moreover, reported atmospheric pollution concentrations - without considering the underlying trends in background concentrations of the areas outside of the LEZ, or adjusting for seasonality - can also be relatively significant. These will be affected by changes in other sources of pollution. In the case for PM traffic accounts for less of the overall impact so the overall reduction may be less. There is a need to compare emissions reductions from specific stations to the background trend in emissions – emissions at stations well outside the zone may also show a reduction in emissions irrespective of the zone's activity. Seasonal adjustments in the dataset may also be necessary. This is highlighted in Holman et al. [D110]: *"In German cities reductions in annual mean PM_{10} and NO_2 concentrations up to 7% and 4% respectively due to the implementation of an LEZ have been reported. In other countries the picture is much more mixed with no effects generally being observed. This may be explained by the German LEZs restricting passenger cars, particularly diesel cars as well as HDVs. Many of the studies, however, have used simple statistical methods that have not taken sufficient account of the confounding factors that affect urban air quality. Studies that have used more sophisticated statistical analyses to remove the confounding factors, particularly the effects of meteorology, suggest that the German LEZs may have resulted in a small, possibly a few percent, reduction in long term average PM_{10} and NO_2 concentrations."*

Table 7 Reported effects of LEZs. Source [D110]

LEZ	Area affected	Vehicles affected & standards	Charges and enforcement	Emission and concentration benefits	Refs
Berlin	88 km^2 of the 889 km^2 city area (covering around a third of the population, or 1 million people)	From 2008: Petrol – Euro 1 or better permitted; Diesel Euro 1 retrofit / Euro 2 permitted (all cars targeted) From 2010: all cars (including passenger cars) Euro 3 with particulate filter or better; HGVs goods vehicles retrofitting allowed. Some exemptions permitted.	Currently €80 + admin fee for not having a sticker (indicating a non-compliant vehicle); manual enforcement of parked cars by police	10% reduction NOx & PM_{10} estimated (2008 to 2009) from vehicle fleet composition changes, later stages 20% reduction in NOx Ambient concentration reductions of 1.3 µg/m^3 for NO_2 (period not clear), and 4.33 µg/m^3 for PM_{10} (2007 – 2008)	[D123], [D27], [S95], [S57]
Lisbon	Zone 1 – city centre Zone 2 – one third of the city area (around 25 km^2)	From 2011: Zone 1 pre-euro vehicles banned (daytime) From 2012: Zone 1 Euro 2 and below vehicles banned (daytime / early evening); Zone 2 pre-euro vehicles banned (daytime / early evening) Residents of the zones are exempt	Charges for non-compliance unclear in the literature Manual enforcement by police	2011 – 2013 – concentration reductions for roadside measurements inside LEZ of 9 µg / m^3 PM_{10} and 7 µg / m^3 NOx; no urban background measurements inside LEZ undertaken; reduction in NOx was found to be not statistically significant for outside LEZ	[S44]
Milan	Ecopass zone (historic city centre, 8.2 km^2); Lombardia region; Greater Milan	Ecopass / Milan C - From 2008, drivers of all pre-Euro 4/IV diesel vehicles charged; from 2011 all vehicles charged. Lombardia LEZ restriction on pre Euro 1 2-stroke motorcycles and mopeds and pre-Euro III diesel fuelled public buses. Milan LEZ - restricts pre-Euro 1	Enforcement – ANPR technology. Milan C- currently €5 for petrol / diesel, non- residents, and €2 for residents. Higher charges for coaches and	Data for Ecopass zone – analysis of monitoring data in 2008-2009 found no statistically significant reduction in PM_{10} (NOx not monitored), although reductions in vehicle numbers were seen	[D110], [D55]

LEZ	Area affected	Vehicles affected & standards	Charges and enforcement	Emission and concentration benefits	Refs
		gasoline, and pre Euro 3/III diesel vehicles from 7:30 to 19:30 on weekdays; diesel vehicles fitted with a DPF to meet Euro 3/III standards are allowed in the LEZ.	buses. Discounts for frequent users. Penalties up to €285 for non-compliance.		
Amsterdam	Partial - 20 km^2	Introduced without penalties in 2008. Penalties apply from 2009, Euro III HGVs prohibited; from 2010 Euro III HGVs without a DPF also prohibited.	ANPR Current fine for non-compliance is €230	NO_2, PM_{10} and NOx measured (2008-2010) – for full dataset no statistically significant reductions seen, although a partial dataset (roadside only) saw statistically significant reductions of 6% PM_{10}, 6% NOx and 5% NO_2.	[D110], [D55]
Copenhagen	Partial – 100 km^2	2008: HGVs had to meet Euro II; from 2010 Euro III Some exemptions (for hardship)	Manual inspection Current fines are up to €10,000	0.7 µg / m^3 reduction in PM (not clear from source over which time period, or whether any data adjustments made)	[D110]
Stockholm	Partial - 35 km^2 Covering 330,000 inhabitants	All vehicles charged Exemptions 2009-2012 for low emissions vehicles. LEZ for freight (all HGVs including buses)	ANPR Congestion charge €1-2 in either direction, up to €6 per day. 1,000 SEK (€95)	Estimated reductions calculated from changes in vehicle fleet (from emissions per vehicle). Stated as 10-15% reduction in pollutants; 8.5% reduction NOx. No monitoring data available.	[R76]

A report on the Danish National Air Pollution Control Programme [R197] provides further information on 'environmental zones' established in the country: "*In the period 2008-2010 environmental zones were established in the major Danish cities (Copenhagen, Frederiksberg, Aalborg, Aarhus, and Odense). The requirements for the present environmental zones are that trucks and buses must be at least Euro 4 vehicles or have a particle filter fitted on them. The environmental zone requirements have led to a considerable reduction of particle exhaust emissions of 16% and in NOx emissions of 8% compared with exhausts from all categories of vehicle for the most polluted street in Copenhagen (H.C. Andersens Boulevard) in 2010*." This indicates that since the Holman study [D110] was completed, the Danish standards have been made more stringent, and significant emission savings have been realised.

The Milan Ecopass zone – which became the Milan C scheme - also restricts passenger cars, but here the data did not show a significant reduction in PM emissions (NOx / NO_2 was not measured). However, this zone is relatively small in size, at only 8 km^2; the Berlin zone, by contrast, covers an area ten times this size. The Milan C scheme is also a combination of a congestion charging scheme and an LEZ. All vehicles are subject to the charge but this is relatively modest, so arguably the fee is insufficient to drive much change in behaviour. By comparison, the more polluting vehicles are banned from Berlin's centre, with a charge of €80 (plus administration fee) levied for non-compliance.

Overall impacts to society from the reduction in pollution will vary depending on the area over which the pollution reduction is seen, and the population residing within (and working within) the area. Health benefits of those zones for which data is presented in the table are likely to be greatest for the Berlin zone, which covers the largest geographical area, and the biggest population.

Compliance costs for the individuals and businesses affected by the LEZ are usually much greater than the set up and running costs of LEZs [D4]. The magnitude of the compliance costs depends on different factors:

- The range (how many different types) of vehicles included in the scheme;
- The number of affected vehicles of each type;
- The type of abatement measures required for compliance (e.g. retrofitting vs. vehicle/fleet replacement);
- The number of individuals and businesses affected;
- The nature and scope of any exemptions.

The costs of compliance for businesses will not be entirely borne by the businesses affected. A proportion of the compliance costs will be passed on to the consumers through higher fares for passenger transport services, and through higher transport costs for freight (and thus higher product prices, employment costs and fees). According to the economic and business impact assessment of the London LEZ, two-thirds of the compliance costs to businesses were expected to be passed on to consumers [R170].

The potential for passing on costs to consumers and citizens seems likely to be relatively high where there are few alternatives available. The question of whether additional costs are ultimately borne by consumers and citizens, or by industry, is of interest in respect of the distribution of costs of LEZs. More generally there are some inherent difficulties in appraising the benefits of LEZ schemes.

- Newer vehicles are replacing older ones all of the time; the introduction of a low emissions zone generally accelerates this trend, though the pace of acceleration will slow if the nature of restrictions is not changed. Ideally, the additional benefits derived from the introduction of an LEZ would be gauged relative to a counterfactual of what might have been expected with no zone in place. Such an impact is not possible to quantify using monitoring data alone, although statistical adjustments to allow for consideration of the background concentrations trends will assist in this respect.
- The continual transition of vehicle replacement also means that benefits arising from any scheme may be eroded over time unless the scheme is continually updated to restrict more vehicle classes. This depends on the other factors influencing the way in which vehicle users make their decisions regarding which vehicle to purchase / use (which include, for example, registration and circulation taxes which are implemented by finance ministries and other bodies: these generally have an environmental component within their structure). In addition, care is needed when comparing schemes that have been put in place at different points in time as results will not necessarily be comparable even with the same design of scheme due to the changes in vehicle classes happening over time.
- Vehicles in an area do not suddenly change on the first day of the zone; provided sufficient notice is given of the planned introduction of the policy, fleet operators may begin upgrading vehicles before the start date of the scheme. This is good for health impacts since some of the benefits come prior to the formal date of introduction of the scheme but it can complicate the process of clearly attributing benefits to the LEZ itself.

Two types of costs have been identified in the literature that are associated with LEZs. These are:

- The costs associated with initial set-up and with running the scheme. These include:
  - Set up costs;
  - Annual operating costs;
  - Annual revenue from non-compliance (revenue from fines/penalties offsets the annual operating costs).
  - Cost of associated compensation schemes (e.g. subsidy for changing vehicle, buying EV); and
- Cost to businesses and individuals associated with pollution abatement or compliance with the scheme. These include:
  - Cost of retrofitting (e.g. installing diesel particulate filters);
  - Cost of fleet/vehicle replacement;
  - Cost of avoiding the zone (e.g. fuel and time costs associated with going around the scheme area); and
  - Cost of not-making the journey (e.g. cost of lost business opportunity, welfare cost to individuals).

The magnitude of the setup and running costs of implementing an LEZ mainly depends on two factors:

- The size of the LEZ (i.e. the area covered); and

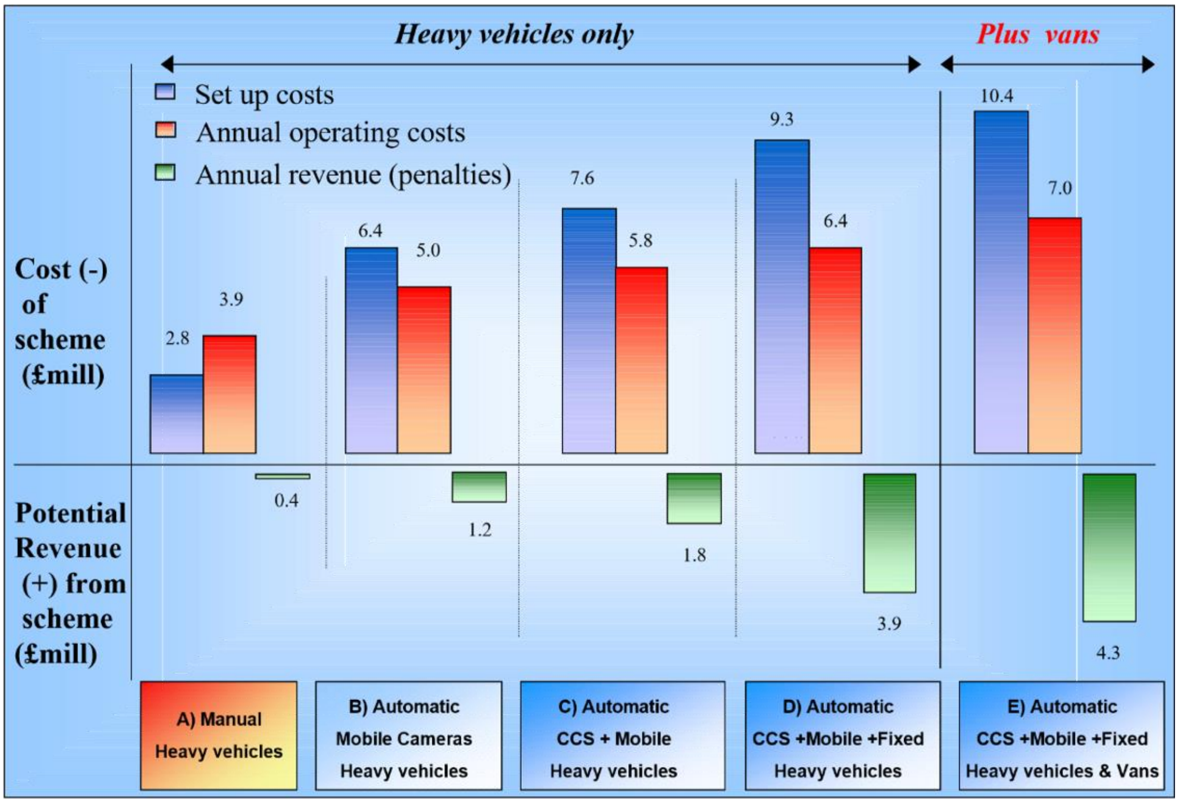
- Type of enforcement implemented (e.g. manual enforcement vs. automatic enforcement using an Automatic Number Plate Recognition (ANPR) system).

All components of the set-up and running costs will increase as the size of the zone increases. On the other hand, the type of enforcement system used in the zone will only affect the initial set up and annual running costs of the scheme. Contrasting with this there are of course economies of scale, with set-up and running costs averaged per vehicle affected likely to be fall as zones increase in size.

The feasibility study of London LEZ scheme compared the potential set up and operating costs for the scheme under different options (types of enforcement, included vehicle types, etc.), as well as the potential revenue generated under each option [R2]. Manual enforcement had the lowest set up and operating costs, compared to the automatic enforcement options, but the potential revenue derived from using manual enforcement was also considered likely to be the lowest, due to very low detection rate under this system. For automatic enforcement options, both costs and revenue potentials increase with the inclusion of different types of automatic monitoring and enforcement equipment used (mobile cameras, fixed cameras, etc.), as well as types of vehicle included in the schemes.

Manual enforcement had relatively low set up costs with relatively high operating costs, while the automatic enforcement has relatively high set up costs with relatively low operating costs.

Figure 1 Estimated Costs (£ Million) of the Recommended London LEZ Schemes



Source: [R2]

F.1.4.2 Other transport measures

Martin et al. [D122] considered novel techniques for reducing urban exposures, including the use of urban vegetation, photocatalytic pavements and traffic rearrangements. Trees were found to have a small effect on exposure, though 'vegetal barriers' were effective by separating pedestrians from traffic. Photocatalytic pavements had a negligible effect. Re-routing traffic could play a significant role, but overall effect is obviously dependent on where traffic is displaced to: In this case there are clear opportunities for losers as well as winners.

Turrini et al [D148] considered active mobility policies through a case study in Lombardia where PM_{10} exceeds the limit values and there is high use of private cars for commuting. Consideration was given to walking, cycling and increased use of public transport. Benefits of active travel were noted, particularly when used in concert with end of pipe pollution controls. The authors noted a limited impact of active mobility of air quality per se.

CE Delft, appointed by the Dutch Court of Auditors, evaluated the cost-effectiveness of measures being introduced to address poor air quality by stimulating the market for new vehicle technologies. These measures would be included under the 'cleaner vehicles' and 'fuel switching' categories used in the EEA database. The 8 policy schemes considered, along with their duration, are presented in Table 8. In all cases, subsidies were time limited, reflecting developments in the vehicles market.

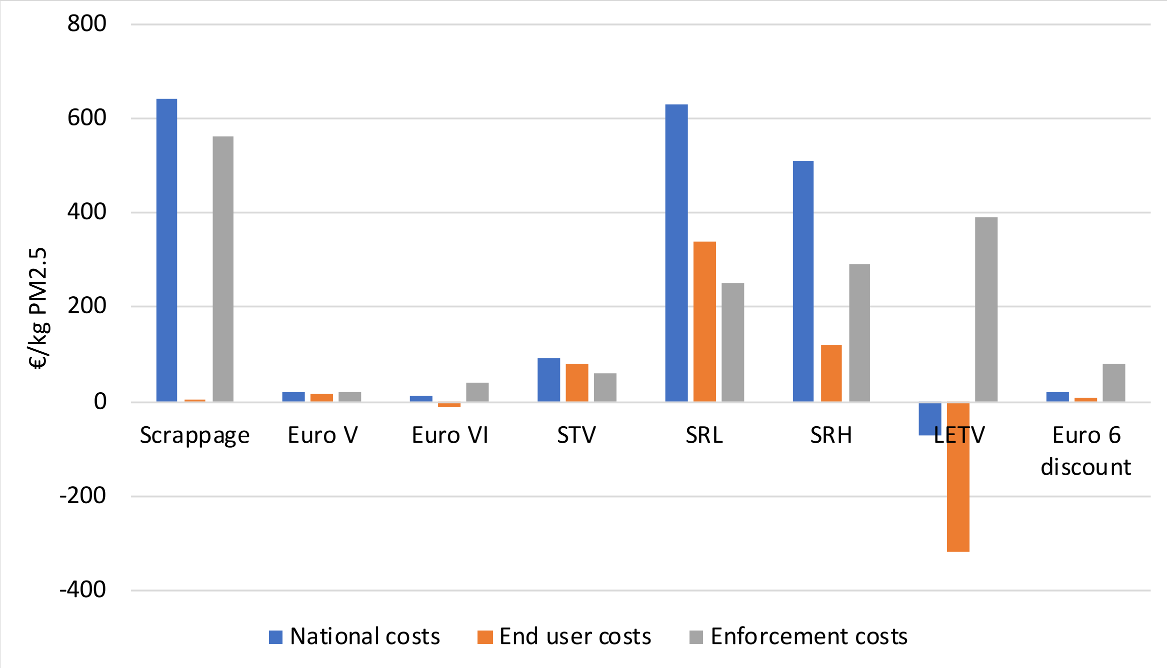
The cost-effectiveness of the above policies, as estimated by the study, is presented in Figure 2. Reductions in NO_x are also expressed in terms of $PM_{2.5}$ emissions using shadow prices, making it possible to compare policies that reduce only $PM_{2.5}$ with policies that reduce only NOx, or policies which reduce both pollutants. The costs for each policy are expressed as Euro per avoided kg $PM_{2.5}$-equivalent (combining both NO_x and PM impacts). A policy is then considered to be cost-effective if the cost of the policy is lower than the average damage costs of the pollution, estimated at EUR 183 per kg $PM_{2.5}$-equivalent (i.e. the policy can reduce $PM_{2.5}$ emission by a kg for a cost which is lower than the damage caused by the same amount of $PM_{2.5}$).

Table 8 Policy Schemes Examined in CE Delft Study

Measure	Duration
Scrappage: National scrappage scheme for cars and vans via subsidy	2009-10
Euro V: Subsidy scheme for new Euro V/EEV HGVs and buses	2006-09
Euro VI: Subsidy scheme for Euro VI HGVs and buses	2012-13
STV: Subsidy scheme for new diesel taxis and vans with particle filter	2006-10
SRL: Subsidy scheme for retrofitted particle filters in cars and light vans	2006-10
SRH: Subsidy scheme for retrofitted particle filters in HGVs and buses	2006-10
LETV: Subsidy scheme for new low-emission taxis and vans	2012-15
Euro 6 discount: Purchase Tax discount for Euro 6 diesel cars	2011-13

Source: [R158]

Figure 2 Cost effectiveness assessment by CE Delft of traffic related measures.



Source: [R158]

For each policy, costs and cost-effectiveness are estimated from three different perspectives: those of the end-user (businesses and private individuals), government and national society. The national cost-effectiveness reflects the efficiency of the policy (i.e. whether it was beneficial to society as a whole), while the end-user and government costs indicate who is bearing which share of the costs. The three groups of costs cannot be combined since otherwise some of the costs (e.g. those associated with taxes) would be double counted.

The study concludes that the policies Euro V, Euro VI, STV, LETV and Euro 6 discount are cost effective from a national perspective, as the cost of implementing these policies is lower than the average damage costs of EUR 183 per kg $PM_{2.5}$.

For the remaining three measures (Scrappage, SRL, SRH), the costs of reducing the emissions are higher than the average damage cost; as such these are reported as cost-ineffective. However, a comparison with national average damage costs might not be appropriate if the vehicles covered by these policies are mainly driven in urban areas where unit damage costs will be higher than the national average because of higher population densities.

There was a strikingly large range in performance of the measures. The worst performing measures had costs more than three times the level of benefit they delivered. These were:

- a national scrappage scheme for cars and vans via subsidy; and
- a subsidy scheme for retrofitted particle filters in cars and light vans

The most cost effective scheme – the subsidy scheme for new Euro V/EEV HGVs and buses – delivered benefits more than nine times the level of the costs. This highlights the potential for misallocating financial resources through inappropriate choice of measures, and in turn emphasises the need for data on cost-effectiveness of measures.

The CE Delft study also raises issues concerning the problems of ex-ante assessment of measures. In the study, the Euro 6 discount policy is found to be cost-effective based on the reported emissions from these vehicles operating under a controlled test environment. However, the assessment of cost-effectiveness may have reached a different conclusion if analysis was based on ex-post measurement, given observations on performance of vehicles in on the road under 'real world' conditions.

F.1.4.3 Measures for control of stationary emission sources

Table 3 confirmed the significant contribution of measures to tackle emissions from stationary combustion for a number of countries, where this is analysed on the basis of the number of measures implemented. This information suggests that such measures are important for a number of countries including Poland, Czech Republic, Denmark, Romania and Germany.

Table 9 summarises information on stationary combustion derived from the literature, and from responses to the targeted questionnaire provided by four countries – Lithuania, Denmark, Czech Republic and Poland. Associated information on the benefits – relating to reductions in PM - is provided in two cases. Data here is provided in the form of reductions in the mass of pollutants, making it possible for this to be compared with the earlier data on the cost effectiveness of transport emissions measures derived from the CE Delft study.

The data for Poland and Denmark indicate higher cost-effectiveness for the boiler improvements than for the transport measures set out in the CE Delft study (focussing on scrappage schemes and upgrading of vehicle technologies). It is also noted that the boiler improvements are not solely being undertaken to reduce air emissions but also to reduce greenhouse gas emissions, through integrated investments that also aim at increasing the proportion of renewable energy and increasing energy efficiency. Attributing the full cost of these programmes to air quality improvement is thus incorrect.

Table 9 Summary data on costs and effectiveness from the JRC's catalogue of Air Quality Measures

Country	Measure	Costs	Benefits
Lithuania	Solid fuel quality requirements through legislation Modernisation of residential solid fuel heating appliances through economic incentives Public awareness campaigns on consequences of solid fuel combustion	Cost of subsidy scheme = €3.3 million for 2018 accounting for up to 50% of the cost of new boilers. €15 million from European Structural and Investment Funds for boiler replacement	No data
Czech Republic	Boiler replacement scheme; subsidies available for flue gas treatment, the installation of new or refurbished heat distribution systems, and improving energy performance of buildings	€113 million had been granted by the end of 2015 (start point of scheme unclear) again using European Structural and Investment Funds	No data
Poland	LIFE-IP MALOPOLSKA project: information provision and decommissioning of boilers for a Polish region	Approx. 15 million PLN (or €3.5 million) was spent from 2016 - March 2018; includes operational funding	In 2016, 7,333 solid fuel boilers were eliminated with 14.52 t of PM_{10} and 13.34 t of $PM_{2.5}$.
Denmark	2008-9: Funding available to phase out burners from 1980 or earlier (the oldest boilers). Individuals can apply for DKK 2,150 (€530) if they replaced old wood boiler with new boiler or alternative heat source. Scheme deemed successful with over 5,600 boilers scrapped. Since 2008,	€2.93 million for boiler scrappage scheme €2.93 million for new technologies	3,500 boilers replaced (scrappage scheme); estimated total reduction of 1,500 tonnes of $PM_{2.5}$ and 500 tonnes of BC. Estimated reduction in PM from reduction in limit value – 2%

Country	Measure	Costs	Benefits
	national programme for environmentally friendly technologies funded development and testing of technologies for reduction of pollution from wood stoves. From 2016, the limit value for wood stoves will be reduced to: Max. 4 g total PM per kg wood or max. 30 mg total PM per Nm3, 13% oxygen		

Sources: [R133], [R12], Poland's response to targeted questionnaire

Table 10 Data on boiler improvements

Member State	Scheme	Description	Cost	Benefit
Czech Republic	Joint Boiler Replacement Scheme	Czech Ministry of the Environment offers up to 9 billion Czech crowns (appr. 340 million €) to subsidize Czech households for the replacement of old solid fuel boilers with environmental friendly equipment. Furthermore, subsidies are offered for flue gas treatment, for installation of new or refurbished heat distribution systems, as well as for improving the energy performance of the building, e.g., through partial replacement of windows or roof insulation.	3 billion Czech crowns (appr. 113 Mio €) have already been granted by the end of 2015	expected energy savings 49.6 TJ (2014-2016)
Denmark	Scrapping scheme for old wood stoves	Danish Environmental Protection Agency, 2015-2016.	DKK 45 million	
Denmark	Scrapping scheme for old wood stoves	2008-2009. The funding went to phasing out burners dated from 1980 or earlier. Individuals can apply for DKK 2,150 (€530) if they replaced old wood boiler with new boiler or used alternative heat source. Scheme deemed successful with over 5,600 boilers scrapped.	DKK 20 million (€2.93 million)	estimated to have achieved a total reduction of 1,500 tonnes $PM_{2.5}$, and 500 tonnes BC
Denmark	new heating technologies	Since 2008, the national programme for environmental friendly technologies has	DKK 20 million	

Member State	Scheme	Description	Cost	Benefit
		funded development and testing of technologies for reduction of air pollution from wood stoves.		
Denmark	Emission Limit Values (ELVs)	Emission limits for stoves and boilers, 2008. Beginning in 2016 the limit value for wood stoves will be reduced to: Max. 4 g total PM per kg wood or max. 30 mg total PM per Nm3, 13% oxygen		The Danish EPA estimates that the new law will yield a net PM reduction of 2%.
Europe	EU Directive on Ecodesign	New solid fuel boilers with a rated heat output of 70 kW or less are labelled on an energy efficiency scale ranging from A+++ (most efficient) to G (least efficient)		By 2030, the proposed requirements for those products, combined with the effect of the energy labelling, are expected to save around 41 petajoules (0.9 million tonnes of oil equivalent (Mtoe)) per year, corresponding to 0.4 million tonnes of CO2. They are also expected to reduce PM emissions by 27 kilotonnes per year, organic gaseous compound emissions by 5 kilotonnes per year and CO emissions by 399 kilotonnes per year.
Norway	Grants to upgrade boilers and stoves, Bergen		5,000 NOK (approx. 600 Euros) per boiler	Between 1999 and 2011, approximately 7,000 new boilers and stoves were installed as a result of this municipal effort, representing a total reduction of approximately 85 tons of particulate matter. Bergen authorities estimate that the

Member State	Scheme	Description	Cost	Benefit
				yearly concentration of PM emissions will be reduced by 10%, and the number of residents in areas where the daily average concentrations exceed national targets will be reduced by 35%
Norway	Grants for new stoves, Oslo	Scrapping payment plan to promote the replacement of old stoves. The payments also include instruction in proper fire lighting practices.	Grants amount to NOK 3,000 (approx. 350 Euros) for individuals residing inside the Ring Road 3 belt way and 1,500 NOK (approx. 225 Euros) for those residing outside this beltway	More than 8,000 new stoves have been installed through this grant program. 8,000 stoves have been replaced, resulting in a reduction of approx. 70 tons of particulate matter emissions (SSB 2013). The cost-effectiveness in this case can be estimated at 300 NOK per kilogram of decreased particle emission.
Norway, Sweden, Denmark, Finland	Nordic subsidy programs to replace old stoves and boilers.	Table summarizing estimated costs and effects.		
Sweden	Planning and Building Act (2010:900) and Environmental Code (1998:808)	Swedish Environmental Court ruled that burning wood in urban areas should be limited, precautions taken and in some instance, the Court has banned wood burning; in other cases, burning was limited to certain hours per day and/or prohibited during the summer months. Many municipalities in Sweden seem to have established informal policies regarding wood		

Member State	Scheme	Description	Cost	Benefit
		burning or provided advice about how to light a fire. Such policies are not mandatory, but rather serve as a guiding document that provides information to residents.		
Lithuania	Fossil fuel boiler replacement fund	Replacing fossil fuel boilers to a renewable energy heating systems, including biomass boilers.	For 2018 period 3.3 million Euros are available for subsidies (up to 50 % cost of installation)	
Europe	Mitigating solid fuel use in residential sector	Table summarizing measures across EU member states.		
Poland	Law on Environmental Protection of the Regional Parliament	2013, Explicitly defined the types and qualities of fuels allowed for heating purposes in the area. A transitional period of five years has been give since the approval of the law and its full enforcement to allow users to install new heating devices.		
Northern Ireland	Grant to replace your boiler	Grants of up to €1260 is available for low income households to replace an oil/inefficient boiler with a gas boiler.		

F.1.5 Measures to improve information provision

Some information was provided on the cost of information provision measures in Poland via the Eionet database [D50]. This is provided in Table 11. The data in the table represents the total cost of undertaking the measure. No data is provided in respect of the effectiveness of these measures, which commenced in 2017: such data would have been useful to assess whether it would be worthwhile undertaking similar action elsewhere. Information campaigns are often undertaken alongside other measures aimed at tackling specific pollutants. In the case of this example, information separately provided in response to the targeted questionnaire confirms that, across the country, there has been a substantial programme of boiler replacement. As such, it would be difficult to separate out the benefits arising from the information campaign from that which has occurred as a result of the investment in lower emissions boilers.

Table 11 Cost of Information Provision Measures in Poland (2017-2022)

Description of measure	Cost
Educational campaigns aimed at making the society aware of: the harmfulness of waste incineration in household furnaces, the benefits of connecting to centralized heat sources, thermo-modernization, the promotion of modern low-emission heat sources and others.	300,000 PLN
Conducting educational campaigns aimed at raising awareness in the fields of: - the impact of air pollution on human health; harmfulness of waste incineration in household furnaces; benefits of connecting to centralized heat sources; promotion of low-emission heat sources	50,000 PLN

F.1.6 Costs and Benefits of Programmes and Plans

A limited amount of information is available from cases where air quality management plans, as well as the measures contained within them, have been evaluated. The Dutch National Air Quality Cooperation Programme (NSL) covers the provinces Overijssel, Gelderland, Utrecht, Zuid-Holland, Noord-Brabant and Limburg and parts of Noord-Holland and Flevoland: it also involves all major cities within these provinces. The programme came into force in 2009 and is still in operation. It involves a combination of national, provincial and local measures to improve air quality:

- National measures include tax benefits for various types of vehicles fitted with a soot filter and stimulation of zero-emission mobility.
- Along several highways, barriers were placed to prevent the spread of air pollution.
- Local measures include i.e. improvement of traffic circulation, environmental zones, electrification of public transport and scrapping scheme for older vehicles.

The costs of the NSL were provided in the response to the targeted questionnaire and are as follows:

- Total cost: €1,519 million
- Of which
  - Commissions from government for research and other activities: €10 million
  - Subsidies to purchasers on Euro 6/Euro VI etc: €504 million
  - Contribution of the NSL to local governments: €320 million
  - Studies and development of infrastructure projects (source documentation suggests this relates to developments in the road network): €645 million

- Competitive, sustainable, safe food chains (reducing emissions from agriculture): €40 million

Information provided in the source document indicates these costs represent the total budget allocation for 2006-2018. The population in the areas covered by the plan is 11 million (or 65% of the country's population): this suggests costs of around €138 per capita over the period, or an average of €10.6 per inhabitant per year. Some of the measures, notably the infrastructure projects will clearly have a far greater lifetime than the duration of the plan itself, in the order of decades, though others will have benefits over a shorter period of overall around 20 years (taking account of the duration of the plan and vehicle lifetime), such as the cleaner vehicle subsidies. As elsewhere, one cannot ascribe all of these costs to the AAQ Directives, given that air quality will be one of several objectives for infrastructure development.

Only data concerning the forecast benefits are presented in the source documentation (for the years 2016 and 2020): as such this cannot be used to ascertain the benefits of the measures with high confidence as it can only be an approximation of actual performance. However, data from the EEA confirms that the proportion of the population exposed to concentrations of NO_2 in excess of the annual mean limit for NO_2 fell from 3% to 2% between 2012 to 2016, whilst the proportion exposed to concentrations of PM in excess of the annual mean limit for PM remained at 0% throughout this period.

The Czech Republic has provided information on total costs by sector. The total costs for the plan implemented in 2015 are indicated to be €25 billion, or €2,500 per capita over the period of the plan, though again noting that at least some of the measures have a lifetime extending far beyond that of the plan, and costs cannot be attributed entirely to air pollution mitigation. Measures introduced are shown in Table 12. The table confirms that measures have been implemented in relation to the transport sector and with respect to the upgrading of household boilers, whilst fees have been imposed on industry. There has been a relatively substantial spend on both transport and boiler upgrades. The percentage of the urban population exposed to concentrations in excess of the annual mean limit value for $PM_{2.5}$ fell from nearly 10% to less than 5% during the period 2012 to 2016, although the proportion of the population exposed to levels of NO_2 above the limit rose slightly during the same period from 1.2% to 1.4%.

Table 12 Summary of Measures included within the Czech Republic's Plan

Measures	Actors	Funding
Investing in decreasing industrial emission	All regions in CZ	Operator + EU funds + National funds
Stringent industrial fees	Selected operators	Operator
Investing in bypasses, railways and public transportation	All regions in CZ	Municipality/national authority + EU funds + National funds
Legal framework concerning the minimal requirement for household boilers and industrial sources	/	Operators, households, EU/National funds
Investing in low emission household boilers (minimising the number of obsolete boilers)	All regions in CZ	Public + national and regional funds (till 2014), Public + EU funds + national and regional funds (since 2014)

Madrid's air quality plan indicates total costs over the period 2011 to 2014 were indicated to be €161million, suggesting an average annual expenditure of around €40 million. Most of this spend was related to transport measures, as set out in Table 13. Remaining measures were targeted at the residential commercial and institutional sector (costs €1.4 million) and cleaning and waste management (€5 million). The most significant areas of spend relate to investment in public transport: as elsewhere, allocation of the full costs of these measures to air quality improvement is incorrect as they will be introduced for a variety of reasons, foremost of which may be reduced congestion and improved mobility. Data on the proportion of the population exposed to above limit values is not available for Madrid. However, Madrid continues to exceed both the hourly and annual limit values for NO_2, having also done so throughout the period that the above expenditure was made, though concentrations are falling. The trend data for NOx by activity sector since 1999 shows that road transport has the biggest impact on NOx emissions. However, emissions have diminished from 19,226 tonnes in 1999 to 7,012 tonnes in 2014. The target value for ozone is exceeded in Madrid, but the PM limits are not.

Table 13 Costs of Madrid's Plan - Transport, 2011-2014. Source: Municipality of Madrid

Summary of measures	Cost €
Deterrence and restriction of the use of private motor vehicles	€11 million
Promotion of cleaner technologies and cleaner fuel	€0.17 million
Promotion of a more efficient and sustainable public transport	€126 million
Management measures for improving passenger transport	€0.15 million
Promotion of alternative means of mobility	€13 million
Improvements to road maintenance techniques	€3 million
Research and investigation on the subject of sustainable transport and mobility	€0.44 million
Total – transport and mobility	€154 million

Given continued exceedance of limit values, further measures are contained in Madrid's air quality and climate change plan for 2017-2020. This shows increased expenditure compared to the earlier period by more than a factor 3. Again, transport is a prime target for action. The linkage of climate and air quality recognises the potential for co-benefits and trade-offs between the two issues.

Table 14 Costs of Madrid's Plan 2017-2020. Source: Municipality of Madrid [D163]

Summary of measures	Cost €
Actions targeting the road network and public space aimed at reducing private traffic intensity and promoting active mobility modes	€154 million
Actions targeting air quality targeting the vehicle pool and key sectors with a high impact on mobility patterns	€330 million
Proposal for urban regeneration	No data
Low emission and energy efficient urban management	€46 million
Energy management energy in municipal buildings and facilities	€3.2 million
Adaptation strategies and solutions based on nature (vulnerability and resilience to climate change)	€7.7 million
Proposal for awareness-raising and communication	No data
Environmental awareness-raising and education	€3.0 million
Total	€544 million

F.1.7 Assessment of Benefits from Reported Changes in Air Quality

Benefits of improving air quality are reflected through a reduction in impacts to human health, ecosystems, materials used in buildings and other goods, agriculture and forestry. Impacts are mapped to pollutants in Table 15 reflecting typical practice in European impact assessments.

Table 15 Mapping of impacts to pollutants.

	PM	NO_2	SO_2	O_3	Metals	PAH
Health						
Mortality	✓	✓	✓	✓	✓	✓
Cardio-respiratory morbidity	✓	✓	✓	✓		
Cancers					✓	✓
IQ					✓	
Ecosystems	✓	✓	✓	✓		
Agriculture				✓		
Forestry				✓		
Materials damage			✓	✓		

Source: Authors.

Notes: Includes indirect effects, e.g. from formation of sulphate and nitrate aerosols or ozone following emission of precursor gases. Some analysts explicitly account for increased levels of lung cancer from $PM_{2.5}$ exposure, others implicitly include this effect via quantification against all-cause mortality.

Over time, the range of effects linked to these air pollutants is growing as further research is published. A review by the Royal Colleges of Physicians and of Paediatrics and Child Health in the UK, for example, reported impacts of air pollution across the full life course from early childhood to death in old age, and a number of effects including dementia and diabetes that are not currently quantified in impact assessments [R151]. In two papers published in 2016, Nedellec and Rabl quantified a broader range of impacts of metals than are typically assessed, leading to substantial increases in damage costs [S89, S90]. In both cases there are questions regarding mechanisms of effect and the weight of evidence supporting quantification, and the decision as to what should currently be carried forth to quantification is subjective. However, there is sufficient evidence to conclude that a listing such as that provided here in Table 15 may not be complete, providing bias towards underestimation of the benefits of measures undertaken to improve air quality, and of the costs of inaction or poor implementation.

Estimates of health impact were received from a number of respondents to the consultation. In almost all cases estimates represent the total health burden of air pollution in the assessed region rather than the specific benefits of actions taken under the AAQ Directives. However, it is notable that all of the information received puts the costs of health damage in the order of hundreds of millions or billions of Euro.

A study for Public Health England [R148] assessed the benefits that would accrue to the National Health Service and social care if air pollution were reduced to meet the AAQ Directives limit values across England. The study indicates health care benefits over an 18 year period of EUR 2 billion from meeting the NO_2 limit value. Whilst the study demonstrates the potential for significant cost it is limited in scope, excluding costs via lost amenity and lost productivity, and not accounting for mortality and a number of other health impacts.

Given the lack of available data analysis was undertaken to estimate the benefits (and later, costs of poor implementation).

F.1.7.1 Quantification of impacts and associated costs

The information presented in this section is relevant to both the quantification of the benefits of actions and the social costs of poor implementation. Analysis has focused on health impacts for two reasons:

1. Past analysis has shown that overall impacts when converted to an economic equivalent are dominated by health [e.g. R110].

2. Most of the actions arising from the Directives are focused on urban areas, further biasing the benefits towards health impacts.

The methods for quantifying benefits are summarised as follows:

1. Identify the fraction of the population living in areas where concentrations of the pollutants most widely exceeded (PM_{10}, NO_2, O_3) are above limit values, and then the number of people affected.

2. Describe the average excess pollution levels that people are exposed to.

3. Quantify damage costs of health impacts per person per unit of pollutant.

4. Combine population, pollution and damage costs to estimate total impact for each pollutant.

The ALPHA-RiskPoll (ARP) model has been used to quantify the impact of unit change in pollutant concentrations (1μg.m^{-3} $PM_{2.5}$ and NO_2, 200ppb.hours ozone SOMO35). ARP has been developed and used in other analysis for the European Commission and the European Environment Agency, and hence the methods used are fully consistent with related activities [R111, S108, R46]. The response functions used for these pollutants follow the recommendations of the HRAPIE (Health Response to Air Pollutants in Europe) study led by WHO-Europe on behalf of the Commission [R192]. The functions were supplemented by population data from UN World Population Prospects [D149] and disease incidence data from WHO [D157]. Valuation data are reported by Holland [R108] in 2005 prices, here updated by year. In all cases, EU average values are adopted for the monetisation. The costs of unit changes in pollution levels have been calculated at the national level for each year from 2008 to 2017, in order to capture differences in health status between countries and over time. The lowest cost of unit change per capita is seen in Luxembourg, and the highest in Bulgaria.

The population living in areas where pollutant concentrations are above the limit values is taken from the annual air quality reports of the European Environment Agency [D43], covering all years at the European level Table 16. Data is also available at the national level for years since 2012, and the national data have been used to weight average EU damage costs according to patterns of exceedance.

An indication of the benefits of the actions taken as a result of the 2008 Directive can be gained from consideration of the extent to which population exposure in excess of the limit values has changed over time (noting that this will include also effects of other legislation on air pollutants, though the benefits of reducing concentrations below the limit values are not considered in the analysis that follows). The population living in areas where pollutant concentrations are above the limit values is taken from the annual air quality reports of the European Environment Agency [e.g. R45, R50, R51, R53], covering all years at the European level. The effectiveness chapter discusses similar data but expressed against number of zones where exceedances appear. For quantification purposes it is necessary to use a related but different data set that identifies the number of people concerned.

Table 16 *Percentage of the EU urban population exposed above (Exc.): daily limit value (PM_{10}), annual limit value from 2015 ($PM_{2.5}$), target value (O_3) and annual limit value (NO_2), 2008 to 2016. Reductions (Red.) are all compared against 2008 levels. Negative reductions indicate an increase in population exposed above limits.*

	PM_{10}		$PM_{2.5}$		O_3		NO_2	
	Exc.	Red.	Exc.	Red.	Exc.	Red.	Exc.	Red.
2008	23.9	-	12.6	-	15.3	-	12.3	-
2009	24.4	-0.5%	8.8	3.8%	16.1	-0.8%	14.3	-2%
2010	25.2	-1.3%	10.8	1.8%	17.4	-2.1%	11.7	0.6%
2011	29.6	-5.7%	13.6	-1.0%	16.1	-0.8%	11.8	0.5%
2012	21.9	2.0%	11.5	1.1%	15.5	-0.2%	8.8	3.5%
2013	20.5	3.4%	8.5	4.1%	16.2	-0.9%	9.0	3.5%
2014	16.4	7.5%	8.0	4.6%	7.3	8.0%	7.4	4.9%
2015	18.6	5.3%	7.4	5.2%	29.5	-14.2%	8.4	3.9%
2016	13.2	10.7%	5.5	7.1%	12.4	2.9%	7.3	5.0%
2017								

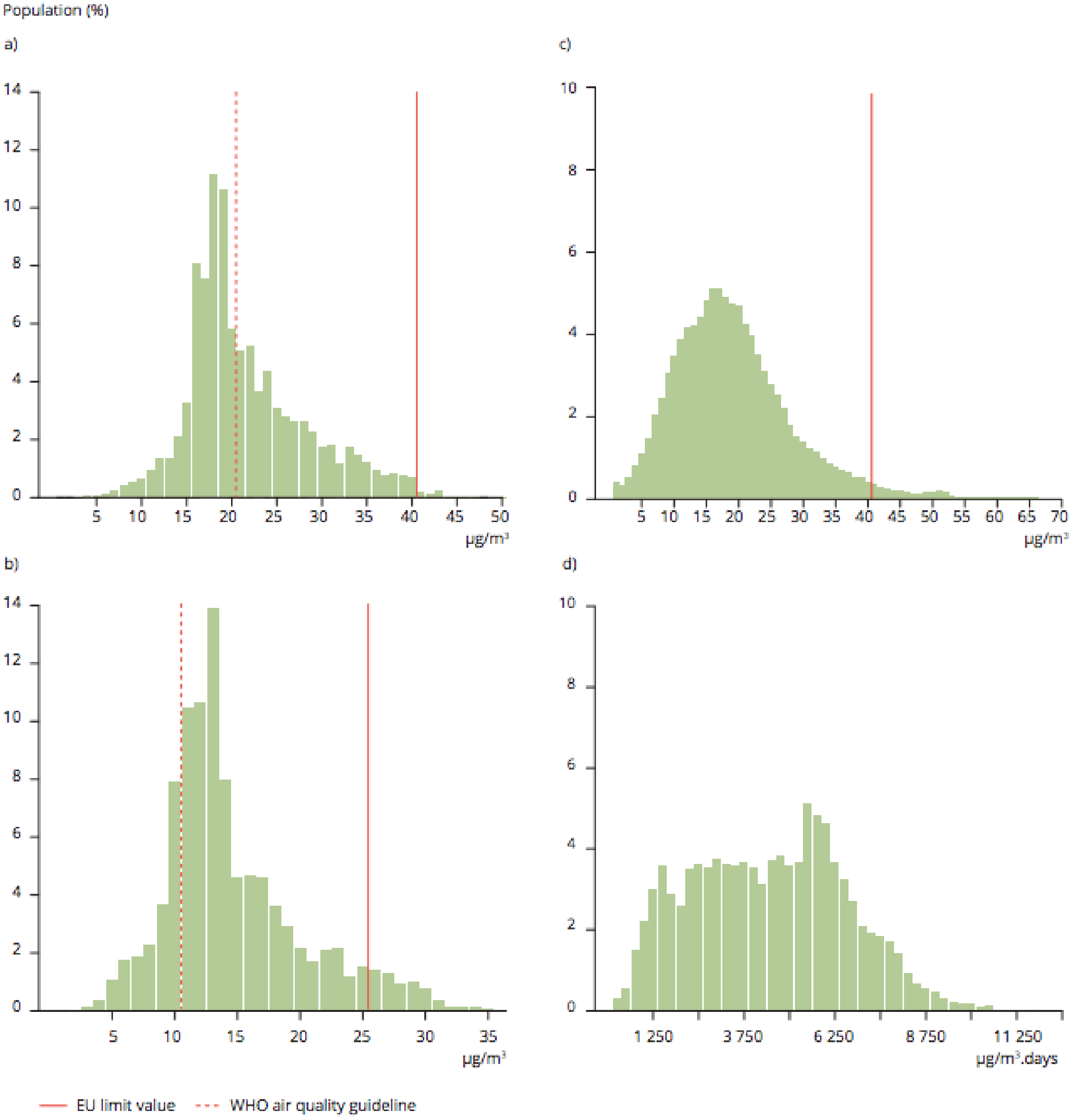
Source: Adapted from [R61]

Table 16 shows that there is not steady improvement in air quality over time, though for PM_{10}, $PM_{2.5}$ and NO_2 there is a reasonably clear trend towards a reduction in exposure above the limit values. The national data on which the table is based show major fluctuations between years. For NO_2 in Slovakia, for example, 100% exceedance is shown in 2013, but no more than 6% in 2012, or 2014-2016. For $PM_{2.5}$ in Italy, the percentage of the population exposed above the limit value falls and rises from year to year. Weather conditions will play a part in this variability, but other factors may also come into play. It is noted that the EU28 figures are more stable, and these are here preferred for quantification of benefits, though the distribution of population subject to exceedance is used to weight the EU average damage cost per unit exposure.

The extent of exceedance in terms of concentration has been taken from EEA analysis (*Figure 3*).

Figure 3 Frequency distribution of the total population exposure to (a) PM_{10} (annual mean), (b) $PM_{2.5}$ (annual mean), (c) NO_2 annual mean and (d) O_3 SOMO35. Source: Figure 9.2 EEA (2018)

Figure 9.2 Frequency distribution of the total population exposure to (a) PM_{10} (annual mean), (b) $PM_{2.5}$ (annual mean), (c) NO_2 (annual mean) and (d) O_3 (SOMO35) in 2015



Source: ETC/ACM, 2018b.

Source: Figure 9.2, [R53]

Damage costs per person per unit of pollution, calculated using the inputs described above, are shown in the following tables.

Table 17 Damage costs, EUR/person/µg.m^{-3}, for health impacts of $PM_{2.5}$ with mortality valued using value of a life year.

Core mid VOLY	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	50.9	51.0	51.6	52.9	53.9	54.3	54.3	53.9	53.8	54.4
Belgium	51.7	51.7	52.3	53.5	54.6	55.0	54.9	54.6	54.4	55.0
Bulgaria	65.7	66.1	67.1	68.3	69.2	69.3	68.8	67.9	67.7	68.6
Croatia	58.4	58.5	59.3	60.6	61.6	61.9	61.7	61.1	60.9	61.6
Cyprus	52.6	52.9	53.7	54.9	55.9	56.2	56.1	55.6	55.5	56.1
Czech Republic	56.9	57.0	57.6	58.8	59.8	60.1	59.9	59.3	59.2	59.9
Denmark	53.9	54.0	54.8	55.7	56.4	56.4	56.0	55.2	55.1	55.8
Estonia	64.2	63.6	63.7	64.2	64.4	64.0	62.9	61.5	61.3	62.0
Finland	52.0	52.2	53.0	54.0	54.8	55.0	54.8	54.2	54.0	54.6
France	49.6	49.7	50.3	51.4	52.3	52.7	52.5	52.1	52.0	52.7
Germany	51.9	52.1	52.8	54.1	55.2	55.7	55.7	55.4	55.2	55.9
Greece	51.7	52.1	53.0	54.1	55.0	55.3	55.1	54.6	54.4	55.0
Hungary	63.5	63.7	64.5	65.6	66.3	66.3	65.7	64.8	64.7	65.5
Ireland	52.2	52.0	52.4	53.5	54.4	54.6	54.4	53.8	53.7	54.3
Italy	49.1	49.2	49.9	51.0	51.9	52.2	52.1	51.6	51.5	52.2
Latvia	66.3	66.5	67.4	68.5	69.3	69.4	68.8	67.9	67.7	68.5
Lithuania	67.4	68.3	70.1	70.6	70.9	70.4	69.3	67.8	67.6	68.4
Luxembourg	52.1	52.1	52.7	53.7	54.5	54.7	54.3	53.7	53.5	54.2
Malta	53.0	53.2	53.9	55.0	55.8	56.0	55.7	55.0	54.9	55.6
Netherlands	51.0	51.0	51.6	52.7	53.6	54.0	53.8	53.3	53.2	53.9
Poland	59.4	59.6	60.4	61.5	62.4	62.6	62.2	61.4	61.3	62.0
Portugal	53.7	53.7	54.4	55.2	55.8	55.8	55.3	54.5	54.3	54.9
Romania	65.9	65.7	66.2	67.2	68.0	68.0	67.3	66.3	66.1	66.9
Slovakia	60.9	61.1	62.0	63.2	64.0	64.2	63.8	63.0	62.8	63.6
Slovenia	54.1	54.0	54.5	55.5	56.2	56.4	56.0	55.3	55.1	55.8

Core mid VOLY	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	50.3	50.5	51.3	52.1	52.7	52.7	52.2	51.4	51.4	52.0
Sweden	49.3	49.5	50.3	51.4	52.3	52.7	52.6	52.1	52.0	52.7
United Kingdom	51.5	51.7	52.3	53.4	54.2	54.5	54.2	53.6	53.5	54.1
Min	49.1	49.2	49.9	51.0	51.9	52.2	52.1	51.4	51.4	52.0
Max	67.4	68.3	70.1	70.6	70.9	70.4	69.3	67.9	67.7	68.6
Average	55.7	55.8	56.5	57.6	58.4	58.6	58.2	57.5	57.4	58.1

Source: Author’s calculations using the ALPHA-RiskPoll model

Table 18 Damage costs, €/person/µg.m^{-3}, for health impacts of $PM_{2.5}$ with mortality valued using value of statistical life.

Core mid VSL	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	145.8	146.5	148.7	148.0	146.4	143.1	138.2	132.4	132.7	135.0
Belgium	155.8	156.9	159.7	158.1	155.4	150.9	144.8	137.9	136.9	137.9
Bulgaria	226.7	230.1	236.0	239.9	242.6	242.4	239.8	235.7	236.0	239.8
Croatia	180.3	183.4	188.5	193.1	196.8	198.4	197.9	196.4	196.2	198.9
Cyprus	109.6	110.6	112.9	113.3	113.3	111.9	109.4	106.4	107.0	109.2
Czech Republic	159.7	160.5	163.1	165.0	166.0	165.1	162.5	159.0	159.7	162.9
Denmark	160.4	160.7	162.7	160.1	156.5	150.9	143.6	135.4	136.4	139.4
Estonia	194.9	195.1	197.3	197.2	195.7	191.8	185.8	178.5	178.3	180.7
Finland	149.1	150.6	153.7	153.4	152.2	149.0	144.3	138.8	138.6	140.5
France	137.9	138.8	141.3	139.6	137.0	132.6	126.7	120.1	119.7	121.1
Germany	163.4	165.3	169.1	170.3	170.5	168.7	165.1	160.5	160.6	163.1
Greece	156.4	159.2	163.7	165.3	166.1	164.9	162.0	158.1	157.3	158.6
Hungary	202.0	203.8	207.7	208.7	208.6	205.9	201.0	194.7	195.8	199.7
Ireland	154.6	156.3	159.7	150.7	140.4	128.1	114.5	100.3	101.2	103.3
Italy	154.6	156.3	159.8	159.1	157.4	153.5	147.9	141.2	141.4	143.7
Latvia	209.7	212.2	217.0	221.9	225.7	227.0	225.9	223.4	224.4	228.5
Lithuania	199.7	204.0	210.6	215.6	219.6	221.2	220.5	218.4	218.4	221.3
Luxembourg	129.4	129.5	131.0	125.6	119.5	112.0	103.6	94.8	94.8	96.5
Malta	129.4	131.4	134.9	132.6	129.6	124.8	118.8	112.0	116.3	122.4
Netherlands	133.1	134.0	136.3	136.1	135.1	132.4	128.4	123.6	124.4	127.1
Poland	157.0	159.1	163.0	164.8	165.7	164.7	162.0	158.4	158.9	161.9
Portugal	157.2	158.4	161.3	162.7	163.1	161.5	158.2	153.9	154.0	156.3
Romania	184.8	186.5	190.2	195.1	199.2	201.2	201.1	199.9	200.4	203.8
Slovakia	152.4	154.3	157.8	159.7	160.7	159.9	157.5	154.1	155.4	159.0
Slovenia	148.8	150.3	153.4	153.4	152.5	149.7	145.4	140.2	140.7	143.3

Core mid VSL	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	138.5	139.6	142.3	141.1	138.9	134.9	129.5	123.2	123.4	125.2
Sweden	154.5	155.0	157.2	153.3	148.2	141.1	132.5	123.0	122.8	124.3
United Kingdom	149.9	149.8	151.4	149.0	145.7	140.6	134.0	126.7	126.5	128.1
Min	109.6	110.6	112.9	113.3	113.3	111.9	103.6	94.8	94.8	96.5
Max	226.7	230.1	236.0	239.9	242.6	242.4	239.8	235.7	236.0	239.8
Average	160.6	162.1	165.4	165.4	164.6	161.7	157.2	151.7	152.1	154.7

Source: Author’s calculations using the ALPHA-RiskPoll model

Table 19 Damage costs, €/person/µg.m^{-3}, for health impacts of NO_2 with mortality valued using value of a life year

Core mid VOLY	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	23.7	23.7	23.9	24.4	24.8	25.0	24.9	24.7	24.5	24.8
Belgium	24.2	24.1	24.3	24.8	25.2	25.4	25.3	25.1	25.0	25.2
Bulgaria	32.3	32.4	32.9	33.4	33.7	33.7	33.3	32.8	32.7	33.0
Croatia	28.1	28.1	28.4	29.0	29.4	29.5	29.3	28.9	28.8	29.1
Cyprus	24.6	24.7	25.1	25.6	26.0	26.1	25.9	25.7	25.5	25.8
Czech Republic	27.1	27.0	27.2	27.7	28.1	28.2	28.0	27.6	27.5	27.8
Denmark	25.5	25.5	25.8	26.2	26.4	26.3	26.0	25.5	25.4	25.7
Estonia	31.7	31.2	31.2	31.2	31.1	30.7	30.0	29.2	29.1	29.3
Finland	24.4	24.5	24.8	25.2	25.5	25.5	25.3	24.9	24.8	25.0
France	22.9	22.9	23.1	23.6	23.9	24.0	23.9	23.6	23.6	23.8
Germany	24.0	24.0	24.3	24.8	25.3	25.5	25.4	25.2	25.1	25.3
Greece	24.0	24.2	24.6	25.0	25.4	25.4	25.3	25.0	24.9	25.1
Hungary	31.2	31.2	31.6	32.0	32.2	32.1	31.7	31.2	31.1	31.4
Ireland	24.5	24.3	24.4	24.8	25.2	25.3	25.1	24.8	24.7	24.9
Italy	22.5	22.5	22.7	23.2	23.5	23.6	23.5	23.2	23.1	23.4
Latvia	33.1	33.1	33.5	34.0	34.3	34.2	33.8	33.2	33.0	33.4
Lithuania	33.7	34.2	35.1	35.2	35.2	34.7	34.0	33.1	33.0	33.3
Luxembourg	24.5	24.5	24.7	25.0	25.3	25.2	24.9	24.5	24.4	24.7
Malta	24.9	25.0	25.3	25.7	26.0	26.0	25.7	25.3	25.2	25.5
Netherlands	23.7	23.7	23.9	24.3	24.7	24.8	24.6	24.4	24.3	24.5
Poland	28.7	28.7	29.1	29.5	29.8	29.8	29.5	29.0	28.9	29.2
Portugal	25.3	25.3	25.5	25.8	26.0	25.9	25.5	25.0	24.9	25.1
Romania	32.2	32.0	32.2	32.6	32.9	32.8	32.4	31.9	31.8	32.1
Slovakia	29.7	29.7	30.1	30.5	30.8	30.8	30.5	30.0	29.9	30.2
Slovenia	25.5	25.3	25.5	25.8	26.1	26.0	25.7	25.3	25.2	25.4

Core mid VOLY	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	23.2	23.3	23.6	23.8	24.0	23.9	23.6	23.1	23.0	23.3
Sweden	22.8	22.8	23.1	23.6	24.0	24.1	24.0	23.7	23.6	23.9
United Kingdom	24.2	24.2	24.5	24.9	25.2	25.2	25.0	24.7	24.6	24.8
Min	22.5	22.5	22.7	23.2	23.5	23.6	23.5	23.1	23.0	23.3
Max	33.7	34.2	35.1	35.2	35.2	34.7	34.0	33.2	33.0	33.4
Average	26.5	26.5	26.8	27.2	27.5	27.5	27.2	26.8	26.7	27.0

Source: Author’s calculations using the ALPHA-RiskPoll model

Table 20 Damage costs, €/person/µg.m^{-3}, for health impacts of NO_2 with mortality valued using value of statistical life.

Core mid VSL	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	82.6	82.9	84.2	83.5	82.3	80.0	76.9	73.4	73.5	74.8
Belgium	88.7	89.3	91.0	89.7	87.8	84.9	81.1	76.8	76.1	76.6
Bulgaria	132.2	134.2	137.7	139.9	141.3	141.1	139.4	136.9	137.1	139.3
Croatia	103.8	105.6	108.6	111.2	113.3	114.1	113.9	112.9	112.8	114.3
Cyprus	60.0	60.6	61.8	61.9	61.6	60.6	59.1	57.2	57.5	58.7
Czech Republic	90.9	91.3	92.7	93.6	94.0	93.3	91.7	89.5	90.0	91.7
Denmark	91.6	91.7	92.8	91.0	88.5	84.9	80.4	75.3	75.9	77.6
Estonia	112.8	112.8	114.1	113.7	112.6	110.1	106.3	101.8	101.7	103.0
Finland	84.7	85.5	87.3	86.9	85.9	83.8	80.9	77.4	77.3	78.4
France	77.7	78.2	79.6	78.3	76.5	73.6	69.9	65.8	65.6	66.3
Germany	93.2	94.3	96.4	96.9	96.9	95.6	93.3	90.5	90.5	91.9
Greece	89.0	90.6	93.2	94.0	94.3	93.5	91.6	89.2	88.7	89.4
Hungary	117.2	118.2	120.5	120.9	120.6	118.7	115.6	111.8	112.4	114.7
Ireland	88.0	89.0	91.0	85.1	78.6	70.9	62.4	53.7	54.2	55.4
Italy	88.0	89.0	90.9	90.3	89.0	86.5	82.9	78.8	78.9	80.2
Latvia	122.1	123.6	126.4	129.2	131.3	132.0	131.2	129.7	130.3	132.7
Lithuania	115.8	118.4	122.3	125.2	127.5	128.3	127.9	126.6	126.6	128.2
Luxembourg	72.5	72.5	73.3	69.7	65.6	60.8	55.5	50.0	50.0	50.9
Malta	72.3	73.5	75.5	73.9	71.8	68.7	64.9	60.7	63.3	67.0
Netherlands	74.7	75.2	76.4	76.1	75.2	73.5	70.9	68.0	68.5	69.9
Poland	89.3	90.5	92.7	93.6	93.9	93.2	91.4	89.2	89.5	91.2
Portugal	89.5	90.2	91.9	92.5	92.5	91.5	89.4	86.8	86.8	88.1
Romania	106.0	107.0	109.1	112.0	114.4	115.5	115.5	114.8	115.1	117.1
Slovakia	86.4	87.5	89.6	90.4	90.9	90.2	88.6	86.5	87.3	89.4
Slovenia	84.2	85.1	86.8	86.6	85.8	83.9	81.2	78.0	78.3	79.7

Core mid VSL	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Spain	78.0	78.6	80.1	79.1	77.5	74.9	71.5	67.6	67.7	68.7
Sweden	88.1	88.3	89.5	86.8	83.5	79.0	73.6	67.7	67.5	68.3
United Kingdom	85.2	85.1	86.0	84.2	82.0	78.7	74.6	70.0	69.9	70.8
Min	60.0	60.6	61.8	61.9	61.6	60.6	55.5	50.0	50.0	50.9
Max	132.2	134.2	137.7	139.9	141.3	141.1	139.4	136.9	137.1	139.3
Average	91.6	92.5	94.3	94.1	93.4	91.5	88.6	85.2	85.5	86.9

Source: Author’s calculations using the ALPHA-RiskPoll model

Table 21 Damage costs, €/person/100 ppb days, for health impacts of O_3 with mortality valued using value of a life year. Note: VSL is not used for ozone health impact assessment and valuation under current practice for air quality assessments informing the European Commission.

Core mid VOLY	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	0.41	0.42	0.43	0.43	0.44	0.44	0.44	0.44	0.44	0.45
Belgium	0.41	0.42	0.42	0.43	0.44	0.44	0.44	0.43	0.43	0.44
Bulgaria	0.49	0.50	0.51	0.52	0.53	0.54	0.54	0.53	0.54	0.55
Croatia	0.43	0.43	0.44	0.46	0.47	0.47	0.47	0.47	0.47	0.48
Cyprus	0.37	0.38	0.38	0.39	0.40	0.40	0.40	0.40	0.40	0.41
Czech Rep	0.42	0.42	0.43	0.44	0.45	0.45	0.45	0.45	0.45	0.46
Denmark	0.41	0.42	0.43	0.43	0.44	0.44	0.44	0.43	0.43	0.44
Estonia	0.45	0.45	0.46	0.47	0.48	0.48	0.48	0.47	0.47	0.48
Finland	0.42	0.43	0.43	0.44	0.45	0.46	0.45	0.45	0.45	0.46
France	0.40	0.40	0.41	0.42	0.43	0.43	0.43	0.42	0.42	0.43
Germany	0.43	0.43	0.44	0.45	0.46	0.46	0.46	0.46	0.46	0.47
Greece	0.41	0.42	0.43	0.44	0.45	0.45	0.45	0.45	0.45	0.45
Hungary	0.45	0.45	0.46	0.47	0.48	0.49	0.48	0.48	0.48	0.49
Ireland	0.41	0.41	0.42	0.42	0.42	0.42	0.41	0.40	0.40	0.41
Italy	0.41	0.42	0.43	0.44	0.44	0.44	0.44	0.44	0.44	0.45
Latvia	0.45	0.46	0.47	0.48	0.49	0.50	0.50	0.50	0.50	0.51
Lithuania	0.46	0.46	0.47	0.49	0.50	0.50	0.51	0.50	0.51	0.51
Luxembourg	0.40	0.40	0.41	0.42	0.42	0.42	0.41	0.41	0.41	0.42
Malta	0.39	0.40	0.40	0.41	0.42	0.42	0.42	0.41	0.42	0.43
Netherlands	0.39	0.40	0.40	0.41	0.42	0.42	0.42	0.42	0.42	0.43
Poland	0.42	0.42	0.43	0.44	0.45	0.46	0.46	0.45	0.45	0.46
Portugal	0.41	0.42	0.42	0.43	0.44	0.45	0.45	0.44	0.44	0.45
Romania	0.45	0.45	0.46	0.47	0.49	0.49	0.49	0.49	0.49	0.50
Slovakia	0.41	0.42	0.43	0.44	0.45	0.45	0.45	0.45	0.45	0.46

Core mid VOLY	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Slovenia	0.41	0.41	0.42	0.43	0.44	0.44	0.44	0.43	0.44	0.44
Spain	0.40	0.40	0.41	0.42	0.43	0.43	0.43	0.42	0.42	0.43
Sweden	0.42	0.42	0.43	0.43	0.44	0.44	0.43	0.43	0.43	0.43
UK	0.41	0.41	0.42	0.42	0.43	0.43	0.43	0.42	0.42	0.43
Min	0.37	0.38	0.38	0.39	0.40	0.40	0.40	0.40	0.40	0.41
Max	0.49	0.50	0.51	0.52	0.53	0.54	0.54	0.53	0.54	0.55
Average	0.42	0.42	0.43	0.44	0.45	0.45	0.45	0.45	0.45	0.46

Source: Author’s calculations using the ALPHA-RiskPoll model

Results are presented for 2 scenarios, with average exceedance above the limit values for any pollutant of 1 µg.m^{-3} and the other combining average exceedance of 2µg.m^{-3} $PM_{2.5}$, 7 µg.m^{-3} NO_2 and 5 µg.m^{-3} O_3 [R53]. The lower figure is intended to easily be scaled against alternative scenarios should the need arise, recognising linearity in the response functions for the range over which they are likely to be applied (reflecting the conclusions of the WHO-Europe HRAPIE study). The upper figure takes the mid-point of the ranges for PM_{10} and NO_2 for the exceeded population from Figure 9.2 of the EEA's 2018 Air Quality in Europe report and an indicative figure of 5 µg.m^{-3} for O_3. Results indicate the likely order-of-magnitude of benefits of the AAQ Directives.

Table 22 *Benefits of the 2008 Directive, based on a reduction in exposure of 1ug.m^{-3} amongst the population no longer subject to exceedance. Low to high ranges reflect alternative assumptions on mortality valuation. Units EUR millions. Results rounded to 2 significant figures.*

	$PM_{2.5}$		O_3	NO_2	
	Low	High		Low	High
2008	0	0	0	0	0
2009	810	2,400	-2	-180	-670
2010	390	1,200	-6	55	200
2011	-220	-650	-2	47	170
2012	250	720	-1	330	1,200
2013	920	2,600	-3	310	1,100
2014	1,000	2,900	25	460	1,500
2015	1,100	3,200	-44	360	1,100
2016	1,600	4,300	9	460	1,500
2017					
Totals	5,900	17,000	-24	1,900	6,100

Source: Author's calculations

Ozone levels are highly dependent on meteorological conditions as well as emissions of precursor pollutants (NOx and VOCs). Overall, there has been little change in levels of ozone, though 2015 was clearly a bad year for ozone, and dominates the time series for the pollutant, leading to a net cost.

Table 23 Benefits of the 2008 Directive, based on a reduction in exposure of 2µg.m^{-3} $PM_{2.5}$, 7 µg.m^{-3} NO_2 and 5 µg.m-3 O_3 amongst the population no longer subject to exceedance. Low to high ranges reflect alternative assumptions on mortality valuation. Units_EUR millions. Results rounded to 2 significant figures.

	$PM_{2.5}$		O_3	NO_2	
	Low	High		Low	High
2008	0	0	0	0	0
2009	1,600	4,800	-12	-1,300	-4,700
2010	780	2,300	-31	390	1,400
2011	-440	-1,300	-12	330	1,200
2012	490	1,400	-3	2,300	8,100
2013	1,800	5,300	-14	2,200	7,400
2014	2,100	5,800	130	3,200	11,000
2015	2,300	6,300	-220	2,500	8,000
2016	3,100	8,700	45	3,200	10,000
2017					
Totals	12,000	33,000	-120	13,000	42,000

Source: Author's calculations

Total benefits across the 3 pollutants for the 1ug.m^{-3} scenario are EUR 8 to 23 billion over the period 2008 to 2016. For the second scenario involving larger changes in pollution, intended to be more realistic of experiences to date, the total benefit for the period is about 3 times higher, ranging from EUR 25 to 76 billion, from which the midpoint (EUR 50 billion) is taken as an indicative estimate (see below). It is recognised that there are some significant uncertainties in this analysis, especially arising from the estimated change in exposure. However, the analysis serves a purpose in indicating a broad order of magnitude for benefits, being in the order of several billion EURO per year by 2016. It is noted that annual benefits increase over the years, reflecting a reduction in the area subject to exceedance of the limit values.

There are factors biasing the results both to overestimation and to underestimation. With respect to overestimation there is particularly the question of the extent to which changes in exposure are a consequence of the Directives under assessment. With respect to underestimation the analysis only considers reduction in exposure defined against typical exceedance in 2016 (it will have been higher in earlier years), and does not account at all for benefits associated with reductions in exposure below the limit values, both within and outside affected areas. With this in mind, use of the range of EUR 25 to 76 billion could be misleading, and be seen to include more elements of uncertainty than relating to valuation alone. With this in mind, the final estimate carried through to the main report is the midpoint of the range, EUR 50 billion for the period 2008-2016.

Similar data are not available for the metals. For BaP there has been little change in exposure according to EEA 2018. Whilst a quantification of benefits for BaP is not provided here, given little improvement in concentrations, an assessment of the costs of not meeting the limit values for the pollutant is provided in response to Evaluation Question 4.

There are several factors to be considered alongside these estimates:

1. They only include health benefits, omitting benefits to natural ecosystems, agriculture, forestry and materials. However, results elsewhere indicate that health impacts will dominate the economic benefits. (Bias to underestimation)

2. There is evidence for additional health benefits to those quantified here [R151]. However, with mortality dominating economic assessments, and mortality quantified on an all-cause basis, rather than cause-specific, underestimation as a result of this factor may be minor. (Bias to underestimation)

3. Benefits of reduced exposure will not be limited to the area of exceedance, but spill over into surrounding areas. These additional benefits are not accounted for. (Bias to underestimation)

4. Benefits of reducing exposure do not cease once the limit values are reached, given the pollutants considered here

5. Possible co-benefits and trade-offs associated with air quality measures on other policy areas are not accounted for. In general for environmental policies in transport and energy, the co-benefits tend to outweigh trade-offs and hence this creates a bias to underestimation of benefit.

6. The reduction in concentrations is not solely a consequence of the two Directives considered here, but also a result of other legislation on pollutant emissions, including the Industrial Emissions Directive, vehicle emissions directives and fuel quality directives. (Bias to overestimation of benefit ascribed to the 2008 Directives).

In response to the estimate of benefits generated in this analysis, a review was performed of the methods used for quantification of the benefits of the AAQ Directives and the costs of poor implementation, to assess consistency with other estimates (noting that there are no other direct estimates of the benefits of the AAQ Directives in isolation of other legislation). The first part of the review considered the methods used, highlighting consistency with other analysis undertaken for the European Commission [e.g. R108, R111] and the European Environment Agency [e.g. R53]. Population data, health response functions and monetary values are fully consistent. Quantification against total exposure, based on use of these models gives similar results. As discussed above, the main areas where there is uncertainty concern the reduction in population exposure in areas where there was exceedance of limit values in 2008, and the extent to which this reduction in exposure can be attributed specifically to the AAQ Directives. The lack of data at an EU28 level specific to the exposure changes attributable to the AAQ Directives is problematic for the current assessment: the figures used in relation to these two elements of the analysis are referenced to available data to the extent possible, but likely to be conservative.

The benefits quantified for 2016 (the most recent year for which data were available) indicate a reduction in equivalent attributable deaths of around 8,000 compared to the situation in 2008. This equates to 8% of the reduction in mortality burden quantified by the EEA (total 100,000 deaths), comparing 2008 and 2016. The EEA estimates describe the total benefits of actions on air across the whole population and across all legislation. The EEA estimates are thus not restricted to assessment of areas where limit values are exceeded. In contrast, the analysis here is focused on the urban population subject to exceedance of the limit values in 2016, about 15% of the EU urban population, having roughly halved since 2008, with quantification considering only exposure in excess of the limit values.

The WHO-Europe led HRAPIE study [R183] indicated that there are no identifiable thresholds for effects of the pollutants for which quantification has been performed. The HRAPIE recommendations included 'cut points' for analysis for NO_2 and ozone, but these reflect limitations on the availability of data below certain concentrations. For NO_2, particularly, the cut-point for analysis is set well below the limit value whilst for $PM_{2.5}$ there is no cut-point. In consequence, the EEA's analysis includes effects across the whole EU population and not only (as here) those living in areas where the limit values are exceeded (acknowledging that the AAQ Directives will have benefits outside of areas of exceedance, though data limitations prevent quantification of these). The benefits of the AAQ Directives as quantified here are thus only a part of the benefits evident from the EEA's analysis.

There is a long list of relevant actions taken to improve air quality, some focused on urban centres where limit value exceedance is most likely, and some benefitting everyone (again, bearing in mind the lack fo thresholds for pollutant impacts at the level of the general population):

1. Industrial controls, e.g. via the IED (benefitting everyone)
2. Product standards, e.g. for boilers, that are primarily aimed at energy efficiency (benefitting everyone)
3. Boiler replacement programmes (benefitting all, but more likely to be focused on urban centres)
4. Fuel switching away from coal for various reasons (climate and economic) (benefitting everyone)
5. Euro standards affecting all vehicles, not just those accessing areas with exceedances (benefitting everyone)
6. Traffic measures designed to address congestion (benefitting urban centres mainly)
7. Directives (e.g. sulphur in liquid fuels) (benefitting everyone)
8. National emission ceilings directive (benefitting everyone)
9. Actions on solvents (benefitting everyone)

The following table shows emission changes 2008 – 2016 for the EU28 [R199]. Actions most likely to be taken under the AAQ Directives concern the road transport and 'commercial, institutional and households' sectors. In total, emission changes for these 2 sectors account for 55% of the reduction for $PM_{2.5}$, 43% for NOx and 9% for SO_2. However, reduction for these sectors will be linked not only to measures introduced specifically to meet the AAQ Directives but also to the other actions listed above, most of which will bring benefit to the whole population rather than just those in air quality management areas.

Table 24 Changes in EU28 emissions by sector

	$PM_{2.5}$		NOx		SO_2	
	2008	2016	2008	2016	2008	2016
Agriculture	51	49	509	505	1	1
Commercial, institutional and households (CIH)	843	766	1,467	1,237	994	692
Energy production and distribution	108	61	2,492	1,672	5,334	2,726
Energy use in industry	140	104	1,417	999	1,264	952
Industrial processes and product use	176	144	269	144	316	247
Non-road transport	45	33	930	235	145	72
Road transport	233	148	4,481	3,148		
Waste	74	71	49	47		
Other						
Total	**1,670**	**1,376**	**11,614**	**7,987**	**8,054**	**4,690**
Change		294		3,627		3,364
Total for CIH and road transport	**1,076**	**914**	**5,948**	**4,385**	**994**	**692**
Change for CIH + road transport		162		1,563		302
Change in CIH and Road transport as % of total change		55%		43%		9%

Source: [R199]

Taking these various factors into account, the estimate of benefits here that are specific to the AAQ Directives, corresponding to a benefit of around 8,000 deaths in 2016 in contrast to the 100,000 deaths derived by the EEA accounting for all measures that reduce air pollutant exposure is not unreasonable.

Two further factors should be noted:

1. The benefits of the AAQ Directives will continue to increase over time as residual exceedances are eliminated.

2. The strict allocation of benefits between measures introduced directly as a consequence of the AAQ Directives and measures introduced under other air quality legislation is misleading, to the extent that exceedance of the limit values is a driver for adoption of additional legislation.

F.1.7.2 Unquantified impacts

An extensive assessment of the monetary value of ecosystem impacts of air pollution was carried out under the ECLAIRE study [R110]. Crop damages from exposure to ozone were estimated at EUR 8 billion/year (for the period 2010-2030), damage to forests from ozone in terms of loss of production and GHG sequestration at between EUR 3 and 34 billion/year, and damage to biodiversity through nitrogen deposition and eutrophication at between EUR 3 and 12 billion/year, depending on the method adopted. These estimates total EUR14 to 54 billion/year. Although these damages are large, they are significantly smaller than the estimated monetary equivalent of health impacts, of between EUR 240 and 1,200/year in 2010. A high level of uncertainty was associated with the impacts on biodiversity in particular, for which valuation data are extremely limited. It is noted, however, that there is extensive exceedance of the critical load for nitrogen across Europe [R85].

Extrapolation of these results to the present analysis would require knowledge of emission changes linked to the AAQ Directives. As this data is not available it is not possible here to assess the benefits of pollutant emission reductions on natural and managed ecosystems, though it is noted that there is clear linkage between the AAQ Directives and these impacts via nitrogen.

Another impact that has been of interest over the years concerns damage to building materials, particularly cultural heritage. However, this was mainly linked to SO_2 emissions, and is of declining importance now, given typically much lower concentrations of SO_2 in urban areas. It may, however, be a significant omission in regions where coal is still burned for household heating.

One further benefit of the AAQ Directives that is not quantified concerns equity, in seeking to ensure that no individual is exposed to levels of air pollution that are considered unacceptable. Where excess risk is imposed by society on a specific group it is not uncommon for more costly interventions to be deployed. Evidence was first collated by Tengs et al (1995) surveying the cost-effectiveness of 500 life-saving interventions, where costs per life saved were observed to range up into the billions of US dollars [S116]. This establishes that 'equity' should be treated as a benefit in its own right.

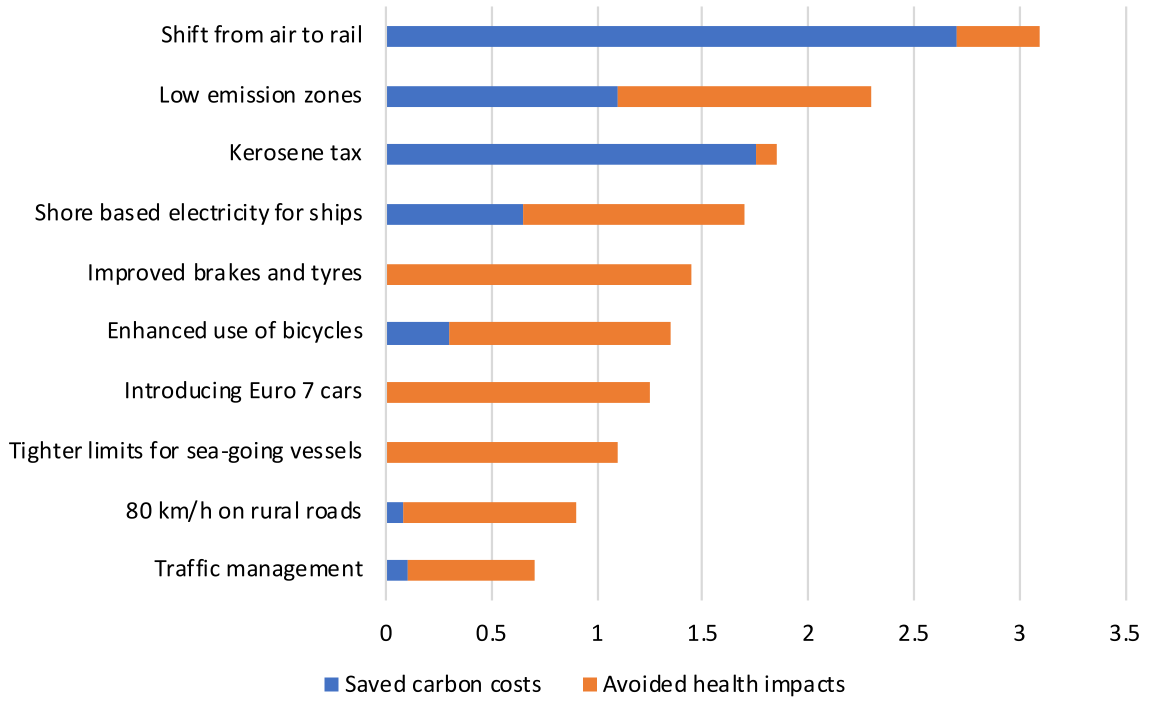
F.1.7.3 Co-benefits of environmental and other social policies

Co-benefits and trade-offs are ancillary effects of policies that affect issues other than that primarily targeted by an action. A common example is the greenhouse gas benefits of air quality policies (and vice-versa) [S113], linked because the two share a common source via the combustion of fossil fuels. Energy efficiency measures leading to boiler replacements are a good example. Particularly close links are also noted between transport policies and the AAQ Directives, especially those undertaken at a local level, such as expansion of public transport services, promotion of walking and cycling and of course, low emission zones.

They are relevant here because efficient practice is to take account of ancillary effects when designing policies, in order to maximise possible co-benefits and mitigate any trade-offs that may be present. It is not suggested that a detailed assessment needs to be made of individual co-benefits and trade-offs in the course of this work. However, demonstration of the capacity to account for co-benefits and trade-offs provides a useful indicator. This capacity may be demonstrated in different ways for example through involvement of government at different levels in the development of air quality improvement actions or involvement of environmental, transport and social planners in the design of air quality, transport and other action plans.

Friedrich [D101] assessed the co-benefits of policies in terms of effects on emissions of greenhouse gases and air quality and related social costs. The ten most effective measures from this analysis *are shown in Figure 4. Friedrich also considered different heating systems for houses, finding that private costs were similar for natural gas, light fuel oil, log wood and wood pellets, but that health* costs varied substantially with log wood and wood pellets having significantly higher damage than the fossil fuels considered (noting that fossil fuels such as coal or heaver oils would certainly perform no better than wood on this parameter).

Figure 4 Top 10 most effective measures for climate and air protection, 2020. Units: EUR billion.



Source: [D101].

The following table provides a mapping of co-benefits and trade-offs to different types of measure, demonstrating their varied nature, from reducing emissions of greenhouse gases (or in a few cases, increasing them), to effects on equality, mobility, noise and congestion.

Table 25 Mapping of measures for improving air quality to possibly significant co-benefits and trade-offs (disbenefits)

Measure category	Examples of measures	Major possible co-benefits	Major possible trade-offs
Measures reducing traffic			
Traffic management	Access restrictions, parking levies, road user charging, traffic light phasing	Reduce noise, congestion, accidents, GHG emissions	Equality (unequal access according to ability pay)
Promotion of cycling and walking	Cycle networks, cycle hire, integration of active and public transport	Reduce noise, congestion. Improve physical fitness, equality, mobility, GHG emissions	
Provision of alternatives to private vehicle use	Park and ride, lift share, car clubs, cycle hire Public transport service improvements (new routes, higher frequency, night services)	Reduce noise, congestion, GHG emissions	
Fuel switching	Diesel to petrol		Increased GHG emissions in some cases
	Oil based fuels to alternatives	Potential for substantial reductions in GHG emissions where fuel/power generation is carbon free	
Improved traffic management			
Freight and delivery management	Route management, out of hours deliveries, freight partnerships	Reduce noise, congestion, accidents	
Improved transport infrastructure	Public transport improvements (dedicated bus lanes, new rail lines)	Reduce noise, congestion, GHG emissions Promote mobility, equality	
	Road and junction improvements	Reduce noise, congestion, accidents, GHG emissions	
Direct actions on emissions			
Promotion of low emission transport	Use of LEZs, taxi licensing, priority parking, fee reduction	Reduce noise, congestion, accidents if scheme reduces vehicle numbers, GHG emissions	Equality (e.g. unequal ability to afford LEZ compliant vehicles, etc.)
Improvements to vehicle fleet efficiency	Driver training, improved vehicles	Cost savings over vehicle lifetime Reduce GHG emissions	Upfront cost

Measure category	Examples of measures	Major possible co-benefits	Major possible trade-offs
Public information			
Provision of public information	Transport alternatives, restricted activities (permitted fuels, use of bonfires), safer routes, access to air quality data for sensitive groups	Reduce noise, congestion Promote mobility, safer environments	
Measures on stationary sources			
Policy guidance and development control	Sustainable procurement	Cost savings from use of more efficient equipment and vehicles Reduce GHG emissions	
	Coordination of activities between authorities, publication of controls on development, and on construction and demolition activities	Reduce noise, nuisance dust, GHG emissions	
Energy efficiency measures for stationary sources	Insulation, purchase of more efficient appliances, optimisation of activities, boiler maintenance	Improved efficiency leading to cost savings Reduce GHG emissions Improved equality and energy security, reduced fuel poverty	Upfront cost
Fuel switching	Switching from solid fuels or oil to gas and on to renewables and electricity	Improved efficiency leading to cost savings Reduce GHG emissions	Upfront cost
End-of-pipe controls on industry	Particle filters, de-NOx equipment, flue gas desulphurisation		Some increase in GHGs, though typically small
Energy efficiency measures for stationary sources	Insulation, purchase of more efficient appliances, optimisation of activities, boiler maintenance	Improved efficiency leading to cost savings Reduce GHG emissions Improved equality and energy security, reduced fuel poverty	Upfront cost

Source: Author's assessment and [S113]

F.1.8 Potential for double counting / misallocation of costs and benefits

Given that there are a number of policy areas at a local level that lead to the adoption of similar measures (e.g. boiler replacements for reducing greenhouse gases and local air pollutants, public transport provision to enhance mobility, reduce congestion and reduce air pollution), the question arises of how costs and benefits should be allocated across policies in order to prevent double counting, particularly of benefits. The situation for costs at a local level is not so critical, as it is easier (in theory) to gain some perspective on total costs, whereas for benefits it would be entirely possible to credit different policies with some total of air quality benefit, given that these benefits do not come out of a predefined budget.

The same applies at a higher level when considering the attribution of benefit to legislation on air quality, the extent to which both costs and benefits might be attributed to the AAQ Directives rather than the Industrial Emissions Directive, fuel quality directives, vehicle emission directives and so on.

A detailed assessment of this issue is not possible in the context of the present report because of data limitations. It is noted several times here that measures identified in air quality management plans often include actions that have clearly been initiated for other purposes such as reducing congestion, with air quality being a co-benefit. This is not intended as a criticism of such plans, indeed the recognition of commonality in approach offers significant benefits for efficiency in terms of aligning policies and avoiding policy clashes.

Instead, the potential for double counting, or more precisely, misallocation of costs and benefits has been noted where it arises. Further assessment on this point would require additional information from governments and planners that is not currently available. Future initiatives on data collection and review should take this issue into account.

F.1.9 Have the benefits (improved air quality) been achieved in a cost-effective manner?

The standard approach to assess cost-effectiveness is to list measures for air quality improvement together with costs and anticipated benefits of schemes. Extensive databases of this kind have been developed for technical options for industry, vehicles, agriculture and benefits of specific measures on which to draw conclusions on this aspect. For the measures of particular interest to local air quality management, however, data availability is weak, particularly with respect to ex-post estimates. This is reflected by the findings of the EUROSAI report [R95]. Whilst this is less of a problem for cost assessment where budgets may be fixed in advance and ex-ante estimates of cost may be a reasonable indication of final costs, it is a major concern for estimates of benefit, especially, for non-technical measures such as modal shift in transport.

The CE Delft analysis for the Netherlands [R158] provides evidence that some significant actions on transport, costing government €383 million, generated net benefits. Some measures involving subsidies for retrofitting particle filters and for scrappage subsidies did not generate net benefits but were still considered a cost-efficient way of meeting the targets when compared to damage costs in urban areas. In other analysis for the European Commission, air quality improvement measures have repeatedly been estimated to generate net benefits (as in the review of the Thematic Strategy on Air Pollution [R10]). These, however, deal almost entirely with technical measures that are already deployed, and hence for which knowledge of costs and associated emission reductions is good. Such measures, being focused on particular types of equipment operating under reasonably standard conditions, are also subject to many fewer variables than the measures typically introduced for air quality improvement.

In the absence of an extensive body of evidence on the costs and benefits of many of the actions adopted in air quality action plans, the assessment of cost effectiveness is based on alternative considerations:

- Are the main sources of emissions associated with exceedance of the limit values being targeted?
- Are links to other policy priorities explored?
- Is guidance available to assist local planners in identification of actions?

Turning first to the question of whether or not the major sources of emission affecting exposure above the target values (as opposed to simply the major sources of emission) are targeted. For the metals the link should be very strong, given that they are only likely to be emitted in significant quantity from a select number of industrial sites. The same does not apply to PAHs so much: whilst the largest individual emitters are likely to be industrial, the largest sources overall are domestic combustion of solid fuels. As noted above, there has been little improvement in BaP exposure, with the EEA [R61] reporting that:

"In 2016, 21 % of the urban population in the EU-28 was exposed to BaP annual concentrations above the EU target value (1.0 ng/m³) and 90 % was exposed to concentrations above the estimated reference level (0.12 ng/m³ as annual mean). Since 2008, there has been no significant change in the extent of the urban population exposed to high BaP concentrations. Between 17 % and 24 % of the EU-28 urban population was exposed to BaP concentrations above the target value in 2008-2016, whereas 81-91 % of the EU-28 urban population was exposed to BaP concentrations above the estimated reference level over the same period."

Emissions of NOx and $PM_{2.5}$ are shown in the following figures for nine selected Member States, selected to demonstrate variation in the strength of emission sources.

Figure 5 Emissions of NOx in 9 Member States, % from each source

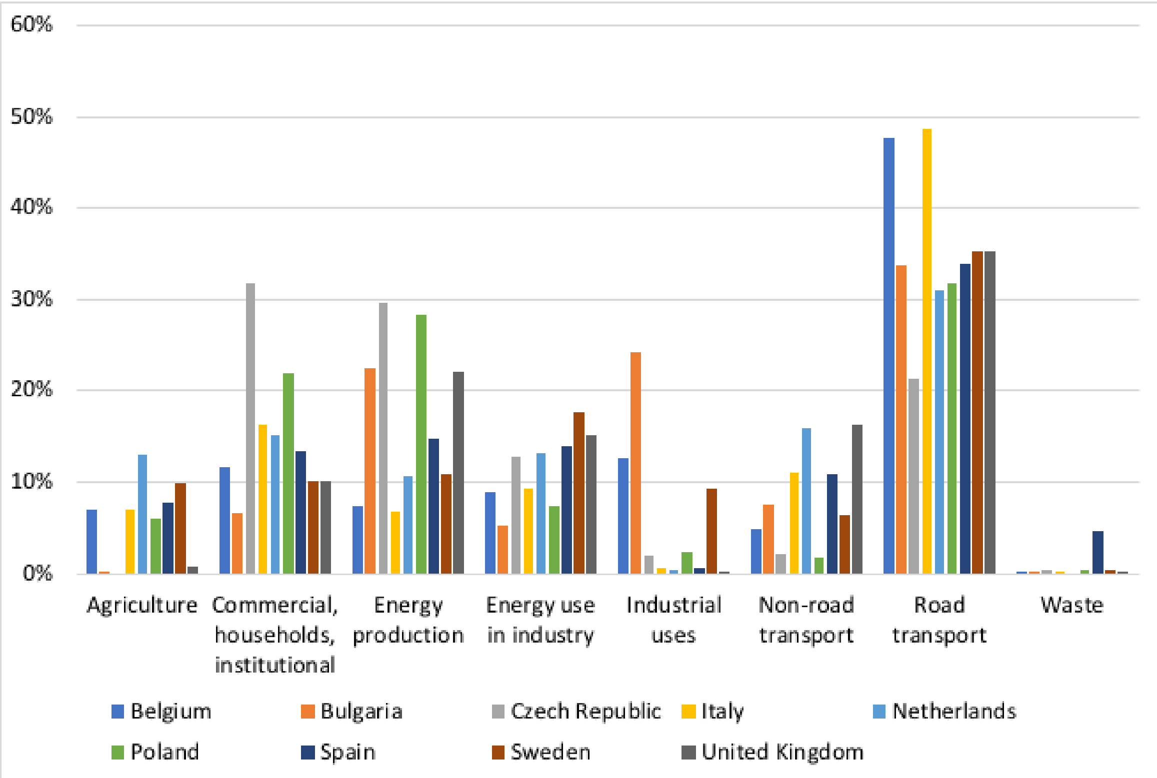
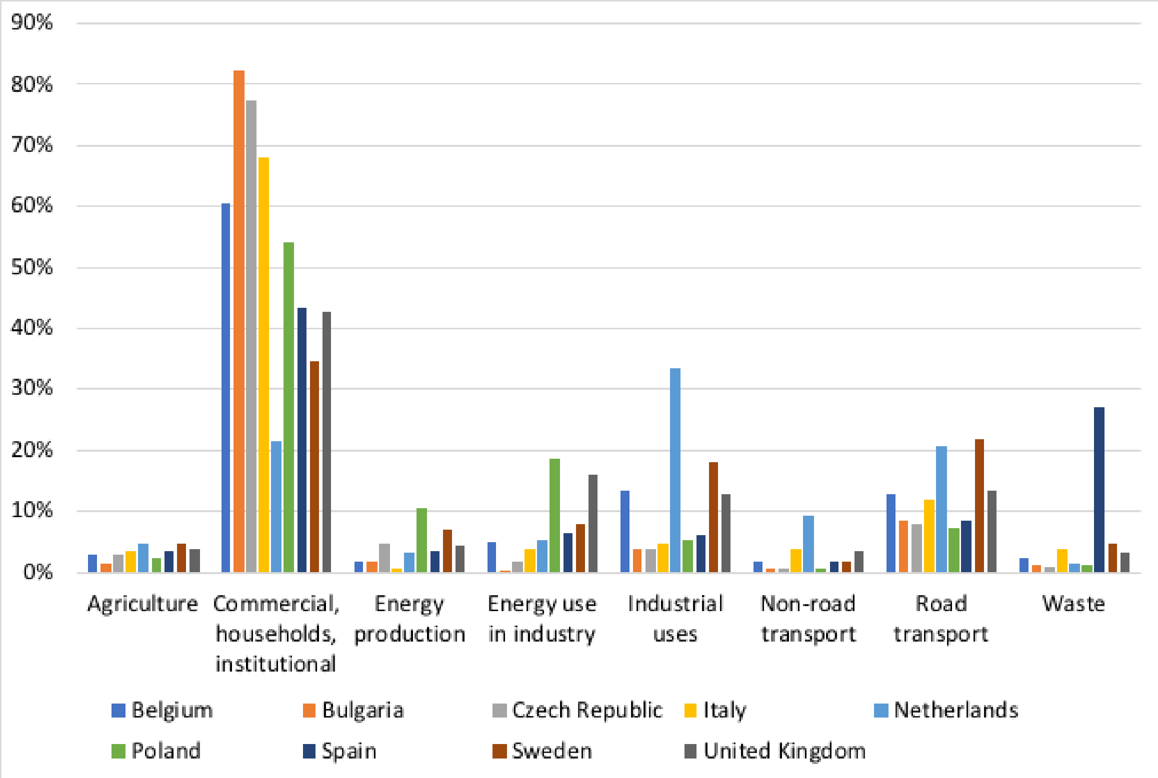


Figure 6 Emissions of $PM_{2.5}$ in 9 Member States, % from each source



There are differences between Member States with respect to the strength of emission sources. For NOx, for example, Poland and the Czech Republic have higher emissions from commercial, institutional and domestic sources and energy production than other countries, whilst emissions of NOx for Belgium and Italy are significantly higher for transport as a proportion of their national total, than they are for other countries. This is reflected to some degree in the proportion of measures in different categories from Table 3 for each country. This comparison cannot be pushed too far, or be regarded as being definitive, given the issues raised around the cataloguing of measures in the EEA database, and the fact that data on emissions alone does not provide a good indication of human exposure. However, the comparison at least shows that thought has gone into the selection of measures at a local level and that countries are not simply copying over plans from elsewhere.

Links to other policies are certainly being explored where appropriate, particularly in relation to climate and transport. Evidence for this comes from the lists of measures identified for air quality improvement, some of which are clearly of most relevance to climate and transport. Together, these two policy areas appear to be the source of much of the funding of measures considered here to be carried out for air quality improvement, with air quality acting as a co-benefit to the other policies.

F.1.10 To what extent have costs been equitably distributed across different sectors?

The word 'equitable' here reflects the need for action to be focused on the most cost-efficient approaches to reducing population exposure. The European air policy assessments made by IIASA using the GAINS model [D111] take a similar approach, seeking to identify the most cost-effective options not simply for reducing emissions, but for achieving certain health and environmental objectives. A barrier for the analysis is the general lack of information on the costs and effectiveness of measures. Although some data have been collected through the literature review, public consultation and national case studies, it provides only a very limited body of evidence. As a result, it is necessary to consider additional types of data to answer the question of whether or not costs are equitably distributed.

A first consideration is whether actions are targeted on the sources that are primarily responsible for exceedance of limit values. Analysis by Kieswetter and Amann [R128] provides a breakdown of different sources of $PM_{2.5}$ at monitoring stations in 20 EU Member States. The sources covered in the Figure are:

- Households
- Primary PM from traffic
- Secondary PM from traffic and agriculture[1]
- Secondary PM from industry and agriculture
- Primary PM from industry
- Natural sources

Results for all countries show that significant contributions to $PM_{2.5}$ concentrations are made by natural, international and national sources that are not under local control. Secondary pollutants and natural sources make a significant contribution in all cases. Of the cases shown, all except the UK have exceedance of the WHO guideline without including local (urban+street) contributions. Taking all 28 Member States into account, only Estonia, Finland, Ireland, Portugal, Spain, Sweden and the UK are without exceedance of the WHO value from non-local (i.e. natural, international and national) emissions from the 2009 data. These countries form the outer boundary of the EU from the west to the north east with their location (reducing transboundary input) being one reason for the low background levels in these countries.

For the local contributions, industrial sources on average (accepting that there will be exceptions at sub-national level where industry dominates) make a minor contribution (typically <10%) to concentrations. There is then variation in the dominant local source between 'Households' and 'Traffic' by country:

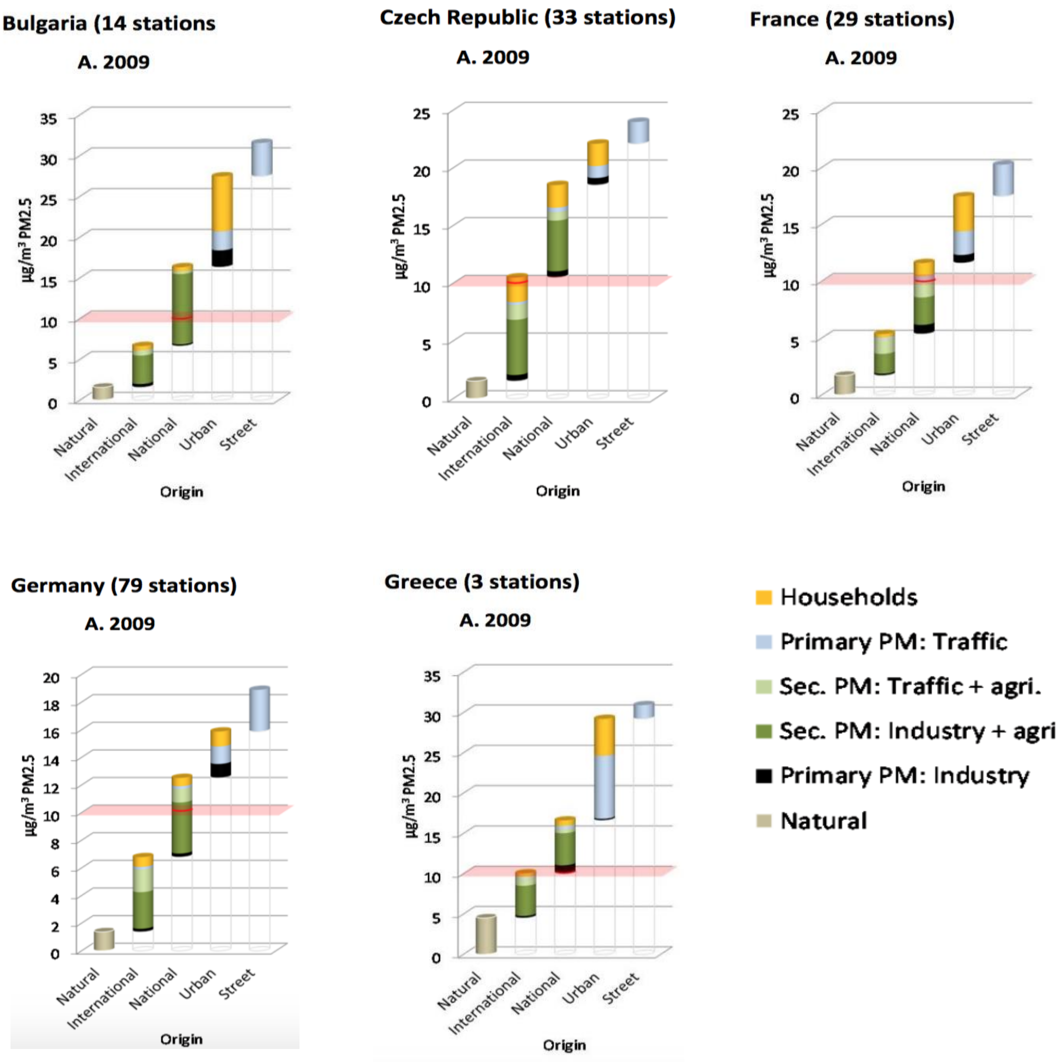
- Countries where 'Traffic' dominates:
  - Austria, Belgium, Finland, France, Germany, Greece, Ireland, Netherlands, Spain, Sweden, UK

- Countries where 'Households' dominates:
  - Bulgaria, Estonia, Lithuania, Poland, Portugal, Romania, Slovakia

- Countries where there is roughly equal contribution from 'Traffic' and 'Households'
  - Czech Republic, Hungary, Italy

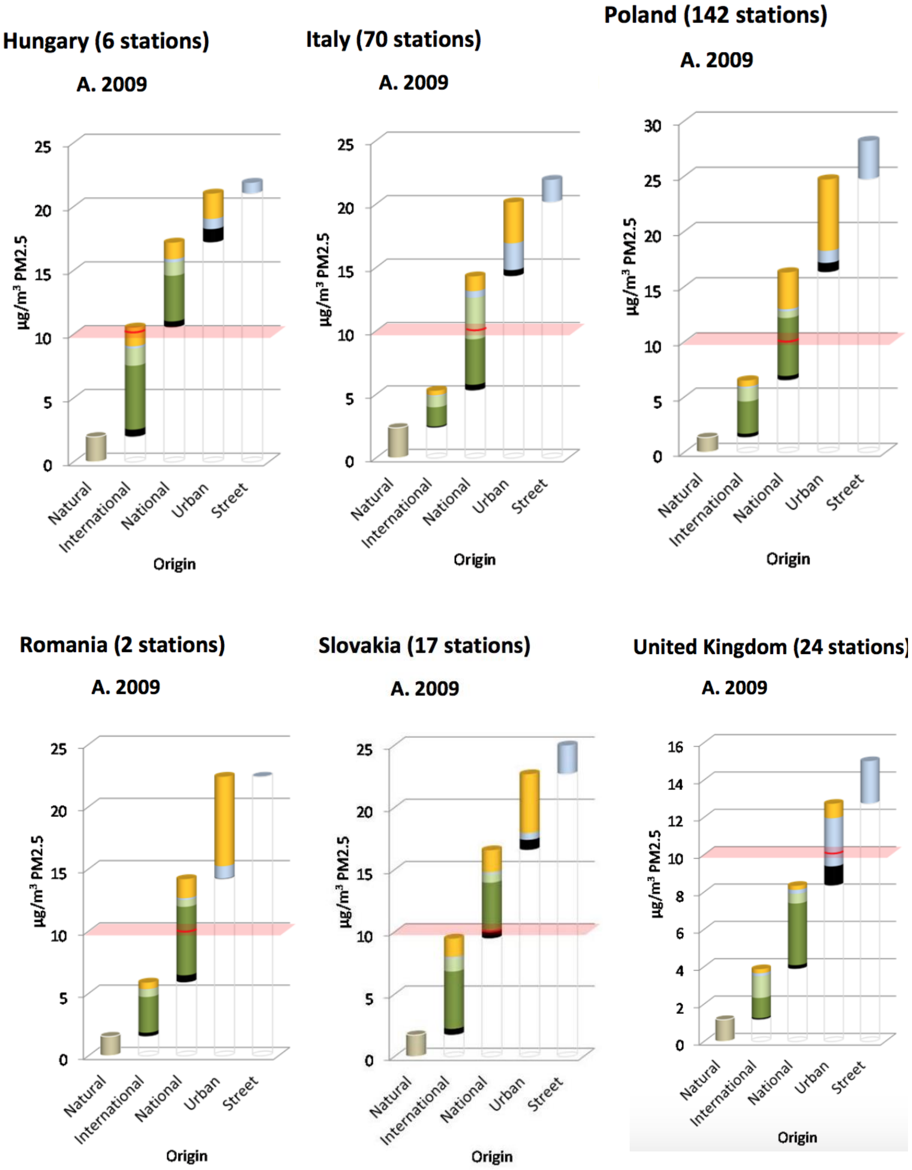
[1] Secondary PM is generated in the atmosphere following release of precursor pollutants, notably SO_2, NOx and NH_3, the latter being produced mainly by agriculture.

Figure 7 *Contribution of sources to urban $PM_{2.5}$ levels in 2009 in EU Member States (Bulgaria, Czech Republic, France, Germany and Greece). The horizontal red line indicates the WHO guideline level at 10µg.m^{-3} rather than the EU limit value.*



Source: [R128]

Figure 8 *Contribution of sources to urban $PM_{2.5}$ levels in 2009 in EU Member States (Hungary, Italy, Poland, Romania, Slovakia and UK). The horizontal red line indicates the WHO guideline level at 10µg.m^{-3} rather than the EU limit value.*



Source: [R128]

These results are in broad agreement with the analysis of measures presented in Table 3 which provides a count of the number of measures in various categories. Most countries have a clear focus on traffic related measures, but for Belgium, Czech Republic, Italy, Poland, Romania and Slovakia there is also a focus on stationary sources. For Bulgaria and Lithuania there is a very even spread of measures across categories. For Bulgaria this is further supported by information from the case study covering Plovdiv and Asenovgrad where actions are listed for both the transport sector and buildings. Estonia and Hungary are not covered by Table 3. With respect to equitable demand across the sectors the reference to the spread of measures by country from Table 3 is not perfect, as the number of measures may be poorly linked to costs. However, it is at least an indication that the relevant sources are being targeted and that the authorities in each country are taking account of local conditions when designing air quality management plans.

Turning to other countries, the focus of measures on the sectors causing the highest problems continues. For example, the measures listed in the Swedish case study (low emission zones, restrictions on studded tyres, speed reductions on certain roads, street cleaning) are focused on transport which is the main source of $PM_{2.5}$ controllable at a local level according to the Kieswetter analysis. The same applies in the Netherlands also, and for Madrid (see the discussion around Tables 13 and 14, above).

Some relevant data for this question regarding costs by sector have been provided to the study. Data submitted by the Czech Republic during the current assessment is presented in the table below. Transport measures account for 27% of incurred costs, industry 35%, and households and the energy sector (presented together) 37%. Costs to agriculture are only 0.2% of the total. Supporting information provided by the Czech authorities (presented in Table 25) confirms that some of the funding for the transport and energy measures was provided from EU funds, used to fund the larger infrastructure spend such as investment in bypasses and some of the boiler upgrades.

Table 26 Sectoral Cost Breakdown from the Czech Republic

Sector	Who is affected by the costs	Activities	Total Costs (2015-2020)	% breakdown
Traffic	Municipalities and state	Investment in bypasses, railways and public transport	€6,974 million	27%
Industry	Operators	Emissions reduction for specific activities	€8,935 million	35%
Households, energy sector	Households, municipalities, operators	Household boiler upgrades	€9,440 million	37%
Agriculture	Farmers	Not stated	€58.5 million	0.2%
TOTAL			€25,407 million	

The distribution of Czech costs is not dissimilar to the pattern observed in emissions for NOx, where the largest emitters are households and the power sector, followed by traffic. It is important to note that a number of the actions contained in the plan have not been undertaken specifically for air quality improvement but also, and in some cases primarily, to meet other policy objectives. For example, investment in bypasses, railways and public transport may be done mainly to reduce congestion and improve mobility, whilst household boiler upgrades may be undertaken to reduce greenhouse gas emissions and energy poverty.

The response from the Polish authorities to the targeted questionnaire provided information relating to the costs in selected years for different activities undertaken by the authorities in the Mazowieckie region (population 5 million), which includes the country's capital, Warsaw. Information is presented in with costs incurred for measures covering transport and the upgrading of boilers for this region. The following points are noted:

- The incurred costs varied considerably across the years – total spend was around 50 million PLN (€11 million) in 2008 and 2014, for example, but over 600 million (€140 million) in 2017 – noting that in the case of the latter, the total costs covered a wide range of measures;

- Costs were incurred at many different levels of government, and by a range of government bodies. These include various environmental funds (at both the municipal and provincial levels), EU funds (from the cohesion policy operational programmes), state budgets, and city budgets;

- Whilst government bodies were indicated to have been responsible for meeting the costs of the transport measures, in the case of the measures tackling pollution from the combustion of fuels (which includes measures to tackle emissions from boilers) the costs were more widely distributed, being met in part by funds from private companies and heat recipients.

- Those incurring the costs changed over time – for example, whilst the costs of replacing the heating systems was initially incurred by heat recipients, these costs were later met by the Provincial Environmental Protection and Water Management Fund in Warsaw from 2014 onwards (by which point the second phase of operational funds had commenced, which had a greater emphasis on air quality);

- In contrast to the information provided from the Czech authorities, in the case of this Polish region, the transport measures appeared to incur the highest costs, with relatively significant costs being incurred related to the construction of bypasses and the reconstruction of roads, for example. In both these cases, funding was provided by EU Funds. As was previously discussed in respect of the data provided on costs and benefits from the JRC with reference to the impacts of large infrastructure schemes, and in respect on the data from the Czech Republic, these measures are unlikely to have been implemented solely to tackle air pollution.

Overall, the evidence collated across various countries supports the view that measures have been targeted on the sectors responsible for the highest burden to air quality that is controllable at a level appropriate to local air quality management. Better availability of data on the costs and benefits of different types of action could, however, improve the efficiency of measures undertaken.

Table 27 Costs for the Mazowieckie region of Poland

Action	Year	Costs incurred by	Costs
STATIONARY COMBUSTION: Limiting low living emission (emission from energetic combustion of fuels) – development of low emission lowering program, implementation of low emission lowering program.	**2008**	– Municipal Environment Protection and Water Management Funds; – Przedsiębiorstwo Energetyki Cieplnej (PEC) „ŻYRARDÓW" Sp. z o.o. (Ltd) in Żyrardów – the company operating the district heating plant – Provincial Environmental Protection and Water Management Fund in Warsaw – municipal funds – EU funds State budget	379,645 PLN
TRANSPORT: Limiting pollutant emissions from transport: Improving car transport through reconstruction of roads, construction of city by-passes,		– State budget – municipal funds – Provincial Environmental Protection and Water Management Fund in Warsaw – EU funds National Road Fund	52,356,548 PLN
STATIONARY COMBUSTION: Limiting low living emission (emission from energetic combustion of fuels) – development of low emission lowering program, implementation of low emission lowering program.	**2009**	– Municipal Environment Protection and Water Management Funds, – Provincial Environmental Protection and Water Management Fund in Warsaw, – PEC Ltd. – ZEC Ltd. – Municipal Environment Protection and Water Management Fund (Płock), – Budget of Płock city, – FORTUM Ltd. budget of housing communities	3,403,504 PLN
STATIONARY COMBUSTION: Limiting low living emission (emission from energetic combustion of fuels) – connecting to heat distribution network, replacement of heating systems.		– PEC Ltd. Own funds of heat recipients	495,781 PLN

Action	Year	Costs incurred by	Costs
TRANSPORT: Limiting pollutant emissions from transport: – Improving car transport through reconstruction of roads, construction of city by-passes, maintaining cleanliness of national roads through the increase of incidence of street cleaning (including wet cleaning of streets in dry season).		– Municipal funds, – Provincial Environmental Protection and Water Management Fund in Warsaw, – EU funds, National Road Fund	106,223,571 PLN
STATIONARY COMBUSTION: Limiting low living emission (emission from energetic combustion of fuels) – development of low emission lowering program, implementation of low emission lowering program.	**2010**	– Municipal funds, – EU aid funds, – PEC „ŻYRARDÓW" Ltd. – ZEC Ltd. – Budget of Płock city, – FORTUM Ltd. – Budget of housing communities, Provincial Environmental Protection and Water Management Fund in Warsaw	1,384,688 PLN
STATIONARY COMBUSTION: Limiting low living emission (emission from energetic combustion of fuels) – connecting to heat distribution network, replacement of heating systems.		– PEC Ltd. own funds of heat recipients	2,761,132 PLN
TRANSPORT: Limiting pollutant emissions from transport: – Improving car transport through reconstruction of roads, construction of city by-passes, maintaining cleanliness of national roads through the increase of incidence of street cleaning (including wet cleaning of streets in dry season).		National Road Fund	150,624,673 PLN
STATIONARY COMBUSTION: Replacement of heating systems.	**2014**	Provincial Environmental Protection and Water Management Fund in Warsaw	3,156,830 PLN
STATIONARY COMBUSTION: Thermo-modernisation		Provincial Environmental Protection and Water Management Fund in Warsaw	33,001,130 PLN

Action	Year	Costs incurred by	Costs
STATIONARY COMBUSTION: Connecting to heat distribution network.		Provincial Environmental Protection and Water Management Fund in Warsaw	17,514,600 PLN
OTHER: Alternative energy sources.		Provincial Environmental Protection and Water Management Fund in Warsaw	233,610 PLN
OTHER: including: – ecological education; – creating new bicycle paths; – greenery planting; – cleaning of chimney ducts and replacement of window joinery; – improving car transport through reconstruction of roads; creating mobile waste collection points.		Provincial Environmental Protection and Water Management Fund in Warsaw	426,610 PLN
STATIONARY COMBUSTION: Replacement of heating systems.	**2017**	Provincial Environmental Protection and Water Management Fund in Warsaw	4,608,407 PLN
STATIONARY COMBUSTION: Thermo-modernisation		Provincial Environmental Protection and Water Management Fund in Warsaw	11,999,126 PLN
STATIONARY COMBUSTION: Connecting to heat distribution network.		Provincial Environmental Protection and Water Management Fund in Warsaw	21,767,626 PLN
Alternative energy sources.		Provincial Environmental Protection and Water Management Fund in Warsaw	76,311 PLN
OTHER, including: – ecological education; – bicycle paths; – greenery planting; – improving car transport through reconstruction of roads; – street wet cleaning in spring-autumn season as required (in particular in dry season);		Provincial Environmental Protection and Water Management Fund in Warsaw	633,205,780 PLN

Action	Year	Costs incurred by	Costs
– replacement of busses in public transport with vehicles fitted with engines complying with Euro 5 exhaust gas emission standard, development and modernisation of public transport system; – setting-up the safe parking systems (Park & Ride system), development of parking network; – modernisation of street lighting - replacement with more effective luminaries; – development of pedestrian traffic - construction of sidewalks, traffic lights; creating mobile waste collection points.			
STATIONARY COMBUSTION: Thermo-modernisation		Provincial Environmental Protection and Water Management Fund in Warsaw	11,999,126 PLN

F.2 Evaluation question 4: Cost differences

The present section contains additional evidence concerning *EQ 4: Where there are significant cost differences between Member States and/or between different sectors and/or as regards costs to stakeholders (including social costs as a consequences of poor implementation), what is causing them; and are the costs of compliance proportionate to the benefits brought by the directives?*

Under this question, we consider differences in costs as follows:

1) For Member States, we consider:

   a. First, the source of variation in the direct costs;

   b. Second, the source of variation in the indirect costs;

2) For sectors, we focus on the way in which the indirect compliance costs vary across sectors, drawing from the responses to Question 3;

3) For 'stakeholders', we focus on the costs to citizens. For the social costs associated with poor implementation, although, formally, social costs are defined as the loss of producer and consumer surplus as a result of moving from one market equilibrium to another, we have taken this question to refer to the potential (in this case, monetised) damages being suffered from those who are exposed to exceedances in limit values;

4) For the final sub-question, we consider the costs – direct, and indirect – which the Directive appears to impose on all actors as compared with the benefits.

The response to this Question largely draws upon analysis undertaken in responding to Questions 4 and 6. In addition, we have drawn upon the following:

- Responses from the open public consultation (open public consultation).
- Data collected through the series of national case studies undertaken for the current assessment.
- Modelled social costs of the exposure of the urban population subject to exceedances to concentrations of key pollutants at marginal levels above limit values.

F.2.1 Where there are significant cost differences between Member States, what is causing them?

Member States experience a number of costs associated with the AAQ Directives:

- the costs of establishing the required monitoring, reporting and assessment infrastructure in line with the AAQ Directives (the administrative costs or direct costs to MS); and
- the costs of introducing those measures intended to improve air quality (as a result of exceedances of the AAQ Directives' limit values) (the indirect costs to Member States).

These are discussed, in turn, below.

Direct costs: Administrative Costs

The first of the above cost categories relate principally to the requirements of the Directive which affect all Member States on a more or less equal basis. To the extent that data have been made available, these have been examined under Question 5 above and are not covered again here. As indicated in the analysis, complete data for any Member State have been difficult to come by, which limits the ability to draw firm conclusions on variation in costs. However, some comments can be made:

a) As expected, the total costs seem to scale with a country's population;

b) There is potential for improving the efficiency of monitoring systems by using modelling or low-cost sensors alongside more sophisticated monitoring equipment that meets the requirements of the Directives, as reflected by responses from some Member States (e.g. Estonia). However, these different approaches are not alternatives, but complementary.

c) Given that the AAQ Directives place restrictions on the extent to which modelling approaches can be chosen, depending on the concentrations of the air pollutants, it follows that Member States freedom to choose lower cost approaches will be influenced by the prevailing concentration of the relevant pollutants;

d) Costs will be influenced by the extent to which the responsibility for monitoring, assessment and reporting is decentralised;

e) There is some variation in costs arising from some Member States not having installed the required infrastructure (sampling points, monitoring stations).

Indirect Costs: Costs of the measures put in place

In respect of implementing measures to address exceedances, a range of 'government levels' may be involved, for example at local, regional and national levels. Some stakeholders will have a clear remit for action to improve air quality, whilst others, for example with responsibility for climate and energy, transport or agriculture, may not. This can generate inconsistency between policies, an issue raised in several of the national case studies (Bulgaria, Germany, Ireland, Slovakia and Spain).

The costs associated with actions to address exceedances in limit values are affected by a large number of variables that create significant potential for cost differences between Member States. These include:

1. Numerous factors affecting the prevailing air quality:

    a. The size of cities: larger cities will be more prone to a build-up of pollution levels than smaller cities simply from higher levels of activity.

    b. Population density which may lead to higher emissions per unit area given associated higher activity levels.

    c. City architecture such as the presence of canyon streets that can trap pollutants causing elevated concentrations.

    d. Background pollution levels and meteorological conditions that are outside the control of planners at a local and possibly national level.

    e. Age and quality of the building stock, with older and poor quality buildings likely to be less energy efficient.

f. Heating systems in place and fuels used, noting that in some countries there is still a strong reliance on solid fuels. Domestic use of these fuels can generate significant air quality problems.

g. Age of the vehicle fleet, reflecting the standard of emission controls on vehicles.

h. The type of vehicles in circulation, noting significant variation in emissions according to size, model and manufacturer, especially under real world driving conditions [2].

i. Age of industrial facilities which will affect the technologies in place, plant efficiency and other characteristics.

j. Structure of the road network and the extent to which heavy traffic is separated from the population.

k. Existing provision of public transport with respect to the quality of vehicles, frequency of services, operating hours, etc.

l. Existing provision of measures that encourage walking and cycling.

2. Variation in the cost effectiveness of adopted measures. The different types of measure also have different distributional consequences across Member States (and the different levels of governance), industry and citizens.

3. Public attitudes for example with respect to the use of public transport, walking and cycling.

4. The ease with which existing industrial facilities can be adapted either to use cleaner fuels, or to be retrofitted with specific abatement technologies.

5. Anticipated trends in industry, vehicle purchases and technologies, noting in particular the actions that are necessary for decarbonisation.

6. The extent to which responsibilities for developing action plans are centralised or devolved may have an impact on the efficiency of the process by which plans are developed, and the strength of the rationale for the choice of specific measures selected for use in addressing exceedances.

7. Equally, the extent to which Member States provide guidance to more decentralised levels of government, and the quality and content of that advice, might be expected to affect costs. The case studies show significant variation in the provision of guidance, with Sweden having developed comprehensive guidance through its Handbook for Environmental Quality Standards for Ambient Air, whilst for others (e.g. Slovakia) such guidance is not available.

8. The extent to which those responsible for air quality improvement work with planners and decision makers in other fields such as climate mitigation, waste management and transport, enabling synergies between policies to be developed, and plans to be developed in a timely fashion.

[2] https://equaindex.com/equa-air-quality-index/

9. Linked to this, the understanding of the co-benefits and trade-offs that are likely to be present across different policies, and ways of enhancing the former and mitigating the latter.

A number of these issues lead to unavoidable variation between countries, to the extent that they reflect geographic conditions, current fuel use, transport systems, urban design, etc. However, several may lead to avoidable variation, relating to differences in cost effectiveness of measures, behavioural issues, availability of guidance, etc.

The limited amount of ex-post data identified in the literature, from the national case studies and through the consultation exercise carried out here creates clear difficulties for this part of the evaluation, as comparison requires a consistent dataset for EU countries. Even where data have been provided, it is often difficult to identify the part of costs that are associated with the AAQ Directives rather than other air quality legislation and other policy concerns such as reducing congestion or greenhouse gas emissions. In the absence of such information, we consider the costs for compliance with EU air quality legislation estimated using the GAINS model [R11], though acknowledging that these estimates are not specific to the requirements of the AAQ Directives. Costs for a scenario based on current EU legislation covering technical emission control options as applying in 2017 are shown in the table below. The measures included in the model are mainly concerned with the pollutants covered under the 2008 Directive but have some relevance also to the 2004 Directive: reducing emissions of particles, for example, will also reduce emissions of many toxic metals and PAHs as these substances tend to condense onto particles in the flue gas stream. The final column, showing cost per person are most relevant for the purpose of comparison across countries.

Table 28 Costs of air pollution controls (not only related to the AAQ Directivess) calculated by the GAINS model, corresponding to Current Legislation in 2017, ranked by cost/person.

	Cost, €M/y	Population	€/person
Romania	1,833	19,679,306	93
Malta	41	430,835	95
Hungary	939	9,721,559	97
Cyprus	120	1,179,551	102
United Kingdom	7,257	66,346,899	109
Croatia	461	4,189,353	110
Portugal	1,155	10,329,506	112
Latvia	223	1,949,670	114
Greece	1,463	11,159,773	131
Slovakia	731	5,447,662	134
Italy	8,226	59,359,900	139
Bulgaria	1,000	7,084,571	141
Sweden	1,395	9,910,701	141
Spain	6,794	46,354,321	147
Lithuania	428	2,890,297	148
France	9,924	64,979,548	153
Germany	14,218	82,114,224	173
Netherlands	3,253	17,035,938	191
Austria	1,725	8,735,453	197
Czech Republic	2,114	10,618,303	199
Ireland	960	4,761,657	202
Slovenia	428	2,079,976	206
Belgium	2,365	11,429,336	207
Denmark	1,235	5,733,551	215
Estonia	288	1,309,632	220
Finland	1,214	5,523,231	220
Poland	9,131	38,170,712	239
Luxembourg	296	583,455	507

Source: Adapted from [R11]

Accepting the limitations of using modelled data for the present purpose, the GAINS results provide a basis for consideration of variation between Member States and have the significant advantage over other sources of being derived on a consistent basis across all Member States using a framework that Member States are familiar with and have had opportunity to provide data and their own perspectives.

Excluding Luxembourg, there is a factor 2.5 variation between Member States in the cost per capita of the air pollution controls covered by the GAINS model. There is little evidence of countries clustering into regional groupings in any systematic way. Reasons for variation in the costs estimated using the GAINS model reflect many of the factors raised in the list above, for example concerning the age and size of the vehicle fleet, the types of industries present, the age of industrial facilities, vehicles, and other pollutant sources, etc.

An important lesson from this dataset is that factors that may be anticipated to generate differences in costs between Member States exhibit some potential to cancel one another out. For example, on the last point on the list, richer countries may engage in more 'potentially polluting activities', but they will tend to be in a better position to do them in a non- (or less-) polluting way, for example through use of renewable energy technologies, rather than use of fossil fuels, or by use of a newer vehicle fleet, or electric vehicles.

F.2.2 Where there are significant cost differences between different sectors, what is causing them?

Our evaluation under Question 3 above highlighted the proportion of the measures that are deployed by Member States that are focused on key sectors. The impact is related to two factors:

- The choice of measures used to improve air quality; and
- The way in which the design of the measure affects the distribution of costs across different industry sectors.

It was clear from the analysis under Question 3 that most countries focus on transport related measures. These measures, however, have different impacts across sectors. In Table 29 below, we highlight how different transport-related measures imply quite different distributions of cost across government, and industry / households. We also include the scrappage scheme in Denmark, and some measures used in Poland, though for these, we do not have the exact distribution of costs, only the list of those who incur them. It should be noted that not all of the measures and hence costs can be attributed directly to the AAQ Directives as they will be implemented primarily for different reasons, such as congestion relief.

Table 29 Cost Distribution for Selected Measures and Benefits Data with benefits for air quality noting that some may be implemented primarily for non-air quality reasons

Measure	Distribution of costs					Benefits	References
	Businesses	Private individuals	Government - national	Government – local / regional	International funding		
Scrappage (NL)	€0.8m		€85m		-	0.7k tonnes NOx 0.01k tonnes $PM_{2.5}$	CE Delft
Subsidy for Euro V (NL)	€50m		€53m		-	17.25k tonnes NOx -0.04 tonnes $PM_{2.5}$	CE Delft
Subsidy for Euro VI (NL)	-€9m		€28m		-	3.6k tonnes NOx 0.02k tonnes $PM_{2.5}$	CE Delft
Subsidy for new diesel taxis / vans with particle filters (NL)	€38m		€28m		-	0.48k tonnes $PM_{2.5}$	CE Delft
Subsidy for particle filters cars / vans (NL)	€43m		€31m		-	0.13k tonnes $PM_{2.5}$	CE Delft
Subsidy for retrofitted particle filters in HGVS / buses (NL)	€57m		€137m		-	0.48k tonnes $PM_{2.5}$	CE Delft
Low emission taxis / vans (NL)	-€10m		-€11m			0.16k tonnes NOx	CE Delft
Euro 6 discount (NL)	€2m		-€12m			0.55 tonnes NOx	CE Delft
Congestion charging / LEZ (SE - Stockholm)	€27m		-€58m			10-15% reduction NOx and PM2.5	Eliasson
Boiler scrappage scheme - DK	-	-	€2.9m	-	-	1.5k tonnes $PM_{2.5}$	Norden
Replacement of heating systems (PL)	Costs incurred	Costs incurred	Costs incurred	Costs incurred	Costs incurred	13.34 kg for one region (3 m people)	Targeted questionnaire
Road construction and road cleanliness (PL)			Costs incurred	Costs incurred	Costs incurred	No data	Targeted questionnaire

As noted under Question 3 above, the Czech Republic is one of the Member States where the emphasis on non-transport areas – in terms of the proportion of the total measures implemented – is comparatively large. There is a broad similarity in the order of magnitude of costs across traffic (27% of the total for the reported costs), industry (35%), and the 'households, energy sector' (37%). The measures include a mix of activities that vary in the extent to which they are tailored to reducing emissions to reach compliance with the AAQ Directives. Measures that may be closely aligned to the AAQ Directives include household boiler upgrades (accepting that these will in part also be linked to climate actions) and some industrial interventions, whilst those that are not so closely aligned include investment in bypasses and railways. In the latter case, the recognition of a link to air quality in the actions taken is important in order that schemes can be designed to maximise air quality benefit and limit any negative side-effects. The sectors addressed reflect those that can be addressed by local measures. The data from the Czech Republic indicates that almost 40% of the costs were associated with upgrades to boilers – with burdens falling on householders and municipalities. Industry was also affected as a consequence of the need to reduce emissions for some industrial activities.

Other MS have indicated that the bulk of activity has been centred around transport emissions. This is supported to some extent by the distribution of measures by number identified in Question 3. It is of course accepted that the number of measures may not accurately reflect the distribution of costs.

Some additional insight regarding the distribution of costs has again been obtained from the GAINS model. Analysis for the Commission using the GAINS model has previously estimated a breakdown of costs of air pollution control measures by sector, comparing the situation in 2005 and under various scenarios for 2020. In this analysis, the costs of measures in the transport sector show a high increase (they more than double) between the legislation in place before and after 2010, mostly due to the implementation of the EURO emission standards for road vehicles. Costs of control measures in the domestic sector were estimated to rise by about 50% over the period. The model estimates that costs of measures in the industrial sector would hold almost steady over the period.

Table 30 Share of air pollution control costs (not only related to AAQ Directives) across sectors from the GAINS model. 2005 prices.

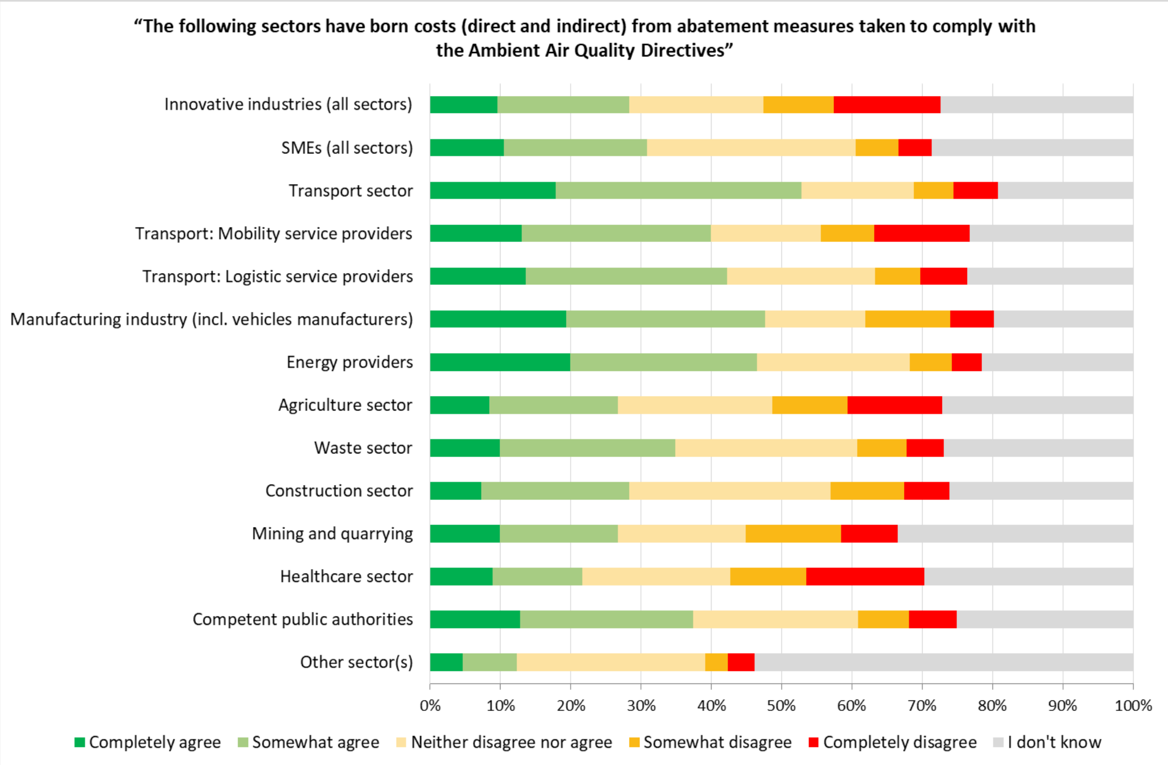
	2005, EUR billion	2005, %	2020 est, EUR billion	2020, %
Power generation	10.5	23%	10.4	12%
Domestic sector	5.1	11%	7.4	9%
Industrial combustion	2.3	5%	2.4	3%
Industrial processes	4.2	9%	4.7	6%
Fuel extraction	1.1	2%	1	1%
Solvent use	0.3	1%	1.5	2%
Road transport	19.6	43%	47	56%
Non-road mobile	0.9	2%	7.8	9%
Waste treatment	0	0%	0	0%
Agriculture	1.1	2%	1.9	2%

Source: [R6, Table 8.1]

As noted previously, the measures considered in the GAINS model are a subset of all those available, focused on technical solutions. They do, however, provide a view of costs from a consistent perspective across Member States.

Respondents to the open public consultation were asked for their opinion about different sectors bearing the direct and indirect costs from abatement measures. The results are presented in the figure below.

Figure 9 open public consultation Question 8.23: To what extent do you agree with the following statement? "The following sectors have borne costs (direct and indirect) from abatement measures taken to comply with the Ambient Air Quality Directives."



Source: open public consultation Question 8.23.

The highest proportion of all respondents indicating that they 'completely agree' or 'somewhat agree' with the view that the sector has born costs to comply with the AAQ Directives was in relation to the Transport sector. 53% of the total sample identified transport as incurring costs. Amongst those expressing an opinion (excluding those who neither disagreed nor agreed, and those who did not know) the figure rises to 82%. 49 respondents who reported that 'transport' had borne costs declared themselves as being from a particular sector, as follows: 14 from public administration and defence, 13 from professional, scientific and technical activities, 8 from the motor trade and 14 from other sectors. However, more respondents (64) cited their response as being from themselves in an 'individual capacity' than linked to sector.

Manufacturing industry (including vehicle manufacturers) ranked second in the overall number reporting in this way (47% of all respondents, or 71% when excluding those expressing no opinion). 46 respondents who reported that 'manufacturing' had borne costs declared themselves as being from a particular sector, as follows: 12 from public administration and defence, 10 from manufacturing and 24 spread across other sectors. Only 21 respondents for this sector cited their response as being from themselves in an 'individual capacity'.

Third in the ranking of sectors having borne costs was energy providers (47% of respondents, or 84% when excluding those expressing no opinion). 45 respondents who reported that 'energy providers' had borne costs declared themselves as being from a particular sector, as follows: 11

from public administration and defence, 9 from professional, scientific and technical activities, 87 from the energy sector and 18 spread across other sectors. 40 respondents cited their response as being from themselves in an 'individual capacity' than linked to sector.

Focussing only on responses from the Public Administration sector, the highest proportion of all respondents indicating that they 'completely agree' or 'somewhat agree' with the view that the sector has born costs to comply with the AAQ Directives was again in relation to the Transport sector. 74% of the total sample identified transport as incurring costs, or 97% once those expressing no opinion are excluded. The next ranked response was in relation to the competent public authorities, for whom the proportion indicating costs were incurred was 72% (or 96% when those expressing no opinion were excluded).

In general, the responses from the total sample and from those in public administration followed a similar pattern, but with the public administration responses weighting the costs to Competent public authorities more strongly (perhaps unsurprisingly).

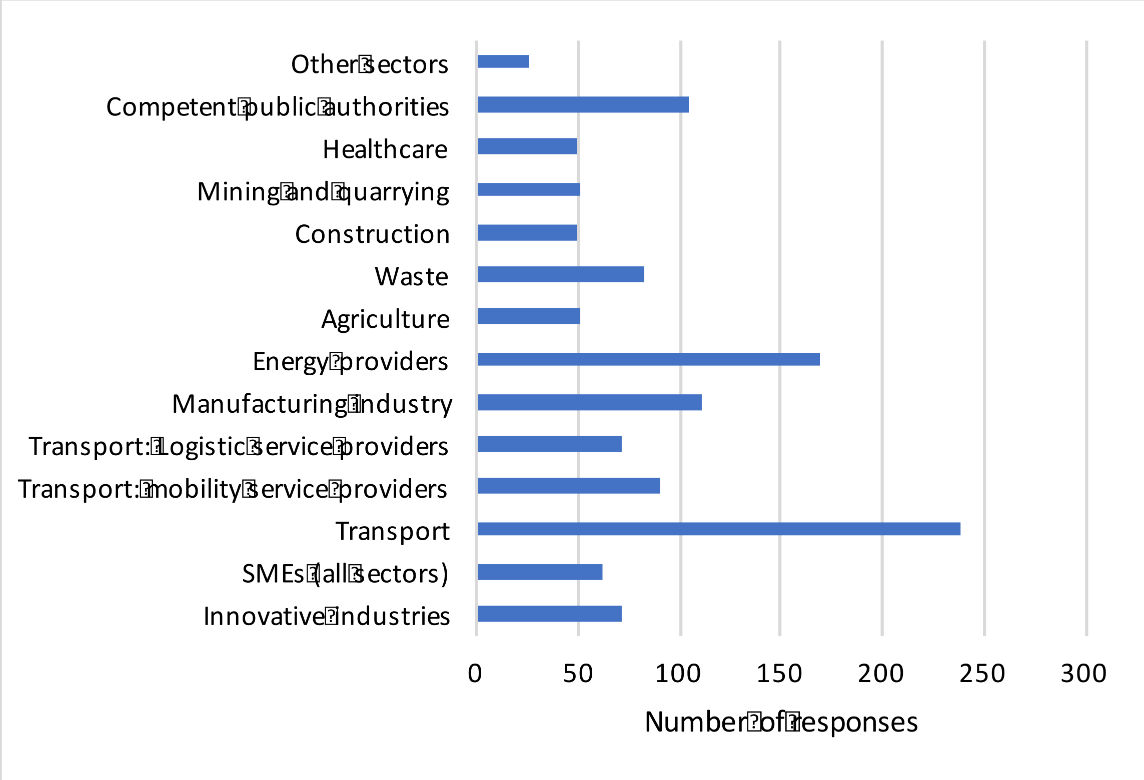
In only one Sector – Healthcare – was the proportion indicating that they agreed 'somewhat' or 'completely' that costs had been incurred (22%) exceeded by the proportion that suggested they 'somewhat' or 'completely' disagreed with the same statement (28%). It is possible that respondents were looking at healthcare from two different perspectives, one considering whether healthcare providers had been required to introduce additional abatement measures, for example in relation to the incineration of medical waste, and the other from a perspective of the healthcare costs incurred from poor air quality. The responses from Public Administration alone were 30% and 21%, respectively: although more felt that costs were incurred than did not, this was still the sector for which the balance was most strongly in favour of costs not being incurred in the set of responses.

None of the sectors shown were deemed to have borne no costs.

The extent to which respondents distinguished between controls arising specifically from the Ambient Air Quality Directives as opposed to environmental regulation more generally (including the National Emission Ceilings Directive, Industrial Emissions Directive, directives on fuel quality, vehicle standards, etc.) must be questioned. The reality is that, at the European level, all sectors have been affected by the body of legislation that exists on air pollution, which is in line with the Polluter Pays Principle.

Following from Question 8.23, respondents were asked to select up-to five sectors that they felt had born the highest costs. As with the previous question, the most prominent Sectors were transport, energy provision, manufacturing industry and competent local authorities, followed closely by 'Transport: Personal mobility service providers'.

Figure 10 *Question 8.24: In your opinion, which five sectors have borne the highest costs from abatement measures taken to comply with the Ambient Air Quality Directives?*



Source: open public consultation Question 8.24.

Within each of the above sectors the respondents were also asked to identify subsectors and/or activities that have borne the greatest costs from abatement measures. Subsectors and activities highlighted in the responses are listed below (more detailed results are presented in Appendix C).

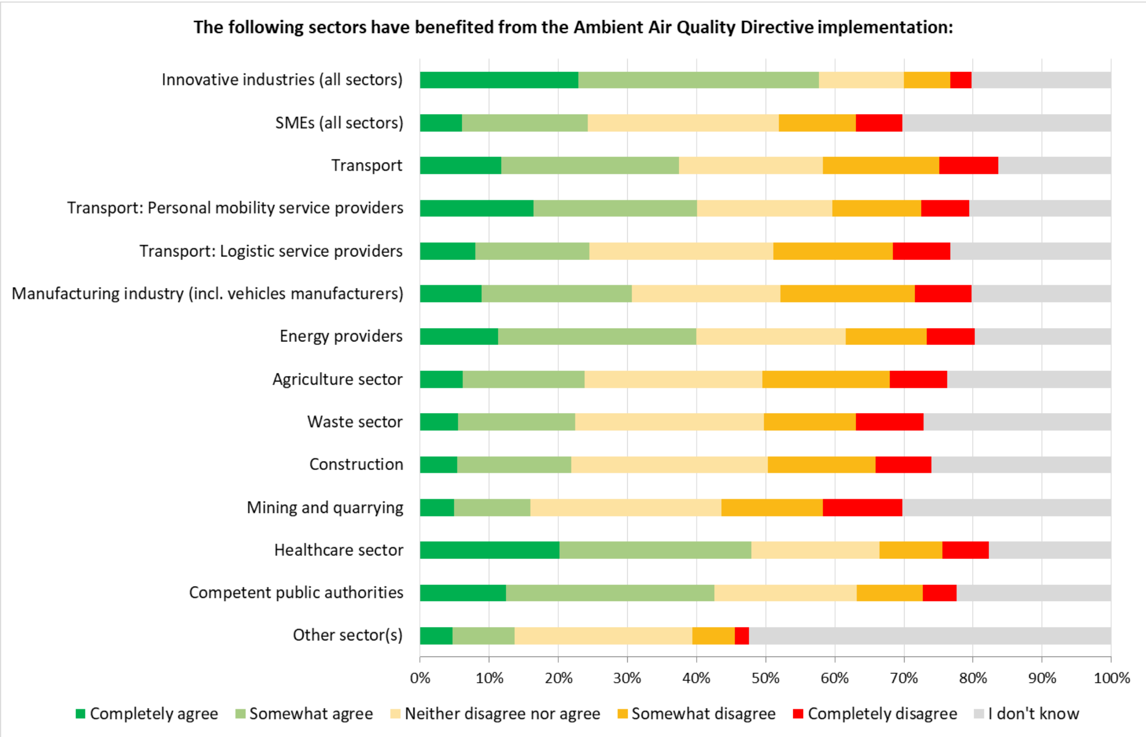
- Small craft enterprises
- Vehicle reliant business activities
- Automobile industry, especially diesel and alternative vehicle manufacturing
- Diesel vehicles
- Public transport
- Air transport
- Freight transport
- Logistic service providers
- Vehicle and car manufacture
- Energy production from fossil fuel
- Livestock breeding
- Waste disposal through incineration and landfilling
- Cement and concrete manufacturing
- Coal mining
- Hospital treatment
- Air quality monitoring activities by government

The view that transport had the highest costs seems quite broadly shared. A breakdown of respondents finds that, not surprisingly, those linked to the motor trade believe that they are exposed to a high share of cost, but this view is shared by others including those involved in public administration and in professional, scientific and technical activities. The same applies to the energy sector also.

The appearance of the Transport sector, and of many associated activities and businesses, in the listings made by respondents is likely to result from emissions from road traffic often being targeted by air quality management measures, alongside a widespread appreciation of the role of transport on air quality at a local level.

A further question in the open public consultation asked for views on the sectors that had benefited from AAQ Directive implementation. The results are presented in the figure below.

Figure 11 open public consultation Question - To what extent do you agree with the following statement? "The following sectors have benefitted from the Ambient Air Quality Directive Implementation."



Source: Question 8.3: To what extent do you agree with the following statement? "The following sectors have benefitted from the Ambient Air Quality Directive Implementation." (N=424-454 – different numbers of respondents for each statement)

There was a considerable (and varying by sector) proportion of 'I don't know' responses to this question. If one excludes these, then the majority (or very close to a majority) of the respondents agreed that the following sectors have benefitted from the AAQ Directives implementation:

- Innovative industries (all sectors)
- Transport: Personal mobility service providers
- Energy providers
- Healthcare sector
- Competent public authorities.

The logic behind this listing is unclear. Presumably the healthcare sector appears because of the health benefits of reducing air pollution being anticipated to reduce demand for health services.

However, the logic for the sectors covering energy, transport and competent local authorities both benefitting, but bearing much of the cost is unclear. As noted in the report on the open public consultation, some analysis was undertaken of the responses received from the different sectors. The data does not appear to support the assertion that respondents felt other sectors had benefitted, whilst they had not; however, it is noted that the number of responses received from the specific sectors is, in most cases, relatively small.

The prominence of Energy providers and Manufacturing Industry is interesting. It is possible that respondents have made comments on how they feel they are regulated more generally when it comes to air pollution than specifically in relation to the AAQ Directives. Equally, however, and as indicated in the discussion around Evaluation Question 3, these two sectors, being major point source emitters of pollutants targeted by the AAQ Directives, might be targeted indirectly through (for example) measures to tighten permit conditions as a means to ensure compliance with the AAQ Directives. This, as noted above, may be a way in which the AAQ Directives deliver positive benefits in a more 'systemic' sense, whilst also being a mechanism through which additional costs are visited upon some sectors which are major point source emitters.

Stakeholders

The costs which stakeholders face are affected by the choice of measures which Member States, or other public authorities, choose to deploy in addressing, or preventing, exceedances in limit values. This is closely related to the questions regarding the efficiency and cost effectiveness of measures which was discussed under Question 3. As indicated there, unfortunately, not all measures chosen appear to be the most efficient, or cost-effective ones.

Citizens can be negatively affected by measures which are excessively costly: equally, some citizens may benefit from schemes designed to subsidise new or upgraded boilers, or the purchase of new vehicles. The distributional consequences of each measure will reflect the nature of the target beneficiaries. The overall consequences for citizens will reflect the mix of measures used.

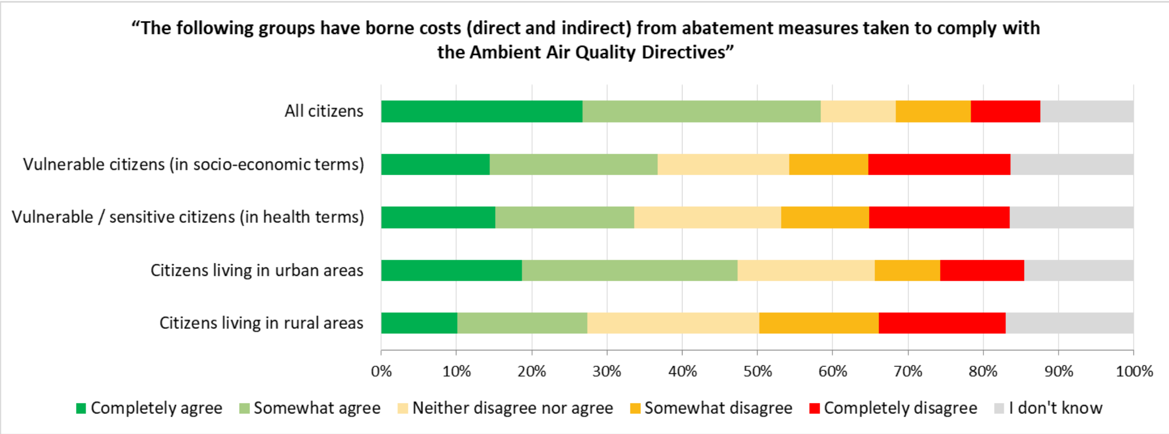
The response from the Czech Republic highlights the type of measure that can have an impact on households (and municipalities and energy companies), with the cost of household boiler upgrades appearing to have been a significant component of costs.

Many of the transport measures particularly, impose a direct cost burden on car users, and there is some concern that this will disproportionately affect poorer members of society. Increased parking charges and fees for LEZs and congestion zones, for example, might be expected to affect the poor more than the rich, reflecting differences in disposable income. Many of the subsidies applied in the vehicle market apply to new cars only, which would tend to benefit those who are sufficiently wealthy to buy new vehicles. An alternative view was provided in the consultation responses from ClientEarth and other NGOs, citing a study carried out by Austrian organisation VCÖ on social aspects of mobility, which concluded that the implementation costs of LEZs affect mostly the richest 75% of the population, to a large extent because within the poorest 25% of the population, 44% do not own a car[3]. There is also the potential to mitigate impacts from discouraging one form of transport (typically private car use) by taking positive action to encourage use of public transport, walking and cycling as part of a low emission zone or congestion charge scheme. For the poorest in society this may have significant advantage in improving mobility.

[3] https://www.vcoe.at/themen/mobilitaet-als-soziale-frage

Under the open public consultation, respondents were asked for their opinion on which stakeholder groups have borne the direct and indirect costs from abatement measures. The results are presented in the figure below.

Figure 12 open public consultation Question 8.22: To what extent do you agree with the following statement? "The following groups have borne costs (direct and indirect) from abatement measures taken to comply with the Ambient Air Quality Directive Implementation."



Source: open public consultation Question 8.22

There is not a great deal of variation in the results across different groups beyond a view that those living in urban areas are more likely to have borne costs than those living in rural areas. Reasons for the higher scoring given to those living in urban areas include the fact that air pollution is often portrayed as an urban problem, and that the best publicised pollution controls, such as Low Emission Zones and Smokeless Fuel Zones are focused on specific cities. Recognition of costs to citizens in rural areas demonstrates, however, that there is at least some recognition that air pollution is not only an urban issue.

F.2.3 Analysis of Social Costs of Poor Implementation

The social costs of poor implementation fall into three categories:

1. Social costs to health and the environment of continued exposure of the population to levels that exceed the limit values after the compliance date has passed. These costs to health are quantified below. Given that the compliance date for PM_{10} was carried over from previous legislation and has yet to be met in many areas, but pre-dates the adoption of the Directive for PM_{10}, a significant cost is present from the start of the analysis. For similar reasons, a large cost is linked to non-compliance with the NO_2 limits that came into full effect from 2010. For the purpose of evaluation of the current Directive the question is thus one of how quickly these initial costs can be eliminated.

2. Social costs to health and the environment arising from achievement of the limit values by the legislated date, but later than would have been economically optimal (taking both costs and benefits of action into account). Quantification of these costs has not been carried out here as it would require a full cost-benefit assessment of cases where compliance has been achieved, and the data needed for such analysis is not available. However, the potential for significant costs associated with delayed action to address poor air quality deserved to be recognised.

The approach used to quantify the social costs of poor implementation is broadly similar to that used above for assessment of the benefits of the AAQ Directives, though there are differences in some of the data used for the assessment. Methods are summarised as follows:

1. Identify the fraction of the population living in areas where concentrations of those pollutants for which exceedances are most often observed (PM_{10}, NO_2, O_3) are above limit values, and then, the number of people affected;

2. Quantify damage costs of health impacts per person per unit of pollutant; and

3. Combine the population, and the damage cost datasets to estimate the total impact of exceedances associated with each pollutant.

The population living in areas where pollutant concentrations are above the limit values is taken from the annual air quality reports of the European Environment Agency [D43], covering all years at the European level.

Table 31 Percentage of EU urban population exposed above limit values. Shading indicates exceedances prior to the legislated compliance date with limit or target values. For criteria, see notes at foot of table.

Year	$PM_{2.5}$	PM_{10}	O_3	NO_2
2000		32.4	17.9	25.9
2001		30.1	30.5	22.3
2002		31.5	20.7	23.1
2003		41.8	54.9	31
2004		28.2	19.4	20.6
2005		34.0	22.7	21.4
2006	16.7	37.8	45.5	18.2
2007	11.6	30.4	21.8	20.7
2008	12.6	23.9	15.3	12.3
2009	8.8	24.4	16.1	14.3
2010	10.8	25.2	17.4	11.7
2011	13.6	29.6	16.1	11.8
2012	11.5	21.9	15.5	8.8
2013	8.5	20.5	16.2	9
2014	8	16.4	7.3	7.4
2015	7.4	18.6	29.5	8.4
2016	5.5	13.2	12.4	7.3

Source: [D43]

Criteria:

- Percentage of population exposed to:
  - Annual mean $PM_{2.5}$ concentrations above 25 µg/m^3.
  - Percentage of population exposed to daily PM_{10} concentrations exceeding 50 µg/m^3 for more than 35 days a year.
  - Percentage of population exposed to maximum daily 8-hour mean O_3 concentrations exceeding 120 µg/m^3 for more than 25 days a year.
  - Annual mean NO_2 concentrations above 40 µg/m^3.

For PM_{10} the EEA provides this information for the percentage of the population exposed to excess levels for the limit value for daily concentrations, rather than the annual mean limit, 40 µg.m^{-3}. Quantification of impact, however, requires quantification against the annual average exposure in order to derive a reasonably complete estimate of effect, given that the dominant impacts of exposure to PM concern chronic (long-term) exposure. It is assumed that exceedance of the annual limit value for PM_{10} can be assessed against exceedance of the value for $PM_{2.5}$ of 25 µg.m^{-3}. Comparison of the limit values implies a ratio of $PM_{2.5}$:PM_{10} of 25/40 = 0.625 which is in line with typical estimates of the $PM_{2.5}$ fraction indicating that there should be broadly similar levels of exceedance of the annual mean concentration of the two limit values. It is accepted that the finer $PM_{2.5}$ fraction of PM_{10} is more hazardous than the coarser $PM_{2.5-10}$ because it can penetrate deeper into the lung. Given that the area exceeded for the PM_{10} daily limit value is much larger than for the $PM_{2.5}$ annual average (by a factor of 2 overall) an estimate based on the annual mean will biased to underestimate the costs of inaction given that activity would be needed over a larger area than implied by exceedance of the annual mean limit value for $PM_{2.5}$. To recognise associated uncertainties, the calculations for the lower bound for damage associated with PM exceedance are based on the area where $PM_{2.5}$ exceedance occurs whilst the upper bound is calculated from the area covered by exceedance of the daily limit value for PM_{10}.

The EEA also provides information on the percentage of urban population exposed above the legal limits by Member State (for example, Table 32 showing data for 2015). In the answer to Question 3 it was noted that trends at the EU level were more stable across years than those at national level. Accordingly, average EU damage costs were adopted for each pollutant, weighted by the population exposed above limit/target values between 2012 and 2016 and used alongside the fraction of population experiencing exceedance across the EU. The same approach is adopted here.

Whilst these data help to quantify the number of people affected by poor implementation (as defined above) they do not provide an indication of the extent of exceedance: clearly the social costs will be greater the more that the limit values are exceeded. The EEA [R61] reports the distribution of the EU population against pollutant concentrations. From Figure 9.2 of the EEA report, it is estimated that average exposure associated with exceedance is equal to 2µg.m^{-3} $PM_{2.5}$ and 7 µg.m^{-3} NO_2. No similar figures are available for ozone, but an indicative range of 3 to 5 µg.m^{-3} O_3 has been adopted here. In the absence of data for each year the same assumptions on excess concentration for the group exposed above the limit values has been followed for all years. This will underestimate results for the earlier years given evidence for declining average concentrations. However, the analysis will still provide a broad indication of the magnitude of the costs to society of poor implementation. A further source of underestimation is that actions to improve air quality will typically reduce concentrations outside areas where limit values are exceeded: these wider consequences of poor implementation are not considered here.

Table 32 Percentage of EU urban population exposed to pollutant concentrations above the daily limit value for PM_{10}, annual limit value for $PM_{2.5}$, target value for O_3 and annual limit value for NO_2 in 2015 by country.

	$PM_{2.5}$	PM_{10}	O_3	NO_2
Austria	0%	0%	98%	5%
Belgium	0%	0%	0%	3%
Bulgaria	78%	55%	0%	0.5%
Croatia	81%	3%	94%	3%
Cyprus	6%	0%	0%	0%
Czech Republic	19%	7%	89%	1%
Denmark	0%	0%	0%	2%
Estonia	0%	0%	0%	0%
Finland	0%	0%	0%	1%
France	1%	0%	17%	4%
Germany	0.5%	0%	37%	5%
Greece	4%	0%	97%	3%
Hungary	27%	0%	100%	2%
Ireland	0%	0%	0%	0%
Italy	60%	26%	80%	35%
Latvia	4%	0%	0%	4%
Lithuania	2%	0%	0%	0%
Luxembourg	0%	0%	0%	9%
Malta	100%	0%	0%	0%
Netherlands	0%	0%	0%	2%
Poland	81%	46%	38%	1%
Portugal	1%	0%	0%	2%
Romania	54%	2%	12%	1%
Slovakia	6%	9%	60%	5%
Slovenia	100%	0%	100%	0%
Spain	5%	0%	34%	16%
Sweden	0%	0%	0%	0.5%
United Kingdom	0%	0%	0%	11%

Source: [D43]

The data for 2015 in the above Table have been combined with information on urban populations from UN sources at the national level in the table below.

Table 33 Population exposed in excess of limit values, 2015.

		Population subject to exceedance		
	Urban population	PM_{10}	O_3	NO_2
EU urban	380,648,013	71,181,178	114,194,404	34,258,321
Austria	5,008,930	-	4,908,751	250,447
Belgium	11,048,237	-	-	331,447
Bulgaria	5,310,568	4,142,243	-	26,553
Croatia	2,378,726	1,926,768	2,236,002	71,362
Cyprus	777,234	46,634	-	-
Czech Republic	7,791,316	1,480,350	6,934,271	77,913
Denmark	4,979,108	-	-	99,582
Estonia	899,890	-	-	-
Finland	4,672,016	-	-	46,720
France	51,343,241	513,432	8,728,351	2,053,730
Germany	63,078,413	315,392	23,339,013	3,153,921
Greece	8,755,057	350,202	8,492,405	262,652
Hungary	6,897,667	1,862,370	6,897,667	137,953
Ireland	2,939,375	-	-	-
Italy	41,393,818	24,836,291	33,115,054	14,487,836
Latvia	1,354,612	54,184	-	54,184
Lithuania	1,971,134	39,423	-	-
Luxembourg	511,081	-	-	45,997
Malta	403,728	403,728	-	-
Netherlands	15,273,879	-	-	305,478
Poland	23,065,377	18,682,955	8,764,843	230,654
Portugal	6,617,197	66,172	-	132,344
Romania	10,711,013	5,783,947	1,285,322	107,110
Slovakia	2,931,170	175,870	1,758,702	146,559
Slovenia	1,115,846	1,115,846	1,115,846	-
Spain	36,933,458	1,846,673	12,557,376	5,909,353
Sweden	8,450,611	-	-	42,253
UK	54,035,311	-	-	5,943,884

Source: [D43] and author's calculations

Analysis draws on the methods and results from assessment of the benefits of actions undertaken under the AAQ Directives above. The costs of unit changes in pollution levels have been calculated at the national level for each year from 2008 to 2017, in order to capture differences in health status between countries and over time. The lowest per capita cost of the changes in concentration being modelled is seen in Luxembourg, and the highest per capita cost of the changes seen in Bulgaria. To recognise this variation when quantifying total damage at the EU level, average estimates of damage associated with the changes in exposure modelled have been generated, weighted against the number of individuals exposed to excess pollution levels.

Table 34 *Average unit damage estimates for PM_{10} and NO_2 (EUR per person.1µg.m^{-3} $PM_{2.5}$ and EUR per person/1µg.m^{-3} NO_2) and ozone (EUR per person/200ppb hours SOMO35) weighted by the fraction of the total population subject to exceedance by country.*

Year	PM_{10}		O_3	NO_2	
	Low	High		Low	High
2008	36.3	107	0.83	23.3	85.7
2009	36.4	108	0.84	23.3	86.4
2010	36.9	110	0.86	23.6	88.1
2011	37.6	111	0.88	24.0	87.3
2012	38.1	111	0.90	24.3	85.9
2013	38.3	110	0.90	24.4	83.4
2014	38.1	108	0.90	24.2	80.0
2015	37.7	105	0.89	23.9	76.1
2016	37.6	105	0.89	23.8	76.1
2017	38.0	107	0.91	24.0	77.2

Source: Author's calculations

Results of the damage assessment are given in the following table.

Table 35 *Quantification of the costs of poor implementation regarding fine particles ($PM_{2.5}$/PM_{10}), NO_2, and ozone. Units: €million. Results rounded to 2 significant figures.*

	$PM_{2.5}$		O_3		NO_2	
Average exceedance, µg/m^3	2.0	2.0	3.0	5.0	7.0	7.0
	Low	High	Low	High	Low	High
2008	€ 5,300	€ 31,000				
2009	€ 3,700	€ 32,000				
2010	€ 4,700	€ 32,000	€ 85	€ 140	€ 7,500	€ 28,000
2011	€ 6,000	€ 39,000	€ 81	€ 140	€ 7,700	€ 28,000
2012	€ 5,100	€ 29,000	€ 79	€ 130	€ 5,800	€ 20,000
2013	€ 3,800	€ 26,000	€ 83	€ 140	€ 6,000	€ 20,000
2014	€ 3,600	€ 20,000	€ 37	€ 62	€ 4,900	€ 16,000
2015	€ 3,300	€ 23,000	€ 150	€ 250	€ 5,500	€ 17,000
2016	€ 2,400	€ 16,000	€ 63	€ 110	€ 4,700	€ 15,000
2017						
Total	€ 38,000	€ 250,000	€ 580	€ 970	€ 42,000	€ 140,000
Overall total: Low		**€ 81,000 (2008-2016)**			**€7,200 (2016)**	
Overall total: High		**€ 390,000 (2008-2016)**			**€31,000 (2016)**	

Source: Author's calculations

Definition of ranges:

- $PM_{2.5}$: low uses VOLY for mortality valuation and area exceeded for annual mean $PM_{2.5}$ limit; high uses VSL for mortality valuation and area exceeded for daily mean PM_{10} limit
- Ozone: Both high and low are based on use of VOLY for mortality valuation, range attributable to alternative estimates of target value exceedance only
- NO_2: low uses VOLY for mortality valuation; high uses VSL for mortality valuation

As for the estimation of benefits, the range provided for the costs of poor implementation estimated here includes only one element of uncertainty, relating to the valuation of mortality. Given that the range may be assumed to be a more comprehensive summary of uncertainty, it is considered here to be more appropriate to carry through a mid-estimate of EUR 240 billion for the period 2008-2016, and note that whilst it provides an indication of the broad scale of the costs of poor implementation, it is subject to potentially significant uncertainties.

By way of comparison, modelling of total exposure (i.e. to all European citizens, and irrespective of compliance with limit values) to $PM_{2.5}$ and ozone in 2010, using the same models and assumptions, has previously generated an annual estimate of the costs of air pollution of €500 to 1,400 billion/year [e.g. R111]. The overall costs of air pollution damage thus far exceed the costs of poor implementation, as one would expect given the lack of threshold for response for the pollutants of interest.

An indication of the annual effects of exceedance of the limit values for PM_{10}, NO_2, and ozone at a national level is provided in the following table, including ranges for economic cost and quantification of some important health endpoints.

Table 36 *Estimated economic impacts and selected illustrative health impacts from non-compliance with the AAQ Directives in 2016. Excludes co-benefits from reduced congestion, greenhouse gas emissions, etc., and benefits to ecosystems and related to equity considerations. Results rounded to 2 significant figures.*

NB: these results only provide indicative orders of magnitude

	Economic impact, EUR M		Deaths	Hospital admissions	Child bronchitis
	Low	High			
Austria	20	55	35	62	-
Belgium	200	620	280	200	-
Bulgaria	290	1,800	310	280	1,100
Croatia	33	130	49	53	28
Cyprus	-	-	-	-	-
Czech Republic	71	390	93	130	205
Denmark	15	49	22	16	-
Estonia	-	-	-	-	-
Finland	4	13	<10	<10	-
France	290	980	430	370	75
Germany	570	1,800	850	780	-

	Economic impact, EUR M		Deaths	Hospital admissions	Child bronchitis
	Low	High			
Greece	41	120	72	110	-
Hungary	16	41	34	75	-
Ireland	-	-	-	-	-
Italy	2,600	12,000	3,400	2,900	4,000
Latvia	6	19	<10	<10	-
Lithuania	-	-	-	-	-
Luxembourg	17	55	25	18	-
Malta	-	-	-	-	-
Netherlands	54	170	78	55	-
Poland	1,000	6,700	1,100	1,100	3,900
Portugal	10	32	15	10	-
Romania	120	470	170	140	90
Slovakia	120	460	160	140	100
Slovenia	1	-	<10	10	-
Spain	440	1,400	660	560	-
Sweden	6	18	<10	<10	-
UK	1,300	4,000	1,800	1,300	-
Totals	7,200	31,000	9,600	8,300	9,400

Note: the low-high range for costs considers uncertainty only in valuation of mortality.

It has been noted that these costs of poor implementation exceed the estimates of benefits so far derived from the AAQ Directives (as described above in Section 1.7.1). The reason for this is a function of the timing of compliance with the limit values. The PM_{10} limit value should have been met everywhere in 2005, ahead of the 2008 start date of the current assessment, but was not. The NO_2 limit should have been met in 2010, shortly after the 2008 AAQ Directive came into force, but again was not. This means that the analysis starts with a significant cost of poor implementation. Benefits, in contrast, start at zero for 2008 and build up thereafter. Over time, the benefits of the legislation and the costs of poor implementation have converged,. Based on the trajectories for each identified here, benefits will dominate in future years as the number of areas where there is exceedance of the limit values continues to fall. The situation considered is differen to that for much other pollutant legislation, where there is a significant amount of time between entry into force and the full requirements of legislation being met. In the case of the National Emission Ceilings Directive (including revisions), for example, there has been more than a decade between entry into force and the requirement for meeting emission ceilings. Importantly, the analysis presented here demonstrates that the benefits of the AAQ Directives are growing year by year, whilst the costs of poor implementation are falling.

The EEA does not provide similar data for the metals, noting simply that any exceedances will be localised to certain industrial facilities. For BaP, however, exposure is more widespread, with around 22% of the urban population exposed above the 1 ng/m^3 target value for which a compliance date of 31 December 2012 was set in the 2004 Directive (subject to Member States taking all necessary measures not entailing excessive costs). It is also noted that there is no clear trend in concentrations of BaP. Exceedance has been reported in 13 countries: Bulgaria, Croatia, Czech Republic, France, Germany, Hungary, Italy, Latvia, Lithuania, Poland, Slovakia, Slovenia and the UK for 2015. For the western Member States concentrations at sites where exceedance is found are typically in the range of 1 to 2 ng/m^3. Figures are higher for central and eastern Member States figures where exceedance is found, typically in the range of 1 to 4 ng/m^3, with the exception of Poland, which has the highest concentrations, ranging from roughly 2 to 8 ng/m^3. Following the methods of the 2001 economic evaluation of air quality targets for PAHs for the Commission leads to an estimate of about 100 cancers per year associated with PAH for the EU28 per ng/m^3 in excess of the BaP target. An alternative scenario was developed for this study using exposure data from EEA and % population exposed above the target value. This covered only six of the countries and about a third of the population with excess exposure but included Poland where the largest concentrations are observed. This generated an estimate of 109 lung cancers per year, 100 of which were in Poland. Assuming typical fatality rates in the order of 90% for lung cancer and applying the value of statistical life adopted for work on air quality policy by the European Commission indicates an annual damage of between €120 and 270 million per year.

Further data of relevance to, but not specifically estimating, the social costs of poor implementation – and taken from the responses to the Targeted Questionnaire – are shown in the Table below. Information is supportive of the conclusion that the overall costs of air pollution on health and the benefits of action are in the order of billions of Euro.

Table 37 Responses to the Targeted Questionnaire regarding the social costs of poor implementation.

Respondent	Social costs of air pollution	Method / approach
Client Earth	The total mean health impact from reduced air pollution in 2010 due to the introduction of Stage 1 zones to be EUR 700 million in the 25 LEZ cities in the sample. The total mean health benefits are EUR 2.4 Billion for the more stringent stage 2 zones when applied to the same cities	The key finding of the paper is a decrease in urban PM_{10} levels that can be attributed to the introduction of LEZs. We also find that more stringent zones (stage 2 zones) reduce PM_{10} concentrations more than three times as much as stage 1 zones. We translate these changes in PM_{10} levels into health impacts using a concentration response function, which we apply to the 3.96 Mio inhabitants of the 25 LEZ-cities of our sample. The mean health benefits amount to ~700 Mio. EUR in the year 2010 if all cities are assumed to use stage 1 zones, whereas total mean health benefits are EUR 2.4 Billion for the more stringent stage 2 zones, if assumed to be applied in all 25 cities.
Client Earth	Total health impacts from road transport emissions amount to 15 Billion EUR in Germany in 2010, if VSL-adjusted values are applied to a study on the external costs of transport (Infras 2007).	
Client Earth	The public health benefits of improving air quality have been estimated at around EUR 200 million (NPV).	
Euro federation of Allergy (NGO)	A study based on Skopje, the capital of the former Yugoslav Republic of Macedonia showed that "in the year 2012, at current pollution levels (49 µg/m^3), estimated that $PM_{2.5}$ may have caused an estimated attributable mortality of 1199 deaths, as well as 547 hospital admissions for cardiovascular diseases and 937 hospital admissions for respiratory diseases, with a social cost of between EUR 570 M and 1470 M.	
Euro federation of Allergy (NGO)	Welfare costs from premature deaths due to air pollution in OECD Europe in 2015: 730 billion USD. By 2060 between 1660-1690 billion USD.	It is possible to attribute a cost to non-market impacts, such as the premature deaths and the costs of pain and suffering from illness, using estimates of willingness-to-pay (WTP) based on direct valuation studies. The welfare

Respondent	Social costs of air pollution	Method / approach
		costs of the premature deaths caused by air pollution are calculated using the value of a statistical life (VSL). This is a long-established metric, which can be quantified by aggregating individuals' WTP to secure a marginal reduction in the risk of premature death over a given timespan. The VSL values used are calculated using a reference OECD value of 2005 USD 3 million and then using benefit transfer techniques to calculate country-specific values following OECD (2012). This is done on the basis of country-specific income adjustments, with an income elasticity of 0.8 for high-income countries, 0.9 for middle-income countries and 1 for low-income countries.
	US$ 1.6 trillion is the economic cost of the approximate 600 000 premature deaths and of the diseases caused by air pollution in the WHO European Region in 2010, according to the first-ever study of these costs conducted for the Region. The amount is nearly equivalent to one tenth of the gross domestic product (GDP) of the entire European Union in 2013.	
Atmo	Cost of inaction listed at EUR 100 billion/year (for France only)	
Atmo	A study by INERIS estimated the benefit of respect for European emission ceilings (by 2030) in terms of mortality and morbidity to EUR 18 billion year for a cost of reduction measures estimated at 6 billion.	
Atmo	Cost estimated at EUR billion for health costs tangible, between EUR 68 and 97 billion for intangible health costs and at least to EUR 4.3 billion for non-health costs.	
Atmo	In addition, the National Workers' Health Insurance Fund employees (Cnamts) measured the cost of occupational diseases related to air pollution, through payments from companies compensating for annuities paid to the insured. This amounts to about EUR 1 billion/year.	

Respondent	Social costs of air pollution	Method / approach
Atmo	According to the pollutants studied, the types of costs and the values tutors, the annual social cost of air pollution in France is estimated between 20 and 30 billion euros by the CGDD, EUR 50 billion by the World Health Organization (WHO) and the Organization for Economic Co-operation and Development (OECD), or between EUR and 100 billion by the "Clean air for Europe" program put implemented by the European Commission. As for the cost of pollution of indoor air, it has been evaluated by ANSES and the Observatory of air quality (OQAI), which reach an amount of close to EUR 20 billion a year	
Atmo	According to the number of deaths estimated by pathology associated with indoor air pollutants and the number of years of life lost, they are able to quantify the cost of the mortality linked to the various pollutants: EUR 437 million for deaths leukaemia's due to benzene, EUR 2 billion for deaths from radon-related lung cancer, or EUR 5.7 billion for deaths caused by exposure to particles. The total cost of deaths from exposure to pollutants selected indoor air thus amounts to EUR 8.8 billion.	In order to measure the cost of production losses generated by pathologies attributable to indoor air pollutants, the study refers to work carried out by INCa in 2007. This cost is calculated by multiplying potential production value of an individual at a given age by the number of persons dying from the pathology studied in the corresponding age, and then adding up the values obtained for the different age groups. For example, the loss of production generated by lung cancer is evaluated by INCa at EUR 135 856 per person died. Multiplying this value by the number of cancer deaths lung burden (2,074), a cost of loss of production linked to this pollutant of EUR 282 million. This cost is EUR 36 million for benzene or EUR 1,1 billion for particles. The total cost of production losses due to air pollutants interior studied is estimated at 1.5 billion euros
Greater London authority	The estimated economic costs of the health impacts linked to exposure to air pollution in London ranged from GBP 1.4 billion (long-term exposure to $PM_{2.5}$ and mortality; short-term exposure to $PM_{2.5}$ and hospital admissions; short-term exposure to NO_2 and both deaths brought forward and hospital admissions) to GBP 3.7 billion (replacing short-term	See: Walton, H. et al, (2015), "Understanding the Health Impacts of Air Pollution in London", King's College London for GLA and TfL

Respondent	Social costs of air pollution	Method / approach
	exposure to NO_2 and deaths brought forward with long-term exposure to NO_2 and mortality). Inclusion of other less well established health outcomes would increase the economic costs although this has not been estimated in this report.	
Greater London Authority	UK wide: The associated annual health costs of these health outcomes have been estimated at between GBP 22.6 billion and 71.3 billion.	The UK impact pathway approach developed by the UK Department for Environment, Food and Rural Affairs (DEFRA) and the Committee on the Medical Effects of Air Pollutants (COMEAP)
Greater London Authority	Estimated that cars and vans are responsible for more than a quarter (GBP 5.9 billion a year) of the total UK health damage costs from air pollution, with cars contributing about a sixth (GBP 3.8 billion) and vans about a tenth (GBP 2.2 billion). About four fifths of the car health costs are due to pollution from diesel cars and one fifth due to conventional and hybrid electric petrol cars. Virtually all of the annual van health damage costs are due to diesel vans.	The UK impact pathway approach developed by the UK Department for Environment, Food and Rural Affairs (DEFRA) and the Committee on the Medical Effects of Air Pollutants (COMEAP)
Polish Ministry	Total value of external health care costs of poor-quality air in Podkarpackie Voivodship is estimated at EUR 1.3 - 2.7 billion per year.	Adopted by the EU Commission valuation of external costs specified in the Commission Green Book, results of European ExternE research project, methodology of AF "assigned fraction", IIASA analyses.

F.2.4 Are the costs of compliance proportionate to the benefits brought by the directives?

The analysis related to Evaluation Question 5 sought to give some indication of the administrative costs which are incurred by Member States in monitoring, evaluating and reporting on ambient air quality. For the monitoring component, the costs to those Member States for which data were available was estimated to less than half a euro per inhabitant on average. In a comprehensive review of all costs of the air quality regime for monitoring, assessment and reporting in France, the costs were €0.98 per inhabitant/year. It is understood that the French data t includes additional elements that are outside the scope of the current assessment.

Taking the French figure as an indication of the upper bound of the administrative costs per head, and with the EU-28 population being reported by Eurostat at 512.6 million in 2018, the total administrative costs could be up to EUR 0.5 billion. Information from countries other than France suggests that likely costs will be are lower and it is recognised that only a fraction of these administrative costs are attributable directly to the Directives under examination here, given the requirements of earlier legislation. These costs can be compared with the social costs of exceedances, which are estimated (above) at between EUR 260 billion for the period 2008 to 2017, or around EUR 24 billion for the year 2016.

High costs have been reported for some of the measures identified in this report. Total costs for the Czech plan implemented in 2015 were indicated to be EUR 25 billion. However, the measures with highest costs are frequently those adopted primarily for reasons other than air quality improvement, such as control of greenhouse gases, alleviation of congestion, reducing noise, increasing mobility, etc. A societal cost-benefit analysis cannot simply compare one benefit (e.g. improved air quality) of such measures against total cost as this would clearly bias the outcome of the assessment: the complete package of benefits (and any trade-offs, though these tend to be limited) should be included. It could be argued, for simplicity, that costs should only be included where the main objective of a measure is air quality improvement, though this risks important co-benefits and trade-offs being disregarded from the wider policy framework. Without extending the scope of the analysis presented here very considerably to include a large number of co-benefits of actions (even ignoring the lack of data on costs of measures) it is not possible to carry out a detailed like-for-like comparison of the costs and benefits of the actions taken under the AAQ Directives to improve air quality to answer the question of whether costs of action are proportionate to benefits. However, it is possible, based on the data and analysis presented here, to conclude that whilst costs are likely to be in the order of billions of Euro, so will benefits.

F.3 JC 5.1: Data on costs of implementing the requirements of the AAQ Directives for monitoring, reporting and assessment

The present section contains additional evidence concerning the costs of implementing the requirements of the AAQ Directives for monitoring, reporting and assessment.

F.3.1 *Approach*

Distinction between Business-as-usual Costs and Administrative Burden

It is important to understand that part of the administrative costs from monitoring, assessment and reporting tasks would have incurred in the absence of the AAQ Directive requirements. They are the business-as-usual (BAU) costs. The other part of the administrative costs are then the (additional) costs of having to comply with the (additional) AAQ Directive requirements to monitoring, reporting and assessment. They are the so-called administrative burdens.

In Table 38, we provide a list of administrative tasks that are carried out within the air quality monitoring, assessment and reporting regimes. For each of these tasks, we indicate with 'x' whether the task is a monitoring and assessment task or a reporting task, and whether part or all of the costs of the task also would have been incurred in the absence of the AAQ Directives (BAU cost) and/or whether part or all of the costs can be attributed to the AAQ Directives (administrative burden). Hence, when the administrative costs of a given task comprise of both BAU costs and administrative burdens, two 'x's are entered.

Regarding monitoring infrastructure, we assess that part of the costs of monitoring equipment also would have been incurred without the AAQ Directives – some of which actually may have been incurred prior to the adoption of the AAQ Directives. Many Member States are, however, also assessed to have had to purchase new monitoring equipment in order to comply with the additional requirements of the AAQ Directives.

Regarding approval of measurement systems, the standardising methods and the running of laboratories are administrative tasks introduced by the AAQ Directives and so comprise administrative burdens. Regarding calibrating equipment, part of this was also in place prior to the AAQ Directives, while new, additional equipment have had to be purchased to comply with the AAQ Directives.

Regarding ensuring the accuracy of measurements, most of the administrative tasks would also have been carried out in the absence of the AAQ Directives – but the AAQ Directives have imposed additional requirements to the tasks. Actually, ensuring traceability of measurements is a new requirement.

Regarding data analysis and assessment methods, modelling and the analysis of factors responsible for exceedance would also have taken place in the absence of the AAQ Directives. The AAQ Directives have, however, increased the requirements to these tasks, and have added a requirement to the use of objective-estimation techniques.

Regarding informing the public about air quality, there were no such requirements prior to the AAQ Directives. Hence, all administrative costs are here defined as administrative burdens.

Finally, regarding the transmission of information and reporting to the Commission, we underline that requirements to the reporting of ambient air quality information changed in January 2014. However, it is not straightforward to assess whether the costs incurred from the 2014 requirement are higher that the costs saved from not having to comply with the previous requirements. For the other tasks, we assess that the AAQ Directive requirements have led to higher administrative costs, i.e. administrative burdens.

It should be acknowledged that the evidence gathered is not always as detailed as shown in the table. The table therefore merely serves as explaining the basis for our data gathering efforts – i.e. what we have been looking for in the literature and what we have asked for in the stakeholder consultation. Furthermore, it serves as a basis for understanding what is covered by the often more aggregate information gathered.

Table 38 Breakdown of types of costs associated with Air Quality Monitoring, Reporting and Assessment and which cost elements are considered part of Business as Usual and which are considered as Administrative Burden

Key: Column 1: Business-as-Usual – Monitoring and Assessment in the absence of the AAQ Directives

Column 2: Business-as-Usual – Reporting in the absence of the AAQ Directives

Column 3: Administrative burden due to AAQ Directives – Monitoring and Assessment

Column 4: Administrative burden due to AAQ Directives – Reporting

	1	2	3	4
Monitoring infrastructure; including	X		X	
a) equipment for monitoring of pollutants outside the scope of the AAQ Directives	X			
b) equipment which was being used to monitor pollutants under the scope of the AAQ Directives before AAQ Directives were implemented	X			
c) new equipment purchased for implementation of the AAQ Directives			X	
Approval of measurement systems, including:	X		X	
a) Standardising methods			X	
b) Calibrating equipment	X		X	
c) running of laboratories			X	
Ensuring the accuracy of measurement, including;	X		X	
a) ensuring traceability of measurements			X	
b) MS quality assurance and quality control systems	X		X	
c) involvement in community-wide quality assurance programmes	X		X	

	1	2	3	4
d) EN/ISO 17025 accreditation of laboratories	X		X	
Data analysis and assessment methods, including;	X		X	
a) modelling	X		X	
b) objective-estimation techniques			X	
c) analysis of factors responsible for exceedances	X		X	
Informing the public about air quality, including;				X
a) ambient concentrations of the pollutants				X
b) observed and forecast levels exceeding air quality objectives				X
c) recommended behaviour to reduce pollution/ exposure				X
d) effects on health and vegetation				X
Transmission of information and reporting to the Commission, including;		X		X
a) reporting of ambient air quality information according to Commission Decision 2004/461/EC (until 01/01/2014)		(X)		
b) reporting of ambient air quality information according to Commission Implementing Decision of 12/12/2011 (from 01/01/2014)				(X)
c) changes made to the list and delimitation of zones and agglomerations		X		X
d) zones and agglomerations in which concentrations exceed air quality objectives		X		X
e) levels assessed and, if relevant, the dates and periods when were exceedances were observed		X		X
f) an assessment on contributions from natural sources and re-suspension		X		X

Source: authors

Approach to collecting cost data

Only Member State Authorities, at whatever geographic level, with responsibility for implementing air quality assessment, monitoring and reporting regimes can provide accurate estimates of administrative costs and burdens. As such, an extensive effort has been made to gather information directly from Member State authorities. The approach to gathering this information has included;

- issuing of a targeted questionnaire seeking information on administrative costs and burdens;
- re-issuing of the targeted questionnaire to those Member States who did not respond to first questionnaire;
- interviews with Case-Study Member States; and
- follow-up calls and emails to seek clarification where necessary.

It was originally considered that Award Notices published in the Official Journal of the European Union might be a useful source of cost data however, following interrogation of this data, two key problems emerged;

- all such data are *ex-ante* as they represent estimates made by the buying authority of the cost of procuring the goods or services; and
- actual costs incurred may have been higher than those estimated and additional contracts may have needed to be let in order to achieve the total aims of the contract and so there can be no surety that the costs stated represents the total costs for the services described.

In order to gather information on administrative costs, the targeted questionnaire asked Member States to provide estimates of the costs, covering both the equipment used and time spent by the relevant persons, of;

- monitoring and assessment of ambient air quality, including;
  - measurement;
  - calculations;
  - predictions; or
  - estimations;
- approval of measurement systems, such as;
  - standardising methods;
  - calibrating equipment;
  - engaging in networks; and
  - running laboratories;

- ensuring the accuracy of measurements if not included in the above
- analysis of assessment methods;
- preparing air quality plans, and measures to maintain good air quality
- informing the public (Art 26) about air quality; and
- reporting and transmission of information to the Commission (Art 27).

To gather information on the Administrative Burden, members states were asked to indicate what share of the Administrative Costs outlined above is attributable specifically to complying with the terms of the Directive and which would not have occurred in the absence of the Directive.

Finally, Member State authorities were asked to indicate whether there are ways in which they believe that the monitoring, reporting and assessment regime in their Member State could be made more efficient.

F.3.2 Limitations

Overall, responses to the first round Targeted Questionnaire were disappointing as regards the extent to which relevant data has been made available. Only three MS were forthcoming with any quantitative information on administrative costs. However, greater response was received to the 2nd Targeted Questionnaire. The combined data from these sources is presented in Table 39. In addition to the data provided through the Targeted Questionnaire, interviews undertaken to inform the case studies gathered some further information on administrative costs which is outlined in Table 40. Finally, in response to follow-up queries on targeted questionnaire responses both Spain and Sweden provided bottom-up calculations of monitoring costs and some associated costs. These are presented in Table 41 and Table 42. Despite these range of data sources, the quantity of information available for the analysis of administrative costs and burdens is limited. A recent report by the European Organisation of Supreme Audit Institutions on Air Quality highlighted that at a national level, information on air quality budgets held by competent authorities can be improved and in certain cases, no complete picture is available. Indeed, two of the MS reviewed reported that they had no national and local financial estimates nor access to information on annual budgets. [R95]

F.3.3 Results

Raw Cost Data returned

Table 39 Overview of Administrative Cost and Burden information provided by Member States in response to the Targeted Questionnaires

Member State	Cost type	Cost	Cost Year(s)	Who bears the cost
Poland	Monitoring and Assessment	55 million Polish zloty (EUR 12.7 million)	Not stated	Shared by National and Local Government
	Estimated Annual Cost of air quality measurements and tests, and investments	EUR 2,332,622	2008 - 2018	National Government
	activities related to the functioning of air quality measurement and assessment systems	EUR 4,726,426	Not stated	"
	Investment and operating costs related to monitoring of $PM_{2.5}$	EUR 2,829,868	Not stated	"
	Labour costs related to the functioning of air quality measurement and assessment systems	EUR 2,461,899	Not stated	"
	Annual average costs related to the approval of measurement systems	EUR 4,656	Not stated	"
	Ensuring the accuracy of measurements	EUR 69,840	Not stated	"
	Data analysis and evaluation methods	EUR 972,060	Not stated	"
	Informing the public about air quality	EUR 154,737	Not stated	"
	One-off costs incurred in the years 2013-2017 concerning adjustment of the system to the reporting requirements and submission of information to the European Commission	EUR 56,990	2013 - 2017	"

Member State	Cost type	Cost	Cost Year(s)	Who bears the cost
	Annual cost of reporting to the Commission	EUR 25,611	Not stated	"
	Implementation and annual monitoring of the air quality forecast for the Podkarpackie Voivodship (Lower Carpathia)	EUR 190,507	Not stated	Regional Government
	Public Information Provision through local television between 2008-2018 as well as training and conferences, educational materials and posters, and lessons for children in schools. In the Podkarpackie Voivodship (Lower Carpathia)	EUR 100,629	2008 - 2018	"
	Other environmental education in the Podkarpackie Voivodship (Lower Carpathia)	EUR 325,251	Not stated	Local Government
	Public Information Provision in the Wrocław Agglomeration (City of Wrocław), Dolnoslaskie Voivodship	EUR 139,697 EUR 23,283 EUR 16,763	2016 2017 2018	Local Government
	Public Information Provision in the City of Wałbrzych, Dolnoslaskie Voivodship	EUR 1,199 EUR 1,341 EUR 1,979 EUR 2,118 EUR 2,514 EUR 1,583 EUR 1,862 EUR 1,606	2011 2012 2013 2014 2015 2016 2017 2018	

Member State	Cost type	Cost	Cost Year(s)	Who bears the cost
Netherlands	Monitoring network cost	EUR 3.9 Million per year	Estimate for 2018	Not stated
	Reporting and Assessment Regime change costs	EUR 150,000 per year	Estimate for 2018	Local Government
Czech Republic	Monitoring and Reporting staff	"*Dozens of experts*" employed	Not stated	Not stated
Croatia	Monitoring network cost; State air quality network – URBAN STATIONS (2003-2010) – maintenance of 8 automatic monitoring stations	2 million Croatian Kuna per year (EUR 264,243)	2003-2010	National Government
	Monitoring network cost and approval of measurement systems; 12 background stations including 10 automatic stations, calibration laboratory facilities and equipment, chemical laboratory facilities and part of equipment.	8 million Kuna (EUR 1.12 million)	2008-2012	75% through EU 25% through Member State Budget
	Monitoring network cost; Gravimetric analysis	3 million Kuna (EUR 392,958)	2014	National Government
	Monitoring Network Cost; Construction of four monitoring stations: Slavonski Brod-1 (SB-1)	2,000,000 Kuna (EUR 274,382)	2010	National Government

Member State	Cost type	Cost	Cost Year(s)	Who bears the cost
	Slavonski Brod-2 (SB-2)	1,600,000 Kuna (EUR 209,578)	2014	
	Varaždin (VŽ)	400,000 Kuna (EUR 52,537)	2015	
	Karlovac (KA)	400,000 Kuna (EUR 52,537)	2015	
	Approval of measurement systems; Cost of 3 reference laboratories; dedicated only for participation in AQUILA activities.	250,000 Kuna per year (EUR 43,662 per year) Total cost: 750,000 (EUR 130,986)	2015 - 2017	National Government
	Monitoring Network Cost; Upgrade of state monitoring network	16 million Kuna (EUR 2.1 million)	2017	85% through EU 15% through Member State Budget
	Reporting cost (total cost over period); Web page: "*Air quality in Republic of Croatia*" - an upgrade of previous webpage but developed in 2014 according to IPR requirements therefore the costs are directly linked to the implementation of the Directive.	2 million Kuna (EUR 301,268)	2014 -2017	National Government

Member State	Cost type	Cost	Cost Year(s)	Who bears the cost
	Air Quality Monitoring; The annual operational plan adopted by the Committee established by Ministry of Environment and Energy to perform air quality monitoring at the State AQ Monitoring Stations as well as AQ assessment and to fulfil data quality objectives. Includes PM_{10} and $PM_{2.5}$ gravimetric analysis costs for year 2015 – 2017.	8,950,000 Kuna (c. EUR 1.2 million) 12,500,000 Kuna (c. EUR 1.6 million) 9,200,000 Kuna (EUR 1.2 million) 9,800,000 Kuna (EUR 1.3 million)	2014 2015 2016 2017	National Government
France	Cost an aggregated level for the total activities of France's Authorized Air Quality Monitoring Associations (AASQAs) including activities outside the scope of monitoring including public information provision and assessing impacts of Air Quality Plans.	EUR 65.6 million	2016	National Government, Local Government and the General Tax on Polluting Activities (Industry)
	Annual operating cost of the Prev'Air system which provides daily air quality forecasts and mapping. This system has been in place since 2003 and the cost of its operation does not represent an administrative burden.	EUR 357,000	2016	National Government, Local Government
Sweden	Cost of modelling of regional background concentrations of ground-level ozone, nitrogen dioxide, sulphur dioxide, and deposition	EUR 65 000	Not stated	Not stated
Estonia	Total capital cost, and the operating cost, of the complete monitoring infrastructure that is required to assess ambient air quality	EUR 400,000	Not stated	Not stated

Member State	Cost type	Cost	Cost Year(s)	Who bears the cost
Denmark	Cost of the additional monitoring infrastructure that was required in order to meet the requirements of the Directives since 2008	EUR 515,000	Not stated	Not stated
	Costs of time spent by the relevant persons involved in assessment of Ambient Air Quality	EUR 50,000	Not stated	Not stated
	Costs associated with approval of measurement systems (e.g. standardising methods, calibrating equipment, engaging in networks and running laboratories)	EUR 40,000	Not stated	Not stated
	Share of costs associated with approval of measurement systems attributable specifically to complying with the terms of the Directives since 2008	EUR 20,000	Not stated	Not stated
	Costs of data analysis and assessment methods, such as such as air quality modelling and health impact assessment	EUR 25,000	Not stated	Not stated
	Share of costs associated with data analysis and assessment methods attributable specifically to complying with the terms of the Directives since 2008	EUR 20,000	Not stated	Not stated
	Costs related to informing the public (Art 26) about air quality	EUR 3,600	Not stated	Not stated
	Costs related to reporting and transmission of information to the Commission (Art 27)	EUR 10,000	Not stated	Not stated
	Monitoring under AAQ Directives	13 million Danish Krone (c. EUR 1.7 million)	Not stated	Not stated
	Monitoring related to European Monitoring and Evaluation Programme (EMEP) / Convention on Long-range Transboundary Air Pollution (CLRTAP)	5 million Danish Krone (c. EUR 670,000)	Not stated	Not stated

Member State	Cost type	Cost	Cost Year(s)	Who bears the cost
	Supporting activities (data reporting, accreditation, modelling, database maintenance, intercomparisons, QA/QC, etc.)	6 million Danish Krone (c. EUR 800,000)	Not stated	Not stated

Note: Where MS authorities provided data that was subsequently superseded by email clarifications the original data has not been presented.

1 Poland – [D132, D133]
Netherlands – [D28]
2 Czech Republic – [D125, clarified by D21]
3 Croatia – [D20]
4 France – [R130]
5 Sweden – [D138, clarified by D141]
6 Estonia – [D124]
7 Denmark – [D23]

Table 40 Overview of Administrative Cost and burden information provided by Member States in during Case Study interviews and follow-up clarification calls

Member State	Cost type	Cost	Cost Year(s)	Who bears the cost
Bulgaria	Monitoring; Total cost of national environmental monitoring system (incl. air, water, noise etc.)	3.7 million BGN (EUR 1.89 million Euro)	2017	National Government
Slovakia	Monitoring Network; Operating the monitoring network	EUR 1 – 1.2 million per year	Not stated	80% EU Sources 20% National Government
	Staff costs; FTEs in National Air Quality Unit	8 FTEs	Not stated	
	FTEs in regions working on air quality	9 FTEs	Not stated	
	Employees in the Hydro-meteorological Institute responsible for monitoring, modelling and reporting	27 employees	Not stated	
Ireland	EPA Annual capital replacement cost	EUR 380,000	Estimate for 2018	National Government
	EPA Annual staff cost for AAQ Directives	EUR 493,000	Estimate for 2018	National Government
	EPA Annual current cost (excluding staff)	EUR 458,735	Estimate for 2018	National Government
	Staff involved in local monitoring activity	2 FTEs	Estimate for 2018	National Government

Member State	Cost type	Cost	Cost Year(s)	Who bears the cost
	Dublin City Council monitoring infrastructure capital cost	EUR 160,000	Estimate for 2018	Local Government
	Dublin City Council monitoring infrastructure operating cost	EUR 40,000	Estimate for 2018	Local Government
	Costs of time spent by the relevant persons involved in making measurements, calculations, predictions or estimations in Dublin	EUR 300,000	Estimate for 2018	Local Government
Italy	Estimate of operational cost of the Italian monitoring network	EUR 5,000,000	Calculated estimate for 2018 based on average operating costs of a station in 2016 multiplied by the number of stations in 2018	Regional Government
Sweden	For the main pollutants, the total capital cost, and the operating cost, of the complete monitoring infrastructure that is required to assess ambient air quality	EUR 1,859,490 p.a.	Estimate for 2018	National and Local government
	AAQ Directive Implementation by the Swedish EPA and SEPA Environmental Information Unit	EUR 350,000	Estimate for 2018	National Government
	EPA Staff costs total across Ambient Air Quality in general	EUR 600,000		
	EPA staff costs for AAQ Directive Implementation	EUR 200,000 – 300,000	Estimate for 2018	National Government

Member State	Cost type	Cost	Cost Year(s)	Who bears the cost
	Monitoring at a National Level for compliance with the AAQ Directives	EUR 550,000	Estimate for 2018	National Government

Sources:

1. *Slovakia – [D134]*
2. *Bulgaria – [D13]*
3. *Ireland – [D112]*
4. *Italy – [D113]*
5. *Sweden – [D139, clarified by D141]*

Table 41 Administrative Cost information provided by the Spanish Ministry for the Ecological Transition

Region	Maintenance per station	Maintenance all stations	Analysis	Other expenses	Administrative expenses	Total per year excluding new equipment	Acquisition of new Equipment
RED EMEP/VAG/CAMP		EUR 681,920	EUR 465,000			EUR 1,146,920	= EUR 125,417.71 (2017) + EUR 406,735.46 (2015)
Andalucía	EUR 15,000-EUR 20,000	EUR 1,000,000		EUR 1,500,000	EUR 200,000	EUR 2,700,000	
Castilla Y León. Ayto. Valla-dolid	EUR 68,894	EUR 344,471				EUR 344,471	
Castilla Y León	EUR 26,621	EUR 612,300				EUR 612,300	
Comunidad Valenciana	EUR 38,675	EUR 688,690	EUR 717,386	EUR 66,915	EUR 74,000	EUR 1,546,991	
Navarra		EUR 123,000	EUR 53,420	EUR 70,000	EUR 3,600	EUR 250,020	
Com. Madrid	EUR 24,300	EUR 583,200		EUR 100,000	EUR 100,000		211,200.00
La Rioja	EUR 13,950	EUR 69,750			EUR 33,200	EUR 146,950	44,000.00
Baleares	EUR 69,667	EUR 100,000	EUR 25,000	EUR 5,000	EUR 150,000	EUR 418,000	100,000.00
Cantabria	EUR 300,000						

País Vasco						EUR 1,000,000	
Extremadura	EUR 46,759	EUR 220,000	EUR 110,000		EUR 44,071	EUR 374,071	
Ayto. Zaragoza		EUR 283,140					
Asturias	EUR 18,400	EUR 290,000		EUR 20,000	EUR 70,000		80,000.00
Castilla-La Mancha		EUR 115,634					309,980.49
Galicia		EUR 529,958	EUR 337,740			EUR 867,698	
Totals	**N/A**	**EUR 5,642,063**	**EUR 1,708,546**	**EUR 1,761,915**	**EUR 674,871**		**EUR 1,277,334**

Source: [D135]

Table 42: Administrative Cost information provided by the Swedish Environmental Protection Agency

Pollutant Statistic\	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3
Total number of fixed AQD measurements	41	41	6	2	27
Total number of fixed EoI measurements that are relevant to include	7	15	2	1	0
Estimated annual cost per fixed measurement site in Swedish Krona (SEK)	135,000	135,000	135,000	135,000	135,000
Total estimated annual cost for fixed measurements per pollutant (SEK)	6,480,000	7,560,000	1,080,000	405,000	3,645,000
Total estimated annual cost for all fixed measurements (SEK)	19,170,000				
Exchange Rate – SEK to EUR	0.097				
Total estimated annual cost for all fixed measurements	**EUR 1,859,490**				

Source: [D140]

Monitoring and Assessment Costs

Within the context of the Directives, "Assessment" refers to any method used to measure, calculate, predict or estimate the concentration of a pollutant in ambient air or the deposition thereof on surfaces in a given time. Monitoring refers to fixed or indicative measurements or samples taken at sampling points located in accordance with the requirements of the Directives and using reference methods.

Table 43 outlines the Administrative Cost data provided by Member States, sub-divided into specific cost areas, with notes as to the scope of the costs being reported.

All Member States who were able to provide administrative cost estimates provided an estimate of the total annual cost of their monitoring networks, with the exception of Bulgaria, which provided a total cost of their entire environmental monitoring network.

For all Member States who responded, it appears that the cost of monitoring networks represents the largest share of the total administrative costs. The estimates of total annual monitoring network cost range from around EUR 1 million in the case of Slovakia, to over EUR 60 million for France, however it should be noted that the French costs included activities outside the scope of monitoring including public information provision and assessing impacts of Air Quality Plans and the majority of MSs which provided costs of monitoring were below EUR 5 million.

Table 43: Administrative Cost data (Monitoring and Assessment) provided by Member States divided into cost areas

Cost area Member\ State	Monitoring	Approval of measurement systems	Ensuring the accuracy of measurements	Data analysis and assessment methods	Level at which costs are incurred	Notes
Poland	EUR 12.7 million pa	EUR 4,656	EUR 69,840	EUR 972,060	Shared by National and Local Government	Cost year for total monitoring costs not stated
Netherlands	EUR 3.9 million pa	N.A.	N.A.	N.A.	Not stated	Cost of operating the monitoring network for 2018
Slovakia	EUR 1 – 1.2 million pa	N.A.	N.A.	N.A.		Cost year for total monitoring costs not stated.
Croatia	c. EUR 1.2 million in 2014 c. EUR 1.6 million in 2015 c. EUR 1.2 million in 2016 c EUR 1.3 million in 2017	Cost of 3 reference laboratories (2015-2017); EUR 43,662 per yea Total cost:	N.A.	Gravimetric analysis in 2014; €392,958	National Government	All costs represent a direct cost for achieving compliance with the AAQ Directive in the view of the Croatian Ministry of Environment and Energy
Sweden	EUR 1,859,490 pa [1] EUR 600,000 [2]	EUR 150,000	EUR 200,000[3]	EUR 65,000[4]	Shared by National and Local Government	1) Estimated annual cost for all fixed measurements 2) EPA staff costs involved in ambient air quality monitoring 3) EPA costs covering approval of measurement systems, ensuring

						the accuracy of measurements and data analysis and assessment methods 4) Includes only national modelling of regional background concentrations and deposition of ground-level ozone, nitrogen dioxide and sulphur dioxide.
Spain [5]	EUR 5,642,063 for maintenance of monitoring stations EUR 1,277,334 for acquisition of new equipment	N.A.	N.A.	EUR 1,708,546	National and Regional Government	The Spanish ministry reported EUR 2,436,786.20 of administrative and other expenses which could not be attributed to any specific cost area. 5) Costs do not reflect all costs incurred across the country (data for some regions are missing)
Bulgaria	EUR 1.89 million Euro in 2017 [6]	N.A.	N.A.	N.A.	National Government	6) Total cost of national environmental monitoring system (incl. air, water, noise etc.)
Estonia	EUR 400,000 [7]	EUR 40,000	Included in *"Approval of measurement systems"*	EUR 25,000	Not stated	7) the total capital cost, and the operating cost, of the complete monitoring infrastructure that is required to assess ambient air quality
France	EUR 65.6 million [8]	N/A	N.A.	N.A.	National Government, Local Government and the General Tax on Polluting Activities (Industry)	8) Cost data was only available at an aggregated level for the total activities of France's Authorized Air Quality Monitoring Associations (AASQAs) including activities outside the scope of monitoring including public information provision and assessing impacts of Air Quality Plans.

Denmark	13 million Danish Krone[9] (c. EUR 1.7 million) 5 million Danish Krone[10] (c. EUR 670,000)	6 million Danish Krone[11] (c. EUR 800,000)	Included in *"Approval of measurement systems"*	Included in *"Approval of measurement systems"*		9) Monitoring under AAQ Directives 10) Monitoring related to European Monitoring and Evaluation Programme (EMEP) / Convention on Long-range Transboundary Air Pollution (CLRTAP 11) Supporting activities (data reporting, accreditation, modelling, database maintenance, intercomparisons, QA/QC, etc.)

Sources: See Tables 2 – 5

Table 44: Per capita cost of monitoring networks in 2017

	Low	Medium	High
Poland		€0.33	
Netherlands		€0.23	
Slovakia	€0.18		€0.22
Croatia		€0.31	
Sweden		€0.25	
Spain		€0.14	
Estonia		€0.34	
France		€0.98	
Denmark		€0.41	

Source: own calculations, based on: population data – Eurostat (2018) Note, Spanish figures is based on incomplete data as Spanish National Authorities were unable to provide data for all regions so is an underestimate; the French figure is likely an overestimate as it includes cost of activities outside the scope of monitoring; the Danish data may represent overestimate as it is not clear that all costs are for ambient air quality monitoring; the Swedish figure may not reflect the full range of costs due to the limitation in the data provided which are detailed in the Notes Column of Table 43; the Estonian figure may be an underestimate as although the Estonian Ministry provided costs of monitoring infrastructure purchased since 2008 it was unclear whether the costs reported were regularly or one-off costs and they have not therefore been included.

The per capita costs of the monitoring networks for Member States for which data have been obtained range from €0.14 in the case of Spain to €0.98 for France. However, the Member States with lower end figures seem to be those ones which have decentralised their monitoring and assessment to a significant degree, and so it remains unclear whether these costs capture the administrative costs across all the relevant public actors. A similar challenge was encountered in undertaking the Swedish Case Study which could not capture the full costs of monitoring as some monitoring responsibility is delegated to a regional level, and no national data collation exercise has yet been undertaken. Additionally, the Podkarpackie Voivodship of Poland reported a cost of EUR 190,507 for the implementation and annual monitoring of its air quality forecast which suggests that regional governments could incur significant additional costs in relation to monitoring. The costs presented above should therefore be reviewed bearing in mind the limited body of data which has been received through the consultations and the case studies, and the limitations inherent to the data collected.

Spain, which has the second most-expensive network overall, is the cheapest per capita of the countries for which data have been obtained. It should be noted that the Spanish ministry reported €2,436,786 of annual "administrative" and "other expenses" which could not be attributed to a specific area of administrative costs, and some portion of which might relate to monitoring activities. There was not full regional coverage in the Spanish data. The French data, on the other hand, is relatively comprehensive and likely includes some activities unrelated to the Directives (albeit that it also excludes some small expenditures from the total).4

As part of the Case Study interviews for Italy carried out as part of this project, cost data from 2016 for monitoring stations were collected from stakeholders and multiplied by the number of monitoring stations in Italy to arrive an estimate of the total monitoring network cost for Italy. This estimate has not been included here as it was not deemed sufficiently robust.

Costs for the approval of measurement systems including such activities as standardising methods, calibrating equipment, engaging in networks and running laboratories were provided by Denmark, Poland, Croatia, Estonia and Sweden. Costs per capita are displayed in Table 45. Denmark's data is not included as reporting costs were included.

Table 45: Per Capita costs of Approval of Measurement Systems

Member State	Cost per capita
Poland	EUR 0.0001
Croatia	EUR 0.0105
Sweden	EUR 0.0150
Estonia	EUR 0.0304

Source: Author calculations

It is unclear why the Polish costs are so much lower per capita that for the other three Member States.

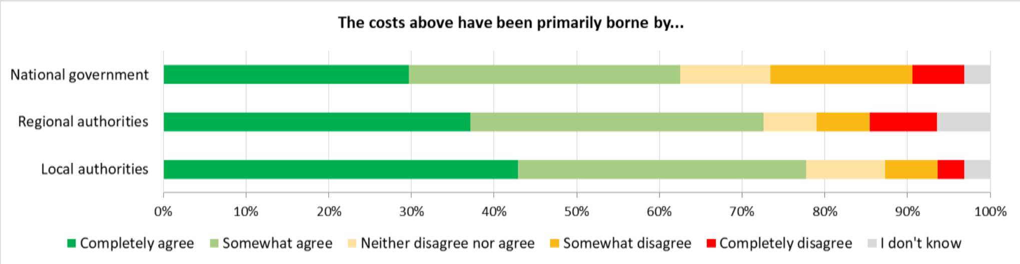
Only Sweden and Poland were able to provide an estimate of the total annual cost of ensuring the accuracy of measurements, the figures being EUR 50,000 and € 69,840 respectively, which equate to EUR 0.005 and EUR 0.002 per capita. It should be noted that this was an estimate of costs incurred at a national-level only.

Estimates of the cost of data analysis including assessment methods other than monitoring were provided on a per annum basis by Spain and Poland and equated to EUR 0.037 and EUR 0.026 respectively. Both Sweden and Croatia provided partial estimate, however, due to the significantly different scopes of the analysis and assessment activities for which costs are reported, a per capita cost comparison is inappropriate.

[4] The French Ministry for Sustainable Development has confirmed that there is, at present, no more disaggregated cost data available

Responses from the Public Administration sector to question 8.20 of the Open Public Consultation which asked respondents about the distribution of administrative costs are presented in Figure 13.

Figure 13 *Question 8.20: To what extent do you agree with the following statement? "The costs above have been primarily borne by…" (responses from Public Administration and Defence sector)*



Source*:* Question 8.20: To what extent do you agree with the following statement? "The costs above have been primarily borne by…" (responses from Public Administration and Defence sector, N=62-64 – different numbers of respondents for each statement)

Generally, the number of respondents believing each level of government to be primarily bearing costs followed the order (from highest to the lowest number):

- Local authorities;
- Regional authorities;
- National government.

Reporting Costs

In March 2017, the Commission published a study supporting a Fitness Check of monitoring and reporting obligations arising from EU environmental legislation [R83]. As part of this, the annual costs to Member States, the Commission and the European Environment Agency that arise from complying with all EU environmental legislation reporting obligations were estimated. The estimate of the costs incurred included:

- costs of time taken to fulfil reporting requirements;
- costs of developing and maintaining systems for reporting; and
- out-sourcing costs, such as the costs of consultants' time in processing and synthesising reports.

The administrative burden incurred as a result of time taken for reporting by Member States to the EEA/EC was estimated using the Standard Cost Model. The aim of the analysis was not to provide precise costs, but a broad overview of the likely scale of costs in reporting by Member States.

The total estimated annual cost to Member States of reporting obligations in EU environmental legislation was €13 million. The fraction of this total cost attributable to reporting under the AAQ Directives was not stated: however, the Ambient Air Quality Directives were noted as legislative items which were responsible for "fairly large" administrative burdens in the order of €100,000 to

€1,000,000 per year, as they require "regular reporting by MS of very detailed and extensive information that should already be available but require significant time to compile."

Key assumptions used in the March 2017 Commission analysis [R83] for the estimation of the financial burden of reporting obligations for the AAQ Directives include:

- for reporting Information on Ambient Air Quality by Member States with involvement from the EEA, that;
  - based on estimates from the EEA, an average of around 50 days input of quality assessment (QA)/ quality control (QC) are required annually per Member State;
  - activities including QA processes, and uploading the data flows to the E-reporting system, are estimated to require around 5 to 6 months of EEA staff time, across 3 to 4 FTEs; and
  - According to the EEA, large investment costs, within the context of the EEA budget, were incurred in bringing online the EEA centralised Air Quality e-reporting database, estimated at around €1 million, largely comprised of third-party software development costs; and
- for air quality plans in agglomerations exceeding limit or target values;
  - for reporting of plans, the time needed is not significant as plans only need to be collated and transmitted to the Commission, and so 1-3 days of staff time are required per plan;
  - for extraction of, and reporting on, specific measures, time requirements may be more significant as it is not an automated process and reporting must comply with a specific format: 1-3 days of staff time were assumed to be required per report of measures.

Regarding the administrative costs to the EEA and Commission of reporting, the annual cost to the European Environment Agency of reporting was estimated at €760,000 for the air quality topic area based on the average budget and costed FTEs dedicated to air quality reporting by the EEA from 2014 – 2016. No data from earlier periods was available. It was noted by the report authors that air quality reporting has involved large investment in developing new reporting systems, including the Air Quality E-Reporting Database, with most of this cost arising through software development by contractors.

The JRC was also approached for figures, asked for updated figures in regard to its activities, which include:

- Organising EU-wide quality assurance programmes for the National Reference Laboratories: inter-comparisons are regularly organised and take place at our European Reference Laboratory of air pollution (ERLAP)
- Chairing the European network of National Reference Laboratories (AQUILA), that has the aim to provide technical support to the development and implementation of correct measurements under the EU air quality directives (https://ec.europa.eu/jrc/en/aquila)
- Chairing the European Forum for air quality modelling (FAIRMODE), a network to improve efficiency and governance through modelling (http://fairmode.jrc.ec.europa.eu)

- Developing methodologies and tools to support urban and regional authorities in designing mitigation action plans.

The JRC was not able to identify costs specifically related to these activities.

In the Targeted Questionnaire issued as part of the present study, information on administrative costs, and the burden of reporting, was sought from Member States. Table 46 details the costs and administrative burden reporting as provided by competent authorities in Member States.

Table 46 Administrative Cost data (Reporting) provided by Member States divided in cost areas

\ Cost area Member State	Administrative Cost	Administrative Burden	Notes
Sweden	N/A	EUR 100,000[1]	1) Annual costs of reporting and transmission of data to the Commission
Croatia	N/A	EUR 300,000 [2]	2) Cost of commissioning and maintenance of the *'Air quality in Republic of Croatia,'* website between 2014 and 2017.
The Netherlands	N/A	EUR 150,000 [3]	3) Annual cost of on transmission of data to the Commission having implemented new requirements related to reporting and exchange of information, which applied from 1 January 2014 based on CID 2011/850/EC
Estonia		EUR 10,000[4] EUR 3,600 [5]	4) Annual costs related to reporting and transmission of information to the Commission (Art 27) 5) Annual costs related to informing the public (Art 26) about air quality
France	EUR 357,000 [6]	N/A	6) Annual operating cost of the Prev'Air system which provides daily air quality forecasts and mapping. This system has been in place since 2003 and the cost of its operation does not represent an administrative burden.
Poland	N/A	EUR 25,611[7]	7) Annual cost of reporting to the Commission

		EUR 56,990[8]	8) One-off costs incurred in the years 2013-2017 concerning adjustment of the system to the reporting requirements and submission of information to the European Commission
		EUR 154,737[9]	9) Costs of informing the public about air quality incurred by National Government
		c. EUR 10,062.9[10]	10) Public Information Provision through local television between 2008-2018 as well as training and conferences, educational materials and posters, and lessons for children in schools, in the Podkarpackie Voivodship
		EUR 23,283[11]	11) Public Information Provision in the Wrocław Agglomeration (City of Wrocław) of the Dolnoslaskie Voivodship
		EUR 1,862[12]	12) Public Information Provision in the City of Wałbrzych, Dolnoslaskie Voivodship

Sources: See Tables 2 – 5

As can be seen from the 'Notes' column in Table 46, the scope of the reporting activities for which cost estimates have been provided Member States varies significantly.

Estonia, Poland and Sweden have provided comparable data for the cost of reporting to the Commission. It is not clear from the commentary provided by the Member States alongside their cost estimates what the reason for this difference in costs is. The Swedish EPA did note in their response to the re-issued targeted questionnaire that they are currently in the process of developing a more modern and efficient system for reporting (initiated in order to meet requirements for e-reporting according to the EU's reporting provisions 2011/850/EU) and that, once the new system is fully implemented, they expect that the annual costs for reporting will be significantly reduced. It is not, however, known whether Estonia included the cost of making changes in line with CID 2011/850/EC in their annual costs. Poland included their one-off costs incurred as a result of changes to reporting and submission requirements which, if combined with the annual cost of reporting, would bring their total cost far closer to that of Sweden.

The cost estimate provided by the Netherlands for communicating information to the Commission, which includes the costs of ensuring compliance with CID 2011/850/EC is closer to that provided by Sweden. The Netherlands relies on a number of sampling points rough twice that of Sweden (274 compared to 131)[5] and so it may be the case that Sweden could realise cost savings as a

[5] Analysis of Data flow C - Downloaded from the EEA/Eionet e-Reporting database on 04/01/2019

result of efficiencies in reporting once they have implemented changes to their systems in line with CID 2011/850/EC.

The cost estimates provided by Sweden and the Netherlands for data transmission to the Commission are comparable to the estimates made in the 2017 Commission report study supporting a Fitness Check of monitoring and reporting obligations arising from EU environmental legislation [R83], of between £100,000 and £1,000,000 per year. It remains unclear why the cost estimate provided by Estonia and Poland is so much lower.

Regarding costs of reporting information to the public, Estonia, France and Poland provided estimates of cost incurred by national level authorities, which are presented on a *per capita* basis in Table 47.

Table 47 Per Capita Cost of reporting to the public (2017)

Member State	Cost per capita
Estonia	EUR 0.0027
France	EUR 0.0053
Poland	EUR 0.0006

Source: Derived from Table 39 and Author calculations

The differences in *per capita* costs above may be underlaid by the difference between the activities that these costs relate to. France's higher cost may represent the fact that the operating cost of the Prev'Air system includes some analysis activities which sit behind the forecasting and mapping. Poland's lower cost might be underlaid by the large role that regional and local authorities have in public information provision. The Podkarpackie Voivodship reported public information costs of around EUR 100,000 over ten years, and the cities of Wrocław and Wałbrzych reported costs in 2017 of EUR 23,283 and EUR 1,862 respectively. Given that there are 16 Voivodships in Poland, it is likely that costs being incurred other than at a National Level will be significant, and may go some way to explaining Poland's lower national-level public information provision costs. However, the reason for the differences is not clear and cannot be stated with certainty.

F.4 JC 5.2: Variability in costs, extent of devolution and availability of guidance

The present section contains additional evidence concerning efficiency of monitoring, reporting and assessment regimes.

F.4.1 Approach

The efficiency of monitoring, assessment and reporting regimes could be considered from a number of different perspectives:

1 The extent to which the AAQ Directive sets out an approach which is consistent with an efficient approach to monitoring, assessment and reporting, consistent with the objectives of the Directive;

2 The extent to which Member States make choices regarding their approach to monitoring, assessment and reporting which are, within the constraints established by the AAQ Directives, efficient ones;

3 The extent to which Member States choose approaches to monitoring, assessment and reporting that are, in general, efficient, efficiency being understood as 'delivering what the AAQ Directives require of a monitoring, assessment and reporting regime at least cost'.

Our approach to this judgement criterion is focused on the second and third approaches above. In our evaluation, we consider:

a) whether the means by which Member States choose to monitor, assess and report on ambient air quality, to the extent that they have a choice under the Directive, are efficient or not and
b) whether the means by which Member States are required to monitor, assess and report on ambient air quality are efficient in meeting the requirements of the Directives.

F.4.2 Limitations

As mentioned in Section F.3.2, the level of response to Targeted Questionnaires (first round and reissued) provided only a small sample of Member States from which to draw conclusions on the efficiency of monitoring, reporting and assessment regimes. Although interviews undertaken to inform the case studies and follow-up queries provided some further insights, the sample size remains small.

F.4.3 Results

Assessment of efficiency of Member State implementation of monitoring, assessment and reporting regimes

Degree of centralisation

An important organisational feature which is not determined by the terms of the Directive, but which is a matter of choice for Member States, is the degree to which responsibility for monitoring, assessment and reporting is centralised, or devolved. The decision made in this regard may impact upon the efficiency with which compliance with the terms of the AAQ Directive in relation to monitoring, assessment and reporting is achieved.

During case study interviews, the Swedish Environmental Protection Agency suggested that the extent of devolution of monitoring requirements in Sweden creates inefficiencies in monitoring, and that a more centralised approach would be preferable. Specifically, it was suggested that greater centralisation would allow the EPA to ensure that sufficient monitoring stations are installed and that data collected is of sufficient quality to inform modelling activity (which could, in turn, reduce overall costs).

Additionally, it was highlighted by the Swedish EPA that where responsibility is devolved, guidance and tools need to be produced by national-level actors to support the work of those to whom responsibility is devolved. Effective use of guidance and tools (such as models) cannot be guaranteed and, where it is not, this can give rise to inefficiency. Where useful guidance is produced within Member States it might be shared between them.

The suggestion that in some cases collaboration across governance levels could be improved is corroborated by the recent EUROSAI report on Air Quality which highlighted that intra-Member State coordination between, and cooperation amongst, the various actors at national, regional and local levels is frequently inadequate. They highlighted gaps in the allocation of responsibility at a local level and national institutions not taking a sufficiently coordinating role, as specific problem areas. [R95]

Another important consideration for efficiency where extensive devolution of responsibility takes place is whether adequate funding is provided to discharge the associated responsibility. Both the Swedish EPA and Greater London Authority have highlighted, that in their respective Member States, Local Government has responsibility for administrative functions devolved to them in the context of similar constraints: in the case of Sweden, local government does not receive additional funding to carry out these functions, while in the UK, local government spending is being cut back by central government. These situations may make more it difficult to undertake the duties assigned, and indeed, may lead to more serious problems where the development of air quality plans and the implementation of associated measures is compromised (as appears to be the case in the UK).

The Swedish EPA commented that lack of funding primarily affected small and medium-sized municipalities, which often struggle to secure sufficient resources to meet the minimum requirements of the Directives. This can have a number of negative impacts on air quality assessment and management, for example impacting:

- whether there is a sufficient number of monitoring stations in operation in cities to provide adequate information on air quality;
- the level of quality assurance and control that is carried out;
- the level of modelling or objective estimation that is carried out; and
- whether the information required to underpin effective action planning is available, e.g. source apportionment, modelling area of exceedance, projections/scenarios and effectiveness of potential measures.

Strictly speaking, this is not a matter related to efficiency, but the adequacy of funding to enable efficient monitoring and assessment. It does, however, raise the possibility that in some governance structures, most likely, the ones involving greater devolution of responsibility, funding constraints may be more likely to arise (though equally, such funding shortages are far from inevitable). The recent EUROSAI report on Air Quality corroborated that funding is an issue highlighting that three of the eight EU Member States it reviewed reported that budgets allocated for air quality are insufficient. [R95]

A further impact of devolution highlighted by the Swedish EPA is that significant outsourcing of monitoring and assessment responsibility to consultants frequently takes place. The EPA noted that in some cases this has proved positive, as it ensures that tasks are carried out by experts with a high level of competence. However, some problems have arisen regarding the specifications of requirements used by municipalities in the procurement process. This can lead to situation whereby the services that consultants are procured to provide do not meet legislative requirements. Detailed guidance and checklists are however being developed to support municipalities with procurement. The Swedish EPA suggested that it might be more efficient if procurement was done centrally, on the national level, as it is a time-consuming process for many municipalities. Additionally, a more centralised approach would also lead to more harmonisation in air quality assessment and greater ease in ensuring that legislative requirements are met in all cases.

Approaches to Public Information Provision

The 2013 Air Implementation Study conducted by the European Environment Agency reviewing implementation of EU air quality policy in 12 cities across Europe highlighted that the approaches adopted by local authorities to public information vary in their range and effectiveness. [R63]

It noted that while information was being provided across the cities reviewed, the use of public media was low and use of social media websites or new technologies such as smartphone applications, or apps, was inefficient. In a recently published follow-up study, the EEA has noted between the pilot study conducted in 2013 and the 2018 follow-up 5 of the 10 participating cities have not changed their information strategy. They note however, that all cities now use at least two different forms of communication, and some use as many as five including;

- website on monitoring network and institutions;
- smartphone apps and social media;
- bulletins and billboards;
- telephone services; and
- open governance data and teletex.

Variability in the forms of communication adopted was also revealed by the responses to the targeted questionnaire with some Member States reporting only incurring costs for website maintenance and upgrades, and other reporting costs for broader communication campaigns spanning local television, training activities, conferences, production of educational materials and posters, and lessons for children in schools.

The extent to which Member State authorities choose more or less varied media, and take advantage of modern platforms and new technology, such as social media and smartphone apps, to communicate with the public, will dictate the efficiency of reporting regimes.

Assessment of efficiency of monitoring, assessment and reporting requirements - Changes to reporting of information on Ambient Air Quality

The Netherlands, Poland and the Czech Republic reported that new requirements related to reporting and exchange of information, which applied from 1 January 2014 based on Commission Implementing Decision 2011/850/EC, have resulted in administrative burdens being incurred. In the Netherlands the impact is estimated an additional €150,000 per year, Poland reported one-off costs of EUR 56,990 and in the Czech Republic, although it is noted that additional staff time has been required, no quantified estimate of financial impact has been provided.

The aim of these changes to reporting requirements was to establish a standardised framework and infrastructure for reporting geospatial information at the EU level and through implementation of automated reporting processes time and administrative burden of reporting may be reduced in the long term, and the Commission and Member States have, with support from the EEA, jointly produced a common understanding of requirements to help facilitate implementation. [R83, P89]

F.5 JC 5.3: Evaluation of the costs of action relative to the benefits brought by the AAQ Directives

The present section contains additional evidence concerning whether the directives have caused unnecessary or excessive administrative burden, taking into account their objectives.

F.5.1 Approach

There is, evidently, some subjectivity in adjudicating on whether a given cost (of any type) is unnecessary or excessive. We define these terms as follows:

- *'Excessive administrative burden'* is considered to be a burden which is far larger than it needs to be in order to achieve the objectives and benefits of the Directives
- *'Unnecessary administrative burden'* indicates elements of the administrative burden which serve no particular purpose in terms of their contribution to the objectives of the Directives.

In order to give some indication as to whether the administrative burden is excessive, we have sought to compare what, on the basis of the information we have available to us, is believed to be an upper end estimate of the administrative burden for the EU with an estimate of the benefits associated with the AAQ Directive.

Regarding the necessity of administrative burden, an assessment is made based on qualitative feedback supplied by Member States to the Targeted Questionnaires and during case study interviews, specifically related to how the requirements of the Directive relate to the its objectives.

F.5.2 Limitations

It might be appreciated from the analysis of data received and presented earlier in this report that data on administrative costs are relatively limited. A minority of Member States have offered information. Of those that did so, the majority were able to make some estimate of the administrative costs related to monitoring, but few provided estimates of costs of other assessment methods and reporting. As a result, it has proved difficult to separate out the burden component of the administrative costs that can be readily identified.

Additionally, as mentioned in Section F.3.2, the level of response to Targeted Questionnaires (first round and reissued) provided only a small sample of Member States from which to draw conclusions on the necessity of monitoring, reporting and assessment requirements. Although interviews undertaken to inform the case studies and follow-up queries provided some further insights, the sample size remains small.

F.5.3 Results

Only Estonia, Croatia and Sweden have provided any relatively complete estimate of the burden incurred as a direct result of the AAQ Directives. These are presented in Table 48.

Table 48 Administrative Burden Cost data provided by Member States

Member State	Known Administrative Burden	Administrative burden per capita
Sweden	EUR 1,150,000	EUR 0.12
Croatia	EUR 1,344,000	EUR 0.32
Ireland	EUR 1,831,735	EUR 0.38
Denmark	EUR 670,000	EUR 0.29

Source: Derived from Table 39, and author calculations.

It should be noted that the scope of these costs differs; The Swedish data include only monitoring network costs at the national level and do not account for activities delegated regionally, the Croatian costs lack utility and maintenance costs for monitoring stations and also reference laboratory staff costs and the Irish data lack the cost of 2 full-time equivalent staff involved in local monitoring activity. The Denmark cost represents the complete costs of monitoring for the AAQ Directive.

Regarding the scale of administrative burden relative to administrative costs, only Estonia and Sweden were able to supply relevant information. In a response to the follow-up questionnaire Estonia indicated that the component of total administrative costs that could be considered to be administrative burden was just over half of the total. The Swedish EPA commented in their response to the targeted questionnaire that;

"the majority of the requirements that dictate the number of fixed measurements that are required in Sweden were…present in previous EU directives. The 2008 directive in itself has therefore probably only lead to a relatively small increase in costs."

This aligns with the estimate of administrative burden incurred by Sweden (Table 48) relative to administrative cost of monitoring activities which represent the majority of costs for most Member States (Table 44).

Is the Administrative Burden Excessive?

The upper end estimate of costs for monitoring, assessment and reporting of the air quality information comes from France, at €0.98 per inhabitant per year. As noted above, however, this figure covers the full range of activities for France related to air pollution, monitoring and reporting and so potentially overstates the costs. Other figures suggest the administrative costs related to the AAQ Directive are likely to be somewhat less than this (see above).

Combining:

- the highest (Estonia/Sweden) figure that has been reported regarding the proportion of administrative costs that are likely to be burdens; with
- the highest (France) per capita administrative cost; and
- applying this to the EU population,

this would give an estimated administrative burden of €300 million for the EU as a whole.

This can be compared with:

- The benefits of improved air quality delivered by the Directives, estimated (see Question 3 below) at €6.3-€19 billion per annum; and
- The social costs of exceedances, which are estimated (see Question 4 below) at between €100 and €517 billion for the period 2008 to 2017, or around €8.4-€39.0 billion for the year 2016.

Judged against these potential gains, the administrative burden, whilst certainly not trivial, does not seem excessive: the social costs of poor implementation obviously do not account for the benefits that accrue where the Directive is well implemented, delivering reduced concentrations of pollution against the counterfactual.

Based on the data available it appears that taking into account the objectives of the Directives with regards to monitoring and reporting, and the potential benefits of action on exceedances taken as a result of this monitoring and reporting, administrative costs to Member States, the EEA and the Commission are not excessive.

Is There Evidence That Administrative Burdens are Unnecessary?

Regarding the unnecessary administrative burdens, relatively few have been brought to our attention. The Ministry of the Environment of the Czech Republic has commented that, whilst monitoring and assessing air quality is considered costly, it is viewed as essential for subsequent action to be taken, and so not viewed as excessive. The response to the targeted questionnaire from the Croatian Ministry of Environment and Energy lists a number of specific administrative burdens but not with a view to highlighting them as excessive.

It was noted earlier in the section on Effectiveness, that one of the key factors influencing the achievement in Member States of representative, high-quality monitoring and assessment of air quality, is a lack of clarity or sufficient guidance in the AAQ Directives on aspects of monitoring network design, or use of modelling to supplement measurement data.

As noted in effectiveness, the criteria for classifying measurement stations are described in literature as rather generic (in particular urban background and suburban background). Stricter and clearer criteria for micro-scale siting, macro-scale siting and representativeness of stations are suggested to improve comparability of measurements across cities [R44, R32]. The JRC-Aquila position paper [P121] in addition notes that the spatial representativeness of measuring sites is not defined in the legislation, which can hinder the effectiveness of the monitoring network design and suitability to assess exposures and model performances.

Where these ambiguities result in either:

- the installation of expensive monitoring stations and subsequent reporting of data which do not meet the goals of the Directive; or
- the development of models which authorities with responsibility for air quality are then ensure of how to apply;

this could represent an unnecessary burden.

The issue of reporting is also worthy of examination. Member States make reports to the EEA on the measures in their air quality plans. Our own experience of this database is that it has some useful points, but also, that it is difficult to extract information from (see also comments in relation to Question 3 below). Via personal communication, [D45] the EEA outlined that it has made use of information provided by countries on air quality plans for the following purposes:

- a 2018 EEA briefing on Improving Europe's air quality – measures reported by countries;
- online data viewers for information on air quality plans;
- annual air quality reports, the most recent being the '*Air quality in Europe' - 2018* report; and

- the 2013 Air Implementation Pilot [R44] — *'Lessons learnt from the implementation of air quality legislation at urban level,'* and its 2018 follow-on, *'Europe's urban air quality — re-assessing implementation challenges in cities'* [R63]. These reports are based on exchanges with city representative at a series of workshops, and focus on five areas of air quality policy implementation. Preparation for the workshops built on information submitted by countries under the Ambient Air Quality Directives.

The EEA is also currently developing a database to better capture information submitted under CID (2011/850/EU) Annex II data flows H to K as a basis for a more systematic analysis.

These activities could be argued to contribute to the objective of the AAQ Directives of:

> *"maintaining air quality where it is good and improving it in other cases,"*

in so far as they facilitate the efforts of the EEA to share good practice and learning between MS related to measures implemented to improve air quality. [R44, R63] In addition, the activities of the EEA in collating and making available to the public this reported information contributes to the objectives of:

> *"obtaining information on ambient air quality in order to help combat air pollution and nuisance and to monitor long-term trends and improvements resulting from national and Community measures;"* and
>
> *"ensuring that such information on ambient air quality is made available to the public."*

The reporting activities can therefore be seen as necessary.

F.6 JC6.1: Assessment of the evidence for transmission of effects of environmental legislation on competitiveness, evidence of impacts on a sectoral basis

F.6.1 Approach

In our approach to evaluating this judgement criterion, we have considered the following aspects:

a) Effects of environmental regulations in general on competitiveness

b) Potential impacts of AAQ Directives on EU competitiveness

c) Impacts of AAQ Directives on competitiveness of different sectors.

The analysis was conducted based on the data available in the existing literature and stakeholder consultation through targeted questionnaire.

F.6.2 Limitations

The main limitation of the analysis was that there is a lack of primary research quantifying impacts of AAQ Directives on EU competitiveness. So most of our analysis remains qualitative and based on impacts of air quality regulations in general on competitiveness.

F.6.3 Results

Effects of Environmental Regulations on Competitiveness

According to the Better Regulation Toolbox, EU initiatives are likely to affect competitiveness when they affect at least one of the following:

1. A sector's capacity to produce products at a lower cost and/or offer them at a more competitive price (cost/price competitiveness);
2. The quality or the originality of a sector's supply of goods or services (innovative competitiveness);
3. Effective market competition and undistorted access to markets including inputs and materials, public procurement, etc.;
4. The sector's market shares on international markets.

To understand the impacts of the AAQ Directives on EU competitiveness we need to first understand transmission mechanism for the effects of environmental regulations on competitiveness in general.

A recent review study discussed the different possible effects of environmental regulations on competitiveness [S26]. Table 49 presents different potential effects of environmental regulations on firm competitiveness. It should be noted that these effects are not unidirectional, and can have feedback effects on production costs and firm responses (e.g. process innovation can reduce production costs, and in turn affect firm responses).

Table 49 Competitiveness Effects Due to Differences in Environmental Regulations

First-order effect	Second-order effect	Third-order effects			
Cost impacts	**Firm responses**	**Economic outcomes**	**Technology outcomes**	**International outcomes**	**Environmental outcomes**
Changes to relative costs (direct and indirect costs)	Production volume	Profitability	Product innovation	Trade flows	Pollution levels and intensity
	Product prices	Employment	Process innovation	Investment location	Pollution leakage
	Productive investments	Market share	Input-saving technologies	Foreign direct investment (FDI)	
	Investment in abatement		Total factor productivity (TFP)		

Source: [S26].

Most of the effects listed above, can have both positive and negative effects on competitiveness depending on the type and stringency of regulation, and time horizon considered.

In reality, a widening body of research appears to conclude that in general, the increased costs associated with implementing ambitious environmental policies can lead to some adverse effects on the competitiveness at least in the shorter term, especially for the pollution-intensive sectors. In the longer term, on the other hand, there can be positive impacts on competitiveness associated with increased innovation. [S26]

In regards to the AAQ Directives' impact on EU competitiveness more specifically, it is important to note that European regulations for air quality and air pollutant emissions have existed in some form or another since the 1970s. This implies that within the EU, the short term indirect impacts of increased compliance costs with such regulations should largely have been internalised by industry, and offset by the longer term benefits of cost-efficiency in production and innovation. It is difficult therefore to disentangle and attribute a marginal competitiveness impact solely to the AAQ Directives, independent of this wider body of regulations.

Impacts of AAQ Directives on EU Competitiveness

Before undertaking ex-post analysis, we need to identify the key impacts of the AAQ Directives on EU competitiveness. For this, a general equilibrium model for the EU can be used to detect different potential impacts on competitiveness through production, consumption and international trade of goods and services that are affected by air quality regulations.

An impact analysis was carried out on the EU Clean Air Policy Package (CAPP) by JRC in 2014 using the GEM-E3 general equilibrium model [R124]. In addition to the economic impacts of the CAPP, the study analysed the effects of CAPP on the competitiveness of the various sectors to

2030. Although the study analysed the impacts of the CAPP rather than the AAQ Directives specifically, the direction of impacts on competitiveness should be similar. The study identified the following impacts on EU competitiveness:

- Reduction in output, employment, productivity and competitiveness in regulated sectors due to an increase in production costs as a result of abatement activities required to comply with the regulation;
- Increase in household abatement activities, resulting in lower household disposable income and consumption of other goods, which leads to lower output in the economy and loss of global competitiveness;
- Increase in output, employment, investment and market share in production of abatement technologies; and
- Increased labour productivity due to better health and reduced workdays lost, which increases the output in the economy and increases competitiveness.

The net impact of AAQ Directives on EU competitiveness would depend on the magnitude of the positive and negative impacts. The study came to conclude that, there is a loss of EU competitiveness for the sectors required to undertake abatement activities. However, after taking into account the increase in production of abatement technologies, and the increase in labour productivity due to reduced morbidity, the net effect on EU competitiveness is negligible.

Moreover, higher innovation in industries producing compliant products and technologies, could result in an additional gain in global market share and hence increased EU competitiveness. It is also necessary to consider the extent to which the approach taken in the Directives can be seen to have stimulated industries for which there is a global market. Where this is the case, the competitiveness of EU industries can be said to have been improved as a consequence of the AAQ Directives' introduction.

Impacts of AAQ Directives on Sector Competitiveness

The actual effect on competitiveness *in the global economy* of the AAQ Directives logically depends on the extent to which the affected sectors are those which are heavily exposed to international trade. We noted above, under Question 3, that whilst it appears that a range of measures have been implemented affecting a wide range of sectors, the measures broadly address the following:

- Transport (and traffic);
    - Technological and infrastructure measures, including cleaner vehicles
    - Limiting Traffic via restrictions / charges
- Industry (abatement measures going beyond BAT, restricting use of some fuels, efficiency measures, and relocation);
- Other, including measures targeting buildings (energy efficiency, district heating, restricting use of some fuels / fuel switching).

These possible effects on the competitiveness of these sectors is considered below.

Transport related measures

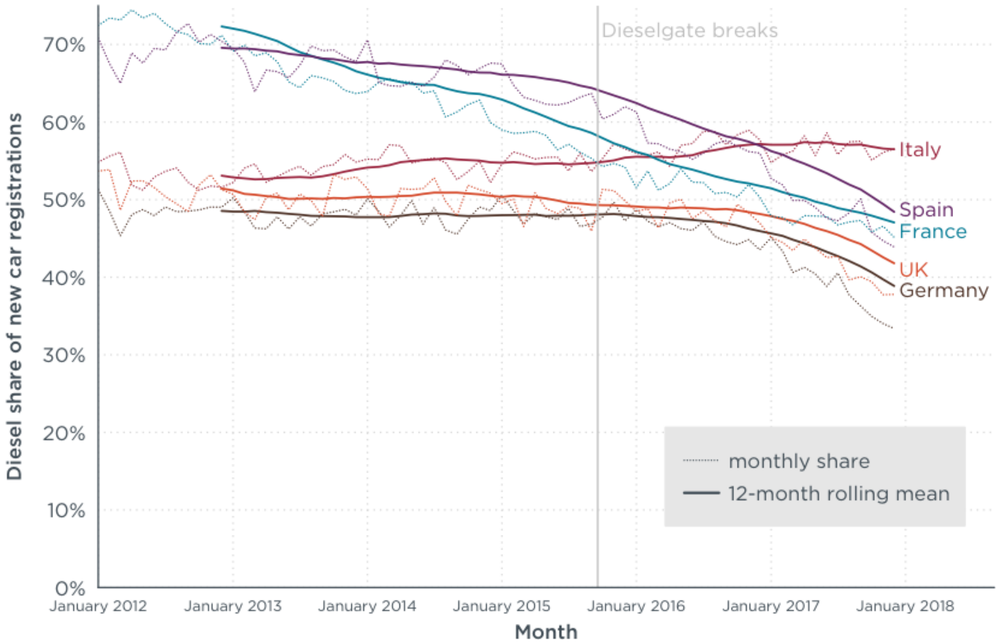
In respect of the measures in relation to traffic and transport – which, as indicated, account for the majority of the measures identified in the EEA database – then it can reasonably be argued that in the direct sense, international competitiveness is not a relevant issue: all citizens and vehicles are affected in the same way, irrespective of their origin, by the majority of the measures. For example, all hauliers, whether from inside or outside Europe, are affected equally by a measure that restricts, or charges, all HGVs in the same way, irrespective of their country of origin. The same applies for transport services in one country or another. To the extent that the measures relate to charges and restrictions applied to a given zone, the only thing that matters within that zone is whether a vehicle of a given type seeks access to it: that is not an activity which is readily 'tradeable'.

It could be considered that measures could harm a logistics / distribution business. This could lead to considerations as to the rationale for relocation. However, the measures being applied in respect of transport relate mainly to urban centres, and it seems unlikely that major logistics operations would be located close to the urban centres precisely because of the implications for the efficiency of their logistics.

There are likely to have been some impacts on the market shares of the manufacturers of some vehicle types, for example, electric vehicles might be beneficiaries, but possibly also diesel vehicles might be negatively affected. The matter is complicated by the fact that measures other than the AAQ Directives also affect these matters. Indeed, measures such as registration taxes and circulation taxes, as well as taxes on vehicle fuel, exert a more general impact across the economy of a given Member State, so might be expected to be more significant: this point is largely substantiated by the literature, which focuses on the support given – historically – to diesel vehicles over petroleum driven ones [S138, S139]. Such literature tends to support the view that it is the national level policies, rather than specific measures implemented to address exceedances in air quality, that are the factors most strongly influencing the competitiveness of vehicles globally (including within the EU). In some cases, the implementing measures might be expected to increase the turnover of vehicles, with those vehicles being negatively affected by measures being replaced earlier than might otherwise have been the case. Generally, it can be expected that there may be winners and losers, in the short-term, from the measures implemented. The effects on the competitiveness of industry globally, however, are far less clear, and indeed, they may be considered relatively slight, other than to the extent that some small (additional) stimulus may be given to the developing e-mobility sector (see also the results of the open public consultation below).

Some indication of what could, in theory, happen as a result of increased emphasis on measures used to address air quality can be gained from an understanding of the effect on market shares of the so-called 'dieselgate' scandal. An analysis was conducted by the International Council on Clean Transportation (ICCT) on the change in market shares of diesel vehicles and electric vehicles following the breaking of the news that diesel vehicles were potentially more polluting than had been claimed [R119]. The figure below shows that four of the five countries analysed (Germany, France, Spain and the UK), display declining market shares for diesel car registration, implying a loss of market share for diesel car manufacturers in these countries. The relevance of this is that it highlights how some of the measures taken to address air quality could have an effect on market shares of different vehicle types. However, as noted above, the impact of the measures implemented under the AAQ Directives might have relatively constrained (geographically) effects when compared with broader policies, so it cannot be said, with certainty, that such measures are the major influencing factors on patterns of vehicle uptake, still less that such measures exert a clear influence on the competitiveness, globally, of EU industry.

Figure 14 Diesel shares of new car registrations in France, Germany, Italy, Spain, and the UK.



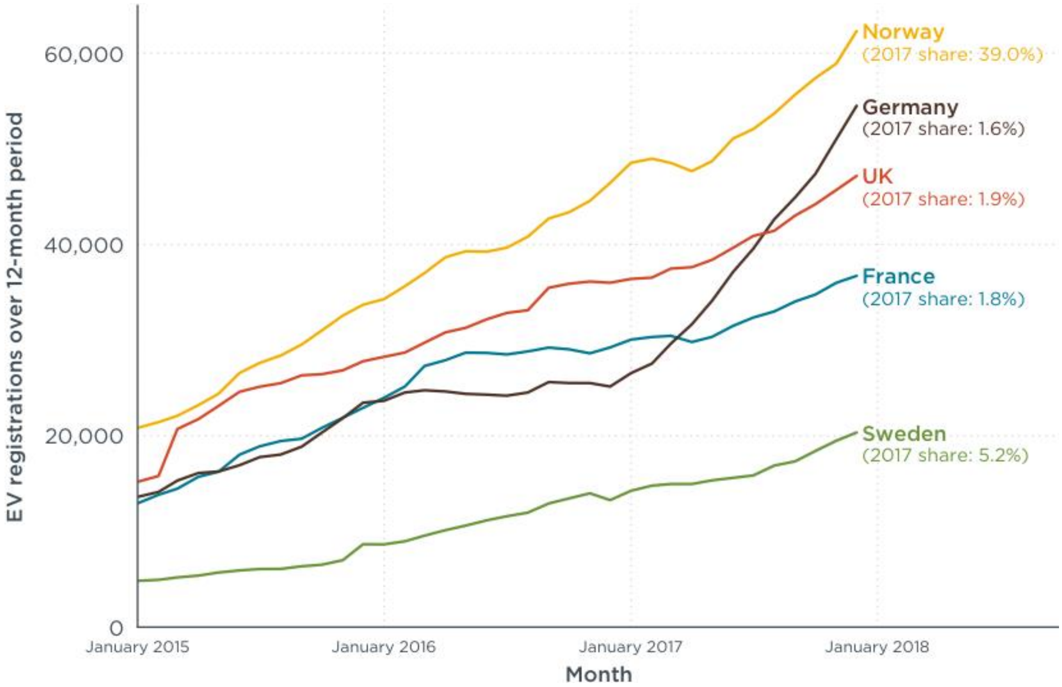
Source: [R119]

What is of some interest in respect of transport related measures is the potential spur to innovation given to the development of low-emissions transport solutions. This was recognised by respondents to the public consultation, who cited, as sectors benefiting from the implementing measures under the AAQ Directives, e-mobility solutions, including electric vehicles, which are likely to be growth sectors for the future in respect of transport, and on a global scale.

The figure below portrays the growing market shares for ultra-low and zero emission vehicles in France, Germany, Norway, Sweden, and the UK, which could represent a growing opportunity for the EU and European car manufacturers not only within the EU market, but also in the global market in future (recognizing that air quality is far from being a uniquely 'European' problem). Once again, these graphics are not indicative of the effects of the AAQ Directives alone, since they reflect the outcome of a range of policies adopted within the different countries including Regulation (EC) No 443/2009 on emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles.

The measures implemented as a result of the AAQ Directives can, however, be part of the mix of measures that strengthens the incentives given to switching towards e-mobility solutions, and away from more polluting transport options.

Figure 15 *Electric passenger car registrations over 12-month period in France, Germany, Nor-way, Swe-den, and the UK. EV shares of 2017 registrations in parentheses.*



Source: [R119]

Industry

Where industry is concerned, the influence of AAQ Directives is believed to have been relatively slight. According to our analysis of the EEA database of measures (see Table 3), some countries have focused more on stationary emitters than others. The number of measures, expressed as a proportion of the total, is an imperfect way of understanding the potential impact, in a given country, on a sector's competitiveness: it is, however, capable of indicating those countries where there is likely to have been some impact on industry. The countries where this has been more of a focus are: Belgium, Czech Republic, Denmark, France, Poland, Romania and Spain, with Italy and Lithuania also deploying a range of measures.

In terms of global competitiveness, only those installations which are both a) affected by such measures, and b) engaged in tradable good sectors, will be negatively affected. Without further detail on the specifics of the industries affected by these measures, and, indeed, the associated costs, it is difficult to be entirely clear about the competitiveness impacts of the AAQ Directives. Furthermore, it should be noted that where Member States include such measures within, for example, their Operational Programmes for the environment, then some of the investments required by industry may also be partially met by funding from the European Structural and Investment Funds, as indicated in recent investigations undertaken by the Court of Auditors. This would likely reduce any competitiveness impacts such as they were expected to occur. Nonetheless, one of the targeted questionnaire responses, from the Czech Republic, noted:

> *We have no data to prove or disprove negative impacts on competitiveness although it can be deduced that due to the implementation of mitigating measures EU is hampering its competitiveness (for example to compete with Asia). Implementation of emission reduction measures is very costly so it can have a negative effect on the economic viability of industry (or the given sector).*

> *Nevertheless, from our perspective the good air quality is a strategical advantage because it ensures productive and healthy citizens. Good air quality is also in compliance with the sustainability concept.*

These highlights, on the one hand, the possibility of some negative impacts on competitiveness, though it should be noted that Czech Republic is, as noted above, one of the Member States with a significant proportion of its measures targeting industry / stationary emitters. The response also highlights the potential upside of improved air quality more generally: the suggestion is that competitiveness impacts, to the extent that they are negative, are quite targeted, whilst one can view the benefits as being widely distributed across the population, potentially improving productivity across sectors (industrial and otherwise).

A similar remark was also made in the response from the Netherlands:

> *The direct and strict implementation of the AAQ Directives initially led to a 'lock-down' in Dutch spatial development. As a consequence the National Cooperation Program on Air Quality (NSL) was introduced. It could conceived that initially the Dutch (and thus EU) competitiveness in the global economy would have been hampered. On the other hand the NSL eventually led to improved living conditions for the population through the improvement of air quality, which is supportive to economic, social and environmental sustainability.*

As with the Czech Republic response, this indicates that any negative impacts that may have arisen might have been offset by the benefits associated with improved living conditions for the affected population.

Some sectors of industry are likely to benefit from the AAQ Directives' implementation: those involved in measurement, monitoring, and assessment of air pollutants, and those engaged in supplying relevant equipment, will probably have been encouraged to innovate in this space. One example in this respect, provided by ATMO Grand Est, is a personal indoor air quality monitoring product Foobot.[6] Foobot is largely exported to China and US in response to the public concern about air quality in these countries.

Buildings

Competitiveness effects vis-a-vis the activities being directly targeted in relation to implementation of the AAQ Directives are likely to be especially weak since construction activities are not significantly exposed to international competition. Indirectly, the sectors which could be expected to be affected are the solid fuels, which might be losers under some measures, and the providers of low-emissions heating systems, which might be expected to benefit from some measures.

Views of open public consultation Respondents

Analysis of the stakeholder responses to the open public consultation reveals that, similar impacts have been identified by the stakeholders. In addition, one of the responses suggested that scientific evidence is limited regarding the impacts on competitiveness, and more research is required to understand the true impacts.

[6] https://foobot.io/

The analysis also revealed the views of those respondents to the questionnaire in respect of the key sectors that would bear most of the abatement costs. These are:

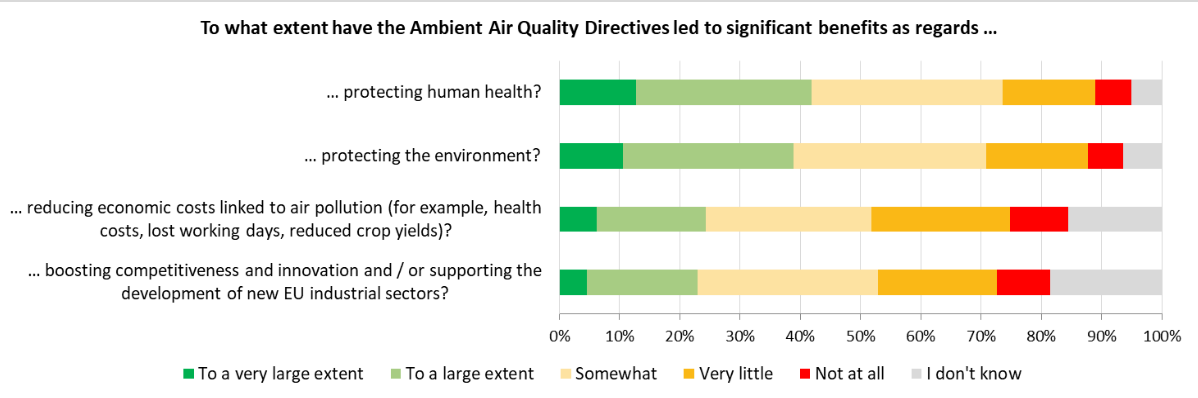
- Manufacturing (including vehicle manufacturing);
- Power generation, and
- Agriculture.

The views of stakeholders on impacts of AAQ Directives on EU competitiveness are provided in Box 1.

Box 1: Stakeholder Views on Impacts of AAQ Directives of EU Competitiveness

The open public consultation asked stakeholders to give their views on the extent to which the Directives are seen as boosting competitiveness and innovation, or supporting the development of new industrial sectors. Responses are shown in the Figure below. This indicates that a majority of respondents – slightly over 50% - felt competitiveness and innovation had been boosted to at least some extent as a consequence of the Directives' implementation.

Figure 16: Open public consultation question – To what extent have the Ambient Air Quality Directives led to significant benefits as regards…



Source: Question 8.1: To what extent have the Ambient Air Quality Directives led to significant benefits as regards (N=465-473 – different numbers of respondents for each statement)

Further evidence provided by the survey considers the impact on different industrial sectors. Respondents were asked for their opinion about different industrial sectors benefiting from AAQ Directives' implementation. The results are presented in the Figure below. There were a considerable (and varying by sector) proportion of 'I don't know' responses to this question. If one excludes these, then the majority (or very close to a majority) of the respondents agreed that the following sectors have benefitted from the AAQ Directives implementation:

- Innovative industries (all sectors);
- Transport: Personal mobility service providers;
- Energy providers;
- Healthcare sector;

- Competent public authorities.

These sectors can therefore be suggested as the beneficiaries of the Directive. Innovative industries will be split across a number of different sectors – these would be expected to be represented in the four sectors identified in the list below.

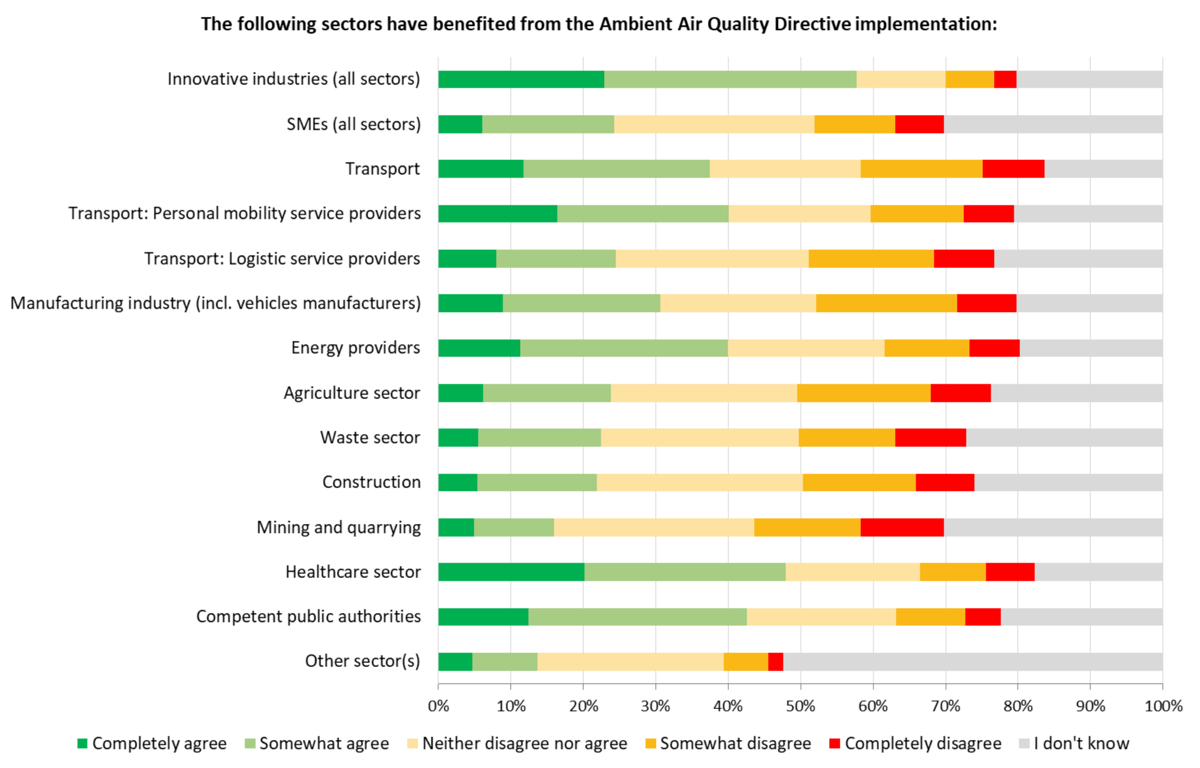
If one compares the proportion of respondents who were somewhat or completely agreeing, with those somewhat or completely disagreeing, then the following sectors are those where the number disagreeing that the sector had benefited was greater than the number suggesting the sector had benefited:

- Transport: Logistic service providers;
- Agriculture sector;
- Waste sector;
- Construction;
- Mining and quarrying.

The above list can be considered as indicative of sectors where industrial competitiveness may have been hampered as a consequence of the Directives.

The remaining sectors (SMEs (all sectors), Transport, Manufacturing industry, and Other Sectors) are those for which a) the number agreeing that the sector benefited were larger than those disagreeing, but b) where the numbering agreeing was some way short of a majority of the respondents who offered an opinion. These sectors may therefore be considered as those in which no clear benefit or dis-benefit in respect of competitiveness has been seen as a consequence of the Directives' introduction.

Figure 17: Open public consultation question – To what extent do you agree with the following statement? "The following sectors have benefitted from the Ambient Air Quality Directive Implementation."



*Source: Question 8.3: To what extent do you agree with the following statement? "The following sectors have benefitted from the Ambient Air Quality Directive Implementation." (*N=424-454 – different numbers of respondents for each statement)

The mixed picture for the Transport sector is noted – some businesses in this sector are seen as being a beneficiary of its introduction, whilst others are not. A follow up question asked respondents to select up-to five sectors that they felt had benefitted the most from AAQ Directives' implementation. The following sectors were selected, in the top five beneficiaries, by more than 200 respondents:

- Innovative industries (all sectors);
- Transport;
- Healthcare sector;
- Transport: Logistic service providers.

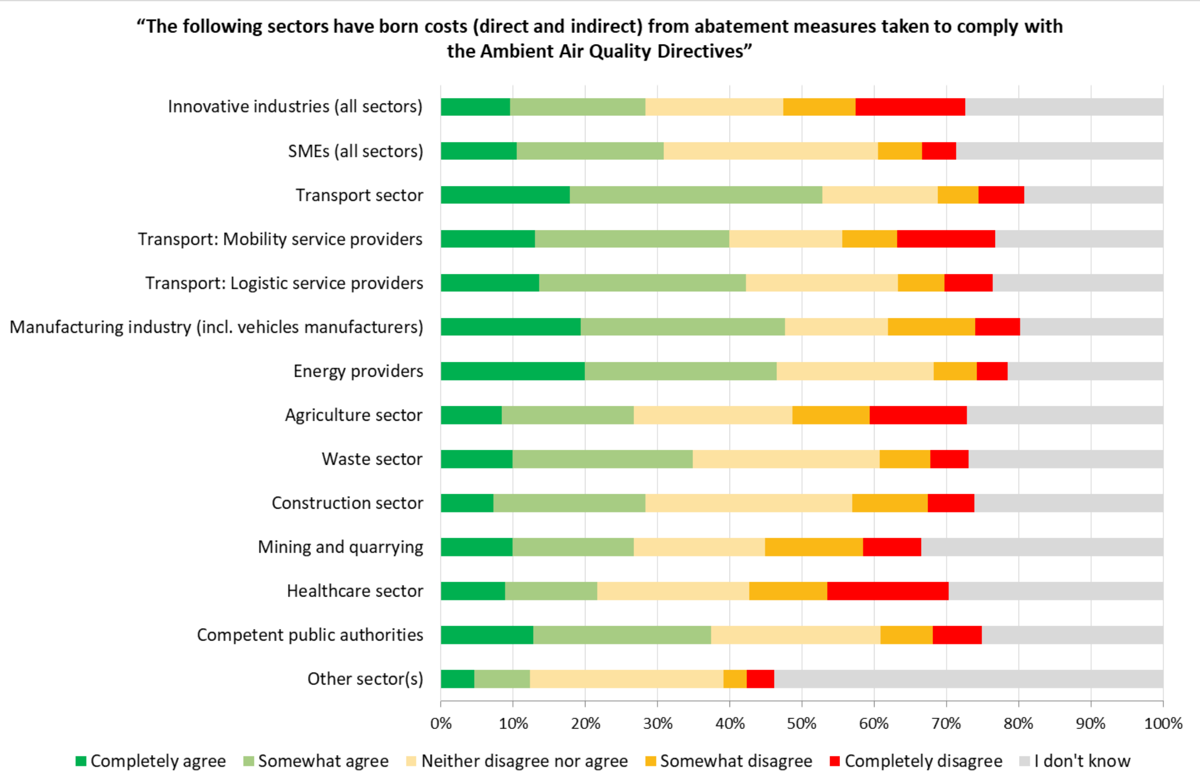
The transport sector again features prominently in this list. Key elements of the transport sector which were seen to benefit were public transport and electric vehicles.

Respondents were also asked for their opinion about different sectors bearing the direct and indirect costs from abatement measures. The results are presented in the Figure below.

The highest proportion of respondents indicating that they 'completely agree' or 'somewhat agree' with the view that the sector has born costs to comply with the AAQ Directives was in relation to the Transport sector, with the closely related sectors, Mobility Service Providers and Logistic Service Providers also receiving a high proportion of responses of this nature. Manufacturing industry ranked second in the overall number reporting in this way, closely followed by Energy providers. The next highest ranked 'sector' by this measure was the Competent public authorities. None of the sectors shown were deemed to have borne no costs. In only one Sector – Healthcare – was the proportion indicating that they agreed 'somewhat' or 'completely' that costs had been borne by the sector exceeded by the proportion that suggested they 'somewhat' or 'completely' disagreed with the same statement.

Figure 18: open public consultation Question – To what extent do you agree with the following statement? "The following sectors have borne costs (direct and indirect) from abatement measures taken to comply with the Ambient Air Quality Directives."

Source: Question 8.23: To what extent do you agree with the following statement? "The following sectors have



*borne costs (direct and indirect) from abatement measures taken to comply with the Ambient Air Quality Directives." (*N=373-426 – different numbers of respondents for each statement)

Taking the results of this question with that of the previous questions indicating those who were deemed to be the beneficiaries of the Directives, this suggests that in many cases, the view of stakeholders responding to the open public questionnaire is that the same sectors who have borne the costs of arising from the abatement measures are also those who are felt to have benefited from the legislation.

Conclusions

In summary, it would seem that there are few reasons to believe that the AAQ Directives has major implications for global competitiveness. There are reasons to believe that some sectors might have received a spur to innovate from the AAQ Directives, but equally, there are some sectors that might have received a short term negative impact, albeit, locally confined.

This last point – the locally confined nature of many of the implementing measures – should not be lost in the context of this discussion. The effects of most measures are likely to be quite locally confined, and whilst some measures affect major cities in the EU, the extent to which industries widely exposed to international competition are directly, and significantly, affected by the measures is, as a result, likely to be somewhat limited. A positive feature of the AAQ Directives' implementation may be that the innovation towards low-emissions solutions, in transport and energy in particular, are likely to have positive spill-overs far beyond the local situations where they are applied in the context of implementing measures under the AAQ Directives.

F.7 JC6.2: Effects of measures introduced under the AAQ Directives on economic, social and environmental sustainability.

F.7.1 Approach

For this judgement criteria, we focused on the specific impacts of measures introduced under the AAQ Directives on economic, social and environmental sustainability in the EU based on the existing literature.

F.7.2 Limitations

The main limitation of the analysis was the lack of primary research on ex-post impacts of measures introduced under the AAQ Directives on economic, social and environmental sustainability. Therefore, much of the conclusions were based on ex-ante impact assessments of related policies.

F.7.3 Results

Performance of the EU in the Global Index for Environmental Sustainability

An analysis of the global competitiveness of EU industry resulting from environmental legislations was carried out in the World Economic Forum's *Europe 2020 Competitiveness Report* [R194]. The analysis revealed that, in terms of the economy-based averages the EU leads in the global index for environmental sustainability compared to BRICS, developed countries and candidate countries, though other developed economies are not significantly far behind.

The analysis also ranked all EU Member State performance from 1 to 28, with first rank representing the best performing country, and providing the distribution of the EU 28 average index scores across all countries. It is worth noting that the performance of the individual Member States on the basis of this indicator is not evenly distributed, with some performing as well as the top three global countries (Sweden), and others like Hungary performing at a lower level.

It should be noted that the indicator in the WEF study does not focus on air pollution regulation specifically. However, it is of relevance to understanding the implementation, stringency and therefore likely impacts of environmental regulation, including air pollution regulations, globally.

Below we discuss the impacts of AAQ Directives implementation on economic, social and environmental sustainability.

Economic Sustainability

There can be substantial economic and financial benefits associated with implementation of air quality regulations in Europe. The impact assessment of the EU Clean Air Policy Package (CAPP) analysed the net impacts on EU GDP [R124]. It was shown that there is a decrease in GDP due to increase in abatement expenditure. However, the negative impact on GDP from higher abatement expenditure is offset by the benefits from avoided morbidity due to improved air quality, and thus resulting in a net positive impact on EU GDP.

A recent study by the OECD showed that a non-implementation of the AAQ Directives would indirectly entail costs of air pollution which are experienced in current pricing mechanisms (i.e., these are not 'external' costs) [S91]. These costs include those linked to reduced labour productivity, additional health expenditure, and crop and forest yield losses. The study projected that these costs will increase to reach approximately 2% of EU GDP in 2060, leading to a reduction in capital accumulation and a slowdown in economic growth. Ignoring these indirect economic consequences can lead to a significant miscalculation of the morbidity costs of air pollution.

Another study on economic impacts of decarbonising passenger vehicles in Europe for European Climate Foundation has modelled various possible vehicle technology futures using a scenario based approach [R17]. The study showed that there are potentially large economic benefits associated with decarbonising passenger car transport in Europe. The potential benefits if Europe embraces the transition are substantial:

- *Reduced use of oil and petroleum products will cut energy import dependence and reducing carbon emissions.*
- *Net gains in value added and employment.*
- *EV and grid synergies by moving demand away from peak periods to periods of low system demand, limiting increases in peak electricity demand.*

On the other hand, the same report highlighted a number of 'transitional challenges' that would need to be confronted in order to secure these benefits:

- *The implementation of a rapid charging infrastructure will require investments reaching several billion euros per year by 2030.*
- *The transition to low-carbon mobility causes a wide range of impacts in employment across several sectors. After 2030 the transition to electric mobility will increase employment in sectors such as construction and infrastructure, as well as services, but is likely to have an adverse impact on employment in the automotive value chain.*
- *The transition poses a significant challenge to maintain the competitiveness and market share of the European auto industry, by remaining at the cutting edge of clean technology innovation.*

It seems possible, therefore, that in the sector where most of the measures introduced as a result of the AAQ Directives are applied, there may be benefits to be gained. In responding to the targeted questionnaire, the Greater London Authority noted (of relevance to the above) that implementation of the AAQ Directives has enabled technological advances in the taxi industry, with benefits including:

- *Improved air quality, particularly in central London, historically the fleet was a significant contributor to poor air quality.*

- *Creation of a new market for Zero Emission Capable taxis, which led to significant investment from industry and a new manufacturing plant in the UK for electric vehicles. Subsequently, the taxi and other variants are being marketed competitively around the world.*

- *Creation of demand for electric vehicle charging infrastructure in London, which has led to a new competitive framework of suppliers of rapid charging infrastructure, with businesses from the UK, France, Netherlands and elsewhere in Europe making investment.*

In addition, there could be economic benefits due to innovation in industries producing compliant products and technologies, as discussed in the previous section on EQ7.1. A recent study on environmental technology sector in Austria suggests that the innovative industry make relatively minor contribution to the GDP of Austria, and the contribution of the innovative sector related to air quality is even smaller [R193]. The study estimated that the export-oriented innovative environmental technology sector in Austria accounts for 6% of general industry turnover (8 billion Euros in 2011). Air quality related technology accounts for about 6% of the environmental technology sector (0.5 billion Euros).

Social Sustainability

One of the measures of social sustainability is the potential effect of AAQ Directives on employment generation. The impact assessment of the EU Clean Air Policy Package (CAPP) also analysed the impacts on employment [R124]. Three types of effects on employment were discussed in the study:

- Decrease in employment levels in the regulated sectors due to an increase in production costs from higher abatement activities required to comply with the regulation;
- Increase in employment in the production of abatement technologies; and
- Increase in labour productivity and supply, and consequently an increase in the employment level due to better health and reduced workdays lost from improved air quality.

The study concluded that the net effect on employment is insignificant if the former two effects are considered due to sectoral reallocation of jobs. However, if the health related benefits are taken into account, there would be a net positive impact on employment.

The study on impacts of decarbonising passenger cars in Europe [R17], on the other hand, modelled substantial increase in employment with transition toward a low carbon mobility in Europe. The study predicted a net increase in employment in the following sectors:

- Electricity;
- Hydrogen;
- Services; and
- Most manufacturing sectors.

On the other hand, a small decrease in employment is predicted for the automotive manufacturing sector, and the petrol and diesel fuels sector, resulting in a significant increase in overall employment in Europe.

It is possible that implementation of AAQ Directives in the EU can lead to similar increase in employment levels in Europe. However, in the absence of ex-post evaluation studies on the impact of AAQ Directives, it is difficult to quantify the potential magnitude of these impacts.

There were no studies that were identified in respect of the AAQ Directives' effects on industry in this regard. This is likely to be because the effects are expected to be relatively targeted and localised, depending upon the affected industries' contribution to specific problems of exceedances.

Besides direct impacts of air quality, some of the urban traffic related measures such as, congestion charging zone, restriction of passenger vehicles in parts of city centre, speed restrictions in residential zones, etc., could also generate wider social benefits in terms of reduction in traffic related accidents. Rotaris et al. [S104] assessed the initial impacts of the Ecopass scheme in Milan which introduced a charging scheme to enter an 8 km^2 area of the Milan city centre from January 2008. Besides the benefits from air quality improvements and reduction in travel time, the study also estimated a benefit of €8 million from reduction in accidents during the first 11 months of operation of the Ecopass scheme.

In addition, passenger vehicle restrictions in city centres can also increase social cohesion. Often these schemes involve development of green infrastructure, new pedestrian zones and cycle paths, which can increase social activities and social cohesion in these areas, along with providing additional mental health benefits. However, these benefits are often very difficult to quantify, and it will be even more difficult to measure the contribution of AAQ Directives in such benefits.

It should be noted that some of the abovementioned urban traffic related measures could also have adverse cost impacts on the poorer fraction of the society due to an increase in transport costs and requirements to upgrade older non-compliant vehicles as a result of these measures. Moreover, a considerable body of evidence suggests that the people of lower socio-economic status tends to be more exposed to the air pollution problem. A recent EEA report [S128] found that areas characterised by lower socio-economic status (e.g. higher unemployment rate, lower proportion of population with higher education, lower average household income) tended to have higher levels of $PM_{2.5}$, PM_{10} and O_3 pollution. The report also noted that EU policies tend not to explicitly include actions targeting vulnerable groups.

Environmental Sustainability

As discussed under the Effectiveness section of the study, implementation of AAQ Directives has resulted in some improvements in air quality across Europe. However, besides the direct impacts on air quality improvements in Europe, there are likely to be further beneficial impacts in respect of reduced climate change emissions. The main areas where the two measures – improving air quality, and reducing fossil-related GHG emissions – come into conflict are in respect of switching between diesel and petrol-fuelled vehicles, and in respect of moves to greater burning of biomass. Other than where measures have led to these changes, reducing air emissions may also have reduced GHG emissions. Local measures on vehicle access charging and restriction have likely resulted in increased demand for low-emission vehicles with very low, or zero, CO_2 emissions, resulting in a further climate benefits.

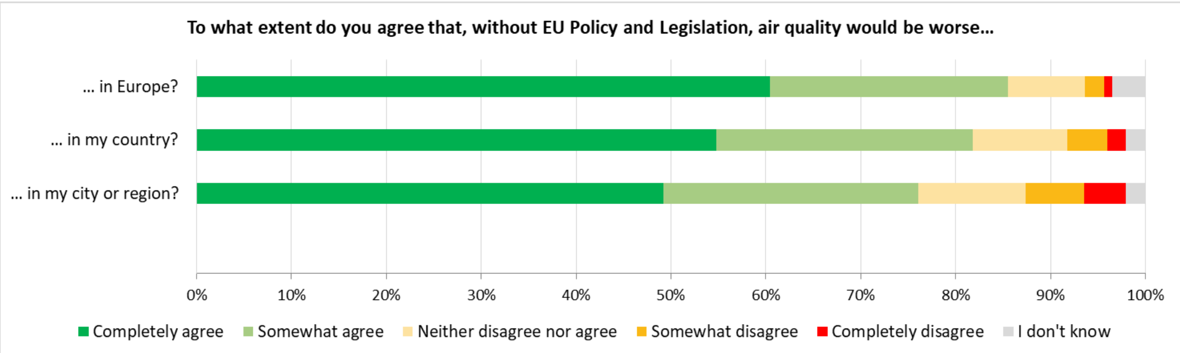
Implementation of the AAQ Directives resulted in reduced ozone formation directly through adopting the limit value on ozone concentration, and indirectly through control of methane and NOx emissions.

The outputs from the public consultation also provide stakeholder views on the extent to which the AAQ Directives have improved environmental sustainability. This is presented in Box 2.

Box 2: Stakeholder View on Environmental Sustainability of the AAQ Directives

Respondents were asked the extent to which they agreed that, without EU policy and legislation, air quality would be worse in Europe, the respondent's country, and the respondent's city or region. The results are presented in the Figure below. The majority of the respondents either completely agreed or somewhat agreed that EU policies and legislation had helped prevent worsening off air quality: the respondents felt this most strongly in relation to Europe as a whole, and they were slightly less positive about the effects in their city or region. Even so, the responses in respect of the city and region were largely supportive of EU policy and legislation's effect with more than 75% expressing agreement that in the absence of the policies and legislation, matters would be worse. Marginally more than 10% of respondents disagreed somewhat, or completely, that matters would have been worse in their city or region.

Figure 19: Open public consultation question: To what extent do you agree that, without EU policy and legislation, air quality would be worse…



Source: Open public consultation Question 3.6: To what extent do you agree that, without EU policy and legislation, air quality would be worse. (N=473-483 – different numbers of respondents for each statement)

Conclusions

Generally, there appear to be good reasons to believe that the AAQ Directives have enhanced economic, social and environmental sustainability.

The main concern one might have regarding economic sustainability relates to the matters we discussed under Questions 4 and 5, related to the potential for choosing measures to deal with poor air quality that are inefficient. Fundamentally, polluters should pay, but there is enough evidence in the review of measures to indicate that market based approaches to dealing with poor air quality, reflecting a polluter pays model, are not widely used.

F.8 Targeted Questionnaire Section on Efficiency

a) costs of assessment of ambient air quality (costs of measurement, calculations, predictions or estimations)

1. Estimates of the costs incurred

*a. the **<u>total</u>** capital cost, and the operating cost, of the complete monitoring infrastructure that is required to assess ambient air quality, as required by the AAQ Directives.*

If possible, please split between the costs induced by the AAQ Directives:

*b. the capital cost, and the operating cost, of the **<u>additional monitoring infrastructure</u>** that has been required in order to meet the requirements of the 2008 Directive)*

c. The costs of additional activities, such as modelling and health impact assessment

2. Where not included in the above, the costs of time spent by the relevant persons involved in the activity (either directly, expressed in EUROS, or as a number of full-time equivalent (FTE) staff involved in making measurements, calculations, predictions or estimations)

3. Information on what these costs cover, for example, whether they cover:

a. All automatic monitoring stations in the country (if so, how many?) or only those reported to the EEA.
b. Costs of other monitoring (e.g. passive samplers / diffusion tubes)
c. Costs of air quality modelling and health impact assessment
d. Both capital and operating costs
e. Administrative costs
f. Costs of data dissemination, e.g. to the public

Given that the questionnaire has been circulated to all Member States I suggest that we seek to tabulate information in a common style

*b) **Estimates of the costs associated with approval of measurement systems (e.g. standardising methods, calibrating equipment, engaging in networks and running laboratories);** (either directly, expressed in EUROS, or as a number of full-time equivalent (FTE) staff involved in the activity, or both)*

Could you please indicate the approximate share of these costs that are attributable specifically to complying with the terms of the Directive (and that would not have occurred in the absence of the Directive).

*c) **Estimates of the costs of ensuring the accuracy of measurements (if not included in the above), such as time spent undertaking quality assurance tasks;** (either directly, expressed in EUROS, or as a number of full-time equivalent (FTE) staff involved in the activity)*

Could you please indicate the approximate share of these costs that are attributable specifically to complying with the terms of the Directive (and that would not have occurred in the absence of the Directive).

*d) **Estimates of the costs of analysis of assessment methods;** (either directly, expressed in EUROS, or as a number of full-time equivalent (FTE) staff involved in the activity)*

Could you please indicate the approximate share of these costs that are attributable specifically to complying with the terms of the Directive (and that would not have occurred in the absence of the Directive).

e) ***Estimates of the costs of preparing air quality plans, and measures to maintain good air quality*** *(either directly, expressed in EUROS, or as a number of full-time equivalent (FTE) staff involved in the activity)*

Could you please indicate the approximate share of these costs that are attributable specifically to complying with the terms of the Directive (and that would not have occurred in the absence of the Directive).

Please indicate how many plans the data provided cover, for example whether they cover only national plans or also plans developed by local authorities and statutory agencies (such as environmental protection agencies).

f) ***Estimates of the costs related to informing the public (Art 26) about air quality*** *(either directly, expressed in EUROS, or as a number of full-time equivalent (FTE) staff involved in the activity)*

Could you please indicate the approximate share of these costs that are attributable specifically to complying with the terms of the Directive (and that would not have occurred in the absence of the Directive).

Specifically in relation to the requirements of Article 26, this requires Member States to provide, annually, reports which:

> *'summarise the levels exceeding limit values, target values, long-term objectives, information thresholds and alert thresholds, for the relevant averaging periods.* ***That information shall be combined with a summary assessment of the effects of those exceedances.'***

Could you please share the latest annual report which contains the summary assessment of the effects of the exceedances described above.

g) Estimates of costs related to reporting and transmission of information to the Commission (Art 27)

(either directly, expressed in EUROS, or as a number of full-time equivalent (FTE) staff involved in the activity)

h) The total costs of items a) to g) above.

(either directly, expressed in EUROS, or as a number of full-time equivalent (FTE) staff involved in the activity)

Could you please indicate the approximate share of these costs that are attributable specifically to complying with the terms of the Directive (and that would not have occurred in the absence of the Directive).

i) Are there ways in which you believe the monitoring, reporting and assessment regime in your Member State could be made more efficient *(e.g. cheaper for the same outcome)? Please elaborate on your response.*

5. ***Has guidance been developed or used in your country for the production and appraisal of air quality action plans?*** *If so, please provide references.*

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Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

Final Report

Appendix G: Detailed Evidence for Coherence

APPENDIX G DETAILED EVIDENCE FOR COHERENCE

The appendix presents more detailed evidence concerning the coherence of the AAQ Directives in support of the evidence and conclusions of the support study for the regulatory fitness check. The appendix goes more in-depth, presenting the evidence collected from the different data sources of the regulatory fitness check which were triangulated in the main report.

The evaluation of coherence included two questions. An overview of the questions, judgement criteria and main data sources is presented below.

Evaluation Question (EQ)	Judgement Criteria (JC)	Sources
Evaluation Question 7: To what extent do the AAQ Directives complement or interact with other environmental policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as the NEC Directive and IED Directive as well as EU climate legislation and policy); and how do these policies and legislation support or hamper the implementation of the EU air quality legislation?	The AAQ Directives are coherent internally and with each other The AAQ Directives are coherent with other air pollution legislation and policy including overarching EU Clean Air Policy, and EU's international commitments The AAQ Directives are coherent with other EU environmental legislation The AAQ Directives are coherent with EU climate policy and legislation (including international commitments) Member States have put in place an integrated approach to the implementation of the AAQ Directives and other environment and climate legislation and policy	Literature review Stakeholder consultation (open public consultation, targeted questionnaire, workshops) Case studies
Evaluation Question 8: To what extent do the AAQ Directives complement or interact with sectoral policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as energy, transport, agriculture, cohesion, fiscal policies); and how do these policies support or hamper the implementation of the EU air quality legislation?	The objectives of key EU sectoral policies support AAQ objectives, including public information EU funding instruments support MS actions to improve air quality EU/national fiscal policies or measures support MS actions to improve air quality EU-level coordination mechanisms support a coherent approach to achieving AAQ objectives An integrated approach at MS level	Literature review Stakeholder consultation (open public consultation, targeted questionnaire, workshops) Case studies

G.1 *Evaluation question 7: Coherence with environmental and climate policies*

This evaluation question asks: *To what extent do the AAQ Directives complement or interact with other environmental policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as the NEC Directive and IED Directive as well as EU climate legislation and policy); and how do these policies and legislation support or hamper the implementation of the EU air quality legislation?*

G.1.1 JC 7.1: The AAQ Directives are coherent internally and with each other

Approach

The assessment reviews coherence internally, i.e. within each of the two AAQ Directives, and between the two Directives. The assessment covers two complementary indicators for this topic:

- the two Directives do not have internal inconsistences; and
- the Directives are consistent between each other in terms of their objectives and provisions.

These indicators are considered together.

The assessment is carried out via a review of the historical development of the Directives, a comparison of their legal texts focusing on their objectives and key provisions, a review of implementing legislation and an overview of the perceptions of stakeholders.

Limitations to the approach

The approach to analysis is fairly straightforward and major limitations have not been identified. It should be noted that the assessment of the internal coherence of the AAQ Directives is separate from the assessment of their effectiveness, and the analysis presented here does not consider the effectiveness of the provisions of the Directive, nor whether specific areas where there are issues with coherence have led to issues for their effectiveness; however, the assessment of effectiveness did not find major issues related these areas where there issues concerning coherence.

Results

Historical development

According to Recital 3, Directive 2008/50/EC was adopted to incorporate the latest health and scientific developments and the experience of the Member States, and to improve clarity, simplification and administrative efficiency. Directive 2004/107/EC was one of the five 'Daughter Directives' of the previous legal framework. Both Directives were designed to avoid, prevent or reduce harmful effects of different pollutants on human health and the environment.

The Preamble of the 2008/50/EC Directive considers that once sufficient experience has been gained in relation to the implementation of Directive 2004/107/EC "consideration may be given to the possibility of merging its provisions with those of this Directive" (Paragraph 4, Preamble). Furthermore, the Impact Assessment prepared ahead of Directive 2008/50/EC states that "the Fourth Daughter Directive will be merged later through a simplified "codification" process". These statements confirm the complementarity of the 2004 Directive and the 2008 Directive.

Objectives

The two Directives share common objectives, though Directive 2008/50/EC includes two objectives not found in Directive 2004/107/EC (see the table below).

Table 1 Pollutants covered under the AAQD and under the NEC, MCP and IED

Objective	Directive 2004/107/EC	Directive 2008/50/EC
Avoiding, preventing or reducing harmful effects on human health and the environment	✓	✓

Objective	Directive 2004/107/EC	Directive 2008/50/EC
Establishing common methods and criteria for the assessment of ambient air quality	✓	✓
Ensuring that information is made available to the public	✓	✓
Maintaining air quality where it is already good and improving it in other cases	✓	✓
Obtaining information on ambient air quality to help combat air pollution, monitor long-term trends and improvements from measures		✓
Promoting increased cooperation between the Member States		✓

Notes: From Article 1 of each Directive. The objectives are paraphrased.

In each Directive, the objectives are then addressed by its provisions: this is a first example of their internal coherence. The provisions moreover contain a coherent structure of actions for air quality:

- Ambient air quality standards (target values and limit values) are set for key pollutants to protect human health and the environment
- Assessment requirements and common methods to determine ambient air quality levels
- Provisions for providing information on air quality to the public
- Requirements for action to maintain good air quality and improve it where necessary

Both Directives also contain mechanisms for their review, including to understand if updates are necessary to take into account technical and scientific progress.

These two additional objectives in Directive 2008/50/EC indicated in the Table above do not undermine the overall coherence with the 2004 Directive, as they provide support to reduced ambient air pollution in line with the common objectives.

At the same time, as noted above, Directive 2004/107/EC was historically one of the five daughter directives for air quality and the Preamble of Directive 2008/50/EC refers to its possible merger into the 2008 Directive. The latter Directive contains a range of provisions not found in the earlier Directive: these are gaps in coherence between the two Directives are described in the following paragraphs.

Limit values and target values

The analysis has identified three important and linked issues under the directives concerning their coherence: limit vs. target values, air quality plans and alert thresholds.

Directive 2008/50/EC includes both limit and target values, while Directive 2004/107/EC only includes target values which are to be attained *where possible* over a given period (within the established zones and agglomerations). According Article 3 of Directive 2004/107/EC or Article

17 of Directive 2008/50/EC, national measures to implement target values should not entail disproportionate costs; however, for an ambient air quality limit value, on the other hand, the obligation is binding as to the concentration to be achieved. The 2008 Directive requires Member States to put in place the necessary plans and programmes when any limit value or target value is exceeded. The 2008 Directive is, therefore, more stringent. Moreover, there is a difference in treatment of pollutants, as those under the 2004 Directive only have target values.

In addition, there is an issue of internal coherence for Directive 2008/50EC, which sets both annual and short-term limit values for SO_2, NO_2 and PM_{10} but only an annual limit value for $PM_{2.5}$.

Air quality plans

Directive 2008/50/EC obliges Member States to develop air quality plans setting measures to address exceedances of target values and limit values (as well as short-term action plans to address risks that alert thresholds will be exceeded). The 2004 Directive does not mention the development of air quality plans as such where there are exceedances of its target values. It does state that Member States are required to submit the measures taken, not entailing disproportionate costs, in order to attain the target values.

Alert Thresholds

Alert thresholds are established under Article 13 and 19 and Annex XII of Directive 2008/50/EC to prevent impacts to human health in the short-term, during pollution peaks. However, alert thresholds are only set for SO_2 and NO_2, while none are set for PM_{10} or $PM_{2.5}$. This appears to indicate a lack of internal coherence in this Directive in the approach regarding the different pollutants[1].

Monitoring stations

The European Court of Auditors [P91] raises an issue about the internal coherence of Directive 2008/50/EC concerning monitoring: while Member States should maintain sampling points for diffuse sources of PM_{10} where there has been an exceedance in the last three years (Annex V of the Directive), a similar time period is not set for other pollutants such as NO_2 and $PM_{2.5}$.[2]

In the targeted questionnaire, further points were raised about the coherence of monitoring provisions. An NGO response raises issues of internal coherence for Directive 2008/50/EC concerning the relationship between the minimum number of monitoring stations, which is set by zone/agglomeration, and the ratio of urban and traffic stations, which is set across all Member State territory[3].

A further comment refers to reference methods, which are provided for fixed sample points (i.e. for monitoring) but not for modelling[4].

Supporting regulatory acts

The AAQ Directives are supported by regulatory acts. Provisions for the implementation of the Directives are set out in Implementing Decision 2011/850/EC on the reciprocal exchange of information and reporting on ambient air quality. Directive 2015/1480 amending the 2004 and 2008

[1] The Commission's proposal for the Directive [P2] also set alert thresholds for SO_2 and NO_2 but not for PM_{10} or $PM_{2.5}$.

[2] These provisions concerning the three-year period for sampling points for PM_{10} are not found in the Commission proposal for the Directive [P2], and thus would have been introduced in interinstitutional negotiations.

[3] The specifications concerning the relationship between the minimum number of monitoring stations, set by zone/agglomeration, and those concerning the ratio of urban and traffic stations, which is set across all Member State territory, are also found in the Commission's proposal for the Directive [P2].

[4] The Commission's proposal for the Directive [P2] also provides reference methods for monitoring but not modelling.

Ambient Air Quality Directives laying down rules concerning reference methods, data validation and location of sampling points clarifies provisions in the AAQ Directives.

The Implementing Decision sets out methods and requirements for reporting. The Implementing Decision is coherent with the Ambient Air Quality Directives: it supports reciprocal exchange of information, thereby promoting increased cooperation between Member States, which is listed among the objectives of the 2008 Directive but not the 2004 Directive.

The provisions of Commission Directive 2015/1480 include the improved clarification of the reference methods and requirements for quality assurance. This Directive thus strengthens monitoring under Directives 2004/107/EC and 2008/107/EC: it is coherent with these two Directives.

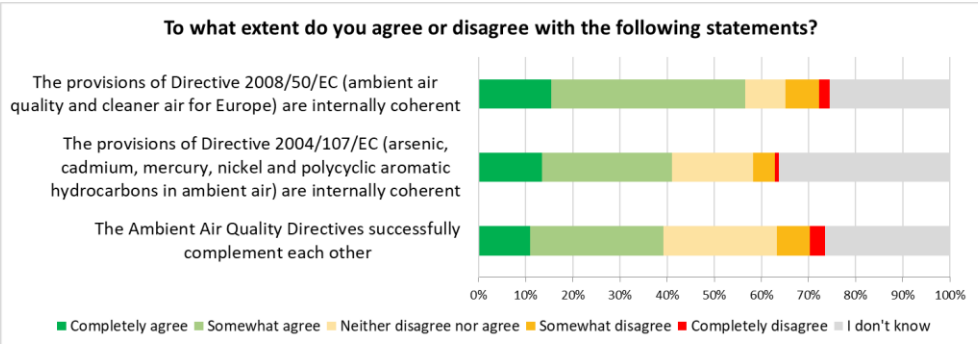
An overall finding is that the AAQ Directives form a coherent regulatory system to improve air quality in the EU: the Directives, including the supporting regulatory acts, complement each other.

Stakeholder responses
In the open public consultation included questions on the internal coherence of the AAQD, high shares of respondents perceived that the AAQD were internally coherent and coherent with each other.

Text box 1 Public consultation responses on internal coherence

In total, 56% of respondents indicated that they either ‘completely agree’ or ‘somewhat agree’ that the provisions of Directive 2008/50/EC are internally coherent; only 9% ‘somewhat’ or ‘completely’ disagreed; and 26% responded ‘I don’t know’. The total for these two positions is lower for Directive 2004/107/EC, 41%, and 36% responded ‘I don’t know’. A total of 39% of respondents either ‘completely’ or ‘somewhat’ agreed that the AAQD ‘successfully complement each other’; here, 26% responded ‘I don’t know’, though a high share (24%) neither agreed nor disagreed.

Figure 1 OPC responses on internal coherence



For the targeted questionnaire, 15 of the 41 responses referred to internal coherence. One response, from Client Earth with other environmental NGOs, stated that the overall structure of the AAQ Directives establishes a system of objectives and measures that are generally coherent and mutually supportive. This response, however, raises several issues including the lack of limit values under Directive 2004/107/EC and short-term limit values for $PM_{2.5}$ under Directive 2008/50/EC, a topic noted also by other respondents. Several respondents, including Client Earth and one Member State, note that target values are less stringent than limit values and as a result have received less Member State attention in implementation of the AAQD. These responses thus support the analysis from the desk research.

G.1.2 JC 7.2: The AAQ Directives are coherent with other air pollution legislation and policy including overarching EU Clean Air Policy, and EU's international commitments.

Approach

The assessment covers three closely linked indicators:

- Coherence with the 2013 Clean Air Policy Package, in terms of: objectives
- Coherence with other EU air pollution legislation, in terms of 1) their objectives and 2) their provisions
- Coherence with the objectives of the CLRTAP and other international air pollution commitments

The evidence has been collected from desk research, including the legislative and policy documents under consideration, the impact assessment of the Clean Air Policy Package and several key studies.

The assessment considered synergies and gaps at the level of the *objectives* of these policy and legislative documents as well as their *provisions*. It also considered the synergies and gaps of the AAQ Directives towards these documents.

Limitations to the approach

One limitation is that the sources consulted did not provide in-depth information on Member State implementation of EU air pollution legislation; this is due in part to the fact that the results of key legislative provisions introduced over the evaluation period, such as the strengthened requirements to ensure links between National air pollution control programmes (NAPCPs) under the Industrial Emissions Directive (IED) and the AAQ Directives were not yet evident. (The impact assessment of the Clean Air Policy Package noted gaps earlier in the evaluation period that were addressed in the Package.)

Results

Indicator 1: Coherence with the objectives of the 2013 Clean Air Policy Package

The Clean Air Policy Package was published by the European Commission on 18 December 2013, setting out objectives for reducing the health and environmental impacts of air pollution by 2030. It contained *The Clean Air Programme for Europe* [P37], a Commission strategy outlining measures to address air pollution.

The Clean Air Programme for Europe confirms the approach to tackling ambient air quality taken by the AAQD and highlights the problems of compliance with the EU's air quality standards: 'EU air quality standards are widely exceeded in densely populated areas'. The impact assessment for Clean Air Policy Package [P41] calls for 'greater coherence' across policy instruments.

The Programme focuses on achieving compliance with air quality targets by 2020 as well as setting background concentration levels on a downward trend via longer-term *objectives* for 2030: a 52% reduction in health impacts and a 35% reduction in ecosystem area exceeding eutrophication limits (both compared to 2005 levels)[5]. As such, the Programme supports the implementation

[5] The health objectives refer to premature mortality due to particulate matter and ozone. The Programme indicates that without the Package, health impacts were projected to fall 40% by 2030 and ecosystem area by 22%.

and enforcement of the AAQD and there is a strong coherence between the Programme and the Directives.

The Programme also states that the "long-term EU objective for air pollution implies no exceedance" of WHO guidelines for human health, nor of "critical loads and levels which mark the limits of ecosystem tolerance". Directive 2008/50/EC refers to WHO standards in its Preamble (recital 2) but does not contain provisions to attain these standards; moreover, the Directive, while protecting vegetation and ecosystems by setting critical levels (e.g. in Annex XIII for SO_2 and NOx), does not refer to levels to ensure ecosystem tolerance. Consequently, there are gaps in coherence, as the AAQD do not fully support the long-term objectives of the Programme, which may be explained by the fact that the Programme was not in place at the time of adoption of the AAQD.

The Package included a revision of the National Emissions Ceilings Directive and a proposal for a Directive on emissions from Medium Combustion Plants (both discussed under indicator 2), as well as proposal to accept an Amendment to Abate Acidification, Eutrophication and Ground-level Ozone under the Convention on Long-Range Transboundary Air Pollution (the Convention is discussed under indicator 3 below).

In conclusion, the objectives of the Programme are strongly coherent with the AAQ Directives. The Programme itself involves actions in different areas, including those for air emissions as well as key sectors. The impact assessment of the Programme [P41] highlights that the set of actions can together bring improvements in air quality.

The AAQD were in place before the 2013 Clean Air Policy Package and thus do not refer to *The Clean Air Programme for Europe* and its new objectives for 2030. Nonetheless, Directive 2008/50/EC states in its Preamble (recital 2) that 'World Health Organisation standards, guidelines and programmes' should be taken into account in ambient air quality objectives: consequently, it sets a similar overall objective. (Directive 2004/107/EC does not refer to WHO guidelines: the latter, however, cover four pollutants – particulates, ozone, nitrogen dioxide and sulphur dioxide – and thus do not address the pollutants covered in the 2004 Directive.)

Indicator 2: Coherence with other EU air pollution legislation

The assessment for this indicator focuses on three directives: the National Emissions (NEC) Ceiling Directive, the Medium Combustion Plant (MCP) Directive and the Industrial Emissions Directive (IED). The table below provides an overview of the pollutants covered by the AAQD and other EU air pollution legislation.

Table 2 Pollutants covered under the AAQD and under the NEC, MCP and IED

Pollutants	AAQD	NEC	MCP	IED
SO_2	2008/50/EC	✓	✓	**
NO_x	2008/50/EC	✓	✓	**
PM_{10}	2008/50/EC			***
$PM_{2,5}$	2008/50/EC	✓		✓
Pb	2008/50/EC			✓
C_6H_6	2008/50/EC			

Pollutants	AAQD	NEC	MCP	IED
CO	2008/50/EC		✓	**
O_3	2008/50/EC	*	*	*
As	2004/107/EC			✓
Cd	2004/107/EC			✓
Hg	2004/107/EC			✓
Ni	2004/107/EC			✓
B(a)P	2004/107/EC			
NMVOC		✓		
NH_3		✓		
Dust	***		✓	**
VOCs				✓
Metals and their compounds	****			✓
Asbestos				✓
Cl				✓
F				✓
CN				✓
CMR Substances				✓
PCDDs				✓
PCDFs				✓

Notes:

* O_3 (ozone) in the troposphere is not emitted directly from pollution sources but is formed from photochemical reactions of 'primary' pollutants: ambient levels of O_3 are largely due to reactions in atmosphere of the three types of primary pollutants – nitrogen oxides, carbon monoxide and volatile organic compounds (VOCs).

** Pollutants listed in the technical provisions of the IED relating to combustion plants

*** Note that 'dust' encompasses PM_{10} and $PM_{2.5}$.

**** Note that 'metals and their compounds' encompass Cd, Hg, Ni.

The AAQD address ambient air quality while the NEC, MCP and IED address emissions: in principle, one aspect of coherence will be to have the emissions-oriented directives cover the same pollutants as the AAQD. However, there is not always a direct relationship: as noted below the table, tropospheric ozone levels result from precursors including NO_x, VOCs and NH_3.

The table shows that most of the pollutants addressed under the AAQD are covered by NEC, MCP or IED. One of the pollutants not covered by the latter three directives is ozone, whose precursors are nevertheless addressed: for example, VOCs and ammonia under the NEC; NOx under all three directives. Benzene and Benzo(a)pyrene are not covered by the three directives (both arise from vehicle emissions, Benzene also from industry and Benzo(a)pyrene from domestic wood and coal combustion).

The **NEC Directive** provides the framework aiming to ensure the implementation of the EU emission reduction commitments for 2020 and 2030 agreed under the LRTAP Convention (Convention on Long-range Transboundary Air Pollution). It sets limits on the amount of air pollutants which can be emitted by each Member State, requiring them to adopt National Air Pollution Control Programmes.

The *objective* of the National Emissions Ceilings (NEC) Directive 2016/2284/EU is to move towards achieving levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment (Article 1), contributing to achieving the air quality objectives set out in EU legislation, as well as aiding progress towards the EU's long-term objective of meeting WHO's air quality guidelines.

This objective is coherent with the objectives of the AAQD, which are also focused on preventing and reducing the effects on human health and the environment as a whole of their respective pollutants.

Key *provisions* of the NEC Directive that interact with the AAQD are listed below:

- National emission reduction commitments: the Directive sets Member State limits on emissions of nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO_2), ammonia (NH_3) and fine particulate matter ($PM_{2.5}$) (Article 4). Three of these pollutants coincide with those covered by the AAQD, as outlined in the table above. Moreover, the NEC addresses NO_2 and VOCs, two of the main ozone precursors.

- National air pollution control programmes (NAPCPs): the Directive requires Member States to draw up, adopt and implement national air pollution control programmes (Article 6). These programmes should assess the national emission sources likely to have an impact on air quality, take account of the need to reduce air pollutant emissions, prioritise emission reduction measures for black carbon when taking measures to achieve the national reduction commitments for fine particulate matter, and ensure coherence with other relevant plans and programmes. The last requirement is applicable also to the air quality plans set up under the AAQD. At the same time, the AAQD air quality plans address exceedances at in zones and/or agglomerations, and thus are in most cases prepared at the zone or agglomeration level; while NAPCPs under the NEC Directive are prepared at national level. Member States will need to address this difference in geographical scales; overall, however, air quality plans may support Member States in achieving their obligations under the NEC Directive.

As the first NAPCPs were to be submitted by Member States by 1 April 2019 (Article 10), and the conclusion of this report predated that deadline, it was not possible to determine the impact of these programmes, nor the degree to which Member-State level implementation is coherent with the AAQD objectives.

- Monitoring air pollution impacts: the NEC Directive includes the obligation that Member States coordinate with other monitoring programmes established under EU Legislation (Article 9), including the AAQD relevant requirements.

The 2013 Clean Air Policy Package introduced the requirements for national programmes to assess impacts on air quality and ensure coherence with other plans, including air quality plans under the AAQD, as well as coordination with air quality monitoring: on this basis, the 2016 revision of the NEC Directive strengthened coherence with the AAQD, compared to the previous NEC Directive, 2001/81/EC, as amended before 2013.

Indeed, the impact assessment for Clean Air Policy Package [P41] calls for 'greater coherence' across policy instruments and refers in particular to 'untapped synergies between the AAQD and NECD': consequently, prior to the Package and the 2016 revision of the NEC Directive, there were gaps in coherence. These were addressed in particular by the introduction of ceilings for $PM_{2.5}$ emissions along with the requirements to link NAPCPs with air quality and to coordinate monitoring with the AAQDs.

In turn, the AAQD – specifically Directive 2008/50/EC – refers to the NEC Directive: the Preamble to this Directive notes the link between emissions ceilings and ozone levels (13) and states that progress towards the targets and long-term objective for ozone should be determined by the emissions ceilings (for ozone precursors) as well as air quality plans. Moreover, air quality plans should be consistent with and integrated with plans and programmes prepared under the NECD (18).

In reducing air emissions, the NEC Directive's objectives and its provisions should support those of the AAQD. The impact assessment of the NEC Directive [as summarised in P43] indeed underlines its role in improving air quality, in particular in the time period to 2030: while health burdens and eutrophication were falling the baseline scenario, the revision of Directive would reduce the health burden of air pollution by a further 25%, while eutrophication levels would fall an additional 50% on top of the baseline trend.

The **Medium Combustion Plants Directive** (2015/2193/EU) regulates pollutant emissions from combustion plants with a rated thermal input equal to or greater than 1 megawatt (MW) and less than 50 MW. It complements EU legislation for large combustion plants (> 50 MW), covered under the Industrial Emissions Directive (IED) and for smaller appliances (heaters and boilers <1 MWh) covered by the Ecodesign Directive.

The MCP Directive refers to the 2030 *objectives* of Clean Air Programme and moreover indicates that its objectives are "the improvement of environmental quality and human health" (recitals 8 and 33). Recital 24 also considers potential interactions between the MCP Directive and the 2008 AAQD but notes that Member States are not prevented from implementing more stringent air quality protections than those in the MCP Directive as part of air quality plans under the 2008 AAQD.

Key *provisions* of the MCP Directive which interact with the AAQD are:

- Permits, registration: the MCP Directive states that any new medium combustion plant operated has a permit or is registered, as well as ensuring that old MCPs have a permit or are registered by 2024 and 2029 (depending on capacity) (Article 5).

- Emission limit values: the Directive sets emission limit values for sulphur dioxide (SO2), nitrogen oxides (NOx) and dust (particles) from medium combustion plants. Furthermore, the Directive contains a reference to the 2008 AAQD, specifying that in zones not complying with the air quality limit values set up under the AAQD, the Member States will assess the need to apply stricter emission limit values than those set out in the MCP Directive (Article

6). As limiting source-emissions contributes to improving ambient air quality and the AAQD is specifically mentioned, these provisions are assessed to be coherent.

The impact assessment for the Clean Air Policy Package [P41], which included this Directive, highlights that it would reduce emissions of SOx, NOx and particulates. It addresses sources such as district heating plants and industrial facilities that are often close to settlements, and thus can have an important effect on air quality. Consequently, the objectives and provisions of the MCP Directive support those of the AAQD[6]. (The AAQD do not refer to the MCP Directive, which was introduced after them.)

The **Industrial Emissions Directive** 2010/75/EU lays down rules on the prevention and control of pollution arising from industrial activities, as well as prevent (or reduce) emissions into air, water and land. It incorporates emissions standards for large combustion plants. The IED states (Article 1) that its *objective* is to achieve a high level of protection of human health and of the environment.

Key *provisions* of the IED related to the AAQ Directives include the following:

- Specific emission limit values for large combustion plants (50 MW and larger) for a number of pollutants, most but not all of which are included in the AAQD (see table above).
- Best Available Techniques (BAT): the IED specifies that permit conditions for operators must be based on the Best Available Techniques (BAT), in turn based on BAT reference documents. These documents are used by competent authorities to set the emission limit values for operators (under normal operating conditions). As these provisions are meant to further address the emission of pollutants (including the ones listed in the AAQD) into ambient air (as well as to water and soil).

The 2010 IED incorporated and revised prior EU directives [P16, P17]. Notably, the IED clarified and strengthened the concept of BAT and revised the minimum emissions limit values for large combustion plants: these changes strengthened provisions related to air emissions, and the impact assessment for the IED indicated that it would contribute to meeting air quality targets.

The European Court of Auditors [P91] has noted that the IED still 'allows Member States to set less stringent emission limit values' if they determine that BAT would lead to 'disproportionately higher costs' than the environmental benefits, and also provides for 'flexibility instruments', under which some Member States have less stringent standards for certain plants, such as district heating.

The AAQD refer to the Large Combustion Plant (LCP) Directive, which was incorporated into the IED: the Preamble (recital 18) to Directive 2008/50/EC calls for air quality plans to be consistent with and integrated with plans and programmes prepared under the LCP Directive; this is also stated in Art. 23(2) of Directive 2008/50/EC. The Preamble to Directive 2008/50/EC also states that air quality plans should take into account permits under the former Integrated Pollution Prevention and Control (IPPC) Directive, 2008/1/EC, which was incorporated in the IED; Art. 23(2) of Directive 2008/50/EC does not, however, contain a similar provision.

The 2013 Clean Air Programme noted the importance of full implementation of the IED for air quality in terms of achieving air quality objectives, but also noted that the review of BAT reference

[6] As the AAQDs were adopted prior to the MCP Directive, they do not include specific references to this Directive

documents was underway and moreover that the effectiveness of the IED would also depend on MS application of these documents. Consequently, the objectives of the IED support those of the AAQD; so do its provisions, though its flexibility allow variations in MS implementation.

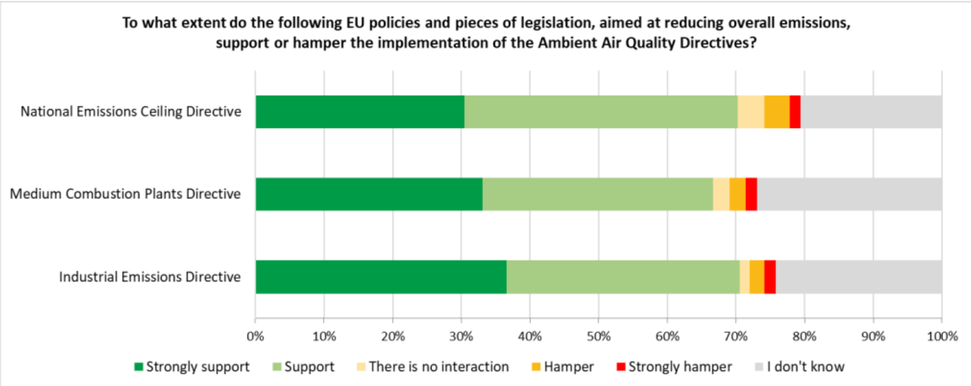
Key results from stakeholder consultations

Responses to the open public consultation indicated that the NEC, MCP and IED Directives support the implementation of the AAQD (see the box below).

Text box 2 Public consultation responses on the NEC Directive, MCP Directive and IED

For all three Directives, the average score is over 4.0 on a scale of 1 (not at all) to 5 (to a very large extent). For all three Directives, over 30% of respondents replied that they strongly supported implementation of the AAQD and over 30% replied that they support its implementation.

Figure 2 OPC responses on coherence with the NEC Directive, MCP Directive and IED



In a position paper submitted to the OPC, one stakeholder expressed concerns that the scope of the MCP Directive may leave gaps in the legislative framework with respect to small space heating and power plants.

Almost half of the responses to the targeted stakeholder consultation (18 out of 41) at least mention other air legislation. For the most part, these responses support the conclusion of the desk research that the NEC, MCP and IED are coherent with the objectives of the AAQD: for example, the response by Client Earth, with other environmental NGOs, stated that these three Directives "play an important role in achieving the goals established by the AAQ Directives". Regarding the NEC Directive, one MS ministry noted that its emission inventories are prepared using a top-down method, while for local air quality plans more detailed local inventories are needed and the two approaches may yield differing results. Regarding the IED, one public authority stated that small sources such as household heating had greater contributions to air quality than a major polluting facility; this response as well as an industry response indicated concerns about the cost of investments to meet IED requirements.

In an ad hoc contribution to the fitness check, a port authority expressed concerns that the treatment of biomass combustion under the MCP Directive may lead to higher air pollutant emissions.

Indicator 3: Coherence with international air pollution commitments

The assessment for this indicator focuses on two international agreements: the Convention on Long-range Transboundary Air Pollution (CLRTAP) and international rules for air pollution from ships under the International Convention for the Prevention of Pollution from Ships (the revised MARPOL Annex VI).

The **Convention on Long-range Transboundary Air Pollution** (CLRTAP), an international agreement covering the UNECE region, establishes a broad action framework on air pollution, with the *objective* of protecting people and the environment against air pollution. The Parties commit to undertaking information exchanges, consultation, research and monitoring and to develop policies and strategies to combat the discharge of air pollutants. The objectives support those of the AAQD. EU incorporates the emissions reduction provisions of the CLRTAP and its Protocols via the NEC Directive, so these are not further addressed here (see, however, discussion of the NEC Directive above).

In 2008, the International Maritime Organisation (IMO) adopted amendments to Annex VI to the **International Convention for the Prevention of Pollution from Ships** (the *revised MARPOL Annex VI*) containing regulations for the prevention of air pollution from ships. The main changes introduced aimed at the progressive reduction in SO_X, NO_x and PM emissions, as well as the introduction of emission control areas, which aim to contribute to reducing concentrations of the above-mentioned pollutants in cities and coastal areas worldwide.

The Revised MARPOL Annex VI came into force on 1 July 2010 and Directive 2012/33/EU introduced into EU law one of the main changes of the revision, namely the mandatory use of marine fuels with a maximum sulphur content of 0.10% in European SO_X Emission Control Areas and, as of 2020, 0.50% sulphur content in SO_x in all other EU waters. Directive (EU) 2016/802 now incorporates previous EU level legislation on sulphur, including Directive 2012/33/EU and, implicitly, the revised Annex VI to the MARPOL Convention. As both the revised MARPOL Annex VI, as well as Directives 2016/802 (Article 1), aim to reduce emissions of sulphur dioxide and the reduction of harmful effects of such emissions on humans and the environment, their objectives and provisions support the objectives of the AAQD.

The Preamble of Directive 2008/50/EC refers to the Convention on Long-Range Transboundary Air Pollution. The Statement by the Commission accompanying this Directive refers to ongoing efforts to reduce air emissions from ships in the context of the International Maritime Organization, which were then realised in the 2008 amendments to the International Convention for the Prevention of Pollution from Ships (addressing SO_x, NO_x and PM emissions).

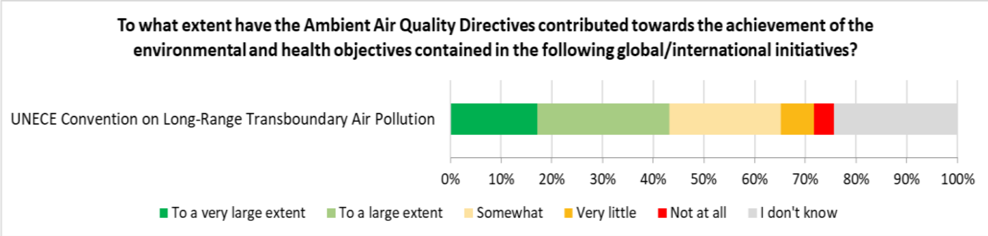
Overall, the *objectives* and *provisions* of these two international agreements are assessed as strongly coherent with those of the AAQ Directives. Coherence grew stronger over the evaluation period, in particular with the introduction of Revised MARPOL Annex VI.

Key results from stakeholder consultations

In the open public consultation (see the box below) and the targeted questionnaire, respondents perceived that the AAQD were coherent with these international agreements.

The OPC asked if the AAQD contributed to the objectives in the CLRTAP. Over 40% of the respondents felt that they contributed to the CLRTAP's objectives 'to a very large extent' or to 'to a large extent', while only 11% replied that they contributed 'very little' or 'not at all' (see the figure below).

Figure 3 Open public consultation results concerning the CLRTAP



In the targeted questionnaire, 13 of the 41 responses referred to international issues. For example, two respondents noted that CLRTAP is leading to reductions in air pollutant emissions across the UNECE region, thus contributing to better air quality in the EU. Moreover, one respondent stated that the MARPOL restrictions affecting maritime SO_2 emissions have had positive impacts on air quality around Baltic Sea ports. A further comment highlighted that the common approach to monitoring under the AAQD provided an international reference point.

G.1.3 JC 7.3: The AAQ Directives are coherent with other EU environmental legislation

Approach

This criterion examines the coherence between the AAQ Directives and key EU environmental legislation. The analysis covers the following indicator:

- Coherence with key EU environmental legislation and policy, in terms of 1) objectives and 2) provisions

The analysis covers selected EU environmental legislative and policy documents across three categories: overarching policy documents; key cross-cutting policies and legislation; and key areas of environmental legislation with strong links to air quality[7].

Evidence has been collected from desk research, mainly an analysis of the legislative and policy documents under consideration; relevant studies were found, notably for the Nitrates Directive.

The assessment considered the *objectives* of these policy and legislative documents as well as their *provisions* in terms synergies and gaps with the objectives and provisions of the AAQ Directives.

Limitations to the approach

EU environmental legislation and policy cover a broad range of issues, including overarching policy documents, cross-policies and legislation, specific environmental themes and financing. Many of these are likely to have some interaction with the AAQ Directives. Here, the analysis focuses on a selected set of key policy and legislative documents which appear to have the strongest links.

As for JC 8.2, one limitation is that the desk research did not provide in-depth information on Member State implementation of EU environmental legislation.

[7] Financing for the environment provided by the EU LIFE Programme is addressed separately under JC9.2 on EU financing.

Results

The assessment covers the policy documents and legislation shown in the following table:

Table 3 EU Environmental legislation and policy documents assessed for JC8.3

Legislation and policy documents
Overarching policy document
6th and 7th Environmental Action Programme
Cross-cutting policies and legislation
Circular Economy Package
Green Public Procurement
EIA and SEA Directives
Key areas of environmental legislation that can interact with the AAQD
Nitrates Directive
Noise Directive
Habitats and Birds Directives

Overarching policy documents

Under Article 132(3) of the TFEU, the EU's priority environmental objectives should be set out in a general environmental action programme. The **7th Environmental Action Programme** (7th EAP), from November 2013, provides a framework for European environmental policy until 2020 [P106]. The Programme calls for full compliance with EU air quality legislation by 2020, as well as reducing air pollution impacts on ecosystems and biodiversity, as part of its first Priority Objective: to protect, conserve and enhance the Union's natural capital. Under its third Priority Objective – to safeguard the Union's citizens from environment-related pressures and risks to health – the 7th EAP calls for significant improvement of air quality by 2020, "moving closer to WHO recommended levels". The Programme moreover calls for managing synergies and trade-offs with climate and other environmental objectives. This overarching policy document is thus strongly coherent with the AAQD, and indeed calls for their full implementation.

Monitoring of performance in meeting the objective is also aligned with the 2008 AAQD: The EEA monitors progress against this goal by measuring exceedances in urban areas of the air quality standards in the 2008 AAQD[8].

The 7th EAP follows the **6th Environmental Action Programme** (6th EAP) [D87], published in 2001, which set an objective that air quality levels 'do not give rise to unacceptable impacts on, and risks to, human health and the environment'; the 2004 and 2008 air quality directives both refer to the 6th EAP in their first recitals. The 7th EAP continued the strong level of coherence in the previous document.

[8] According to the EEA's 2017 Environmental Indicator Report, it is unlikely that this goal will be met by 2020 due to widespread exceedances in urban areas. The main causes for this are reported to be emissions from the transport sector (particularly road transport) and residential combustion in urban areas.

The 6th EAP is mentioned in first recital of both the 2004 and 2008 Air Quality Directives: the AAQD are thus coherent with this overarching policy document (the 7th EAP was published after the Directives). One gap in coherence, however, concerns long-term objectives: Directive 2008/50/EC also refers to WHO standards in their Preamble (recital 2), but do not contain provisions for reaching these standards (this is also an issue with the 2013 *Clean Air Programme*, described under JC8.2 above).

Cross-cutting policies

The 2015 **Circular Economy Package** (COM (2015) 614 final) sets out actions to be taken at the EU-level to support the transition to a circular economy in which the consumption of resources is decoupled from economic growth and waste and pollution are reduced. The links between the Circular Economy Package and air quality are rather general in nature. The package itself does not specifically target air quality objectives; nonetheless, air quality is mentioned in the Communication [P47], in relation to reduced air pollutant emissions as a result of improved waste management practices.

The objectives of the circular economy package and EU air quality policy are compatible: it can be expected that actions taken in one area will support the objectives of the other area. For example, circular economy actions taken to improve the resource efficiency of industrial processes or to reduce the disposal of waste to landfill are likely to contribute to reduce ambient air pollution. Measures taken to reduce microplastic pollution (e.g. from tyres) under the Plastics Strategy (COM(2018) 28 final), which falls within the Circular Economy Package, could contribute to reduced particulate matter concentrations.

The AAQ Directives do not refer to the 2015 Circular Economy Package, which was published after them, or circular economy goals.

Green public procurement (GPP) is a voluntary initiative to encourage public authorities to purchase of environmentally friendly goods, services and works and thus reduce impacts on the environment. In a 2008 Communication, 'Public procurement for a better environment' [P19], the European Commission set out these objectives. The Commission has moreover promoted common criteria for a range of sectors, from cleaning products and services to office buildings to transport. The criteria refer, among other impacts, to air pollution: for example, the criteria for transport [P35] encourage procurement of low-emission vehicles among the approaches to reduce air emissions. Consequently, both the *objectives* and *detailed documents* of the GPP policy are strongly coherent with the AAQD. The AAQD, however, do not refer to green public procurement.

Key areas of environmental legislation

The **Nitrates Directive** (91/676/EEC) aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices.

There is an indirect link between actions to address water pollution from nitrates and those to address air quality. Nitrates runoff derives from the application of both animal manure and inorganic fertiliser in agriculture. Manure and fertiliser are also sources of air emissions, in particular nitrogen oxides (NO_x)[9] and ammonia (NH_3), a precursor of $PM_{2.5}$. These emissions come from fertiliser applications to soil and from livestock housing and manure storage systems. As NH_3 is

[9] However, the exact extent of the impact of NO_x emissions from these sources on overall NO_2 concentrations in ambient air in cities is uncertain.

one of the main precursors of $PM_{2.5}$, measures aimed at limiting NH_3 ground and surface water pollution also have an impact on the reduction of $PM_{2.5}$ concentrations. By addressing the practices that lead to nitrate concentrations in ground and surface waters, the Nitrates Directive helps reduce concentrations of air pollutants [P23], as these practices also contribute to NO_x and NH_3 emissions. However, the exact extent of the impact of NO_x emissions from these sources on overall NO_2 concentrations in ambient air is somewhat uncertain, as a combination of factors (including application method, soil type, and local climate conditions) influence air emissions of nitrogen from fertiliser use [S66].

The Nitrates Directive has the objective of reducing water pollution caused or induced by nitrates from agricultural sources and preventing further such pollution. As the *objective* is limited to water pollution, there is no direct interaction with the AAQD.

The *provisions* of the Nitrates Directive, however, may support reductions in air pollution and thus could support better air quality. Under the Directive, Member States should establish action programmes in designated vulnerable zones, with the aim to reduce water pollution caused or induced by nitrates from agricultural sources and prevent further such pollution. Although the measures to be contained in the action programmes do not make any reference to ambient air quality, they may reduce air emissions.

The AAQD, in turn, do not refer to the Nitrates Directive.

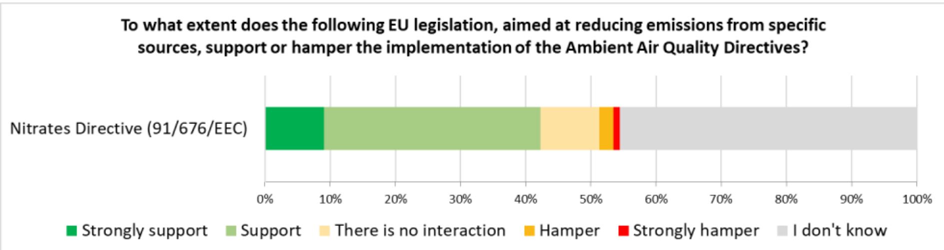
The potential to reduce emissions is seen in a study for the European Commission on the impact of the Nitrates Directive [S2]: the study, based on modelling, concludes that implementation of measures in the Action Programmes under the Nitrates Directive helped to decrease the gaseous Nitrogen emissions in the period 2000-2008. This study indicates that the provisions of the Nitrates Directive have in part supported the achievement of the AAQD objectives.

A high share of respondents to the open public consultation also perceived that implementation of the Nitrates Directive supported the AAQD (see the box below).

Text box 3 Public consultation responses on the Nitrates Directive

In the open public consultation, over 30% of respondents perceived that the Nitrates Directive supported the AAQD and almost 10% that it 'strongly' supported the AAQD. In contrast, under 5% of respondents indicated that the Nitrates Directive hampered or strongly hampered the AAQD. (It can be noted that a large share – over 40% – answered "don't know" regarding the interactions of the Nitrates Directive and the AAQD.)

Figure 4 OPC responses on coherence with the Nitrates Directive



The **Noise Directive** (2002/49/EC) is the main EU instrument to identify noise pollution levels and trigger action at Member State and EU level. Under the Directive, Member States are required to prepare and publish noise maps and noise management action plans for certain agglomerations, roads, railways and airports.

In 2016, a report [S120] from the European Commission's Science for Environmental Policy reviewed academic research on links between noise and air pollution and socioeconomic status: it noted that cities are both noise and air pollution hotspots. Due to industry and transport representing common sources of both noise and air pollution at city level, measures aimed at addressing noise pollution may have an impact on ambient air quality, and vice versa. Furthermore, some psychological and physical health impacts, such as heart disease, are associated with both types of pollution. In 2018, WHO/Europe published guidelines for noise for the European region [P136]. These guidelines highlight that noise and other environmental pressures, including air pollution, can have a cumulative effect on human health. The guidelines call for a coordinated approach to the control of noise sources and other environmental health risks, including those related to air pollution.

The *objective* of the Noise Directive refers to addressing harmful effects due to exposure to environmental noise. The Directive does not refer to air quality. The *provisions* of the Noise Directive, such as the preparation of action plans, pertain to the reduction and prevention of environmental noise and do not address air quality. However, as noted above, several key sources of noise pollution are also sources of air pollution emissions. Nonetheless, there is no provision in the Noise Directive requiring that indicating the noise action plans be synchronised with air quality plans.

The AAQD do, however, refer to the Noise Directive: both the Preamble (18) and Art. 23(2) of Directive 2008/50/EC call for air quality plans to be consistent and integrated with plans prepared under the Noise Directive. This link supports the potential for achieving synergies between the measures adopted under the two Directives.

One of the case studies (Germany) noted that addressing air quality and noise management together at local level has synergies, in particular in terms of traffic planning and management.

The SEA Directive (Directive 2001/42/EC) and the EIA Directive (Directive 2011/92/EU) aim to ensure that environmental impacts are considered in strategic planning and development consent of projects that are likely to have significant effects on the environment. The SEA Directive requires that public authorities carry out a Strategic Environmental Assessment (SEA) during the preparation of certain public plans and programmes which are likely to have significant effects on the environment. The EIA Directive requires that development consent for certain public and private projects likely to have significant environmental effects are subject to an environmental impact assessment (EIA).

In terms of *objectives*, both directives refer to the protection of the environment; while they do not refer directly to air quality, these objectives support the objectives of the AAQ Directives.

In terms of *provisions*, SEA is mandatory for many types of plans and programmes that could affect air quality, including those for agriculture, energy, industry, transport, waste management, or land-use planning. EIA is mandatory for projects listed in Annex I of the Directive, including potential sources of air pollution such as oil refineries, power stations, industrial installations, and transport infrastructure.

The SEA Directive requires that the environmental report includes the likely significant environmental effects of implementing the plan or programme on a list of issues, which includes air and human health. Annex IV of the EIA Directive requires that the EIA report contains a description of the project, which includes an estimate, by type and quantity, of expected air emissions produced during the construction and operation phases.

Further details regarding the EIA and SEA Directives are provided in the box below.

Text box 4 Detailed provisions of the EIA and SEA Directives

In terms of *objectives*, the SEA Directive aims to 'provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development'. The EIA Directive does not explicitly identify an objective; however, the recitals refer to a number of policy goals, noting that 'development consent for public and private projects which are likely to have significant impacts on the environment should be granted only after an assessment of the likely significant environmental effects of those projects has been carried out'. These objectives support the objectives of the AAQ Directives: air quality undoubtedly falls within the environmental considerations and effects referred to in the objectives of the SEA and EIA Directives.

In terms of *provisions*, the obligation to carry out an environmental assessment prior to the adoption of a plan or programme or to the decision to grant development consent to a project supports the achievement of the air quality standards set out in the AAQ Directives, insofar as EIAs and SEAs require the assessment of impacts of plans and projects on the air quality of the affected area. In terms of screening, SEA is mandatory for many types of plans and programmes that could affect air quality, including those for agriculture, energy, industry, transport, waste management, or land-use planning. EIA is mandatory for projects listed in Annex I of the Directive, including oil refineries, power stations, industrial installations, and transport infrastructure. (Member States can also designate certain projects listed under Annex II as subject to an EIA.)

The criteria[10] to be taken into account at the screening stage to determine whether a plan or project is likely to have significant effects on the environment, and should therefore require an EIA or SEA, support integration of air quality objectives into decision-making on plans and projects[11]. These include the cumulative or transboundary nature of the impacts (EIA and SEA Directives), the location of a project in an area where environmental quality standards have already been exceeded (EIA Directive), and the location of a project in a densely populated area (EIA Directive).

The provisions on the content of the assessment to be carried out support the AAQ Directives' objectives of improving and maintaining good air quality and of ensuring information on air quality is available to the public, supporting the integration of air quality objectives into decision-making on plans and projects. The SEA Directive requires that the environmental report includes the likely significant environmental effects of implementing the plan or programme on a list of issues (Annex I, paragraph (f)), which includes air and human health. The Commission's Guidance on the implementation of the SEA Directive specifies that the 'notion of human health should be considered in the context of the other issues mentioned in paragraph (f)', meaning that health issues related to exposure to air pollution should be considered in the assessment.

[10] Set out in Annex II of the SEA Directive and Annex III of the EIA Directive

[11] In practice, one NGO has raised concerns that projects have been wrongly 'screened out' of EIA because impacts on air quality are not considered to be significant, or air quality considerations are excluded from the assessment itself at the scoping stage [R1]. This is an issue of potentially inappropriate implementation rather than the provisions of the Directive itself.

Annex IV of the EIA Directive requires that the EIA report contains a description of the project, which includes an estimate, by type and quantity, of expected air emissions produced during the construction and operation phases. The EIA report should also include a description of the environmental aspects likely to be significantly affected by the project, including air and human health. Finally, the report should contain description of the likely significant effects of the project on the environment resulting from the emissions of pollutants, and the risks to human health or the environment.

There are potential synergies between the monitoring requirements set out by the AAQ Directives and requirements for monitoring under the EIA and SEA Directives. Article 10 of the SEA Directive states that Member States should monitor the significant environmental effects of the implementation of plans and programmes. Article 8a of the EIA Directive refers to monitoring measures for projects that are approved. The articles in both Directives mention that existing monitoring arrangements resulting from EU and national legislation may be used to avoid duplication of monitoring.

The AAQ Directives do not specifically refer to the SEA or the EIA Directives.

The **Nature Directives** refer to Directive 92/43/EEC (Habitats Directive) and Directive 2009/147/EC (Birds Directive), which aim to protect nature and biodiversity at EU level.

Air pollution can harm ecosystems: notably, the deposition of sulphur and nitrogen compounds leads to the acidification of soils and water bodies and to the eutrophication of water bodies. These depositions can harm forests and grasslands as well as freshwater ecosystems [S35]. In addition, ground-level ozone can harm vegetation including trees, in turn affecting forest ecosystems.

Consequently, coherence between the Nature Directives and the AAQD is assessed in terms of the support provided by the AAQD in protecting natural habitats and biodiversity.

The Ambient Air Quality Directive 2008/50/EC highlights "the risk posed by air pollution to vegetation and nature ecosystems" (Recital 10) and also identifies the importance of ensuring effective protection against harmful effects on vegetation and ecosystems from exposure to ozone (Recital 12). Moreover, the Directive sets out measures to "… avoid, prevent or reduce harmful effects on human health and the environment as a whole" (Art. 1). Directive 2004/107/EC sets out target values for air pollutants with the aim of preventing or reducing harmful effects on the environment, as well as on human health. Consequently, the objectives of the AAQD support those of the Nature Directives.

Additionally, the 2008 Directive aims to assess the risks and compliance with critical levels for the protection of vegetation, specifying rules for setting up sampling points at suburban, rural and rural background level with the aim of protecting both human health and vegetation. These rules are coherent with the *objectives* of the Nature Directives regarding the protection of natural habitats. In terms of provisions, the Nature Directives focus on biodiversity protection, without making a direct link to ambient air quality. Article 4(4) of the Birds Directive does, however, refer to the obligation of Member States to take appropriate steps to avoid pollution or deterioration of bird habitats. Concerning the provisions of the 2008 Directive, Annex XIII sets critical levels of SO_2 and NOx concentrations for the protection of vegetation and Annex VII sets target values and long-term objectives for ozone for the protection of vegetation. The Directive moreover requires specific sampling points targeted at the protection of vegetation and natural ecosystems. Consequently, through these provisions the Directive seeks to maintain and restore natural habitats and thus supports the Nature Directives.

An EEA study [S35] has found that EU air policy (including the AAQD, as well as the NEC Directive) has contributed to reductions in atmospheric deposition of sulphur and nitrogen compounds, yielding positive impacts on ecosystems, Natura 2000 sites and habitats. The study estimates that by 2020, the ecosystem area where acidification critical loads are exceeded will be as low as in the 1880s (only 4% of the EU-28 area). This is attributed to EU policy aimed at SO2 and NOx as well as cooperation under the LRTAP Convention. Moreover, these impacts are expected to include an increase in species richness that will have a positive effect on biodiversity, at least in grasslands, which were used as a case-study for the report.

Stakeholder comments

In the OPC, the closed (multiple choice) questions did not ask about the Noise Directive, the SEA and EIA Directives or the Nature Directives. No responses were received in the OPC's open questions concerning these Directives.

There were few comments in the responses to the targeted questionnaire on environmental legislation. One stakeholder pointed to a negative interaction between noise reduction and air quality; however, further details were not provided. No comments were received concerning the SEA or EIA Directives or the Nature Directives.

The joint response from Client Earth and other environmental NGOs to the targeted questionnaire, however, highlighted the positive role of the Directive on Access to Environmental Information in supporting AAQD objectives. However, it was stated in this response that national-level implementation of this Directive differs, sometimes creating unfavourable conditions, which can even lead to measures hampering access to justice, through the imposition of strict criteria to recognising legitimate interest in order to challenge actions or inactions by public authorities; and furthermore, this response stated that there was a lack of EU legislation implementing the access to justice rights established by the Aarhus Convention and that this lack also affects the achievement of the AAQD objectives.

This NGO response also stated that the lack of legislation that targets sources of ammonia emissions is a gap, as the NEC Directive's limits on ammonia are not sufficient to support AAQD objectives.

G.1.4 JC 7.4: The AAQ Directives are coherent with EU climate policy and legislation (including international commitments)

Approach

This criterion examines the coherence between the AAQ Directives and EU climate policy and legislation. For this judgement criterion, on indicator has been identified:

- Coherence with key EU climate legislation and policy, in terms of: 1) objectives and 2) provisions

There are close links between climate and air quality policy. This section first reviews these links and then examines key elements of the EU legislative and policy framework for climate.

The evidence has been collected from desk research, including: EU climate change legislative and policy documents, related impact assessments and supporting studies, relevant literature on the links between air quality and climate policy, and stakeholder input. The analysis focused on identifying the synergies and gaps that exist between the objectives and provisions of EU climate policy and air quality objectives. This criterion considers key pieces of EU climate legislation and policy; however, other EU climate policies on the sectoral sources of greenhouse gas emissions (e.g. energy, transport) are considered under JC9.1 below. Interactions between the EU-ETS and Cohesion Policy are discussed in JC9.2 below.

Limitations to the approach

Evaluating the coherence of the objectives in EU climate policy with the AAQ Directives on the basis of desk research is relatively straightforward. However, evaluating the coherence of the provisions of EU climate policy and legislation is more complex, requiring consideration of the possible interactions between climate legislation and policy and climate policy responses focused on emission sources. To the extent possible, the assessment of JC9.1 has aimed to focus the assessment on the specific provisions of climate policy and legislation, while identifying these interactions where appropriate. The coherence with legislation and policy on emission sources is then covered in further detail under JC9.1 below.

Results

In general terms, climate and air policies can have a positive or negative effect on each other's policy objectives depending on the measures adopted [S18].

Air pollutants and greenhouse gases originate from the same sources, such as industrial installations and fossil fuel combustion in transport and energy generation. Some ambient air pollutants have a climate-forcing impact and are important greenhouse gases – these include the 'black carbon' component of particulate matter and ozone and its precursors, particularly methane. Sulphur dioxide, on the other hand, has a short-lived cooling effect while nitrogen dioxide, has both a cooling and a warming effect and is thought to have a net, short-lived cooling effect [S68]. In other cases, the specific effects of certain ambient air pollutants on climate are not yet fully understood – for example, while the negative impact of black carbon on both air quality and climate change is well understood, the effect on the climate of other components of particulate matter emitted from, for example, biofuel combustion, is less clear [S68].

Table 4 below outlines the effects of key anthropogenic compounds on both air quality and the climate. In the case of such pollutants, there is an especially strong need to ensure policy settings in both fields are coherent to avoid unintended consequences in both policy fields.

Table 4 Air pollution and climate effects – anthropogenic compounds

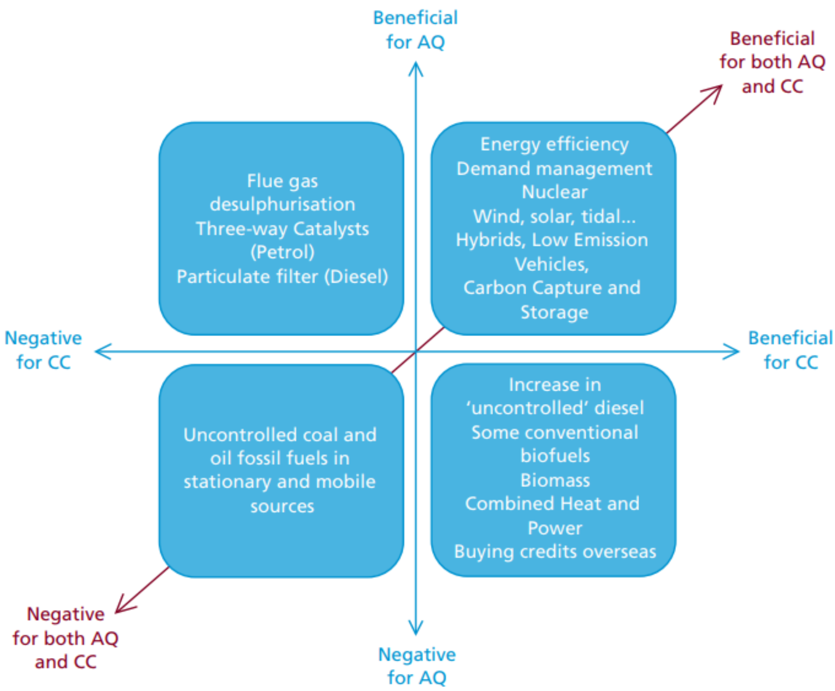
Compound	Approx. atmospheric residence time	Pollutant effect(s) on health and/or ecosystems	Climate effects
Carbon dioxide (CO_2)	150 years	Ocean acidification, Affects photosynthesis	Long-lived climate-forcer
Methane (CH_4)	8 years	Precursor of tropospheric ozone	Medium-lived climate-forcer
Ozone (O_3)	1 month	Health and vegetation damages	Short-lived climate-forcer
Sulphur dioxide (SO_2)	1 week	Health damages, ecosystem acidification	Precursor of PM sulphate, short-lived cooling climate
Nitrogen oxides (NO_x)	1 week	Health damages, precursor of tropospheric ozone, ecosystem acidification, water eutrophication	Precursor of PM nitrate, short-lived cooling climate

Compound	Approx. atmospheric residence time	Pollutant effect(s) on health and/or ecosystems	Climate effects
Ammonia (NH_3)	1 week	Ecosystem acidification, water eutrophication	Precursor of PM ammonium, short-term cooling climate
Black carbon (BC)	1 week	Health damages	Absorbs solar radiation, warming climate
Volatile organic compounds (VOCs)	variable	Health damages, precursors of tropospheric ozone	Precursors of tropospheric ozone

Source: Maione et al, Air quality and climate change: Designing new win-win policy for Europe, Environ. Sci. Policy (2016) [D121].

Finally, climate change impacts air quality. Climate change may worsen concentrations of air pollutants and exacerbate the health impacts of these pollutants. In what is referred to as the 'climate penalty' by the Intergovernmental Panel on Climate Change [S68], climate change can impact air quality by influencing atmospheric chemistry through temperature increases, disrupting deposition and ventilation rates through changes in wind and rainfall patterns, and increasing emissions from wildfires [R24, S70]. In the case of ozone, there is an observed correlation between temperature and surface ozone in polluted regions [S68]. In Europe, this was observed during the 2003 heatwave when particularly high ozone levels were reported [S70]. The effect of increased temperature on particulate matter is less clear [S70], but climate change may also contribute to increase particulate matter concentration due to emissions from climate-induced wildfires. In Europe, projections based on high-levels of climate change could result in particulate matter emissions from wildfires exceeding anthropogenic sources in summer months (with decreased anthropogenic emissions due to policy interventions partially contributing to this projected outcome) [S79].

Figure 5 Air quality (AQ) and climate change (CC) policy interactions



Source: Defra, 2010 [P4].

Coordinated measures to abate greenhouse gas and air quality emissions can achieve policy benefits for both climate and air quality objectives [S28]; conversely, a failure to coordinate action on climate and air quality can lead to counterproductive policies and unintended consequences. Integrated policy-making can support win-win policies for both air quality and the climate, and help overcome challenges such as the differing time and geographical scales involved in the policy responses in the two areas. The figure above illustrates how policy responses can interact to support or frustrate the objective in each policy area.

EU climate change policy framework

The EU's key climate change policy objectives, and measures to support achieving them, are set out in the Europe 2020 Strategy [P27], the EU's 2020 Climate and Energy Package of legislation [P18, adopted in 2008] and the 2030 Climate and Energy Framework [P45, adopted 2014], while long-term objectives are set out in the 2050 Low Carbon Roadmap [P28, adopted 2011] and the Long-Term Emissions Reduction Strategy [P71, adopted 2018]. These policy objectives are underpinned by the EU's international climate commitments, under the United Nations Framework Convention on Climate Change, its Kyoto Protocol and the Paris Agreement.

These documents set out a number of mitigation targets: the 2020 Package includes a commitment to reduce greenhouse gas emissions by at least 20% (compared to 1990 levels) by 2020; and the 2030 Framework includes an emissions reduction target of at least 40% by 2030. In terms of long-term targets, the 2050 Roadmap includes a long-term emissions reduction target of 80% by 2050, while the Long-Term Emissions Reduction Strategy sets out a vision for achieving net-zero greenhouse gas emissions by 2050. (These targets are flanked by renewable energy and energy efficiency targets, discussed in Question 9 below.)

Broadly speaking, the emissions reduction targets are coherent with the objectives of the AAQ Directives. The 2050 Roadmap notes the synergies between GHG emissions reductions and air quality objectives, observing that the combined effect of GHG reductions under the Roadmap and existing air quality measures would lower air pollution to 65% below 2005 levels by 2030. The impact assessment for the 2030 Climate and Energy Framework found that emissions of $PM_{2.5}$, SO_2 and NO_x are reduced under all options to achieve the 40% target [P46]. Modelling in the supporting analysis for the Long-Term Emissions Reduction Strategy [P72] suggests that air pollutant emissions and air pollution costs are significantly reduced under the scenarios set out in the Strategy.

Unlike the 2050 Roadmap and the Long-Term Emissions Reduction Strategy, the 2020 Package and 2030 Framework do not make specific reference to the links between the climate objectives set out in these documents and EU air quality goals. This suggests in the more recent years of the evaluation period that the links between climate and air quality policy have been given greater recognition. However, even in the earlier years of the evaluation period, some links in the policy-making process can be seen: while air quality is not specifically mentioned in the 2020 Climate and Energy Package, the Package included amendments to the Fuel Quality Directive and the Sulphur Directive with respect to both climate change and air quality aspects of the Directives, indicating that there was some coordination in policy-making at that time.

Modelling of the impacts of EU climate policy supports the finding that climate policy contributes to air quality goals. Modelling carried out by the European Topic Centre on Air Pollution and Climate Change Mitigation in an evaluation of the Roadmap suggests that emissions of all primary air pollutants – NO_x, SO_2 and $PM_{2.5}$ – fall under all greenhouse gas emission reduction scenarios studied [S18]. A 2014 study by IIASA for the Parliament on the 2030 Climate and Energy Framework [S65] made similar conclusions that EU climate policy would contribute to air quality policy goals and would help achieve these goals at a lower cost.

Nonetheless, the legislation adopted to secure these targets should also be examined in terms of coherence with EU air quality policy. The 2020 Package included supporting legislation to meet the targets:

- Legislation updating the EU Emissions Trading Scheme (ETS) Directive (Directive 2003/87/EC)
- Effort Sharing Decision (Decision 406/2009/EC)
- Renewable Energy Directive (Directive 2009/28/EC)
- Amendments to the Fuel Quality Directive (98/70/EC) and the Sulphur Directive in relation to fuel used by inland waterway vessels (Directive 1999/32/EC[12]) (set out in Directive 2009/30/EC)
- CO2 Emissions from Passenger Vehicles Regulation (Regulation 443/2009)
- Carbon Capture and Storage Directive (Directive 2009/31/EC).

The analysis now considers the two cross-cutting instruments – the EU ETS Directive and the Effort Sharing Decision (and the subsequent Climate Action Regulation) – to review their coherence with air quality policy. Sector-specific legislation supporting climate and energy targets – including the Renewable Energy Directive, the Fuel Quality Directive, the Sulphur Directive, and CO_2 emissions standards for passenger cars – are considered separately under Question 9 below. The coherence of the CCS Directive with the AAQ Directives is not evaluated here. Stakeholders have not raised concerns about the coherence of this directive in the Open Public Consultation or the Targeted Questionnaire. An EEA study [S33] found that CCS is likely to be generally beneficial for both climate and air quality policy.

EU ETS Directive[13]

The EU ETS Directive (Directive 2003/87/EC, as amended) sets a cap on EU-wide greenhouse gas emissions from the installations within the energy, industrial and aviation[14] sectors. Installations covered by the ETS Directive must reduce their emissions by 21% by 2020 (compared to 2005 levels).

In terms of *objectives*, the ETS Directive is largely coherent with the AAQ Directives in that there are no direct conflicts or overlaps between the pieces of legislation. The objectives of the ETS Directive are confined to the establishment of 'a scheme for greenhouse gas emission allowance trading… to promote reductions of greenhouse gas emissions in a cost-effective and economically

[12] This Directive has since been codified by Directive 2016/802. The Directive sets out limits on the sulphur content of heavy fuel oil used in land-based applications, gas oil, marine gas oil and marine diesel oil. The amendments of 2009 under the 2020 Climate and Energy Package apply to fuel used by inland waterway vessels.

[13] Interactions between the EU-ETS and ESIF funding for air quality measures in ETS installations are discussed under JC 9.2 below.

[14] Currently only applies to flights within the European Economic Area until the end of 2023.

efficient manner'[15]. While there is no reference to synergies between climate policy and air quality in this objective (or the rest of the Directive), this objective is not inconsistent with the objectives of the AAQ Directives.

In terms of *provisions*, the ETS Directive establishes a requirement that covered installations hold permits for greenhouse gas emission, an EU cap on allowances, and a system for the allocation and trade of the allowances. These provisions are potentially relevant to the AAQ Directives in two respects: the sources and gases covered by the Directive; and the interaction between the Directive and air quality legislation.

The sources and gases are outlined in Annex I of the Directive, and include:

- Carbon dioxide (CO_2) from energy and heat generation, energy-intensive industry installations (e.g. oil refineries, steel works, producers of iron, aluminium, cement, glass, chemicals), and inter-EU aviation
- Nitrous oxide (N_2O) from production of nitric, adipic and glyoxylic acids and glyoxal
- Perfluorocarbons (PFCs) from aluminium production.

These gases are not ambient air pollutants covered by the AAQ Directives. The ETS (in line with the Kyoto Protocol) does not cover short-lived greenhouse gases which are often also important ambient air pollutants – notably, black carbon and ozone. The AAQ Directives seek to reduce atmospheric concentrations of these pollutants; in this regard, there is a synergy between the Directives in that the AAQ Directives support the ETS Directive's objective to reduce greenhouse gases. In the case of ozone, the AAQD can play an important role. Ozone is not emitted directly into the atmosphere by human activities, but results from chemical reactions between ozone precursors (CO, NO_x, CH_4, and VOCs) and sunlight in the atmosphere. Thus, ozone has proven difficult to regulate using an emissions-based approach [D121]. The target values for ozone precursors in the 2008 AAQ Directive help address this policy challenge.

While the ETS Directive does not specifically refer to the AAQ Directives, or air quality in general, it does refer to the Integrated Pollution Prevention and Control Directive (now the Industrial Emissions Directive), which controls, among other things, the emission of ambient air pollutants (see JC8.2, discussed above). Member States are required to ensure coordination in setting the conditions and procedures for permits under both Directives (Article 8). In this indirect sense, there is coherence between the ETS Directive and the EU's air quality policy framework.

Effort Sharing Decision (ESD)

The ESD (Decision 406/2009/EC and Regulation (EU) 2018/842) aims to reduce emissions from sources not covered by the ETS – transport, agriculture, waste, industry and small energy generation. Emissions in these sectors must be reduced to 10% below 2005 levels by 2020, and to 30% below 2005 levels by 2030. The Decision sets binding Member State targets for achieving emissions reductions in these sectors. It is up to the Member States to decide how to achieve the targets through national policies. Members States are supported in achieving the targets through relevant EU legislation covering specific emissions sources (for example, CO_2 emission standards for cars and vans, the Energy Performance of Buildings Directive).

Again, in terms of **objectives**, the Decision is not incoherent with the AAQ Directives. It aims to lay down 'the minimum contribution of Member States to meeting the greenhouse gas emission

[15] Article 1.

reduction commitment of the Community for the period from 2013 to 2020 for greenhouse gas emissions covered by this Decision, and rules on making these contributions and for the evaluation thereof'. The Decision, and its supporting regulations[16], makes no direct reference to air quality, but in adopting the 2018 Regulation setting our Member State targets for the 2021-2030 period, the Council Presidency noted the important role of the Effort Sharing Decision as a 'tool in our armoury to reduce greenhouse gas emissions and improve air quality'.

In terms of **provisions**, there are links between the gases covered by the Decision and those targeted by the AAQ Directives. The Decision covers all seven Kyoto greenhouse gases from sources not already covered by the ETS Directive. These are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- 'F gases': Hydrofluorocarbons (HFCs) Perfluorocarbons (PFCs), Sulphur Hexafluoride (SF_6)
- Nitrogen trifluoride (NF_3)

The inclusion of methane here is important, due to its role in ambient air pollution as an ozone precursor. Therefore, measures taken under the Effort Sharing Decision can support the objectives of the AAQ Directives. As with the ETS Directive, the AAQDs can complement the Effort Sharing Decision by addressing short-lived greenhouse gases such as ozone and black carbon in particulate matter.

The policies implemented by Member States to achieve the targets in the Effort Sharing Decision may complement or impede the achievement of air quality objective, depending on the specific measures taken. This question is explored in the following assessment criterion and in, with respect to sectoral policy, under Question 9 below.

EU Adaptation Strategy

The EU Adaptation Strategy (COM (2013)0216) was adopted by the European Commission in 2013 with the aim of contributing 'to a more climate-resilient Europe'. It sets out three objectives: Promoting action by Member States; Promoting better informed decision-making; and Promoting action in key vulnerable sectors. Eight actions are set out to support these objectives.

The Strategy itself makes limited reference to air quality, with one specific reference to improved air quality as a co-benefit of some climate change adaptation measures (e.g. ecosystem-based approaches). A number of the actions under the Strategy could potentially align with the Air Quality Directives – in particular the actions to encourage Member States to adopt adaptation strategies (Action 1) and to support adaptation in cities (through the Covenant of Mayors framework, Action 3) could support Member States and local government authorities to adopt measures necessary for addressing climate-related air pollution.

[16] Regulation 389/2013 (Registry Regulation); Regulation 525/2013 (Monitoring and Reporting Regulation); Decision 2013/162/EU (Decision on the Effort of Member States 2013-2020); and Regulation 2018/842 (Regulation on the Effort of Member States 2021-2030).

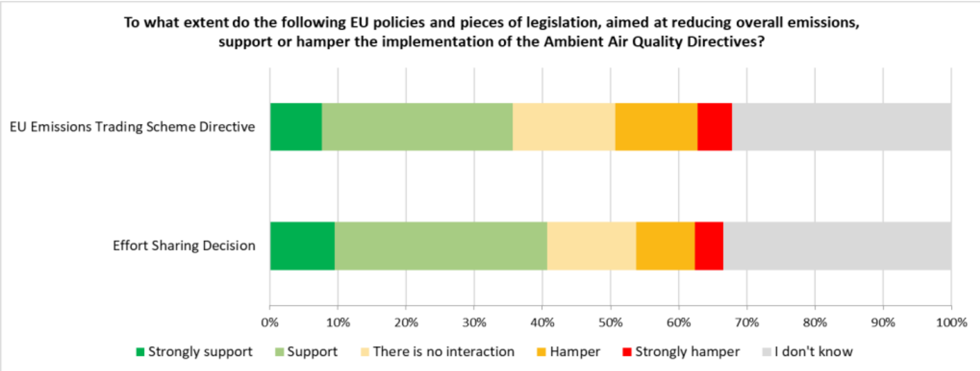
In addition, the Impact Assessment for the Strategy (SWD(2013)132) considers the links between climate and air quality policy, noting climate change may adversely affect air quality and suggesting that the 2008 Ambient Air Quality Directive may support adaptation (for example, through ozone alert thresholds). It also notes that the links between climate change and tropospheric ozone need to be better understood.

Stakeholder consultation

In responding to the Open Public Consultation, stakeholders indicated a largely positive perception about the interactions between the ETS Directive, the Effort Sharing Decision and the AAQ Directives (see the box below).

While there was not a strong view that these policies support the AAQ Directives, only 17% of respondents (for the ETS Directive) and 13% (for the Effort Sharing Decision) replied that they hamper the AAQ Directives.

Figure 6 Open Public Consultation responses on EU ETS and the Effort-Sharing Decision



Three stakeholders also submitted position papers to the OPC which expressed concerns about tensions between air quality objectives and climate policy responses, particularly in the energy and transport sectors.

When addressing coherence between the AAQDs and climate policy, respondents to the targeted questionnaire expressed concern about tensions between these policy areas. However, responses tended to focus particularly on sectoral climate change policy responses, with sectoral policies on transport (support to diesel vehicles, particularly at Member State-level) and energy (treatment of biomass energy generation under the Renewable Energy Directive) attracting the most concern. These issues are considered under Question 9 below (see JC9.1 on sector policies and JC9.2 and EU/national fiscal policies).

In a small number of cases, respondents noted broad synergies between EU climate and air quality policy, and the joint response from Client Earth and other environmental NGOs noted the synergies between climate and air policy with respect to methane and short-lived climate forcers (black carbon, ozone and ozone precursors). One NGO stakeholder indicated that the AAQ Directives support such policies as the Effort Sharing Decision and the EU-ETS. Furthermore, the Client Earth response and one other NGO response acknowledged that the AAQDs, the Fuel Quality Directive and the EU Directive on Sulphur Content of certain liquid fuels contribute to both climate and air quality objectives.

G.1.5 JC 7.5: An integrated approach at Member State level: Member States have put in place an integrated approach to the implementation of the AAQ Directives and other environment and climate legislation and policy

Approach

For this judgement criterion, there are two indicators:

- Integrated implementation of AAQ Directives and other EU air pollution legislation
- Integrated implementation of AAQ Directives and other environment and climate legislation

These indicators are considered together.

Evidence has been collected from desk research, the Member State case studies as well as stakeholder inputs.

Limitations to the approach

One key limitation is that the evidence gathered on integration at Member State level for the most part covers a range of issues. Environmental and climate policies and legislation are addressed together with sectoral policy legislation; moreover, most of the information gathered concerns sectoral integration (covered under JC 9.5 below).

Results

As noted above (see JC8.2), some Member States have used flexibility mechanisms under the IED to postpone the introduction of more stringent BAT standards.

Results from the case studies provide examples of both integration between the AAQD and other environment and climate legislation and policy, as well as examples where greater integration is needed.

In Bulgaria, the case study noted difficulties in ensuring links between the AAQD on the one hand and the IED and NEC Directive on the other; among the issues, a delay in the transposition of the NEC Directive led to uncertainties for the preparation of air quality plans. Moreover, NEC Directive requirements as yet have not been considered in the national air quality programme in preparation.

The case studies moreover noted that difficulties in coordination, in particular between local and national levels of government, hampered integration between the AAQD and other environmental and climate actions: this issue was raised in the case studies for Germany and Slovakia.

Stakeholder consultation

The responses to the targeted questionnaires also identified issues for coherence at Member State level. One public authority indicated that the 'low capacity' of bodies monitoring facilities regulated under the IED is hampering air quality improvements. Another comment referred to a lack of coherence in national climate change policies that promoted diesel vehicles and biomass for heating. Further comments were received concerning sectoral coordination (see JC9.5, addressed below).

In a policy paper submitted alongside its response to the OPC, the Urban Agenda's Partnership for Air Quality highlighted the need for multi-sector cooperation to address air quality issues. The Partnership called for 'an integrated approach to different environmental policies' and highlighted in particular the need to ensure synergies between air quality and climate change policies.

G.2 Evaluation question 8: Coherence with sectoral policies

Evaluation question 9 asks: *To what extent do the AAQ Directives complement or interact with sectoral policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as energy, transport, agriculture, cohesion, fiscal policies); and how do these policies support or hamper the implementation of the EU air quality legislation?*

The evaluation matrix sets out five judgement criteria for this evaluation question: these are addressed in the following sections.

G.2.1 JC 8.1: Key EU sectoral policies support AAQ objectives, including public information

Approach

The assessment covers one indicator:

- Coherence in the objectives and key provisions of key policy and legal documents for energy, transport, health, agriculture, cohesion, fiscal and other policies (cross-cutting, e.g. Juncker priorities and EU Urban Agenda)

The analysis below considers in turn the following key sectoral policies: and the objectives of the AAQ Directives in the following sectors:

- Transport
- Energy
- Agriculture
- Health
- Urban Policy

EU policy statements that cut-across multiple sectors are also considered below, under the sub-heading 'Cross-cutting policies'. EU funding, including Cohesion Policy, is addressed separately under JC9.2 on EU funding instruments.

The assessment considers the coherence between the objectives of the sectoral legislation and policy documents and coherence in terms of their key provisions.

Limitations to the approach

On the one hand, the assessment covers a range of policy and legislative documents, and as such it provides a survey rather than in-depth results for individual documents.

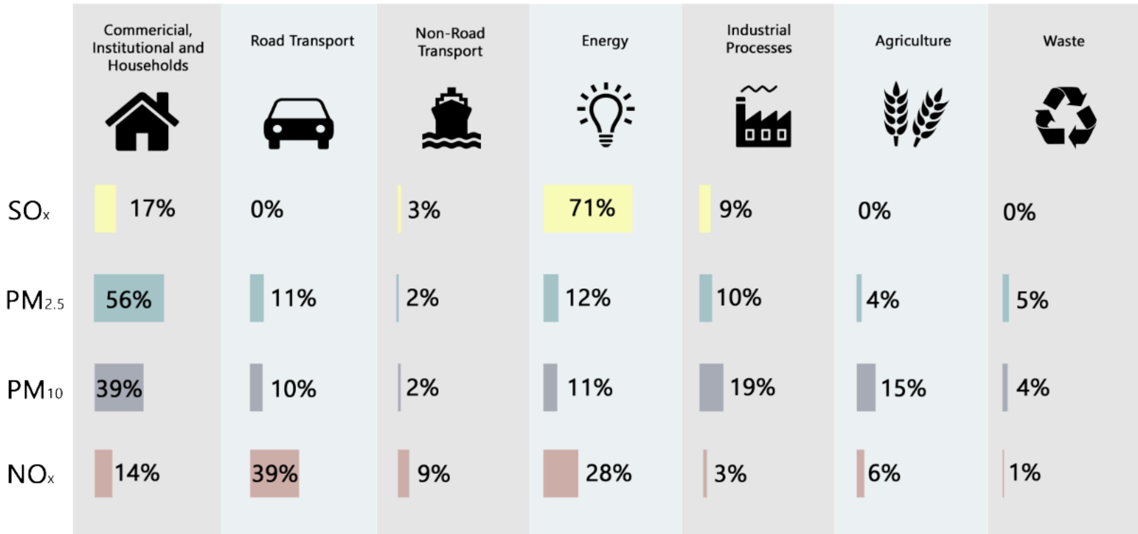
On the other hand, the assessment has focused in each case on synergies with the AAQ Directives. Many of policy and legislative documents interact with each other. Interactions between climate policies (covered under JC 8.4) and key sectoral policies such as energy and transport (JC 9.1) are presented due to their close links.

Results

Transport

The transport sector is a key source of the air pollutants targeted by the AAQ Directives. Air pollutants are emitted from the following transport modes: road, waterborne (marine and inland waterways), aviation, and rail (directly from diesel-powered rail and indirectly in the case of electric rail). Road transport is the biggest sectoral contributor to NO_x emissions (of which NO_2 is a component), accounting for 39% of all NO_x emissions in the EU-28 in 2016. Road transport also accounted for 20% of CO emissions and 10% of PM_{10} and 11% of $PM_{2.5}$ emissions in 2016. When road transport and non-road transport emissions are combined, the transport sector accounts for almost half of all NO_x emissions [R61]. A large majority – 89% – of exceedances of AAQ Directive limit values for nitrogen dioxide were recorded at roadside monitoring locations [S36]. Most road transport pollutants are emitted through vehicle exhaust and, to a lesser extent, evaporative emissions. Abrasion emissions also contribute to particulate emissions, due to wear of tyres, brakes and road surfaces [S36]. **Error! Reference source not found.** below highlights the important contribution of road transport to concentrations of NO_x – in contrast, non-road transport accounts for 7% of NO_x emissions.

Figure 7 Sources of air pollutants in the EU in 2016



Source: Adapted from European Court of Auditors [R90], based on EEA data [R61]. Note: Energy includes both emissions from energy generated in the power sector and from energy use in industry.

As noted in the discussion of climate policy in JC8.4 above, the transport sector is also a key source of CO_2, and measures taken to reduce greenhouse gas emissions from transport sources can also impact air pollutant emissions. These impacts can be positive or negative, depending on the nature of the action taken. For example, measures to promote low- and zero-emissions vehicles taken to reduce CO_2 emissions will also help reduce air pollutant emissions. Conversely, measures supporting diesel-fuelled cars (in place of petrol cars) may slightly reduce CO_2 emissions at the expense of increasing emissions of ambient air pollutants such as NO_2 (at least up to early Euro 6 vehicles, in the case of the European legal framework) In the current vehicle technology context, supporting diesel may even be detrimental from a CO_2 perspective because it affects the development and market penetration of alternative powertrains such as plug-in hybrids (PHEVS).

As transport, and in particular road transport, is a significant source of NO_x and other emissions, coherence between the EU's air quality and transport policy objectives is critical to achieving the AAQ Directives' objectives of achieving and maintaining good air quality[17].

[17] Directive 2008/50/EC, Art. 1(5); Directive 2004/107/EC, Art. 1(b)

Transport policy statements

At the highest level, the EU sets out broad **transport policy *objectives*** in a number of documents: the 2011 Transport White Paper, TEN-T policy [P107], the Low-Emission Mobility Strategy [P54], and the three recent Mobility Packages outlining policy measures for the transport sector [P68, P75, P88]. Emissions from the transport sector regulated at EU by a large number of directives and regulations on fuel and vehicle standards. In addition, with transport policy being a shared competence, so Member State-level actions also have an important impact on emissions from the sector.

The **Transport White Paper** of 2011 [P25] sets out a vision for a 'competitive and sustainable transport system' in Europe, and measures to achieve this vision by 2050. 'Clean urban transport and commuting' is included as part of the vision set out by the White Paper, which notes the need to reduce the impact of conventionally-fuelled vehicles on urban air quality. Of the ten goals for achieving this vision, one is focused on 'Phasing out conventionally-fuelled cars in cities by 2050'. Given that this would result in significantly reduced emissions from petrol and diesel-fuelled vehicles, achieving this objective would also have a positive impact on air quality, which is noted in the White Paper. This goal is in line with the objectives of the AAQ Directives to improve and maintain air quality. Other goals in the White Paper could also potentially support the objectives of the AAQ Directives, including the support to shift away from road freight to other modes and building the rail network – both these goals could help reduce emissions from road transport. The White Paper also proposes better internalisation of external costs, including air pollution, into road charging.

The **Trans-European Network for Transport**, or TEN-T, is the EU transport infrastructure development policy set out in Regulation 1315/2013 [P107]. It aims to develop a trans-European network of road, rail, air and waterborne infrastructure by 2030, and is supported by funding under the Connecting Europe Facility. The objectives of the policy, as set out in Article 4 of the Regulation, relate to sustainability, including the objective to contribute to 'low greenhouse gas emissions, low-carbon and clean transport, fuel security, *reduction of external costs and environmental protection'*. While specific references to air quality are rather limited, the objectives are generally in line with those of the AAQ Directives. Modelling carried out for the impact assessment of the Regulation found that air emissions under the 2013 TEN-T policy would be lower than under a business-as-usual scenario (i.e. implementation of the 30 priority projects under the 2007-2013 TEN-T programme) due to coordinated planning of infrastructure networks at the EU-level [P30]. However, it should be noted that this modelling was based on the assumption of effective implementation and enforcement of Euro emissions standards for vehicles under the Type Approval Framework.

The 2016 **Low-Emission Mobility Strategy** (COM/2016/501) [P54] sets out the European Commission's strategy for achieving the shift to low-carbon transport while also meeting the mobility needs of people and goods. It notes the need to address the impact of transport on air quality; while the Strategy does not explicitly set out a list of objectives, it states in the second paragraph, 'The ambition is clear… Emissions of air pollutants from transport that harm our health need to be drastically reduced without delay'. It sets out a range of actions to achieve its objectives, and notes that, given the impacts of road transport in particular on greenhouse gas emissions and air pollution, much of the action will focus on this mode of transport. Actions within the Strategy that potentially impact on air quality include:

- Improving vehicle testing procedures so that testing better reflects real driving emissions of air pollutants, through a package of revisions to type approval rules.

- Developing options for addressing the CO_2 emissions from heavy vehicles.
- Revisions to road charging rules to better internalise the externalities of transport (which includes air pollution).
- Support to cities to develop actions supporting the shift to low-emission mobility.

The **three Mobility Packages** released by the European Commission in 2017 and 2018 provide more detail on the measures to be taken in transport policy under the Strategy. Each Mobility Package acknowledges the impact of transport on air quality and notes that the transition to low-emissions mobility necessitates the reductions of air pollution from the sector. They also note the impact of road transport, and emissions from diesel cars, on air quality. The packages set out a number of provisions that may impact air quality:

- Mobility Package 1 (COM/2017/0283) [P68] includes provisions on road pricing based on environmental performance of vehicles, which would support the internalisation of air pollution costs (proposed revisions to Directive 1999/62/EC).
- Mobility Package 2 (COM/2017/615) [P88], is focused on 'Delivering on low-emissions mobility' and its key element is the regulatory proposal to strengthen CO_2 emissions standards for new cars and vans from 2020, which also includes incentives for manufacturers to increase their production of low- and zero-emission vehicles. This proposal is likely to impact on air quality. It also launches the Clean Transport Facility, using CEF and EFSI financing for projects on clean transport, with an emphasis on public transport.
- Mobility Package 3 (COM/2018/293) [P75] includes measures that are likely impact on air quality, most notably a proposal for such CO_2 emission standards for heavy vehicles.

With their emphasis on shifting to 'clean' or low-emissions mobility and goals of reducing the impact of transport on air quality, the objectives of the Low-Emission Mobility Strategy and the Mobility Packages are clearly in line with the objectives of the AAQ Directives to achieve and maintain good air quality.

In addition to these policy statements, there is a significant body of EU legislation aimed at limiting the emission of pollutants from vehicles.

Legislation on fuel quality
Fuel quality legislation aims to limit the impact of transport emissions on health and the environment by setting out technical standards for the fuel used in transport. The **Fuel Quality Directive** (98/70/EC) sets EU-wide technical standards for petrol, diesel and biofuels used in road and non-road mobile machinery (including vessels on inland waterways and tractors). The recitals of the Directive make multiple references to the need for fuel quality standards to address the emissions of air pollutants from vehicle exhaust and evaporative fumes, and Article 1 states that the scope of the Directive is to set technical standards for fuels 'on health and environmental grounds'. Under the Directive, Member States must ensure that fuels placed on the market comply with the fuel quality specifications set out in the Directive. The **Sulphur Directive** (Directive 2016/802, consolidating Directive 1999/32/EC and its amendments) limits the sulphur content in heavy fuel oil, gas oil, marine gas oil and marine diesel oil. Under the Directive, Member States must ensure that fuels are not used within their territory if sulphur content exceeds the limits set out in the Directive. As noted in the recitals, air quality protection is the rationale for the Directive and, under Article 1, the ultimate purpose of the Directive is to 'reduce the harmful effects of [sulphur dioxide] emissions on man and the environment'. It is thus clear that, with this emphasis on

protecting human health and the environment from air pollution, the objectives of the Fuel Quality and Sulphur Directives are coherent with those of the AAQ Directives.

Legislation on vehicle emissions
In addition to fuel quality standards, EU legislation seeks to limit emission of air pollutants through emissions limits for vehicles, as implemented through the **European Type Approval framework**. This framework sets out harmonised EU technical requirements for vehicles and their components (including pollution control devices). Under the framework, vehicles within a 'type' are approved by national authorities before being put on the market – manufacturers must demonstrate all new vehicles sold, registered or put into service in the EU are type-approved. The technical requirements include emissions limits for CO, NO_x, unburnt hydrocarbons (HC) and PM. The legal framework for the type approval system is set out in the Type Approval Directive (Directive 2007/46/EC[18]). In terms of *objectives*, a key purpose of the Type Approval Directive is harmonising standards for vehicles placed on the market in the EU[19]. Nonetheless, the recitals note that the 'main objective of the legislation on the approval of vehicles is to ensure that new vehicles, components and separate technical units put on the market provide a high level of safety and environmental protection' (Recital 14). The Directive states that the technical requirements for vehicles should be specified in regulations, which 'should primarily seek to ensure a high level of road safety, health protection, environmental protection, energy efficiency and protection against unauthorised use' (Recital 3).

These technical requirements are set out in a number of regulations, including the following relevant to emission limits:

- Regulation 715/2007[20], setting out emission limits for light passenger vehicles and commercial vehicles (Euro 5 and Euro 6).
- Regulation 595/2009[21], setting out emission limits for heavy-duty vehicles (Euro VI).

Again, the *objectives* of these Regulations are focused on supporting the internal market for vehicles by harmonising technical standards, as stated in Article 1 of each Regulation. But in both cases, the recitals note the need to ensure a high level of environmental protection by reducing the emissions of air pollutants from road transport.

Similarly, the **Non-Road Mobile Machinery Regulation** (Regulation 2016/1628) uses a type approval approach to set out emission limits for combustion engines non-road mobile sources, which include construction machinery, agricultural machinery, trains, and inland waterway vessels. The Regulation applies to carbon monoxide, hydrocarbons, nitrogen oxides and particulate matter. Given the purpose of the Regulation is to set air emission limits, as set out in Article 1, there is a clear coherence with the Ambient Air Quality Directives, and Recital 11 of the Regulation specifically refers to air quality, and the contribution of the new emission limits set out in the Regulation to air quality objectives.

[18] Directive subsequently amended. Consolidated version available here: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:02007L0046-20180331.

[19] Article 1

[20] As implemented and amended by Regulation 692/2008, Regulation 459/2012 and Regulation 2016/427.

[21] As implemented and amended by Regulation 582/2011.

While not directly focused on addressing ambient air quality, the EU legislative framework for transport includes **CO_2 emissions standards for cars and vans** from 2015, as set out in Regulation 443/2009 (cars) and Regulation 510/2011 (vans), with a proposal to set emissions limits for heavy-duty vehicles from 2025 published by the Commission in May 2018. A proposal for post-2020 CO2 emission standards for cars and vans was also published by the Commission in November 2017 and Regulation 2019/631 setting CO_2 emissions standards for cars and vans from 2020 was adopted on 17 April 2019. The objectives of the Regulations 443/2009 and 510/2011 are very much focused on climate change mitigation and reducing CO_2 emissions.

However, more recent regulatory action in the area indicates growing coherence with EU air quality goals. The proposal for post-2020 CO_2 emission limits for cars and vans (COM/2017/676) notes synergies between climate mitigation and air quality targets, with the potential that the more ambitious CO_2 emission targets and the incentive mechanism for low- and zero-emission vehicles will contribute to reduced emissions of air pollutants in addition to reduced CO_2 emissions. These considerations are reflected in the recitals to Regulation 2019/631. Similarly, the proposal for CO_2 emission standards for heavy-duty vehicles (COM/2018/284) states that 'reducing air pollution notably in cities' is a key objective of the proposal, with increased support for LNG vehicles and monitoring of air quality impacts included in the proposal.

While the objectives of EU legislation on the emissions of vehicles are broadly coherent with EU air quality objectives, in some specific cases there may be issues in terms of their *provisions.* The emissions standards set out in the Euro 5 and 6 norms under the Regulations may be less coherent. The Type Approval Regulation sets out emissions standards for passenger cars[22], with petrol-fuelled cars required to meet more stringent NO_x limits than diesel cars under both Euro 5 and 6. Article 5 of the Regulation provides for a general prohibition of the use of defeat devices to circumvent the emission limits set out in the Regulation. However the same Article includes an exemption for cases where "the need for the device is justified in terms of protecting the engine against damage or accident and for safe operation of the vehicle" (Article 5(2)(c)).

The Euro 5 and 6 emissions limits have been effective in reducing PM emissions. However, stakeholders responding to the targeted questionnaire argued that the different NO_x emission limits applying to petrol and diesel cars is not in line with the objectives of the AAQD. Furthermore, they argued that the implementation of the Regulation failed to address the issue of defeat devices, resulting in vehicles exceeding emissions in real-world driving conditions. Some authorities in Member States commented, in the targeted questionnaire, that this has meant that the Euro norms cannot be reliably used as the basis for national or local measures to manage transport measures (e.g. Low Emissions Zones based on the Euro standard of vehicles), as the expected emissions reductions standards do not materialise. This view was echoed by the European Court of Auditors [P91]. Stakeholders also argued that this testing failure exacerbated the negative impacts of measures taken (by Member States and manufacturers) to support diesel vehicles meet the CO_2 standards for passenger cars.

Independent studies support stakeholder concerns about ineffective implementation of the Euro 5 and 6 standards in regards to testing procedures for NO_x emissions In 2017 the ICCT [S67] reviewed NO_X emissions from diesel vehicles in terms of conformity factor – i.e. the ratio between the on-road NO_X emissions for a vehicle and the laboratory testing limit for NO_X emissions. For Euro 5 diesel vehicles, the limit is 180 mg/km; and for Euro 6, the limit is 80 mg/km. The ICCT found that, on average, 'on-road NO_X and CO_2 emissions from diesel passenger cars are much higher than laboratory emission standards and type-approval values. For Euro 5 diesel cars, these

[22] Annex I

conformity factors ranged from just over 1, meaning that those cars almost met legal limits under real-world conditions, to 11, meaning that actual emissions were 11 times higher than the legal limit. The average conformity factor for this category was 4.1. For Euro 6 cars, the CF range was slightly wider, from just under 1 to almost 12; the average CF for all tested Euro 6 diesel models was 4.5'.

The European Parliament, in its 'Report on the Inquiry into Emission Measurements in the Automotive Sector' [R94] found shortcomings in the EU vehicle testing system, including:

- The reliance on the New European Drive Cycle (NEDC), which was not fit to assess NO_x levels emitted by diesel vehicles in real driving conditions; inadequacies had been known since 2004-2005;
- The absence of Member State monitoring and enforcement of the Euro Standards Regulation (EC) No 715/2007, in particular the failure to identify the use of defeat devices prior to the emergence of the Dieselgate in September 2015;
- Car manufacturers not being required to disclose or justify their emission strategies to type approval authorities;
- The failure of the Commission and Member State to act in response to non-compliance by manufacturers.

During the evaluation period, measures have been taken since 2015 to address the issues that arose out of the testing failures in the Type Approval framework. A package of legislation was adopted between 2016 and 2018 to strengthen the Commission's powers in the implementation and enforcement of the Type Approval Framework (Regulation 2018/858), replace the previous laboratory test procedure (the NEDC) with the Worldwide Harmonised Light Vehicle Test Procedure (WLTP), and progressively introduce the Real Driving Emissions (RDE) test from 2016 to 2020.

However, the regulatory package also introduced conformity factors for the RDE, which meant that vehicle NO_x emissions during the RDE test can exceed the Euro 6 emissions standards by a factor of: 2.1 (i.e. 168mg/km for diesel vehicles) from 2018 (new models) or 2019 (new vehicles); and of 1.5 (i.e. 114.4 mg/km for diesel vehicles) from 2020 (new models) or 2021 (new vehicles) (Annex IIIA, Commission Regulation 692/2008 as amended by Commission Regulation 2016/646). Some cities challenged these conformity factors, arguing that they undermined the ability of local authorities to achieve air quality standards. In December 2018, the General Court of the EU annulled these conformity factors but allowed them to remain in place for 12 months to allow time for legislation to be amended [L5].

Regarding the provisions of the CO_2 emissions standards for vehicles, the regulations did not specify a particular technology to be used by manufacturers to meet these standards, some manufacturers opted to use diesel technology to meet their obligations. During consultations, while not specifically identifying issues in the EU regulations themselves, some stakeholders suggested that policy settings for CO_2 emissions from vehicles have prompted Member State actions to promote diesel cars.

Other transport legislation

Air quality is also supported by other pieces of EU transport legislation. The **Eurovignette Directive** (Directive 1999/62/EC, as amended) seeks to harmonise Member State systems for the road charging of heavy goods vehicles; these systems aim to internalise the external costs of the use of heavy vehicles, including air pollution costs, and as such support EU air quality goals. The Commission's 2017 proposal to revise the Directive (COM/2017/0275) final would extend it to more vehicles, including light duty vehicles, and would phase-out time-based user charges in favour of distance-based charges, which would strengthen the internalisation of external costs such as air pollution. However, this proposal has not yet been adopted. The **Alternative Fuels Infrastructure Directive** (Directive 2014/94/EU) aims to establish an EU-wide framework for deploying alternative fuels infrastructure, such as charging infrastructure for electric vehicles and hydrogen refuelling points, with a key goal being to minimise the environmental impacts of transport (Article 1). The Directive requires Member States to adopt national policy frameworks for alternative fuels markets in the transport sector and to deploy infrastructure appropriate to national circumstances. The Directive may have supported the objectives of the AAQ Directives by helping address market barriers to alternative transport fuels.

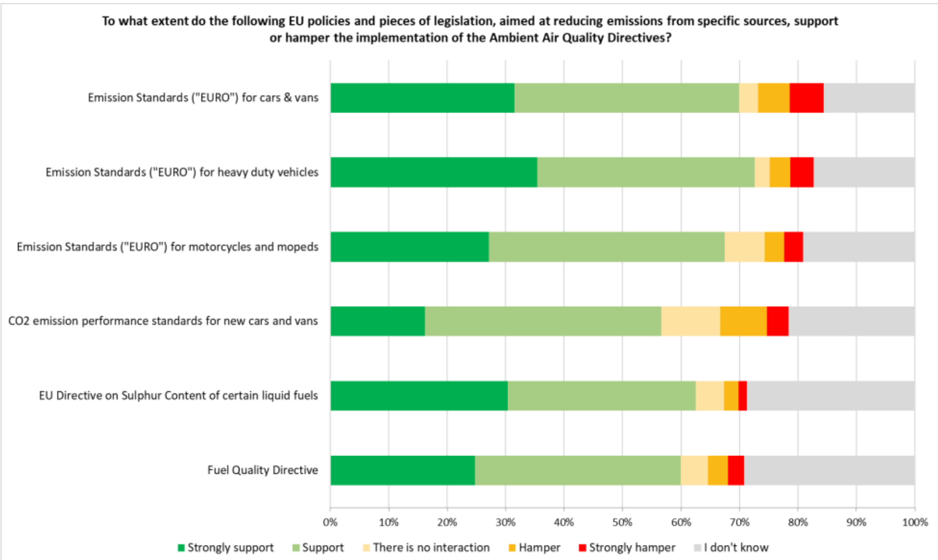
The **Clean Vehicles Directive** (Directive 2009/33/EC) aims to build market support for clean vehicles by introducing energy efficiency and emissions standards (both of greenhouse gases and air pollutants) into public procurement procedures. A study supporting the Commission's evaluation of the Directive found that the Directive had been limited in terms of effectiveness and, in the case of air pollutants, may have had a negative impact due to a tendency to support diesel vehicles [P82]. The Commission subsequently proposed revisions to the Directive intended to address these issues (COM/2017/0653); Parliament agreed on revisions in February 2019 and the proposal was before the Council at the time of concluding this report.

Stakeholder responses

Text box 5 Results from open public consultation

In the Open Public Consultation, respondents were largely positive about the extent to which EU transport legislation supports the implementation of the AAQ Directives. On key pieces of legislation, as outlined in the figure below, most respondents reported that the legislation was supportive of the AAQ Directives. Nonetheless, concerns were expressed by a reasonably significant minority that the CO_2 emissions standards for new cars and vans hamper air quality objectives, with 12% of respondents expressing such concerns. Similarly, respondents indicated concerns about the Euro standards, with 11% of respondents stating Euro 5 and 6 standards for cars and vans hamper the AAQ Directives.

Figure 8 OPC responses on EU vehicle emissions and fuel quality legislation



In a position paper submitted to the OPC, one stakeholder expressed concerns that CO_2 emission performance standards for cars and vans had contributed to emissions of air pollutants.

In the targeted questionnaire responses, stakeholders noted some aspects of the EU transport policy framework that are supporting air quality objectives. It was noted that the Fuel Quality Directive has had a positive impact on sulphur dioxide emissions from vehicles and has helped limit the negative impacts of older vehicles without the expense of retrofitting. Other transport legislation cited as supporting the objectives of the AAQ Directives included the Sulphur Directive, the Road Charging (Eurovignette) Directive and the Clean Vehicles Directive. Concerns about transport legislation hampering air quality policy objectives reflected those highlighted in the Open Public Consultation, focusing on the CO_2 emission standards for cars and vans and the Euro standards for cars and vans.

A relatively large number (21) of respondents to the targeted questionnaire commented on concerns about the coherence between air quality and transport policy, particularly in relation to measures to reduce greenhouse gas emissions from road transport and the impact of the Euro standards on air quality. When addressing climate-related measures for road transport, respondents did not specifically identify issues in the EU legislation itself but pointed to actions taken at the Member State-level to support the objectives of the Regulation. In particular, fiscal incentives to support diesel vehicles were mentioned by stakeholders. Some stakeholders also pointed out that, in and by themselves, the EU CO_2 emissions standards for cars and vans were coherent with air quality policy objectives, but they created incentives for manufacturers to focus on diesel vehicles, which have somewhat lower CO_2 emissions, and shortcomings in the implementation of the Euro standards failed to address air pollutant emissions from these vehicles.

On the subject of Euro standards, stakeholders noted that the standards have had a positive impact on emissions of particulate matter, thereby supporting the objectives of the AAQ Directives. But on the subject of NO_x emissions, stakeholders expressed concerns that the Euro Standards, and the testing regime supporting the standards up to 2017, failed to identify that vehicle NO_x emissions would exceed the emissions limits in real world driving conditions. One stakeholder noted that the adoption of the Real Driving Emissions test procedure and the recent revisions to the Type Approval framework will help address these issues for new vehicles, but the legacy of vehicles approved prior to the new testing regime will continue to hamper the objectives of the AAQ Directives. Two Member State authorities noted that legacy vehicles are likely to contribute to air quality problems in lower-income Member States. Two Member State authority respondents noted that, as vehicle testing did not successfully ensure that vehicles met emissions limits, Euro standards cannot reliably be used as a basis for national or local road transport emissions reduction measures (e.g. low emissions zones).

The question of how Member State-level measures on transport influence the AAQDs is addressed in JC 9.3 and 9.4 below.

Energy

The energy sector – energy production and distribution – is a significant contributor to concentrations of ambient air pollutants in Europe. In 2016, the sector was the largest single emitter of sulphur dioxide (accounting for 51% of total EU-28 emissions), nickel (37%), and mercury (39%). It also is a significant emitter of nitrogen oxides (17% of EU-28 emissions), arsenic (22%) and cadmium (13%). Fuel combustion in households for heating and energy use in industry are also significant sources of ambient particulate matter [R61].

The energy sector is also a key source of CO_2 emissions. Air pollution abatement measures in the energy sector are also closely linked to climate policy: Measures to reduce ambient air emissions from energy generation are often coupled with efforts to reduce greenhouse gas emissions [P69]. As noted in JC8.4 above, policy actions can achieve win-win outcomes for both policy areas. For example, energy efficiency measures and power generation from most renewable energy sources can result in reduced CO_2 emissions and reduced ambient air pollution from energy generation. Conversely, some measures that deliver results in one policy area can negatively impact the other area. For example, renewable energy policies that emphasise energy generation from biomass sources will reduce CO_2 emissions but can increase ambient air pollution.

Given the significant contribution of the energy sector to ambient air pollution in Europe, coherence in policy-making is important for air quality objectives. This section reviews the coherence of the *objectives* of key EU energy policies with those in the AAQ Directives.

The **2020 Climate and Energy Package** (COM/2008/30), published in 2008, sets out the European Union's climate and energy goals[23]. The Package includes two targets relevant to the energy sector:

- A 20% share of renewable energies in EU energy consumption by 2020
- A 20% energy efficiency target (i.e. energy consumption in 2020 is 20% below projected energy use).

While the Climate and Energy Package itself does not specifically seek to address air quality, the energy aspects of the package have links with air quality. The energy efficiency target supports the objectives of the AAQ Directives – measures to reduce demand for energy will reduce emission of air pollutants through reduced energy generation. Increased energy generation from renewable sources can also support air quality goals in a similar manner, by reducing air pollutant emissions from fossil fuel combustion. However, the extent to which this is achieved depends on which renewable energy sources displace which forms of conventional energy generation, as some renewable sources – notably biomass – are associated with high emissions of air pollutants.

The European Commission's 2015 **Energy Union Communication** (COM/2015/080) sets out the strategy for achieving a 'resilient Energy Union with a forward-looking climate change policy'. The Communication sets out a vision for the Energy Union, centred on market integration, energy security, sustainability and competitiveness. Five 'dimensions' are set out that aim to deliver this vision, focused on similar issues. Fifteen action points for achieving the Energy Union are also set out in the Communication.

The impacts of the energy sector on air quality are not specifically addressed by the Communication, its vision or the supporting dimensions and action points. The Communication makes some reference to policy measures that could impact air quality. It notes the need to phase out environmentally harmful energy subsidies, which would in principle support the objectives of the AAQ Directives. It also notes the proposal for a new Renewable Energy Package, including a 2030 target a new policy for 'sustainable biomass'. In principle, an increased renewable energy target could positively impact air quality, due to a reduction in air pollutant emissions from fossil fuel combustion. However, the inclusion of biomass within this target could potentially offset some of these benefits, due to increased emissions from the burning of solid biomass.

[23] The coherence of the CO_2 emissions reduction targets and measures is evaluated under JC8.4 above.

Under the framework of the Energy Union Communication, and **the 2030 Climate and Energy Framework**, a package of legislation was outlined in the **Clean Energy Communication** (COM/2016/860) in 2016. The goal of the Clean Energy Communication is to 'modernise the economy and boost investments in clean energy related sectors', setting out regulatory proposals that aim to support the clean energy transition. Three main goals are identified: putting energy efficiency first; achieving global leadership in renewable energies; and providing a fair deal for consumers. The Communication itself does not specifically address air quality. The emphasis on energy efficiency is broadly coherent with EU air quality goals. Within the discussion on renewable on renewable energies, consideration is given to the broader environmental impacts of biomass uses; however, the focus here is on the climate and circular economy aspects of biomass and air quality is not mentioned.

Looking more closely at key EU legislation to achieve these goals, the overall objectives of the Energy Efficiency Directive (Directive 2012/27/EU, as amended) and the Renewable Energy Directives (Directive 2009/28/EC, as amended, and Directive 2018/2001, recast) are not directly in conflict with the goals of the AAQ Directives.

Air quality is not specified as a goal in the **Energy Efficiency Directive**. Nonetheless, the Directive briefly acknowledges the synergies between the air quality and energy efficiency objectives: In setting out the framework for Member State National Energy Action Plans, it notes that Member State plans should include information on how measures in the plans support improved air quality (Article 24(2) and Annex XIV). The 2018 adoption of a higher energy efficiency target for 2030 (32.5% below business-as-usual), and provisions for revising this target upwards by 2023 (Directive (EU) 2018/2002), should better support air quality objectives by reducing emissions from energy generation.

The primary objective of the two Renewable Energy Directives (Directive 2009/28/EC and Directive 2018/2001) in force during the evaluation period is to establish 'a common framework for the promotion of energy from renewable sources' (Article 1) through the setting of mandatory national targets. In terms of *objectives,* the Directives are not inconsistent with the objectives of the AAQ Directives. In terms of *provisions,* the Directives are likely to have supported air quality goals through increased generation of energy from low-emissions sources, such as solar or wind, and decreased fossil fuel energy generation. These benefits were noted in the impact assessments for both the 2009 Directive and the 2018 Directive.

However, the inclusion of biomass in the renewable energy sources that can be used by Member States to meet the Renewable Energy Target may weaken the contribution of the Directive to EU air quality goals. In addition, biomass energy generation may negatively impact air quality in some specific locations.

The recast Renewable Energy Directive 2018 notes the need to ensure biomass is used efficiently and limits emissions of air pollutants (Recital 105). This is paired with sustainability criteria set out in Article 29, with Article 29(11) requiring that electricity generated from biomass-fuelled installations of 50MW meet certain efficiency standards. While this is a relatively minor reference to air quality, this suggests a growing recognition of the need to ensure coherence in renewable energy policy during the evaluation period and is likely to contribute to reduced air pollutant emissions through more efficient use of biomass. The impact assessment carried out for the 2018 Directive suggests that biomass use under the new Directive would remain constant and possibly decrease between 2020 and 2030. It concluded that the Ecodesign Directive, Industrial Emissions Directive and Medium Combustion Plants Directive will help mitigate against the negative air quality impacts of any increased use of solid biomass for energy [P55] and it was therefore decided not to include specific controls on air pollution from biomass-fuelled energy generation within the Directive.

The **Energy Union Governance Regulation** (Regulation (EU) 2018/1999), proposed under the 2016 Clean Energy Communication and adopted in December 2018, links between climate, energy and air quality policy are recognised in the proposed Regulation's recitals and provisions. Integrated National Energy and Climate Progress Reports must include information on the impacts of climate and energy policies on air quality (Article 17); and reporting on renewable energy must include information on the estimated impacts of biomass fuels on air quality (Article 20 and Annex IX).

The **Ecodesign Directive** (Directive 2009/125/EC) sets out ecodesign requirements for energy-related products, and thus sets out emission limits for sources of ambient air pollution, in particular domestic heating products, such as solid-fuel boilers, which are an important source of PM. Fuel combustion in the commercial, institutional and household sector – primarily through the use of domestic boilers and heaters – is the largest source of primary PM_{10} and $PM_{2.5}$ in Europe [R53].

The Ecodesign Directive does not specifically set out an air quality objective, but Article 1 includes reference to the Directive's contributions 'to sustainable development by increasing energy efficiency and the level of protection of the environment', which is clearly linked to the EU's air quality objectives. The Directive's focus on energy efficiency indirectly supports the objectives of the Air Quality Directives, by reducing emissions associated with power generation. The inclusion of air emissions among ecodesign parameters for products (Annex I of the Directive) shows strong coherence with the Air Quality Directives. The Impact Assessment for the 2009 recast of the Directive (SEC(2008) 2115) briefly notes, in relation to the EU added-value of the Directive, that the Directive is necessary to address the cross-border nature of air pollution.

Looking more specifically at the product-specific ecodesign requirements set out under the Directive, the purpose of the product-specific regulations is to provide the specific ecodesign requirements for product classes, necessary for implementing the Directive. As such, the regulations do not specifically set out an objective related to air quality (or energy efficiency or environmental protection more broadly). Nonetheless, the recitals of the regulations identify the environmental aspects each measure seeks to address.

In the case of two product groups of strong relevance to air quality – solid fuel heaters (Commission Regulation 2015/1185) and solid fuel boilers (Commission Regulation 2015/1189) – there are strong links to air quality objectives in the regulation texts. In the ecodesign regulations for solid fuel boilers and solid fuel heaters, the recitals identify the emission of ambient air pollutant, particularly particulate matter, as relevant environmental aspects. A review of the Impact Assessment for the Solid Fuel Boiler Regulation (SWD(2015) 92), shows that air quality protection is a clear objective of the Regulation, with addressing the 'negative impacts of emissions affecting air quality and human health' set out in the problem requiring action. The Impact Assessment for the Solid Fuel Heater Regulation (SWD(2015) 90) similarly gives strong consideration to air quality objectives. These regulations under the Ecodesign Directive should thus reduce emissions from these sources, including emissions related to biomass combustion. However, it has been noted by the Court of Auditors [P91] and in a study for the ENVI Committee of the European Parliament [S88] that the long transition period for ecodesign measures for these products (2020 for solid fuel boilers, and 2022 for solid fuel heaters), as well as the long lifespans of the products themselves, means that the positive impacts on air quality will not be achieved in the short-term. In its response to the Court of Auditors report, the Commission noted that the transition period reflects a balance of environmental objectives with the need to allow consumers and industry time to adjust to the change.

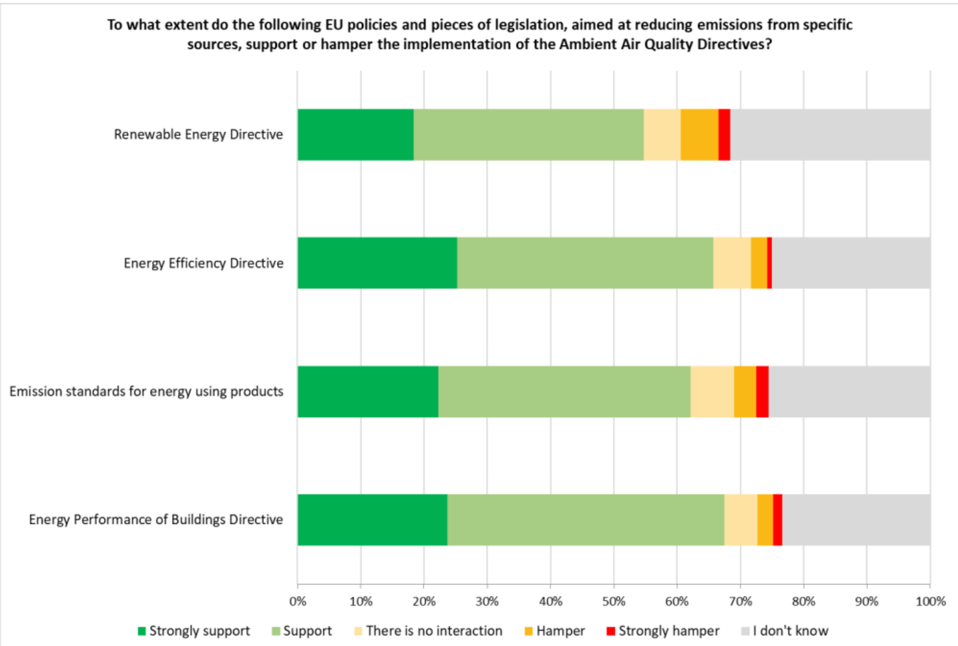
Stakeholder responses

In the open public consultation, a majority of respondents perceived that EU energy legislation supported the AAQD (see the box below). This is in line with the responses to the targeted questionnaire, where a relatively small number of respondents (14 respondents) addressed the coherence of EU energy policy with the AAQDs. The Energy Efficiency Directive, the Effort Sharing Decision, the EU Emissions Trading Scheme, Ecodesign Legislation are among the policies mentioned, although respondents often do not provide more specific details beyond noting the potential synergies between these instruments and air quality goals. Many respondents who expressed concerns about the coherence between the two policy areas focused on the impacts of the inclusion of biomass in the Renewable Energy Directive, with this topic being a particular concern for government authorities. Two NGO responses noted that efforts to decarbonise energy generation would also be likely to contribute to air quality. Two respondents (an NGO and a local authority) expressed support for the Ecodesign Directive, noting its contributions to air quality objectives; however, the respondents noted the relatively long transition periods in the legislation mean that positive impacts on air quality will not be achieved in the short-term.

Text box 6 Results from the open public consultation

When asked about the coherence between key EU energy sector legislation and the AAQ Directives, a majority of respondents to the Open Public Consultation agreed that EU legislation on energy overall supported the implementation of the AAQ Directives, as indicated in the figure below. When concerns were expressed, they tended to focus more on the Renewable Energy Directive, with 8% of respondents reporting that the Directive hampered the implementation of the AAQ Directives.

Figure 9 Open Public Consultation responses concerning EU renewable energy and energy efficiency legislation



Agriculture

The **Common Agricultural Policy** (CAP) is the agricultural policy of the European Union. The CAP consists of two 'pillars': the first includes direct payments (i.e. annual payments to farmers to help stabilise farm revenues in the face of volatile market prices and weather conditions) and market measures (to tackle specific market situations and to support trade promotion); the second pillar concerns Rural Development Policy and it is aimed at achieving balanced territorial development and sustaining a farming sector that is environmentally sound, as well as promoting competitiveness and innovation [S97].

In terms of air quality, the most relevant issue associated with agriculture is ammonia emissions, which is a PM and ozone precursor.

In recent years, the CAP has undergone a series of reforms that have improved its environmental sustainability. In particular, the 2013 reform aimed at finding a balance between agricultural production, rural development and the environment [D63]. It brought about a fundamental change to the architecture of the CAP, with the introduction of payments for implementing compulsory 'green' measures under Pillar 1, previously the domain solely of 'compensatory' income support payments. The rationale behind the introduction of these green measures was to provide a substantial funding resource to support basic environmental management on all agricultural land in the EU-28 [R115].

The 2010 Communication from the European Commission, entitled '**The CAP towards 2020**: meeting the food, natural resources and territorial challenges of the future' [P22] highlighted that the reform was necessary, inter alia, "to enhance the sustainable management of natural resources such as water, air, biodiversity and soil [and]… GHG emissions…". This Communication set the stage for the 2013 legislation that governs that CAP in the period 2014-2020.

The main legislation for **Pillar I** is Regulation (EU) No 1307/2013, the direct payment regulation. Its Preamble states that 'the enhancement of environmental performance' is one of the CAP's objectives [P108], however, there is no direct reference to air quality. Under Pillar I, the CAP provides income support to EU farmers; one condition is to ensure cross-compliance with environmental, health, animal welfare and land management rules.

Regulation (EU) No. 1306/2013 sets out key areas for cross-compliance, referring to a range of issues, such as water and biodiversity; air pollutant emissions, however, are not included. This Regulation does, however, include a ban on the burning of arable stubble (with the goal of maintaining soil organic matter), a measure that should reduce air emissions of particulates in agricultural areas. The Regulation also identifies the Nitrates Directive among its cross-compliance requirements: although this Directive does not address air pollutant emissions, its implementation should reduce agricultural emissions of ammonia (see G.1.3 above).

Under **Pillar II** of the CAP, Regulation No 1305/2013 of the European Parliament and of the Council on support for rural development by the European Agricultural Fund for Rural Development [P109] lays out the objectives and priorities for rural development within the EU. The objectives of the EAFRD Regulation are three-fold: 1) fostering the competitiveness of agriculture; 2) ensuring the sustainable management of natural resources, and climate change and 3) achieving a balanced territorial development of rural economies and communities including the creation and maintenance of employment. Environmental issues are, via the second objective, one of three core issues of the regulation, one that is highly important in the context of sustainable development in rural areas and the focus of this project.

To foster the three objectives, six Union priorities have been identified in the EAFRD Regulation. Each priority includes sub-priorities/focus areas. Priority area 5 refers to 'promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy' and sub-priority 5D calls for reducing 'greenhouse gas and ammonia emissions from agriculture'. These priorities form the basis of the intervention logic through with the Member States are to develop their Rural Development Programmes (RDP). Focus area 5D: 'Reduction of GHG and ammonia emissions' is relevant for air quality. At least 30% of funding for each RDP must be dedicated to measures relevant for the environment and climate change [D63]. (For further information on EAFRD funding supporting Member State action, please see the assessment of JC9.2 below.)

Finally, strengthened coherence between EU agriculture policy and air quality objective can be seen in specific measures to limit emissions from agriculture under the Industrial Emissions Directive (Directive 2010/75/EU). The 2017 Best Available Techniques Reference Document for the intensive rearing of poultry and pigs include ammonia emissions limits for the first time. This measure should support the goals of the AAQ Directives by limiting emissions of this precursor of secondary PM.

In conclusion, the overall policy and legislative documents for the CAP now incorporate environmental protection in their objectives and give the environment greater attention than previously. While the second pillar of the CAP provides a funding opportunity for the implementation of air quality measures (through focus area 5D) and thus supports the AAQDs' objectives, the coherence of the first pillar appears less strong: there is no specific focus on air quality at objective level, nor specific measures to directly tackle ammonia emissions are included as air pollutant emissions in cross-compliance. Recent measures to limit emissions from intensive pig and poultry farms under the Industrial Emissions Directive – contained in the 2017 Best available techniques Reference document (BREF) for the sector [P65] – may suggest a growing recognition of the need to address ammonia emissions from the agriculture sector.

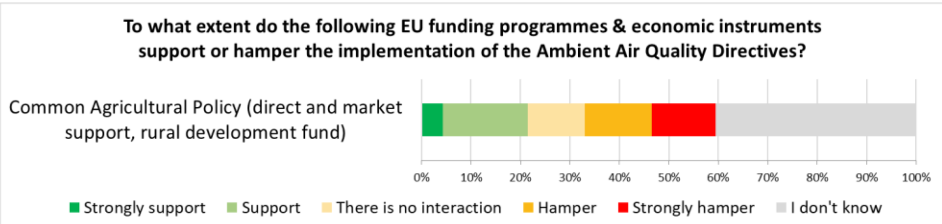
The AAQD, on the other hand, do not refer to directly agriculture or farming. Nonetheless, air pollution can have negative impacts on water and soil, thus affecting crops and forestry, and some air pollutants, notably ozone, can directly affect crops [D62, D115]. Directive 2008/50/EC sets standards to protect vegetation, notably including target values for ozone and critical levels for sulphur dioxide and nitrogen oxides.

Stakeholder responses

Text box 7 Results from the open public consultation

Many respondents to the OPC perceived that the CAP did not support the AAQD (see the figure below): 26.5% of the respondents stated that the CAP hamper or strongly hamper the AAQDs' objectives, against 21.4% which stated that it supports or strongly supports the AAQDs' objectives. 11.6% stated that the two policies do not interact while 40.5% didn't know.

Figure 10 Open public consultation responses concerning the CAP



Several environmental organisations consulted via the targeted questionnaire claim that the Common Agricultural Policy is not meeting its environmental objectives and therefore it is not supporting the AAQDs' objectives. Six of the responses referred to the impact of agriculture on air quality, in particular ammonia and methane emissions. One public authority noted that manure management requirements will reduce air pollutant emissions from agriculture. Another public authority stated that animal welfare requirements for chickens, though improving animal welfare have increased particulate emissions from agriculture. The response from Client Earth and other NGOs stated that the CAP's direct payments supports 'existing production and consumption systems' and does not adequately address their environmental impacts, including air pollutant emissions.

Health

Human health impacts are a central rationale for air pollution policy. The EEA has noted that, while air pollution has improved, it continues to affect the health and well-being of Europeans [S34]. The literature review has examined the EU health policy to identify health objectives pursued at EU-level, to analyse the coherence between these and the objectives of air quality legislation.

Member States are primarily responsible for health policy, under the EU Treaties, with the EU complementing Member State health policy action by supporting the development of legislation, providing investments (for example, under ESIF, for reforms of health systems or preventative health measures), and promoting good practices. Under Article 168(1) of the TFEU – the so-called mainstreaming clause – the EU is required to take into account the protection of human health: 'A high level of human health protection shall be ensured in the definition and implementation of all Union policies and activities'. EU health policy has emphasised that health considerations should be mainstreamed across EU policies.

EU health policy goals for the period 2008-2013 were set out in the **Second Health Programme**, [P117] which sets three objectives:

- Improving citizens' health security
- Promoting health, including the reduction of health inequalities
- Generating and disseminate health information and knowledge.

The EU's current health policy goals can be seen in the **Third Health Programme** (2014-2020) [P40], which has four specific objectives:

- Promoting health, prevent disease and foster healthy lifestyles through 'health in all policies'
- Protecting EU citizens from serious cross-border health threats
- Contributing to innovative, efficient and sustainable health systems
- Facilitating access to high quality, safe healthcare for EU citizens.

The AAQ Directives are directly relevant to the objectives of both Health Programmes. The objectives of the Directives to achieve and maintain good air quality[24] contribute to the health objectives of improving health security and promoting health, by seeking to limit the risks to human health posed by bad air quality.

The objectives of the AAQ Directives focused on ensuring that information on air quality[25] is made public also supports the third objective of the Second Health Programme and the first objective of the Third Health Programme by supporting citizens' ability to take measures to protect their health.

The second objective of the Third Health Programme, focused on protecting citizens from transboundary health threats, includes environment and climate threats to health (as per point 16 of the Preamble and Annex I on thematic priorities). The 2008 AAQ Directive, promotes cooperation between the Member States in reducing air pollution (Art. 25 of the 2008 AAQ Directive), supporting this goal.

The health promotion objective in the Second Health Programme refers to the need to address the health effects of wider environmental determinants. It mentions air quality, but refers specifically indoor air quality. As noted, the Third Health Programme refers to environment and climate threats to health; it does not refer directly to air pollution and its impacts on health.

Given the alignment between the objectives of the AAQ Directives and EU health policy, these two areas are broadly coherent. The objectives of the EU Health Programmes, however, refer only briefly to environmental and climate impacts on health, with no specific mention of ambient air quality.

Stakeholder responses
Coherence with EU health policy was mentioned by relatively few respondents to the Targeted Questionnaire. A joint NGO response from Client Earth and others noted that the AAQ Directives support EU health policy objectives by addressing harmful air pollutants, including ozone, ozone precursors and black carbon in particulate matter. A response from a health NGO stated that health concerns should be better integrated across all EU policies, including air quality policy.

Urban policy

The Urban Agenda for the EU, launched in 2016, is the main EU-level policy initiative for urban policy [D150]. The agenda is a multi-level dialogue between the European Commission, Member States and cities to address policy issues at the city-scale. As set out in the Pact of Amsterdam, which establishes the Urban Agenda, air quality is one of the 12 priority themes of the initiative. Under this priority theme, the Agenda aims to "realise systems and policies to ensure a good air quality for human health", covering legislative and technical approaches to limiting emissions. The Partnership on Air Quality is one of the four pilot partnerships under the Agenda and has been undertaking actions to support a coordinated urban approach to air quality.

Given the high priority given to urban air quality within the Urban Agenda, and the establishment of the Partnership on Air Quality as one of the first partnerships, the Urban Agenda is assessed as strongly coherent with the objectives of the AAQ Directives. (See also JC9.4 on EU-level coordination mechanisms.)

[24] Directive 2008/50/EC, Art. 1(5); Directive 2004/107/EC, Art. 1(b)

[25] Directive 2008/50/EC, Art. 1(4) ; Directive 2004/107/EC, Art. 1(d)

Directive 2008/50/EC in turn contains several provisions that address urban areas. Notably, it refers to 'agglomerations' (Art. 2), air quality zones that are urban areas with over 250,000 inhabitants (or less if they exceed a level of population density defined by the Member State). The Directive also calls on Member States to report an 'average exposure indicator' based on the urban background level of pollution (Art. 2 and Annex XIV).

There was relatively limited stakeholder input on EU-level urban policy. In the targeted questionnaire, when urban policy was mentioned, the focus tended to be on measures at the local level (e.g. spatial planning, urban access restrictions for vehicles). One response noted a general synergy between air quality and funding for sustainable urban development under EU Cohesion Funds. The OPC did not include a specific question on urban policy at the EU-level. However, a position paper was submitted by the Partnership on Air Quality, which stressed the importance of a coordinated and integrated approach to addressing urban air quality and identified issues relevant to other questions within the Fitness Check.

Cross-cutting policies

During the evaluation period, broad policy objectives for the European Commission were set out in the Europe 2020 Strategy [P27] and the Juncker Priorities for the European Commission 2014-2019 [P124]. Neither document makes specific reference to air quality, however Europe 2020 makes some references to the importance of environmental protection and notes the need for 'greening' taxation systems, which could support air quality goals; however, the overall emphasis in the discussion on environmental protection is on climate change mitigation. The Junker Priorities make little reference to environmental protection. The AAQ Directives themselves, which preceded these policy statements, do not specifically reference the goals set out in the documents.

Despite this absence of direct links, there may be synergies between the AAQ Directives and these high-level policy statements. Both the Europe 2020 Strategy and the Juncker Priorities emphasise the need for urgent and ambitious climate action (Priority 2 and Target 3, Europe 2020; Priority 3, Juncker Priorities). As noted under JC 8.4 above, reduction of greenhouse gas emissions is expected to lead to lower ambient air pollution. The AAQ Directives may also support the goals relating to 'Sustainable growth' (Priority 2, Europe 2020) and 'Jobs, growth and investment' (Priority 1, Juncker Priorities) by supporting innovation and protecting the health of the EU workforce. In the OPC, 47% of respondents agreed that the AAQ Directives support research and innovation – increasing to almost 75% of respondents, when those responding 'I don't know' are excluded. Almost 30% of all respondents agreed that the AAQ Directives support jobs, growth and investments – increasing to 50% when 'I don't responses' are excluded; and almost 40% held the view that there is no interaction between the AAQ Directives and 'Jobs, growth and investment'.

G.2.2 JC 8.2: EU funding instruments support MS actions to improve air quality

Approach

There are three indicators for assessment criterion JC9.2:

- EU funding programmes support air quality and sustainable urban development
- EU spending (in particular, spending by the European Structural and Investment Funds, ESIF) for investments that may hinder air quality objectives
- LIFE Programme supports air quality goals

The assessment covers the three indicators in turn.

The assessment for all three indicators considers the coherence of EU funding programmes with the AAQD in terms of their *objectives* as well as their *spending* (where information is available). In contract, the AAQ Directives do not refer to EU funding programmes in the provisions: for example, the list of information to be provided for air quality plans (Annex XV of Directive 2008/50/EC) does not include information on financing. In at least two of the case studies (Bulgaria and Italy), air quality plans refer to the use of EU funds to support measures addressing air pollution. Overall, while the AAQD in no way hinder EU funding instruments, the lack of references to EU funding in the AAQD might be limiting the uptake of EU funds for air quality measures.

The assessment draws largely from desk research, in particular assessments of the EU legislation governing the ESIF as well as information available on their spending. The assessment also draws on detailed information from the case studies.

Limitations to the approach

One limitation is that data available on spending varies across the EU funds considered. For the ESIF, for example, information is available on actual spending in the 2007-2013 programming period; as implementation is underway for the 2014-2020 period, currently available spending data will be incomplete and may not provide an accurate indication of final spending for the period. Consequently, data on Member State allocations was used. However, here too there are issues: final spending levels are often different from initial allocations.

A further limitation is that aggregate information on the impacts of EU financing in terms of reduced air pollutant emissions and improved air quality is not available. This is the case in particular for the largest share of resources relevant for air quality, those going to ‘indirect’ investments such as those for energy efficiency and urban transport.

Results

EU funding programmes support air quality and sustainable urban development

The five European Structural and Investment Funds are: the European Regional Development Fund (ERDF) and the Cohesion Fund (CF), which primarily finance infrastructure and physical investments; the European Social Fund, which supports investments in human capital; the EAFRD for rural development, which is covered in JC 9.1 under the CAP; and the European Maritime and Fisheries Fund. Within the five European Structural and Investment Funds (ESIF), the analysis focuses on ERDF, CF and EAFRD as the main sources of funding to support investments that can improve air quality – as well as their potential funding that can hinder air quality objectives, for example for projects that lead to higher emissions of air pollutants. This indicator also considers other EU funding programmes: the Connecting Europe Facility (CEF), Horizon 2020 and the European Fund for Strategic Investment (EFSI).

Regulation No 1303/2013 (the Common Provisions Regulation, CPR) sets out common provisions for five EU funding instruments: the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund (CF), the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF). It sets objectives and priorities for these five European Structural and Investment Funds (ESIF) in the 2014-2020 Programming Period. In the first recital of its Preamble, the Regulation cites Article 174 of the Treaty on the Functioning of the European Union: 'reducing disparities between the levels of development' of European regions. It targets all regions and cities in the EU to support job creation, business competitiveness, economic growth, sustainable development, and improve citizens' quality of life [D62].

Since 2000 the integration of environmental considerations into all aspects of programme development and implementation has gradually become more systematic and comprehensive [R195]. For the 2014-2020 financing period, an explicit effort was made to align the objectives of Cohesion Policy funds to those of the Europe 2020 Strategy via a focus on thematic objectives and investment priorities. The Preamble of Regulation 1303/2013 states that the 'objectives of the ESI Funds should be pursued in the framework of sustainable development and the Union's promotion of the aim of preserving, protecting and improving the quality of the environment' (recital 14).

The most relevant thematic objective for the improvement of air quality is Thematic objective 6: preserving and protecting the environment and promoting resource efficiency. Under this thematic objective, in fact, there are two investment priorities which directly tackle 'air pollution':

- Investment priority 6(e): taking action to improve the urban environment, to revitalise cities, regenerate and decontaminate brownfield sites (including conversion areas), reduce air pollution and promote noise-reduction measures;

- Investment priority 6(f) promoting innovative technologies to improve environmental protection and resource efficiency in the waste sector, water sector and with regard to soil, or to reduce air pollution.

In addition, air pollution can be tackled via indirect through investments under other thematic objectives, such as TO4: supporting the shift towards a low-carbon economy in all sectors or TO7: promoting sustainable transport and removing bottlenecks in key network infrastructures.

In conclusion, the CPR's *objectives* and its overall architecture for the programming period 2014-2020 is coherent with the air quality legislation as it supports the achievements of its objectives by envisaging specific direct investments to tackle air pollution.

With regard to *provisions*, the CPR first sets out requirements to mainstream environmental considerations in all spending: Article 8 of the CPR calls for environmental protection and sustainable development concerns to be integrated into Partnership Agreements and Operational Programmes. Moreover, the CPR calls for strategic environmental assessments of Operational Programmes (Art. 55) and environmental impact assessments of major projects (Art. 101) and the integration of environmental requirements in project selection [P49]. In addition, the CPR introduces ex-ante conditionality for environment as well as for other themes (Annex XI): the environmental requirements, however, address the water and waste sectors but not air pollution.

With regard to compatibility of provisions on ESIF spending on air quality and the EU-ETS, concerns have been raised that there are constraints on ESIF spending on reducing ambient air pollution emissions in EU-ETS installations, discussed in the box below.

A central element of the ESIF is the financing provided to Member States. The following sections first considering financing under ERDF and CF and then under the EAFRD. The ESF and EMFF are not addressed as they do not have direct interactions with air quality.

ERDF and CF allocations for air quality
As noted, ERDF and CF make direct financial allocations for environmental investments, including air pollution. A recent study for the European Commission analysed the integration of environmental concerns in Cohesion Policy across three programming periods – 2000-2006, 2007-2013, and 2014-2020. The study concluded that over EUR 4.5 billion were allocated for direct *air quality* spending categories across the three programming periods[26]. Moreover, this amount has increased from about EUR 430 million in the 2000-2006 period to EUR 1.6 billion in the following period [S102]. Member States have allocated about EUR 2 billion in the current period[27].

Member States have used these resources for pollution control at large industrial facilities, for the reconstruction of building heating systems, for public transport improvements and in some cases, also for air emissions from the agriculture sector [S102]. An example of how ERDF has been used for air quality investments in Croatia is presented in the box below.

Text box 8 Use of EU funds in Croatia

In Croatia, EU funds have to a high extent assisted in the implementation of the AAQ Directive. Before Croatia joined the EU, funds from the Phare fund were used to establish and expand the air quality state monitoring network. In the 2014-2020 period, Cohesion Fund has been used to modernise the network, equip chemical laboratories and develop the system for modelling air quality at the local and regional scale.

In September 2017 a grant contract was signed for the strategic project "*Upgrade and modernisation of the state air quality monitoring network – AIRQ"* within the framework of the Operational Programme "Competitiveness and Cohesion 2014-2020" (total project budget: EUR 16.5 million). Through this project, in the period until the end of 2021, new stations for achieving compliance with the minimum number of sampling points for fixed measurements will be set up, existing monitoring stations and equipment will be modernised, two EMEP Level 1 and one EMEP Level 2 stations will be set up, NRLs chemical laboratories will be upgraded, air quality calibration laboratory will be improved, the IT system will be upgraded and the new air quality modelling system will be established.

Source: Croatia's response to targeted questionnaire

In addition to the allocations for the priority themes directly related to air quality, allocations for renewable energy, energy efficiency and sustainable transport can have positive impacts on air quality. Indirect contributions potentially beneficial to clean air were planned through the low carbon economy (EUR 45 billion), environmental protection and resource efficiency (totalling EUR 63 billion) and network infrastructure (totalling EUR 58 billion) thematic objectives. On a smaller scale, the ERDF also provides funding opportunities for innovation, in line with regional or national smart specialisation strategies, some of which may be used for air quality [P59]. Spending in the

[26] The figure represents the sum of allocations for two categories of intervention under thematic objective 6: *'47. Air quality'* and *'48. Integrated Prevention and Pollution Control'*[26]. It should be noted that the second theme by its nature includes a range of actions that go beyond air pollution investments. The figures are not adjusted for inflation.

[27] The allocations for 2014-2020 are indicative and can change until the end of the programming period. See https://cohesiondata.ec.europa.eu/.

direct and indirect categories of intervention under Cohesion Policy may be quite similar: either could cover investments for public transport or building heating systems

Nonetheless, a paper by the Partnership on Air Quality [R146] found that few Operational Programmes explicitly allocate funding to air pollution reduction projects. The Partnership argues that Cohesion Policy could better support the AAQD if air quality was prioritised by the Member States and regions in their OPs, rather than relying on the integration of air quality measures with other priority areas [R147].

In addition, the European Court of Auditors [P91] noted that, although good projects targeting local pollution problems were identified in the case studies for its report on air quality, in other cases Cohesion Policy resources were not used to tackle known air pollution sources, such as domestic heating in Sofia.

EAFRD allocations for air quality
Under the EAFRD, one of the focus areas for spending covers air emissions, Focus area 5D: 'Reduction of GHG and ammonia emissions' is relevant for air quality. Various measures can be activated to contribute to this objective, from hard physical investments to reduce emissions (ammonia abatement measures, installation of air washers and coverage of storage manure facility) to support for more environmentally friendly farming practices through agri-environment-climate measures (e.g. sustainable fertilisation practices) and organic farming. These investments can be complemented by measures for knowledge transfer, business development and cooperation [D53]. These provisions provide an opportunity for Member States to incorporate air quality investments in their Rural Development Programmes.

The EAFRD's focus area 5D includes actions to address both GHG and ammonia emissions; consequently, data on spending and results solely for ammonia emissions, as a precursor for key air pollutants, are not available.

The target established for Focus area 5D was to mobilise EUR 2 billion of public expenditure to reduce GHG and/or ammonia emissions on 7.7% of EU agricultural land. Out of the 112 RDPs, only half of them included spending under Focus Area 5D [D53].

The data available indicate that EUR 972 million were spent across Member States by the end of 2016. Only a very limited number of RDPs, seven, reported investments in livestock management in view of reducing GHG and or ammonia emissions and only 113.000 livestock units are concerned (most in Denmark). Consequently, by the end of 2016 only 11% of the EU-28 target to reach 0.77% of the total livestock was achieved [S21].

With only half of the RDPs addressing Focus area 5D [D53], it seems that Member States have not fully taken up the opportunity to fund air quality measures and, for those who did so, implementation is progressing slowly.

Total ESIF spending
As noted above, the ESIF can provide both direct and indirect spending for environment, including air quality. Consequently, EU funding for air quality is higher than the allocations available for direct investments.

In the 2014-2020 programming period, EU funding from several financial streams addressed air pollution, by either directly supporting air quality projects, or effectively mainstreaming air quality objectives in other investments (e.g. infrastructure, agriculture and rural and regional development) [S22]. A study[28] in progress has provisionally estimated that around EUR 76 billion has been allocated to actions contributing purely or partially to air quality. This includes funding from ERDF and CF as well as financing under EAFRD [P59].

Case study examples[29]
In Bulgaria, the OP Environment (ESIF) for the period 2014-2020 [D103], air quality is a designated priority axis with the specific objective of '*Reducing ambient air pollution by lowering the quantities of PM_{10} and NOx*' with a budget of EUR 50 million. Three types of measures are addressed:

- Air quality plans: review and analysis of the municipal plans on ambient air quality and support for their preparation/revision, implementation and control;
- Measures addressing pollution from domestic heating: replacement of domestic combustion installations/boilers on solid fuel, installation of PM filters on individual domestic combustion installations, alternative heating;
- Measures addressing pollution from public transport: reducing the use of conventional fuel in public transport, replacement of the public transport vehicles exhaust systems (retrofitting) and supplementary measures.

In Germany, in the 2014-2020 period, six ERDF programmes addressed air quality: four financed air quality investments (€ 37.0 million, 40%) and two, Integrated pollution prevention and control (IPPC) investments (€ 55.3 million, 60%). (The German case study also noted that the city of Berlin had difficulty financing air emissions improvements to buses due to EU rules on air quality spending to less favoured neighbourhoods.)

In Ireland, Horizon 2020 supported the iSCAPE project, coordinated by Trinity College Dublin, which aims to advance and integrate the control of carbon emissions and air quality in European cities through developing remediation strategies, policy interventions and behavioural change initiatives.

In the 2007-2013 programming period, the direct investments under ERDF for air quality (Priority code 47) in Italy were EUR 25.4 million: the Operational Programmes of four regions – Tuscany, Sicily, Campania and Calabria region – contained investments under this code. In particular, these regions used EU funds to finance improvement of their air quality monitoring networks [D104]. In addition, EUR 43 million EUR were allocated to integrated prevention and pollution control investments (Priority code 48), which could include actions to reduce air pollution: the Operational Programmes of five regions – Umbria, Sicily, Puglia, Campania and Calabria – made these allocations.

In the 2014-2020 programming period the use of EU funds for air quality investments fell considerably, as none of the regions allocated ERDF resources for investments under the intervention code 83 (Air Quality measures). A total of EUR 30.7 million (less than three-quarters of the amount in the previous period) was allocated to IPPC intervention code investments: allocations were made in the regional OPs for Basilicata, Calabria, Campania and Puglia.

[28] Report by Ricardo Energy and Environment on a tracking methodology for air quality, forthcoming.

[29] The full case studies are found in Appendix J.

In addition to the allocations for the priority themes directly related to air quality, Italy's Operational Programmes made allocations for renewable energy, energy efficiency and sustainable transport: investments in these areas can have positive impacts on air quality. For example, several regions are currently using EU funds to promote a renewal of public transport systems to ensure and maintain good air quality levels. ERDF funds are used to support the preparation and the implementation of Sustainable urban mobility plans[30].

The regional Rural Development Programmes (RDPs), co-financed by the European Agricultural Fund for Rural Development (EAFRD), has supported measures that reduce agricultural emissions of air pollutants. The RDPs are identified as a key source of funding for agriculture measures in, for example, the 2013 and 2018 air quality plans for Lombardy and the Sicily. Data on the overall EU resources allocated air pollution in Italy are not available, however.

In Slovakia, in the 2007-2013 programming period, EUR 107 million of ESIF resources (ca. 6% of the environmental investments [R37]) were used to finance air quality improvements. For the 2014-2020 programming period the allocation to air quality is somewhat higher (ca. EUR 215 million) and correspond approximately to 9.5% of the direct environmental investments (of EUR 2.25 billion) [R36]. Activities supported in the 2014-20 period include: 1) technological and technical measures to reduce air emissions from air pollution sources, in particular with the view of meeting the NEC and the AAQ Directives requirements; 2) improvements of air monitoring; and 3) greater awareness of air protection.

In the first area, under the 7th call, 10 contracts were awarded to provide a non-repayable financial contribution in the total amount of approximately EUR 64.2 million (out of which EUR 35.3 million from the Cohesion Fund). In 8 cases, funding contracts were reached with U.S. Steel Košice, in one case with Žilinská teplárenská a.s. and in one case with Schüle Slovakia s.r.o. Finally, in the framework of the 14th call, 8 contracts were concluded to provide non-repayable contribution in the total amount of EUR 80.2 million (out of which EUR 68.1 million from the Cohesion Fund). In 7 cases, these were contracts with U.S. Steel Košice; and one contract with KOSIT a.s. U.S. Steel Košice, which is a large integrated steel producer in the Košice region, specified that EU resources have been used to finance technological improvements allowing further reduction of emissions (i.e. emissions further below the limits provided in the applicable BAT conclusions).

In the second area, EU funding has been, among other things, used on investments in the monitoring network (i.e. modernisation of the existing monitoring stations and establishment of additional monitoring stations), upgrade of hardware and software solutions and to address large sources of pollution.

In Spain, the National OP of the European Regional Development Fund [D105] includes as a priority and specific objective, 'actions to improve the environment in cities', which includes the improvement of air quality among the results expected to be obtained. One of the indicators to measure the results achieved will be the number of days per year when limits on air quality are exceeded. Among the examples of actions to be taken, it includes the design and implementation of plans to improve urban air quality, provided that they imply investments, such as the implementation of measuring stations for air quality indicators in cities. The total budget foreseen is EUR 24.9 million.

[30] For example, the Emilia Romagna region has prioritised ERDF funds to this aims: https://mobilita.regione.emilia-romagna.it/mobility-sostenibile/sezioni/por-fesr-2014-2020-per-la-mobilita-sostenibile

One project directly related to air quality policy is the update and improvement of the air quality monitoring system of the Instituto Universitario de Medio Ambiente (IUMA) of the University of A Coruña for an amount of EUR 147,525 [R118].

The regional OPs for Andalusia, Ceuta and Extramadura include funding lines for air quality, and the regional OP for Madrid includes allocations for energy efficiency, renewable energy and the promotion of sustainable urban mobility, among actions that could reduce air emissions.

In case study interviews, however, it was stated that Spain does not typically use EU Structural funds to promote compliance with the AAQ Directives[31]: this is more due to the lack of knowledge and awareness of the available funding possibilities.

The Sweden case study indicates that this Member State, in the programming period 2014-2020, has not made use of ESI funds to support air quality measures.

Connecting Europe Facility (CEF)
The Connecting Europe Facility (CEF) provides finance for investments in transport, energy and telecommunications infrastructure in Europe. The total budget for CEF in the 2014-2020 period is EUR 32 billion, with CEF-Transport accounting for most of this budget (EUR 24.05 billion). Approximately EUR 9 billion of CEF is to be invested in infrastructure projects that have some benefit for air quality, with most investments occurring in the transport sector [P59].

The key focus of CEF-Transport is on co-funding the construction of the TEN-T network, the EU transport infrastructure development policy focused on establishing an integrated network of land, sea and air transport modes across the EU. The extent to which CEF supports air quality is very much linked to how the TEN-T network contributes to air quality objectives. Initially, the priorities of the TEN-T network were based on filling in missing links, removing bottlenecks and interconnecting modes along key European transport axes. In 2013, the focus shifted to aligning priorities with broader EU transport policy by supporting low-carbon and sustainable modes of transport while enhancing and innovating transport and mobility [D68]. While not explicitly referencing air quality, the 2013 TEN-T Guidelines set a range of binding standards that require developing infrastructure on safer and more energy efficient transport services [P107]. These include reinforced provisions on enhancing multi-modal transport networks, shifting freight transport from road to rail, using intelligent road transport systems and developing innovative transport solutions such as alternative fuel (e.g. hydrogen terminals). These measures may indirectly contribute to reduced air pollution by improving the efficiency of transport, supporting non-fossil fuels and supporting the shift away from road transport.

During the 2007-2013 funding period, approximately EUR 8 billion was allocated to the TEN-T network. Most of this funding went to developing an interoperable railway network - especially for freight railway lines and developing measures for promoting maritime and inland waterway transport [R160]. These investments should reduce air pollutant emissions by supporting a shift away from road transport. In addition, some of this funding also contributed towards developing new technologies and innovation for the promotion of low carbon transport. Examples include feasibility studies on user acceptance of electric vehicles, pilot studies on fast charging stations along highways, testing renewable energy sources for port activities, studies for using alternative fuels, building smart energy efficient and adaptive port terminals, and identifying strategies for reducing particle emissions caused by short sea shipping [R160]. Aggregated quantitative data

[31] Municipality of Madrid on 21 September and Ministry of Environment on 24 September

on the exact funding for air quality projects for the 2007-2013 period is not publicly available at this stage.

In an effort to further reduce air pollutant (and greenhouse gas) emissions in the 2014-2020 funding period, the European Commission has signalled stepping up efforts to boost cleaner mobility and alternative fuels infrastructure through investment proposals of EUR 4.5 billion from public and private co-financing under CEF. In 2018, funding of EUR 1 billion for 39 clean transport projects was proposed for upgrading Europe's rail network, further developing alternative fuels infrastructure and paving the way for zero emission water transport [P69].

Horizon 2020

Horizon 2020 (H2020) is Europe's flagship financial instrument dedicated to driving smart, sustainable and inclusive economic growth. Funding supports research and development across a range of thematic areas broadly covering health, environment, transport, business, technology and security. There is no explicit objective for improving air quality under H2020, rather the programme tackles this issue either directly or indirectly under its three priorities of: (1) Excellent science; (2) Industrial leadership and (3) Societal challenges. The societal challenges relating to health (SC1), sustainable agriculture (SC2), clean energy (SC3), green transport (SC4) and climate and environment action (SC5) all potentially support air quality objectives.

It is estimated that EUR 13 billion in funding from both the 2007-2013 and 2014-2020 Horizon framework programmes was dedicated to projects that either directly or indirectly contributed to improving air quality [D58, P91]. In 2016 alone, approximately 19 million EUR was allocated to funding projects that supported innovations such as building air quality sensors to collect real time data on pollution and engaging citizens in developing local air pollution reduction strategies [D58].

During the seventh framework period (2007-2013) funded projects related to air quality included a study quantifying the long-term health effects of air pollution, identifying mitigation strategies and policies for improving air quality, and developing air quality monitoring technologies in urban areas [D70]. Other projects focused on developing innovative greener technologies, including a total of EUR 420 million was invested in 107 research and innovation projects under the umbrella of The European Green Cars Initiative.

European Fund for Strategic Investments (EFSI)

The European Fund for Strategic Investment (EFSI) is a joint initiative of the European Investment Bank (EIB) and the European Commission. The Fund is aimed at mobilising EUR 315 billion[32] in private investments to support long-term projects in four key areas covering innovation and skills, small and medium sized enterprises, infrastructure, and climate and environment. Up to 2020, EFSI is a financial guarantee totalling EUR 33.5 billion, of which EUR 26 billion comes from the EU budget and EUR 7.5 billion from the EIB [D71].

There is no explicit mention of air quality in the EFSI Regulation (Regulation 2015/1017). However, there is a strong focus on funding investments that align with other Union policies with complementary priorities that benefit in some way to improving air quality, such as H2020 and the TEN-T. Article 9 of the EFSI Regulation places requirements on the use of EU funding by prioritising projects that link with EU policy priorities, including expanding the use or supply of renewable energy, energy efficiency, development and modernisation of energy infrastructure, and developing smart and sustainable urban mobility transport infrastructure, equipment and

[32] Recently increased to EUR 500 million

technologies. It is estimated that approximately EUR 95 billion of the EUR 315 billion provided for loans and financial instruments under EFSI will have been allocated for projects with an air quality dimension such as energy and transport [P59].

Examples of EFSI resources supporting air quality objectives include investments in renewable energy infrastructure such as wind and solar photovoltaic (PV) power plants [D48], and in equipment for monitoring air quality at street level in urban cities. Likewise, sustainable transport projects accounted for EUR 5.8 billion of EIB funding in 2015 [R168]: Member States have used this funding for deploying cleaner and alternatively fuelled public transport based on hydrogen fuel and hybrid sources [D49].

Stakeholder views
Only a small number of stakeholders provided input as to how EU funding instruments contribute to the efforts of the Member States to improve air quality. Of those who did respond, the majority of stakeholders as well as the public[33] consider that ESIF support can play an important role in supporting the AAQD objectives. In the targeted questionnaire responses, it was noted that Member States, regions and cities with notable air quality problems have used ESIF resources to reduce air pollution. Other programmes mentioned in responses to the targeted questionnaire as relevant for supporting the objectives of the AAQDs were the Health Programme, the LIFE programme (see below) and Horizon 2020.

In a response to the targeted questionnaire, one national public authority stated that the Phare fund and Cohesion Policy funds are used in a complementary manner to expand and modernise the air quality monitoring networks and acquire infrastructure for modelling and testing (equipment for chemical laboratories). They are considered to be an important support for the implementation of the AAQDs.

That being said, some stakeholders mentioned funding in a general way without specifying the name of the instrument and suggested that they can undermine objectives of the air quality policies, if not used for sustainable projects. As mentioned in the transport section, funding of infrastructure projects which attract traffic to a certain area can lead to more pollution. In the same vein, agricultural funding, especially CAP, is considered to have a negative impact by encouraging practices that undermine air quality. One NGO working in the field of health stressed the importance of integrating an impact assessment of projects to be funded so that there would be more coherence between the funding instruments and AAQDs.

In the second stakeholder workshop, a national NGO stated that EU funding for biomass created a conflict with the AAQDs, and CAP funding has also supported activities that can increase air pollution. Stakeholders also mentioned difficulties in using EU funding to address air quality, including due to specific rules, such as those tying certain funding in urban areas to neighbourhoods with poor social status.

ESIF spending for investments that may hinder air quality objectives
Cohesion Policy in the transport and energy sector can also finance road infrastructure or other projects that might negatively affect air quality [R146]. The analysis here focuses on two areas of transport investments – roads and airports – and one area of energy investments, biomass.

[33] 42.7% of the OPC respondents stated that Cohesion Policy funding supports or strongly supports the AAQDs' objectives, against only 5.8% who stated that it hampers or strongly hampers them. 8.5% stated that the two policies do not interact and 42.9% did not know.

Operational Programmes using Cohesion Fund and ERDF resources provided a total of EUR 46.5 million for investments in roads in the 2007-13 programming period (see the figure below). About 70% of this amount was spent by EU13 Member States, which have larger infrastructure needs. In the 2014-2020, Member States have allocated a lower amount, EUR 30 million, for road investments.

In general, ESIF investments in roads will need to undergo an EIA procedure, and national road or transport programmes should undergo an SEA procedure: these should identify and mitigate potential negative impacts on the environment, including increased pressure on air quality (see also JC8.3 above). Moreover, new road infrastructure may in some cases reduce such pressures by alleviating congestion. In other cases, new road infrastructure may increase sprawl, however: for example, a 2016 EEA study noted that a 2013 assessment of the impact of highway construction in Poland estimated that planned investments, including some supported by EU funds, would to some extent increase urban sprawl and related environmental pressures [R52].

Table 5 ESIF resources for roads (EUR million)

	EU15	EU13	Territorial Cooperation	Total
2007-13 programming period (spending)	12.9	33.2	0.4	46.5
2014-20 programming period (allocations)	2.11	27.5	0.4	30.0

Source: DG Regio data, elaborated [S102]. Data for 2014-20 are available from: European Commission, European Structural and Investment Funds Data: https://cohesiondata.ec.europa.eu/2014-2020/ESIF-2014-2020-categorisation-ERDF-ESF-CF-planned-/3kkx-ekfq.

Notes: Data for the 2007-13 programming period refers to actual spending; data for the 2014-2020 refers to allocations, as reported to the European Commission (September 2018 data).

Operational Programmes for the ESIF have also supported investments in airports. Here, Member States allocated lower amounts than for roads: EUR 1.68 million in the 2007-13 programming period and EUR 0.43 million in the current programming period.

Table 6 ESIF resources for airports (EUR million)

	EU15	EU13	Territorial Cooperation	Total
2007-13 programming period (spending)	12.9	33.2	0.4	46.5
2014-20 programming period (allocations)	2.11	27.5	0.4	30.0

Source: DG Regio data, elaborated [S102]. Data for 2014-20 are available from: European Commission, European Structural and Investment Funds Data: https://cohesiondata.ec.europa.eu/2014-2020/ESIF-2014-2020-categorisation-ERDF-ESF-CF-planned-/3kkx-ekfq.

Notes: Data for the 2007-13 programming period refers to actual spending; data for the 2014-2020 refers to allocations, as reported to the European Commission (September 2018 data).

New airport investments could increase air traffic and related air emissions; at the same time, the amounts indicated are small and may have been used for traffic control or passenger terminal improvements that may not have had an impact on overall air traffic.

As noted for JC 9.1, biomass represents a renewable energy source that can reduce greenhouse gas emissions – however, emissions of air pollutants from biomass plants can contribute to air quality problems. Member State use of ESIF resources for biomass energy consequently could increase local air pollution. The impacts will depend on the specific investments made as well as the energy sources replaced by new biomass capacity. The European Court of Auditors [P91] raised concerns that EU funding for biomass could have negative impacts on air quality and moreover that this funding increased from the 2007-2013 to the 2014-2020 programming period.

OPs made expenditures of EUR 690 million for biomass investments in the 2007-2013 period (the original allocations, however, were higher: EUR 1.5 billion). In the 2014-2020 programming, allocations for biomass reached EUR 1.6 billion, according to DG Regio data, of which about EUR 921 million in EU13 Member States and EUR 681 million in EU15 Member States.

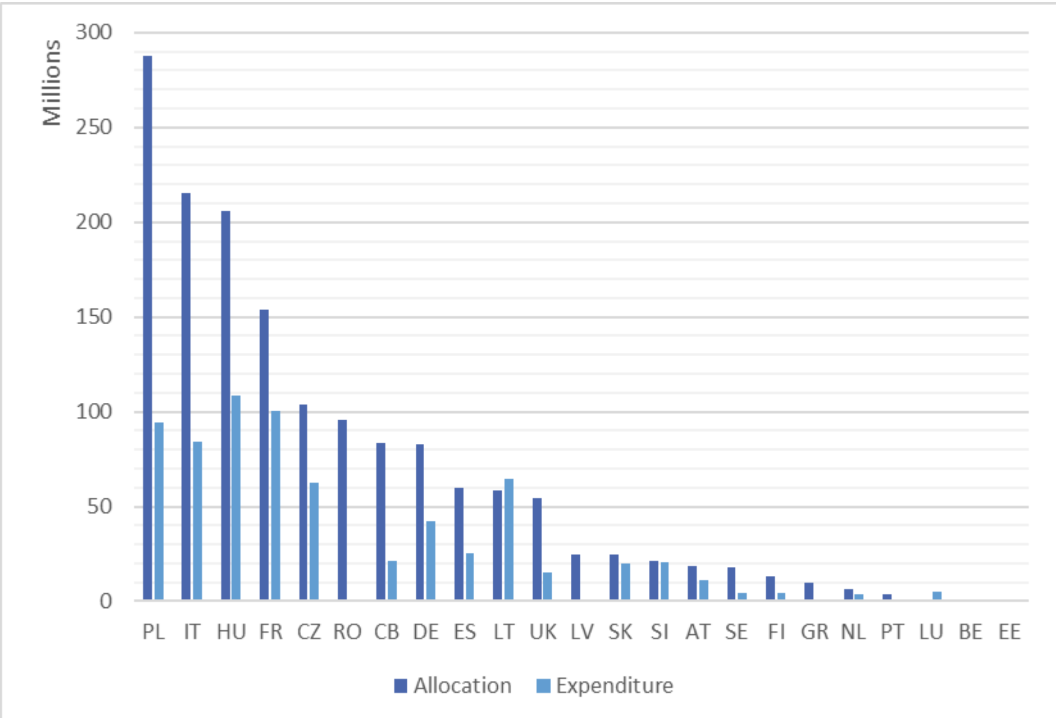
Table 7 ESIF resources for biomass energy (EUR million)

	EU15	EU13	Territorial Cooperation	Total
2007-13 programming period (spending)	358.6	309.7	21.2	689.5
2014-20 programming period (allocations)	680.5	921.3	27.2	1629.0

Source: DG Regio data, elaborated [S102]. Data for 2014-20 are available from: European Commission, European Structural and Investment Funds Data: https://cohesiondata.ec.europa.eu/2014-2020/ESIF-2014-2020-categorisation-ERDF-ESF-CF-planned-/3kkx-ekfq.

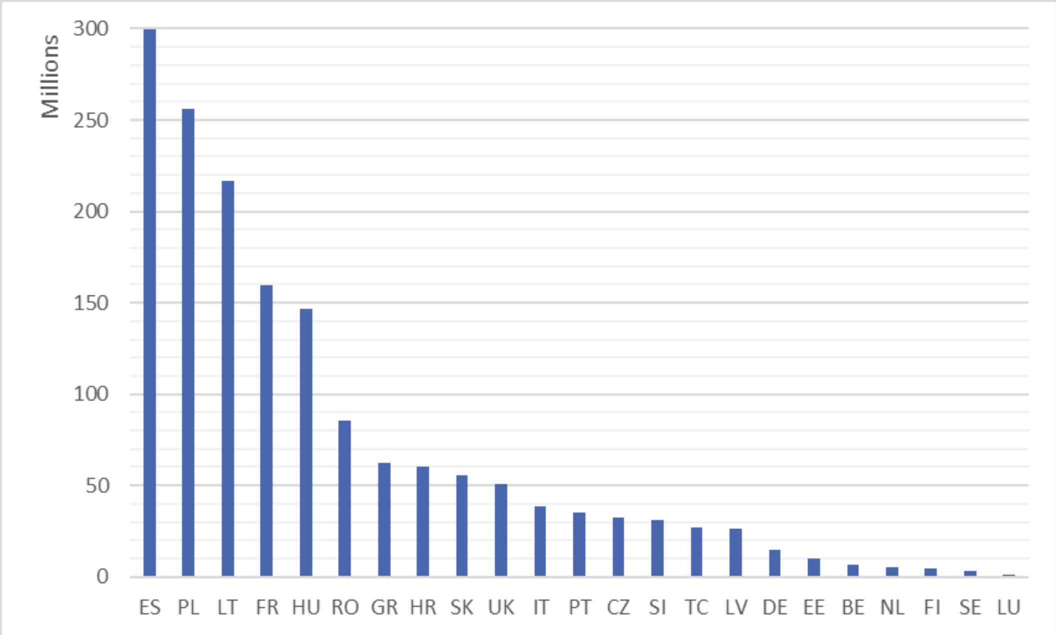
Notes: Data for the 2007-13 programming period refers to actual spending; data for the 2014-2020 refers to allocations, as reported to the European Commission (September 2018 data).

Figure 11 EFRD and CF allocations and expenditures for biomass, 2007-13 period



Source: see Table 7 above

Figure 12 EFRD and CF allocations for biomass, 20014-20 period



Source: see Table 7 above

The impacts of ESIF spending on biomass on air pollutant emissions and air quality can depend on a range of factors, including the type of heat and/or energy sources replaced by biomass and the specific equipment financed. For example, investments in biogas facilities are likely to have lower air emissions than those in combustion plants; investments to replace ageing household boilers with more efficient and low-emissions models could reduce emissions. (See also section G.2.1)

Compatibility between ESIF spending on air quality and EU-ETS

A specific issue was investigated concerning potential issues in the relationship between ESIF spending on air quality and the EU-ETS. In principle, ESIF funds cannot be used for investments to achieve GHG emissions reductions in installations covered by the EU-ETS (ERDF: Article 3(3), Regulation 1301/2013; Cohesion Fund: Article 2(2), Regulation 1300/2013). The purpose of this restriction is to avoid facility operators from benefit twice from the same activity (through the ESIF funding and the benefit of not being required to surrender EU Emission Allowances for the avoided emissions), thus supporting the integrity of the EU-ETS and the additionality of ESIF investments.

Concerns have been raised that this interaction between ESIF and the EU-ETS is not coherent with EU air quality objectives, as it could prevent ESIF investments in the abatement of ambient air pollutants in ETS installations. However, the recitals for both the ERDF and the Cohesion Fund Regulations make it clear that these funds can be used to support investments in ETS industries 'aimed at reducing air pollution, even if one of the indirect effects of such activities is the reduction of greenhouse gas emissions' (ERDF: Recital 3, Regulation 1301/2013; Cohesion Fund: Recital 7, Regulation 1300/2013). This would suggest that, on the basis of the legal foundation of the funds, ESIF spending on air quality is compatible with the EU-ETS, and the EU-ETS does not present a barrier to EU investments in air quality.

Text box 9 Interaction between EU-ETS and ERDF and Cohesion Funds: Relevant regulatory provisions

ERDF Regulation 1301/2013

Recital 3

'Specific provisions concerning the type of activities which can be supported by the ERDF, in order to contribute to the investment priorities within the thematic objectives set out in Regulation (EU) No 1303/2013, should be laid down. At the same time, activities outside the scope of the ERDF should be defined and clarified, including investment to achieve the reduction of greenhouse gas emissions from activities listed in Annex I to Directive 2003/87/EC of the European Parliament and of the Council (4). In order to avoid excessive financing, such investment should not be eligible for support from the ERDF as it already benefits financially from the application of Directive 2003/87/EC. That exclusion should not restrict the possibility of using the ERDF to support activities that are not listed in Annex I to Directive 2003/87/EC even if those activities are implemented by the same economic operators, and include activities such as energy efficiency investments in district heating networks, smart energy distribution, storage and transmission systems and measures aimed at reducing air pollution, even if one of the indirect effects of such activities is the reduction of greenhouse gas emissions, or if they are listed in the national plan referred to in Directive 2003/87/EC.'

Article 3(3)

'The ERDF shall not support: […] (b) investment to achieve the reduction of greenhouse gas emissions from activities listed in Annex I to Directive 2003/87/EC'

Cohesion Fund Regulation 1300/2013

Recital 7

'Investment to achieve the reduction of greenhouse gas emissions from activities listed in Annex I to Directive 2003/87/EC of the European Parliament and of the Council (5) should not be eligible for support from the Cohesion Fund as it already benefits financially from the application of that Directive. That exclusion should not restrict the possibility of using the Cohesion Fund to support activities that are not listed in Annex I to Directive 2003/87/EC even if those activities are implemented by the same economic operators, and include activities such as energy efficiency investment in the co-generation of heat and power and in district heating networks, smart energy distribution, storage and transmission systems and measures aimed at reducing air pollution, even if one of the indirect effects of such activities is the reduction of greenhouse gas emissions, or if they are listed in the national plan referred to in Directive 2003/87/EC.'

Article 2(2)

'The Cohesion Fund shall not support: […] investment to achieve the reduction of greenhouse gas emissions from activities listed in Annex I to Directive 2003/87/EC'

The LIFE Programme supports air quality goals

The aims of the LIFE programme include the protection and improvement of the quality of the environment and implementation and enforcement of EU environmental and climate policy and legislation [P111]. Its *objectives* thus support the AAQD.

The LIFE Programme, in its priority area for environment and resource efficiency, supports projects that (as per Article 10 of Regulation 1298/2013):

- "develop, test and demonstrate policy or management approaches, best practices and solutions, including… innovative technologies, to environmental challenges…"
- "support… integrated approaches for the implementation of plans and programmes… [under] environmental policy and legislation, primarily in the areas of water, waste and air"
- "improve the knowledge base" for EU environmental policy and legislation.

Under the LIFE Environment sub-programme, the thematic priorities include air quality legislation and compliance with air quality standards (Annex III). Moreover, the impact assessment for the Regulation highlighted potential results including health impacts from reductions in air pollution [P29]. The previous legislation for LIFE, Regulation 614/2017, also highlighted air quality as a priority in one of the three components, Environmental Policy and Governance. Consequently, the *provisions* of the LIFE programme support the AAQD.

In terms of *implementation*, The LIFE programme has supported projects for the implementation of air quality plans under its sub-programme for Environment, under which there are allocated 1.1 billion euro [P91]. The EC estimates that, in the period 2014-2020 around EUR 300 million has been allocated to projects with a direct or indirect impact on air quality [D61]. As the LIFE Programme requires beneficiary co-financing, it leverages public and private resources at national and local levels.

According to the EC, air quality has been a major focus of the programme after water and waste since 1992 [D61]. A 2012 assessment [R126] found that projects addressing air pollution had focused mainly on industrial pollution prevention, in particular via technological innovations. LIFE projects have nonetheless also covered a range of other actions, including for sustainable urban mobility, monitoring and modelling, capacity building, encouraging behavioural change, agriculture and industry, waste and energy.

Under the current programming period (from 2014) a total of 51 of the 434 LIFE projects in the 2014-16 calls target air quality direct or indirectly, according to the LIFE data hub [D29]. LIFE projects in the current programming period support air quality via actions for products, processes, services, information and awareness raising in the sectors of transport, energy, urban environment and industry [D58]. One project supports NGOs in Germany and the Czech Republic undertake legal actions for clean air (LIFE Legal Actions, funded under the 2015 LIFE call) [P43].

The current LIFE Programme has introduced integrated projects, which can support Member State authorities in the preparation of programmes and strategies, including air quality plans. One example is the preparation of an air quality plan for the Małopolska Region in Poland, financed under the 2014 LIFE call; this project will also support the use of ERDF funds to address air emissions. Another is the LIFE PREPAIR Project, financed under the 2015 call, whose activities include the implementation of measures under regional Air Quality Plans in northern Italy and the strengthening of coordination among Italy's regions and also with authorities in Slovenia [D58].

Evidence from the case studies

In Germany, the LIFE Programme has financed four projects related to air quality since 2008, including a legal action programme run by Deutsche Umwelthilfe (DUH), a clean heat project, a clean air project, and an experimental industrial air pollution control project.

As noted, in Italy the PREPAIR Project (Po Regions Engaged to Policies of AIR), currently underway, supports the implementation of measures foreseen in regional plans in the Po Valley and in the Po Valley agreement, to strengthen the sustainability and durability of results [D6]: the project's geographical coverage is the Po Valley with the regions and cities that mainly influence air quality in the basin. Its actions are also extended to Slovenia in order to assess and reduce pollutants transportation across the Adriatic Sea. The project will last for 7 years (from 2017 to 2024). The total budget is EUR 16.8 million, of which EU co-financing totals EUR 10.0 million. The recently completed OPERA project (see section 3.4.3 below), also financed by LIFE, developed a modelling tool to estimate costs and benefits of air quality measures [D5]: this tool, RIAT+,will be used in the PREPAIR project to estimate the results of ongoing air quality plans in the Po basin.

The LIFE Programme supported air quality actions in Sweden. A list of actions is presented in the Appendix to the case study. For example, the project CLEANTRUCK - CLEAN and energy efficient TRUCKs for urban goods distribution had as primary objective to demonstrate the commercial and technical viability of alternative fuels and new technologies for vehicles for the distribution of goods. The aim of the project was the overall reduction of GHG emissions but also other forms of pollution. The innovations introduced by the project were envisaged to achieve annual reductions of CO_2 emissions by 1,500 tonnes, NOx, pollution by 17 tonnes, noise pollution and the reduction of generation of the breathable fraction of fine particles (up to 2.5 μm) by 240 kg [D120].

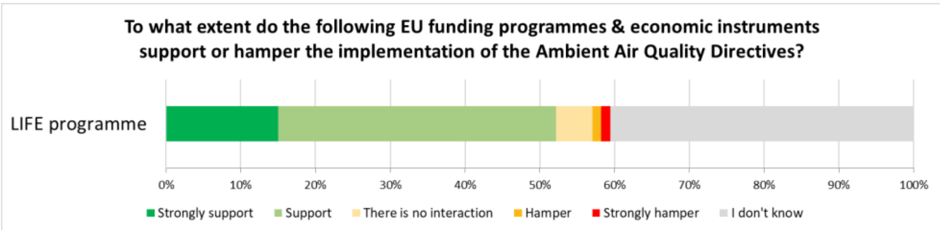
Stakeholder responses

In the open public consultation, 52% of respondents felt that the LIFE Programme 'strongly supports' or 'supports' implementation of the AAQD. A high share of respondents, 41%, indicated 'don't know', however.

Text box 10 Results from open public consultation

In the open public consultation, 52% of respondents felt that the LIFE Programme 'strongly supports' or 'supports' implementation of the AAQD. A high share of respondents, 41%, indicated 'don't know', however.

Figure 13 Open public consultation results concerning the LIFE Programme



G.2.3 JC 8.3: EU/national fiscal policies or measures support MS actions to improve air quality

Approach

This criterion examines the coherence between the AAQ Directives and fiscal policies and measures at the EU and Member State levels. There are two indicators for this assessment criterion[34]:

- EU rules for taxing energy products and vehicles support air quality objectives
- MS rules for taxing energy products and vehicles support air quality objectives

In evaluating the first indicator the analysis considers relevant EU legislation, particularly the Energy Taxation Directive. This analysis is based on the Directive itself, related policy documents, and relevant literature. The evaluation of the second indicator is based on relevant literature and input from the Member State case studies.

Limitations to the approach

The analysis for the first indicator is relatively straightforward, based on a review of the EU objectives and provisions for the taxation of energy projects. For the second indicator, the analysis was restricted to literature and evidence from the case studies, and did not include in-depth analysis of Member State taxation legislation.

Results

EU rules for taxing energy products and vehicles

In line with this indicator, this criterion considers how EU rules for taxing energy products, specifically the Energy Taxation Directive, support air quality objectives. It also briefly considers how EU rules for the taxation of vehicles interact with air quality objectives.

Taxation of fuel

The Energy Taxation Directive (2003/96/EC) covers products used as motor or heating fuel and electricity and sets minimum level of taxation for these products (in Article 7 and Annex I). The primary objective of the Directive is to support the functioning of the internal market by harmonising energy taxation levels (Recitals 2 to 5). The Directive notes the role that energy taxation can play in environmental protection, specifically climate change mitigation (Recitals 7 and 8). It also notes that tax exemptions or reductions may prove necessary due to environmental considerations (Recital 28).

Article 7 and Annex I of the Directive allow for the lower taxation of diesel. The minimum level of taxation for diesel (EUR 330 per 1,000 litres) is 8% lower than the level for unleaded petrol (EUR 359). In addition, Article 18 and Annex II set out the derogations allowing Member States to apply tax rates below the minimum level of taxation for certain products. These derogations include

[34] The original approach for this assessment criterion had one indicator focused on EU-level rules for the taxation of energy products. To allow a more comprehensive evaluation of how the Directive supports air quality at the Member State-level, particularly in relation to transport fuel, an additional indicator has been added to the evaluation framework: MS rules for taxing energy products and vehicles support air quality objectives. Fiscal policies relating to vehicles have also been added to the two indicators under this criterion to allow for consideration of how EU and MS tax and fiscal incentives for vehicles may impact air quality objectives.

reduced rates of taxation for diesel fuel. Most Member States have diesel taxes between 10% and 40% lower than petrol in 2017 [R166] (see also the following indicator regarding Member State rules for taxing energy products).

The OECD [R143] argues that the favourable tax treatment of diesel is not justified on environmental grounds, arguing:

- Tax rates are levied on a per litre basis; diesel has higher environmental impacts (in terms of CO_2, NO_x and PM emissions) on a per litre basis.
- While diesel is more fuel efficient than petrol (diesel contains approximately 10% more energy than petrol per litre), this efficiency does not reduce the environmental cost of each litre of diesel fuel. This fuel efficiency may be overstated, when the characteristics of the average diesel vehicle (heavier mass, larger engine) and any rebound effect are taken into account. Furthermore, drivers fully capture the efficiency benefits of diesel, so the greater fuel efficiency of diesel is not a justification for lower diesel tax rates.
- The social costs (noise, congestion, safety) of diesel are also likely to be higher on a per litre basis, given that diesel cars are driven more kilometres per litre of fuel.

Similar arguments are made in publications by stakeholders such as Transport & Environment [R167].

As the Energy Taxation Directive sets tax rates on a per litre basis, the tax rates do not reflect the relative environmental costs of each litre of fuel. By setting a lower minimum tax rate for diesel fuel, the Directive may be at odds with the objectives of the AAQ Directives.

In 2011, the European Commission proposed amendments to the Directive that would remove the favourable tax treatment of diesel (COM(2011) 169); however, this proposal failed to secure the support of the Parliament or Council [P92], and was subsequently withdrawn by the Commission.

The Commission is currently evaluating the Energy Taxation Directive. No information on the results of this evaluation was available as of March 2019.

Taxation of passenger vehicles
The role of the EU taxing passenger cars is largely focused on supporting the internal market, e.g. avoiding double taxation of vehicles (Directive 83/182/EEC). There is limited EU legislation on how passenger cars should be taxed. EU law permits Member States to charge registration or circulation taxes on cars, including taxes based on the pollutants emitted by a vehicle [D67].

In 2005, with the goal of supporting the internal market and reducing CO_2 emissions, the Commission proposed a Directive (COM(2005) 261) that would require Member States to restructure passenger vehicle taxation (including by abolishing registration fees payable upon purchase of a car and replacing these fees with a CO2-differentiated annual circulation tax). The Impact Assessment accompanying the proposal (SEC(2005)809) suggests that the proposal could potentially have a negative impact on air quality (by increasing the proportion of diesel cars in the vehicle fleet), depending on how buyers responded to the tax change. The proposal was ultimately withdrawn following unsuccessful negotiations in the Council. As the proposal preceded the evaluation period it is not considered in any depth in this analysis.

MS rules for taxing energy products and vehicles

Taxation of fuel

As of 1 January 2018, all but two Member States (the United Kingdom and Hungary) tax diesel fuel at a lower rate than petrol [D66][35], which can incentivise the purchase and use of diesel-fuelled vehicles, potentially leading to increased ambient air pollution.

Some other Member States are beginning to align tax rates for diesel and petrol. Since 2018, Belgium has been progressively increasing diesel excise duties to bring them into parity with excise duties on petrol [D136]. France [P122] and Portugal [R167] are also seeking to reduce the tax gap between diesel and petrol fuel. Often (e.g. France) this convergence policy is based on air quality concerns. However, public opposition to these changes may threaten the reforms.

This remains an area where policies in most MS are not coherent with the AAQD objectives.

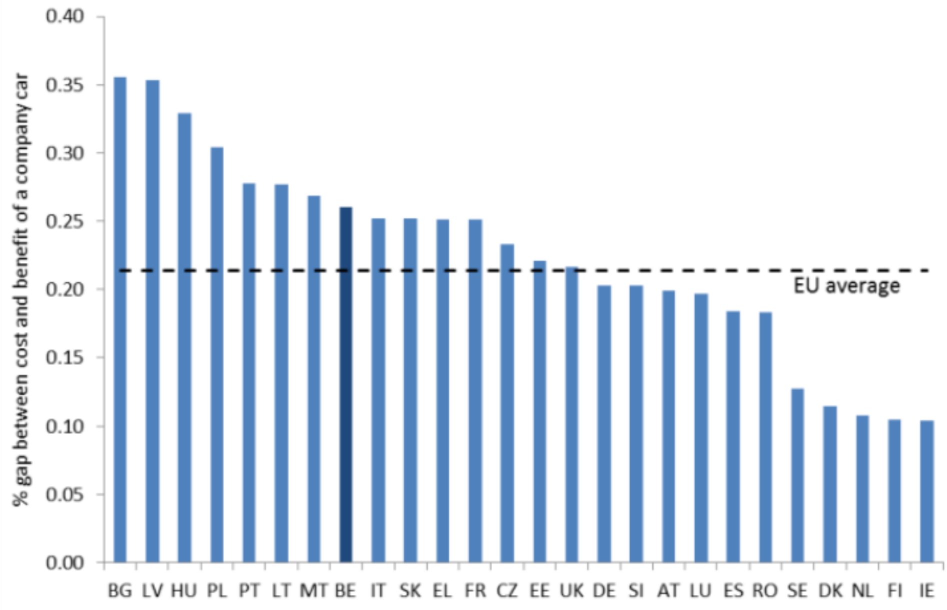
Taxation of vehicles

The tax regimes in some Member States incentivise vehicle ownership through favourable tax treatment of company vehicles [P64]. In general, these incentives are created through tax advantages for employers who offer employees company cars as in-kind benefit. These advantages are seen in how the benefit of private use of company cars is calculated for the purpose of income tax (imputation rate) and the treatment of the costs relating to company cars (including fuel costs). In many countries, these tax policy settings effectively result in a subsidy for private use of company vehicles. These incentives reduce the costs of road transport for employees, encouraging them to use cars over other modes of transport [R29]. In Member States with lower fuel taxes on diesel and other measures that support vehicles with lower CO_2 emissions (e.g. reduced registration or circulation taxes), these measures also have the potential to increase the number of diesel cars in a country’s vehicle fleet. These two potential effects of favourable tax treatment of company vehicles – i.e. increased car transport and increased share of diesel cars – combine to increase emissions of NO_x and PM.

Beneficial tax treatment for company cars occurs in a number of Member States. According to the European Commission, in 2015 all Member States for which data is available effectively subsidised the private use of company cars [P64], as illustrated in Figure 14 below.

[35] Starting in 2018, Belgium is progressively increasing diesel excise duties to bring them into parity with excise duties on petrol [D136]. France [P122] and Portugal [R167] are also seeking to reduce the tax gap between diesel and petrol fuel.

Figure 14 Subsidy for private use of company cars, percentage gap between cost and benefit of a company car, 2015



Note: Percentage gap between the company cost of providing a car and the taxable benefit of using the car, as compared to the car price. Information for Cyprus and Croatia is missing. EU average is the weighted average.

Source: European Commission [P64]

The European Semester Country Reports have also noted the issue of company car tax treatment in some countries, with the 2018 reports noting issues in Belgium and Germany. The 2019 Country Reports also note that, in some Member States where this problem is particularly pronounced, steps have recently been taken to remove incentives for vehicle ownership or to strengthen their incentives for low- or zero-emissions vehicles. For example, in 2016 Luxembourg introduced "sustainable mobility" tax reforms that result in increased benefits to employers that offer low-emissions vehicles to employees. Belgium is introducing a "mobility allowance" that would allow some employees to take cash payment instead of a company car as an in-kind benefit and is reducing the tax deductibility of diesel vehicle costs relative to other vehicles [R149].

This is an area where MS policies are not coherent with the AAQD's objectives, though there has been some movement to improve coherence.

Fiscal incentives for low and zero-emission vehicles

In addition to CO_2-based incentives for vehicles, Member States also have fiscal policies in place to encourage the uptake of low or zero-emission vehicles (hybrid, electric and fuel cell cars). These include tax incentives, purchase premiums and reductions in taxes for ownership or circulation, targeting both acquisition costs and ownership costs.

According to the EEA, only two countries don't have any financial incentive measures in place for zero- and low-emissions vehicles (HR and PL). Other Member States have introduced tax exemptions for the purchase and/or recurring costs of these vehicles [D46].

Another form of incentive is bonuses provided for the purchase of ultra-low or zero emission vehicles. Bonuses range from EUR 2,500 to EUR 10,000 and used in countries such as France, Germany, Ireland, Luxembourg, Slovenia and Romania [D46, R84]. Some Member States deploy schemes which will favour electric cars over combustion engines in term of fuel costs. For instance, in the Netherlands, a lower tax rate applies to electricity supplied at charging stations for electric cars [R84].

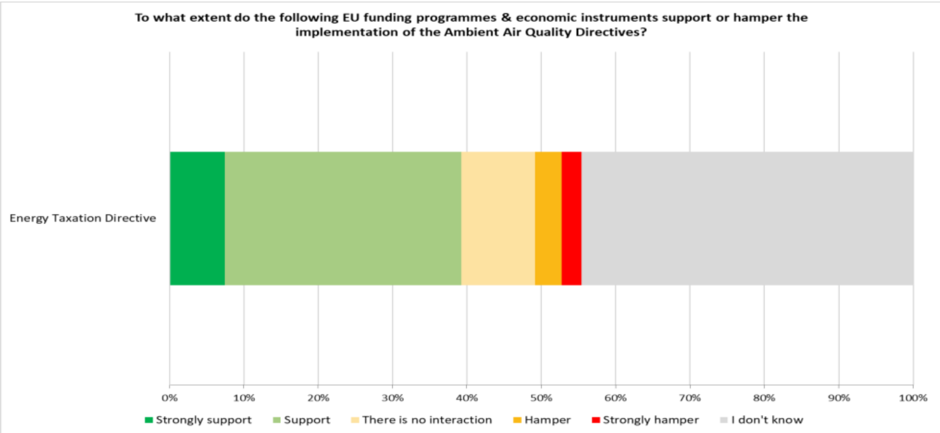
Where these incentives are based on criteria that are broader than CO_2 emissions alone, or where they particularly incentivise electric vehicles, they may positively impact air quality.

Stakeholder responses

Text box 11 Results from open public consultation

On the question of whether the Energy Taxation Directives supports or hampers the AAQ Directives, responses to the OPC do not indicate a strong stakeholder consensus on the topic. A plurality of respondents (45%) said that they do not know how the Directive impacts the implementation of the AAQ Directives, while 39% said that the Directive supports or strongly supports the AAQ Directives.

Figure 15 Open Public Consultation responses concerning the Energy Taxation Directive



In position papers submitted to the OPC, one respondent mentioned concerns that the Energy Taxation Directive supports diesel-fuelled road transport, potentially contributing to worse air quality.

In the responses to the Targeted Questionnaire, a limited number (four) of responses mentioned fiscal or tax measures relevant to air quality. All responses focused on Member State tax practices. One response noted that national vehicle tax measures based on CO_2 emissions from vehicles supported diesel vehicles, negatively impacting air quality. One respondent noted efforts in France to align diesel and petrol tax rates and stated that Member States should establish 'coherent tax systems, removing subsidies for polluting activities'. The other respondents made a rather general references to national approaches to environmental taxation. In an ad hoc stakeholder contribution, a port authority expressed concerns that the treatment of onshore power generation in ports under the Energy Taxation Directive may lead to higher air pollutant emissions from ships.

Assessment

While the objectives of the Energy Taxation Directive are generally coherent, there is less coherence in the provisions, particularly in the provisions setting lower minimum tax rates for diesel than for petrol. Implementation is, for most Member States, not coherent.

G.2.4 JC 8.4: EU-level coordination mechanisms support a coherent approach to achieving AAQ objectives

Approach

There is one indicator for this judgement criterion:

- Coordination mechanisms are in place at the EU-level to support integrated approaches for air quality improvements

This criterion considers coordination mechanisms in place at the EU-level to support a coherent approach to achieving the objectives of the AAQ Directives. The analysis considers two types of coordination mechanisms: first, those mechanisms in place at EU-level to support the integration of air quality into EU sectoral policy-making; second, mechanisms in place at the EU-level to coordinate with Member States to support a coherent approach to achieving the objectives of the Directives across the Member States.

The main source of information has been desk research, in particular document reviews.

Limitations to the approach

A key gap in the information available concerns the effectiveness of these mechanisms to support integration of air quality into sectoral policy. In part, this can be inferred from the results: for example, the analysis presents information on results of coordination for integration into EU sectoral policy-making. For EU-level mechanisms to support coordination with Member States and within Member States, however, the evidence does not demonstrate the specific results, some of which may still be in preparation.

Results

Coordination within EU sectoral policy making

There are a number of coordination mechanisms in place at the EU-level that, directly or indirectly, support an integrating air quality into EU sectoral policy. At the highest level, Commissioners' Project Teams can support the integration of policy objectives across sectoral policies. In the case of air quality, the *Energy Union Project Team*, which coordinated the Energy Union package and the three Mobility Packages, has been important in integrating air quality concerns into EU energy and transport policy. As an example of the integration of air quality into energy policy, Commission services identified the work of this Project Team that led to calls by the Commission for Member States to align National Air Pollution Control Programmes under the NEC Directive with the integrated National Climate and Energy Plans to be required under the Energy Union Governance Regulation (Regulation (EU) 2018/1999)[36]. Air quality considerations are reflected in the Energy Union legislative package, for example, through the requirements for Integrated National Energy and Climate Progress Reports under Article 17 of the Governance Regulation. It should be noted that there is no Project Team dedicated to air quality.

Comitology committees and Commission expert groups are also potential opportunities to integrate air quality concerns into the development of EU policy and legislation, including implementing measures. The *Technical Committee on Motor Vehicles* (TCMV), established to assist the Commission on legislation under the Type Approval Framework, is one such forum, composed of Member States representatives. The participation of DG Environment, together with other Commission services, in the TCMV means that air quality considerations can be factored into discussions. The Commission Working Group on Motor Vehicles expert group is composed of stakeholders from

[36] Email communication with European Commission, 18 July 2018.

industry, NGOs and academia intended to support a balanced representation of views. The working group on Real Driving Emissions - Light Duty Vehicles, a sub-group of the Working Group on Motor Vehicles, supported significant progress on better regulation of light vehicle emissions during the evaluation period, through its work on the development of the Real Driving Emissions (RDE) test. However, the European Parliament's EMIS inquiry found that industry groups were over-represented in the group and were able to delay the work of the group in developing the RDE test procedure. It also found that new rules for Commission expert groups adopted in 2016 (C(2016) 3301 final) should better balance the representation of stakeholders in expert groups and improve the transparency of proceedings [R94].

The Commission has also promoted sectoral fora, such as the *European Sustainable Shipping Forum* [D82], to discuss the intersection between air quality and sectoral policy with Member State authorities, industry and NGOs.

Coordination between EU and Member States

There are mechanisms in place at the EU-level that may support integration of air quality and sectoral policy at the Member State-level. Particularly important in this respect are the *Clean Air Dialogues*, which are bilateral dialogues between the Commissions and Member States facing implementation challenges. As noted on the website for the Dialogues [R64], key objectives are 'promoting clean air policy in other sectoral areas' and promoting 'synergies and avoid policy tensions between air quality policies, climate and energy policies, transport policies, agricultural policies and other policies, as well as links with health policy'. A review of the outcomes of the meetings held in 2017 and 2018 show that the Dialogues do indeed focus in large part on sectoral policy impacting on air quality objectives, with significant discussions taking place relating to transport [P60, P61, P62, P70], energy and heating [P60, P61, P62, P70] , agriculture [P60, P61, P62, P70] and industry policy [P62, P70]. Other EU-level initiatives that aim to improve Member State implementation of EU environmental legislation may also improve the coordination of Member State policy approaches to air quality. These include the Environmental Implementation Review (which is closely coordinated with the Clean Air Dialogue) and the Compliance and Governance Forum.

The impact assessment for the 2016 revision of the *NEC Directive* [P43] highlights the need to ensure coherence with other policies – such as those for agriculture, climate, energy and transport – as well as a lack of coordination between national authorities responsible for the NEC programmes and regional and local authorities responsible for air quality planning. The NEC Directive [P114] can support coordination at Member State level: in preparing the National Air Pollution Control Programmes for this Directive, Member States should 'ensure coherence with other relevant plans and programmes' under EU or national legislation (Art. 6). The impact assessment for the 2016 revision of this Directive notes the need to ensure coherence with other policies – such as those for agriculture, climate, energy and transport – as well as a lack of coordination between national authorities responsible for the NEC programmes and regional and local authorities responsible for air quality planning.

While not specifically focused on ensuring coherence with sectoral policies, there are EU-level mechanisms that support a more harmonised approach to implementing the Directives across the EU. Both Directives contain provisions establishing[37] a committee to assist the Commission in the implementation of the Directives. The *Ambient Air Quality Expert Group* implements these provisions in both Directives. As indicated by its mission, the work of the Expert Group is focused on the implementation of the Directives by national authorities; nonetheless, it supports a more

[37] Article 6, 2004/107/EC, and Article 29, 2008/50/EC.

harmonised application of the Directives and can be considered to support a coherent approach to their implementation. In this respect, *AQUILA*, the Network of Air Quality Reference Laboratories, and *FAIRMODE*, the Forum for air quality modelling in Europe, can also be said to contribute to harmonised implementation in relation to quality of air quality data and modelling of air quality respectively. As the Expert Group also serves as the committee established by the NEC Directive,[38] it also supports an integrated approach with this Directive. However, a review of the membership of the Expert Group[39] indicates that most members are drawn from Member State environmental authorities, therefore, the opportunities for the Group to support coherence with sectoral policy are limited.

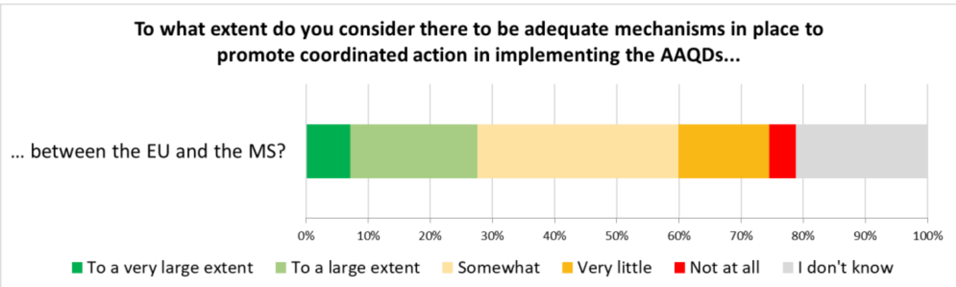
Other EU environmental initiatives that can support MS coordination include the Environmental Implementation Review [D76] (which is closely coordinated with the Clean Air Dialogue), a tool to improve MS implementation of EU environmental legislation and policy. The Environment and Governance Forum – set up by the European Commission under the Action Plan on environmental compliance and governance (2018) to strengthen compliance with EU environmental requirements [D75] – brings together a range of Member State actors, including judges, prosecutors, audit institutions, IMPEL and national environment agencies. Neither of the Forum's first two meetings, held in 2018, specifically addressed air quality, though they covered potentially relevant topics, such implementation of the Action Plan and improving access to justice [D72, D73].

Stakeholder responses

Text Box 12 Results from open public consultation

Respondents to the open public consultation generally agreed that mechanisms in place to promote coordinated action between the EU level and Member States in implementing the AAQ Directives was adequate, with almost 60% of respondents perceiving that mechanisms to support coordination between the EU and the Member States are at least somewhat adequate (see the figure below). The targeted questionnaire responses did not address this topic in any detail.

Figure 16 Open Public Consultation responses concerning coordination mechanisms between the EU level and Member States



G.2.5 JC 8.5: An integrated approach at Member State level

Approach

This judgement criterion covers three areas:

[38] Article 17, 2006/2284.

[39] Available on the Register of Commission Expert Groups [D82] at http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=2790.

- Member State air quality plans are coordinated with planning initiatives promoted by EU sectoral legislation;
- Member State air quality plans are integrated or linked with spatial planning;
- Member State coordination mechanisms support a coherent approach to achieving AAQ objectives.

The assessment mainly used desk research, including from studies and Internet sources as well as information from the country case studies.

Limitations to the approach

An important limitation is that integration issues can vary across Member States and also within Member States. The case studies have provided an overview for these selected countries; however, further evidence gathering at national level and in-depth would be needed to provide an exhaustive picture.

Results

Whether Member State air quality plans are coordinated with planning initiatives promoted by EU sectoral legislation, including public information

EU sectoral legislation includes a number of planning initiatives to support integrated sectoral policy-making at the Member State-level. One of the most relevant of these measures, in terms of air quality, is the European Commission's concept for Sustainable Urban Mobility Planning (SWD(2013) 524 final) set out in the 2013 Urban Mobility Package (COM(2013) 913 final). According to this concept, a Sustainable Urban Mobility Plan (SUMP) should "reduce air and noise pollution, greenhouse gas emissions and energy consumption", and therefore support the objectives of the AAQ Directives.

In response, cities across the EU have been preparing Sustainable Urban Mobility Plans. According to an EU database, by late 2018, 378 urban areas across the EU had developed urban mobility plans or sustainable urban mobility plans that were available online[40]. These can address a need identified in the case studies for this study: ensuring urban transport planning integrates environmental concerns. Member States take a variety of approaches. In Germany, for example, the SUMP concept is being addressed in recent urban transport plans (*Verkehrsentwicklungsplaene*); one concern, however, is that these transport plans overlaps with air quality and climate change plans, creating an additional administrative burden. In Sweden, many larger cities have transport plans that taken on board national guidance for Transport for an Attractive City; in Slovakia, two cities have prepared SUMPs, following a national approach based on EU guidance[41]. In Bulgaria, however, the case study found that few municipalities have as yet adopted SUMPs.

In the Italy case study, the development of SUMPs in Italian cities was considered to have the potential to further strengthen regional and local cooperation related to air quality. Selected Italian SUMPs reviewed referred to regional air quality plans and took on board their objectives. In

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[40] Results from the Eltis database [D77] (consulted December 2018): http://www.eltis.org/mobility-plans/city-database

[41] Eltis web site [D52] (consulted December 2018): http://www.eltis.org/mobility-plans/member-state-profiles

Italy, many of the SUMPs have recently been approved; moreover, these plans are strategic documents whose provisions need to be implemented via further decisions. Consequently, it is not yet possible to identify results of Italy's SUMPs in terms of air quality improvements.

The implementation of energy efficiency policies in Italy, including via national financing for households, enterprises and public administrations, is seen as supporting air quality objectives. On the other hand, the rising use of biomass combustion for household and local heating – in part supported by climate policies – has contributed to air pollution problems. The national government has sought to address this via standards for low-emissions furnaces and a voluntary agreement reached with furnace producers.

In the responses to the targeted questionnaire and the OPC, stakeholders did not provide specific information about the role of SUMPs in supporting the AAQDs. Nonetheless, some stakeholders did emphasise the role of sustainable urban transport planning in protecting air quality. A public authority mentioned the failure to take air quality into account in the planning of public transport within their member State. An NGO response pointed to another local example, stating that initiatives which aim to reduce traffic, such as building of expressways usually end up attracting more traffic to urban areas, with adverse impacts on air quality. A research institute mentioned the inclusion of air quality limit values in national integrated environmental planning law in the Netherlands, which has supporting the coherence of air quality goals with transport and spatial planning.

Whether Member State air quality plans are integrated or linked with spatial planning and urban and regional levels

Spatial plans, defined in this section as localised land-use plans produced by local and regional level of government, can potentially affect air quality, thus highlighting the need for close cooperation and strong alliances between actors at all government levels. For example, designing cities so that the public can access their jobs, schools, shops, and recreational facilities by foot, bike, or public transport will reduce pollution from traffic, while open parks and green belts can help disperse pollution concentrations and reduce the number of people exposed to high levels of pollution. On the other hand, a spatial plan that mandates a certain number of car parks for a new development might be at odds with the air quality objectives, which would recommend as few car parks as possible in an effort to deter people from driving.

This assessment criterion has two indicators:

- Spatial planning integrated with or linked to air quality plans at urban level
- Spatial planning integrated with or linked to air quality plans at regional level

These two indicators are addressed together. Member States undertake spatial planning at different scales and it is difficult to address urban and regional plans separately: consequently, these indicators have been combined.

Article 23 of the AAQD requires Air Quality Plans be produced in zones or agglomerations where levels of pollutants in the ambient air exceed any limit value or target value. This Plan is to set out measures to ensure pollution exceedances are kept as short as possible and may also include specific measures aiming to protect sensitive population groups, including children.

According to Article 2 of the AAQD, agglomerations are defined as 'a conurbation with a population in excess of 250,000 inhabitants' or zones with a given population density per km^2 to be established by the Member States. A zone is defined simply as part of the territory of a Member State delimited for the purpose of air quality assessment and management. Such zones and agglomerations also fall under the jurisdiction of local or regional spatial planning authorities.

It is thus not uncommon for a municipality or region to be covered simultaneously by both local/regional spatial plans and air quality plans. It is therefore important to ensure coherence between the different plans, especially if the objectives of both plans are to be achieved.

Spatial planning in itself is not an EU competency, and unlike other sectors, there is no EU-level legislation. The Urban Agenda for the EU was set up to promote an integrated and coordinated approach to deal with the urban dimension of EU and national policies and legislation, with the aim to improve the quality of life in urban areas. The Urban Agenda for the EU was agreed upon by the EU Ministers Responsible for Urban Matters in the Pact of Amsterdam (May 2016), which also outlined the establishment of 'partnerships' which cover specific areas of concern – air quality was one of the first four partnerships launched in 2016. The final action plan of the air quality partnership [P8] identified two main areas of concern:

- Coordination between different levels of governance (national, regional, local)
- Coordination within cities between air, health, energy, transport and urban planning, taking into account citizen involvement in urban policy development.

With respect to the first concern, it was noted in the final action plan [P8] that air quality planning is not always under the responsibility of cities, with air quality plans drafted and adopted at regional or even national level.

Spatial planning can play a large role in the quality of the air, as stressed by several speakers, for example those representing the WHO and the European Environment Agency, at the Clean Air Forum [R87].

Several studies examine air quality plans in Europe and consider the role of spatial planning in these plans – for example, Bondarouk and Liefferink [D9] examined air quality plans in the Netherlands, while Gollata and Newig [S48] did the same in Germany. Both articles highlighted that municipal jurisdictions may not necessarily align with AQ agglomerations. For example, in Germany 10.9% of the spatial plans assessed by Gollata and Newig identified a zone or agglomeration crossing municipal borders. Carmichael & Lambert [S14] also noted that local actors lack the powers to effectively address air pollution, especially where economic interests may be affected, leading to discouragement and the perception of local air quality management as a box-ticking exercise.

There is evidence that there are several initiatives in place, at either local or national level, to better integrate air quality and spatial planning, as shown by the examples from the Netherlands and the UK, presented in the box below.

Text box 13 Netherlands: embedding air quality in land-use planning

In the Netherlands the air quality management process is embedded in domestic legal procedures for land-use planning – and there have been cases where new developments were blocked in cases where it could be proven that it would have negative impacts on EU air quality limits[42][S14]. There are also examples of guidance documents being used to promote integration, various voluntary guidance document has been issued in the UK, ranging from UK-wide guidance documents [P119] to municipal level documents.

What is required in an air quality plan is set out in Annex XV of the AAQD: there is no requirement that air quality plans should include elements of spatial planning. Indeed, in the Slovak case country study, it was found that air quality has not been conclusively integrated in local spatial planning. Despite this, there are examples of air quality plans including spatial planning elements, as illustrated by the experience of Berlin (see the box below).

According to Annex XV of Directive 2008/50/EC, there is no requirement that air quality plans should include elements of spatial planning. Nonetheless, one example of an air quality plan that includes spatial planning elements is seen in Berlin, described in the box below.

Text box 14 Berlin: integrating air quality and spatial planning

The Berlin Air Quality Plan links closely to urban planning: measures from spatial, urban and landscape planning were integrated into the Air Quality Plan, along with those from traffic, heat supply, construction and installations in industry and commerce. In addition, measures from other plans such as the Urban Development Plans for traffic, centres and also industry and commerce were included.

In March 2011, the competent authority for pollution control was formally identified as one of the authorities which must be involved in urban land-use planning pursuant to §§ 4/4a BauGB. Since then, all urban land-use plans of districts consider air pollution.

In addition, the reduction of traffic has been integrated into spatial planning, for example though the requirements of the Joint Regional Planning with Brandenburg. Traffic has been controlled/reduced through the development of residential areas (thus creating shorter distances to workplaces and retail areas) and considering the placement of traffic-intensive businesses.

Insofar as conflicts with the objectives of air quality planning, i.e. limit value exceedances occur as a result of the planning, compensation measures have to be integrated into the plan to prevent limit value exceedances. If not possible with appropriate measures, the extent and duration of the exceedance should be reduced.

It appears that only a few Member States appear to have ensured coherence between spatial planning and implementation of the AAQD.

Stakeholder responses

The consultation results are in line with this assessment. In the Open Public Consultation, only 16% of respondents thought the objectives of the AAQD are integrated with spatial planning at regional level to either a large extent or a very large extent, while 20% thought the same regarding spatial planning at urban level.

One public authority responding to the targeted consultation, stated that urban planning sometimes fails to take into account air pollution impacts of new developments, for example residential

[42] These findings appear in a UK case study by Carmichael and Lambert, where they cite the findings of their Dutch counterparts.

areas that are not well connected to public transport or are located near polluting industrial facilities. Another public authority responding to the targeted consultation noted that divided competence among different levels of government hindered integration of spatial planning and air quality. One research institute pointed to the Netherlands' inclusion of air quality limit values in national integrated environmental planning law as a positive example of how national legislation can support the coherence transport and spatial planning with air quality goals.

Whether Member State coordination mechanisms support a coherent approach to achieving AAQ objectives

Indicator: Coordination mechanisms are in place at the Member State-level to support integrated approaches for air quality improvements

The coordination of policy responses at the Member State-level is critical to the successful implementation of the Directives. Both horizontal (between different levels of government) and vertical (between different ministries and authorities of government) coordination is needed to ensure that air quality objectives are factored into policy-making affecting emission sources [S48].

The experiences of Member States in implementing the Directives is critical to understanding whether Member State approaches are coherent. The case study of Slovakia helps to illustrate some of the challenges. Stakeholders reported that the coordination of policy responses between different sectors was limited, resulting in measures that are 'very simple and lack[ing] quantified targets to assess the implementation progress'. The district authority reported that, while they are responsible for preparing air quality plans, they lack the authority to enforce the measures included in such plans and are not involved in coordination mechanisms with other levels of government. In the Bulgarian case study, similar concerns were noted.

This observation was reflected by the European Court of Auditors, who found that Air Quality Plans 'could not deliver significant results in the short term because they went beyond the powers of the local authorities responsible for implementing them' [P91]. The Court of Auditors also found that there is often insufficient coordination between national and local authorities – for example, measures outlined in an air quality plan prepared by a local authority may not be supported by necessary national legislation or funding. A position paper from the Urban Agenda also highlights 'ineffective communication between levels of governance'.

Results from the case studies

The **Germany** case study indicated there is a lack of coordination with sectoral authorities at both state and federal level (such as agriculture, transport and energy), as these authorities have no responsibility for air quality and do not integrate it in their planning. Agriculture, in particular, is mentioned as the last sector to receive any requirements for emission reductions. In the case of Lower Saxony/Hanover, reduction of regional NH_3 emissions from agriculture could be a key component of the Air Quality plans, but the need for NH_3 reduction has not been raised. Climate plans don't address synergies with AQ and AQ plans do not address the synergies with climate. This results in the costs of these policies being over-estimated.

The **Bulgaria** case study indicated that coordination, integration and mainstreaming is insufficient in sectoral policies. This is true for both the national (strategic) and municipal levels, particularly between the air quality objectives and climate and energy strategies for reducing greenhouse gas (GHG) emissions and improving energy efficiency.

The example was given that only 25 Bulgarian municipalities (around 10% of all municipalities) have signed the Covenant of Mayors and prepared Sustainable Energy Action Plans (SEAPs). Of those, only two have signed also the Mayors Adapt initiative and are expected to prepare Sustainable Energy and Climate Action Plans (SECAPs).

Nonetheless, according to the instructions for development of air quality plans, municipalities establish 'Programme Councils' consisting of representatives from the RIEWs, Ministry of Interior, Health Inspectorates, civil protection and other relevant institutions.

Moreover, air quality actions have been coordinated with the Ministry of Labour and Social Policy, particularly in relation to the social help provided for purchase of heating fuel and the broader issue of energy poverty and its links to air quality. In the transport sector, the Ministry of Transport is expected to strengthen the mandatory annual technical checks for vehicles and introduce stickers for different emission levels in order to help distinguish the vehicles and facilitate the implementation of low emission zones in the municipalities. In addition, some changes to the tax policy are also planned. The calculation of the vehicle tax will be based on two components – the value of the vehicle and an environmental component based on the vehicle's emission certificate. It is expected that the environmental component will lead to gradual decommissioning of the oldest vehicles.

In **Ireland**, the Department of Communications, Climate Action and Environment is currently leading development Ireland's first National Clean Air Strategy (NCAS), addressing industrial emissions, household emissions, transport and agriculture. As part of developing this plan, DCCAE are coordinating with other departments within Irish government to ensure an integrated approach is taken to air quality improvement. Detail was not available; however the EPA noted in interview that it will address key conflicts between the AAQ Directives' and National Climate Change Policy's objectives.

The **Italy** case study highlighted the difficulty in integrating air quality plans with other sectoral plans, particularly in the areas of climate and transport policy. However, the situation improved as of the development of the Po Basin Action Plan in 2013. The regional authorities, the Ministry of the Environment and technical bodies (namely ENEA, ISPRA, CNR) meet regularly, three times per year,

The development of Sustainable Urban Mobility Plans (SUMPs) in Italian cities was mentioned as a having the potential to further strengthen regional and local cooperation.

Finally, the Case Study indicated that the development of regional air quality plans has spurred coordination with mobility plans, rural development programmes and energy efficiency initiatives. The Air Quality Plans have also increased coordination at regional and municipal levels, as well as between municipal governments.

The **Sweden** country study pointed to the collaboration taking place in the design of air quality plans between authorities working in different areas, such as the cooperation between municipalities, county administrative boards and transport authorities. Measures taken at national level by the Transport Administration and by local public transport authorities were specifically mentioned as relevant for AAQD objectives' attainment. However, interviewees also indicated that further coordination and ownership is necessary.

The **Slovakia** case study indicated that the limited coordination between different actors, including the allocation of responsibilities, are a major barrier to the implementation of the AAQD. Authority to carry out measures is often not in place at regional and local levels. District offices lack competences to ensure that certain measures laid down in air quality plans (e.g. establishment of low emission zones) are implemented on the ground. A proposed bypass in one urban area was considered as desirable for air quality improvement by the district office, but the authority with the power to approve the development differs and may not take the necessary decision.

The *National Air Pollution Control Programme*, now in preparation, will provide measures to reduce national emissions so as to comply with the requirements (national emission ceilings) as per the revised NEC Directive. The programme is expected to set coordinated directions for policies and actions on air quality, renewable energy, energy renovation and eradication of energy poverty.

The national government is also preparing a new air quality strategy (*The Strategy for the Improvement of Air Quality in Slovakia*).[43] Other sectors are actively involved in the preparation in the strategy and it is envisaged that they will be also involved in the implementation of the strategy. Sixteen working groups have been established to elaborate the strategy to discuss different air quality issues (e.g. industrial emissions, transport, agriculture, etc.), including representatives of various sectors. While the preparation of the 2013 PM_{10} strategy also included extensive consultation, the different sectors were less involved.

In **Spain**, the Clean Air Dialogue [D25], at which it was concluded that coordination problems are evident between the various levels and types of public administrations competent to ensure the implementation of the AAQ Directives in Madrid. The Commission urged Spain to implement measures to ensure better coordination and thereby improve policies and maximise benefits.

The Ministry of Environment (currently the Ministry for Ecological Transition, MITECO) is responsible for coordinating the autonomous communities and the municipalities. In 2011 it established a coordination group to share lessons on the implementation of air quality measures at urban level. The Ministry organises regular meetings and thematic workshops, such as a workshop with network managers or on low cost microsensors.

The case study found is a coordination issue between the Madrid local government (municipality) and the regional government of Madrid (province). For example, setting up priority bus lanes in the main access roads to Madrid has been blocked for years and no resources are set aside for their establishment.

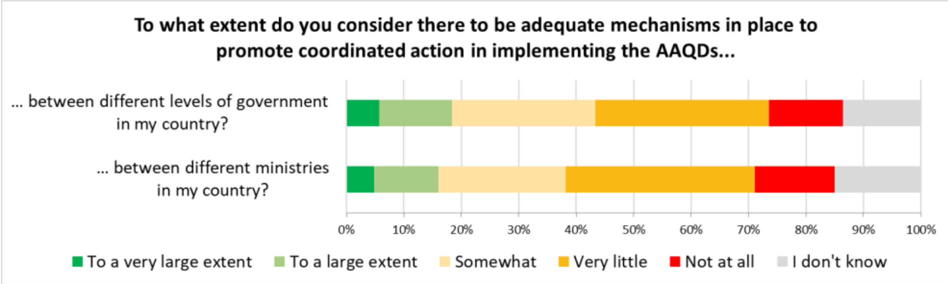
Stakeholder responses

Text Box 15 Results from open public consultation

Responses to the Open Public Consultation suggest stakeholder concerns about the coordination of policy responses at the Member State-level. Regarding coordination mechanisms between different levels of government and between different ministries, more respondents indicated a negative response ('very little' or 'not at all') than a positive response, as shown in the figure below.

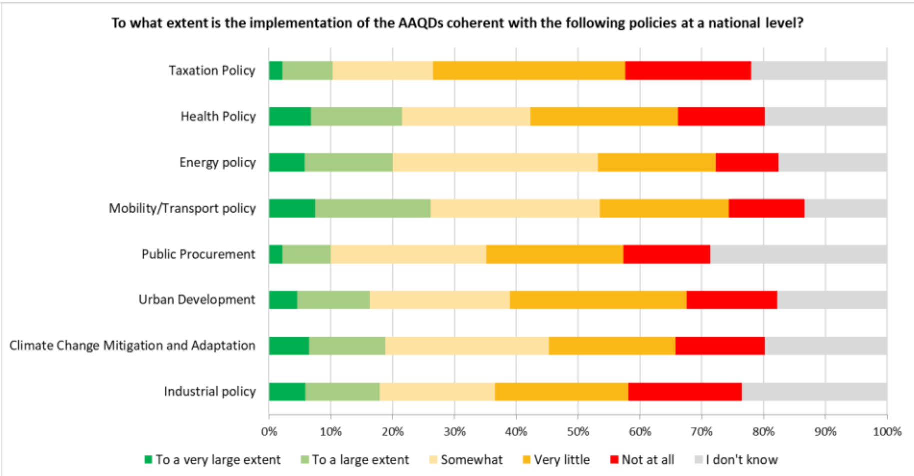
Figure 17 Open Public Consultation responses concerning MS coordination mechanisms

[43] More information on http://www.minzp.sk/strategia-ochrany-ovzdusia.html.



Moreover, when asked about the coherence of the implementation of the AAQDs with sectoral policies, many respondents to the open public consultation had negative perceptions across all eight sectors in the questionnaire: taxation, health, energy, mobility/transport, public procurement, urban development, climate change and industrial policy. For all eight sectors, the share of negative responses (those indicating 'very little' or 'not at all') outweighed the positive ones (those indicating 'to a large extent' or 'to a very large extent'), though between 20% and 33% indicated 'somewhat'. The highest share of positive responses were seen for mobility/transport policies, while the lowest went to taxation policy and public procurement (the latter received the highest share of 'don't know' responses, 39%).

Figure 18 Open Public Consultation responses concerning policy coherence at national level



The OPC included an open question on coordination within Member States. This was completed by just over one-third of the respondents. Those who responded were overwhelmingly negative, with only 41 indicating positive elements (and some of these referred to EU rather than national factors). Key problems cited by respondents included lack of coordination among national ministries (i.e. fragmentation and silos), lack of involvement of key ministries and agencies (several responses referred in particular to the lack of involvement of health authorities), lack of coordination among levels of government (i.e. national to local), government priorities that do not support air quality (e.g. promotion of biomass and diesel) and lack of sufficient action to address air quality.

In a policy paper submitted alongside its response to the OPC, the Urban Agenda's Partnership for Air Quality identified the need for cooperation among different levels of authorities as one of the four key issues for the AAQ Directives. The Urban Agenda cited the National Air Cooperation Programme in the Netherlands as an example of good practice where governments from national, provincial and local levels cooperation on measures to address air quality issues.

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Final Report

Appendix H: Detailed Evidence for EU Added Value

APPENDIX H DETAILED EVIDENCE FOR EU ADDED VALUE

The appendix presents more detailed evidence concerning the EU added value of the AAQ Directives in support of the evidence and conclusions of the support study for the regulatory fitness check. The appendix goes more in-depth presenting the evidence collected from the different data sources of the regulatory fitness check which were triangulated in the main report.

The evaluation of EU added value included two questions. An overview of the questions, judgement criteria and main data sources is presented below.

Evaluation Question (EQ)	Judgement Criteria (JC)	Sources
EQ 9: To which degree have the AAQ Directives, including common EU air quality standards and comparable air quality assessment, management and information approaches enabled Member States and their competent authorities to take successful action to improve beyond what would have been possible without EU action?	JC 9.1: The extent to which the AAQ Directives have brought added value by triggering changes to national and local legislation, thus improving air quality beyond what would have been achieved without EU action. JC 9.2: The extent to which the AAQ Directives brought added value by setting up comparable air quality assessment and information approaches enabling Member States and their competent authorities to take successful action, thus improving air quality beyond what would have been achieved without EU action.	Literature review Stakeholder consultation (open public consultation, targeted questionnaire, workshops) Case studies
EQ 10: What has been the EU added value of the AAQ Directives, do the Directives and their means of implementation create synergies or overlaps with other Community objectives, and how has the distribution of responsibilities between EU, Member State, regional and local level impacted on air quality management?	JC 10.1: The extent to which the AAQ Directives have brought added value by creating synergies and avoiding overlaps with Community objectives. JC 10.2: The extent to which the AAQ Directives have brought added value by ensuring a more appropriate distribution of responsibilities between EU, Member States, regional and local air quality management.	Literature review Stakeholder consultation (open public consultation, targeted questionnaire, workshops) Case studies

H.1 Evaluation question 9: Common air quality standards and assessment approaches

The Evaluation Question 9 assessed *"to which degree have the AAQ Directives, including common EU air quality standards and comparable air quality assessment, management and information approaches enabled Member States and their competent authorities to take successful action to improve beyond what would have been possible without EU action?"*

This section provides further detail on the approach and evidence linked to the following judgement criteria:

- *JC 9.1: The extent to which the AAQ Directives have brought added value by triggering changes to national and local legislation, thus improving air quality beyond what would have been achieved without EU action*
- *JC 9.2: The extent to which the AAQ Directives brought added value by setting up comparable air quality assessment and information approaches enabling Member States and*

their competent authorities to take successful action, thus improving air quality beyond what would have been achieved without EU action

H.1.1 JC 9.1: Added value in terms of air quality standards

Approach

The assessment of the added value of the AAQ Directives in terms of setting up a common air quality standards framework across Member States has looked into: (a) the situation prior to the AAQ Directives at EU level and in the Member States in terms of air quality limits, with a focus on the changes introduced by the Directive 2008/50/EC and Directive 2004/107/EC, (b) the effect and added value of the changes in air quality standards introduced had on actual air quality levels.

The evidence collected to assess the added value of the AAQ Directives in terms of setting up a common air quality standards framework has been compiled based on desk research of previous literature and studies containing information about the status prior to the implementation of the AAQ Directives and after the enforcement of the directives. In particular, the mapping of air quality standards prior to the entry into force of the AAQ Directives per pollutant and Member State relied on evidence collected from the assessments and position papers drafted for the European Commission prior to the adoption of standards for individual pollutants. Amongst the sources consulted were:

- Position paper on NO_2 [P83]
- Position paper on Pb [P81]
- Position paper on SO_2 [P86]
- Second Position Paper on Particulate Matter (December 2014) [P76]
- First Position paper on PM_{10} [P127]
- Position paper on CO [P87]
- Position paper on Benzene [P80]
- Position paper on Ozone [P84]
- Position paper on As, Cd and Ni [P79]
- Position paper on PAH [P85]

These have been complemented with evidence collected via contacts (email and telephone exchanges) with authorities in the countries for the 7 case studies. Authorities in 4 of the 7 Member States responded and provided additional information (i.e. Ireland, Italy, Sweden, and Slovakia). Where no data was available, the report provides an explanation as to why that is the case.

Limitations to the approach

The main limitations in relation to the approach highlighted above include:

- The position papers used in performing the mapping of the standards prior to the AAQ Directives do not provide full coverage of the situation in the Member States for each and every pollutant. Thus, several gaps exist. Although additional desk research was performed to identify the situation prior to the directives in cases where data gaps where identified, it has not always been possible to find additional information for certain Member States due to the language barriers.

- In cases where data gaps still remained after performing in-depth desk research, contacts with the authorities in the 7 case studies were used to fill in data gaps. In some cases, but not all, the national authorities provided additional data to fill in gaps. Nevertheless, data gaps still remained.

Results

A. Results: Desk research, targeted consultation, case studies

(a) Added value of changes triggered by the AAQ Directives to the national and local legislation

Concerning the situation in terms of air quality standards prior to the AAQ Directives (in particular prior to Directive 2008/50/EC, Directive 2004/107/EC), evidence collected indicates that the EU legislation brought added value by triggering changes to national and local legislation leading to the increased harmonisation of standards in the Member States. In line with the principle of subsidiarity, the EU intervention to harmonise standards is justified to prevent different and changing requirements in individual jurisdictions from negatively affecting the creation of a level playing field in addressing air quality challenges. Furthermore, the transboundary nature of air pollution further warrants the need for EU action. The measures to harmonise the standards are also proportionate. Aligning the standards across EU Member States and their implementation did not impose disproportionate costs on the Member States.

Directive 2008/50/EC was the first to introduce air quality objectives for fine particles ($PM_{2.5}$) including a limit value and objectives targeting exposure of the population to fine particles, thus contributing to the harmonisation of the approach towards dealing with fine particles concentrations across Member States. Furthermore, Directive 2004/107/EC (Fourth Daughter Directive) introduced target values for arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons. The two directives brought added value by setting up a common framework for air quality standards for 5 pollutants that had previously not been regulated at EU level, i.e. $PM_{2.5}$, As, Cd, Ni, PAH.

Directive 2008/50/EC was not the first at EU level to regulate concentrations for other pollutants (PM_{10}, NO_2, NO_x, SO_2, O_3, CO, C_6H_6) and did not introduce any changes to the already existent EU level standards for these pollutants. Thus, the added value of the directive in terms of air quality standards for these pollutants was limited to only reinforcing already existent standards. As presented in the table below, the air quality standards for concentrations of SO_2, NO_2, NOx, PM_{10}, Pb have been introduced by the Council Directive 1999/30/EC (First Daughter Directive) and are currently almost 20 years old. Similarly, the currently applicable air quality standards for concentrations of CO and C_6H_6 were first introduced by Directive 2000/69/EC (Second Daughter Directive) and are now 18 years old. Furthermore, the initial proposals of the First and Second Daughter Directives set higher standards in terms of limits or number of times exceedances could occur, but these standards were eventually weakened before being adopted. For example, for the PM_{10} annual limit value, the European Commission proposed 30µg/m^3, but the present AAQ Directive value is 40µg/m^3. For the NO_2 hourly limit value, the European Commission initially proposed that it could be exceeded eight times per year, but the current standards allow for exceedances 18 times. Similarly, the target value of O_3, first introduced by the Directive 2002/3/EC (Third Daughter Directive) is now over 15 years old and the limit currently in force is less strict than in the past [P91]. The table below presents an overview of the directives that introduced the currently applicable air quality standards for specific pollutants.

Table 1 Standards introduced in legislation for specific pollutants

Pollutant	EU level legislation
SO_2, NO_2, NOx, PM_{10}, Pb	Current standards introduced by Council Directive 1999/30/EC (First Daughter Directive)
CO, C_6H_6	Current standards introduced by Directive 2000/69/EC (Second Daughter Directive)

Pollutant	EU level legislation
O_3	Current standards introduced by Directive 2002/3/EC (Third Daughter Directive)
As, Cd, Ni, BaP/PAH	Current standards introduced by Directive 2004/107/EC (Fourth Daughter Directive)
$PM_{2.5}$	Current standards introduced by Directive 2008/50/EC

Source: European Commission, DG ENV

The introduction of air quality standards, both by the Directive 2008/50/EC and by Directive 2004/107/EC as well as the previous air quality directives, has triggered important changes to national legislation in the Member States in terms of the applicable air quality standards. The transposition of the directives by Member States led to the harmonisation of air quality standards for pollutants across the Member States.

Prior to the adoption of the AAQ Directive (both by the Directive 2008/50/EC and by Directive 2004/107/EC as well as the previous air quality directives), Member States had different approaches to regulating pollutant concentrations in terms of type of pollutants, the level of protection (weaker or stricter limits) and their legal nature (binding or voluntary, limit values, target values or guidelines, obligation of results or obligation of means). In the absence of the introduction of common air quality standards by the 2008 and 2004 directives but also by the previous air quality directives, it is likely that the status quo ante would have continued, meaning that Member States would have continued to have different air quality standards and levels of protection in relation to specific pollutants.

Prior to the introduction of the Directive 2008/50/EC and Directive 2004/107/EC (Fourth Daughter Directive), on an EU level, there was **no harmonised approach on target or limit values for dealing with concentrations of fine particles ($PM_{2.5}$), arsenic, nickel, cadmium and benzo(a)pyrene/PAH**. Legally binding limits only existed in a few Member States and the approach to setting target or limit values and guidelines varied both across types of pollutants, target/limit values/guidelines and their application. More specifically:

- For **fine particles ($PM_{2.5}$)**, although no comprehensive mapping of the legal standards for this pollutant at Member State level prior to the AAQ Directives was available[1], some indication of the pre-existent standards at national level were identified through national level desk research and contacts with relevant authorities in the case of the 7 case study Member States. Amongst the 28 Member States where information was available (13 Member States), only 2 Member States (Bulgaria, France) had standards in place prior to the adoption of the AAQ Directive, whereas in the case of 10 Member States (Belgium, Czech Republic, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Sweden, United Kingdom) no standard was in place.

  A recent study [S72] also shows the added value of the AAQ Directives in terms of aligning the air quality standards across Member States. Amongst the 28 Member States, the study

[1] The assessments done for the European Commission on particular matter prior to the directives did not include any detailed information on the limit levels in each Member State.

found that 24 Member States have strengthened their $PM_{2.5}$ standard to 25 µg/m³ (year) (Austria, Belgium, Croatia, Cyprus, Czech Republic, Estonia, Finland, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovenia, Slovakia, Spain, United Kingdom) in line with the requirements of the Directive 2008/50/EC, whereas 1 Member State (Sweden) had a standard stricter than the Directive 2008/50/EC (20 µg/m³ year) and 4 Member States (Denmark, France, Germany, Ireland) had other types of standards but the study does not specify which type. No data was available for Bulgaria.

Harmonisation means not only a level playing field in terms of ensuring the health of citizens and protection of the environment but also a level playing field in the internal market as Member States cannot lower the air quality standards in view of possible or apparent competitive advantages for national businesses.

- For arsenic, cadmium, nickel, prior to the implementation of the Directive 2004/107/EC, legally binding standards only existed in Austria and Germany, whereas Belgium and the Netherlands had standards in their national legislation but they were not legally binding.

  For **cadmium (Cd)**, prior to the implementation of the AAQ Directives, Belgium and Germany had a concentration limit of 40 ng/m³ (annual means ng/m³) which is less strict than the limit imposed by the AAQ Directives. Furthermore, Belgium had a deposition target of 20 µg m² per day, the Netherlands used a target value of 1.0 g per hectare per year, corresponding to 0.27 µg m² per day, Germany used a target value of 5 µg m² per day and Austria used a value of 2 µg m² per day.

  Arsenic (As) was regulated through air quality standards only in Belgium and Germany which used a target value of 5 ng/m³ (annual means) and the Netherlands which had a concentration target value of 0.5 ng/m³.

  When it comes to **nickel (Ni)**, prior to the implementation of the AAQ Directives, the Netherlands had a concentration target value of 0.25 ng/m³ and Belgium applied a target value of 5 ng/m³ (annual means). Austria, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Portugal, Spain, Sweden, United Kingdom had no standards in place. Data for the other Member States was not available.

- Similarly, for **polycyclic aromatic hydrocarbons (PAH)**, there was no guidance to Member States or EU level legislation regulating the levels of PAH prior to the Directive 2004/107/EU. Amongst Member States only Italy had legally enforceable ambient air quality standards for PAH and in 6 other Member States there were only guidelines or non-legally binding values (Belgium, Croatia, France, Netherlands, Sweden, and United Kingdom). The limit or target and guide values varied across Member States. To measure the concentration of PAH, all Member States that had standards in place used BaP as a marker and one Member State (Sweden) had gone one step further and set a value for fluoranthene as well. The table below provides an overview of the situation in the Member States in terms of PAH standards prior to the implementation of the AAQ Directives.

Table 2 Air quality standards existent in Member States prior to the implementation of the Directive 2008/50/EC and Directive 2004/107/EC

NB: 'No data' means that the comprehensive desk research and (for the 7 case studies – Bulgaria, Germany, Ireland, Italy, Slovakia, Spain, Sweden) exchanges with the national authorities via email did not lead to the identification of the situation a priori the Directive 2008/50/EC and Directive 2004/107/EC.

Member State	$PM_{2.5}$	As	Cd	Ni	PAH
AAQ Directives	25 µg/m³ (1 year)	6 ng/m³ (1 year)	5 ng/m³ (1 year)	20 ng/m³ (1 year)	1 ng/m³ (1 year) (expressed as concentration of BaP)
Austria	No data	No standard	Limit values (legally binding) C: No standard D: 2 µg $m^{-2}d^{-1}$	No standard	No standard
Belgium	No standard	Limit values (legally binding) 5 ng/m³ (annual mean)	Limit values (legally binding) C: 40 ng/m³ (annual mean) D: 20 µg $m^{-2}d^{-1}$ (annual mean)	Limit values (legally binding) 5 ng/m³ (annual mean)	Proposed values (Flanders) BaP (annual average) 1 ng/m³ as a limit value 0.5 ng/m³ as a guide value 0.017 ng/m³ as a target value
Bulgaria	Action levels 40 µg/m³ not to be exceeded more than 14 times per year 20 µg/m³ (annual mean)	No data	No data	No data	No data
Croatia	No data	No data	No data	No data	Guideline values BaP (annual average) 2 ng/m³ as a limit guide value 0.1 ng/m³ as a recommended guide value
Cyprus	No data	No data	No data	No data	No data
Czech Republic	No standard	No data	No data	No data	No data
Denmark	No data	No standard	No standard	No standard	No standard
Estonia	No data	No data	No data	No data	No data

Member State	$PM_{2.5}$	As	Cd	Ni	PAH
Finland	No data	No standard	No standard	No standard	No data
France	Limit values 40 µg/m³ (annual mean) Only from 2007	No standard	No standard	No standard	Recommended values BaP (annual average) 0.7 ng/m³ as a limit value 0.1 ng/m³ as a quality objective
Germany	No data	Limit values (legally binding) 5 ng/m³ (annual mean) with some regional variations	Limit values (legally binding) C: 40 ng/m³ (annual mean) D: 5 µg $m^{-2}d^{-1}$	No standard	Target values BaP: 1.3 ng/m³
Greece	No data	No data	No data	No data	No data
Hungary	No data	No data	No data	No data	No data
Ireland	No standard	No standard	No standard	No standard	No standard
Italy	No standard	No standard	No standard	No standard	Quality objective (legal) BaP (running annual average) 2.5 ng/m³ since 1/1/1996 1 ng/m³ since 1/1/1999
Latvia	No data	No data	No data	No data	No data
Lithuania	No data	No data	No data	No data	No data
Luxembourg	No data	No standard	No standard	No standard	No standard
Malta	No data	No data	No data	No data	No data
Netherlands	No standard	Guide value (not legally binding) 0.5 ng/m³ (annual mean)	Guide value (not legally binding) D: 0.27 µg $m^{-2}d^{-1}$	Guide value (not legally binding) 0.25 ng/m³ (annual mean)	Quality objective (non-legal) BaP (annual average) 1 ng/m³ as a limit value 0.5 ng/m³ as a guidance value
Poland	No standard	No data	No data	No data	No data

Member State	$PM_{2.5}$	As	Cd	Ni	PAH
Portugal	No standard	No standard	No standard	No standard	No standard
Romania	No data	No data	No data	No data	No data
Slovakia	No standard	No standard	0,01 μ/m³	No standard	No standard
Slovenia	No data	No data	No data	No data	No data
Spain	No data	No standard	No standard	No standard	No standard
Sweden	No standard	No standard	No standard	No standard	Recommended guidelines BaP: 0.1 ng/m^3 Fluoranthene: 2 ng/m^3
United Kingdom	No data	No standard	No standard	No standard	Recommended guidelines BaP (annual average) 0.25ng/m^3

Legend: C=Concentration, D= Deposition, Source: COWI based on various sources as below.

For $PM_{2.5}$:

BE – [D164]

BG – Case Study Report (Bulgaria), analysis of legislation

CZ – [P140]

FR – [P141]

IE – Information via email received from the Irish Environmental Protection Agency, National Ambient Air Quality Unit, Office of Radiation Protection and Environmental Monitoring

IT – Information via email received from Italian National Institute for Environmental Protection and Research, Area for monitoring air quality and operational climatology, Department for monitoring and protecting the environment and for biodiversity conservation (Decree Ministry of environment 25/11/1994)

NL – [S140]

PL – [S141]

PT – [S142]

SE – Information via email received from the Swedish EPA

SK – Information via email received from the Slovak Ministry of Environment

For As, Cd, Ni: ALL COUNTRIES – [P79]

For PAH: ALL COUNTRIES – [P85]

As highlighted above, Directive 2008/50/EC and Directive 2004/107/EC did not introduce any changes to the standards set for SO_2, NO_2, NO_x, PM_{10}, Pb, CO, C_6H_6, O_3 but just reiterated them. The currently applicable standards for these pollutants were introduced at different phases in time and, although outside the scope of the fitness check, the following sections also briefly reflect on the situation prior to the First, Second and Third Directives and the changes triggered by them to the national legislation. More specifically:

- For **particulate matter (PM_{10})**, amongst countries where data was available, there were 5 countries (Bulgaria, Ireland, Italy, Slovakia, Sweden) that had standards in place, some with standards stricter than the currently applicable standards (e.g. Italy).

  A recent study [S143] shows the added value of the AAQ Directives in terms of aligning the PM_{10} standards across Member States. Amongst the 28 Member States, the study found that all Member States (apart from Bulgaria where data was no available) apply the daily and yearly standards of Directive 2008/50/EC for PM_{10}, i.e. none of them has a stricter limit value in place.

- For **nitrogen dioxide (NO_2)**, compared to the other types of pollutants, a large number (17) of Member States had standard limits or guidance (Austria, Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Hungary, Italy, Luxembourg, Netherlands, Poland, Portugal, Sweden, Spain, Slovakia, Romania), which in some cases were stricter and/or more detailed than the current levels (e.g. Austria, Netherlands). A recent study on the harmonisation of air quality legislation indicates that the implementation of the AAQ Directives had an important effect in harmonising the standards across Member States. As of 2017, the limits for NO_2 (1 hour) are the same across all Member States[2] apart from Sweden, where the limit value is of 90 µg/m³. When it comes to the limits for NO_2 (annual mean), the study indicates that the standards were aligned with those in the directive (40 µg/m³) in all Member States[3] apart from one, Belgium, where the limit value was 30 µg/m³.

- For **sulphur dioxide (SO_2)**, amongst countries where data was available, only 5 Member States (Austria, Finland, Germany, Netherlands, and United Kingdom) had standards on air quality prior to the implementation of the AAQ Directives and they were generally above the current air quality standards set by the AAQ Directives.

- For **carbon monoxide (CO)**, amongst countries where data was available, 10 Member States (Austria, Finland, Germany, Ireland, Italy, Netherlands, Portugal, Slovakia, Sweden, and United Kingdom) had air quality standards. Several Member States had limit values or guidelines that match the current AAQ Directives threshold of 10 µg/m³ (maximum daily 8 hour mean) (i.e. Austria, Portugal – limit value, Finland – guideline). Two Member States (Sweden, Netherlands) had stricter target limits than the currently applicable standards and 1 Member State had a limit value slightly higher than the current limits (United Kingdom - 11.4 mg/m³ 8h running mean).

[2] No data was available for Bulgaria.

[3] No data was available for Bulgaria.

- For **ozone (O_3)**, amongst countries where data was available, 8 Member States (Austria, Germany, Ireland, Italy, Netherlands, Sweden, Slovakia and United Kingdom) had standards in place prior to the implementation of the AAQ Directives and 9 Member States (Belgium, Denmark, Finland, Greece, France, Luxembourg, Portugal, Slovakia, Spain) had no standard in place. For the rest of the Member States, data was not available concerning the situation prior to the AAQ Directives. The approach to regulating O_3 varied across Member States both in terms of nature (binding or non-binding) and limit values. For example, Austria had alert levels as well as target levels which were in line with the applicable legislation at that time (Directive 92/72/EC). It should be noted that ever since, the limit value in the currently applicable directives has actually increased compared to the Directive 92/72/EC (120 µg/m³ maximum daily 8 hour mean compared to the previous 110 µg/m³ as 8h average). Prior to the harmonisation of the standards through the Third Daughter Directive, the Netherlands had non-binding and guidance limits for 1h means, 8h means and the growing season. The limit for the 8h means was of 160 µg/m³ (8 hour) and the permitted exceedance was of maximum 5 days per year. This was higher than the currently applicable threshold of 120 µg/m³ (maximum daily 8 hour mean) permitted 25 days averaged over 3 years. A recent paper assessing the levels of harmonisation of air quality legislation in terms of O_3 indicates that, as of 2017, most Member States have adopted the same threshold for O_3 as in the directives (120 µg/m³) with the exception of 4 Member States (Austria, Poland, Ireland, United Kingdom) where different standards applied (e.g. UK 100 µg/m³).

- For **lead (Pb)**, prior to the First Daughter Directive, amongst countries where data was available there were 15 Member States that had limit values or guidelines in force (i.e. Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Slovakia, Spain, Sweden, United Kingdom). Some Member States had limit values that were in line with the current limit value of 0.5 µg/m³ (1 year) (Finland, Netherlands) but the majority of Member States had limit values that were above the current threshold (Belgium, Denmark, France, Ireland, Italy, Luxembourg, Portugal, Spain, United Kingdom) and one Member State (Poland) had limit values that were stricter than the currently applicable limits. Notably, one Member State (Austria) had no standards in place.

- For **benzene (C_6H_6)** assessments made prior to the implementation of the AAQ Directives indicated that only a limited number of countries had fixed limit or target values and a reference period. For C_6H_6, amongst countries where data was available 8 Member States (Austria, Germany, Italy, Ireland, Netherlands, Portugal, Sweden, and United Kingdom) had limit values in place prior to the adoption of the Second Daughter Directives (and later the Directive 2008/50/EC). Notably, several Member States had a limit value that was above the threshold currently set by the AAQ Directives (Austria, Germany, Italy, Netherlands, Portugal, and United Kingdom). One Member State (Netherlands) also had a guideline in addition to the limit value whose limit was 5 µg/m³ (1 year) and one Member State (Sweden) had a guideline value lower that the currently applicable directives in force (1.3 µg/m³ (annual mean) but no limit values. Seven Member States (Belgium, Denmark, Finland, France, Greece, Luxembourg, and Slovakia) had no standard for C_6H_6 in place and for the rest of 13 Member States there was no data available.

The table below provides an overview of the status in the Member States prior to the implementation of the Council Directive 1999/30/EC (First Daughter Directive), Directive 2000/69/EC (Second Daughter Directive) and Directive 2002/3/EC (Third Daughter Directive).

Table 3 Air quality standards existent in Member States prior to the implementation of the First, Second and Third Daughter Directives

NB: 'No data' means that the comprehensive desk research and (for the 7 case studies – Bulgaria, Germany, Ireland, Italy, Slovakia, Spain, Sweden) exchanges with the national authorities via email did not lead to the identification of the situation a priori the Council Directive 1999/30/EC (First Daughter Directive), Directive 2000/69/EC (Second Daughter Directive) and Directive 2002/3/EC (Third Daughter Directive).

Member State	**PM_{10}**	**NO_2 and NO_x**	**SO_2**
AAQ Directives	50 µg/m³ (24 hour), 40 µg/m³ (1 year)	200 µg/m³ (1 hour), 40 µg/m³ (1 year)	350 µg/m³ (1 hour), 125 µg/m³ (24 hours)
Austria	*No data*	Guideline values: 200 µg/m³ (30 min. mean) 100 µg/m³ (24 h mean) *Lower Austria* Limit value: 200 µg/m³ (30 min. mean) 100 µg/m³ (24 h mean) Upper Austria Limit value: 300 µg/m³ (30 min. mean) 100 µg/m³ (24 h mean) 150 µg/m³ (97.5 percentile of 30 min. mean) 50 µg/m³ (month mean)	Limit value (vary per region and season) 50-300 µg/m³ (24HM) 30-300 µg/m³ (HHM) Alert value (according to level of associated PM_{10}, as 3HM) Pre-warning 400-600 µg/m³ Warning I 600-800 µg/m³ Warning II 800-1000 µg/m³ Limit values (forest, vary depending on month) 50-100 µg/m³ (24 HM) 70-150 µg/m³ (HHM) Guidelines Health 200 µg/m³ (HHM) up to 3 per day 120 µg/m³ (24 HM) Protection of forests 50 µg/m³ (HHM) 30 µg/m³ (24HM) 15 µg/m³ (growing season)
Belgium	*No data*	Guideline values 200 µg/m³ (98 percentile 1 h. mean)	*No data*
Bulgaria	Limit values to fulfil by 2008 40 µg/m³ (annual mean) 50 µg/m³ daily limit not to be exceeded more than 35 times per year Limit values to fulfil by 2010 20 µg/m³ (annual mean) 50 µg/m³ daily limit not to be exceeded more than 7 times per year	Guideline values 85 µg/m³ (30 min. mean)	*No data*

Member State	PM_{10}	NO_2 and NO_x	SO_2
Czech Republic	*No data*	Guideline values 100 µg/m³ (NOx) (daily average mean) 100 µg/m³ (NOx) (30 min. mean)	*No data*
Croatia	*No data*	*No data*	*No data*
Denmark	*No data*	*No data*	*No data*
Finland	*No data*	Guideline values 70 µg/m³ (24 h mean) 150 µg/m³ (99 percentile of 1h per month mean)	Limit values 80 µg/m³ (24HM) 250 µg/m³ (98 percentile 24HM) Guide values Health 250 µg/m³ (99 percentile 1HM monthly) 80 µg/m³ (2nd highest 24H value of month) Vegetation 20 µg/m³ (AM)
France	*No data*	Limit values 200 µg/m³ (98 percentile of 1h mean) 200 µg/m³ (95 percentile of 24 h mean)	*No data*
Germany	*No data*	Guideline values 80 µg/m³ (annual mean) 200 µg/m³ (98 percentile of 30 min means)	Limit values 120 µg/m³ (annual median) 180 µg/m³ (winter median) 250 µg/m³ (98 percentile) Alert values Pre-warning 600 µg/m³ Warning I 1200 µg/m³ Warning II 1800 µg/m³
Greece	*No data*	*No data*	*No data*
Hungary	*No data*	Guideline values As stated 1.1.1987 50 µg/m³ (annual mean) 70 µg/m³ (24 h mean) 85 µg/m³ (30 min mean) Other areas: 120 µg/m³ (annual mean) Protected areas 70 µg/m³ (annual mean) 85 µg/m³ (24 h mean) 100 µg/m³ (30 min mean)	*No data*

Member State	**PM_{10}**	**NO_2 and NO_x**	**SO_2**
Ireland	Limit Value 50 µg/m³ (24 h mean) not to be exceeded more than 35 times a calendar year 40 µg/m³ (calendar year)	150 µg/m³ (24 h mean) 200 µg/m³ (30 min average) Limit Value 200 µg/m³ (hourly mean) not to be exceeded more than 18 times a calendar year 40 µg/m³ (calendar year)	Limit Value 350 µg/m³ (hourly mean) not to be exceeded more than 24 times a calendar year 125 µg/m³ (24 h mean) not to be exceeded more than 3 times a calendar year
Italy	Quality objective (legal) 40 µg/m³(running average annual)	Limit value (annual): 200 µg/m³ - 98°percentile hourly mean Information thresholds: 200 µg/m³ (1 hour mean) Alert thresholds: 400 µg/m³ (1 hour mean)	Limit value (annual): 80 µg/m³ - median of daily values Information thresholds: 125 µg/m³ (1 hour mean) Alert thresholds: 250 µg/m³ (1 hour mean); no more than 2% of hourly data in a year must exceed the alert thresholds
Luxembourg	*No data*	Limit value 200 µg/m³ (NOx) (98 percentile of daily means)	*No data*
Netherlands	*No data*	Limit value 135 µg/m³ (98 percentile of 1 h means) 175 µg/m³ (99.5 percentile of 1 h means) Guide value 25 µg/m³ (50 percentile of 1 h means) 80 µg/m³ (98 percentile of 1 h means)	Limit value 830 µg/m³ (1HM) 500 µg/m³ (24HM) 75 µg/m³ (50 percentile 24HM) 200 µg/m³ (95 percentile 24HM) 250 µg/m³ (98 percentile 24HM) Target values 30 µg/m³ (50 percentile 24HM) 80 µg/m³ (95 percentile 24HM) 100 µg/m³ (98 percentile 24 HM)
Poland	*No data*	Limit value 150 µg/m³ (NO_x) (30 min average) 50 µg/m³ (NO_x) (daily average) 8 µg/m³ (NO_x) (annual average) 500 µg/m³ (NO_x) (30 min average) 150 µg/m³ (NO_x) (daily average) 22 µg/m³ (NO_x) (annual average)	*No data*

Member State	PM_{10}	NO_2 and NO_x	SO_2
Portugal	*No data*	Limit value 200 µg/m³ (NOx) (98 percentile)	*No data*
Romania	*No data*	Limit value 300 µg/m³ (30 min average) 100 µg/m³ (daily average)	*No data*
Slovakia	Limit value TSP (total suspend. particles) 150 µg/m³ (daily average) 60 µg/m³ (yearly average)	Limit value 100 µg/m³ (NO2) daily average 200 µg/m³ (NO2)30 min. mean 80 µg/m³ (NO2) (yearly average)	Limit value 150 µg/m³ (SO2) daily average 500 µg/m³ (SO2)30 min. mean
Spain	*No data*	Limit value 200 µg/m³ (NOx) (98 percentile) Guideline 135 µg/m³ (NOx) (98 percentile)	*No data*
Sweden	Criteria/assessment values (not regulated) 110 µg/m³ daily mean 50 µg/m³ 6 months	Limit values 110 µg/m³ (hourly mean 98 percentile, Oct-March) 75 µg/m³ (daily mean 98 percentile, Oct – March) 50 µg/m³ (average Oct-Mar)	Limit values 200 µg/m³ (hourly mean (98 percentile, Oct - March) 100 µg/m³ (daily mean (98 percentile, Oct - March) 50 µg/m³ (arithmetic mean value Oct-March)
United Kingdom	*No data*	*No data*	100 ppb (15 min mean)

Source: COWI based various sources as below

For SO_2:
ALL COUNTRIES (except IE, IT, SE, SK – see below) - Hecq (1997). SO_2 Position Paper.
For NO_2:
ALL COUNTRIES (except IE, IT, SE, SK – see below) - Working Group (1997), Position paper on Air Quality: Nitrogen Oxide.
For PM_{10}:
ALL COUNTRIES (except IE, IT, SE, SK – see below): CAFE Working Group on Particular Matter (2004), Second Position Paper on Particulate Matter, Technical Working Group on Particles (1997), Particles Position Paper. Ambient Air pollution by particulate matter

IT – Information via email received from Italian National Institute for Environmental Protection and Research, Area for monitoring air quality and operational climatology, Department for monitoring and protecting the environment and for biodiversity conservation
IE – Information via email received from the Irish Environmental Protection Agency, National Ambient Air Quality Unit, Office of Radiation Protection and Environmental Monitoring
SE – Information via email received from the Swedish Environmental Protection Agency
SK – Information via email received from the Slovak Ministry of Environment

Member State	CO	O_3	Pb	C_6H_6
AAQ Directive	10 µg/m³ (maximum daily 8 hour mean)	120 µg/m³ (maximum daily 8 hour mean)	0.5 µg/m³ (1 year)	5 µg/m³ (1 year)
Austria	Limit value 10 mg/m³ (8h mean) Alert value (moving 3h mean) Pre-warning 20 mg/m³ Warning I 30 mg/m³ Warning II 40 mg/m³	Alert values Early warning 200 µg/m³ as running 3 hourly means Warning I 300 µg/m³ Warning II 400 µg/m³ Target Value 110 µg/m³ as 8h average (same definition as in Directive 92/72/EEC)	No standard	10 µg/m³ (annual mean)
Belgium	*No data*	No standard	Limit value 2 µg/m³ yearly mean	No standard
Bulgaria	*No data*	*No data*	*No data*	*No data*
Czech Republic	*No data*	*No data*	*No data*	*No data*
Croatia	*No data*	*No data*	*No data*	*No data*
Denmark	*No data*	No standard	Limit value 2 µg/m³ yearly mean	No standard
Estonia	*No data*	*No data*	*No data*	*No data*
Finland	Guidelines (non-mandatory): 20mg/m³ (1h mean) 8 mg/m³ (8h mean)	No standard	Limit value 0.5 µg/m3 as an annual mean	No standard
France	No data	No standard	Limit value 2 µg/m³ yearly mean	No standard
Germany	Limit value 10 mg/m³ (annual mean)	Limit value 120 : 2 µg/m³ (30 min)	Limit value 2 µg/m³ yearly mean	15 µg/m³ (annual mean)

Member State	CO	O_3	Pb	C_6H_6
	30 mg/m³ (98 percentile 30 min mean for a year)		Deposition standard: must not exceed 250 µg/m2/day on areas of 151 km2 or 0.550.5 km²	
Greece	*No data*	No standard	*No data*	No standard
Hungary	*No data*	*No data*	*No data*	*No data*
Ireland	<u>Limit Value</u> 10 mg/m³ (8h mean)	<u>Target Value</u> 120 µg/m³ (maximum daily 8 hr mean) not to be exceeded more than 25 days per calendar year averaged over 3 years <u>Target value (veg)</u> 18,000 µg/m³.h (AOT40, calculated from 1hr values from May to July averaged over 5 years)	<u>Limit value</u> 0.5 µg/m³ (calendar year)	<u>Limit value</u> 5 µg/m³ (calendar year)
Italy	<u>Limit value (annual)</u> 10 mg/m³ (maximum daily 8 hour mean) 40 mg/m³ (maximum hourly mean) <u>Information thresholds:</u> 15 mg/m³ (1 hour mean) <u>Alert thresholds:</u> 30 mg/m³ (1 hour mean)	<u>Limit value (month)</u> 200 µg/m³ (maximum hourly mean) 110 µg/m³ (maximum daily 8 hour mean) <u>Information thresholds:</u> 180 µg/m³ (1 hour mean) <u>Alert thresholds:</u> 360 µg/m³ (1 hour mean)	<u>Limit value</u> 2 µg/m³ yearly average	<u>Quality objective (legal)</u> (running annual average) 15 µg/m³– since 1/1/1996 10 µg/m³– since 1/1/1999
Latvia	*No data*	*No data*	*No data*	*No data*
Lithuania	*No data*	*No data*	*No data*	*No data*
Luxembourg	*No data*	No standard	<u>Limit value</u> 2 µg/m³ yearly average	No standard
Malta	*No data*	*No data*	*No data*	*No data*

Member State	CO	O_3	Pb	C_6H_6
Netherlands	Limit values 6 mg/m³ (98 percentile of 8h mean) 40 mg/m³ (99.9 percentile of 1h mean) Limit value for busy streets (temporary): 8.25 mg/m³ (98 percentile of 8h means until 1-1-2000)	Limit value (non-legal) 240 µg/m³ (1 hour), permitted exceedance max. 2 days per year 160 µg/m³ (8 hour), permitted exceedance max. 5 days per year 100 µg/m³ (growing season May – September, 10.00 – 17.00 hour) Guide value 120 µg/m³ (1 hour) no exceedance 50 µg/m³ (growing season average)	Limit value 0.5 µg/m³ yearly average 2 µg/m³ in 24 hours (98 percentile)	Limit value 10 µg/m³ (annual mean) 15 µg/m³ (annual mean, busy traffic) Guideline: 5 µg/m³ (annual)
Poland	*No data*	*No data*	Limit value 1 µg/m³ 24 hours average 0.2 µg/m³ yearly average	*No data*
Portugal	Limit values 40 mg/m³ (1h mean, 1 exceedance) 10 mg/m³ (8h running mean) 1 mg/m³ (24h mean)	No standard	Limit value 2 µg/m³ yearly average	10 µg/m³ (annual)
Romania	*No data*	*No data*	*No data*	*No data*
Slovakia	5 mg/m³ (daily average) 10 mg/m³(30 min average)	110 µg/m³ (8 h running mean)	0,5 µg/m³ (yearly average)	No standard
Slovenia	*No data*	*No data*	*No data*	*No data*
Spain	*No data*	No standard	Limit value 2 µg/m³ yearly average	*No data*
Sweden	Limit value 6 mg/m³ (98 percentile of 8h running mean)	Target value 120 µg/m³ (1h mean) no more than 12 hours per year 150 µg/m³ (not to be exceeded) 50 µg/m³ (April to September)	Guideline 1.5 µg/m³ as an average for three months	Guideline 1.3 µg/m³ (annual mean)
United Kingdom	11.4 mg/m³ (8h running mean)	50 ppb (8h daily average)	Limit value 2 µg/m³ yearly average	16 µg/m³ (annual mean)

Source: COWI based on various sources as below

For CO:

ALL COUNTRIES (except IE, IT, SE, SK – see below) – [P87]

For O_3 :

ALL COUNTRIES (except IE, IT, SE, SK – see below) – [P84]

For Pb:

ALL COUNTRIES (except IE, IT, SE, SK – see below) – [P81]

For C_6H_6:

ALL COUNTRIES (except IE, IT, SE, SK – see below) – [P80]

IT – Information via email received from Italian National Institute for Environmental Protection and Research, Area for monitoring air quality and operational climatology, Department for monitoring and protecting the environment and for biodiversity conservation

IE – Information via email received from the Irish Environmental Protection Agency, National Ambient Air Quality Unit, Office of Radiation Protection and Environmental Monitoring

SE – Information via email received from the Swedish Environmental Protection Agency

SK – Information via email received from the Slovak Ministry of Environment

(b) Effect and value added of harmonisation in terms of actual air quality levels

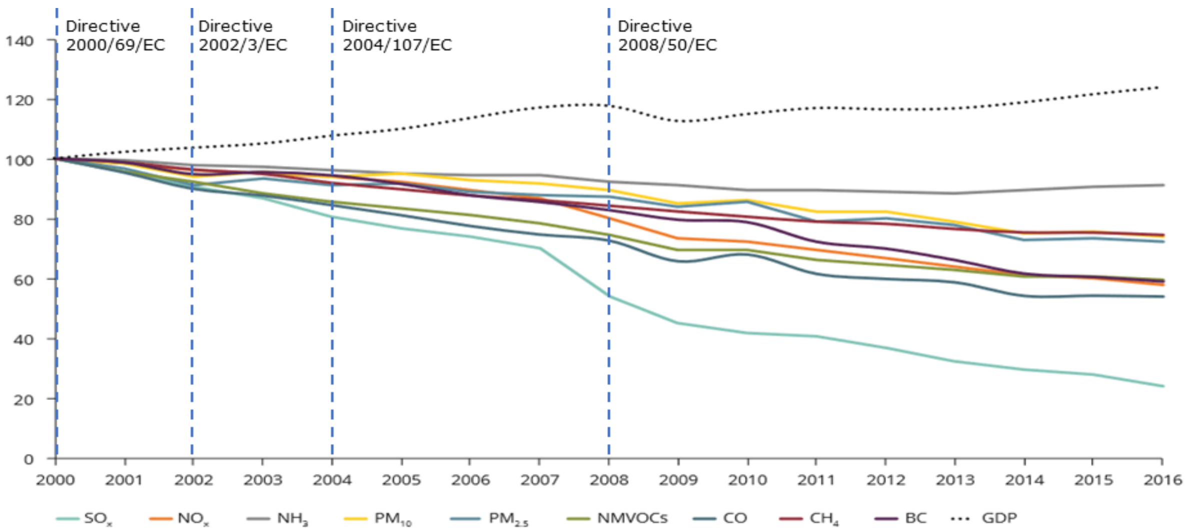
Despite the introduction of harmonised air quality standards in terms of pollutants by the AAQ Directives, as further evidenced in the section of effectiveness, Member States continue to have difficulties in complying with set standards. These findings are further elaborated in section 7.2 of the report and Appendix E on effectiveness.

When comparing historical trends of emissions with the temporal milestones of the adoption and implementation of the AAQ Directives, no notable changes can be observed in terms of trends of emissions. Furthermore, an exact attribution of trends observed in terms of emissions to the harmonisation of rules on air quality standards is not possible due to confounding (cf. below). As presented in the figures below and according to the EEA Air Quality in Europe 2018 Report, trends over the past decade (2000-2016) show a decline in total emissions levels across all types of pollutants, although variations in terms of the level of reductions per type of pollutants and across Member States exist.

Despite declining trends, including across pollutants for whicih standards were introduced specifically by the Directive 2008/50/EC and Directive 2004/107/EC, i.e. $PM_{2.5}$, As, Ni, Cd, PAH, as mentioned above it is difficult to ensure a precise attribution of these developments to the enforcement of AAQ Directives standards due to the presence of confounding factors that may have also impacted these trends (e.g. pre-existent national legislation in place, prevalence or changes of activity in certain sectors, in specific Member States).

While the effect and added value of the AAQ Directives in terms of declining trends in emissions and concentrations of pollutants cannot be precisely quantified, it can be concluded that the effect the AAQ Directives had on the harmonisation of air quality standards and on incentivising action at Member State level made an important contribution to spearheading these declining trends. In the absence of uniform air quality standards, it is likely that Member States would have continued with the same or similar practices in terms of air quality standards.

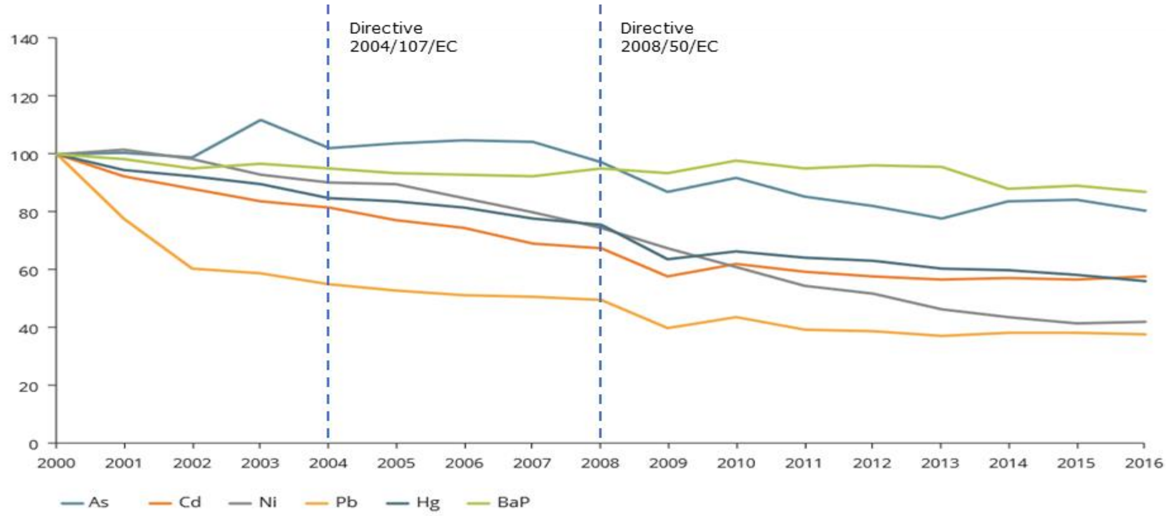
Figure 1 Development in EU emissions 2000-2016 (% of 2000 levels) and AAQ Directives milestones [4]



[4] CH4 emissions are total emissions (Integrated Pollution Prevention and Control sectors 1-7) excluding sector 5: Land use, land-use change and forestry. The present emission inventories include only anthropogenic VOCs emissions. Under the CLRTAP Gothenburg Protocol, parties are encouraged to report emissions of BC, one of the constituents of PM. It means that reporting on BC emissions has been voluntary and has not been compulsory for every country.

Source: EEA Air Quality in Europe 2018 Report with edits by the authors of this report

Figure 2 Development in EU emissions 2000-2015 (% of 2000 levels) and AAQ Directives milestones



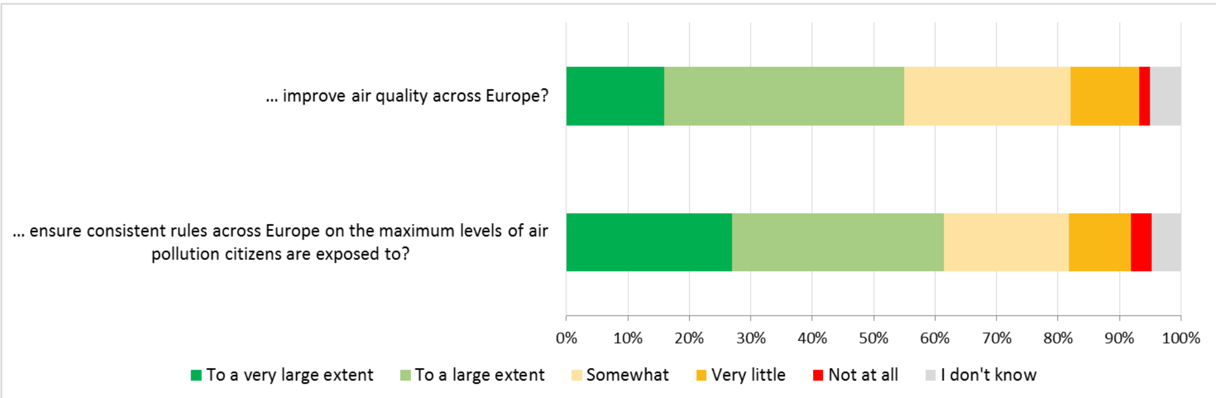
Source: EEA Air Quality in Europe 2018 Report with edits by the authors of this report

B. Results: Open public consultation

The open public consultation, question 4.5 asked respondents to assess *"to what extent has EU policy and legislation on air quality helped to improve air quality across Europe?"* and "*to what extent has EU policy and legislation helped to ensure consistent rules across Europe on the maximum levels of air pollution citizens are exposed to?*"

More than 60% of the respondents providing an answer to the second question above considered the AAQ Directives have helped to a very large or a large extent to ensure consistent rules across the EU on the maximum levels of air pollution that citizens are exposed to. Furthermore, more than 80% of respondents considered that the AAQ Directives have helped at least "somewhat" in relation to improving air quality across Europe, with over 50% seeing the Directives as having helped to a large or a very large extent.

Figure 3 Stakeholder responses on the extent to which AAQ Directives has helped improve air quality across Europe and ensure consistent rules



Source: Open public consultation. Question 4.5: To what extent has EU policy and legislation on air quality helped to improve air quality across Europe? N=484, Question 4.5: To what extent has EU policy and legislation on air quality helped to ensure consistent rules across Europe on the maximum levels of air pollution citizens are exposed to? N=483

Overall, the respondents to the targeted questionnaire commented on a number of aspects of EU added value of the AAQ Directives, including amongst others the added value brought by the introduction of common air quality standards, the requirements for monitoring and assessment, the requirements for setting up air quality plans. Most commonly mentioned the added value of the AAQ Directives was in terms of common air quality standards (16 respondents covering national authorities, local and regional authorities, NGOs, scientific or research organisations, industry), monitoring and assessment (8 respondents covering national authorities, local and regional authorities, NGOs), air quality plans (7 respondents covering national authorities, NGOs), information and awareness raising (6 respondents covering national authorities, NGOs).

Generally, there was agreement in terms of the added value that the AAQ Directives brought at added value amongst stakeholders that commented on this issue (national authorities, local and regional authorities, NGOs, scientific or research organisations, industry). Differences in views were most notable when it comes to the added value of air quality standards and (legal) action taken by the EC. More specifically, while national authorities, local and regional authorities, NGOs and scientific organisations broadly commended the added value of the directive in setting air quality standards and incentivising (legal) action which led to improvements in pollution levels, one industry representative raised concerns about EU infringement procedures and the fact that these were causing "politically motivated (unrealistic and not science-based) measures."

H.1.2 JC 9.2: Added value in terms of assessment and information

This section provides further detail on the approach and evidence linked to *JC 10.2: The extent to which the AAQ Directives brought added value by setting up comparable air quality assessment and information approaches enabling Member States and their competent authorities to take successful action, thus improving air quality beyond what would have been achieved without EU action.*

Approach

The assessment of the added value of the AAQ Directives in terms of setting up a common framework for assessment, monitoring and information looked into (a) the changes and added value brought by the AAQ Directives in terms of assessment and monitoring of air quality standards, (b) the changes and added value brought by the AAQ Directives in terms of reporting and information, (c) the added value and effect that the air quality framework had in terms of enabling Member States and competent authorities to take successful action, thus improving air quality beyond what would have been achieved without EU action.

Limitations to the approach

The assessment relied on desk research and information from the case studies. Given the lack of a comprehensive overview of the monitoring and assessment systems in place prior to the implementation of the AAQ Directives at national level, it has been challenging to provide a comprehensive mapping of the situation a priori the directive in terms of monitoring and assessment systems. This constitutes a limitation to the approach but it has been mitigated by providing exemplifications from the case studies, as relevant.

Results

A. Results: Desk research, Targeted consultation, Case studies

(a) Added value in terms of assessment and monitoring

The AAQ Directives include common provisions concerning the assessment and monitoring of air quality across Member States. The AAQ Directives provide a common framework and common rules on how, when, and where to assess air quality and how it is appropriate to supplement the measures of concentrations with other assessment methods (modelling, objective estimation) (Articles 5, 6, 7, 8 Directive 2008/50/EC).

The desk research, data collected from case studies and targeted consultation indicate that the provisions on monitoring and assessment have contributed to increasing the harmonisation and consistency of the assessment and monitoring approaches of air quality across Member States. As further elaborated in the section on effectiveness (see Appendix E), the AAQ Directives provide common rules on minimum numbers of fixed measurement monitoring stations for each pollutant, depending *inter alia* on pollutant type and population; criteria for siting of these monitoring stations; and the reference methods for assessment of pollution concentrations, as well as data quality objectives. The Directives also define rules and responsibilities for assessment regime and criteria, including assessment thresholds that determine the requirements in each zone or agglomeration.

Although Member States had in place their own assessment regimes of air pollutant concentrations prior to the AAQ Directives, the adoption of the common rules led to increased harmonisation in monitoring and more uniform quality checks of data, which in turn also means more comparable and consistent data across the Member States on air quality. Although there is insufficient evidence on how and whether the Member States would have changed their monitoring systems in the absence of the AAQ Directives, it is likely that the differences in monitoring systems would have remained imposing challenges in terms of data quality and comparability across Member States. The need for comparable data on air quality across Member States warranted action at EU level to ensure a more uniform approach to the assessment and monitoring of air quality.

All seven Member States (Bulgaria, Ireland, Italy, Germany, Spain, Slovakia, Sweden) that were subject of the case studies, as well as five other Member States that were subject of a recent audit by the Eurosai Working Group on Environmental Auditing (Estonia, Hungary, Netherlands, Poland, Romania) currently had operational monitoring systems in place but as evidenced by the ongoing infringement cases against Romania and Slovakia on monitoring some improvements are needed in certain countries. Furthermore, the case studies confirmed that in the absence of the AAQ Directives, the Member States would not have had similarly comprehensive monitoring networks and comparable data. The absence of a harmonised approach across Member States in terms of monitoring and the need for a good EU-level understanding of air quality legitimised action at EU-level in relation to air quality assessment and monitoring.

Table 4 Added value of AAQ Directives in terms of monitoring and assessment in selected MSs

Member State	Added value of AAQ Directives
Bulgaria	• No air quality monitoring system in place prior to the AAQ Directive • Set up of air quality monitoring systems according to the AAQ Directive
Germany	• Improvement of the monitoring network and more comparable monitoring
Ireland	• Definition of a new network for air quality monitoring

Member State	Added value of AAQ Directives
Italy	• Upgrading and integration of monitoring stations in the monitoring network
Slovakia	• Increased focus on monitoring of pollutant concentrations in areas with high population exposure
Sweden	• Reinforced focus on PM_{10} levels and traffic measurements • Establishment of a Reference Laboratory for Urban Air Measurement (Reflab) • Definition of detailed quality procedures for monitoring (Manual for Quality Assurance / Quality Control [D165])
Spain	• Increased focus on monitoring of pollutant concentrations in areas with high population exposure

Source: case studies

Nevertheless, despite the high EU added value that the AAQ Directives have in terms of ensuring a harmonised approach to monitoring and assessment, findings from the analysis under effectiveness, case studies and recent reports (e.g. the ECA, Eurosai) conclude that air quality data can be further improved. Furthermore, although the AAQ Directives set minimum number of sampling points and site locations, the site location provisions offer a degree of flexibility in terms of siting their sampling points. Member States can, within the limits prescribed by the AAQ Directives, choose where to set the location of sampling points which can mean that measurements are not always performed near major industries or main urban traffic routes [P91]. Nevertheless, recent studies such as the EEA report on urban air quality [R63] suggest that cities across Member States recognise the added value of the directive in setting requirements for monitoring and recognise the overall beneficial effect of increasing the number of sampling points and some cities have increased the number of sampling points over the past five years (e.g. Belgium – Antwerp, Ireland – Dublin, Spain – Madrid, Czech Republic – Prague). Furthermore, the report found that stakeholders in a number of cities (Belgium – Antwerp, Germany – Berlin, Sweden – Malmo, Italy – Milan, France – Paris, Austria – Vienna) expressed interest in monitoring emerging and non-regulated parameters, such as particulate number, black carbon, ozone precursors, which are not regulated in Annex X of Directive 2008/50/EC, ammonia, pesticides, ultrafine particles, nitrogen, and metals which are not currently regulated by Directive 2004/107/EC.

(b) Added value in terms of reporting and information

The AAQ Directive 2008/50/EC also requires that information regarding air quality is collected and provided to the public and stipulates a set of rules on how that is to be done (Articles 26-27). In addition, Article 3, 4, 5 of the Commission Implementing Decision 2011/850/EU establish common rules on the process for transmitting information and on quality control of data collected. This also includes detailed instructions and provisions on the procedure for encoding the information and making it available to the wider public.

At EU level, the European Environmental Agency played an important role by ensuring the compilation of data and its dissemination in near-real-time to the European public via the Air Quality e-Reporting database and the Air Quality Index. The outreach of the Air Quality Index has been considerable. In its first year of publication, the Air Quality Index was the most consulted publication of the EEA, and was visited 518,016 times over the course of 2017, which amounts to 57% of the total visits received by the EEA's website in 2017. In addition, the EEA regularly publishes reports such as the Air Quality in Europe report, which are also amongst the most consulted publications of the EEA. For example, the Air Quality in Europe – 2017 Report has been visited 70,092 times in 2017, which amounts to 7.7% of the EEA web visits registered in 2017.[5]

At national level, as further presented in the section on effectiveness, presently the vast majority of the designated authorities publish some air quality information (making it available to the public on their website). However, the information was assessed to be of mixed quality, level of detail and accessibility. The analysis done as part of effectiveness evaluated the extent to which information on air quality is easily accessible to the public.

The results indicate that information on air quality was difficult to access or outdated in 16 countries (i.e. Bulgaria, Croatia, Denmark, France, Germany, Greece, Hungary, Italy – Regione Lazio, Latvia, Lithuania, Malta, Netherlands, Slovakia, Spain, Sweden, United Kingdom), whereas in 2 countries (i.e. Slovenia, Italy - Ministry) air quality information was not at all publicly available.

Furthermore, public access to air quality plans is not adequately ensured in 16 countries (i.e. Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Estonia, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Slovakia, Slovenia, United Kingdom), 3 countries (Denmark, Finland, Romania) make available some information about air quality plans but the plans are not directly downloadable and 16 countries (i.e. Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Estonia, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Slovakia, Slovenia, United Kingdom) do not provide any information about air quality plans.

When it comes to the publication of annual reports, in 3 countries the reports were made accessible but did not contain information about exceedances or their effects (Austria, Czech Republic, Estonia, Malta) whereas in 12 countries (i.e. Bulgaria, Croatia, Finland, France, Greece, Hungary, Italy, Latvia, Luxembourg, Poland, Sweden, United Kingdom) there was no annual report identified in the competent authority's website. For 12 Member States (Belgium, Cyprus, Denmark, France, Germany, Ireland, Lithuania, Netherlands, Romania, Slovakia, Slovenia, Spain) annual reports were accessible and contained both information on exceedances and their effects.

Some Member States provide real time data on air quality through a variety of tools, but the quality of the information is of varying levels (see examples in the table below). This is supported also by findings from the Court of Auditors, which flagged some good practices in this regard but also pointed out that the quality and availability of public information on air quality in the Member States was not always found to be clear or useful for the citizens regarding the health impacts and measures to take to mitigate risks. Also, the study found that Member States, regions and cities defined air quality indices differently, resulting in different assessments of the same air quality, somewhat compromising the credibility of the information provided [P91].

[5] Data received from EEA in interview.

Table 5 Evidence of good practice concerning access to information

	Public information available?	Examples of means to provide information
Bulgaria	Yes	• Daily bulletin on exceedances on air quality[6] • Quarterly bulletins on air quality[7] • Common SMS system for exceedances and alert thresholds[8] • Information boards and information on websites of municipalities[9].
Belgium	Yes	• Spatial maps using modelling • Notification during pollution peaks (SMS or email) • Data series of air quality trends
Germany	Yes	• Website of the German Environment Agency (UBA) • Annual Report of the German Environment Agency (UBA) • Dedicated websites of federal states
Ireland	Yes	• Air Quality Index for Health (AQIH) • Periodic Air Quality bulletins and reports • Citizen engagement and citizen science (CE&CS) • Historical data on AQ publically accessible • Air quality app - BreezoMeter • Real-time localised particulate matter monitoring data
Italy	Yes	• Websites of regions containing air quality information • Forecasting tool providing real time data (48-72 hours forecast) • Annual Report on Quality of the Urban Environment, ISPRA • Spatial maps using modelling • Notification during pollution peaks (SMS or email) • Data series that are downloadable for analysis
Slovakia	Yes	• Website providing air quality and exceedances information (Slovak Hydrometeorological Institute and district offices) • Near real-time data on concentrations on the website (most recent hourly and daily values) • Annual Report on air quality
Romania	Yes	• Development of a national air quality network website, allowing public access to historical data from 2007 to present. [10]
Spain	Yes	• Website proving information (Ministry of Environment) • Smartphone app
Sweden	Yes	• Website providing air quality information (EPA • Datasets with air quality measurements

[6] Executive Environment Agency, Daily Bulletin on air quality in the country website.

[7] Executive Environment Agency, Quarterly Bulletin on the state of the environment website.

[8] Interview with ExEA.

[9] Plovdiv Municipality, Local system for air quality website.

[10] See: link

	Public information available?	Examples of means to provide information
		• Annual Reports • Information on air quality provided by municipalities

Source: Case studies, ECA, Eurosai

The AAQ Directives also set information and alert thresholds for sulphur dioxide, nitrogen dioxide and ozone. The alert and information thresholds have been important in ensuring a uniform approach to informing the population in all Member States.

In contrast, the AAQ Directives do not set alert and information threshold for PM_{10} which are then based on national regulation. As further substantiated in the figure below, in the absence of harmonised alert and information thresholds, the requirements at national level are not unified and, as a consequence, there is a risk that in cases where the same level of air pollution will occur, citizens in different countries may or may not be warned by the authorities in spite of the harmful effect of high concentrations on human health.

Table 6 National Information and alert thresholds for PM10

Member State	Warning service	National / Regional Based warning implementation	Information Threshold	Alarm Threshold	Warning Procedure	Reference
Austria (Graz)	Active / Passive	Regional	50 µg/m³	75 µg/m³	Limit has to be exceeded for three days and predicted forecast is not changing the situation	Government of the Land Steiermark
Belgium	Active	National	50 µg/m³ (weather forecast for the next day)	1st stage: 70 µg/m³ 2nd stage: 100 µg/m³ 3rd stage: >75 µg/m³	Warning according to a two days forecast provided by IRCEL	Belgian Interregional Environment Agency (IRCEL); Bruxelles Environnement
Czech Republic	Passive	National	150	75 µg/m³ /12h	Daily average for two consecutive days at two stations within an area of 100 km²	Parliament of the Czech Republic
Finland	Active / Passive	Regional	50 µg/m³ (weather forecast for the next day)	50 µg/m³ (value is exceeded since one day)	Weather forecast for one day	Helsinki Region Environmental Services Authority (HSY)
France	Active	National	50 µg/m³ (weather forecast for the next day)	80 µg/m³	Three Alarm Stages: 1st stage: 80 µg/m³ on an one day forecast or 50 µg/m³ since two consecutive days + forecast for next two days above the level 2nd stage: 80 µg/m3 since two consecutive days + forecast for next two days above the level	Lig'Air – Monitoring the air quality in the Center- Val de Loire region; Atmo Auvergne-Rhône- Alpes - observatory for monitoring air quality

Member State	Warning service	National / Regional Based warning implementation	Information Threshold	Alarm Threshold	Warning Procedure	Reference
					3rd stage: 80 µg/m³ since four consecutive days + forecast for next two days above the level	in Auvergne-Rhône-Alpes
Germany (Stuttgart)	Active/ Passive	Regional (Baden-Württemberg)		50 µg/m³ (weather forecast for the next two days)	Between 15th October and 15 April DWD forecast for at least 2 days without improvement Disadvantage: no exact correlation between weather and air pollution so it is possible that no warning even if high measures Note: Germany in general has no warning procedure and limits where public is informed and steps are undertaken to fight pollution.	Deutscher Wetterdienst
Hungary	Active	Regional	75 µg/m³	100 µg/m³ (situation is present since 2 consecutive days and no improvement is expected for the following day	Weather forecast for 2 consecutive days	Ministry of Agriculture – State Secretariat Environmental Affairs
Italy (Lombardy)	Active	Regional	50 µg/m³	75 µg/m³	For 7 consecutive days and at least two measure stations	Official Bulleting of the Lombardy region
Italy (Piemont)	Active	Regional	50 µg/m³	1st stage: 50 µg/m³ for 7 consecutive days	Valid until 15 April 2017	Regional Council of Piemont

Member State	Warning service	National / Regional Based warning implementation	Information Threshold	Alarm Threshold	Warning Procedure	Reference
				2nd stage: 100 µg/m³ for 3 consecutive days 3rd stage: 150 µg/m³ for 3 consecutive days 4th stage: 180 µg/m³ for 3 consecutive days	Based on the present situation and the weather forecast for the next two days	City of Torino
Luxembourg	Passive	National	50 µg/m³		First alarm in 2017 because 24h value was over 50 µg/m³ at many stations	Tageblat Letzeburg
Poland (national)	Active	National	200 µg/m³	300 µg/m³	Ministry of Environment Threshold is provided when value is exceeded on the daily concentration base	Polish Ministry of Environment
Poland (Krakow)	Active	Regional	150 µg/m³ (at all stations)	300 µg/m³ (at one station)	Local Regulation	Municipality of Krakow
Slovakia	Passive	National	100 µg/m³	150 µg/m³	Slovak Hydrometeorological Office (SHMU) publishes warnings The warnings published after two consecutive days with measures in one affected area and there have to be more than 50% of stations over the critical value	Ministry of Environment of the Slovak Republic
Spain (Catalonia)	Active/ Passive	Regional	50 µg/m³	80 µg/m³	When previous days value of 50 µg/m³ at one station is exceeded and 24-hour forecast indicates that levels will remain high	City of Barcelona

Member State	Warning service	National / Regional Based warning implementation	Information Threshold	Alarm Threshold	Warning Procedure	Reference
UK	Passive	National	76 µg/m³	101 µg/m³ (highly polluted)	UK Daily Air Quality Index (DAQI) Weather forecast in order to the air quality system which is based on a ten-level system (low-very high)	UK Department for Environment, Food and Rural Affairs

The column "Passive / Active" describes the way in which the public is informed and activities are prescribed by governments or municipalities.

Active means a system where the national government has set a limit value where extremely high pollution is defined as a health risk. In case the limit is surpassed, authorities must inform the public through various channels (media, public places etc.) and several activities are undertaken to reduce the smog level. Passive means prescription on the national level that information must be given to the public in case of air pollution, but there is no requirement to take concrete actions to reduce air pollution. If both "Active/Passive" appear, that means that information and measures are not specified on national level but several regions of the country have created their own regulations.

Source: [D159] Marcus Wiesen (2017), Air Pollution Emergency Schemes

Table 7 Other pollutants thresholds (NO_2, O_3, $PM_{2.5}$, SO_2)

Country	Type of pollutant	Information Threshold	Alarm Threshold	Reference
Czech Republic	SO_2	350 µg/m³	500 µg/m³	Parliament of the Czech Republic
Finland	SO_2	350 µg/m³/3h	500 µg/m³/3h	Helsinki Region Environmental Services Authority
Hungary	SO_2	400 µg/m³/3h	500 µg/m³/3h or 400 µg/m³ (exceeded more than 72 hours)	Municipality of Debrecen
UK	SO_2	533 µg/m³ (based on the 15-minute mean concentration)	1065 µg/m³ (based on the 15-minute mean concentration)	UK Department for Environment, Food and Rural Affairs
Czech Republic	NO_2	200 µg/m³	400 µg/m³	
Hungary	NO_2	350 µg/m³/3h	400 µg/m³/3h or 350 µg/m³ (exceeded more than 72 hours)	Municipality of Debrecen
Spain (Barcelona)	NO_2	Intensive Control: 140 µg/m³ Warning: 200 µg/m³ (two measuring stations over 180 µg/m³ within two full hours within one zone(	400 µg/m³ (three consecutive hours within one zone)	City Council of Madrid
Finland	NO_2	150 µg/m³/3h Min. 6h over exceeding on two different measuring stations Intensive communication between city and HSU and information to residents 200 µg/m³/3h for the next two days	400 µg/m³/3h	Helsinki Region Environmental Services Authority

France	NO_2	200 µg/m³	400 µg/m³/h or 200 µg/m³ (exceeded more than 72 hours)	Lig'Air – Monitoring entity of air quality in the Center Val de Loire region
UK	$PM_{2.5}$	54 µg/m³	71 µg/m³	UK Department for Environment, Food and Rural Affairs
Finland	$PM_{2.5}$	40 µg/m³/3h		Helsinki Region Environmental Services Authority

Source: [D159] Marcus Wiesen (2017), Air Pollution Emergency Schemes (Smog Alerts in Europe).

(c) Added value in terms of enabling effective action

The AAQ Directives include provisions requiring the European Commission to enforce Member States' compliance with the Directives. Intensified action on grounds of non-compliance with the requirements of the AAQ Directives indicates that the directives have brought added value in terms of enforcement of provisions in particular when it comes to compliance with limit values. Moreover, in recent infringement cases, the CJEU ruled in favour of the European Commission urging Member States to take further action.

As further presented in the effectiveness section, as of January 2019, the European Commission had pursued 16 ongoing infringement proceedings due to PM pollution[11], 13 due to NO_2[12] and one due to SO_2[13] and two other infringement proceedings regarding air pollution monitoring[14]. At the moment of drafting this report, there was no ongoing infringement procedure on ozone or other pollutants covered by the AAQ Directive. The infringement cases were on grounds of exceedances of air quality limit values and deficiencies in monitoring.

In previous rulings[15], the CJEU merely declared that the Member States had breached the limits in certain years but there was no ruling where corrective action was explicitly required. In contrast, in two recent cases on Poland and Bulgaria[16], the CJEU ruled in favour of the European Commission indicating that merely adopting an air quality plan was not enough and that the Member States had not fulfilled their obligations to keep the period in which limits were exceeded as short as possible [P91]. As highlighted in the Commission Communication 2018/330, these judgements confirm the European Commission's view that persistent exceedances require more effective measures to be taken by the Member States concerned to limit the exceedances to the shortest possible period.

In January 2018, the European Commission invited 9 Member States (Czech Republic, Germany, France, Spain, Hungary, Italy, Romania, Slovakia and the United Kingdom) concerned by pending infringement procedures regarding excessive air pollution due to particulate matter or nitrogen dioxide to an air quality summit in Brussels. The purpose was to urge Member States to present binding commitments for measures to address exceedances and ensure compliance with the rules of the AAQ Directives. The European Commission concluded based on the information by the Member States that six of them would not keep exceedance periods as short as possible, as required by case-law by the CJEU. As a consequence, the European Commission referred the Member States (France, Germany, and the United Kingdom – for NO_2, as well as Italy, Hungary and Romania – for PM_{10}) to the CJEU.

The right of access to justice is not explicitly protected by the AAQ Directives as in other environmental legislation (e.g. waste) [P91] but it is provided for in the Aarhus Convention. Nonetheless, the interim findings suggest that the AAQ Directives have contributed to ensuring access to justice through their provisions on information to the public, requirements to respect set limit values and

[11] Belgium; Bulgaria; Hungary; Italy; Poland; Romania; Czech Republic; France; Germany; Greece; Latvia; Portugal; Slovakia; Spain; Sweden; Slovenia

[12] France, Germany, United Kingdom; Italy, Spain; Austria, Belgium, Czech Republic, Denmark, Hungary, Luxembourg, Poland, Portugal

[13] Bulgaria

[14] Slovakia and Romania

[15] For example Case C-104/15 European Commission v Romania, Case C-48/12 Commission v Poland, C-68-11 Commission v Italian Republic

[16] Case C-336/16 European Commission v Republic of Poland, Case C-488/15 European Commission v Republic of Bulgaria

requirements to draft and enforce air quality plans in situations where exceedances are registered. Citizens have pursued action against national authorities for not ensuring compliance with the AAQ Directives. In the Czech Republic, Germany, France, Italy, Belgium and the United Kingdom, national courts have ruled in favour of citizen's right to clean air and required the Member State concerned to take further action to tackle air pollution [P91].

Notably, some organisations such as ClientEarth have played an important role in ensuring enforcement of the AAQ Directives at national level. For example, after the ruling of the CJEU in Case C-404/13 *ClientEarth v Secretary of State for the Environment*, *Food and Rural Affairs*, which set an important precedent for the right to clean air across Europe, ClientEarth rolled out a litigation campaign to replicate its legal action in the UK in other European countries (currently, 10 EU countries: Belgium, Bulgaria, the Czech Republic, France, Germany, Hungary, Italy, Poland, Slovakia and the United Kingdom). The availability of public and comparable information on air quality in EU Member States, promoted by the AAQ Directives, was essential in order to identify the cities where air pollution levels were particularly high and, as a result, the risks to the health of the population particularly serious (Targeted Questionnaire, response no. 20). Availability of information to the public and awareness of the levels of air quality is an important enabler to ensure enforcement of the AAQ Directives rules.

Data collected through desk research and in the context of the case studies provides mixed evidence concerning the added value that the AAQ Directives have brought in terms of access to justice for citizens at national level. Although there is evidence that legal action for non-compliance with air quality standards has taken place, it is not clear whether this is a direct result of the Directive and in some cases (e.g. Bulgaria) findings suggest that more efforts should be made at national level to clarify the access to justice requirements.

The table below presents some examples of national court cases on air quality in the Member States.

Table 8 Examples of national court cases on air quality

Member State	Court cases concerning clean air
Austria	In October 2017, a lawsuit in the Higher Administrative Court gave citizens a sound legal basis to demand measures to protect them from health hazards arising from air pollutants. The Higher Administrative Court with jurisdiction, ruled on 19 February 2018 that environmental NGOs can order a review of compliance with the legal provisions arising from EU environmental law.
Bulgaria	In Bulgaria, municipal air quality plans cannot be challenged in court. While a possible remedy could be class actions in civil courts, administrative courts are of the opinion that these plans are internal administrative documents and cannot be challenged as judged in several recent cases[17]. The AAQ Directives are not very clear about the access to justice requirements in terms of air quality plans, which leads Bulgarian courts to refrain from action. The provisions of the Aarhus Convention, while providing for access to justice, they do not provide a clear picture on whether air quality plans can be challenged in court.

[17] See Administrative Court Sofia city ruling 6541/25.09.2017 court case 7190/2017; Supreme administrative court ruling 13138/01.11.2017 court case 12064/2017; Supreme administrative court ruling 890/23.01.2018 court case 14145/2017.

Czech Republic	Two citizens, a local NGO and the Frank Bold society filed an administrative complaint against the air quality management plan in Ostrava in 2016. In December 2017, the Supreme Administrative Court rejected the air quality plan for Ostrava as not being appropriate. The ruling may have set a precedent for three other ongoing cases of complaints against air quality plans.
France	After several setbacks, Les Amis de la Terre with support of ClientEarth brought a new case against the French Government. In its judgment of 11 July 2017 (n° 394254), the Conseil d'État departed sharply from its previous decisions stating that the AAQ Directives set an obligation of results and ordered the adoption of new and more effective air quality plans by 31 March 2018.
Germany	The first court case was the Janecek case but based on Directive 96/62/EC. Since then, there have been 28 cases brought to court by Deutsche Umwelthilfe. Most recently the Federal Administrative Court ruled that health protection takes precedence over economic interest and thus cleared the way for diesel bans.
Hungary	Local residents of road no. 86 in western Hungary sued the road operator and maintenance company in 2007 for failing to implement measures to prevent heavy duty road traffic causing health and property damages. This test case was successful and the verdict was affirmed by the Hungarian Supreme Court.
Netherlands	In September 2017, the Court of the Hague ordered in a lawsuit initiated by the environmental protection organisation Milieudefensie that action must be taken immediately in terms of air pollution. The state was sentenced to concrete measures to comply with all European limit values in a "foreseeable and demonstrable" manner.
Poland	In Poland, residents, supported by the Frank Bold society, are currently claiming their right to challenge air quality plans at the Constitutional Court. Although the ruling is not expected until the end of 2018, the increased pressure on the authorities has already led to considerably improved air quality plans.
Slovakia	In 2017, a group of citizens in Bratislava together with the NGOs CEPTA, ClientEarth and Cyklokoalícia brought a claim against the Slovak Government for insufficient protection of air quality in Bratislava to the district court of Bratislava. The claim suggested that the air quality plan for Bratislava was not sufficient, lacked concrete measures and targets and was not compliant with the Slovak and European legislation. The district office in Bratislava that drafted the plan argued that, pursuant to current laws, it is not competent to require other subjects to implement measures to improve air quality and to enforce such measures / impose sanctions in case of non-compliance. The district office further argued that the public was consulted and had the opportunity to comment on the proposed air quality plan. No court decision has been published on the matter until the time of writing of this report.
Sweden	In 2008, the Swedish Society for Nature Conservation (SSNC) brought a case against the city of Stockholm for failing to take measures included in its air quality plan. Despite a 2012 court ruling in SSNC's favour, the lack of any effective remedy has allowed the city to continue to delay taking action.
UK	In February 2018 the High Court ruled that the court should have effective oversight of the UK Government's next air quality plans. This meant that for the first time, an

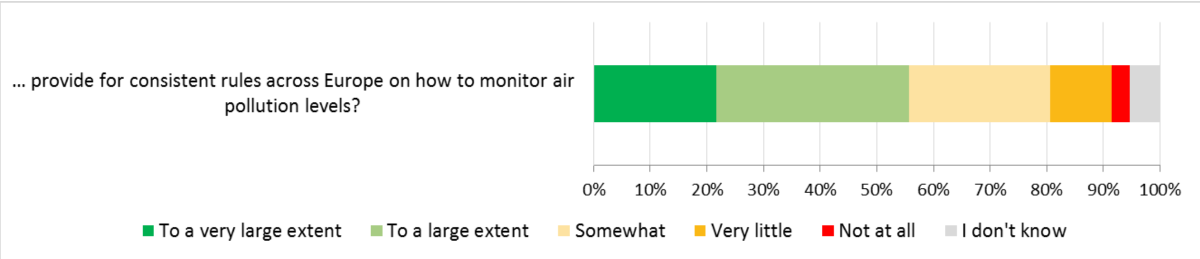
NGO would be able to immediately bring the government back to court if it prepares an air quality plan which is unlawful.

Source: DUH (2018), Environmental Action Germany. Legal Actions for Clean Air. Available at: hyperlink Case Studies.

B. Results: Open public consultation

More than half of the respondents consulted assessed that the AAQ Directives have helped to a very large or large extent to provide for consistent rules across Europe on how to monitor air quality levels.

Figure 4 *Extent to which the EU policy and legislation on air quality helped provide consistent rules for monitoring air pollution across Europe*



H.2 Evaluation question 10: Added value in creating synergies and clarity of responsibilities

Evaluation Question 10 assessed *"What has been the EU added value of the AAQ Directives, do the Directives and their means of implementation create synergies or overlaps with other Community objectives, and how has the distribution of responsibilities between EU, Member State, regional and local level impacted on air quality management?".*

This section provides further detail on the approach and evidence linked to the following judgement criteria:

- *JC 10.1: The extent to which the AAQ Directives have brought added value by creating synergies and avoiding overlaps with Community objectives.*
- *JC 10.2: The extent to which the AAQ Directives have brought added value by ensuring a more appropriate distribution of responsibilities between EU, Member States, regional and local air quality management.*

H.2.1 JC 10.1: Added value in terms of synergies with other Community objectives

Approach

Given the similarities of the evaluation question with the questions under coherence, the analysis for this judgement criterion relied primarily on the evidence collected as part of coherence, while further substantiating the analysis with evidence from the case studies.

Limitations to the approach

The analysis is supported by reliable data and no limitations to the approach were identified.

Results

A. Results: Desk research, Targeted consultation, Case studies

The AAQ Directives have brought added value by reinforcing the commitment of the European Commission to ensure air quality and mitigate the negative effects of air pollution across Member States. The AAQ Directives reinforce the commitment made by the European Union in the (6th and 7th) Environmental Action Programmes to reduce pollutant emissions significantly (Directive 2008/50/EC, Preamble 1). Thus, the AAQ Directives ensure synergies with higher Community environmental objectives to create an appropriate and coherent framework for dealing with air quality issues.

The AAQ Directives are part of a wider body of legislation aimed at tackling air pollution. As presented under coherence, the AAQ Directives are supportive of and coherent with the objectives and provisions of related air pollution legislation, such as the National Emission Ceiling Directive (2016/2284) and source-related legislation as the Medium Combustion Plant Directive (2015/2193) and Industrial Emissions Directive (2010/75/EU).

The AAQ Directives' objectives and provisions are also supportive of other environmental legislation, in particular the Environmental Impact Assessment Directive (85/337/EEC) and the Strategic Environmental Assessment Directive (2001/42/EC). Synergies between the AAQ Directives and other environment-related legislation can be considered to add value at EU level in addressing environmental issues.

The AAQ Directives have also been consistent and ensured synergies with relevant sectoral policies and legislation. As presented under the section on coherence, the AAQ Directives have been broadly consistent and ensured synergies with relevant sectoral policies and legislation. However, weaknesses in the EU Type Approval Framework, and higher NOx emissions limits for diesel cars, undermined air quality protection during the evaluation period. Legislative changes since 2015 – particularly the introduction of the Real Driving Emissions test and a stronger role for the Commission in enforcement – may address many of the weaknesses in the Type Approval Framework. Synergies exist between EU energy efficiency policies and air quality goals; however, the inclusion of biomass under the Renewable Energy Directive may weaken the contribution of that Directive to EU air quality goals. Over the evaluation period, the Common Agricultural Policy has increased attention to environmental issues; the CAP does not, however, include agricultural emissions of air pollutants in its cross-compliance requirements. EU health policy is found to be broadly aligned with air quality policy and synergies with EU air quality goals can be found in EU urban policy.

The evidence collected also indicates that in the absence of action at EU level, consistency and synergies of air quality legislation with other sectoral policy objectives would have been challenged. This is further substantiated by the fact that at national level, in some instances, there is still room for further improvement of coordination of air quality frameworks with other environmental and other sectoral legislation. Some examples of good practices and instances where coordination is challenged are presented below.

Member State	Coherence	Examples of coordination (or lack of coordination) between the objectives of air quality and other sector policy objectives at national level
Bulgaria	+ / -	Air quality objectives have been successfully coordinated with some sectoral policies. For example: **Waste**: Targeted actions taken to improve waste management, including development of anaerobic digestion plants and better management of landfills (including through projects financed with OP Environment in the period 2007-2013) have contributed to improvement of air quality. **Energy**: Air quality actions were coordinated with the Ministry of Labour and Social Policy, particularly in relation to the social help provided for purchase of heating fuel and the broader issue of energy poverty and its links to air quality. **Transport**: The Ministry of Transport is expected to strengthen the mandatory annual technical checks for vehicles and introduce stickers for different emission levels in order to help distinguish the vehicles and facilitate the implementation of low emission zones in the municipalities. **Energy:** Coordination between energy efficiency policies and air quality is insufficient. The newest approved BAT BREFs on burning waste are not applied. Industrial emitters such as coal-fired power plants apply for derogations and renewal of their integrated permits without reference or commitment to apply the BREFs. The link between the application of EU air quality standards and those of the IED and NEC Directive are also missing. Delays in transposition of the NEC Directive lead to uncertainties concerning air quality requirements.

Germany	+/-	**Transport**: The federal environment ministry has legislative authority over the LEZ system in Germany, and has not extended the LEZ system with a "blue sticker" that would enable cities to allow diesel vehicles only as of Euro 6 with low real driving emissions in urban areas where the NO_2 limit value is persistently exceeded. Likewise, the Federal Transport Ministry has until recently refused to come forward with technical regulations to allow retrofit of in-use Diesel vehicles to curb NOx-emissions. There is a lack of coherence and coordination with transport policy when it comes to diesel tax exemptions. **Agriculture:** Efforts to address issues related to agriculture and air quality are made but there is still a need for further coordination between policies. **Climate change:** Climate plans could address the synergies with air quality better.
Ireland	+	**Cross-sector**: The National Clean Air Strategy incorporates air quality goals and objectives alongside other sectoral policies related to air quality, namely: industrial emissions, domestic emissions, transport and agriculture. The aim is to develop an integrated approach towards air quality improvements.
Italy	+	**Cross-sector**: The 2013 Action Plan brought together several national ministries in a cross-sectoral cooperation for air quality management in Italy. The cooperation was between the Ministry of Environment, Land, Sea, the Ministry of Economic Development, Ministry of Transport and Infrastructure, Ministry of Agricultural, Food and Forestry Policies. This was followed by another 2017 Action Plan signed by the Ministry of Environment and by four regions.
Slovakia	+	**Cross-sector**: The Strategy for the Improvement of Air Quality in Slovakia is being prepared and other sectors are actively involved in its preparation. Sixteen working groups have been established to elaborate the strategy to discuss different air quality issues (e.g. industrial emissions, transport, agriculture, etc.), including representatives of various sectors.
Spain	+/-	**Transport:** There is a lack of coherence and coordination. For example, there is a mismatch between the requirements of air quality legislation and the incentives for diesel cars provided by the state (e.g. fiscal and consumer benefits). Spain has applied the Plan RENOVE (re-named PIVE) providing incentives to consumers for buying cars, including diesel cars. The Central Government is working on a new plan to impose increased tax on diesel. The Central Government has also introduced a Plan MOVEA (targeting companies buying electric cars) and MOVELT (incentivising alternative energy vehicles). **Cross sector:** Plan AIRE 2013-2016 is the framework for air quality and includes sectoral measures targeting industry, construction, transport, agriculture, livestock, residential, commercial and institutional sectors.

Sweden	+	**Transport:** The National Transport Administration has become more involved in the development and implementation of measures to reduce air pollution on state and local roads.

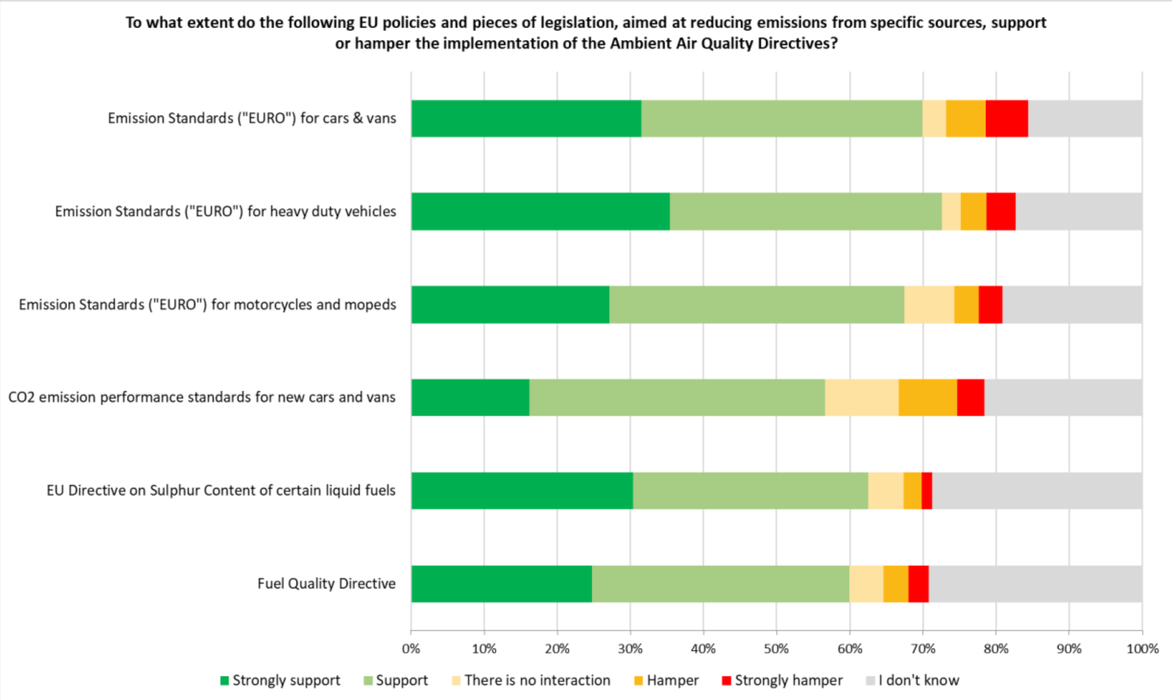
Legend: (+) evidence of coordination between sectoral policies, (-) evidence of lack of coordination between sectoral policies, (+/-) evidence of instances of lack of coordination but measures are taken to remedy such instances.

Source: Case studies

B. Results: Open public consultation

Respondents were largely positive about the extent to which EU transport legislation supports the implementation of the AAQ Directives. On key pieces of legislation, as outlined in the figure below, most respondents reported that the legislation was supportive of the AAQ Directives. Nonetheless, concerns were expressed by 12% of respondents that the CO_2 emissions standards for new cars and vans hamper air quality objectives. Similarly, respondents indicated concerns about the Euro standards, with 11% of respondents stating Euro standards for cars and vans hamper the AAQ Directives.

Figure 5 Open Public Consultation responses concerning EU vehicle emissions and fuel quality legislation



H.2.2 JC 10.2: Added value in terms of appropriate distribution of responsibilities

This section provides further detail on the approach and evidence linked to *JC 11.2: The extent to which the AAQ Directives have brought added value by ensuring a more appropriate distribution of responsibilities between EU, Member States, regional and local air quality management.*

Approach

The analysis for this judgement criterion relies on evidence collected via desk research, case studies, targeted consultation and open public consultation.

Limitations to the approach

Evidence relies predominantly on the outputs from the case studies. Thus, generalisation is limited given that the case studies only refer to 7 Member States.

Results

A. Results: Desk research, Targeted consultation, Case studies

The division of responsibilities between the EU and national level is fairly clear for relevant stakeholders with the EU setting the overall steering and regulatory framework for air quality and the EEA supporting Member States in ensuring the operational monitoring and assessment of air quality, gathering data and disseminating it to the wider public.

The AAQ Directives are not prescriptive in terms of the division of responsibilities at national level as they leave this to the Member States to regulate. Based on the evidence collected at national level, the distribution of responsibilities is generally clear with specific authorities tasked with different areas of responsibility in relation to air quality. However, it is also clear that the coordination of actions between the different levels and actors is often challenging as explained further below. It is notable that all the selected Member States have complex systems in place for managing air quality with multiple stakeholders being involved. Member States had in place governance systems even before the AAQ Directives and changes in their governance systems for air quality ensued only as a result of the requirements to monitor, assess, report and draft air quality plans.

Table 9 Division of responsibilities for air quality at national level in selected Member States

	Regulation and supervision	Monitoring and assessment	Reporting to the EEA / EC	Air Quality Plans (drafting)
Bulgaria	Min. of Environment ExEA	Municipalities ExEA (coord.)	ExEA	Municipalities
Germany	Min. of Environment EPA	Federal States EPA	EPA	Federal States
Ireland	Min. of Environment EPA	Local authorities EPA (coord.)	EPA	Local authorities
Italy	Min. of Environment ISPRA	Regional government Regional ARPA ISPRA (coord.)	ISPRA	Regional government
Spain	Min. of Environment	Autonomous communities (or local authorities) State Meteorological Agency (coord.) National Centre for Environmental Health (methods)	Min. of Environment	Autonomous communities (or local authorities)

Slovakia	Min. of Environment	Local authorities	Min. of Environment	Local authorities
Sweden	Min. of Environment EPA	Municipalities (urban) EPA (rural, national) Reflab (methods)*	EPA	County board or municipalities (by delegation)

Source: case studies, Eurosai (2019), Joint Report on air quality

* Reflab - Reference Laboratory for Urban Air Measurement; ARPA – Regional Agency for the Environment

In complex air quality management systems with a high number of authorities involved and in systems where air quality management is decentralised whereas the central government still maintains steering over regulating adjacent sectors that are the source of pollution (e.g. transport) (e.g. Slovakia, Sweden, Germany), difficulties in effective coordination and implementation of air quality measures were found. A particular case is coordination between public sector institutions in relation to the implementation of air quality plans which appears to be challenging in almost all selected Member States. The issue of coordination seems to arise especially when different levels of governance are involved (e.g. local-central, local-regional). This is due to the fact that in some instances, the AQPs contain measures that fall in the remit of responsibility of other national or regional authorities. Such situations can lead to a decreased effectiveness and added value of AQPs.

Table 10 Examples of instances of coordination (or lack of coordination) of air quality plans measures in selected Member States

Member State	Coordination	Examples
Bulgaria	(+) / (-)	**Central level**: Instances of good coordination between national authorities (ministries) were found (e.g. coordination of Ministry of Environment with Ministry of Labour, Ministry of Transport). However, further coordination can be sought in relation to energy (Ministry of Energy). **Local level**: Coordination between different sectoral policies at local level is insufficient. For example, 25 Bulgarian municipalities have signed the Covenant of Mayors and prepared Sustainability Energy Action Plans. Of those, two have signed also the Mayors Adapt initiative and are expected to prepare Sustainable Energy and Climate Action Plans (SECAPs). Even though some of these municipalities also have air quality problems, links between the SEAPs/SECAPs and the municipal air quality plans are hardly found. In addition, the municipalities rarely update their SEAPs and thus do not take advantage of the available guidance on how to integrate different policy concerns in their SEAPs. Few municipalities in Bulgaria have a Sustainable Urban Mobility Plan (SUMPs) but in general air quality has not been a focus area of those plans. Air quality plans could also be integrated or linked with municipal/ urban/ regional level planning e.g. in the area of land use and spatial planning.

Member State	Coordination	Examples
Italy	(+) / (-)	**Central level:** Instances of good coordination between national authorities (ministries) were found (e.g. 2013 Action Plan). Coordination has also improved as a result of the Art. 20 Coordination Body that prepared national guidelines to avoid regional fragmentation. **Local level**: Coordination on air quality plans at local level has improved and has spurred coordination with mobility plans, rural development and energy efficiency initiatives. The plans have strengthened coordination between regional and municipal levels and among municipal governments.
Ireland	(+)	**Central level**: Coordination between authorities at central level is found. For example, coordination has taken place when it comes to the setup of the National Clean Air Strategy. **Local level**: Strong and productive culture of collaborative partnership working between the Irish authorities and institutions at subnational level. This has facilitated the integration of air quality objectives into a broad range of linked policy areas including urban planning and climate change, suggesting that the AAQ Directives have been cohesive with other areas of policy.
Spain		**Central level**: Coordination between authorities has taken place but can be further improved in particular between authorities responsible for air quality and authorities responsible for transport measures. **Local - Regional level**: Coordination between authorities at local and regional level can be further improved. The coherence of the governance structure imposes difficulties when it comes to the implementation of measures to improve air quality that can fall in the remit of responsibility of authorities other than those at local level that are drafting the air quality measures.
Slovakia	(+) / (-)	**Central level:** Coordination between the authorities at central level has taken place when it comes to the Strategy for the Improvement of Air Quality in Slovakia. **Local - central level:** Allocation of responsibilities and the somewhat limited coordination between different actors constituted a major barrier to the effective implementation of the AAQ Directives in Slovakia and in the Košice region. While, in principle, it is possible to elaborate effective measures for the air quality plans, it is not always possible to see them materialise. For example, the authorities in Slovakia may be well aware that a city bypass would likely improve air quality, but in practice it would be difficult to get such a bypass built because the district office, elaborating the measure, does not have the powers necessary to make the development decision.

Member State	Coordina-tion	Examples
Sweden	(+) / (-)	**Central level**: The central authorities coordinate in the adoption of strategic framework. **Local-Central level**: Coordination in terms of air quality plans between the local and central level can be further improved in some cases. In particular when it comes to the implementation of air quality plans certain measures that are included in the plans are in the remit of responsibilities of national authorities which makes it difficult to ensure their implementation. For example, air quality plans may require a reduction of pollutants in the proximity of national roads but the regulation of national roads is in the area of responsibility of the National Roads Administration. This imposed certain challenges in terms of translating measures into reality. In recent years cooperation has been improved and the National Roads Administration has taken measures to secure air quality.

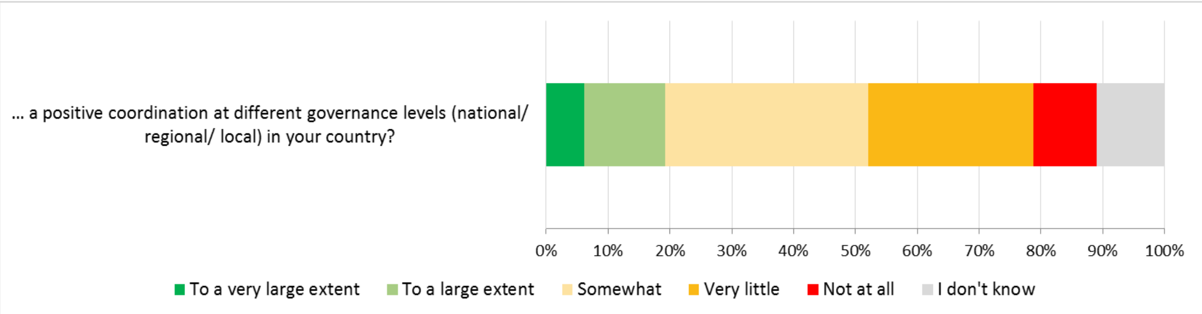
Legend: (+) / (-) There are positive instances of coordination but also aspects that can be improved.

Source: Case studies

B. Results: Open public consultation

The open public consultation asked respondents to assess the extent to which the AAQ Directives have resulted in a positive coordination at different governance levels. As presented in the figure below, opinions somewhat diverged when it comes to the effect of the AAQ Directives on positive coordination at different governance levels (national/regional/local). More than half of the stakeholders consulted considered the AAQ Directives to have had a positive effect on the coordination between different levels of governance in the Member States. However, 37% considered the AAQ Directives to have had little or no effect on this.

Figure 6 Extent to which the AAQ Directives resulted in a positive coordination at different governance levels (national/regional/local)



Source: Open public consultation. Question 10.1: To what extent has the implementation of the Air Quality Directives resulted in the following: A positive coordination at different governance levels (national/regional/local) in your country? N=438.

Only one respondent (local authority) to the targeted consultation commented on the aspect of division of responsibility and indicated that the AAQ Directives should be revised to improve governance elements, in particular to allocate more flexibility to the Member States to allocate responsibilities for the assessment and to establish zones and agglomerations.

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APPENDIX I

SUMMARY OF CASE STUDIES

Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

1 INTRODUCTION

The present appendix provides a brief summary of the emerging findings from the 7 case studies performed as part of the regulatory fitness check of the AAQ Directives.

The seven case studies have been carried out for the purpose of finding greater details for some of the evaluation questions. The main purpose of case studies is to examine, in more detail, the situation regarding the experience and lessons learnt in the implementation of the air quality legislation. The case studies include a more detailed review of implementation and integration successes and problems, the costs of implementation and of non-implementation of the legislation and the administrative burden of implementation and opportunities for improving implementation without compromising the integrity of the purpose of the Directives. As such, the case study complements the information gathered through other sources, such as desk review, targeted questionnaire, open public consultation, interviews, focus groups and stakeholder workshops.

The Member States for detailed case studies have been selected to cover a range of geographies, governance structures and sizes. This led to the selection of the following seven Member States: Bulgaria, Germany, Ireland, Italy, Slovakia, Spain and Sweden.

The seven case studies follow the same template and consistent methodology and questions. At the same time, each case study is unique and provides different insights into the country specific challenges and best practices in relation to the implementation of the AAQDs.

Each case study is focusing on the implementation of the AAQ Directives and then on a specific topic, in particular:

- **Bulgaria** with focus on air quality zone Plovdiv Agglomeration
- **Germany** with focus on Berlin Agglomeration
- **Ireland** with focus on public information provision
- **Italy** with focus on the Sicily region
- **Slovakia** with focus on Kosice region
- **Spain** with focus on Madrid
- **Sweden** with focus on rural environment and ecosystem impacts

The case studies relied on extensive desk research of relevant documents, 40 in-depth interviews with relevant national authorities (central, regional and local), representatives of businesses and business associations, representatives of NGOs, environmental and municipalities associations, research institution and health foundation.

2 KEY FINDINGS

The following sections present the key findings emerging from the case studies.

Table 2-1 Assessment of relevance of the AAQ Directives in the case studies[1]

Bulgaria	Air quality is considered to have deteriorated in the past 10 years by 59% of the respondents to Special Eurobarometer 468 (2017). The AAQ Directives are assessed to address the needs at national level (e.g. in terms of monitoring of air quality, provision of information and planning of measures). The AAQ Directives are considered to target relevant pollutants but the limit values do not sufficiently reflect specific local, climate or social conditions.
Germany	Air quality is considered to have deteriorated in the past 10 years by 29% of the respondents to Special Eurobarometer 468 (2017). The AAQ Directives are assessed to address the needs at national level and are considered to be essential (in particular the monitoring and assessment and the limit values) Pollutants regulated by AAQ Directives remain relevant and there is a need to further focus on pollutants with a high effect on human health (e.g. PM2.5, ultrafine particles).
Ireland	Air quality is positively regarded by citizens as only 17% of Irish citizens consider that air quality has deteriorated in the last 10 years, while 33% suggest that it has improved, according to Special Eurobarometer 468 (2017) The AAQ Directives provisions are considered to be relevant, in particular limit values; there is also evidence that the regulatory framework should be expanded to include PM1.
Italy	A majority of citizens responding to Special Eurobarometer 468 (2017) perceived air quality as having deteriorated in the past 10 years (61% of respondents). The AAQ Directives provisions have been and remain relevant, in particular in relation to air quality plans and limit values which are important to mitigate the negative effects of air pollution.
Slovakia	Air quality is a source of concern for 43% of respondents to Special Eurobarometer 468 (2017) that consider air quality in Slovakia remained the same over the past 10 years and a similar amount considered it has deteriorated. The objectives of the AAQ Directives, in particular those related to the availability of information to the public and monitoring of long-term trends were considered to be relevant. There are different views amongst stakeholders in terms of the air quality standards and whether the existing air quality standards are too lenient.
Spain	Air quality is a concern for Spanish citizens, with 68% of respondents of Special Eurobarometer 468 (2017) considering air quality in the country to have deteriorated over the past 10 years. The current AAQ Directives provisions were considered to be relevant, but findings suggest that the AAQ Directives should be stricter with new pollutants added and stronger limits imposed.
Sweden	Air quality continues to be a concern in Sweden, as Special Eurobarometer 468 (2017) indicates that 46% of respondents perceived air quality stayed the same in the past 10 years and 24% that it has deteriorated. Air quality standards imposed by the AAQ Directives are relevant but the Swedish legislation goes beyond the values imposed in the AAQ Directives and a need to set a daily limit for PM2.5 was indicated.

The case study findings indicate that the selected Member States have monitoring and assessment networks that are generally in line with the requirements of the AAQ Directives.

[1] Based on case studies

Table 2-2 Air quality monitoring in the case studies[2]

Bulgaria	Responsibility of the local authorities together with the ministry of environment: comprises 48 monitoring stations: 30 fixed automated measuring, 5 differential optical absorption spectroscopy, and 9 stations for manual sampling).
Germany	Responsibility of the German states and the Environment Agency (Umweltbundesamt): Air quality is measured in 650 monitoring station throughout Germany.
Ireland	Responsibility of EPA and local authorities; the monitoring network meets the requirements of the AAQ Directives but some rural and urban areas are left without assessment.
Italy	Responsibility of the regions and autonomous provinces (regional/local) and the Italian National Institute for Environmental Protection and Research – ISPRA (national). Improvements of the monitoring network were planned under Sicily's Operational Programme.
Slovakia	Responsibility of the Slovak Hydrometeorological Institute and local authorities. Monitoring network had 34 monitoring stations (2007). In 2016, the monitoring network had 38 stations. Some shortcomings in the monitoring in terms of number of sampling points.
Spain	Responsibility of the autonomous communities and municipalities: 600 fixed measurement stations at national level.
Sweden	Responsibility of the Swedish EPA (rural) and municipalities (urban). Each municipality monitors NOx, SO_x, CO, PM_{10}, $PM_{2.5}$, benzene, BaP, As, Cd, Ni, Pb. Swedish EPA monitors $PM_{2.5}$, NO_2, SO_2, O_3.

Some Member States provide real-time data on air quality through a variety of tools but the quality of the information is of varying levels (see examples in the table below). This is supported also by the findings from the European Court of Auditors, which flagged some good practices in this regard and pointed out that the quality and availability of public information on air quality in the Member States was not always found to be clear or useful for the citizens regarding the health impacts and measures to take to mitigate risks.[3] Also, the study found that Member States, regions and cities defined air quality indices differently, resulting in different assessments of the same air quality, somewhat compromising the credibility of the information provided.

Table 2-3 Information to the public in the case studies[4]

Bulgaria	Daily bulletin on exceedances on air quality Quarterly bulletins on air quality Common SMS system for exceedances and alert thresholds Information boards and information on websites of municipalities
Germany	Website of the German Environment Agency (UBA) Annual Report of the German Environment Agency (UBA) Dedicated websites of federal states
Ireland	Air Quality Index for Health (AQIH) Periodic Air Quality bulletins and reports Citizen engagement and citizen science Historical data on air quality publicly accessible

[2] Based on case studies

[3] European Court of Auditors Special Report on Air Pollution.

[4] Based on case studies

Italy	Real-time localised particulate matter monitoring data Websites of regions containing air quality information Forecasting tool providing real time data (48-72 hours forecast) Annual Report on Quality of the Urban Environment, ISPRA Spatial maps using modelling Notification during pollution peaks (SMS or email) Data series that are downloadable for analysis
Slovakia	Website providing air quality and exceedances information (Slovak Hydrometeorological Institute and district offices) Near real-time data on concentrations on the website (most recent hourly and daily values) Annual Report on air quality
Spain	Website proving information (Ministry of Environment) Smartphone app
Sweden	Website providing air quality information (EPA Datasets with air quality measurements Annual Reports Information on air quality provided by municipalities

The case studies also addressed the issue of costs of the implementation and the costs of non-implementation of the AAQ Directives in the Member States. Data on the costs of implementation and the costs of non-implementation of the AAQ Directives was difficult to find; this is primarily due to the limited number of studies at national level looking into these aspects.

Table 2-4 *Costs of implementation in the case studies*[5]

Bulgaria (national)	Monitoring (of environment): EUR 1.9 million Air quality plans: EUR 1.5 million (approx. EUR 50 000 per plan) Air quality measures: EUR 156.8 million
Germany	No data available
Ireland (Dublin)	Monitoring (infrastructure): EUR 160 000 (since 2008) EPA annual capital replacement cost: EUR 380 000 per year EPA annual staff cost for AAQ Directives: EUR 493 000 per year Dublin City Council monitoring infrastructure capital cost: EUR 160 000 Dublin City Council monitoring infrastructure operating cost: EUR 15 000 per year Costs of time spent by the relevant persons involved in making measurements, calculations, predictions or estimations in Dublin: EUR 300 000 per year Total annual costs (EPA and Dublin Council): EUR 1 806 735
Italy	Monitoring (varies across regions): between EUR 20 000 – EUR 32 000 per station (approx. EUR 5 million per year for all stations) Monitoring (maintenance): EUR 300 000 per year
Slovakia	Ministry of Environment: estimated in the range of EUR tens of millions per year Monitoring (operating): EUR 1.2 million per year
Spain	Plan AIRE implementation: EUR 600 000

[5] Based on case studies

Sweden	Monitoring network maintenance (national): variable according to area (between EUR 100 000 and over EUR 1 million) Contracts with laboratories: EUR 30 000 per year. EPA budget for AAQ: EUR 400 000 per year (approx. EUR 200 000 to EUR 300 000 for AAQ Directives). Total estimated annual cost for all fixed measurements (EUR): EUR 1 859 490 Modelling (regional background concentrations of O3, NO_2, SO_2) annual cost: EUR 65 000 Reference laboratory quality check of data: EUR 50 000

Table 2-5 Costs of non-implementation in the case studies[6]

Bulgaria	Health related external costs: EUR 3 billion per year (2010) Premature deaths: 14,200 (PM), 640 (NO2), 350 (O3) (2015) Total costs (health and non/health) due to traffic pollution: EUR 612 to EUR 778 million (2016)
Germany	No data was available.
Ireland	No data was available.
Italy	No data was available.
Slovakia	Health related external costs: EUR 3 billion per year (2010) Direct economic costs: 1.3 million workdays lost due to sickness, for healthcare of above EUR 10 million per year (income adjusted, 2010), and for agriculture (crop losses) of EUR 35 million per year (2010). Premature deaths: 5 160 (2014)
Spain	Costs of road pollution (both health and non-health related): between EUR 3 916 million and EUR 4 836 million
Sweden	Health related external costs: EUR 3 billion per year (2010) Premature deaths: 7 600 (2015) Socio-economic costs: EUR 5.4 billion (2015)

The majority of the selected Member States made use of EU funding to improve air quality to varying degrees.

Table 2-6 Use of EU funding to fund air quality improvements (examples from the case studies)[7]

Bulgaria	Cohesion policy funds: under OP Environment 2007-2013, adjacent measures (e.g. waste management, public transport) which also supported air quality objectives Cohesion policy funds: under OP Environment 2014-2020 specific objective Reducing ambient air pollution by lowering the quantities of PM10 and NOx (EUR 50 million)
Germany	ERDF: 6 programmes related to air quality 2014-2020 (EUR 92.3 million). LIFE: use of funding to finance 30 projects related to air quality.
Ireland	Horizon 2020: iSCAPE project LIFE Programme includes air quality and emissions as a thematic priority

[6] Based on case studies
[7] Based on case studies

Italy	ERDF: Air quality priority (priority code 47) for the 2007-2013 period (EUR 25.4 million) ERDF: Air quality priority (priority code 83) for the 2014-2020 period (EUR 30.7 million) EAFRD: Rural Development programmes include funding for reducing agricultural emissions LIFE Programme: PREPAIR Project (EUR 10 million – EU); OPERA
Slovakia	ESF: environmental investments for the 2007-2013 period (EUR 1.82 billion) ESF: environmental investments for the 2014-2020 period (EUR 215 million)
Spain	ERDF: OP 'Actions to improve the environment in cities' including air quality measures (EUR 24 million)
Sweden	LIFE Programme: supported air quality actions (e.g. CLEANTRUCK project)

The allocation of responsibilities in relation to air quality is split between the national, regional and local level across selected Member States, as illustrated in the table below. Broadly speaking, the central governance (Ministry of Environment or Environmental Protection Agency) is responsible for the regulation and supervision of air quality.

Monitoring and assessment is devolved at regional and local level in all Member States with the oversight of the national authorities. Air quality plans are generally the responsibility of local and regional levels.

The case studies highlighted that, in some cases, difficulties in effective coordination amongst different levels of government within Member States can be noted. The issue of coordination seems to arise especially when different levels of governance are involved (e.g. local-central, local-regional). This is due to the fact that in some instances, air quality plans contain measures that fall in the remit of responsibility of other national or regional authorities. Such situations can lead to a decreased effectiveness and added value of air quality plans.

Table 2-7 Examples of instances of coordination (or lack of coordination) of air quality plans measures identified in the case studies[8]

Bulgaria	**Central level:** Instances of good coordination between national authorities (ministries) were found (e.g. coordination of Ministry of Environment with Ministry of Labour, Ministry of Transport). However, further coordination can be sought in relation to energy (Ministry of Energy). **Local/regional level:** Coordination between local and central level is insufficient. For example, 25 Bulgarian municipalities have signed the Covenant of Mayors and prepared Sustainability Energy Action Plans. Of those, two have signed also the Mayors Adapt initiative and are expected to prepare Sustainable Energy and Climate Action Plans (SECAPs). Even though some of these municipalities also have air quality problems, links between the SEAPs/SECAPs and the municipal air quality plans are hardly found. In addition, the municipalities rarely update their SEAPs and thus do not take advantage of the available guidance on how to integrate different policy concerns in their SEAPs. Few municipalities in Bulgaria have a Sustainable Urban Mobility Plan (SUMPs) but in general air quality has not been a focus area of those plans. Air quality plans could also be integrated or linked with municipal/urban/regional level planning e.g. in the area of land use and spatial planning.
Italy	**Central level:** Instances of good coordination between national authorities (ministries) were found (e.g. 2013 Action Plan). Coordination has also improved as a result of the work of a coordination body that prepared national guidelines to avoid regional fragmentation.

[8] Based on case studies

	Local/regional level: Coordination on air quality plans at local level has improved and has spurred coordination with mobility plans, rural development and energy efficiency initiatives. The plans have strengthened coordination between regional and municipal levels and among municipal governments.
Ireland	**Central level:** Coordination between authorities at central level is found. For example, coordination has taken place when it comes to the setup of the National Clean Air Strategy. **Local/regional level:** Strong and productive culture of collaborative partnership working between the Irish authorities and institutions at subnational level. This has facilitated the integration of air quality objectives into a broad range of linked policy areas including urban planning and climate change, suggesting that the AAQ Directives have been cohesive with other areas of policy.
Spain	**Central level:** Coordination between authorities has taken place but can be further improved in particular between authorities responsible for air quality and authorities responsible for transport measures. **Local/regional level:** Coordination between authorities at local and regional level can be further improved. The coherence of the governance structure imposes difficulties when it comes to the implementation of measures to improve air quality that can fall in the remit of responsibility of authorities other than those at local level that are drafting the air quality measures.
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Italy	A majority of citizens responding to Special Eurobarometer 468 (2017) perceived air quality as having deteriorated in the past 10 years (61% of respondents). The AAQ Directives provisions have been and remain relevant, in particular in relation to air quality plans and limit values which are important to mitigate the negative effects of air pollution.
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Spain	Air quality is a concern for Spanish citizens, with 68% of respondents of Special Eurobarometer 468 (2017) considering air quality in the country to have deteriorated over the past 10 years. The current AAQ Directives provisions were considered to be relevant, but findings suggest that the AAQ Directives should be stricter with new pollutants added and stronger limits imposed.
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Slovakia	Ministry of Environment: estimated in the range of EUR tens of millions per year Monitoring (operating): EUR 1.2 million per year
Spain	Plan AIRE implementation: EUR 600 000

[5] Based on case studies

Sweden	Monitoring network maintenance (national): variable according to area (between EUR 100 000 and over EUR 1 million) Contracts with laboratories: EUR 30 000 per year. EPA budget for AAQ: EUR 400 000 per year (approx. EUR 200 000 to EUR 300 000 for AAQ Directives). Total estimated annual cost for all fixed measurements (EUR): EUR 1 859 490 Modelling (regional background concentrations of O3, NO_2, SO_2) annual cost: EUR 65 000 Reference laboratory quality check of data: EUR 50 000

Table 2-5 Costs of non-implementation in the case studies[6]

Bulgaria	Health related external costs: EUR 3 billion per year (2010) Premature deaths: 14,200 (PM), 640 (NO2), 350 (O3) (2015) Total costs (health and non/health) due to traffic pollution: EUR 612 to EUR 778 million (2016)
Germany	No data was available.
Ireland	No data was available.
Italy	No data was available.
Slovakia	Health related external costs: EUR 3 billion per year (2010) Direct economic costs: 1.3 million workdays lost due to sickness, for healthcare of above EUR 10 million per year (income adjusted, 2010), and for agriculture (crop losses) of EUR 35 million per year (2010). Premature deaths: 5 160 (2014)
Spain	Costs of road pollution (both health and non-health related): between EUR 3 916 million and EUR 4 836 million
Sweden	Health related external costs: EUR 3 billion per year (2010) Premature deaths: 7 600 (2015) Socio-economic costs: EUR 5.4 billion (2015)

The majority of the selected Member States made use of EU funding to improve air quality to varying degrees.

Table 2-6 Use of EU funding to fund air quality improvements (examples from the case studies)[7]

Bulgaria	Cohesion policy funds: under OP Environment 2007-2013, adjacent measures (e.g. waste management, public transport) which also supported air quality objectives Cohesion policy funds: under OP Environment 2014-2020 specific objective Reducing ambient air pollution by lowering the quantities of PM10 and NOx (EUR 50 million)
Germany	ERDF: 6 programmes related to air quality 2014-2020 (EUR 92.3 million). LIFE: use of funding to finance 30 projects related to air quality.
Ireland	Horizon 2020: iSCAPE project LIFE Programme includes air quality and emissions as a thematic priority

[6] Based on case studies
[7] Based on case studies

Italy	ERDF: Air quality priority (priority code 47) for the 2007-2013 period (EUR 25.4 million) ERDF: Air quality priority (priority code 83) for the 2014-2020 period (EUR 30.7 million) EAFRD: Rural Development programmes include funding for reducing agricultural emissions LIFE Programme: PREPAIR Project (EUR 10 million – EU); OPERA
Slovakia	ESF: environmental investments for the 2007-2013 period (EUR 1.82 billion) ESF: environmental investments for the 2014-2020 period (EUR 215 million)
Spain	ERDF: OP 'Actions to improve the environment in cities' including air quality measures (EUR 24 million)
Sweden	LIFE Programme: supported air quality actions (e.g. CLEANTRUCK project)

The allocation of responsibilities in relation to air quality is split between the national, regional and local level across selected Member States, as illustrated in the table below. Broadly speaking, the central governance (Ministry of Environment or Environmental Protection Agency) is responsible for the regulation and supervision of air quality.

Monitoring and assessment is devolved at regional and local level in all Member States with the oversight of the national authorities. Air quality plans are generally the responsibility of local and regional levels.

The case studies highlighted that, in some cases, difficulties in effective coordination amongst different levels of government within Member States can be noted. The issue of coordination seems to arise especially when different levels of governance are involved (e.g. local-central, local-regional). This is due to the fact that in some instances, air quality plans contain measures that fall in the remit of responsibility of other national or regional authorities. Such situations can lead to a decreased effectiveness and added value of air quality plans.

Table 2-7 Examples of instances of coordination (or lack of coordination) of air quality plans measures identified in the case studies[8]

Bulgaria	**Central level:** Instances of good coordination between national authorities (ministries) were found (e.g. coordination of Ministry of Environment with Ministry of Labour, Ministry of Transport). However, further coordination can be sought in relation to energy (Ministry of Energy). **Local/regional level:** Coordination between local and central level is insufficient. For example, 25 Bulgarian municipalities have signed the Covenant of Mayors and prepared Sustainability Energy Action Plans. Of those, two have signed also the Mayors Adapt initiative and are expected to prepare Sustainable Energy and Climate Action Plans (SECAPs). Even though some of these municipalities also have air quality problems, links between the SEAPs/SECAPs and the municipal air quality plans are hardly found. In addition, the municipalities rarely update their SEAPs and thus do not take advantage of the available guidance on how to integrate different policy concerns in their SEAPs. Few municipalities in Bulgaria have a Sustainable Urban Mobility Plan (SUMPs) but in general air quality has not been a focus area of those plans. Air quality plans could also be integrated or linked with municipal/urban/regional level planning e.g. in the area of land use and spatial planning.
Italy	**Central level:** Instances of good coordination between national authorities (ministries) were found (e.g. 2013 Action Plan). Coordination has also improved as a result of the work of a coordination body that prepared national guidelines to avoid regional fragmentation.

[8] Based on case studies

	Local/regional level: Coordination on air quality plans at local level has improved and has spurred coordination with mobility plans, rural development and energy efficiency initiatives. The plans have strengthened coordination between regional and municipal levels and among municipal governments.
Ireland	**Central level:** Coordination between authorities at central level is found. For example, coordination has taken place when it comes to the setup of the National Clean Air Strategy. **Local/regional level:** Strong and productive culture of collaborative partnership working between the Irish authorities and institutions at subnational level. This has facilitated the integration of air quality objectives into a broad range of linked policy areas including urban planning and climate change, suggesting that the AAQ Directives have been cohesive with other areas of policy.
Spain	**Central level:** Coordination between authorities has taken place but can be further improved in particular between authorities responsible for air quality and authorities responsible for transport measures. **Local/regional level:** Coordination between authorities at local and regional level can be further improved. The coherence of the governance structure imposes difficulties when it comes to the implementation of measures to improve air quality that can fall in the remit of responsibility of authorities other than those at local level that are drafting the air quality measures.
Slovakia	**Central level:** Coordination between the authorities at central level has taken place when it comes to the Strategy for the Improvement of Air Quality in Slovakia. **Local/regional level:** Allocation of responsibilities and the somewhat limited coordination between different actors constituted a major barrier to the effective implementation of the AAQ Directives in Slovakia and in the Košice region. While, in principle, it is possible to elaborate effective measures for the air quality plans, it is not always possible to see them materialise. For example, the authorities in Slovakia may be well aware that a city bypass would likely improve air quality, but in practice it would be difficult to get such a bypass built because the district office, elaborating the measure, does not have the powers necessary to make the development decision.
Sweden	**Central level:** The central authorities coordinate in the adoption of strategic framework. Local/regional level: Coordination in terms of air quality plans between the local and central level can be further improved in some cases. In particular when it comes to the implementation of air quality plans certain measures that are included in the plans are in the remit of responsibilities of national authorities which makes it difficult to ensure their implementation. For example, air quality plans may require a reduction of pollutants in the proximity of national roads but the regulation of national roads is in the area of responsibility of the National Roads Administration. This imposed certain challenges in terms of translating measures into reality. In recent years cooperation has improved and the National Roads Administration has taken measures to secure air quality.

Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

Final Report

Appendix J: Case Studies

Directorate-General for Environment

Written by Adriana R. Ilisescu
September 2019

APPENDIX J CASE STUDIES

- Case study Report – Bulgaria
- Case study Report – Germany
- Case study Report – Ireland
- Case study Report – Italy
- Case study Report – Slovakia
- Case study Report – Spain
- Case study Report – Sweden

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CASE STUDY REPORT
BULGARIA

Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

Written Mariya Gancheva
March 2019

Contents

Appendices

1 INTRODUCTION

This report summarises the findings and conclusions of the **case study for Bulgaria**. The case study had a focus on air quality zone Plovdiv Agglomeration.

The report is one of seven case studies carried out for the Fitness Check of the EU Ambient Air Quality Directives. Its main purpose is to examine, in more detail, the situation regarding the experience and lessons learnt in the implementation of the air quality legislation. The case studies provide a basis for a more detailed examination of the questions of the fitness check and include a review of implementation and integration successes and problems, the costs of implementation and of non-implementation of the legislation and the administrative burden of implementation and opportunities for improving implementation without compromising the integrity of the purpose of the Directives. As such, the case study complements the information gathered through other sources, such as desk review, targeted questionnaire, open public consultation, interviews, focus groups and stakeholder workshops.

The Member States for detailed case studies have been selected to cover a range of geographies, governance structures and sizes. This has led to the selection of the following **seven case study Member States: Slovakia, Germany, Spain, Sweden, Ireland, Bulgaria and Italy**.

The case study report is structured in four chapters, namely:

- **Chapter 1 – Introduction**
- **Chapter 2 – Background and context**, presents general information about the context of the case study
- **Chapter 3 – Findings**, presents detailed findings regarding the relevance of the AAQ Directives, the implementation successes and problems, the factors underlying compliance with the Directives, the costs and benefits.
- **Chapter 4 – Conclusions**, presents a summary of the main findings.

The case study findings rely on extensive desk research and a series of interviews that took place over the period October and November 2018. An overview of the interviews carried out is provided in Appendix A.

The case study has been shared with the interviewed stakeholders in January 2019 for validation of findings and correction of factual mistakes. Feedback received from the stakeholders was integrated in the case study report.

2 BACKGROUND AND CONTEXT

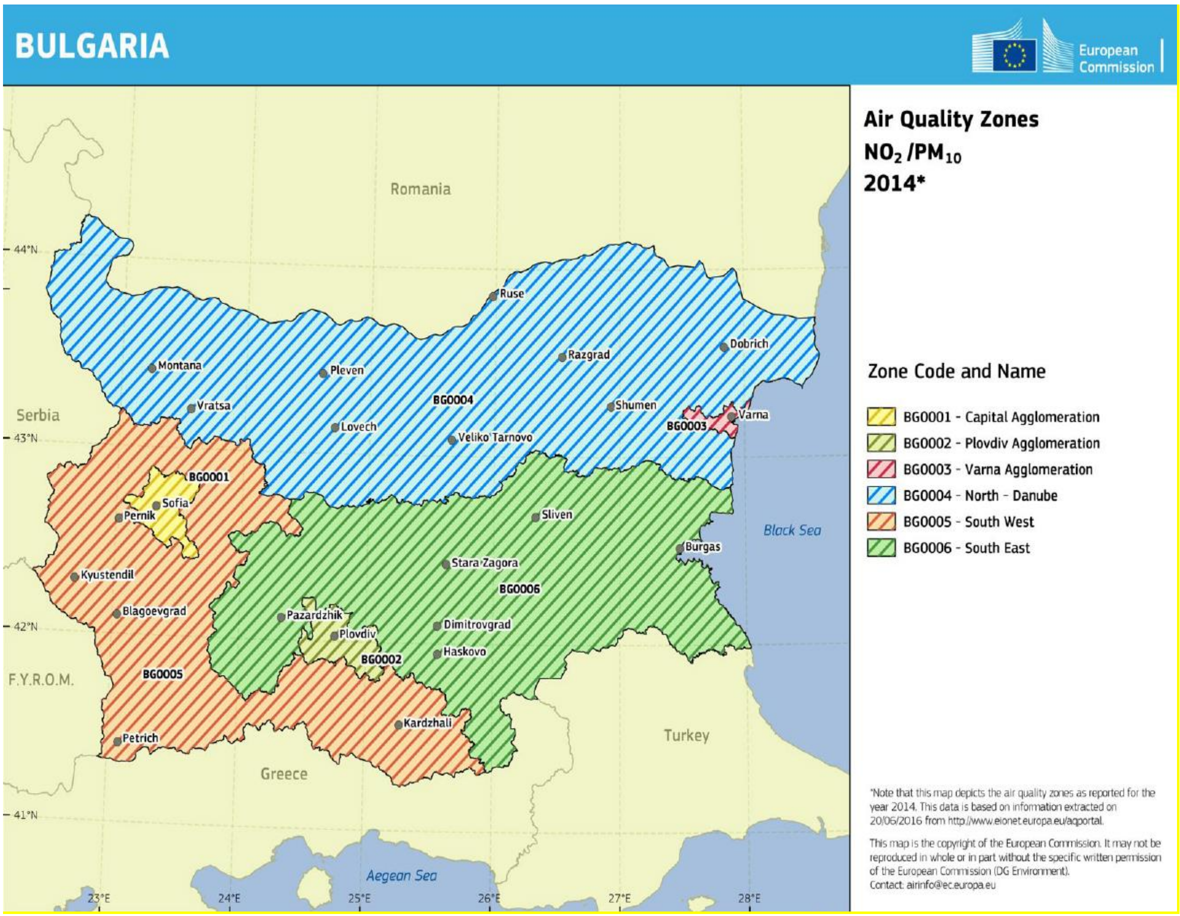
The present chapter contains general information about the air quality framework in Bulgaria.

2.1 Bulgaria and air quality zone characteristics

2.1.1 Scope of the case study

The case study covers the *entire territory of Bulgaria and focuses in particular on the Plovdiv Agglomeration.* As shown in **Error! Reference source not found.** below, for the purpose of assessing air quality the territory of Bulgaria is divided into six zones of which three agglomerations (Capital, Plovdiv and Varna).

Figure 2-1 Air quality zones for NO_2 and PM_{10}, 2014



Source: European Commission, DG Environment, Atlas of air quality zones and monitoring stations (2013 & 2014), Bulgaria.

The *air quality zones* correspond to the so-called *'areas for air quality assessment and management'* defined in the national legislation transposing the Ambient Air Quality Directives (AAQDs)[1]. These areas are identified by the Minister of Environment and Water and are updated every five years unless significant changes in the activities causing changes of the concentration levels of

[1] Ordinance N12 of 15 July 2010 concerning norms for sulphur dioxide, nitrogen dioxide, particulate matter, lead, benzene, carbon monoxide and ozone in ambient air.
Ordinance N11 of 14.05.2007 concerning norms for arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons in ambient air
Ordinance N7 of 3 May 1999 concerning assessment and management of air quality.

the pollutants are observed. The areas are identified based on assessments and according to any exceedances of the assessment thresholds defined in the national legislation. The 2013 Order[2] issued by the Ministry of Environment and Water (MOEW) has divided the territory of the country in six 'areas for air quality assessment and management' that cover all 28 provinces of the country. The division of these areas was based on the existing administrative and territorial organisation of the country and on a preliminary assessment of the air pollution in each municipality. According to the list of beneficiaries eligible for support under the Operational Programme (OP) Environment 2014-2020 for development or update of the municipal air quality plans, 28 municipalities have problems in meeting the AAQD standards and need to prepare air quality plans[3]. The information about the air quality zone coverage and the pollutants monitored is summarised in Appendix D.

2.1.2 Characteristics of air quality zone

The *'Plovdiv Agglomeration' air quality zone covers two municipalities*, which need to prepare air quality plans – Plovdiv and Asenovgrad. Together the two municipalities host about 7% of the population in the country. Furthermore, the Plovdiv Municipality is the most densely populated area in the country. It is over three times more densely populated than the capital city of Sofia with an estimated people density of 3,358 in 2016[4].

The Plovdiv and the Asenovgrad municipalities form an important economic centre and contribute significantly to the economy of the Plovdiv Province. The main economic sectors in Plovdiv are manufacturing (primarily metal products, food, machinery and equipment), services (primarily business services such as IT and wholesale trade but also public and commercial services) and construction. In 2015, the output of the local non-financial sector was EUR 7.3 billion with an added value of EUR 2.2 billion[5]. Leading economic sectors in Asenovgrad are commerce, metallurgy and manufacturing of metal goods, transport and logistics[6].

Both municipalities have specific local climatic and geomorphological characteristics that affect air quality. This is especially relevant for Plovdiv where the geomorphology of the city creates conditions for holding atmospheric masses and forming a specific atmospheric stratification, which impede the dispersion of air pollution[7].

The detailed characteristics of Bulgaria and the Plovdiv Agglomeration are presented in Text box 2-1 below.

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[2] Order 969 of 21.12.2013, Ministry of Environment and Water and Executive Environment Agency, http://eea.government.bg/bg/legislation/air/zapoved_96921.12.2013.pdf.
[3] Operation Programme Environment 2014-2020, Ongoing calls, BG16M1OP002-5.002, http://ope.moew.government.bg/bg/notice/noticedetail/from/noticecurrent/id/77/typeId/1.
[4] National Statistical Institute, 2016, Cities and Their Urbanised Areas in the Republic of Bulgaria 2010-2016, http://www.nsi.bg/sites/default/files/files/publications/URBAN2016_ENG.pdf.
[5] Investment Destination Plovdiv, Local Economy website, http://invest.plovdiv.bg/en/content/local-economy/.
[6] Asenovgrad Municipality, General Economic characteristics website, https://www.assenovgrad.com/objects.php?cid=46.
[7] Plovdiv Municipality, 2011, Update of the programme for improving air quality on the territory of the Plovdiv Municipality 2003-2010 and preparation of Action plan for the period 2011-2013, http://www.plovdiv.bg/wp-content/uploads/okolna-sreda/normativni-dokumenti/Plovdiv_Programa_KAV_2011-2013_Plan%20za%20deistvie.pdf.

Text box 2-1 Bulgaria and the Plovdiv Agglomeration

Bulgaria	
GDP per capita in PPS (2016)	49
GDP per capita growth (% 2008-2016)	18%
Population (1 January 2017)	7.1 million
Governance structure	Unitary
Zones defined as agglomerations (%)	50%

Plovdiv Agglomeration	
Number of inhabitants (2016)	Plovdiv Municipality: 342,525 Asenovgrad Municipality: 61,993
Area:	1,390 km^2

Characteristics of the Plovdiv Agglomeration:

The city of Plovdiv is the second largest city after the capital and the administrative centre of the Plovdiv Municipality and the Plovdiv Province. It is located in the Southern part of Bulgaria, on the banks of the Maritsa river and in the Upper Thracian Plain. It is in a transitional continental climate zone but its micro-climate is affected by the seven city hills (ranging 176-286 m in altitude) and the mountains surrounding the Plovdiv plateau in every direction. The latter creates conditions for holding atmospheric masses and forming a specific atmospheric stratification that impede the dispersion of air pollution.

Asenovgrad, which is located 19km south of Plovdiv in the steps of the Rhodope Mountains, is the second biggest city in the Plovdiv Province and the administrative centre of the Asenovgrad Municipality. The area of the municipality varies as is partly a plateau (210-230 m in altitude) and partly semi-mountainous (240-400 m in altitude).

Sources: Eurostat, GDP per capita in Purchasing Power Standards (PPS) expressed in relation to the European Union (EU28) average set to equal 100; Eurostat, Real GDP per capita, growth rate and totals; Eurostat, Population on 1 January; Eionet data. National Statistical Institute, 2016, Cities and Their Urbanised Areas in the Republic of Bulgaria 2010-2016, and air quality plans of the Plovdiv and Asenovgrad municipalities.

2.2 Air quality monitoring and air quality

The following section presents briefly the arrangements for air quality monitoring and provides a short overview of air quality problems and achievements in Bulgaria. 4.2.5Appendix E includes an overview of the reported exceedances in the European Environment Agency's (EEA) database.

2.2.1 Air quality monitoring

Bulgaria has fulfilled its obligations concerning the number of monitoring stations and the parameters monitored. The *national monitoring system for air quality* is part of the national monitoring system of the environment of MOEW. It consists of 48 monitoring stations: 30 fixed automated measuring stations (AMS); 4 AMS for air quality monitoring in forest ecosystems; 5 Differential

Optical Absorption Spectroscopy (DOAS) systems; and 9 stations for manual sampling and consequent laboratory analysis. In addition, the system has 6 mobile automated stations (MAS) distributed proportionally in the regional laboratories in Sofia, Plovdiv, Pleven, Stara Zagora, Varna and Ruse in order to cover the territory of the whole country and provide additional monitoring (e.g. in areas without any or sufficient number of stations, in cases of emergency or after requests by public and municipal organisations). The MAS operate according to an agreed yearly schedule prepared by the Regional Inspectorates for Environment and Water (RIEWs) and the Executive Environment Agency (ExEA) and approved by MOEW and monitoring points selected within the municipalities where air quality plans are prepared to help track the implementation of these plans[8].

The national monitoring system for air quality controls the concentrations of the following pollutants: particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and nitrogen oxides (NOx), carbon monoxide (CO), ozone (O_3), benzene (C_6H_6), lead (Pb), cadmium (Cd), nickel (Ni), arsenic (As), polycyclic aromatic hydrocarbons (PAHs) as well as other pollutants in specific areas. All AMS and DOAS stations work uninterruptedly and provide real time data to the regional dispatch points and regional databases of the RIEWs and the central dispatch point and national database managed by the ExEA. The stations for manual sampling take samples 4 times a day, 5 days a week with the exception of PM_{10} for which the sampling is every 24 hours[9].

The *monitoring system within the Plovdiv Agglomeration* covers three monitoring stations. In the Plovdiv Municipality there are two AMS that together monitor O_3, NO, NO_2, SO_2, CO, PM_{10}, $PM_{2.5}$, C_6H_6, Cd, C_8H_{10} (xylene), C_7H_8 (toluene) and $C_{20}H_{12}$ (benzo[a]pyrene or BaP)[10]. In the Asenovgrad Municipality there is only one monitoring station for manual sampling, which monitors PM_{10}, Pb and Cd[11].

In addition to the two AMS on its territory, the Plovdiv Municipality has installed one automated meteorological monitoring station that complements the AMS for air quality monitoring. Together all these stations form the 'system for air quality monitoring on the territory of the Plovdiv Municipality' managed together by the Municipality, the local RIEW and the National Institute for Meteorology and Hydrology (NIMH)[12]. The system has been operational since 2004 and provides monitoring, real time dispersion modelling, analysis of the emission sectors contribution, and dispersion modelling of an accidentally released passive substance[13].

2.2.2 Air quality in Bulgaria

Despite *a decrease in emissions of some pollutants* since 1990 (notably sulphur oxides, nitrogen oxides, non-methane volatile organic compounds (NMVOCs) and ammonia), emissions from other pollutants have increased (e.g. $PM_{2.5}$)[14] and the *air quality in Bulgaria remains a concern*. This has resulted in *exceedances of the EU limit values* for some pollutants, although the number of

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[8] Executive Environment Agency, Technical condition of the National automated system for air quality control in the first six months of 2018 website (http://eea.government.bg/bg/nsmos/spravki/2018/air2) and information provided during the stakeholder interview.
[9] Ibid.
[10] Plovdiv Municipality, 2018, Programme for improving air quality on the territory of the Plovdiv Municipality for the period 2018-2023.
[11] Asenovgrad Municipality, 2016, Programme (corrected and expanded) for decreasing the levels of pollution with particulate matter (PM10) and cadmium (Cd) and reaching the established standards in ambient air, with Action plan 2016-2019.
[12] Plovdiv Municipality, Local system for air quality website.
[13] Atanassov, D. et al. 2013, Air Quality Management System of the City of Plovdiv – Annual Analysis for 2013.
[14] Ministry of Environment and Water and Executive Environment Agency, 2018, National report on the state and protection of the environment.

exceedances is generally decreasing. More specifically, the country persistently breached the limit values for PM_{10} and the limit value for SO_2 in one zone, which resulted in infringement procedures by the European Commission. In addition, the limit values for $PM_{2.5}$ were exceeded in four air quality zones although the values became binding only in 2015. At the same time the long-term objectives for O_3 concentrations were not met in several air quality zones[15].

The following table provides a summary of the emissions of air pollutants over the evaluation period (2008-2018) based on the national reports on the state of the environment.

Table 2-1 Emissions of air pollutants in Bulgaria over the evaluation period

Pollutant	2008	2009	2010	2011	2012	2013	2014	2015	2016
PM_{10} (1000 t/y)	59	45	41	45	44	42	46	50	48
$PM_{2.5}$ (1000 t/y)	-	-	-	-	-	-	34	29	32
SO_2 (1000 t/y)	735	657	387	515	329	194	189	142	105
NO_2 (1000 t/y)	194	165	116	138	127	124	134	132	126
CO (1000 t/y)	445	475	321	370	446	346	318	314	271
NMVOC (1000 t/y)	309	332	280	283	279	277	287	282	273
Pb (t/y)	323	291	107	120	117	76	198	81	67
Cd (t/y)	4	3	2	2	2	1	2	1	2
PAH (t/y)	19	88	64	30	32	30	28	27	17

Source: Ministry of Environment and Water and Executive Environment Agency, National reports on the state and protection of the environment 2008-2018.

The *main sources of pollutants* are coal-fired thermal power plants (TPPs) for SO_2 emissions, road transport for NO_2 emissions and domestic heating for PM emissions. Agriculture is the main source of ammonia emissions while natural sources contribute to the largest part of NMVOC emissions[16]. The underlying factors determining the main air pollution source, which is by far domestic heating, are of socio-economic nature and often stem from the energy poverty of numerous households[17]. The following table summarises the shares of each source in the emissions of the main air pollutants for 2016 (although the exact values differ, the same trends are observed over the entire evaluation period).

[15] European Commission, 2017, The EU Environmental Implementation Review, Country Report – Bulgaria, SWD (2017) 35 final.
[16] Ministry of Environment and Water and Executive Environment Agency, 2018, National report on the state and protection of the environment, http://eea.government.bg/bg/soer/2016/soer-bg-2016.pdf.
[17] EUROSAI, 2019, Joint report on air quality, https://english.rekenkamer.nl/publications/reports/2019/01/30/joint-report-air-quality.

Table 2-2 Contribution of the main sources to air pollutant emissions (share of emissions in 2016)

Source	SO_2	NO_2	PM_{10}	$PM_{2.5}$	NMVOC
TPPs	55%	22%	2%	-	-
Road transport	-	34%	7%	8%	4%
Domestic heating	7%	-	56%	82%	8%
Agriculture	-	-	-	-	4%

Source: Ministry of Environment and Water and Executive Environment Agency, 2018, National report on the state and protection of the environment.

A *significant part of the urban population in Bulgaria remains exposed to air pollution above the EU standards*. The table below shows the percentage of urban population exposed to concentrations above EU standards.

Table 2-3 Percentage of urban population in Bulgaria exposed to concentrations above EU standards

P	Measure	2011	2012	2013	2014	2015	2016
P	Annual mean	92.4	92.2	78.1	78.1	25.7	0.0
P	Percentile 90.41	100.0	97.2	90.9	96.7	77.8	86.8
O	Percentile 93.15	2.1	46.3	0.0	0.0	0.0	0.0
N	Annual mean	16.6	1.3	0.5	0.0	0.2	7.1
B	Annual mean	-	36.5	34.2	25.4	34.7	-

Source: European Environment Agency, Bulgaria – air pollution country fact sheet 2017 and 2018.

2.2.3 Compliance with EU ambient air quality standards

In 2016 (the latest year for which national and EEA data is available), *Bulgaria exceeded the limit values for concentrations of PM_{10}, $PM_{2.5}$, BaP and SO_2*. The concentrations of PM_{10} exceeded the annual limit values in 11 stations, while the Average Exposure Indicator (AEI) for $PM_{2.5}$ was above the exposure concentration obligation for Bulgaria ($25\mu g/m^3$). The annual mean concentration of BaP exceeded $1 ng/m^3$ in seven stations, while the hourly and daily limit values for SO_2 were breeched in one station[18].

The latest National Report on the State and Protection of the Environment[19] reports that the overall trend is for the emissions of key pollutants to decrease, namely in the period 1990-2016 the emissions of SO_2, NO_2, NMVOC, and ammonia have decreased. Nevertheless, the emissions of $PM_{2.5}$ and PM_{10} remain problematic. The report summarises the state of air quality in Bulgaria for 2016 as follows:

[18] European Environment Agency, 2018, Air quality in Europe — 2018 report, https://www.eea.europa.eu/publications/air-quality-in-europe-2018.
[19] Ministry of Environment and Water and Executive Environment Agency, 2018, National report on the state and protection of the environment, http://eea.government.bg/bg/soer/2016/soer-bg-2016.pdf.

Non-compliance with the EU standards

- **PM_{10}:** Pollution with PM_{10} continues to be one of the main problems for air quality, it is caused primarily by domestic heating with solid fuels in the winter period (October-March) and road transport. In 2016, exceedances of the average daily limit were observed in all air quality zones. The most exceedances were registered in an AMS in the North air quality zone. Nevertheless, in many cities the average annual concentrations and the number of exceedances of the limit values decreased in the period 2012-2016.
- **$PM_{2.5}$**: Pollution with $PM_{2.5}$ is another problematic area, the main sources of $PM_{2.5}$ emissions are transport, domestic heating and industry. In 2016, the average annual limit was exceeded by only two air quality zones, namely Plovdiv and South-West. However, average exposure of the population (i.e. the AEI) decreased since 2015.
- **BaP**: The target average annual value was exceeded in 10 of the 15 stations monitoring the parameter. Furthermore, the decreasing trend observed over 2012-2015 was not kept and emission increased in 2016.
- **O_3**: In 2016, the short-term target value was exceeded for over 25 days only in three background stations.
- **SO_2**: Even though the overall emissions have decreased and this is not a problematic pollutant at the national level, exceedances persist in the South-East air quality zone. The main sources of SO_2 in this area are the TPPs of the Maritsa-East complex.
- **NO_2**: None of the stations registered exceedances of the average hourly limit and exceedances of the average annual limit were registered only for three AMS.

Compliance with the EU standards

- **Cd**: No exceedances of the target average annual limit achieved that should be achieved in 2013 and maintained further on.
- **Pb**: No exceedances of the average annual limit value in 2016.
- **Ni**: No exceedances of the target average annual limit in 2016.
- **As**: No exceedances of the target average annual limit in 2016.
- **CO**: No exceedances of the target average annual limit in 2016.
- **C_6H_6**: No exceedances of the target average annual limit in 2016.

The report notes that the percentage of the population exposed to pollution with PM_{10} and BaP above the EU standards remains high, while the proportion of the population living with high levels of $PM_{2.5}$ decreased significantly since 2015 and no population is exposed to O_3 emissions above the standards.

Table 2-4 Percentage of the population affected by concentrations of PM_{10}, O_3, NO_2, $PM_{2.5}$, BaP and SO_2 above the EU standards (2016)

Air quality zone	PM_{10}	$PM_{2.5}$	O_3	NO_2	SO_2	BaP
Sofia	100	0	0	0	0	100
Plovdiv	100	100	0	3.6	0	100
Varna	50	0	0	50	0	0
North	87.2	0	0	22.7	0	100
South-West	100	100	0	0	40.7	100
South-East	69.5	0	0	0	0	26.4
Total for the country	87.2	18	0	9.7	2.8	75.1

Source: Ministry of Environment and Water and Executive Environment Agency, 2018, National report on the state and protection of the environment.

Compliance in the Plovdiv Agglomeration

The *problematic pollutants in the Plovdiv Municipality are PM_{10}, $PM_{2.5}$, NO_2 and BaP*. Estimations suggest that the population exposed to concentrations above the limit values in the Plovdiv Municipality were around 15% for $PM_{2.5}$ and all of the population for BaP in 2011[20]. Despite overall reductions in the annual concentrations of these pollutants since 2010, exceedances of the limit values still persist. Data for 2016 shows: 196 exceedances of the average daily limit value for PM_{10} in the two monitoring stations of the municipality; 11 exceedances of the average daily limit for NO_2 in only one of the monitoring stations, which is below the 18 exceedances allowed per year; exceedances of the average annual concentrations of $PM_{2.5}$ and the average annual target value for BaP. The main sources of the emissions are domestic heating with burning of solid fuels and transport, followed by industry and construction. Therefore, higher emissions and more frequent exceedances of the limit values are registered in the cold period of the year (usually October-March). In addition, the unique micro-climate conditions in Plovdiv (in particular the high number of days within a year without wind and/or rain, with temperature inversions and fogs) exacerbate the concentration of pollutants in the air[21].

Nevertheless, concentrations of PM_{10} and NO_2 are problematic in other European cities too. A study[22] of the urban air quality in 10 European cities shows that over the period 2013-2017 the annual average concentrations of PM_{10} exceeded the EU limit in Plovdiv, but this was the case for another city as well (Milan). In the same period, the annual average NO_2 concentrations in Plovdiv decreased and complied with the EU limit values.

[20] Plovdiv Municipality, Programme for reaching the standards of particulate matter smaller than 2.5 microns (PM2.5) and polycyclic aromatic hydrocarbons (PAHs) in the ambient air on the territory of the Plovdiv Municipality with Action plan for the period 2013-2015, http://www.plovdiv.bg/wp-content/uploads/okolna-sreda/Program_AQ_PM2,5&PAH_Pd_2013_2015.Plovdiv.pdf.
[21] Plovdiv Municipality, 2018, Programme for improving air quality on the territory of the Plovdiv Municipality for the period 2018-2023.
[22] European Environment Agency, 2018, Europe's urban air quality — re-assessing implementation challenges in cities, https://www.eea.europa.eu/publications/europes-urban-air-quality.

In the *Asenovgrad Municipality, problematic are the concentrations of PM_{10} and Cd*. In 2014, the population exposed to concentrations of PM_{10} above the limit values was 3,500 people or around 7% of the total population. While the average annual concentration of both pollutants have decreased since 2011, exceedances of the limit values still occur. Data for 2015 shows: 98 exceedances of the average daily limit value for PM_{10} and exceedance of the target annual concentration for Cd. The main sources of emissions are domestic heating with burning of solid fuels, transport and industry. Notably, a significant source of Cd emissions in the area is the production of non-ferrous metals. Similarly to Plovdiv, the exceedances are more predominant in winter, while the climatic conditions exacerbate the situation[23].

Enforcement and infringement cases

In June 2015 the European Commission referred Bulgaria to the European Court of Justice over the c*ontinued breech of PM_{10} emissions limits*, noting '*non-compliance with the annual and/or daily limit values for PM_{10} in all the country's 6 zones and agglomerations other than in Varna, which complied with the annual limit value once – in 2009*'[24]. In 2017, the European Court of Justice issued a judgement against Bulgaria confirming the Commission's view that persistent exceedances necessitate more effective measures[25]. In November 2018, the European Commission expressed concern that the country is showing only limited progress in adopting measures to remedy the situation and urged Bulgaria to fully comply with the Court's ruling. At the same time, the European Commission also sent a letter of formal notice calling Bulgaria to bring the national legislation fully in line with the AAQDs (specifically Directive 2008/50/EC) concerning the provisions to keep periods of exceedance of permitted values as short as possible[26].

2.3 Allocation of responsibility

The responsibility to develop overall policies for air quality and the environment in general is held by the MOEW. The main responsibility for monitoring of ambient air quality lies with the *MOEW, the ExEA and the RIEWs*. The MOEW defines the number and type of monitoring stations, the pollutants, methods and sampling of the national monitoring system for air quality. The day-to-day management of the system is delegated to the RIEWs and the ExEA which collect regional and national real time air quality data respectively[27].

In areas where the emissions of pollutants exceed the limit values, *the mayors and the municipality councils* develop and adopt programmes for reducing the levels of the pollutants and meeting the standards (i.e. air quality plans) in the municipalities affected. These programmes are consulted with the relevant RIEWs and when necessary they can be 'complex programmes' to cover multiple pollutants[28]. In addition, the MOEW has developed instructions on e.g. how the

[23] Asenovgrad Municipality, 2016, Programme (corrected and expanded) for decreasing the levels of pollution with particulate matter (PM10) and cadmium (Cd) and reaching the established standards in ambient air, with Action plan 2016-2019, https://www.assenovgrad.com/userfiles/file/docs3/Pg-A-grad%203.pdf.

[24] European Commission, 2015, Commission refers BELGIUM and BULGARIA to Court and gives Sweden a final warning over poor air quality, press release IP-15-5197, http://europa.eu/rapid/press-release_IP-15-5197_en.htm.

[25] Judgment of the Court of Justice of 5 April 2017 in C-488/15, Commission v Bulgaria, http://curia.europa.eu/juris/liste.jsf?num=C-488/15.

[26] European Commission, 2018, November infringements package: key decisions, European Commission – Fact Sheet, 8 November 2018, http://europa.eu/rapid/press-release_MEMO-18-6247_en.htm.

[27] Executive Environment Agency, Monitoring of air, noise and radiology website, http://eea.government.bg/bg/nsmos/air.

[28] Plovdiv Municipality, 2018, Programme for improving air quality on the territory of the Plovdiv Municipality for the period 2018-2023.

municipal air quality plans should be prepared and how the public should be informed when the alarm thresholds are breeched together with more methodological guidelines on e.g. how the air quality plans should be developed and how local SO_2, PM_{10}, Pb and NO_2 emissions could be assessed and managed[29].

According to the instructions for development of air quality plans, municipalities establish 'Programme Councils' consisting of representatives from the RIEWs, Ministry of Interior, Health Inspectorates, civil protection and other relevant institutions. The councils coordinate the preparation of the air quality plans, their adoption, implementation and monitoring. Interested parties can share their concerns or suggestions with the Programme Councils during the preparation process or comment on the draft air quality plans when those are shared on the municipal websites[30].

2.4 Legal and policy framework and air quality measures

Legal framework

Directive 2008/50/EC was transposed in the national legislation through the '*Ordinance N12 of 15 July 2010 concerning norms for sulphur dioxide, nitrogen dioxide, particulate matter, lead, benzene, carbon monoxide and ozone in ambient air'* (hereafter *'Ordinance 12'*)[31] in force from 31 July 2010 and later amended in June 2017. Directive 2004/107/EC was transposed with '*Ordinance N11 of 14.05.2007 concerning norms for arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons in ambient air'* (hereafter *'Ordinance 11'*) in force from 27 May 2007 and later amended in March 2017. In addition, '*Ordinance N7 concerning assessment and management of air quality'* defines the conditions and processes for air quality assessment and management, while the overall priorities, principles and responsibilities for air quality are defined in the *Air Quality Act*[32]. The Air Quality Act was amended in January 2019 to clarify the transposition of the provisions to keep periods of exceedance of permitted values as short as possible and to respond to the Commission's letter of formal notice from November 2018.

Strategic framework

Bulgaria did not have a dedicated air quality strategy in the evaluation period (2008-2018). The most recent strategic document defining priorities and targets for air quality in that period is the 2007 '*National Programme for reducing the overall annual emissions of sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia in ambient air*'[33]. This strategy defined 2010 targets for meeting the objectives of the now repealed National Emission Ceilings (NEC) Directive

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[29] Instructions and guidance documents are available on the website of the MOEW, 'Air quality – normative acts' webpage, https://www.moew.government.bg/bg/vuzduh/kachestvo-na-atmosferniya-vuzduh/normativni-aktove/.

[30] Instruction for developing programs to reduce emissions and achieve the established limits of harmful substances in the areas for air quality assessment and management where there is exceedance of the established limits, established with Order 996/20.12.2001 and available on the MOEW website, https://www.moew.government.bg/bg/vuzduh/kachestvo-na-atmosferniya-vuzduh/normativni-aktove/.

[31] Weblinks to the national legislation mentioned can be found in Appendix A.

[32] Executive Environment Agency, Legislation concerning ambient air quality website, http://eea.government.bg/bg/legislation/air.

[33] Ministry of Environment and Water, 2007, National Programme for reducing the overall annual emissions of sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia in ambient air, https://www.moew.government.bg/static/media/ups/tiny/filebase/Air/Strategicheski_dikumenti/National_Programm_decr_annual_em_SO2_NOx_NH3_VOC.pdf.

2001/81/EC and defined measures to adopt relevant legislation, control the technical functionality of the vehicle fleet and develop strategies on renewable energy and energy efficiency.

Nevertheless, *a national air quality programme was developed in 2018* by experts from the World Bank and its draft was shared for a one-month public consultation in November 2018[34]. The MOEW clarified that the programme is nearly finished and its adoption is expected in the near future[35]. The programme's horizon is 2024 and its focus is on the sectors that contribute the most to the high emissions of the most problematic air pollutants – domestic heating and transport. As the responsibilities to implement specific measures lie with the municipalities where air quality problems are identified, the national programme does not change the obligations and responsibilities of the municipalities but aims to support them. It identifies sectors where the municipalities cannot act and where solutions at the national level are required e.g. for minimum requirements of the quality of the fuels sold on the market or more stringent requirements for the technical checks of vehicles. While the development of a national programme is considered a step in the right direction, some stakeholders have questioned its focus on only the municipalities that currently do not meet the AAQD standards (see section 2.1) instead of the whole country[36] and the lack of consideration of measures related to other sectors in which local authorities lack competences to act such as regulation of industrial installations[37].

Air quality measures: air quality plans and action plans

Since 2011, *the Plovdiv Municipality has developed and implemented two separate air quality plans or 'programmes'* with integrated action plans to target specific pollutants: a programme to reduce the levels of PM_{10} and NO_2 (2011-2013)[38] and a programme to reduce the levels of $PM_{2.5}$ and BaP (2013-2015)[39]. Overall, the air quality plans contributed to meeting the objectives for some pollutants, while improving the performance concerning others. For instance, the first air quality plan resulted in fulfilment of the objectives concerning SO_2 and Cd emissions through measures targeting the industry and these emissions have not been problematic since. However, the emissions of other pollutants, such as PM_{10}, $PM_{2.5}$, BaP and NO_2, remain a concern despite the various measures the Municipality planned and implemented over the years.

The measures included targeting emissions of the domestic heating sector (e.g. information campaigns, facilitation of gasification of the households, social schemes for purchasing better quality fuels), the transport sector (e.g. renewal of the vehicle fleet of the public transport, development of the trolley bus system, improvement of the road infrastructure) and industry. Overall, all *measures contributed to decreasing or at least limiting these emissions but were not sufficient* to

[34] Council of Ministers, Portal for Public Consultations, Draft National Programme for Improving the Air Quality (2018-2024) website, http://www.strategy.bg/PublicConsultations/View.aspx?lang=bg-BG&Id=3846.

[35] At the time of the interview, MOEW explained that a stakeholder workshop will be held in the last week of September 2018 to present the draft programme. Then it will be reviewed by the Council of Ministers and depending on the feedback of other ministries it will be adopted.

[36] Feedback provided by the EAP.

[37] Za Zemiata and Greenpeace Bulgaria, 2018, Position concerning the Draft National Programme for Improving the Air Quality (2018-2024), http://archive.zazemiata.org/v1/fileadmin/content/energy/docs/stanovishte-NPKAV-ZaZemiata-GreenpeaceBG.pdf.

[38] Plovdiv Municipality, 2011, Update of the programme for improving air quality on the territory of the Plovdiv Municipality 2003-2010 and preparation of Action plan for the period 2011-2013, http://www.plovdiv.bg/wp-content/uploads/okolna-sreda/normativni-dokumenti/Plovdiv_Programa_KAV_2011-2013_Plan%20za%20deistvie.pdf.

[39] Plovdiv Municipality, Programme for reaching the standards of particulate matter smaller than 2.5 micrones (PM2.5) and polycyclical aromatic hydrocarbons (PAHs) in the ambient air on the territory of the Plovdiv Municipality with Action plan for the period 2013-2015, http://www.plovdiv.bg/wp-content/uploads/okolna-sreda/Program_AQ_PM2,5&PAH_Pd_2013_2015.Plovdiv.pdf.

make the municipality permanently fulfil its objectives and meet the required limit values[40]. Therefore, in July 2018, the Municipality published an updated air quality plan or 'programme' that covers all four pollutants for which exceedances of the limit values persist – PM_{10}, $PM_{2.5}$, BaP and NO_2 and outlined further measures to address these exceedances (often by prolonging the implementation of measures undertaken in the previous plans)[41].

The measures that have been implemented in the period 2013-2017 and are planned for continued implementation include measures in two key areas[42]:

- Domestic heating:
  - Ban on marketing, sale and distribution of bituminous coal for household heating/cooking;
  - Fuel conversion in domestic heating;
  - Promoting substitution of old, dirty stoves and boilers with clean models;
  - Energy-efficient buildings with insulation;
  - Use of renewable energy sources.
- Road transport:
  - Low-emission zone;
  - Promoting cycling;
  - Managing traffic flow by reduced speed limits and congestion charges.

The notable successes and air quality good practices implemented in Plovdiv include modernisation of the bus fleet of the public transport, installation of air filters on chimneys and extension of the cycling lanes[43].

The *Asenovgrad Municiaplity has published only one air quality plan* with an integrated action plan to target PM_{10} and Cd emissions in the period 2016-2019[44].

2.5 Information to the public

According to Art. 20 of the Air Quality Act[45], the air quality is monitored with the national system for monitoring and control of the environment of the MOEW, local authorities can install additional monitoring stations if they wish to do so. The information from the national and any local monitoring systems is public property and is published in the official bulletins of MOEW or its related institutions free of charge (Art. 23). Consequently, the ExEA publishes *a daily bulletin*[46] on the air quality in the country on its website. The bulletin shows only the registered exceedances of the limit values of given pollutants (namely SO_2, NO_2, PM_{10}, CO and O_3) and the stations where they

[40] Based on the information provided in the air quality plans (see the previous two footnotes).
[41] Plovdiv Municipality, 2018, Programme for improving air quality on the territory of the Plovdiv Municipality for the period 2018-2023.
[42] European Environment Agency, 2018, Europe's urban air quality — re-assessing implementation challenges in cities, https://www.eea.europa.eu/publications/europes-urban-air-quality.
[43] EUROSAI, 2019, Joint report on air quality, https://english.rekenkamer.nl/publications/reports/2019/01/30/joint-report-air-quality.
[44] Asenovgrad Municipality, 2016, Programme (corrected and expanded) for decreasing the levels of pollution with particulate matter (PM10) and cadmium (Cd) and reaching the established standards in ambient air, with Action plan 2016-2019, https://www.assenovgrad.com/userfiles/file/docs3/Pg-A-grad%203.pdf.
[45] Air Quality Act, latest amendment from 03.02.2017, available for download from the MOEW website, https://www.moew.government.bg/bg/vuzduh/zakonodatelstvo/zakoni/.
[46] Executive Environment Agency, Daily Bulletin on air quality in the country website, http://eea.government.bg/airq/bulletin.jsp.

occurred based on real time data. The information is published for the preceding day and information about other days can be found through a menu searching the archive. In addition, the ExEA publishes *quarterly bulletins*[47] on the air quality in the country based on real time data that has been verified. These quarterly bulletins contain information about SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3, CO and C_6H_6 levels. Summary results, trend assessments for all pollutants and analyses of air quality are published in the *annual National Reports on the State and Protection of the Environment*.

Furthermore, MOEW has defined *alert thresholds* for the concentrations of SO_2, NO_2 and O_3 for which the public should be informed. If these levels are exceeded[48], the RIEWs inform local authorities, the media and stakeholders about the time and duration of the exceedance, the prognosis concerning the expected change of the pollution levels, underlying causes, the areas affected, the sensitive population groups and preventive measures that should be taken[49]. The ExEA also manages a common SMS alarm system that connects the ExEA, MOEW, RIEWs and the municipalities and automatically informs them of any exceedance of the alert thresholds[50].

In addition to the information provided by the ExEA, *some municipalities have installed information boards* that provide real time data about some parameters using the data from the AMS system. The Plovdiv Municipality has an information board installed in front of the municipality building that provides daily information about the air and meteorological conditions in the city[51]. Moreover, the website of the Municipality publishes user-friendly information about the levels of NO_2, SO_2, PM_{10}, benzene and O_3 for each of the two AMS in its territory based on the real time data received. The levels of each pollutant are denoted with a simple traffic-light system that distinguishes between good, acceptable, bad and very bad levels, indicates which parts of the population might be sensitive and provides simple tips for action[52]. In addition, non-interactive graphics in image format show the hourly concentrations of the main pollutants over a 24-hour period[53]. Nevertheless, the website cautions that the information is based only on preliminary hourly values that are also subject to verification by the ExEA in its quarterly bulletins.

2.6 Use of EU funding for air quality improvements

Bulgaria did not specifically target air quality with its OP Environment implementing the EU Cohesion Policy Funds in the period 2007-2013 but measures related to e.g. transport were supported with other OPs. Nevertheless, in OP Environment for the period 2014-2020[54], air quality is a designated priority axis with the *specific objective of 'Reducing ambient air pollution by lowering the quantities of PM_{10} and NOx' and a budget of EUR 50 million*. More specifically, the OP will

[47] Executive Environment Agency, Quarterly Bulletin on the state of the environment website, http://eea.government.bg/bg/dokladi/threemonth/threemonth.02_2018/index.
[48] The alert thresholds are: 500 µg/m³ (SO_2), 400 µg/m³ (NO_2) and 240 µg/m³ (O_3, average hourly value) measured in three consecutive hours at monitoring stations that are representative of the air quality in a region or agglomeration.
[49] Regional Inspectorate for Environment and Water – Plovdiv, Informing the public in case of exceedance of the alert thresholds website, http://plovdiv.riosv.com/main.php?module=info&object=info&action=view&inf_id=31.
[50] Interview with ExEA.
[51] Plovdiv Municipality, Local system for air quality website.
[52] Plovdiv Municipality, Monitoring of the Environment, Air Quality website, http://ecomonitoring.plovdiv.bg/plovdiv/air_quality.jsp.
[53] Plovdiv Municipality, Monitoring of the Environment, Real Time Parameters website, http://ecomonitoring.plovdiv.bg/plovdiv/air_params.jsp.
[54] Operational Programme Environment 2014 – 2020, CCI: 2014BG16M1OP002, http://ope.moew.government.bg/files/useruploads/files/ope_2014-2020_amendment_en_july2017.pdf.

target pollution from domestic heating and transport and foresees the support of three types of measures:

- Air quality plans: review and analysis of the municipal plans on ambient air quality and support for their preparation/revision, implementation and control;
- Measures addressing pollution from domestic heating: replacement of domestic combustion installations/boilers on solid fuel, installation of PM filters on individual domestic combustion installations, alternative heating;
- Measures addressing pollution from public transport: reducing the use of conventional fuel in public transport, replacement of the public transport vehicles exhaust systems (retrofitting) and supplementary measures.

3 FINDINGS

Chapter 3 presents detailed findings regarding the experience and lessons learnt in the implementation of the AAQDs in Bulgaria and the Plovdiv Agglomeration in particular. Specifically, the chapter focuses on the challenges and successes encountered in the implementation of the Directives. Additionally, the relevance of the AAQDs, and their air quality standards, has been explored. Finally, the chapter identifies the factors underlying compliance with and effectiveness of the AAQDs and provides an overview of the costs and benefits associated with the implementation of the Directives.

The findings presented in this chapter rely primarily on input provided by stakeholders interviewed in the context of the case study. These were supplemented as relevant by additional desk research. An overview of the interviews carried out is provided in Appendix B.

3.1 Relevance of the AAQ Directives

The desk research carried out for this case study found that air quality remains an issue in Bulgaria primarily due to exceedances of the EU standards for PM_{10} and $PM_{2.5}$. The country struggles also with the BaP, NO_2 and SO_2 concentrations but to a lesser extent as these emissions are exceeded only in some air quality zones. These findings were confirmed by all stakeholders interviewed who stressed that PM pollution remains problematic in the whole country and even more so in the big cities.

The findings of the 2017 Special Eurobarometer study[55] show that air quality is a concern for Bulgarian citizens. 59% of the respondents thought that air quality in Bulgaria deteriorated over the last 10 years, 27% thought it stayed the same and only 5% considered that it improved. The proportion of the respondents that considered the air quality in Bulgaria improved over the last 10 years is one of the smallest in the EU.

While the objective of controlling pollutant emissions promoted by the AAQDs is highly relevant for Bulgaria, the relevance of the particular standards has been questioned. The MOEW is concerned that the standards set at the EU level do not take into account either the specific climate and meteorological conditions of each country, nor its economic or social situation. This results in imposing standards that are difficult to attain in some areas due to specific local meteorological conditions or economic and social constraints that make some measures unfeasible or ineffective. In the Plovdiv Agglomeration in particular, the impact of the local meteorological and geomorphological conditions in retaining air pollution has been pointed out as a particular challenge in the municipal air quality plans. A 2013 analysis of the city's air quality monitoring and management system found that the '*potential of the atmosphere to disperse the discharged pollutants in the region of Plovdiv turns to be too low. Prevailing part of AQ standard violations for PM_{10} happened in condition of calm weather […] and in stable stratification […]*'[56].

[55] European Commission, 2017, Special Eurobarometer 468, Summary, Attitudes of European citizens towards the environment, http://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/Survey/getSurveyDetail/instruments/SPECIAL/surveyKy/2156.

[56] Atanassov, D. et al. 2013, Air Quality Management System of the City of Plovdiv – Annual Analysis for 2013, https://www.researchgate.net/publication/280484828

3.2 Implementation successes

The implementation and integration successes can be summarised as:

- Successful coordination with some sectoral policies;
- Continued support from the European Structural and Investment Finds (ESIF) over two programming periods;
- Development and completion of the air quality monitoring system.

3.2.1 Successful coordination between air quality objectives and some sectoral policies

Air quality objectives have been successfully coordinated with some sectoral policies. In the environmental field, the targeted actions taken to improve *waste management*, including development of anaerobic digestion plants and better management of landfills (including through projects financed with OP Environment in the period 2007-2013) have contributed to a reduction of the greenhouse gas (GHG) emissions and thus to improvement of the air quality[57].

Actions have been coordinated also with the Ministry of Labour and Social Policy, particularly in relation to the *social help provided for purchase of heating fuel* and the broader issue of energy poverty and its links to air quality. In the past, the social ministry challenged proposals for limiting the provision of social help to exclude the purchasing of fuel. This was justified by the fact that the share of population receiving such social help is small and consequently the effect of a measure limiting the purchasing of fuel with social help will be small, while exacerbating the energy poverty of the most vulnerable. Under a new approach the quality of the solid fuels sold on the market will be controlled at the national level ensuring that the social help can be spent on higher quality fuels. This measure, which entered into force in January 2019, is considered as more suitable and has the support of the social ministry[58].

In the *transport sector*, the Ministry of Transport is expected to strengthen the mandatory annual technical checks for vehicles and introduce stickers for different emission levels in order to help distinguish the vehicles and facilitate the implementation of low emission zones in the municipalities. In addition, some changes to the tax policy are also planned. The calculation of the vehicle tax will be based on two components – the value of the vehicle and an environmental component based on the vehicle's emission certificate. It is expected that the environmental component will lead to gradual decommissioning of the oldest vehicles[59.]

3.2.2 Continued support from the European Structural and Investment Funds

The main EU source of financing for air quality is the *European Structural and Investment Funds (ESIF)*. Even though air quality was not directly targeted in the 2007-2013 programming period, various of the measures funded indirectly contributed to improving air quality e.g. waste management investments, public transport investments (notably for the expansion of the metro system in Sofia) and investments for improving the road infrastructure[60]. As discussed in section 2.6, in the current programming period OP Environment has a dedicated priority axis on air quality that will support a variety of actions.

To date the focus of the calls launched under *OP Environment 2014-2020* has been on the update of the municipal air quality plans: one part of the municipalities that need to prepare such plans

[57] Interview with EAP.
[58] Interview with MOEW.
[59] Ibid.
[60] Interviews with MOEW and EAP.

could apply for funding until January 2017, while the remaining part have time to prepare them until January 2019. In addition, several other cross-cutting measures such as capacity building and monitoring system improvements have been supported. Specific measures for air quality improvement have not been financed by September 2018 although the 2018 indicative work programme of the OP includes the procedure 'Measures for improvement of the ambient air quality'[61] suggesting that such measures might be supported in the future. By September 2018, OP Environment has financed the following air quality measures[62]:

- Creating an information system for reporting of air quality data as part of the National System for monitoring air quality in real time with beneficiary the ExEA;
- Development or update of municipal air quality plans for 11 municipalities, including Asenovgrad and Plovdiv;
- Preparation of a plan for assessing OP "Environment 2014-2020" and activities under Ex-ante conditionalities No 7 and under Priority Axis 5 "Improving air quality" and Technical assistance for the implementation of measures to improve air quality (both operations under the priority axis on technical assistance with beneficiary the MOEW).

3.2.3 Development of the air quality monitoring system

Bulgaria has fulfilled its obligations concerning the number of monitoring stations and the parameters monitored. The *national monitoring system for air quality has been developed further and since 2017 transmits real time data to the EEA*. It is also used to provide information to the public concerning any exceedances of the limit values or the alert thresholds. Although the maintenance can be challenging due to the limited administrative capacity of the ExEA as mentioned in the previous section, the development of the monitoring system continues and further improvements are foreseen. For instance, with a recently launched public tender (with funds from the MOEW) the agency plans to develop the software so that real time data about main air pollutants can be published on its website allowing the public to track air quality in real time. The tender is expected to start soon and to be completed in six months in the beginning of 2019[63].

However, one of the stakeholders stressed that the number of $PM_{2.5}$ monitoring stations, which is in line with the requirements of the AAQDs, is very low and insufficient in some areas requiring stronger and clearer provisions concerning the minimum number of monitoring devices in a given territory to ensure a denser and more complete monitoring[64]. Another stakeholder pointed out that having monitoring stations also in smaller towns or villages can help provide a clearer picture of the air quality status in the whole country[65]. Nevertheless, MOEW pointed out that any revisions to the requirements for the number of monitoring stations, including at the EU level, need to be backed by relevant assessments of the costs and benefits associated. Nonetheless, all stakeholders interviewed were unanimous that monitoring is the most objective and reliable source about air quality and the development of the national monitoring system is a considerable accomplishment and a major improvement since the introduction of the AAQDs.

[61] Operational Programme Environment 2014-2020, Indicative Annual Work Programme for 2018, http://ope.moew.government.bg/files/useruploads/files/igrp_ope_2018-en_mc-17.05.2018.pdf.
[62] Operational Programme Environment 2014-2020, List Of Operations for Priority Axis 5 Improvement Of Ambient Air Quality and Priority Axis 6 Technical Assistance.
[63] Interview with ExEA.
[64] Interview with Za Zemiata.
[65] Feedback provided by EAP.

3.3 Implementation challenges

The key implementation challenges can be summarised as follows:

- Insufficient administrative capacity and financial resources at different levels of governance;
- Insufficient coordination with some sectoral policies, most notably the climate and energy policies;
- Local conditions;
- Data limitations and insufficient methodological guidance for the preparation of the air quality plans;
- Uncertainties in the AAQDs.

3.3.1 Insufficient administrative capacity and financial resources

A significant implementation challenge is the insufficient administrative capacity at the different levels of governance. This is most prominent at the municipal level as all stakeholders agree most *municipalities do not have sufficient in-house capacity for air quality management*. Most often the municipal air quality plans and action plans are prepared by external consultants but their implementation and assessment must be followed up by the municipalities. Often the municipal administrations do not have sufficient internal capacity to do this due to human resource, financial or even expertise constraints (e.g. smaller municipalities might have only one environmental expert and they might not necessarily be specialised in air quality). Strengthening the in-house capacities of municipalities to deal with air quality policies is necessary[66].

The insufficient administrative capacity of municipalities also *limits the use of some EU or EIB financial instruments* with complex application rules and procedures or co-financing requirements. The use of EU funds such as Interreg, LIFE+ and the Urban Innovation Action tend to help only larger municipalities that have or can afford the necessary capacity for obtaining and managing the financing[67]. Moreover, a recent audit of air quality policy in Bulgaria concluded that municipalities do not actively seek and benefit from additional opportunities for funding air quality projects apart from the municipal budgets[68].

Although to a lesser extent, *insufficient administrative capacity is an issue also for the ExEA* that is responsible for air quality monitoring. The service and maintenance of the AMS and of the system for real time data transmission are outsourced as the agency has problems to attract and retain internal experts with relevant knowledge, mainly due to financial constraints. Consequently, these services are procured through public tenders, which according to the legislation are launched every year with budget provided by MOEW. However, this creates risks of delays (e.g. due to delayed provision of the funds, slow tendering procedures) that can be critical and result in delays or even gaps in the air quality monitoring[69].

Another *significant constraint at all levels of governance is the lack of sufficient financial resources* for the different aspects of air quality management. At the national level a considerable cost is the national monitoring system, which is expensive, and the financing is limited (see section 3.5.1 for details). At the local level, municipalities struggle with the financing of the measures for air quality improvement. Significant resources from the EU funds are earmarked for supporting air

[66] Interviews with EAP, Za Zemiata and NAMRB.
[67] Interviews with MOEW and Za Zemiata.
[68] EUROSAI, 2019, Joint report on air quality.
[69] Interview with ExEA.

quality in the current programming period in order to remedy this (for details see section 3.2.2), even if these resources cannot cover all financial needs[70].

3.3.2 Insufficient coordination with climate and energy policies and some environmental policies

The coordination, including integration or mainstreaming of air quality objectives in some sectoral policies, is insufficient. Some stakeholders pointed out that neither at the national level (e.g. in strategic documents) nor at the municipal level (e.g. in the air quality plans) is there consistent coordination between the air quality objectives and *climate and energy strategies* for reducing GHG emissions and improving energy efficiency. Coordination particularly with energy efficiency policies is crucial as more efficient homes can reduce the energy consumption of households and contribute to decreasing the emissions from solid fuels burnt for heating. Furthermore, some opportunities to develop biomass and biogas in the context of the 2020 renewable energy target have been missed as no clear links are established between the climate action policies and air quality objectives[71].

According to one of the stakeholders interviewed, the newest approved *Best Available Techniques (BAT) Reference Documents (BREFs)* e.g. concerning combustion (LCP BAT 2017) and burning of waste, are not necessarily applied. Instead, industrial emitters such as coal-fired power plants apply for derogations (for some pollutants) and renewal of their integrated permits without any references or commitments to apply the newest BREFs[72]. Nevertheless, MOEW stressed that possible trade-offs and risks from the introduction of the latest BREFs exist and should be carefully considered – if these requirements are costly to the operators, there is a risk that the costs are transferred to consumers through higher electricity prices creating a further risk of fuel switch away from power and towards cheaper solid fuels for heating[73].

Links between air quality objectives and the *IED and the NEC Directive* are also missing. More specifically, the delay in the transposition of the NEC Directive lead to uncertainties concerning the updated air quality plans (especially for $PM_{2.5}$ emissions) and its long-term requirements were not taken into account in the national air quality programme that was developed recently (see section 2.4) resulting in missed opportunities for policy coordination[74].

3.3.3 Local conditions

Specific local characteristics also pose challenges to the implementation of the AAQDs. An important factor is the *social aspect* attached to one of the main sources of PM emissions, namely domestic heating. A large part of the population in the country lives below the poverty line and relies on domestic heating with solid fuels, including social schemes that help households purchase coal or firewood each season[75]. Until recently the quality of those fuels was not regulated (see section 3.2.1).

In addition, the *meteorological particularities and geographical features* in some areas such as Plovdiv exacerbate the non-compliance with the air quality standards and pose a challenge to the implementation of the AAQDs. Therefore, to comply with the standards, some municipalities need

[70] Interviews with MOEW and NAMRB.
[71] Interview with EAP.
[72] Interview with Za Zemiata.
[73] Feedback provided by MOEW.
[74] Interview with Za Zemiata.
[75] Interview with MOEW.

to adopt more ambitious targets and take more stringent measures, which is not always technically, financially[76] and/or politically[77] feasible.

At the moment the potential of local conditions to affect the implementation and compliance with the standards is not sufficiently reflected in the AAQDs[78].

3.3.4 Data limitations and insufficient methodological guidance

Another challenge for the preparation of the air quality plans, which according to some of the interviewees hinders implementation, is the *limited availability of easily accessible, free-of-charge data in a suitable format* for emissions and dispersion modelling and development of projections. More specifically, some of the necessary data is either paid (e.g. some meteorological and climate datasets provided by NIMH), or incomplete and covering a short period of time. Comprehensive datasets are usually available only for purchase, which represents a significant expense for most municipalities and when their financial resources are limited, some municipalities do not invest in comprehensive data inputs for their air quality plans. In addition, other organisations such as independent research organisations or NGOs cannot prepare independent studies either as the costs for obtaining data are too high or because the information from the national monitoring system is not available in an easy-to-use format. In particular, some stakeholders pointed out that the data provided through the national monitoring system of the ExEA (and some municipalities like Plovdiv) is not readily available in a machine-readable format, while in some cases authorities refuse to provide hourly PM data, which resulted in several court proceedings[79].

Even though the national legislation defines the air quality data and its format that should be available for all stakeholders and the research carried out in this case study indicates data is publicly available (see section 2.5), one of the stakeholders interviewed suggested that the AAQDs could be more specific about the minimum types of data necessary for air quality management that should be freely available in appropriate machine-readable format in order to strengthen the implementation of the Directives and facilitate the development of independent air quality analyses[80].

Furthermore, one of the stakeholders pointed out that municipalities can also benefit from *more methodological guidance* concerning the assessment of air quality that informs their air quality plans. In particular, days with exceedances should consider both the ambient air temperature and the wind speed as exceedances are lower in months with warm days. Therefore, when considering trends and the effectiveness of local measures, there is a need to assess the impact of high/low winter temperatures and compare similar months or winters. In addition, there is a need for guidance on how to model different land sources in dispersion modelling and which are the most suitable tools to use. There is currently no clear or consistent approach to modelling the dispersion of emissions from land sources and municipalities take different approaches[81]. As stated in section 2.3, several methodological guidance is already available on the MOEW website.

Despite continued progress with developing emission inventories and modelling for air quality management, better tools are needed especially for forecasting peak concentrations (e.g. for NO_2

[76] Feedback provided by MOEW.
[77] Feedback provided by Za Zemiata.
[78] Interview with MOEW.
[79] Interviews with EAP and Za Zemiata.
[80] Interview with Za Zemiata.
[81] Feedback provided by EAP.

in cities). This is a common challenge among multiple European cities[82]. Furthermore, the lack of sufficient data can limit the monitoring of progress towards the air quality objectives. An audit of the air quality policy in Bulgaria found that there are gaps in the planning and reporting of the implementation of air quality measures. Evaluation of progress towards objectives tends to consider only summarised results and does not take into account the contribution of individual measures separately[83].

3.3.5 Uncertainties in the AAQDs

According to some of the stakeholders interviewed, the AAQDs are not specific enough on a number of important issues, which could result in different interpretations and implementation in the Member States[84]. These statements are reflected in the following.

One such aspect is *public participation*. The involvement of different stakeholders in the air quality management process in Bulgaria can be improved. Some of the interviewees found the opportunities, given to stakeholders to consult and provide feedback on the draft national air quality programme that was recently developed, were insufficient and lacked public debates[85]. However, the preparation of the national programme is not a requirement of the AAQDs and its draft was subject to a public consultation like other similar documents (see section 2.4).

Some interviewees also considered that the opportunities provided by the law to stakeholders to provide feedback on the draft municipal air quality plans (currently through 'programme councils' at the municipal level) are insufficient and can be improved further. This is partly due to the fact that public participation in the preparation of those plans is regulated by an old Ordinance from 1999 that does not reflect the needs of the more current legislation. According to this Ordinance the public and any relevant stakeholders only need to be informed, there are no provisions about their involvement in the decision-making process. However, the AAQDs are not very specific about public participation in the decision-making process either, which in turn hinders the improvement of the provisions for stakeholder involvement at the Member State level[86].

Another important aspect where the AAQDs are unclear is *access to justice*. In Bulgaria, the municipal air quality plans cannot be challenged in court at the moment. While a possible remedy could be class actions in civil courts, administrative courts are of the opinion that these plans are internal administrative documents and thus cannot be challenged as judged in several recent cases[87]. Nonetheless, the AAQDs are not sufficiently clear about the access to justice requirements either, which leads Member State courts to refrain from action according to stakeholders[88].

In addition, the AAQDs are not specific enough about the *mechanisms that can be used for achieving the air quality standards*. For instance, one stakeholder stressed that sanctions should be defined for all stages of the AAQDs implementation in order to facilitate and clarify the use of

[82] European Environment Agency, 2018, Europe's urban air quality — re-assessing implementation challenges in cities, link.
[83] EUROSAI, 2019, Joint report on air quality, link.
[84] Interviews with EAP and Za Zemiata.
[85] Feedback provided by EAP.
[86] Interviews with EAP and Za Zemiata.
[87] Administrative Court Sofia city ruling 6541/25.09.2017 court case 7190/2017; Supreme administrative court ruling 13138/01.11.2017 court case 12064/2017; Supreme administrative court ruling 890/23.01.2018 court case 14145/2017; Plovdiv Administrative Court rulings 1972/05.10.2018 court case 3006/2018 and 1996/10.10.2018 court case 3070/2018; Supreme Administrative Court judgement 16049/20.12.2018 court case 14184/2018.
[88] Interview with Za Zemiata.

sanctions at the national or local level[89]. Ambiguities and uncertainties also stem from the definition of Art. 23 of Directive 2008/50/EC as it is not clear what is meant by 'as short as possible'. According to one of the interviewed stakeholders, this resulted in non-consideration of the urgency aspect in the air quality plans of the municipalities in Bulgaria until recently when an amendment to the Air Quality Act was made to remedy this and address the 2017 judgement of the European Court of Justice (see section 2.2.3 concerning the legal action against Bulgaria and section 2.4 for the amendments). However, as this amendment was adopted only recently, and its effects are unknown yet, the plans adopted so far do not include measures that can lead to results and compliance in a short period of time and the authorities tend not to consider the urgency of addressing any exceedances[90].

Another gap according to one of the stakeholders is the lack of an average daily limit value for $PM_{2.5}$ concentrations[91], however other stakeholders did not mention this, while MOEW pointed out that there is a need to ensure compliance with current standards everywhere in the EU before more ambitious targets are set.

3.4 Factors underlying compliance and effectiveness of the AAQ Directives

The following section provides an overview of the factors underlying and hindering compliance with and effectiveness of the AAQDs in Bulgaria and the Plovdiv Agglomeration. Unless specified otherwise, the factors apply to the entire Bulgarian territory, including the Plovdiv Agglomeration.

3.4.1 Factors hindering compliance and effectiveness

Mismatch of the responsibilities and competences at different governance levels

While policies in most sectors, including the environment, are set at the national level, the implementation of specific air quality measures to address certain pollutants is a responsibility of the municipalities in which exceedances are observed. This has proven problematic for addressing emissions from certain sectors such as domestic heating from households and transport. In these sectors, the municipalities either do not have sufficient competences to intervene or their actions are ineffective without measures at the national level.

The main source of PM emissions is the *domestic heating sector*. However, without policies or measures at the national level to control the quality of the solid fuels or heating appliances, the measures municipalities take are ineffective as households can still procure low-quality fuels or burners. Therefore, the stakeholders stressed the need for establishing minimum quality standards/requirements for the firewood and solid fuels sold on the market as well as eco-design standards for the heating equipment at the national level. This will enable municipalities to take more stringent measures or impose sanctions at the local level, if necessary[92]. MOEW clarified that requirements for the quality of the solid fuels sold on the market have been prepared and entered into force in 2019. Moreover, according to news coverage about the draft national air quality programme introduction of eco-design requirements for the heating appliances is recommended by 2020 together with complementary measures at the municipal level to provide alternative

[89] Ibid.
[90] Ibid.
[91] Ibid.
[92] Interviews with EAP, Za Zemiata, NAMRB and MOEW.

heating (e.g. gasification, city heating networks) or replacement of the old burners with more efficient alternatives[93].

Although NO_2 concentrations are not a problem at the national level, they remain high in big cities and primarily result from the *transport sector*. While municipalities can establish low emissions zones on their territories, they cannot control the quality of the private vehicles in circulation. A particular problem in Bulgaria is the circulation of old diesel vehicles, sometimes even without diesel catalysts or filters, which often come from other European countries where more stringent emission requirements made these vehicles become non-compliant on the local markets. Therefore, more stringent control at the national level is needed to control what vehicles are imported and to ensure no vehicles circulate without filters. MOEW clarified that the Ministry of Transport is working on measures for improving the technical checks and updating the tax policies to facilitate the decommissioning of the most polluting vehicles. At the same time, introduction of stickers denoting the emission category of each vehicle is expected to help municipalities implement low emission zones on their territories[94]. Furthermore, one stakeholder suggested that EU-level or national guidelines on what constitutes a 'low emission zone' might be useful for improving the implementation of such measures[95].

Addressing emissions from the public transport is within the competences of the municipalities as they often own the lines and the fleet. In the case of Plovdiv, the lines of the public transport are tendered through a concession to privately owned operators and the city does not directly own or manage the bus fleet. Therefore, the city can control the quality of the vehicles and their emissions only through the tendering requirements[96].

Emissions from industrial sources are limited and the most significant problem is the SO_2 emissions from several TPPs in one municipality of the South-East air quality zone. Nevertheless, this is another area in which municipalities have limited possibilities to act. Permits for industrial installations are issued by the RIEWs or ExEA and the municipalities do not have jurisdiction to control the emissions of such installations or to impose sanctions. Better coordination between air quality and IED policies may help clarify the role and jurisdiction of local authorities on this issue[97]. In the case of the TPPs in the South-East air quality zone, MOEW clarified that these installations are important for the energy security of the country and any decision that concerns them requires coordination with various institutions. Therefore, the emission control measures are decided at the national level and implemented for all four installations. Furthermore, there is a project for a system of preventive measures to be implemented when bad meteorological conditions are forecasted for the area. This measure is expected to help manage the emissions from these installations[98].

Gaps in the overall allocation of responsibilities combined with deficiencies in communication across the different governance levels were found to hinder the effectiveness of air quality policies in Bulgaria. Another potential gap identified by the same audit is the lack of sanctions imposed on municipalities for failing to fulfil their obligations for air quality management[99].

[93] Filipova, I. 2018, Bulgaria now has a programme for reduction of particulate matter in the ambient air, 30 Sep 2018 published in Capital Newspaper, https://www.capital.bg/politika_i_ikonomika/bulgaria/2018/09/30/3318430_bulgariia_veche_ima_programa_za_namaliavane_na_finite/.
[94] Interviews with NAMRB and MOEW.
[95] Feedback provided by EAP.
[96] Interview with NAMRB.
[97] Interview with Za Zemiata.
[98] Interview with MOEW.
[99] EUROSAI, 2019, Joint report on air quality.

Insufficient coordination of air quality policy with sectoral policies at different levels of governance

The *coordination and integration of air quality objectives with sectoral policies at the local level is low* and often missing. For example, only 25 Bulgarian municipalities (around 10% of all municipalities) have signed the Covenant of Mayors and prepared Sustainable Energy Action Plans (SEAPs). Of those, only two have signed also the Mayors Adapt initiative and are expected to prepare Sustainable Energy and Climate Action Plans (SECAPs). Even though some of these municipalities also have air quality problems, links between the SEAPs/SECAPs and the municipal air quality plans are hardly found. In addition, the municipalities rarely update their SEAPs and thus do not take advantage of the available guidance on how to integrate different policy concerns in their SEAPs. There are even fewer municipalities with Sustainable Urban Management Plans (SUMPs) and it is unclear if air quality is integrated in those plans. It is also unclear whether the air quality plans are integrated or linked with municipal/urban/regional level planning e.g. in the area of land use and spatial planning[100].

Despite successes in some areas (see section 3.2.1) coordination of air quality policy with other sectoral policy requires further improvement also at the national level. An important gap in the period before 2019 was the lack of a national air quality strategy[101] that could have defined national objectives or promoted coordinated policies across sectors.

Lack of ambition in some air quality plans

Some of the stakeholders interviewed questioned the ambition of some municipal air quality plans and the overall focus on the strictness of the EU standards instead of on the effectiveness of the local measures. In particular, they criticised the lack of clear objectives or more stringent targets in some cases e.g. where the local conditions hinder the dispersion of air pollutants as in the case of Plovdiv, as well as the lack of specific actions to address the insufficient effectiveness of the measures implemented so far. This was attributed to several of the *cross-cutting implementation challenges*[102]:

- Insufficient internal capacity to prepare air quality plans (e.g. some municipal administrations lack the expertise to identify air quality needs and appropriate measures) and consequent over-reliance on external expertise. It is also critical that municipalities have sufficient capacity to implement the plans later on;
- Insufficient integration between policies - measures to improve the energy efficiency of buildings are not consistently considered;
- Incomplete data for the inventory and modelling of the emissions and pollution sources in some cases - this reduces the quality of the air quality plans as there is insufficient data to develop high quality scenarios and projections or to quantitatively justify the targets and links between measures and emission sources;
- Insufficient public participation and possibility for independent verification of the analyses in the plans, which if facilitated, can support municipalities in their efforts to prepare and implement air quality plans.

Gaps in the information provided to the public

[100] Interviews with EAP and Za Zemiata.
[101] EUROSAI, 2019, Joint report on air quality.
[102] Interviews with EAP and Za Zemiata.

At the moment of writing this case study, the information available daily on the website of the ExEA does not provide real time data and does not cover all parameters monitored (e.g. information about $PM_{2.5}$ emissions is not published in the ExEA daily bulletins). Real time data is provided directly only to RIEWs and the municipalities or consultants working on their behalf to develop air quality plans. Instead, the *focus of the daily information accessible to the public is on reporting any exceedances and not all real time data* from the monitoring system. Some of the stakeholders pointed out that as the exceedances data published in the ExEA daily bulletins is easily available only for 24 hours, this hinders the easy review of historical data for independent research and dispersion modelling[103]. Nevertheless, the ExEA clarified that an ongoing tendering procedure aims to develop the software of the monitoring system in order to allow the provision of real time data for the main parameters to the public.

Improved awareness about air quality issues is important especially for the acceptance of policies and the success of air quality measures[104]. A recent audit concluded that the awareness of Bulgarian citizens on air quality issues, including health risks but also benefits from different policies and measures, can be improved through more centralised efforts to improve awareness[105].

3.4.2 Factors underlying compliance and effectiveness

Improved regulation at the national level

In order to support municipalities in their actions to improve air quality, national policy makers have taken or are currently working on a series of measures that aim to provide some *common regulation of the pollutant emissions at the national level*. One of the most important developments is the introduction of minimum requirements for the solid fuels sold on the market in the Air Quality Act. In addition, as mentioned in section **Error! Reference source not found.**, the Ministry of Transport is also working on several measures that aim to regulate the emissions from the transport sector, while MOEW is in the process of finalising a national air quality programme.

Citizen initiatives

Some municipalities complement the air quality data published by the ExEA with provision of information at the local level e.g. through their websites or information boards. Furthermore, the limitations in the officially published data has led to some *citizen-led initiatives*. For example, Za Zemiata NGO runs a website[106] that informs about air pollution in general and advises the public what to do in the case of pollution peaks. In Sofia, a citizen initiative invested in low-budget sensors, installing more than 100 PM sensors in the city, in order to provide information about concentrations and collect data building a historical database that allows trend analyses and can complement official analyses[107]. In Plovdiv, the Energy Agency Plovdiv operates an independent mobile laboratory for measuring and testing emission concentrations from point source polluters, which covers PM_{10}, $PM_{2.5}$ and NOx for the moment. However, there is little interest in independent monitoring and the mobile laboratories are not often used so far[108].

[103] Interviews with EAP and Za Zemiata.
[104] European Environment Agency, 2018, Europe's urban air quality — re-assessing implementation challenges in cities, https://www.eea.europa.eu/publications/europes-urban-air-quality.
[105] EUROSAI, 2019, Joint report on air quality, https://english.rekenkamer.nl/publications/reports/2019/01/30/joint-report-air-quality.
[106] www.smog.zazemiata.org
[107] Interview with Za Zemiata.
[108] Interview with EAP.

3.5 Costs and benefits of the AAQ Directives

3.5.1 Costs of implementation

Currently there is *no national analysis of the costs of AAQDs implementation*. Nevertheless, some of the available information can provide an indication:

- Monitoring: Although the total cost for the development of the *national air quality monitoring system* is not available, there are some indications about its maintenance cost. According to the ExEA, the annual cost for the entire national system for monitoring of the environment (including air quality, water, noise, radiation etc.) is around BGN 3.7 million or EUR 1.9 million[109]. It is not clear if the cost specifically for air quality monitoring can be separated from the overall monitoring costs, the ExEA was not able to provide data specifically for the air quality monitoring. The recently completed project on the upgrade of the real time reporting system, supported by OP Environment is worth approximately EUR 357,909[110.]
- Air quality plans: The total budget of the call launched for the development and update of the *municipal air quality plans* of the 28 non-compliant municipalities is around EUR 1.5 million suggesting an average budget of approximately EUR 0.05 million per plan[111.] The total budget of the procedures financed under this call so far in 11 municipalities is around EUR 777,502, of which the procedures for the air quality plans in Plovdiv is EUR 47,830 and in Asenovgrad EUR 74,370[112]. The funds spent so far suggest an average budget of around EUR 0.07 million per air quality plan.
- *Measures*: A review of the actual allocations for the programming period 2007-2013 of three OPs (Environment, Good Governance and Transport and Infrastructure) indicated that at the end of the funding period around EUR 156.8 million were allocated to air quality projects[113]. Information provided by the interviewees indicates that these were mainly measures for improving the public transport in different areas.
- Measures in the Plovdiv Agglomeration: Some information about the cost of air quality measures implemented in the Plovdiv and Asenovgrad municipalities is available in the plans themselves but it is not provided consistently. The available information is summarised in the following table.

Table 3-1 Costs of the air quality measures taken in the Plovdiv agglomeration

	Plovdiv Municipality		**Asenovgrad Municipality**
Period	2011	2014	2011-2015
Cost	EUR 9.4 million from municipal budget	EUR 11.9 million from municipal budget	EUR 3.5 million from municipal budget

[109] All estimates are converted using the fixed ECB exchange rate of EUR 1= BGN 1.9558.
[110] Operational Programme Environment 2014-2020, List Of Operations for Priority Axis 5 Improvement of Ambient Air Quality, http://ope.moew.government.bg/files/useruploads/files/list_of_operations_air_en.pdf.
[111] Operation Programme Environment 2014-2020, Ongoing calls, BG16M1OP002-5.002, http://ope.moew.government.bg/bg/notice/noticedetail/from/noticecurrent/id/77/typeId/1.
[112] Operational Programme Environment 2014-2020, List Of Operations for Priority Axis 5 Improvement of Ambient Air Quality, http://ope.moew.government.bg/files/useruploads/files/list_of_operations_air_en.pdf.
[113] COWI and Milieu, 2017, Integration of environmental concerns in Cohesion Policy Funds (ERDF, ESF, CF).

	Plovdiv Municipality		Asenovgrad Municipality
Examples of measures	Regulation of the traffic; road infrastructure renovation; improvement of the street cleaning; greening of public spaces; preparation of an action plan for stimulating the use of new heating technologies and renewable energy	Road infrastructure maintenance/renovation; street cleaning; greening of public spaces	Street cleaning and road maintenance; maintenance of public green spaces; renovation of public buildings

Sources: Air quality plans of the Plovdiv and Asenovgrad municipalities.

3.5.2 Costs of non-implementation

There is currently *no national analysis of the costs of non-implementation of the AAQDs* either. According to the 2013 Commission Impact Assessment, the *health-related external costs* from air pollution in Bulgaria, including the intrinsic value of living a full health life and the direct costs to the economy, are estimated at more than EUR 3 billion per year (income adjusted, 2010). The direct economic costs relate to 2 million workdays lost each year due to sickness related to air pollution, which are associated to annual costs (income adjusted, 2010) of EUR 121 million costs to employers, over EUR 11 million for healthcare and EUR 58 million for agriculture (crop losses)[114]. Furthermore, the EEA estimated that for 2015 around 14,200 *premature deaths* were attributable to fine PM concentrations, 640 to NO_2 concentrations and 350 to ozone concentration[115].

More specifically, the total costs (both health and non-health related) of road traffic related air pollution in 2016 was estimated at EUR 612 - 778 million. The majority of these costs stem from diesel vehicle transport. The specific health costs of diesel vehicle air pollution were estimated at EUR 389 – 459 million, considerably higher than the health costs associated with petrol vehicles (EUR 184 – 266 million)[116].

3.5.3 Benefits of the AAQ Directives

Currently, there is *no national analysis of the valorised benefits from implementation of the AAQDs*. Nevertheless, a number of benefits were identified.

First and foremost, all stakeholders interviewed agree *that the AAQDs have been drivers of change and actions at the national and local levels* that have resulted in decreasing emissions of all pollutants. Particularly important is the reduction of the PM_{10} emissions in some municipalities and an overall reduction of the SO_2 emissions. These significant improvements might not have taken place without the binding element of the Directives. In addition, the AAQDs have contributed to making air quality a more prominent issue fostering the development of air quality plans, provision of information to the public and uptake of citizen initiatives.

There was no systematic data about air quality before the introduction of the European legislation and an important change brought by the AAQDs is the *development of a national monitoring*

[114] Impact Assessment for the European Commission Integrated Clean Air Package (2013) cited in SWD(2017) 35 final.
[115] European Environment Agency, 2018, Air quality in Europe — 2018 report.
[116] CE Delft, 2018, Health impacts and costs of diesel emissions in the EU.

system with improvements in the equipment and data used. The main change since the implementation of the AAQDs in Bulgaria is the monitoring of $PM_{2.5}$ and PM_{10}, which were previously not monitored (instead, only the general PM/dust level was monitored)[117].

Another important transformation facilitated by the Directives and *stakeholder activism* is the abolishment of naphtha (crude oil) as a widespread fuel in industrial installations and public buildings and the replacement of the combustion facilities with capacities to burn other fuels[118].

Air quality standards before 2008

Before the transposition of Directive 2008/50/EC, air quality was regulated according to legislation transposing earlier European air quality legislation (e.g. Directive 96/62/EC, Directive 99/30/EC, Directive 2000/69/EC, Directive 2002/3/EC and Directive 2004/107/EC)[119]. While the introduction of Ordinance 12 made no changes to the limit values of most pollutants, it made the requirements for PM concentrations less precise compared to the pre-2008 requirements as summarised in the following table. Before the transposition of the AAQD the legislation defined additional more ambitious PM_{10} limit values to be attained in a second period of implementation and a daily 'action level' for $PM_{2.5}$. For pollutants regulated by Directive 2004/107/EC the limit values are transposed by Ordinance 11 (for details see section 2.4).

Table 3-2 Changes introduced in national legislation as result of the AAQD (Directive 2008/50/EC)

Pollutant	Situation prior to the AAQDs	Changes introduced by the AAQD to the legislation
SO_2, NO_2, Pb	Defined in Ordinance 9 of 1999[120]	No changes
C_6H_6, CO	Defined in Ordinance 1 of 2004[121]	No changes
O_3	Defined in Ordinance 4 of 2004[122]	No changes
PM_{10}	Defined in Ordinance 9 of 1999; Prior to 2008 the limit values were defined in two stages: Stage I to fulfil by 31.12.2008: • Average daily limit 50 µg/m³, not to be exceeded more than 35 times per year • Average annual limit 40 µg/m³ Stage II to fulfil by 01.01.2010: • Average daily limit 50 µg/m³ not to be exceeded more than 7 times per year • Average annual limit 20 µg/m³	Ordinance 12 defines only the Stage I limit values, there is no longer a reference to the Stage II limit values.
$PM_{2.5}$	Defined in Ordinance 9 of 1999; Prior to 2008 'action levels' were defined as:	Ordinance 12 defines the limit values in two stages:

[117] Interviews with MOEW and ExEA.
[118] Interview with EAP.
[119] Information provided by MOEW.
[120] Ordinance N9 of 3 May 1999 concerning norms for sulphur dioxide, nitrous oxide, particulate matter and lead in ambient air, available at http://www.econ.bg/.
[121] Ordinance N1 of 16 January 2004 concerning norms for benzene and carbon monoxide in ambient air, available at http://www.econ.bg/.
[122] Ordinance N4 of 5 July 2004 concerning norms for ozone in ambient air, available at http://www.econ.bg/.

Pollutant	Situation prior to the AAQDs	Changes introduced by the AAQD to the legislation
	• Average daily level 40 µg/m^3, not to be exceeded more than 14 times per year • Average annual level 20 µg/m^3	Stage I to fulfil by 01.01.2015: • Average annual limit 25 µg/m^3 Stage II to fulfil by 01.01.2020: • Average annual limit 20 µg/m^3 An average daily level or limit value is no longer defined.

Sources: Own analysis based on national legislation.

4 CONCLUSIONS

Chapter **Error! Reference source not found.** presents the summary of the main findings of the case study regarding the main implementation challenges and the potential for improving the implementation of the Directives in Bulgaria. Finally, a summary of the evaluation of the AAQDs is presented.

4.1 Identified problems and potential for improving the implementation of the Directives

The case study identified a number of challenges in the implementation of the AAQDs in Bulgaria. While some of the challenges are related to gaps in the country's implementation, others can be linked to the set-up of the Directives themselves – either gaps or uncertainties in the AAQDs' provisions (see section 3.3.5), or a lack of consideration of each country's specific conditions (see Section 3.3.3). Therefore, the opportunities for improvement are mainly linked to further clarifications at the EU level.

The implementation of the AAQDs can be improved by *EU-level clarifications, including through implementation guidelines*, concerning:

- The kind of sanctions that can be imposed at the different stages of implementation;
- The daily limit values for $PM_{2.5}$ e.g. to provide guidelines or suggestions how to consider those but not to introduce new limit values until current requirements are met;
- The minimum number of monitoring stations to ensure more complete and adequate monitoring in some areas e.g. big cities or small towns, based on appropriate assessment of the costs and benefits associated with a higher number of monitoring stations;
- Access to justice in order to specify whether the air quality plans can be challenged in court and under what conditions:
- The minimum types of data, which is necessary for the analysis of emissions and the preparation of the air quality plans and which should be available free-of-charge and accessible for all stakeholders (in a machine-readable format), as a way to stimulate independent research that can complement official analyses and reporting.

Another aspect for improving the Directives is the *establishment of standards that take into account the specific climatic, economic and social conditions in the Member States*. According to some stakeholders, the current standards appear to consider only the climate and the conditions in Western Europe and do not take into account the specific conditions in other parts of the continent. This leads to adoption of standards that make sense for some countries but not for others e.g. due to a different economic and social context.

The stakeholders pointed out that existing provisions should not be removed but rather clarified or made more specific, while future amendments or a potential introduction of more stringent standards should take into account and be based on the different conditions and resources of each Member State.

4.2 Assessment of the AAQ Directives

The following section presents a summary of the findings of the case study in relation to the relevance, effectiveness, efficiency, coherence and added value of the AAQDs.

4.2.1 Relevance

Despite continuing improvement in the air quality in Bulgaria, the issue remains a concern for citizens as outlined in section 0. Overall, the AAQDs remain relevant for improving air quality in Bulgaria as:

- *Their objectives address the needs at the national level* – before the introduction of the Directives there was no consistent monitoring of air quality, provision of information to the public or planning of mitigation actions (see section 3.5.3). Therefore, the AAQDs ensure that air quality is targeted at the national level.
- *They target pollutants relevant at the national level* – despite improvements over time exceedances of the limit values for PM_{10}, $PM_{2.5}$, NO_2 and in one area – SO_2 emissions - persist (see section 2.2). Thanks to the AAQDs measures are continuously taken to improve performance concerning these emissions. However, the EU-wide limit values do not sufficiently reflect specific local climate, economic or social conditions (see section 3.1).
- *The rules for monitoring and assessment are acceptable* – before the introduction of the AAQDs Bulgaria lacked an air quality monitoring system. Even though the maintenance of the system is costly and more monitoring stations can be installed in the larger cities, the completion and operation of the monitoring systems is one of the main positive changes brought by the Directives (see section 3.2.3).

4.2.2 Effectiveness

The challenges with the implementation and compliance with the air quality standards can be attributed to a number of factors: insufficient administrative capacity at the different levels of governance coupled with insufficient financial resources to finance different measures; insufficient integration of air quality objectives in sectoral policies; mismatch of the responsibilities and competences for air quality management at the different governance levels; local conditions that hinder compliance with the standards; and uncertainties in the AAQDs. Nevertheless, implementation and compliance with the Directives is ensured by improving regulation at the national level; successful coordination with some sectoral policies; support from the ESIF; and development of the national air quality monitoring system together with an uptake of citizen initiatives. More specifically:

- *Monitoring and assessment of air quality function well* – the air quality monitoring system, whose development was fostered by the AAQDs, was completed and it now regularly provides information about the pollutants monitored in line with the requirements of the EU legislation. Monitoring data is used by the ExEA to inform the public and by municipal authorities to prepare air quality plans and track their implementation (see sections 2.2). Even though some municipalities include also modelling in their plans, this remains a limited practice due to data availability and financial constraints. Therefore, some stakeholders call for defining at the EU level the minimum types of data that should be available free-of-charge for all stakeholders. In addition, the actual monitoring and assessment tasks tend to be outsourced as public authorities such as the ExEA and the municipalities have limited resources to carry out these tasks in-house. Strengthening the in-house expertise of public authorities concerning the monitoring and assessment of air quality can be targeted at the national level (see section 3.3.1).

- *Compliance with some of the standards remains problematic* - although compliance has improved over time, exceedances of the limit values for PM_{10}, $PM_{2.5}$, NO_2 and in one air quality zone – SO_2 emissions – persist. This is primarily due to emissions from the domestic heating sector for PM, road transport for NO_x and TPPs for SO_x as confirmed by the national reports on the state of the environment and the stakeholders interviewed. Furthermore, insufficient integration of air quality objectives in certain policy areas, most notably climate and energy policies, limit the effectiveness of some measures to improve compliance with the pollutant limit values. In some areas such as the Plovdiv agglomeration non-compliance is exacerbated also by the local climate conditions. Further clarifications or guidelines about the implementation of the AAQDs can improve compliance at the national level. EU-level clarifications are needed concerning the types of sanctions that can be imposed to improve compliance, the minimum number of monitoring stations and the possibilities of access to justice concerning air quality plans (see sections 2.2 and 3.3.5).
- *Air quality information is regularly provided to the public* - the ExEA publishes daily updates about any exceedances of the limit values for the preceding day as well as quarterly bulletins and yearly reports about the air quality. Even though some stakeholders criticise the lack of real time data and the format in which the ExEA publishes the daily data, the Agency plans to further develop the monitoring system to allow the provision of real time data for the main parameters on its website. In addition, some municipalities including Plovdiv provide real time data about the air quality in their territory on information boards while citizen-led initiatives for providing air quality information have also emerged. Information about breaching the alert thresholds is also provided regularly thanks to automated updates by the ExEA and information provided by the RIEWs to local authorities and the media (see sections 2.5 and 3.2.3). As Bulgaria previously had no air quality monitoring or information system, the provision of information to the public was largely promoted by the AAQDs.
- *Air quality plans and measures have been implemented but with varying degree of success* – the number of municipalities non-compliant with the EU standards and thus required to prepare air quality plans has decreased. However, some municipalities such as Plovdiv or Sofia continue to exceed the limit values and have to prepare air quality plans. In Plovdiv for instance, the implementation of the air quality plans has led to improvements and compliance for some pollutants (e.g. SO_2) but the measures implemented have not been sufficient to ensure compliance for other pollutants (e.g. PM_{10}, $PM_{2.5}$ and NO_2). Some of the main reasons behind this are the local meteorological conditions and inconsistencies of the policies at the national level e.g. until recently there were no requirements for the solid fuels used for domestic heating (see sections 0 and 3.3.2).

4.2.3 Efficiency

There is no analysis of the costs and benefits linked to the AAQDs at the national level. Indications about the cost of monitoring and preparation of air quality plans can be obtained from the budgets of ESIF calls, while indications about the cost of non-implementation are available in EU reports. Nevertheless, comprehensive data about the costs of implementation and non-implementation or benefits is not available.

Based on the available information (see section 3.5.1 for details) the costs of AAQDs implementation in Bulgaria are in the range of:

- *Costs of monitoring, reporting and assessment* – the annual cost of the air quality monitoring system is nearly EUR 1.9 million, which is the annual cost for the entire national system for monitoring of the environment (however it is not clear if the costs per area of environment can be separated). Data about the costs associated with reporting and assessment are not available.
- *Costs of implementation* – the average budget of an air quality plan is around EUR 0.05 – 0.07 million based on the ESIF financing made available for update of the air quality plans in 28 non-compliant municipalities. The latest plans prepared for the municipalities in the Plovdiv agglomeration cost around EUR 47,830 (Plovdiv) and EUR 74,370 (Asenovgrad). The cost of measures implemented in Plovdiv cost around EUR 21.3 million from the municipal budget in the period 2011-2014, while in Asenovgrad around EUR 3.5 million from the municipal budget was spent on air quality measures between 2011 and 2014.

4.2.4 Coherence

The *coordination between air quality objectives and sectoral policies is inconsistent*. While there has been successful integration between ESIF spending in different sectors (including waste management and transport), social and transport policies, links between air quality and climate and energy policies are missing both at the national level and in the municipal air quality plans. Driven by the need to comply with the EU standards, an environmental component was introduced in the calculation of the vehicle taxes, while the EU categories for different emissions levels can now be used by municipalities to control circulation of vehicles on their territories (see section 3.2.1). Moreover, air is a separate priority axis in the latest OP Environment, therefore the ESIF will support the update of air quality plans as well as the implementation of specific air quality measures in the period 2014-2020. In the previous funding period ESIF investments in waste management likely contributed to improved air quality (see section 2.6 and 3.2.2). Nonetheless, the coordination of municipal air quality plans and other local policies is limited and according to some of the stakeholders interviewed it is generally missing (see section 3.4.1).

4.2.5 EU added value

The *overall contribution of the Directives on air quality policy in Bulgaria has been mixed*. The implementation of the Directives, and particularly their binding nature on the standards, have contributed to improving air quality in Bulgaria, developing a system and monitoring concentrations (some of which were not monitored before), informing the public and fostering citizen action. The transposition of Directive 2008/50/EC resulted also in the repeal of previous air quality legislation that defined more ambitious limit values for PM concentrations (two-stage limit values for PM_{10} and an average daily value for $PM_{2.5}$). Nevertheless, Bulgaria was not required to make this repeal because the AAQ Directives allow Member States to have more stringent environmental standards.

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APPENDIX B INTERVIEWS

Organisation	Date of the interview	Notes
Energy Agency Plovdiv	4 September 2018	Telephone interview
Za Zemiata	5 September 2018	Telephone interview
Executive Environment Agency (ExEA)	19 September 2018	Telephone interview
National Association of the Municipalities in Republic of Bulgaria (NAMRB)	19 September 2018	Telephone interview
Ministry of Environment and Water (MOEW)	25 September 2018	Telephone interview
Bulgarian Association of the Municipal Environmental Experts (BAMEE)	28 September 2018	Written feedback

APPENDIX C PILOT INTERVIEW GUIDE

General questions

- What challenges have been encountered when implementing the AAQ Directives?
- How have these challenges been overcome? What has proved to work well and what turned out to work less well? Are there any relevant lessons learned that other Member States could learn from?
- Where do you see the greatest potential to improve further the implementation of the Directives?
- Have any specific initiatives/measures been introduced to support the implementation of the AAQ Directives in the Member State (e.g. national guidance, arrangements for information exchange, etc.)?
- What systems are in place to provide information to the public on air quality, exceedances and alerts, and the implementation of plans and measures?

Specific questions:
The table below outlines the specific themes discussed during the interviews.

Evaluation question	Questions
RELEVANCE	
(1) How relevant are the goals and objectives of the AAQ Directives to the needs of citizens; do the AAQ Directives still address the most relevant pollutants and set relevant standards and obligations to protect human health and the environment; and are the AAQ Directives sufficiently adapted or adaptable to evolving technical and scientific progress?	To what extent do the goals of the Directives correspond to the needs of the citizens (in your country)? Which of the Directives' requirements are in your opinion the most important in relation to the citizens' needs? To what extent have the goals of the Directives been integrated in the strategic documents (on environmental protection) in your country?
(2) How far are the Directives aligned with key EU priorities? Which elements in the Directives are essential to deliver on these priorities, have elements become redundant?	
EFFECTIVENESS	
(3) What factors have contributed to meeting the objectives of the AAQD or to failing to meet these objectives, in terms of: 1) defining common methods to monitor and assess air quality; 2) assessing ambient air quality in order to monitor trends; 3) establishing standards of air quality to achieve across the EU; 4) ensuring that information on air quality is made public; 5) maintaining good air quality, improving it where it is not good; to what level can these factors be attributed to provisions of the AAQ Directives?	What are the main factors that contribute to compliance with/effective implementation of the air quality Directives; hereunder: • air quality standards • reporting requirements • requirements regarding the establishment and implementation of air quality plans and programmes • requirements regarding provision of information to public? • requirements regarding monitoring stations? What are the main barriers (at national/regional/local) level preventing effective implementation of the air quality Directives? Please consider each of the items listed above separately. What would it take to overcome the barriers?
EFFICIENCY	
(4) What are the costs and benefits (monetary and non-monetary) associated with implementation of the AAQ Directives in the Member States, and in the EU; have the benefits (improved air quality) been achieved in a cost-effective manner and to what extent have costs been equitably distributed across different sectors?	What are the costs of implementation of the AAQ Directives? What is the cost of implementation (monitoring, reporting, and planning) for different levels of government, including the use of external expertise on, per year (in FTE)? What is the cost of implementation for different sectors of the industry per year (capital and operating costs of equipment in EUR)? What specific factors contribute to the efficiency/inefficiency of the implementation of the AAQ Directives?
(5) Where there are significant cost differences between Member States and/or between different sectors and/or as regards costs to stakeholders (including social costs as a consequences of poor implementation), what is causing them; and are the costs of compliance proportionate to the benefits brought by the directives?	

Evaluation question	Questions
(6) How efficient are monitoring, reporting and assessment regimes, what are the administrative costs to the Member States and to the Commission; taking account of the objectives and benefits of the directives is there evidence that they have caused unnecessary or excessive administrative burden?	What are the costs of non-implementation of the Directives (e.g. environmental and health costs, uncertainty and market distortion, litigation costs for Member States)? What are benefits associated with the implementation of the Directives in the Member State/air quality zone (e.g. health and environmental benefits, economic benefits, eco-innovation, etc.)?
(7) Has the implementation of the AAQ Directives supported or hampered EU competitiveness in the global economy; has the implementation of the AAQ Directives improved or been detrimental to economic, social and environmental sustainability?	
COHERENCE	
(8) To what extent do the AAQ Directives complement or interact with other environmental policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as the NEC Directive and IED Directive as well as the EU climate legislation and policy; and how do these policies and legislation support or hamper the implementation of the EU air quality legislation?	How and to what extent is the implementation of the AAQ Directives coordinated with the implementation of other EU instruments in the environmental and climate domain (e.g. the National Emissions' Ceiling Directive, the Industrial Emissions' Directive, Large Combustion Plants Directive, etc.)?
(9) To what extent do the AAQ Directives complement or interact with sectoral policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as energy, transport, agriculture, cohesion, fiscal policies); and how do these policies support or hamper the implementation of the EU air quality legislation?	How and to what extent is the implementation of AAQ Directives coordinated with other relevant legislation and policy (e.g. in the area of energy, transport and agriculture)? Are air quality plans coordinated with planning initiatives promoted by EU sectoral legislation (e.g. Sustainable Urban Mobility Plans, TEN-T investments)? Are air quality plans coordinated with national emission reduction plans and measures under the NEC Directive? Are air quality plans coordinated with climate change mitigation policies and plans (for GHG emission reductions)? To what extent are air quality plans integrated or linked with municipal/urban/regional level planning e.g. in the area of land use and spatial planning, energy management, transportation and climate? To what extent are EU funds used to finance measures (e.g. abatement programmes) to maintain good air quality/improve air quality?
ADDED VALUE	
(10) To which degree have the AAQ Directives, including common EU air quality standards and comparable air quality assessment, management and information approaches enabled Member States and their competent authorities to take successful	Have AAQ Directives triggered transformational changes that have enabled the achievement of air quality objectives?

Evaluation question	Questions
action to improve beyond what would have been possible without EU action?	Have AAQ Directives contributed to improvements in monitoring? Have AAQ Directives contributed to improvements in public information and public participation? What are the wider economic, social and environmental impacts of the Directives in the Member State/air quality zone?
(11) What has been the EU added value of the AAQ Directives, do the Directives and their means of implementation create synergies or overlaps with other Community objectives, and how has the distribution of responsibilities between EU, Member State, regional and local levels impacted on air quality management?	How is the implementation of the AAQ Directives coordinated in the Member State (division of responsibilities, coordination across different activities)? To what extent is the implementation of AAQ Directives coordinated in the region (to address transboundary pollution)?

APPENDIX D AREAS OF AIR QUALITY MANAGEMENT

Table 4-1 Air quality zones and the municipalities they cover

Agglomeration/Zone	Provinces covered (MOEW Order 2013)	Municipalities that need air quality plans (2018)	Pollutants (Eionet 2014)	Area (km²) (Eionet 2014)	Population (Eionet 2014)
Plovdiv	Part of Plovdiv: municipalities of Asenovgrad, Plovdiv and Rodopi	Asenovgrad and Plovdiv	C_6H_6; CO; NO_2; O_3; PM_{10}; $PM_{2.5}$; SO_2; BaP; Cd; Pb	1,390	506,913
Sofia	Part of Sofia: larger Capital Municipality	Sofia	C_6H_6; CO; NO_2; O_3; PM_{10}; $PM_{2.5}$; SO_2; As; BaP; Cd; Ni; Pb	1,350	1,249,665
Varna	Part of Varna: Varna, Devnya and Beloslav	Varna and Devnya	C_6H_6; CO; NO_2; O_3; PM_{10}; $PM_{2.5}$; SO_2; As; BaP; Ni	504	397,255
North	Vratsa, Vidin, Montana, Ruse, Veliko Tarnovo, Gabrovo, Lovech Pleven, Dobrich, Targovishte, Shumen, Silistra, Razgrad, part of Varna	Vratsa, Vidin, Montana, Ruse, Veliko Tarnovo, Pleven, Lovech, Dobrich, Gorna Oryahovitsa, and Shumen	C_6H_6; CO; NO_2; O_3; PM_{10}; $PM_{2.5}$; SO_2; BaP; Ni	48,023	2,258,523
South-East	Burgas, Pazardzhik, Yambol, Sliven, Stara Zagora, Haskovo, part of Plovdiv	Burgas, Nesebar, Pazardzhik, Galabovo, Sliven, Stara Zagora, Dimitrovgrad and Haskovo	C_6H_6; CO; NO_2; O_3; PM_{10}; $PM_{2.5}$; SO_2; As; BaP; Cd; Ni; Pb	34,330	1,731,238
South-West	Blagoevgrad, Kyustendil, Pernik, Smolyan, Kardzhali, part of Sofia	Pirdop, Blagoevgrad, Pernik, Smolyan and Kardzhali	C_6H_6; CO; NO_2; NOx; O_3; PM_{10}; $PM_{2.5}$; SO_2; As; BaP; Cd; Ni; Pb	25,315	1,102,083

Sources: Order 969 of 21.12.2013, Ministry of Environment and Water and Executive Environment Agency. Operational Programme Environment 2014-2020, Ongoing calls, BG16M1OP002-5.002. Eionet, Common Data Repository (CDR), (B) Information on zones and agglomerations (Article 6), Bulgaria - 2016 resubmission.

APPENDIX E POLLUTANT CONCENTRATION DATA FOR BULGARIA, 2013-17

Table 4-2 Highest pollutant concentrations in exceedance of EU air quality objectives for protection of health in Bulgaria in 2013-2017 - extract from reporting (Dataflow G).

Pollutant	Averaging period	Objective type and value	Date for achieving objective	Parameter shown	2013	2014	2015	2016	2017
PM_{10}	Calendar year	LV: 40 µg/m^3	1 January 2005	Annual mean, µg/m^3	62	64	69	61	55
	1 day	LV: 50 µg/m^3 not to be exceeded on more than 35 days per year	1 January 2005	Days above	173	171	188	168	127
NO_2	Calendar year	LV: 40 µg/m^3	1 January 2010	Annual mean, µg/m^3	52	-	42	50	43
	1 hour	LV: 200 µg/m^3 not to be exceeded on more than 18 hours per year	1 January 2010	Hours above	-	-	-	-	33
SO_2	1 day	LV: 125 µg/m^3 not to be exceeded on more than 3 days per year	1 January 2005	Days above	5	4	11	9	15
	1 hour	LV: 350 µg/m^3 not to be exceeded on more than 24 hours per year	1 January 2005	Hours above	57	83	118	85	117
CO	Maximum daily 8-hour mean	LV: 10mg/m^3	1 January 2005	Days above	-	-	-	-	-
C_6H_6	Calendar year	LV: 5 µg/m^3	1 January 2010	Annual mean, µg/m^3	-	-	-	-	-
Pb	Calendar year	LV: 0.5 µg/m^3 (measured as content in PM_{10})	1 January 2005	Annual mean, µg/m^3	1	-	-	-	-
O_3	Maximum daily eight-hour mean	TV: 120 µg/m^3 not to be exceeded on more than 25 days per calendar year averaged over three years	1 January 2010	Days above	-	43	30	30	51

Pollutant	Averaging period	Objective type and value	Date for achieving objective	Parameter shown	2013	2014	2015	2016	2017
	Maximum daily eight-hour mean within a calendar year	LTO: 120 µg/m³	Not defined	Days above	114	81	37	30	38
$PM_{2.5}$	Calendar year	LV: 25 µg/m³	1 January 2015 (target value until 1 January 2010)	Annual mean, µg/m³	35	30	35	26	27
	(calculated as Average Exposure Indicator, assessed as a 3-year running annual mean)	ECO: 20 µg/m³	2015	AEI, µg/m³	40	24	27	24	24
As	Calendar year	TV: 6 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	-	-	-	-	-
Cd	Calendar year	TV: 5 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	32	19	11	-	-
Ni	Calendar year	TV: 20 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	-	-	-	-	-
BaP	Calendar year	TV: 1 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	3	3	4	4	3

Source: COWI calculations based on Member State reporting, data flow G. Downloaded in November 2018.

Note: LV: limit value; TV: target value; LTO: Long term objective; ECO: exposure concentration obligation; The values show the maximum exceedance reported in the Member State (if no exceedances are reported in any of the zones of the Member State, the table shows "-")

Legend: "NA": not available in data flow G, "-": no reported exceedances

Publications Office

CASE STUDY REPORT
GERMANY

Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

[Written by Douglas R. Clark]
[*March – 2019*]

Contents

Written by Douglas Clark
March – 2019

EUR [number] EN

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1 INTRODUCTION

This report summarises the findings and conclusions of the **case study for Germany**. The case study had a focus on Berlin Agglomeration.

The report is one of seven case studies carried out for the Fitness Check of the EU Ambient Air Quality Directives. Its main purpose is to examine, in more detail, the situation regarding the experience and lessons learnt in the implementation of the air quality legislation. The case studies provide a basis for a more detailed examination of the questions of the fitness check and include a review of implementation and integration successes and problems, the costs of implementation and of non-implementation of the legislation and the administrative burden of implementation and opportunities for improving implementation without compromising the integrity of the purpose of the Directives. As such, the case study complements the information gathered through other sources, such as desk review, targeted questionnaire, open public consultation, interviews, focus groups and stakeholder workshops.

The Member States for detailed case studies have been selected to cover a range of geographies, governance structures and sizes. This has led to the selection of the following **seven case study Member States: Slovakia, Germany, Spain, Sweden, Ireland, Bulgaria and Italy**.

The case study report is structured in four chapters, namely:

- **Chapter 1 – Introduction**
- **Chapter 2 – Background and context**, presents general information about the context of the case study
- **Chapter 3 – Findings**, presents detailed findings regarding the relevance of the AAQ Directives, the implementation successes and problems, the factors underlying compliance with the Directives, the costs and benefits.
- **Chapter 4 – Conclusions**, presents a summary of the main findings.

The case study findings rely on extensive desk research and a series of interviews that took place over the period September, October and November 2018. An overview of the interviews carried out is provided in Appendix A.

The case study has been shared with the interviewed stakeholders in January 2019 for validation of findings and correction of factual mistakes. Feedback received from the stakeholders was integrated in the case study report.

2 CASE STUDY BACKGROUND

Chapter 1 provides general information about Germany and the city-state Berlin. The purpose of this chapter is to set a background for the more detailed findings presented in Chapter 1. The chapter relies primarily on desk research. The findings from desk research are supplemented by interviews.

2.1 Germany and air quality zone characteristics

2.1.1 Scope and focus of the case study

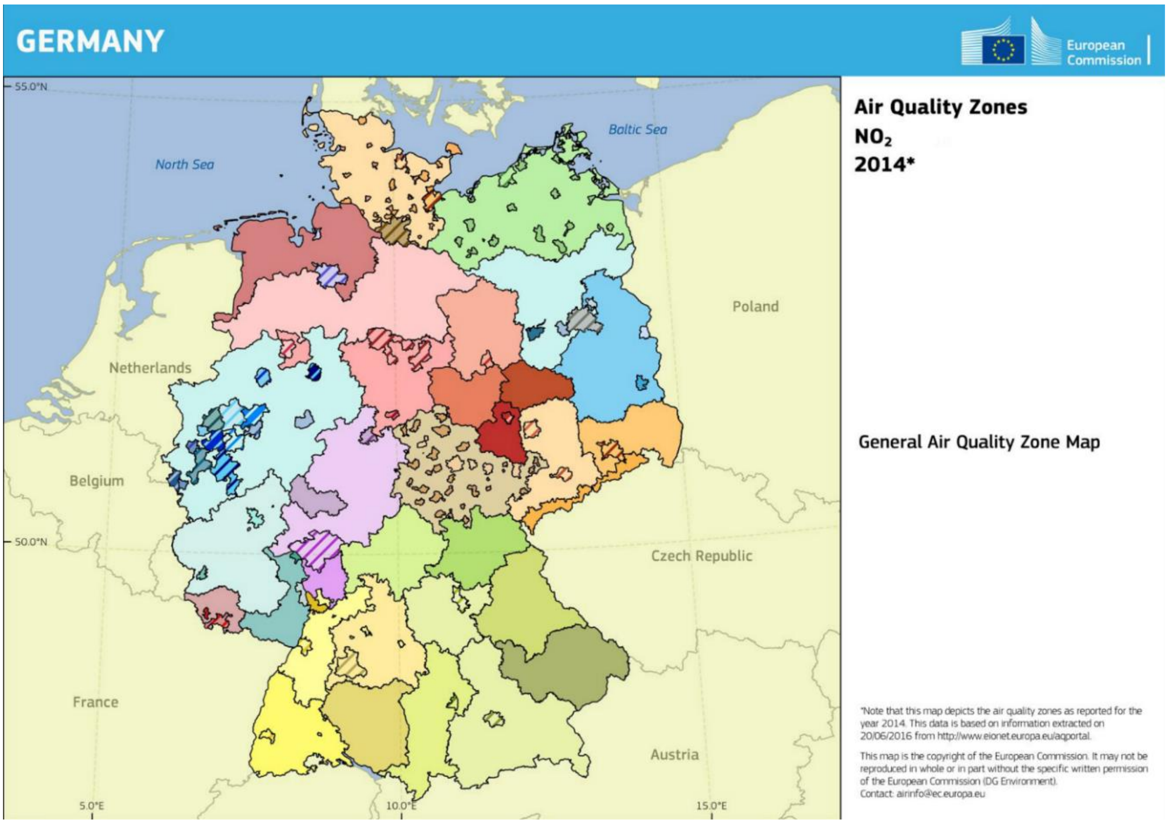
The case study covers the entire territory of Germany and focuses in particular on the Berlin agglomeration.

2.1.2 Characteristic of air quality zones

In Germany, the 16 states are responsible to establish air quality zones and agglomerations. Air quality zones and agglomerations were first established in 2002. Before 2008, the zones were revised almost every year based on the exceedances. This led to an annually changing framework for air quality management that was difficult to follow. Beginning in 2008, the procedure was changed, and now for all pollutants the zones and agglomerations are stable.

As shown in Figure 2-1 below, Germany was divided into 89 zones for assessment of NO_2 in 2014. The number in 2017 was 87. In 2017, there were 86 zones for PM_{10}, and 79 zones for $PM_{2.5}$. The zones for NO_2 and PM_{10} include 36 agglomerations. The boundaries of air quality zones follow administrative division boundaries.

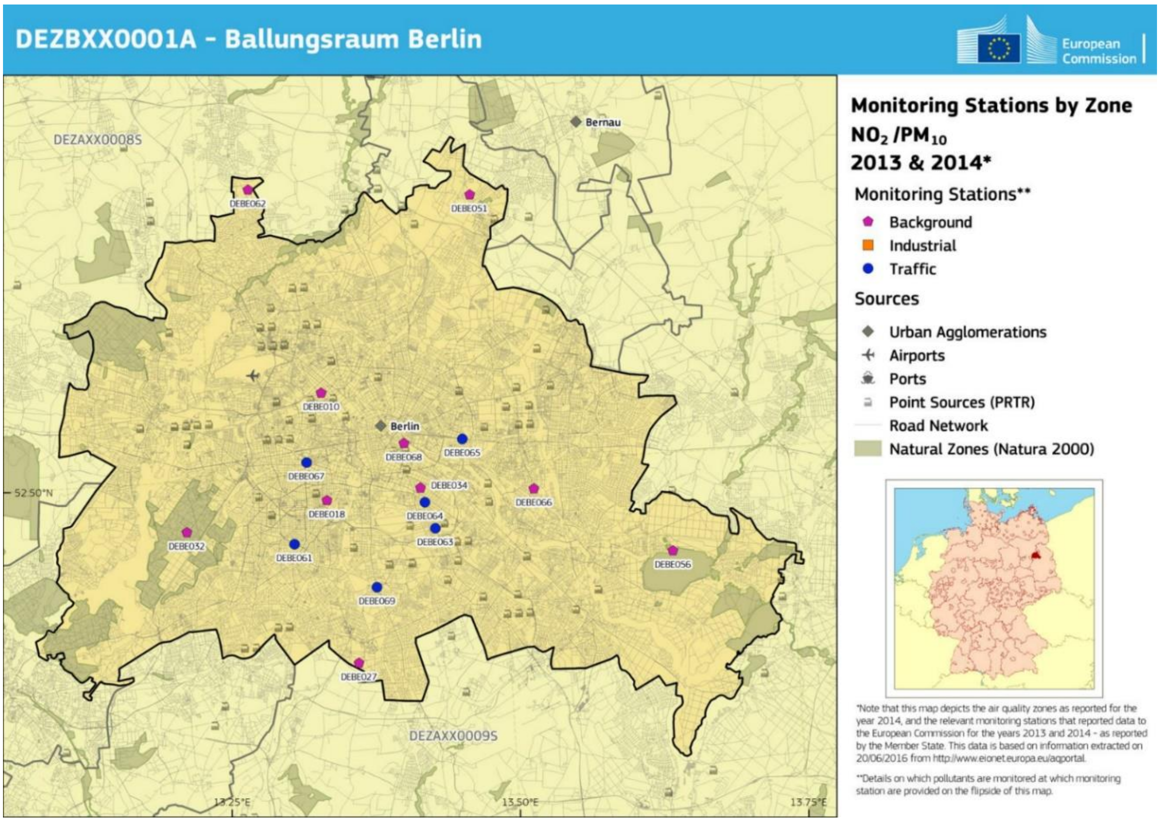
Figure 2-1 Air quality zones for NO_2, 2014. Source: European Commission, DG Environment, Atlas of air quality zones and monitoring stations (2013 & 2014), Germany.



The whole city-state Berlin, one of the 16 German states, is one of the 36 agglomerations in Germany. Berlin is situated in north-eastern Germany, surrounded by the state of Brandenburg. The population of Berlin is 3.7 million (2017), and the area is 892 km^2.

Berlin is bounded on the southwest by Potsdam, the largest city in Brandenburg. Potsdam is a separate agglomeration for air quality assessment.

Figure 2-2 Berlin agglomeration monitoring stations for NO_2 and PM10, 2014. Source: European Commission, DG Environment, Atlas of air quality zones and monitoring stations (2013 & 2014), Germany.



2.1.3 Geomorphology

Germany reaches from the outer ranges of the Alps northward across the Central German Uplands and then across the sandy, rolling plains of the North German Plain. Germany's central and southern regions have forested hills and mountains cut through by the Danube, Main, and Rhine river valleys. In the north, the landscape flattens out to a wide plain that stretches to the North Sea. There are forested hills in the urbanized west of Germany, and agricultural plains in the east.

The detailed characteristics of Germany and of the Berlin agglomeration are presented in the textbox below.

Text box 2-1 Germany and the Berlin agglomeration.

Germany	
GDP per capita in PPS (2017)	123
GDP per capita growth (% 2008-2017)	11.5 %
Population (1 January 2018)	82.5 million
Governance structure	Federal, 16 States (*Länder*)
Zones defined as agglomerations (%)	39%
Berlin agglomeration	
Number of inhabitants:	3.7 million
Area:	891.7 km^2
Characteristics of the Berlin agglomeration: Berlin straddles the river Spree in an area of low-lying marshy woodlands with a mainly flat topography.	

Source: Eurostat tec00114, GDP per capita in Purchasing Power Standards (PPS) expressed in relation to the European Union (EU28) average set to equal 100; Eurostat tec00115, Real GDP per capita, growth rate and totals, sum of annual growth rates 2009 to 2017; Eurostat tps00001, Population on 1 January; Eionet data and the report Air Quality in Germany, 2017.

2.2 *Air quality monitoring and air quality*

This section summarises the air quality monitoring networks in Germany and provides a short overview of air quality achievements in Germany. Detailed information regarding the exceedances reported in the EEA database is presented in Appendix D to this report.

2.2.1 Air quality assessment

The 16 States are responsible for the assessment of air quality. Air quality is measured at over 650 monitoring stations throughout Germany, by the individual States and by the German Environment Agency (Umweltbundesamt, UBA).

UBA operates a national network of seven regional background stations, to monitor background and transboundary pollutant levels. These stations are operated as part of international programmes, including EMEP.

Each of the 16 Federal States operates air quality monitoring networks in their area and make current air quality data available on the websites of the responsible state offices[1]. State monitoring data is also transmitted to the national air quality database at UBA, where it is accessible on UBA's national air quality information service[2]. UBA transmits data to the EEA e-Reporting system for the AAQD and Decision 2011/850/EU reporting obligations.

NO_2, PM_{10}, $PM_{2.5}$, ozone, SO_2 and CO are measured directly in the monitoring stations and real-time data is retrieved and checked. There is a continuous data flow from the measuring stations to UBA.

Both gravimetric and automatic equivalent methods are used to measure PM_{10} and $PM_{2.5}$. Some States only send the laboratory-based gravimetric PM measurements for the official reporting to the EEA as they only consider the reference method to be compliant with the legislative requirements. Gravimetric PM samples are further analysed for metals.

In addition to continuous automatic monitoring using reference and equivalent methods, many of the States collect fixed measurements using passive sampling with 100% time coverage, primarily for NO_2.

The Berlin air quality monitoring network (BLUME) has operated since 1975. It now includes 16 fixed stations with continuous automatic measurements with a different number of instruments for NOx/NO_2 (16 sites), PM_{10} (11), ozone (7), benzene (3), SO_2 (2) and CO (2). There are six traffic stations on busy roads, five inner-city urban background stations (residential and commercial areas) and five suburban background stations. $PM_{2.5}$ is measured gravimetrically at one traffic and three urban background stations. Benzo(a)pyrene and heavy metals in PM_{10} are measured at two and four of the stations, respectively. There is also one meteorological station and one mobile station - the "measurement bus". Data from the automatic stations is available on Berlin's online air quality information service[3].

The Berlin monitoring network also includes up to 30 small and low-cost roadside sampling devices for black carbon (EC/OC) in operation since 1997. Passive samplers for NO_2 are also used at these 30 sites, using a two-week sampling period throughout the year. Due to the delay for laboratory processing, most of these data are only published in annual reports. Given the growing public interest in NO_2 measurements, Berlin has now started publishing the bi-weekly averages of the passive samplers as well. Since 2017, two automatic aethalometer instruments are in operation, measuring especially the contribution from wood burning to PM_{10}.

2.2.2 Air quality in Germany

The following summary of air quality statistics for 2017 in Germany is based on a preliminary analysis by the German Environment Agency (Umweltbundesamt, 2018). The summary includes PM_{10}, $PM_{2.5}$, NO_2 and ozone.

---

[1] https://www.umweltbundesamt.de/themen/luft/messenbeobachtenueberwachen/luftmessnetze-der-bundeslaender

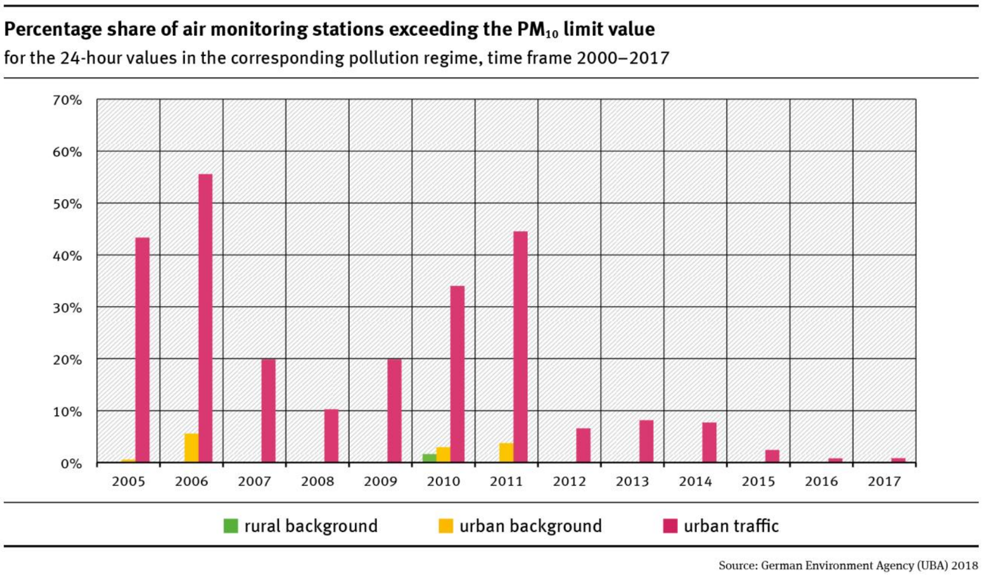
[2] https://www.umweltbundesamt.de/en/data/current-concentrations-of-air-pollutants-in-germany

[3] https://luftdaten.berlin.de/lqi

Air quality

In 2017, the level of PM_{10} particulate matter in Germany was lower compared to 2005–2016 (Figure 2-3). The EU 24-hour PM_{10} limit value was only exceeded at one station in Stuttgart. The WHO 24-hour guideline for PM_{10} was exceeded at 87 percent of all air monitoring stations. The EU annual limit value for PM_{10} (40 µg/m³) was not exceeded in Germany in 2017, although 21 percent of the stations exceeded the WHO annual guideline for PM_{10} (20 ug/m³).

Figure 2-3 Percentage of stations exceeding the 24-hour PM10 limit value in Germany, 2005-2017.



Source: Umweltbundesamt (2018).

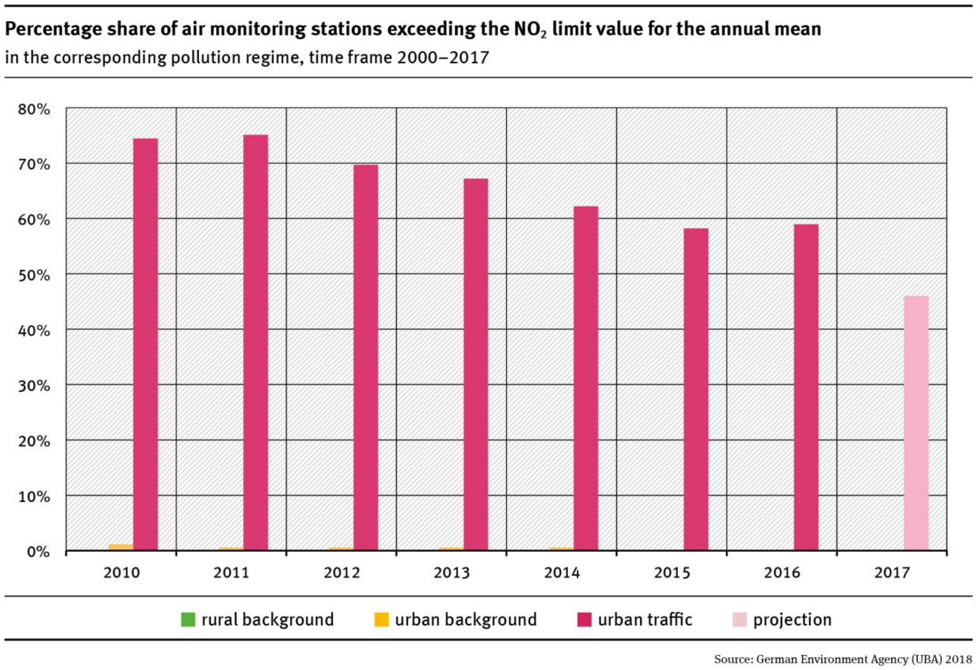
For $PM_{2.5}$, the EU annual limit value was not exceeded at any monitoring station in Germany in 2017. The Average Exposure Indicator (AEI) for $PM_{2.5}$ in 2017 (average of 2015, 2016, 2017) was 12.6 µg/m³ (preliminary), which is already below Germany's 15% national reduction target for AEI by 2020 of 13.9 ug/m³.

The EU annual limit value for NO_2 was exceeded at an estimated 46 % of urban traffic monitoring stations in Germany in 2017 (preliminary, Figure 2-4). The EU annual limit value for NO_2 is the same as the WHO guideline value. The EU one-hour limit value for NO_2 (200 µg/m³ up to 18 times per year) was not exceeded at any station in Germany for the first time in 2017. In previous years, there have been several exceedances at urban traffic stations.

The measured annual average concentrations of NO_2 in Germany declined until the end of the 1990's[4]. Since the year 2000 only a small downward trend is detectable. In 2017 the air in German cities was still highly polluted with NO_2[4].

[4] Schneider et al. (2018). Quantifizierung von umweltbedingten Krankheitslasten aufgrund der Stickstoffdioxid-Exposition in Deutschland https://www.umweltbundesamt.de/sites/default/files/medien/421/publikationen/abschlussbericht_no2_krankheitslast_final_2018_03_05.pdf

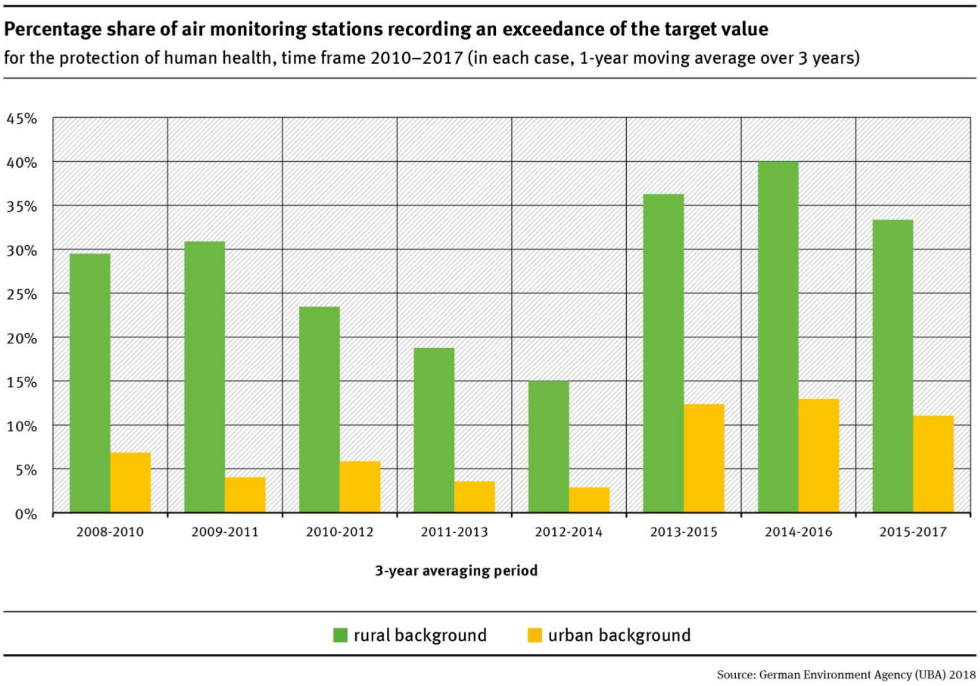
Figure 2-4 Percentage of air quality monitoring stations exceeding the annual limit value for NO_2 in Germany, 2010-2017



Source: Umweltbundesamt (2018).

In comparison with the last 20 years, ozone concentrations were quite low in Germany in 2017. The 8-hour target value for ozone (120 ug/m³ up to 25 day, 3-year average) was exceeded at 17 percent of the monitoring stations in Germany – mostly at rural background stations (Figure 2-5). The alert threshold for ozone (240 ug/m³) was not exceeded, but the information threshold (180 ug/m³) was exceeded on seven days. The long-term objective for 8-hour ozone concentration (120 ug/m³) was exceeded at 95 percent of the stations in Germany.

Figure 2-5 Percentage of air monitoring stations exceeding the 8-hour limit value for ozone in Germany, 3-year averages, 2008-2017.



Source: Umweltbundesamt (2018). Air Quality 2017 – Preliminary Evaluation. [166]

Compliance performance

A summary of maximum pollutant concentrations in exceedance of the AAQD standards is provided in Appendix D for the years 2013 to 2017, for each of the 12 pollutants included in the AAQD. These values are obtained through processing of EEA data flow G data.

In 2017, there were exceedances in Germany of the limit values for NO_2 (annual), PM_{10}, (24-hour), O_3 (8-hour target and long-term objective), and Ni (target). There were no exceedances of the other pollutants. 2017 is the first year that no exceedances occurred in Germany for the 1-hour NO_2 limit value.

In 2013, there were exceedances for NO_2, PM_{10}, O_3, C_6H_6, Cd and Ni. The PAH target value has been exceeded in two of the past five years: 2015 and 2016.

Exposure and health impact

The percentage of urban population exposed to concentrations of PM_{10} above the 24-hour limit value has declined from nearly 9 % in 2010 to 0.1 % in 2016 (Table 2-1). The percentage is zero for $PM_{2.5}$, since 2012. There is considerable variation and no clear trend in exposure to ozone concentrations above the target value. There is also no clear trend in urban exposure to NO_2 concentrations above the annual limit value in the years 2010 to 2016, remaining in the range 5.1 to 6.9 %.

Table 2-1 Percentage of urban population in Germany exposed to concentrations above EU standards.

Pollu-tant	Measure	2010	2011	2012	2013	2014	2015	2016	2017
$PM_{2.5}$	Annual mean	na	na	0.0	0.0	0.0	0.0	0.0	na
PM_{10}	Percentile	8.6	8.4	0.5	0.5	0.8	0.3	0.1	na
O_3	Percentile	11.5	1.3	3.1	4.0	3.6	37.0	2.7	na
NO_2	Annual mean	5.9	5.6	5.8	6.9	6.8	5.2	5.1	na

Source: European Environment Agency, Air pollution fact sheet 2014 – Germany (for 2010, 2011 values), and 2018 (for 2012-2016 values). na = not available.

EEA estimates of premature deaths attributable to $PM_{2.5}$, NO_2 and O_3 exposure in Germany are available for three years, 2013 to 2015 (Table 2-2). Only the estimates for $PM_{2.5}$ show decline over these three years.

Table 2-2 Premature deaths attributable to $PM_{2.5}$, NO_2 and O_3 exposure in Germany.

Pollutant	Measure	2010	2011	2012	2013	2014	2015	2016	2017
$PM_{2.5}$	Annual mean				73 400	66 080	62 300	na	na
PM_{10}	Percentile							na	na
O_3	Percentile				2 500	2 220	3 000	na	na
NO_2	Annual mean				10 610	12 860	13 100	na	na

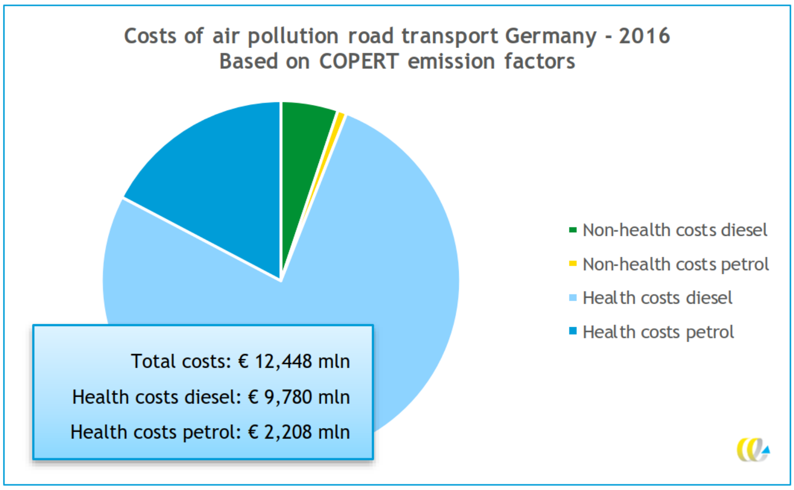
Source: European Environment Agency, Air quality in Europe – 2016 report (for 2013 values), 2017 report (for 2014 values), 2018 report (for 2015 values).

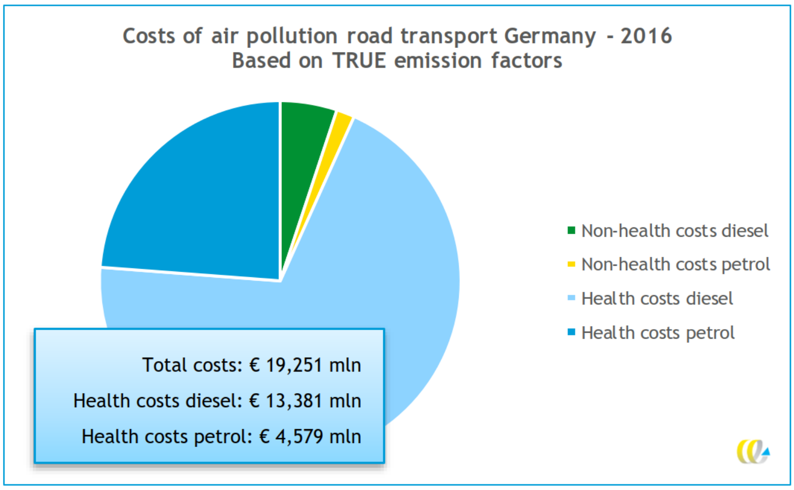
In the Commission's 2013 Impact Assessment, it has been estimated that the health-related external costs from air pollution in Germany are above EUR 58 billion/year (income adjusted, 2010), which include not only the intrinsic value of living a fully healthy life but also direct costs to the economy. These direct economic costs relate to 27 million workdays lost each year due to sickness related to air pollution, with associated costs for employers of EUR 3,500 million/year (income adjusted, 2010), for healthcare of above EUR 240 – 466 million/year (income adjusted, 2010), and for agriculture (crop losses) of EUR 715 million/year (2010).[5]

[5] EC. (2013). SWD(2013)531 - Commission Staff Working Document, Impact Assessment, Clean Air Programme for Europe (p. 352). Retrieved from http://ec.europa.eu/environment/archives/air/pdf/Impact_assessment_en.pdf [248], as cited in: EC DG ENV. (2017). SWD(2017) 38: EU Environmental Implementation Review Country Report - Germany. Commission Staff Working Document (Commission Staff Working Document). Brussels, Belgium: European Commission Directorate-General Environment. Retrieved from http://ec.europa.eu/environment/eir/pdf/report_de_en.pdf

A recent study of the costs of health impacts from road transport emissions (CE Delft, 2018[6]) found that total health and non-health costs to be € 12,4 billion in 2016, based on COPERT emission factors, and € 19.3 billion (55 % more) using TRUE-initiative real-world driving emission factors (Figure 2-6). The shares of total road-transport costs in Germany due to diesel vehicles in 2016 are 82 % and 75 % in these two cases.

Figure 2-6 Costs of air pollution from road transport in Germany in 2016, based on COPERT emission factors and TRUE-initiative real driving emission factors.



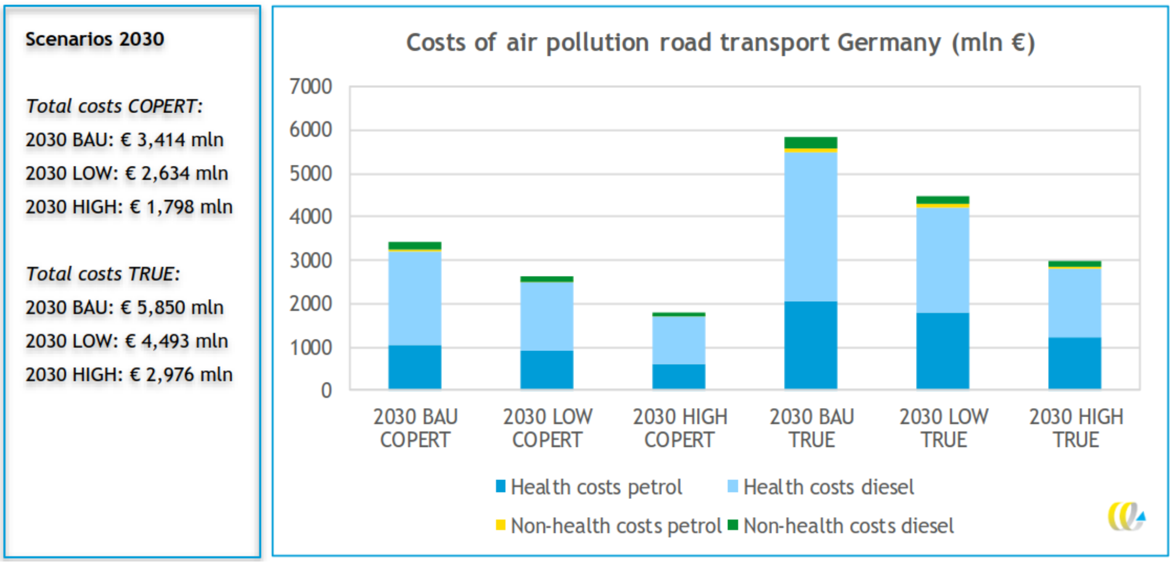


Source: CE Delft, 2018.

The CE Delft study also calculates health and non-health costs due to road transport in 2030, for a business as usual (BAU) scenario assuming existing policies, and low- and high-ambition scenarios of additional measures (faster uptake of zero-emission vehicles, bans of pre-Euro 6 vehicles, fuel taxes, road charging). The costs are much lower in 2030. With COPERT emission factors, the three scenarios total costs are BAU: € 3.4 billion, LOW: € 2.6 billion, and HIGH: € 1.8 billion, corresponding to reductions from 2016 of 73 %, 79 % and 86 % respectively (Figure 2-7). With TRUE-initiative real-driving emission factors, the costs in Germany in 2030 are about 70 % higher than with COPERT emission factors, while the relative reductions from 2016 are similar.

[6] [468] https://www.cedelft.eu/en/publications/download/2631

Figure 2-7 Costs of air pollution from road transport in Germany in 2030, for three scenarios, based on COPERT emission factors and TRUE-initiative real driving emission factors.



Source: CE Delft, 2018.

2.2.3 Air quality in Berlin

An overview of the current air quality status in Berlin is given in Table 2-3. NO_2 remains a serious problem, PM_{10} is coming under control and ozone exceedances are diminishing somewhat. There are no longer exceedances of $PM_{2.5}$, SO_2, benzene or PAH. CO and heavy metals have never been a problem in Berlin.

Table 2-3 Main sources of air pollution and status of compliance in Berlin. Source: Lutz, 2018.

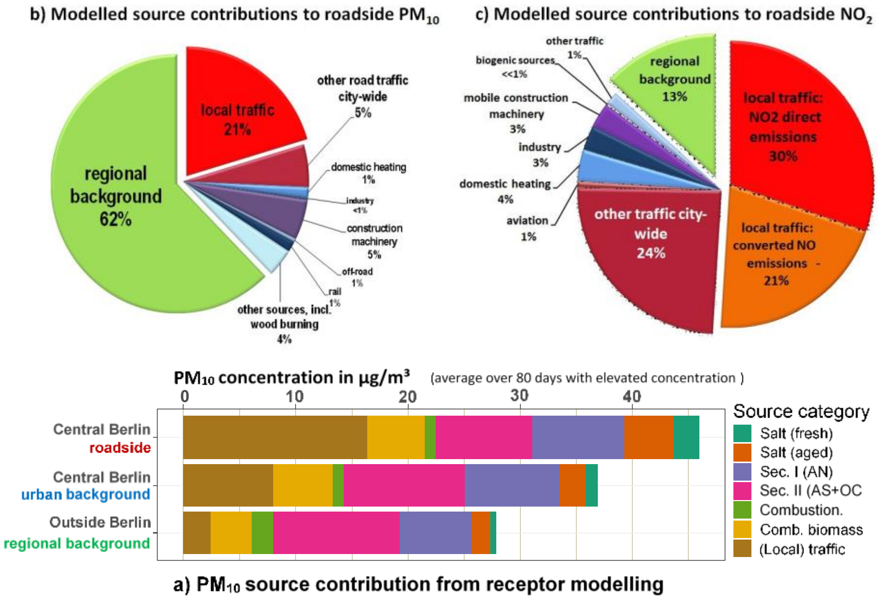
Pollutant	Main sources	Status and main measures
PM_{10}	Long-range transport, traffic, residential heating	Largely solved, shrinking local contribution Switch to clean fuel_& control technology
$PM_{2.5}$	Long-range transport, traffic	Problem solved, at least in relation to the limit value
NO_2	Road traffic (Diesel)	Serious problem, national court verdicts & law suit filed by EU, Diesel bans impending, needs cleaner Diesel vehicles and less traffic
Ozone	long-range transport, traffic	Diminishing problem, to be solved at national & EU level
SO_2	Power plants, industry, domestic heating	Problem solved 20 years ago switch to clean fuel_& control technology
CO, heavy metals	Traffic, heavy industries	Never a problem
Benzene	Traffic	Problem solved 10 years ago, cleaner fuel & vehicle technology

Pollutant	Main sources	Status and main measures
PAH	traffic, domestic heating	Problem solved 5 years ago switch to clean fuel_& control tech-nology

Emissions and source apportionment

At roadside stations in Berlin, about 62 % of the PM_{10} comes from the regional background and 26 % due to traffic, making it difficult to control PM_{10} with only local measures (Figure 2-1). For NO_2 at roadside stations, only about 15 % is due to the regional background, while 75 % comes from traffic, primarily diesel vehicles.

Figure 2-8 Source contributions a) to PM10 at different monitoring sites based on receptor modelling (van Pinxteren et al., 2017) , b) to roadside PM10 and c) to roadside NO₂, both based on dispersion modelling (SenUVK, 2018) (figure from Lutz, 2018).

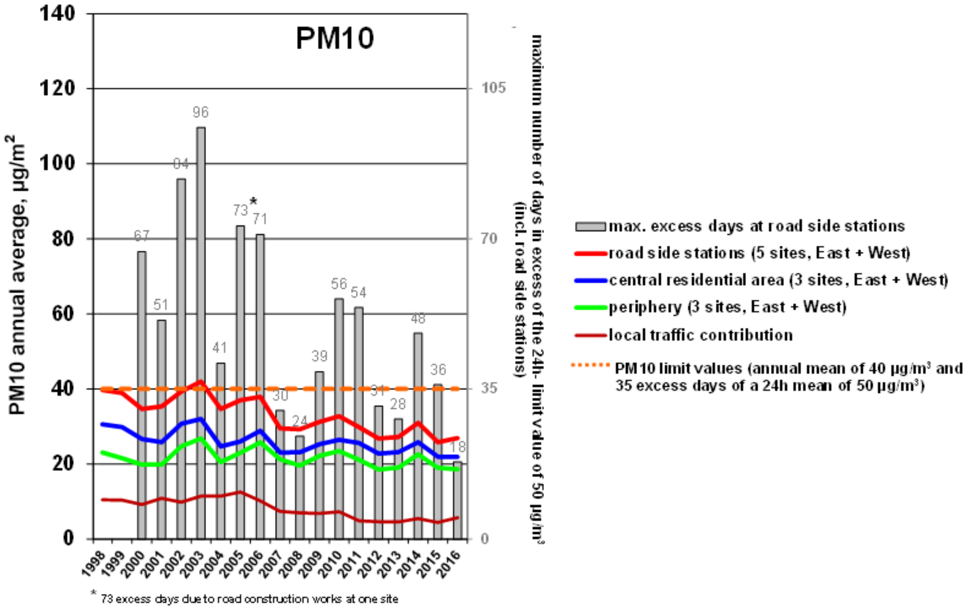


Source: Lutz (2018).

Air quality

For PM_{10}, exceedance of the short-term limit value has been a problem, with the city going in and out of compliance from year to year, due to the high percentile statistic for 24-hour values (50 µg/m³, 35 days per year), primarily due to year to year meteorological variability (Figure 2-9). But at least since 2016 the short-term limit value has been met.

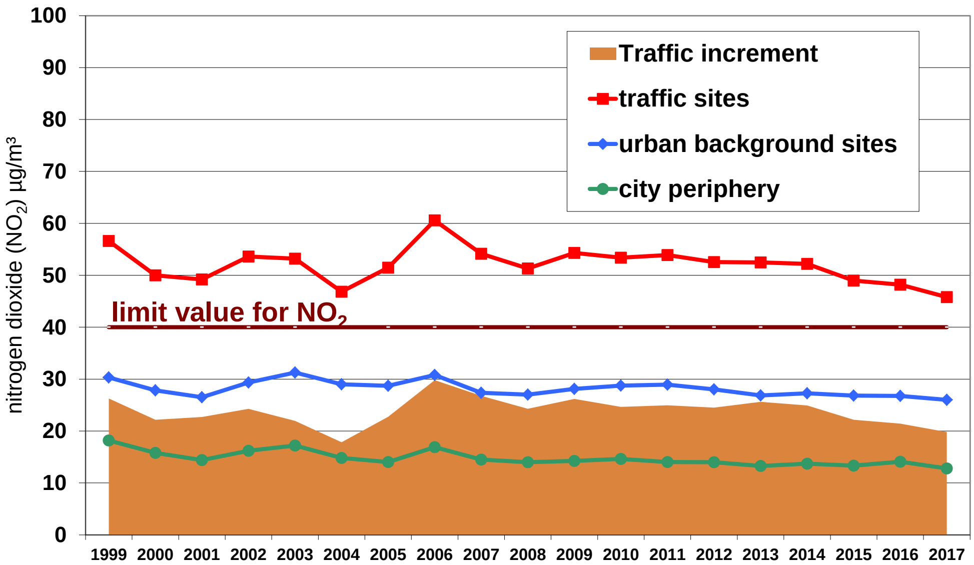
Figure 2-9 *Trend of annual average PM10 concentrations (lines), and maximum number of days over the 24-hour limit value (bars) in Berlin, 1998-2016.*



Source: Lutz (2018).

The levels of NO_2 at monitoring sites in Berlin have not shown a clear trend over the last 20 years, except a slight downward trend the last few years (Figure 2-10) contrary to traffic changes, which show a decline of car traffic volume by 15% since 2002.

Figure 2-10 *Trend of annual average NO₂ concentration in Berlin, by site type, 1999 to 2017. The solid curve is the relative traffic volume.*



Source: Lutz, 2018.

2.3 Allocation of responsibility

Article 3 of the AAQ Directive requires Member States to designate – at the appropriate levels - the competent authorities and bodies responsible for the assessment of ambient air quality and the implementation of other obligations laid down by the AAQ Directive. In Germany, the Federal Ministry for Environment, Nature Conservation and Nuclear Safety is the national authority responsible for the transposition of the AAQ Directive into national law, while most of its implementation like assessment of air quality and establishment of air quality plans, lies in the responsibility of the Federal States. The day-to-day monitoring of air quality and modelling has also been delegated to the Federal States. The Federal States (German Länder) are responsible for ambient air quality monitoring, assessment, as well as for air quality plans. The German Environment Agency (Umweltbundesamt, UBA) manages the reporting on AQ and AQ plans to the European Commission and oversees rural background AQ measurements. It assists the Federal Environmental Ministry in developing national programmes. For harmonization of the quality programmes, two national reference laboratories are notified (UBA and the State Environment Agency of North Rhine Westphalia (LANUV NRW)).

2.4 Legal and policy framework and air quality measures

Legal framework

The legal framework for air quality in Germany is mainly governed by the Act on the Prevention of Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibration and Similar Phenomena, for short: Federal Immission Control Act (BImSchG)[7] and its implementing ordinances and administrative regulations – the Federal Immission Control Regulations (BImSchV). A list of the BImSchV regulations is provided in Appendix C, and key regulations are described below. There are also provisions on air quality control at the Federal State level.

In Germany, the federal level has the legislative authority regarding the AAQD and the States implement this legislation in their territory. The federal level cannot interfere with State implementation and enforcement, but the Federal Government exchanges information with the States through the Federal-State Pollution Control Working Group.

Strategic framework

The German government bases air pollution control on four strategies[8]:

- laying down environmental quality standard
- emission reduction requirements according to the best available technology
- product regulations
- laying down national emission ceilings.

The ambient air limit values are stipulated in the AAQD and are transposed into German law. Major legislation for air quality include:

- Federal Immission Control Act and implementing ordinances

  Air quality control in Germany is mainly governed by the Act on the Prevention of Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibration and Similar Phenomena,

[7] BImSchG – English translation: https://www.bmu.de/filead-min/Daten_BMU/Download_PDF/Luft/bimschg_en_bf.pdf

[8] https://www.bmu.de/en/topics/air-mobility-noise/air-pollution-control/general-information/

short Federal Immission Control Act (BImSchG) and its implementing ordinances and administrative regulations. For example, the AAQD is implemented in national law by the 39. BImSchV. In addition, there are also provisions on air quality control at Länder level.

- Technical Instructions on Air Quality Control (TA Luft)

  The Technical Instruction on Air Quality Control (TA Luft) lays down procedures for authorities to examine applications for new industrial installations or extensions of existing installations with respect to their impact on air quality and deposition of air pollutants. In addition, it lays down emissions limit values for relevant air pollutants from installations. Existing installations must also be upgraded to the best available technology.

- Amendment to Ordinance on Small Combustion Installations (1. BImSchV)

  The amendment to the Ordinance on Small Combustion Installations (1. BImSchV), which entered into force in March 2010, was an important step towards reducing particulate matter emissions from small combustion installations such as stoves and tiled stoves. The amended requirements for new installations and the modernisation of existing installations contribute a noticeable average reduction in particulate matter emissions of five to ten percent in the residential areas concerned.

- Implementation of the Industrial Emissions Directive (IED)

  A large share of the emissions reduction necessary to meet NEC targets will be achieved through the IED implementation.

- Transboundary air pollution control policy

  A significant share of the pollution load is transported from and to neighbouring countries. The transboundary air pollution control policy is thus of strategic importance for air quality in Germany, in particular for the northeast of the country, where Berlin is only 80 km from the border to Poland. Germany participates actively in the constructive dialogue on air pollution control measures at both European and international level, including the Convention on Long-range Transboundary Air Pollution (CLRTAP) and Gothenburg Protocol. Encouraged by the AAQD, bilateral meetings have taken place between Germany and Poland since 2006 dealing with transboundary transport of PM_{10} pollution and how to tackle it.

Air quality measures: air quality plans and action plans

UBA maintains a list of local air quality plans (LRP) in Germany[9]. These plans need to be drawn up by the Federal States or the authorities designated by them, in some cases city authorities or regional governments in larger Federal States, like Bavaria and North Rhine-Westphalia. There are 158 cities listed with links to air quality plans and links to LEZ information for 76 of the cities. There are both air quality plans and combined air quality and short-term action plans.

Some of the larger cities have separate plans for city districts. There are 86 cities whose current plans are the first version, 52 in 1st update, 14 2nd update and 2 in 3rd update. Munich's air quality plan is in its 6th revision, with the 7th update in preparation. 15 other cities have revisions in

[9] UBA - Air quality plans in Germany http://gis.uba.de/website/umweltzonen/lrp_en.php

preparation. About 88 % of the cities have plans covering both PM_{10} and NO_2, while 9 % have plans for NO_2 only, and 3 % PM_{10} only.

Berlin's current air quality plan (for 2011-2017) was published in 2014[10], preceded by the first version pursuant to the AAQD, covering the period 2005-2010.

The third revision of Berlin's air quality plan is under development, to cover years 2018-2025[11]. An online public consultation survey was carried out in December 2018 and a draft AQ plan is expected to be published for public comment and hearing by March 2019. The new AQ plan will benefit from transportation measures included in the Berlin Mobility Act of 5 July 2018[12]. It is a novelty in Germany and will help to avoid court ordered driving bans by shifting car traffic to cleaner modes of transport. These measures include incentive programs for taxis and e-mobility - to quickly eliminate many high-mileage diesel taxis and replace them with green alternatives, public transport, the promotion of cycling, the electrification of car-sharing offers and the demand for a nationwide funding program for electro mobility[13].

Legal actions

Public frustration with the ineffectiveness of air quality plans to reduce exceedances has led to citizens seeking legal action to force cities to take effective measures. However, the AAQD does not expressly grant rights to citizens or organisations to seek legal action to improve air quality, so this had to be tested in the courts.

A landmark legal action known as "Janecek" was brought by a resident of a highly polluted road in Munich in 2008. With support from the German NGO DUH (Deutsche Umwelthilfe), the action passed through all the German courts until it reached the European Court of Justice (ECJ), which confirmed the legally enforceable right to clean air on 25 July 2008 (Janecek case)[14].

With the ruling of the Federal Administrative Court (BVerwG) in Leipzig of 5 September 2013 regarding a legal action brought by the DUH against the State of Hesse on account of the exceedance of air quality limits in Darmstadt, the right of environmental associations to sue was significantly strengthened. This ruling enables environmental and consumer protection organisations to legally pursue compliance with air quality limits throughout the entire city.

The Administrative Court of Wiesbaden stated in its judgement of 30 June 2015 that financial or economic aspects are not a valid excuse to refrain from taking measures to ensure that the limit values are complied with. Air quality plans must, therefore, include all measures that are appropriate to comply with the limit values as soon as possible. These legal cases have paved the way for numerous legal actions against German cities, to require effective air quality plans to be prepared and implemented.

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[10] Berlin Senate, 2014. Air Quality Plan for Berlin 2011-2017 http://www.berlin.de/senuvk/umwelt/luftqualitaet/de/luftreinhalteplan/download/lrp_150310_en.pdf

[11] Berlin Senate – Update air pollution control plan https://www.berlin.de/senuvk/umwelt/luft/luftreinhaltung/luftreinhalteplan_2025/index_en.shtml

[12] Berlin Mobility Act of 5 July 2018 https://www.berlin.de/senuvk/verkehr/mobilitaetsgesetz/index_en.shtml

[13] Press release – Package of measures adopted to improve air quality and avoid driving bans, 18-01-2018 https://www.berlin.de/rbmskzl/aktuelles/pressemitteilungen/2018/pressemitteilung.666959.php

[14] http://curia.europa.eu/juris/liste.jsf?language=en&num=C-237/07

Courts ordered the governments of Dusseldorf, Munich and Stuttgart, respectively to put restrictions on diesel vehicles in place. However, the cities argued that local authorities did not have the power to restrict diesel vehicles, a major source of NO_2. BVerwG ruled 27 February 2018 that cities are obliged to introduce diesel restrictions immediately to protect people's health.

This ruling prompted DUH and the international NGO ClientEarth to take legal actions against 11 more German cities starting in March 2018. Deutsche Umwelthilfe (DUH) presently has legal actions in progress in 28 German cities, supported by ClientEarth.

Infringement cases

The persistent breaches of air quality requirements (for PM_{10} and NO_2) are being followed up by the European Commission through infringement procedures.

The Commission issued a Formal Notice to Germany in January 2009 for failure to respect the 24-hour limit value for PM_{10} to be met in 2005 (under the former AAQD 1999/30/EC). A Reasoned Opinion was issued in September 2010, an additional formal notice in April 2013, and an additional Reasoned Opinion in November 2014[15]. The two zones concerned by the additional Reasoned Opinion are Stuttgart and Leipzig. The infringement procedure is still active, 14 years after the PM_{10} limit value was to have been met.

In May 2018, the Commission referred Germany to the European Court of Justice for failing to address repeated breaches of the NO_2 annual limit value and for failing to take appropriate measures to keep exceedance periods as short as possible[16]. A Letter of Formal Notice was issued in June 2015 and a Reasoned Opinion in May 2017. The referral comes after eight consecutive years of exceedance – in 28 zones including Berlin – of the NO_2 limit value to be met in 2010.

2.5 Information to the public

Pursuant to Article 26 of the AAQ Directive, Member States shall ensure that the public is adequately informed, in good time, about ambient air quality and other issues specified in the above cited Article.

In Germany, each of the 16 Federal States provides online and published air quality information.

At the Federal level, the UBA website provides information about air quality, pollutants and their sources[17]. UBA has an interactive map and data service, which presents information about current and historical air quality levels in Germany. Air quality measurement data from each monitoring station can be downloaded in excel format. The exceedances of limit values are available for each monitoring station in a table format and information on exceedances noted for each year at each measurement station. The UBA website also offers articles and publications on air quality including its annual report on air quality based on preliminary data[18]. Information on health effects of pollutants is also available[19] in both German and English language.

[15] http://europa.eu/rapid/press-release_MEMO-14-2130_EN.htm

[16] http://europa.eu/rapid/press-release_IP-18-3450_EN.htm

[17] https://www.umweltbundesamt.de/themen/luft

[18] https://www.umweltbundesamt.de/sites/default/files/medien/421/publikationen/180213_uba_hg_luftqualitaet_engl_bf.pdf

[19] https://www.umweltbundesamt.de/themen/luft/wirkungen-von-luftschadstoffen/wirkungen-auf-die-gesundheit#textpart-1

2.6 Use of EU funding to fund air quality improvements

There are six ERDF programmes related to air quality in Germany in the 2014-2020 period, totalling € 92.3 million, listed in 0. Four of the programmes are classified as air quality measures (€ 37.0 million, 40 %) and two are in the integrated pollution prevention and control (IPPC) category (€ 55.3 million, 60 %).

Interviewees[20] inform that Berlin would have liked to use EU structural funds (ERDF), e.g. for buses, but the current funding criteria were too restrictive and were coupled with the social status of city districts. The received material needs to be used within the government area receiving the funds, which would forbid bus routes crossing district boundaries. Berlin was divided into rich and poor areas, with only the poor areas being eligible for funding. For bus companies also working outside of these poor urban areas, this funding could not be used. Interviewees highlighted similar barriers for construction machines and marine vessels. The current ERDF funding criteria were thus not flexible enough to be used for air quality, because Berlin's busses, marine vessels and mobile machinery are operating in the whole city.

0 also provides a list of 30 LIFE projects based in Germany since 1993. Four of these projects have been financed since 2008, including a legal action programme run by Deutsche Umwelthilfe (DUH), a clean heat project, a clean air project, and an experimental industrial air pollution control project.

[20] See Appendix B for list of interviews.

3 FINDINGS

This chapter presents detailed findings regarding the experience and lessons learnt in the implementation of the AAQDs in Germany and the Berlin agglomeration. This chapter focuses on the challenges and successes encountered in the implementation of the Directives. Additionally, the relevance of the AAQDs, and their air quality standards, has been explored. Finally, the chapter identifies the factors underlying compliance with and effectiveness of the AAQDs and provides an overview of the costs and benefits associated with the implementation of the Directives.

The findings presented in this chapter rely primarily on input provided by stakeholders interviewed in the context of the case study. These were, as relevant, supplemented by additional desk research. An overview of the interviews carried out is provided in Appendix B.

3.1 Relevance of the AAQ Directives

Air quality continues to be a source of concern to citizens in the Germany. The 2016 Environmental Implementation Review[21] indicated that air quality in Germany continues to be a cause for concern. EEA estimates that in 2015 about 62,300 premature deaths were attributable to $PM_{2.5}$ concentrations, 13,100 to NO_2 concentrations and 3,000 to ozone concentration (Table 2-2). For 2013 to 2015, the numbers of premature deaths due to NO_2 and ozone do not appear to be declining. Furthermore, findings of 2017 Special Eurobarometer confirm that air quality is a concern to German citizens.

The consultation carried out in the context of the case study (for an overview of the interviews carried out see Appendix B) showed that the objectives of the AAQDs are relevant in relation to the citizens' needs. In the following, more detailed stakeholder views on relevance and air quality plans are listed as expressed during interviews:

The stakeholder interviews identified the following opinions on relevance of the AAQD in Germany:

Pollutants: SO_2 levels have improved and are below the LAT, so there is no longer a requirement for measurement of SO_2. CO is also not significant.

Other pollutants: EC and UFP would be useful, but there is not enough data available to set a standard. In particular with regard to UFP monitoring data - including cohort studies on health impacts - is needed to enable health impact assessments before a limit value could be established.

Standards: Binding EU air quality standards are important. There would have been much less ambition to improve air quality in Germany without them.

The health impact from PM_{10} is 4-5 times higher than for NO_2, but only Stuttgart has exceedances for PM_{10}, while nearly half of roadside monitoring stations in Germany have exceedances for NO_2. Years of lost life (YLL) for $PM_{2.5}$ is five times higher than for NO_2, and YLL for ozone is only 25 % of the YLL for NO_2. Yet there are no exceedances for $PM_{2.5}$.

This suggests that the current focus on NO_2 in air quality plans is disproportionate with the impact, compared to the impact of $PM_{2.5}$ and to a lesser extent with PM_{10}. That is because the NO_2 annual limit value is equal to the WHO guideline, while the $PM_{2.5}$ annual limit value is 2.5 times higher than the WHO guideline.

[21] http://ec.europa.eu/environment/eir/pdf/report_de_en.pdf

The use of high-percentile short-term limit values makes them unstable from year to year. For example, the PM_{10} 24-hour limit value allowing 35 days of exceedance (90.41,4-percentile). It is not helpful if the zone flips in and out of compliance from year to year.

When there are both short-term (hourly, daily) and long-term (annual) LV for a pollutant (PM_{10}, NO_2), one of them will be the driver – the one that is most difficult to comply with. It is preferred to have the long-term LV as the driver, because long-term measures are easier to include in an AQ plan.

The O_3 target value is a 3-year average, which helps to even out the wide year to year variations. However, target values, such as for O_3, are not effective, because they do not put pressure on policy makers. There is no threat of infringement, and court challenges are difficult.

The AEI percentage reduction target for $PM_{2.5}$ is in the right direction, like in NEC – a relative rather than absolute reduction. Another advantage of the AEI is its definition based on spatially-averaged urban background measurements representative for the exposure of the majority of the urban population, which could be a useful supplement to the current hot-spot-driven approach, but should be by zone rather than national.

Modelling: Modelling can give a complete spatial distribution of concentrations, which should be used for compliance assessment much stronger that currently required.

AQ plans: Stakeholders find that the requirement to prepare air quality plans is important.

Reference methods: The NO_2 reference method does not work for low background concentrations – it needs to be adopted to new technology.

There is a need for real-time measurements of PM_{10} and $PM_{2.5}$, but the reference methods for PM are based on gravimetric sampling which requires laboratory work. Many city networks use non-reference methods which provide hourly data. If reference method and equivalent method instruments are operated at the same station, the results of the reference method are used for compliance checking. Nonetheless, data for both methods are often submitted to EEA or the Commission for compliance checking, if the equivalent methods have undergone a proof of equivalence according to the AAQD requirements.

Zones: The use of air quality zones makes it easier to structure AQ plans, but it took time to develop common understanding of zones. The background for use of zones is lacking. The first zones were defined in 2003, and the zones were changed every year after that, depending on the exceedances measured, making it difficult for people to know which zone was for which pollutant.

Both authority and NGO stakeholders expressed that having one exceedance make the whole zone in exceedance is too simplistic. Maps showing zones as either in or not in compliance (i.e. "red" zones) does not reflect the actual size of the problem. The AAQD's "hotspot" approach does not reflect exposure, because most people do not spend as much time in hotspots compared to background areas. This suggests that the obligation to prioritise measures to comply with limit values at hotspots takes focus and resources away from reduction of the background levels where exposure – and resulting health impact – is greatest. The AAQD does not distinguish levels of exposure for exceedances nor for the measures needed to comply with the limit values.

Public access to justice: An NGO felt that the AAQD does not fully implement the Aarhus Convention provisions, in particular regarding the public's right to judicial or administrative recourse when provisions of the AAQD are not fulfilled by the competent authorities. National courts and the ECJ have now established these rights, but a more explicit granting of public rights in the AAQD may have been more efficient means to achieve the present state of enforcement.

3.2 Implementation successes

The present section highlights the key implementation successes of the AAQ Directives in Germany. The main implementation successes include:

- Monitoring systems are well developed
- Data processing and transmission from State to UBA and from UBA to EEA is working well.
- Quality systems are well established throughout the networks and harmonized by the National Reference Laboratory (NRL) linked to AQUILA (European network of NRL).

Air quality management in Berlin is administered by the same department as traffic planning, noise management and climate policy. This greatly facilitates the incorporation of air quality considerations into traffic planning and management. Successful pilot projects have helped to clarify the relationship between traffic measures and the resulting air quality impacts and improvements. This close linkage has contributed to the incorporation of air quality considerations in the recently passed mobility law and the sustainable urban mobility plan (SUMP) in Berlin. It is also an important factor to facilitate the development of the revised air quality plan for Berlin, due to be released by March 2019 for public hearing.

3.3 Implementation challenges

3.3.1 Air quality plans and measures

Responsibility for development of air quality plans lies with the States, and the federal government may not interfere in the States' implementation and enforcement of air quality obligations. However, the federal government retains the authority to make legislation governing air quality and air pollution control regulations often following EU legislation, e.g. product standards or BAT. Interviewees inform that this results in situations where cities do not have the legal authority to sufficiently regulate the emission sources contributing to exceedances.

For example, the federal government defines the use vehicle stickers for LEZ (35. BImSchV), but has not authorized the next logical level of vehicle restriction - a "blue sticker" requiring compliance with EURO 6 for diesel vehicles and offering exemptions for older Diesel vehicles retrofitted with an efficient type-approved SCR-system. Unable to progress to a next logical step in LEZ restrictions, court decisions are now requiring cities to adopt bans of diesel passenger cars, without being able to identify easily non-compliant vehicles. Interviewees thus refer to that this makes enforcement rather difficult and ineffective.

In the following, more detailed stakeholder views on implementation challenges are listed as expressed during interviews:

Sector authorities, both at state and federal level, are not always cooperative (agriculture, traffic, energy) and not aware of the binding air quality limit values that the state and city environmental authorities are obligated to comply with. Air quality is not their responsibility, and there is no obligation to integrate air quality in their planning at the national level. Interviewees thus express that in case of budget constraints, air quality is not a priority. To make the plans work, other sectors thus need to be convinced to put the necessary measures and legislation in place. In Berlin, air quality is incorporated in the list of objectives of the SUMP, which enhances cross-sectoral cooperation.

There is no means to obligate individual enterprises to be responsible for a share of the reductions needed to comply with LV – to invest in additional emission reduction measures for further mitigations, beyond what is required by IED and BAT conclusions in their permits.

Some interviewees also pointed to that even though local governments can influence local mobility, they cannot influence the EURO emission standards of the vehicles. The Federal Government has not promoted tighter vehicle emission standards and until very recently failed to come forward with the regulations to allow hardware-retrofit of Diesel vehicles with NOx-catalysts (SCR). There is a clear perception that the Federal Government did not see the difficulties cities were encountering.

When infringements arise, the States meet with the Federal Government but this was felt a being too late in the process.

3.3.2 Legal status of air quality plans

Article 23 of Directive 2008/50/EC provides that in zones and agglomerations where the levels of pollutants in ambient air exceed any limit value or target value (plus any relevant margin of tolerance) Member States "*shall ensure that air quality plans are established for those zones and agglomerations in order to achieve the related limit value or target value specified in Annexes XI and XIV*". The provision does not specify the legal status of the air quality plans and nor does it address the issue of access to legal recourse against potentially insufficient air quality plans.

3.3.3 Tackling regional sources

The new NEC Directive introduces an obligation to report on the progress of implementation of measures [NEC Annex III, Part I, 1(iii)], which will ensure that information is available and updated on the status of measures. The AAQD does not have such an obligation to report on the progress of implementation of AQ plans. The EOI Decision only requires Member States to provide a reference to where the public can have access to regularly updated information about AQ plans and on the implementation of the AQ plans (2011/850/EC Article 13 1(b)), but no requirement on the content of the updated information, or how often it shall be updated. The lack of obligatory progress reporting can make it difficult for citizens to monitor the progress of AQ plans.

There is no means in Germany for local authorities to require the Federal Government to take action on pollution sources that are outside the local jurisdiction, such as when the regional background is a large part of the pollutant levels where exceedances occur (PM_{10}). The Federal Government is not obligated to reduce background concentrations beyond what is obtained by the NEC commitments.

3.3.4 Agriculture and NH_3

Agriculture, responsible for 95 % of the German NH_3 emissions, is the last sector to get any requirements for emission reductions. There is considerable room for improvement in terms of reduction of national NH_3 emissions. One interviewee points to that it is very difficult to make changes in agriculture, because the agriculture lobby is even bigger than the car industry lobby.

One example mentioned by an NGO was that in Lower Saxony/Hannover, reduction of regional NH_3 emissions from agriculture could have been a component of the AQ plans to address former PM exceedances, but this cannot be dealt with on a local level. The State environment ministers meet twice a year with the Federal environment minister. While this issue has been discussed and the need to reduce NH_3 has been raised, progress has been blocked by the agriculture ministries on federal and State level. NGOs indicate that CAP reform has not focused on NH_3 reductions. This suggests that the significance of NH_3 for particulate matter concentrations in ambient air is not widely appreciated. One interviewee mentioned that NGOs and the public have not really taken an interest in NH_3. NGOs seem rather to be interested in diesel cars because it is easier to get the public interested in the impact of diesel cars. There is no real NGO campaign on nitrates in agriculture – only in water.

3.3.5 Use of modelling and indicative measurements

There are huge differences between the States on the use of modelling. Early AQ plans used extrapolation of emission reductions and air quality levels for their projection, which is no longer sufficient considering current modelling capabilities. For projecting vehicle emissions, cities used the only available emission factors (Handbook of Emission Factors, HBEFa) which some years back were outdated in terms of reflecting real-world driving emissions, resulting in overestimation of the emission reductions due to changes in the vehicle park. Timely updates of the HBEFa based on the latest knowledge on real driving emissions has made the picture more accurate over the last three years.

The requirement to report the impact of AQ plans on exposure of the population implies the use of a model, but interviewees point to that some States have used simplistic methods based only on air quality monitoring stations, to estimate the population exposed to level above the limit values.

In Germany, passive sampler data is accepted by UBA only when equivalence to the reference method has been proven and regular calibration takes place also. QA/QC programmes carried out by the German Länder networks, an inter-laboratory comparison carried out by the NRL LANUV as well as equivalence reports showed that passive sampler data could meet the required data quality objectives of the AAQD. UBA maintains that indicative measurements, i.e. data not covering the necessary time required for fixed measurements, are to be kept separate from official data used for compliance testing. At the same time, short measurement campaigns carried out by some NGOs cannot be used for compliance checking. Siting criteria is another issue that has to be addressed in this context, and DUH has been able to present passive sampler data for use in court cases. The NGOs interviewed find the passive sampler data gives good results.

3.3.6 Information to the public

The UBA and Berlin air quality information systems are generally considered to be good by stakeholders, but the interviewed stakeholders indicate that there is considerable variation in quality and ease of accessibility of information services among the States. There is a lack of harmonised requirements and best practices for information services and data access which could help to improve the quality of public air quality information services.

In the following, more detailed stakeholder views on available information to the public are listed as expressed during interviews:

It is possible to download air quality data, but each State has its own system for this. The UBA site is found by interviewees to be good, but download to Excel format appears to be the only choice. Berlin, for example, offers access to and download of all its monitoring and modelling data via the Environment Atlas[22].

[22] https://www.stadtentwicklung.berlin.de/umwelt/umweltatlas/edinh_03.htm

The States cooperate through round tables, where they get together to agree on procedures. One NGO indicates that the technology for providing information services and data is in many cases not up to date with current information technology.

Many States have indicative measurements (i.e. for periods not representing a full calendar year), e.g. from passive samplers, however it is reported during interviews that this data is often hard to find, since for example for NO_2, this data is only used for compliance checking with the yearly limit value and therefore often only published on a yearly basis, as UBA is downplaying of the value of indicative measurements in not accepting them for compliance checking.

3.3.7 Challenges in ensuring public awareness

Some stakeholders point to that it is difficult to communicate the concept of cost-effectiveness regarding air quality improvement measures. The NGOs interviewed concur that quantification of health impacts, such as years of lost life would be useful, and the use of monetary value of these impacts would be even better, for communication of cost efficiency of air quality measures. All the interviewed stakeholders agreed that the presentation of health impact based on premature deaths and years of lost life is problematic in Germany. There is no common language for this type of attribution. For example, a recent UBA study of the health impact of NO_2, expressed in terms of YLL, was severely criticised, and the results were discounted. There is likewise no tradition for CBA based on monetary valuation of premature deaths or YLL. Interviewees find that the lack of quantification of costs and benefits prevents this valuable tool from being used in plan and policy development, and communication of cost efficiency of proposed and implemented measures.

3.4 Factors underlying compliance with and effectiveness of the AAQ Directives

The following section provides an overview of the factors underlying and hindering compliance with and effectiveness of the AAQ Directives in Germany, and Berlin. The factors have been identified through stakeholder consultation conducted in the context of the case study. The views have been correlated with information gathered through desk research.

3.4.1 Factors underlying compliance and effectiveness

- Standard methods and criteria for measurements
- Harmonized quality standards in the networks (due to inter-laboratory comparisons of NRL, role of AQUILA)

3.4.2 Factors hindering compliance and effectiveness

- Lack of coordination between local, regional and federal authorities on measures due to separation of legal authority.
- It is not possible for an AQ plan to impose additional pollution reduction requirements on individual sources (power plants, industries) beyond the requirements in their environmental permits (based on IED and BAT conclusions)
- Delegation of full responsibility for air quality planning to States, while authority to regulate key regional emission sources remains at the federal or even European level.
- Lack of motivation among source sector ministries (transport, energy, industry) to incorporate air quality needs in their policies and measures.

3.5 Costs and benefits of the AAQ Directives

3.5.1 Costs of implementation

There are currently no economic analyses of the costs of implementation of the AAQ Directives in Germany. UBA and Berlin indicated that there should be some data on costs of monitoring, but none was received in the course of this study.

3.5.2 Costs of non-implementation

There is currently no national analysis of the costs of non-implementation of the AAQ Directives.

The case study identified a number of benefits stemming from the implementation of the AAQ Directives. These benefits cannot be quantified, as there are currently no quantitative assessments of benefits the AAQ Directives in Germany, but can be described in qualitative terms.

A number of provisions of the AAQ Directives have been identified as key, in delivering air quality improvements. These include, more generally, the establishment of a harmonised approach throughout the EU towards monitoring, assessment and management of air quality. The following provisions of the AAQ Directive were cited as those most important: 1) the setting of legally binding air quality standards; 2) harmonised standards and methods for monitoring and assessment, including AQ modelling 3) the obligation to prepare air quality plans with measures that remove exceedances as quickly as possible, and 4) the obligation to provide information on air quality to the public.

Maintaining/improving air quality, positive impacts on the eco-system and improvements to citizens' health

Legal challenges to cities' air quality plans have resulted in court rulings so that cities must revise the plans and include effective measures to reduce exceedances, and even to impose specific measures avoided by cities, such as diesel bans, to comply with limit values as quickly as possible. The threat of court imposed diesel bans is a major impetus for cities to rapidly revise air quality plans with comprehensive green mobility and residential heating measures that will be effective to achieve the limit values as quickly as possible. For example, Berlin has adopted a new mobility act and is currently preparing a comprehensive air quality plan revision, with the express intention to avoid a diesel ban as much as possible. The attainment of the NO_2 limit value, which has long been elusive in many cities, will significantly lower the burden on health in heavy-traffic central city areas.

Establishment of common methods and criteria for monitoring

Common methods have enabled Germany to establish comparable air quality monitoring in the 16 States. Inter-laboratory comparisons at the NRL and the work of AQUILA have helped to harmonize quality standards. Without the common standards, each State would have their own style of siting monitoring stations, and different and incompatible measurement methods.

Increased visibility of the issue and interest in solving the problem of air pollution

Interviewees have also noted that the court cases in Germany have received a lot of media attention, and public interest. The Volkswagen emissions scandal, widely known as 'Dieselgate' (illegal manipulation of emission control devices by car manufacturers) has also focused attention on the primary cause of NO_2 exceedances at roadside monitoring stations, and interviewees state that it has become easier for the public to understand the problem with diesel vehicles. Remarks are also made that on the other hand, there is little public awareness, interest and understanding in the contribution of agricultural NH_3 to $PM_{2.5}$ levels, so there is little public or NGO pressure to address the NH_3 emission issue in agricultural policy making. This is even more the case as current not very ambitious PM2.5 standards are not breached.

Clear effort from the industry to reduce emissions

Industry is meeting the emission requirements in the IED and BAT conclusions, in their environmental permits.

Legal actions

Landmark court decisions in Germany, both in German courts and ECJ, establish precedence for citizens' legal right to court actions in other Member States, and precedence for judges decisions in other Member States.

4 CONCLUSIONS

Chapter 4 presents the summary of the main findings of the case study regarding the main implementation challenges, the potential for improving the implementation of the Directives in Germany, and the aspects of the AAQD that may have contributed to the present situation in Germany. Finally, a summary of the evaluation of the AAQD is presented.

4.1 Identified problems and potential for improving the implementation of the Directives

The case study identified the following challenges in the implementation of the AAQ Directives.

Responsibility for air quality plans has been given to the 16 States in Germany. Cities have had difficulty to implement effective AQ plans because they do not have legal authority over many of the sources – for example power plants, industry, inland shipping and ports, which require federal or EU action to regulate. Several of the NGO and authority stakeholders pointed out that the federal sectoral authorities do not have an obligation or interest to incorporate air quality issues into their planning and policy implementation. There is not a mechanism or legal authority to require cooperation of the source sectors with local AQ plans. In addition, the vehicle and non-road machinery emission standards are established at the EU level, which local authorities have no influence over.

There is no mechanism to require individual sources (power plants, industries) to adopt additional air pollution control measures beyond the requirements of their permits (IED, BAT conclusions).

The federal environment ministry has legislative authority over the LEZ system in Germany, and has not extended the LEZ system with a "blue sticker" that would enable cities to require only EURO 6 or diesel vehicles with low real driving emissions in urban areas where the NO_2 limit value is persistently exceeded. A regional authority pointed out that the Federal Transport Ministry has until recently refused to come forward with technical regulations to allow retrofit of in-use Diesel vehicles to curb NOx-emissions. The result is that courts are now ordering bans of diesel vehicles including Euro 5 in LEZ areas, which is effective in reducing NO_2 levels as quickly as possible, but not necessarily cost-effective.

Berlin is found to have made frequent use of environmental procurement criteria to impose strict emission requirements on construction machines used for city projects and suppliers of goods and services to the city, that it otherwise does not have authority to impose.

4.2 Assessment of the AAQ Directives

The following section presents a summary of the findings of the case study in relation to the relevance, effectiveness, efficiency, coherence and added value of the AAQDs.

4.2.1 Relevance

Air quality objectives

The findings of the case study indicate that the objectives of *AAQDs are relevant to the needs of citizens in Germany* as air quality continues to pose a concern to the health of German citizens and the environment.

Pollutants

SO_2 concentrations in Germany are below the LAT, which removes the obligation to measure them at fixed sampling points. However, SO_2 levels are still above the WHO guideline. CO is below the WHO guideline and thus not a problem.[23] The other pollutants remain relevant.

There was monitoring of BC/OC/EC and UFP (particle number) before the AAQD, but measuring of smaller particles was partly stopped in order to focus on PM_{10}. Berlin has continued to measure UFP and BC. UFP/BC directly reflects local combustion emissions, especially traffic and wood combustion, making it a very responsive indicator for local measures in AQ plans.

Monitoring and assessment methods

Legally binding LV and the obligation to prepare AQ plans are essential for effective air quality management. Without the LV and planning obligation, the court cases would not be possible.

Both national and regional authorities noted that the definition of compliance testing in the AAQD is not clear regarding the use of equivalent methods, indicative measurements and modelling for legally-binding compliance testing. The authorities reported that some authorities interpret the AAQD to mean that only measurements based on reference methods and meeting all data quality objectives and siting criteria may be used for formal compliance testing. As a consequence, this results in useful measurements and modelling results not being contributed to EEA databases, and thus not available for public information and research. Although requested, there is no obligation to include these measurements and modelling results in submissions to the EC and EEA. This leaves it to local authority discretion whether to report supplementary data that might indicate additional areas of exceedance. In Germany, the data reported to EEA is limited to the data provided by the networks of the Länder and UBA. Data from other sources such as measurement campaigns are not included.

A regional authority expressed that the reference method for NO_2 is not sufficiently sensitive for low regional background concentrations and needs to be updated with technological advances.

The reference methods for PM_{10} and $PM_{2.5}$ do not permit real-time measurements, which are needed for information to the public during smog episodes. Equivalent methods are used to provide hourly data.

For equivalent methods, a guide (guide to the demonstration of equivalence of ambient air monitoring methods (GDE)) was issued by an EC working group and revised in 2010. For PM_{10} and $PM_{2.5,}$ a CEN standard (DIN EN 16450) exists.

A regional authority expressed that the requirements for demonstration of equivalence to the reference methods are found to be very complex, and difficult to comply with, causing considerable administrative and technical burden for the introduction of new methods. At the same time, it assures that e.g. air quality plans are based on reliable data that is quality assured and traceable to European standards.

4.2.2 Effectiveness

Most of the stakeholders noted that the problem is that politicians refuse to act unless there is a binding obligation in the legislation, backed by potential enforcement action.

[23] As referred to also in table 2-3 (Lutz, 2018)

Monitoring and assessment of air quality

Monitoring is in general found to function well in Germany. Interviewees report that at the time where zones were first established, the background for using zones was unclear, and frequent changes in zones were made in the years that followed. The zone definitions are now stable. 10 years ago, it was agreed not to use modelling for assessment of compliance, which has then indirectly hampered the development and use of modelling for planning and exposure assessment in Germany. In addition to the official data of the State networks, indicative measurements are carried out by NGO's and others with different systems and at different quality levels. NGOs interviewed find these data very useful, while state and federal environment authorities interviewed are concerned that indicative measurements generally do not meet the quality, calibration and time coverage requirements needed to be used for compliance testing.

The methodology for assessment of population exposed to pollutant levels exceeding the limit values is reported to vary considerably from State to State, with the simplest methods potentially leading to significant underestimation of exposed population. There is no binding guidance on the approach to use.

Monitoring in Berlin functions well in general and is supplemented by both indicative measurements and modelling. While indicative measurements have not yet been part of the official compliance monitoring to the EU, these data and model results are being used as a driver for measures to meet the NO2 limit value and to monitor the impact of measures. Having air quality, noise and traffic management in the same department has facilitated coordination of the measurements and assessment in these areas, and for planning of measures.

Compliance with standards

Compliance with the NO_2 annual limit value is a wide-spread persistent problem at urban traffic locations in Germany, including Berlin. The primary reason is the real driving emission of NO_X and NO_2 is much higher than the EURO standards specify.

Exceedance of the 24-hour PM_{10} limit value has been a serious problem, but few PM_{10} exceedances remain. The high percentile definition of the 24-hour PM_{10} limit value (50 µg/m³ not to be exceeded more than 35 days) is sensitive to year to year variations in meteorology and, in the past, has resulted in monitoring stations flipping in and out of compliance from year to year.

There are no exceedances of the EU annual limit value for $PM_{2.5}$. However, smog episodes in cities like Stuttgart indicate that a short-term limit value and alert threshold is needed for $PM_{2.5}$. Without a standardised alert threshold for $PM_{2.5}$, each city defines its own threshold. Interviewees have reported that this is confusing for residents and visitors.

Public information

Public information systems for air quality are working well but could be modernised in some States. There is a lack of harmonised standards and requirements for information services that would help to raise the quality in States where the AQ information systems are less sophisticated.

NGOs have pointed out that the AAQD does not fully implement the Aarhus Convention.

Measures and air quality plans

There are 158 cities with air quality plans in Germany. Compliance with the 24-hour PM_{10} limit value has been achieved except for one zone, while exceedances of the NO_2 annual limit value remain, due primarily to the increase of the diesel share of passenger cars, and real-world driving emissions that substantially exceed the EURO emission limit specifications.

Initial AQ plans did not have effective measures, or the measures were not implemented. Stakeholders reported a number of reasons for this, e.g. due to lack of ambition, lack of legal authority, lack of influence in other sectors, lack of appropriate modelling. There was a lack of analysis of source apportionment to establish a clear connection between sources and ambient concentrations, although Berlin conducted two source apportionment studies on PM10 (2002) and PM2.5 (2007), which laid the ground for the LEZ scheme enforced 2008. Also, according to stakeholders, the first plans in some States did not assess the effect of existing measures. As a consequence, the use of extrapolation of air quality trends based on expected emission reductions was unrealistic and overestimated the benefit of proposed measures.

Low emission zones (LEZ) were first implemented to control PM_{10}. LEZ have been an important measure to reduce PM_{10}-pollution, especially since they accelerated the renewal of the vehicle fleet. Their impact on UFP- and BC-pollution was even higher than their impact on PM_{10}. The Berlin LEZ resulted in 7-10% reduction of PM_{10}, equivalent to about 10 excess days of the 24-hour 50 $\mu g/m^3$ threshold. EC/OC dropped by 50%, largely because about a quarter of the Diesel fleet had diesel particulate filters (DPF) retrofitted. Existing LEZ without a blue sticker are not an appropriate measure to reduce NO_2.

The findings of the case study indicate effectiveness of the AAQDs in maintaining air quality where it is good and improving it in other cases.

4.2.3 Efficiency

No economic analyses of the costs of implementation of the AAQ Directives in Germany were obtained from the desk research or interviews.

4.2.4 Coherence

Interviewees pointed to that climate plans do not address synergies with AQ and AQ plans do not address the synergies with climate. This results in the costs of these policies being over-estimated. When synergies are included, the implementation costs are lower. As example, interviewees mentioned amongst others transport measures to improve air quality, such as improvements to bicycle infrastructure, urban rail systems, parking fees, obviously also have climate benefits.

Cities are also required to prepare Sustainable Urban Mobility Plans (SUMP), which deal extensively with traffic and therefore have substantial synergies with both air quality and climate. However, the general point was also made by a stakeholder that having to prepare separate AQ plans, climate plans and SUMPs, with so much overlap, is an unnecessary administrative burden. These plans should be fully integrated to be more efficient and also to produce better results in all three sectors – air quality, climate and mobility. Berlin has an advantage in this regard – seldom seen in cities – that these three sectors are in the same administrative unit, which has facilitated the inclusion of AQ objectives in the SUMP and in return, the AQ plan of Berlin integrated several mobility-related measures stipulated by the SUMP.

4.2.5 EU added value

The AAQD reference methods, data quality objectives and siting criteria help to harmonize AQ monitoring.

Without the AAQD, it is the general assessment among the interviewed stakeholders that:

1 Germany would not have had similar types of limit values. TA Luft would not go so far, and it only regulates industrial emissions, but not products, traffic, etc.;

2 The local level would not have been involved to make AQ plans. There would not be the local understanding of where AQ problems come from, and what can be done;

3 Germany would not have had monitoring networks and comparable data, and would not have all the data in one place to create harmonised maps of AQ for Germany, for reports and public information;

4 The level of ambition for air quality would be lower. If it were up to the German government, objectives on AQ might have been weakened in the past years.

The AAQD created a level playing field for air quality management which has been important for EU negotiations on air quality objectives.

Error! Reference source not found. summarises the air quality standards in place in Germany prior to the 2004 and 2008 AAQD, and the changes introduced in 2004 or 2008 by the AAQD.

Table 4-1 Changes introduced in national legislation as a result of the AAQD

Pollutant	Situation prior to AAQD	Changes introduced (2004 or 2008) by AAQDs to the legislation
NO_2	NO_2 limits transposed from 1999/30/EC	No change
PM_{10}	PM_{10} limits transposed from 1999/30/EC	No change
$PM_{2.5}$	$PM_{2.5}$ monitoring obligation transposed from 1999/30/EC	$PM_{2.5}$ target, limit value, AEI and AEI reduction target transposed from 2008/50/EC.
O_3	O_3 target and long-term objectives transposed from 2002/3/EC	No change
SO_2	PM_{10} limits transposed from 1999/30/EC	No change
Pb	CO limits transposed from 1999/30/EC	No change
CO	CO limits transposed from 2000/69/EC	No change
C_6H_6	C_6H_6 limit transposed from 2000/69/EC	No change
As, Cd, Ni	No information provided	As, Cd, Ni targets transposed from 2004/107/EC
PAH	No information provided	PAH limit transposed from 2004/107/EC

Access to justice

Landmark court decisions in Germany, both in German courts and ECJ, establish precedence for citizens' legal right to court actions in other Member States, and precedence for judges' decisions in other Member States. The legally binding air quality standards and obligation to prepare AQ plans to address exceedances as quickly as possible have been essential to enable these legal actions.

The legal right to court action had been narrowly defined in Germany to apply only to citizens directly affected by air quality exceedances – i.e. only those living on a polluted street. Court decisions in Germany extended these legal rights to citizen groups and NGOs, with city-wide coverage. This was a major breakthrough that has enabled NGOs to begin legal actions against many cities in Germany. This creates legal precedence that is of benefit to NGOs in other member states.

Access to information on air quality

All 16 German States and the German environment agency (UBA) have air quality information systems which fulfil the basic requirements of the AAQD for public information on air quality. The available information and user-friendliness varies considerably from State to State, according to NGOs, and the Berlin air quality information system is viewed to be the best by the stakeholders interviewed. Without the AAQD, it is unlikely that air quality data and information would be available to the extent it is today. The lack of specific requirements and best practices for information services has contributed to the variable quality of the State air quality information services. NGOs remark that air quality information services have not kept up with changes in information technology. For example, the facilities provided to download data providing only text or spreadsheet export, but not more modern methods that would facilitate automatic retrieval by data analysis systems and apps. There is no provision in the AAQD regarding adaptation of public information services to changing technology as there is for measurement methods.

APPENDIX A REFERENCES

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APPENDIX B INTERVIEWS

Organisation	Date of the interview
German Environment Agency (Umweltbundesamt, UBA)	3 Sep 2018, Berlin
Deutsche Umwelthilfe (DUH)	3 Sep 2018, Berlin (jointly with BUND)
Bund für Umwelt und Naturschutz Deutschland e.V. (BUND) / Friends of the Earth – Germany (FoE-DE)	3 Sep 2018, Berlin (jointly with DUH)
Berlin Senate Department for the Environment, Transport and Climate Protection (SenUVK)	4 Sep 2018, Berlin
North Rhine-Westphalia - State Office for Nature, Environment and Consumer Protection (LANUV)	6 Sep 2018, telephone interview
NABU (Nature And Biodiversity Conservation Union)	25 Sep 2018, telephone interview

APPENDIX C PILOT INTERVIEW GUIDE

General questions

- What challenges have been encountered when implementing the AAQ Directives?
- How have these challenges been overcome? What has proved to work well and what turned out to work less well? Are there any relevant lessons learned that other Member States could learn from?
- Where do you see the greatest potential to improve further the implementation of the Directives?
- Have any specific initiatives/measures been introduced to support the implementation of the AAQ Directives in the Member State (e.g. national guidance, arrangements for information exchange, etc.)?
- What systems are in place to provide information to the public on air quality, exceedances and alerts, and the implementation of plans and measures?

Specific questions

The table below outlines the specific themes discussed during the interviews.

Evaluation question	Questions
RELEVANCE	
(1) How relevant are the goals and objectives of the AAQ Directives to the needs of citizens; do the AAQ Directives still address the most relevant pollutants and set relevant standards and obligations to protect human health and the environment; and are the AAQ Directives sufficiently adapted or adaptable to evolving technical and scientific progress?	To what extent do the goals of the Directives correspond to the needs of the citizens (in your country)? Which of the Directives' requirements are in your opinion the most important in relation to the citizens' needs? To what extent have the goals of the Directives been integrated in the strategic documents (on environmental protection) in your country?
(2) How far are the Directives aligned with key EU priorities? Which elements in the Directives are essential to deliver on these priorities, have elements become redundant?	

Evaluation question	Questions
EFFECTIVENESS	
(3) What factors have contributed to meeting the objectives of the AAQD or to failing to meet these objectives, in terms of: 1) defining common methods to monitor and assess air quality; 2) assessing ambient air quality in order to monitor trends; 3) establishing standards of air quality to achieve across the EU; 4) ensuring that information on air quality is made public; 5) maintaining good air quality, improving it where it is not good; to what level can these factors be attributed to provisions of the AAQ Directives?	What are the main factors that contribute to compliance with/effective implementation of the air quality Directives; hereunder: • air quality standards • reporting requirements • requirements regarding the establishment and implementation of air quality plans and programmes • requirements regarding provision of information to public? • requirements regarding monitoring stations? What are the main barriers (at national/regional/local) level preventing effective implementation of the air quality Directives? Please consider each of the items listed above separately. What would it take to overcome the barriers?
EFFICIENCY	
(4) What are the costs and benefits (monetary and non-monetary) associated with implementation of the AAQ Directives in the Member States, and in the EU; have the benefits (improved air quality) been achieved in a cost-effective manner and to what extent have costs been equitably distributed across different sectors?	What are the costs of implementation of the AAQ Directives? What is the cost of implementation (monitoring, reporting, and planning) for different levels of government, including the use of external expertise on, per year (in FTE)? What is the cost of implementation for different sectors of the industry per year (capital and operating costs of equipment in EUR)? What specific factors contribute to the efficiency/inefficiency of the implementation of the AAQ Directives? What are the costs of non-implementation of the Directives (e.g. environmental and health costs, uncertainty and market distortion, litigation costs for Member States)? What are benefits associated with the implementation of the Directives in the Member State/air quality zone (e.g. health and environmental benefits, economic benefits, eco-innovation, etc.)?
(5) Where there are significant cost differences between Member States and/or between different sectors and/or as regards costs to stakeholders (including social costs as a consequences of poor implementation), what is causing them; and are the costs of compliance proportionate to the benefits brought by the directives?	
(6) How efficient are monitoring, reporting and assessment regimes, what are the administrative costs to the Member States and to the Commission; taking account of the objectives and benefits of the directives is there evidence that they have caused unnecessary or excessive administrative burden?	
(7) Has the implementation of the AAQ Directives supported or hampered EU competitiveness in the global economy; has the implementation of the AAQ Directives improved or been detrimental to economic, social and environmental sustainability?	
COHERENCE	
(8) To what extent do the AAQ Directives complement or interact with other environmental policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as the	How and to what extent is the implementation of the AAQ Directives coordinated with the implementation of other EU instruments in the environmental and climate domain (e.g. the National Emissions’

Evaluation question	Questions
NEC Directive and IED Directive as well as the EU climate legislation and policy; and how do these policies and legislation support or hamper the implementation of the EU air quality legislation?	Ceiling Directive, the Industrial Emissions' Directive, Large Combustion Plants Directive, etc.)?
(9) To what extent do the AAQ Directives complement or interact with sectoral policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as energy, transport, agriculture, cohesion, fiscal policies); and how do these policies support or hamper the implementation of the EU air quality legislation?	How and to what extent is the implementation of AAQ Directives coordinated with other relevant legislation and policy (e.g. in the area of energy, transport and agriculture)? Are air quality plans coordinated with planning initiatives promoted by EU sectoral legislation (e.g. Sustainable Urban Mobility Plans, TEN-T investments)? Are air quality plans coordinated with national emission reduction plans and measures under the NEC Directive? Are air quality plans coordinated with climate change mitigation policies and plans (for GHG emission reductions)? To what extent are air quality plans integrated or linked with municipal/urban/regional level planning e.g. in the area of land use and spatial planning, energy management, transportation and climate? To what extent are EU funds used to finance measures (e.g. abatement programmes) to maintain good air quality/improve air quality?
ADDED VALUE	
(10) To which degree have the AAQ Directives, including common EU air quality standards and comparable air quality assessment, management and information approaches enabled Member States and their competent authorities to take successful action to improve beyond what would have been possible without EU action?	Have AAQ Directives triggered transformational changes that have enabled the achievement of air quality objectives? Have AAQ Directives contributed to improvements in monitoring? Have AAQ Directives contributed to improvements in public information and public participation? What are the wider economic, social and environmental impacts of the Directives in the Member State/air quality zone?
(11) What has been the EU added value of the AAQ Directives, do the Directives and their means of implementation create synergies or overlaps with other Community objectives, and how has the distribution of responsibilities between EU, Member State, regional and local levels impacted on air quality management?	How is the implementation of the AAQ Directives coordinated in the Member State (division of responsibilities, coordination across different activities)? To what extent is the implementation of AAQ Directives coordinated in the region (to address transboundary pollution)?

APPENDIX D FEDERAL IMMISSION CONTROL REGULATIONS (BIMSCHV)

The Federal Immission Control Regulations (BImSchV) are statutory ordinances of the Federal Republic of Germany, which serve primarily to protect against harmful environmental effects caused by air pollution and noise. They are issued by the Federal Environment Ministry on the basis of the Federal Immission Control Act.

In addition to the fundamental requirements of the law, these regulations regulate the numerous details that are essential for practical application, especially of a technical nature and administrative execution.

Wikipedia list, google translate - https://de.wikipedia.org/wiki/Bundes-Immissionsschutzverordnung.

For most recent version of the German legislation, see https://www.bmu.de/service/gesetze-verordnungen/

Table 4-2 Federal Immission Control Regulations (BImSchV)

1. BImSchV	Ordinance on small and medium-sized combustion plants
2. BImSchV	Ordinance on the Emission Control of Volatile Halogenated Organic Compounds
3. BImSchV	Ordinance on the sulfur content of certain liquid fuels, repealed with the entry into force of 10. BImSchV
4. BImSchV	Ordinance on Installations Subject to Licensing
5. BImSchV	Ordinance on Immissionsschutz- und Störfallbeauftragte
6. BImSchV	Ordinance on the Expertise and Reliability of Immission Control Officers, repealed (Content integrated in §§ 7 to 10 of 5. BImSchV)
7. BImSchV	Ordinance on the ejection limitation of wood dust
8. BImSchV	Lawn Mower Noise Ordinance, repealed with the entry into force of 32. BImSchV
9. BImSchV	Ordinance on the Approval Procedure
10. BImSchV	Ordinance on the Quality and Quality of Fuels
11. BImSchV	Regulation on Emission Declarations
12. BImSchV	accident regulation
13. BImSchV	Ordinance on Large Combustion, Gas Turbine and Internal Combustion Engines
14. BImSchV	Ordinance on National Defense Installations
15. BImSchV	Construction Machinery Noise Ordinance, repealed with the entry into force of the 32nd BImSchV
16. BImSchV	Traffic Noise Ordinance

17. BImSchV	Ordinance on Incineration and Co-Incineration of Waste (Thermal Utilization)
18. BImSchV	Sports Facilities Noise Ordinance
19. BImSchV	Ordinance on Chlorine and Bromine Compounds as a fuel additive, repealed with the entry into force of the 10th BImSchV
20. BImSchV	Ordinance on the limitation of emissions of volatile organic compounds during transfer and storage of petrol, fuel mixtures or petrol
21. BImSchV	Ordinance on the limitation of hydrocarbon emissions in the refueling of motor vehicles
22. BImSchV	Ordinance on Immission Values for Air Pollutants, repealed with the entry into force of 39. BImSchV (certain contents taken over there)
23. BImSchV	Regulation on the determination of concentration values, repealed
24. BImSchV	traffic routes - sound insulation regulation
25. BImSchV	Ordinance on the limitation of emissions from the titanium dioxide industry
26. BImSchV	Ordinance on Electromagnetic Fields
27. BImSchV	Ordinance on cremation plants
28. BImSchV	Regulation on emission limit values for internal combustion engines
29. BImSchV	Schedule of charges for type testing of internal combustion engines
30. BImSchV	Ordinance on Facilities for the Biological Treatment of Waste
31. BImSchV	Ordinance on the limitation of emissions of volatile organic compounds when using organic solvents in certain installations
32. BImSchV	Equipment and Machine Noise Ordinance
33. BImSchV	Ordinance to Reduce Summer Smog, Acidification and Nutrient Inputs, repealed with the entry into force of 39. BImSchV (certain contents taken over there)
34. BImSchV	Ordinance on Noise Mapping
35. BImSchV	Ordinance on the Marking of Motor Vehicles with Low Pollution Contribution
36. BImSchV	Ordinance on the Implementation of the Biofuel Quota Regulations
37. BImSchV	Regulation on the allocation of electricity-based fuels and co-processed biogenic oils to the greenhouse gas quota
38. BImSchV	ew regulation with the regulation laying down further provisions on greenhouse gas reduction for fuels; before: *Quota allocation of certain biogenic oils* (repealed)
39. BImSchV	Ordinance on Air Quality Standards and Emission Ceilings

40. BImSchV	open
41. BImSchV	Announcement Ordinance
42. BImSchV	Ordinance on evaporative cooling systems, cooling towers and wet scrubbers
43. BImSchV	Ordinance on national obligations to reduce emissions of certain air pollutants
44. BImSchV	Ordinance on medium combustion, gas turbine and combustion engine systems

APPENDIX E POLLUTANT CONCENTRATION DATA FOR GERMANY, 2013-17

Table E-1 Highest pollutant concentrations in exceedance of EU air quality objectives for protection of health in Germany in 2013-2017 - extract from reporting (Dataflow G).

Pollutant	Averaging period	Objective type and value	Date for achieving objective	Parameter shown	2013	2014	2015	2016	2017
PM_{10}	Calendar year	LV: 40 µg/m^3	1 January 2005	Annual mean, µg/m^3	-	-	-	-	-
	1 day	LV: 50 µg/m^3 not to be exceeded on more than 35 days per year	1 January 2005	Days above	91	62	68	58	41
NO_2	Calendar year	LV: 40 µg/m^3	1 January 2010	Annual mean, µg/m^3	89	89	87	82	78
	1 hour	LV: 200 µg/m^3 not to be exceeded on more than 18 hours per year	1 January 2010	Hours above	63	36	61	35	-
SO_2	1 day	LV: 125 µg/m^3 not to be exceeded on more than 3 days per year	1 January 2005	Days above	-	-	-	-	-
	1 hour	LV: 350 µg/m^3 not to be exceeded on more than 24 hours per year	1 January 2005	Hours above	-	-	-	-	-
CO	Maximum daily 8-hour mean	LV: 10 mg/m^3	1 January 2005	Days above	-	-	1	-	-
C_6H_6	Calendar year	LV: 5 µg/m^3	1 January 2010	Annual mean, µg/m^3	7	-	-	-	-
Pb	Calendar year	LV: 0.5 µg/m^3 (measured as content in PM_{10})	1 January 2005	Annual mean, µg/m^3	-	-	-	-	-
O_3	Maximum daily eight-hour mean	TV: 120 µg/m^3 not to be exceeded on more than 25 days per calendar year averaged over three years	1 January 2010	Days above	43	62	63	48	46

Pollutant	Averaging period	Objective type and value	Date for achieving objective	Parameter shown	2013	2014	2015	2016	2017
	Maximum daily eight-hour mean within a calendar year	LTO: 120 µg/m³	Not defined	Days above	46	52	58	55	50
$PM_{2.5}$	Calendar year	LV: 25 µg/m³	1 January 2015 (target value until 1 January 2010)	Annual mean, µg/m³	-	-	-	-	-
	(calculated as Average Exposure Indicator, assessed as a 3-year running annual mean)	ECO: 20 µg/m³	2015	AEI, µg/m³	NA	NA	NA	NA	NA
As	Calendar year	TV: 6 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	-	-	-	-	-
Cd	Calendar year	TV: 5 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	6	-	-	-	-
Ni	Calendar year	TV: 20 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	22	-	-	-	31
PAH	Calendar year	TV: 1 ng/m³ (expressed as BaP, measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	-	-	2	2	-

Source: COWI calculations based on Member State reporting, data flow G. Downloaded in November 2018.

Note: LV: limit value; TV: target value; LTO: Long term objective; ECO: exposure concentration obligation; The values show the maximum exceedance reported in the Member State (if no exceedances are reported in any of the zones of the Member State, the table shows "-")

Legend: "NA": not available in data flow G, "-": no reported exceedances.

APPENDIX F EU ERDF AND LIFE PROJECTS

Table F-1 EU ERDF 2014-2020 programmes in Germany.

sd	Title	PA_Title	IF_txt	EUR
2014DE16RFOP003	OP Berlin ERDF 2014-2020	Sustainable urban development	Air quality measures	500.000
2014DE16RFOP004	OP Brandenburg ERDF 2014-2020	Integrated development of urban and rural areas	Air quality measures	12.000.000
2014DE16RFOP008	OP Mecklenburg-Vorpommern ERDF 2014-2020	Promoting integrated sustainable	Air quality measures	14.018.000
2014DE16RFOP009	OP Nordrhein-Westfalen ERDF 2014-2020	Sustainable urban and local development / prevention	Integrated pollution prevention and control (IPPC)	53.040.166
2014DE16RFOP012	OP Sachsen ERDF 2014-2020	Sustainable urban development	Air quality measures	10.460.000
2014DE16RFOP014	OP Schleswig-Holstein ERDF 2014-2020	Change of the energy system - building environmentally sound economic and infrastructure	Integrated pollution prevention and control (IPPC)	2.300.000
			Total	92.318.166

Table F-2 LIFE projects in Germany under Air & Noise theme, 1993-2015.

Project Title	Project Nr	Project Website	Year of Finance	Type Of Beneficiary	Themes	Keywords
LIFE Legal Actions - Legal Actions on Clean Air	LIFE15 GIE/DE/000795	http://www.right-to-clean-air.eu	2015	NGO-Foundation	Air & Noise ~ Air pollutants / Information - Governance ~ Awareness raising - Information /	air quality management / environmental training / human exposure to pollutants / public awareness campaign / public health / urban area /
LIFE - CLEAN HEAT - CLEAN HEAT: Reducing particulate matter caused by wood burning	LIFE14 GIE/DE/000490	http://www.clean-heat.eu	2014	NGO-Foundation	Air & Noise ~ Air pollutants / Information - Governance ~ Awareness raising - Information /	air pollution / environmental impact of energy / pollution control / public awareness campaign /
CA - CLEAN AIR	LIFE11 ENV/DE/000495	http://www.cleanair-europe.org	2011	NGO-Foundation	Air & Noise ~ Air pollutants / Information - Governance ~ Improved legislative compliance and enforcement /	air pollution / environmental impact of transport / information system / public health /
Waste air treatment - Novel purification technique for the treatment of waste air in the manufacturing process of para-formaldehyde	LIFE11 ENV/DE/001073	http://granuform-projekt.de	2011	SME Small and medium sized enterprise	Air & Noise ~ Air pollutants / Industry-Production ~ Chemicals /	air pollution / chemical industry / odour nuisance / public health /
ZEM/SHIPS - Zero.Emission.Ships	LIFE06 ENV/D/000465	http://www.zem-ships.eu/en/index.php	2006	Regional authority	Air & Noise ~ Air pollutants / Climate change Mitigation ~ Renewable energies /	atmospheric pollution / climate change mitigation / emission reduction / energy sup-

Project Title	Project Nr	Project Website	Year of Finance	Type Of Beneficiary	Themes	Keywords
					Climate change Mitigation ~ GHG reduction in non EU ETS sectors / Services & Commerce ~ Transportation - Storage /	ply / harbour / navigation / renewable energy /
PARFUM - Particulates, Freight and heavy duty vehicles in Urban Environments	LIFE06 ENV/D/000477	http://www.parfum-life.eu	2006	Local authority	Air & Noise ~ Air quality monitoring / Land-use & Planning ~ Transport planning - Traffic monitoring /	air quality management / integrated management / public transport / traffic emission / urban area /
Sludge Redox - Transfer of the organic constituents of sewage sludge into a soluble form for an efficient production of biogas	LIFE05 ENV/D/000193	http://www.curenta.de/index.php?page_id=162	2005	International enterprise	Air & Noise ~ Air quality monitoring / Energy ~ Supply / Waste ~ Hazardous waste /	hazardous waste / industrial waste / sewage sludge / use of waste as energy source /
HVD - Hydro-Mechanical Descaling Process based on High-Pressure Vacuum Technology Using Scales as Abrasive Blast Medium	LIFE05 ENV/D/000207		2005	SME Small and medium sized enterprise	Air & Noise ~ Air quality monitoring / Environmental management ~ Cleaner technologies / Industry-Production ~ Metal industry /	clean technology / industrial process / iron and steel industry /
Odour scrubber - Demonstration of a closed circuit system resulting in a sub-	LIFE04 ENV/DE/000051	http://www.cargill.de/deu/locations/mainz-euprojekt.shtml	2004	International enterprise	Air & Noise ~ Air quality monitoring / Energy ~ Savings /	air pollution / edible fat / emission reduction / odour nuisance /

Project Title	Project Nr	Project Website	Year of Finance	Type Of Beneficiary	Themes	Keywords
stantial odour emission reduction and energy saving during oilseed pressing						
UFIPOLNET - Ultrafine particle size distributions in air pollution monitoring networks	LIFE04 ENV/DE/000054	http://www.umwelt.sachsen.de/umwelt/en/4890.htm	2004	Regional authority	Air & Noise ~ Air quality monitoring / Land-use & Planning ~ Transport planning - Traffic monitoring / Risk management ~ Human health protection /	air pollution / air quality monitoring /
DAMIVOC - Development of an Aerospace Minimized VOC Exterior System	LIFE03 ENV/D/000044		2003	International enterprise	Air & Noise ~ Air pollutants / Industry-Production ~ Engines - Machinery - Vehicles /	atmospheric pollution / coating / emission reduction / volatile organic compound /
NT-Plasma - Improved application of catalytic supported low temperature plasma plants for waste air purification	LIFE02 ENV/D/000406	http://www.doerken-life.de	2002	SME Small and medium sized enterprise	Air & Noise ~ Air pollutants / Industry-Production ~ Building /	greenhouse gas / treatment of gases /
LISA - LISA (Low Isocyanate Solventfree Adhesives) Procedure for the development and production of solventless adhesives with extremely low	LIFE99 ENV/D/000408		1999	International enterprise	Air & Noise ~ Air pollutants / Industry-Production ~ Chemicals /	alternative material / packaging / pollutant elimination / solvent /

Project Title	Project Nr	Project Website	Year of Finance	Type Of Beneficiary	Themes	Keywords
contents of monomeric isocyanates						
Sustainable painting technique - Demonstration of the technical and economical feasibility of an innovative painting technology for small plastic components by means of high-speed rotation for the reduction of paint consumption and solvent emissions	LIFE99 ENV/D/000434		1999	International enterprise	Air & Noise ~ Air pollutants / Industry-Production ~ Chemicals / Waste ~ Waste reduction - Raw material saving /	emission reduction / paint / plastic / solvent / waste reduction /
Odour reduction - Reduction of the odour emission in the feed mill Oldenburg	LIFE99 ENV/D/000442		1999	Public enterprise	Air & Noise ~ Air pollutants / Environmental management ~ Cleaner technologies / Industry-Production ~ Agriculture - Forestry /	animal foodstuff / emission reduction / odour nuisance /
Dry stage fiber glue - Development and testing of an innovative test plant for an environment-freindly and energy-saving glue blending of dried fibers for the production of MDF boards in the wood industry.	LIFE99 ENV/D/000443		1999	International enterprise	Air & Noise ~ Air pollutants / Industry-Production ~ Chemicals /	emission reduction / energy saving / volatile organic compound / wood product /

Project Title	Project Nr	Project Website	Year of Finance	Type Of Beneficiary	Themes	Keywords
EuroBionet - European network for the assessment of air quality by the use of bioindicator plants	LIFE99 ENV/D/000453	http://www.eurobio-net.com,. http://www.uni-hohenheim.de/eurobio-net/report_eng.html	1999	University	Air & Noise ~ Air quality monitoring / Risk management ~ Human health protection /	atmospheric pollution / environmental assessment / indicator / urban area /
Reduction of energy consumption and air pollution by means of absorptionchillers powered by unconditioned heat-fluxes	LIFE98 ENV/D/000504		1998		Air & Noise ~ Air pollutants / Energy ~ Savings / Industry-Production ~ Agriculture - Forestry /	air pollution / energy saving /
Clean Air System Development and test of an innovative and mobile testing plant for non-polluting drying of wet flakes of the wood material industry	LIFE98 ENV/D/000522		1998		Air & Noise ~ Air pollutants / Industry-Production ~ Wood - Furniture /	air pollution / clean technology / emission reduction / wood product /
Waste site emission reduction - The decrease of the emission potential of a housing development deposing area through controlled optimization of deposing area gas production by a contínously working watering device.	LIFE98 ENV/D/000524	http://www.emsland.de/pages/abfall.htm, , http://www.abfall-wirtschaft-emsland.de/	1998	SME Small and medium sized enterprise	Air & Noise ~ Air pollutants / Waste ~ End-of-pipe treatment - Landfilling /	emission reduction / landfill / treatment of gases /

Project Title	Project Nr	Project Website	Year of Finance	Type Of Beneficiary	Themes	Keywords
Demonstration project 'flameless non-catalytic oxidation of hazardous gases from waste disposal sites'	LIFE97 ENV/D/000457		1997	Regional authority	Air & Noise ~ Air pollutants / Waste ~ End-of-pipe treatment - Landfilling /	end-of-pipe technology / energy saving / flue gas / greenhouse gas / hazardous substance / landfill / pollutant elimination / technology transfer /
Reduce VOC using acid esters - Reduction of VOC emissions by using fatty acid esters for metal cleaning processes	LIFE97 ENV/D/000465	http://www.rrz.uni-hamburg.de/kooperationsstelle-hh/index.html	1997	Research institution	Air & Noise ~ Air pollutants / Industry-Production ~ Metal industry /	alternative material / emission reduction / metal products industry / vegetable oil / volatile organic compound /
Demonstration plant of an individual chamber pressure regulation to avoid emissions of coke ovens.	LIFE97 ENV/D/000473		1997		Air & Noise ~ Air pollutants / Industry-Production ~ Metal industry /	emission reduction / iron and steel industry /
Lacqueur membrane separation - Using a membrane separation process for the depigmentation of water lacquer	LIFE96 ENV/D/000003		1996	International enterprise	Air & Noise ~ Air pollutants / Environmental management ~ Cleaner technologies / Industry-Production ~ Chemicals /	clean technology / paint / volatile organic compound /
Replacing organic solvents with water-paint technology for coating casting articles (gears)	LIFE95 ENV/D/000020		1995		Air & Noise ~ Air pollutants / Industry-Production ~ Chemicals /	alternative material / coating / solvent /

Project Title	Project Nr	Project Website	Year of Finance	Type Of Beneficiary	Themes	Keywords
Qualification of measuring techniques for process-integrated emission control	LIFE95 ENV/D/000030		1995		Air & Noise ~ Air pollutants /	air pollution / hazardous substance / pollution control / volatile organic compound /
Curing of solvent free printing inks with low energy electrons	LIFE94 ENV/D/000052		1994		Air & Noise ~ Air pollutants / Industry-Production ~ Paper - Pulp - Printing /	coating / pollutant elimination / printing industry / solvent /
XHC-free coating pre-cleaning - XHC-free precleaning for environmentally conscious coating processes: a solution for job-coaters	LIFE94 ENV/D/000240		1994		Air & Noise ~ Air pollutants / Industry-Production ~ Chemicals /	cleansing product / coating / ozone layer depletion / pollutant elimination /
Non-emission demonstration plant for coating steel parts with a sintered layer of zinc/aluminium	LIFE94 ENV/D/000502		1994		Air & Noise ~ Air pollutants / Industry-Production ~ Metal industry /	coating / iron and steel industry / pollutant elimination /
Recovery of valuable substances from refuse-incinerator flue gases.	LIFE93 ENV/D/000064		1993		Air & Noise ~ Air pollutants /	flue gas / incineration of waste / treatment of gases /

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CASE STUDY REPORT
IRELAND

Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

Written by Tanzir Chowdhury
March 2019

Contents

Appendices

1 INTRODUCTION

This report summarises the findings and conclusions of the **case study for Ireland**. The case study had a focus on information provision to the public.

The report is one of seven case studies carried out for the Fitness Check of the EU Ambient Air Quality Directives. Its main purpose is to examine, in more detail, the situation regarding the experience and lessons learnt in the implementation of the air quality legislation. The case studies provide a basis for a more detailed examination of the questions of the fitness check and include a review of implementation and integration successes and problems, the costs of implementation and of non-implementation of the legislation and the administrative burden of implementation and opportunities for improving implementation without compromising the integrity of the purpose of the Directives. As such, the case study complements the information gathered through other sources, such as desk review, targeted questionnaire, open public consultation, interviews, focus groups and stakeholder workshops.

The Member States for detailed case studies have been selected to cover a range of geographies, governance structures and sizes. This has led to the selection of the following **seven case study Member States: Slovakia, Germany, Spain, Sweden, Ireland, Bulgaria and Italy**.

The case study report is structured in four chapters, namely:

- **Chapter 1 – Introduction**
- **Chapter 2 – Background and context**, presents general information about the context of the case study
- **Chapter 3 – Findings**, presents detailed findings regarding the relevance of the AAQ Directives, the implementation successes and problems, the factors underlying compliance with the Directives, the costs and benefits.
- **Chapter 4 – Conclusions**, presents a summary of the main findings.

The case study findings rely on extensive desk research and a series of interviews that took place over the period October and November 2018. An overview of the interviews carried out is provided in Appendix A.

The case study has been shared with the interviewed stakeholders in January 2019 for validation of findings and correction of factual mistakes. Feedback received from the stakeholders was integrated in the case study report.

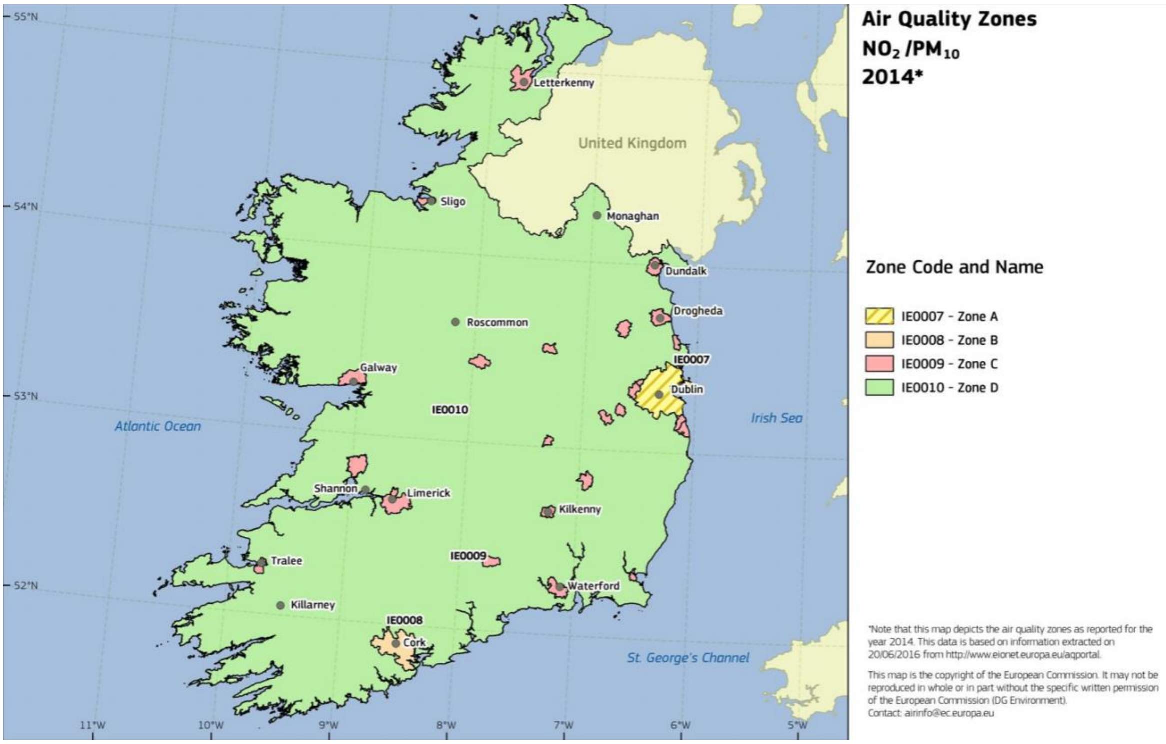
2 BACKGROUND AND CONTEXT

This chapter provides general information about the air quality framework and air quality status in Ireland. The purpose of this chapter is to set a background for the more detailed findings presented in chapter 3. The chapter relies primarily on desk research.

2.1 Ireland and air quality zone characteristics

The case study covers the *implementation of the AAQ Directives in the entire Republic of Ireland*. As shown in Figure below, Ireland has four national air quality zones. Zone A is centred on Dublin, Ireland's largest urban area while Zone B is centred on Cork. Zone C accounts for other remaining large urban areas, while Zone D, the largest, covers rural parts of the country.

Figure 2-1 Air quality zones for NOx and PM10, 2014 (EPA, 2017)



As Dublin and Cork are Ireland's two most populous areas, they are designated as separate zones during, though the zones have been realigned in 2013. For the purpose of the AAQ Directives, Ireland is split into the following zones[1]: Zone A is the largest, consisting of the city of Dublin and three counties (Dún-Laoghaire-Rathdown, South Dublin and Fingal). The population stands at 1,195,789, and the zone encompasses the majority of Ireland's manufacturing industry.

Zone B consists of the city and county of Cork. The population is considerably less, with 220,298 residents. [2] Zone C accounts for the remainder of Ireland's cities and large towns, with populations starting from around 1,500 to 100,000[2]. The total population of this zone is 722,657. Zone D covers the majority of Ireland's land area, and a population of 2,449,508. This rural zone is characterised by a low population density. Key relevant characteristics of Ireland are presented below.

[1] Environmental Protection Agency, 'Air Quality Zones Realignment'.

[2] European Environment Agency, 'AQ Zones'.

Text box 2-1 – Key relevant characteristics of Ireland

Ireland	
GDP per capita in PPS (100=EU28 avg) (2017)	184[3]
GDP per capita growth (% 2008-2017)	21.35[4]
GDP per capita (EUR)	56,400[5]
Population (1 January 2018)	4,838,259[6]
Governance structure	Parliamentary democracy with 31 local authorities
Zones defined as agglomerations (%)	50
Area:	70,280 km^2
Characteristics of Ireland: Ireland has a maritime climate, characterised by warmer winters and cooler summers than continental climates of mainland Europe. The country has a low population density of 70 people per km^2, with few large cities and large expanses of rural land. The rural land is predominantly used for agriculture, with forests and national parks as the remainder. There are mountainous regions across the country. For implementation of the AAQ Directives, Ireland has been divided into four zones of which two are agglomerations.	

Source: Eurostat, GDP per capita in Purchasing Power Standards (PPS) expressed in relation to the European Union (EU28) average set to equal 100; Eurostat, Real GDP per capita, growth rate and totals; Eurostat, Population on 1 January.

2.2 Air quality monitoring and air quality

The following section presents briefly the arrangements made in Ireland for air quality monitoring and overview of the status of air quality in the country.

2.2.1 Air quality monitoring

At the national level, Ireland's Environmental Protection Agency (EPA) takes responsibility for the protection and improvement of the environment. Air quality monitoring falls under the remit of the EPA, who coordinates and manages the monitoring of concentrations of pollutants across the country.

[3] Eurostat (2018) GDP per capita, consumption per capita and price level indices - Statistics Explained, accessed 14 December 2018, https://ec.europa.eu/eurostat/statistics-explained/index.php/GDP_per_capita,_consumption_per_capita_and_price_level_indices
[4] The World Bank (2018) GDP (current US$) | Data, accessed 14 December 2018, https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?end=2017&locations=IE&start=2008
[5] Eurostat (2018) Real GDP per capita, accessed 14 December 2018, https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=sdg_08_10&plugin=1
[6] Eurostat (2018) Populations by country (January 1st), accessed 14 December 2018, at: https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tps00001&plugin=1

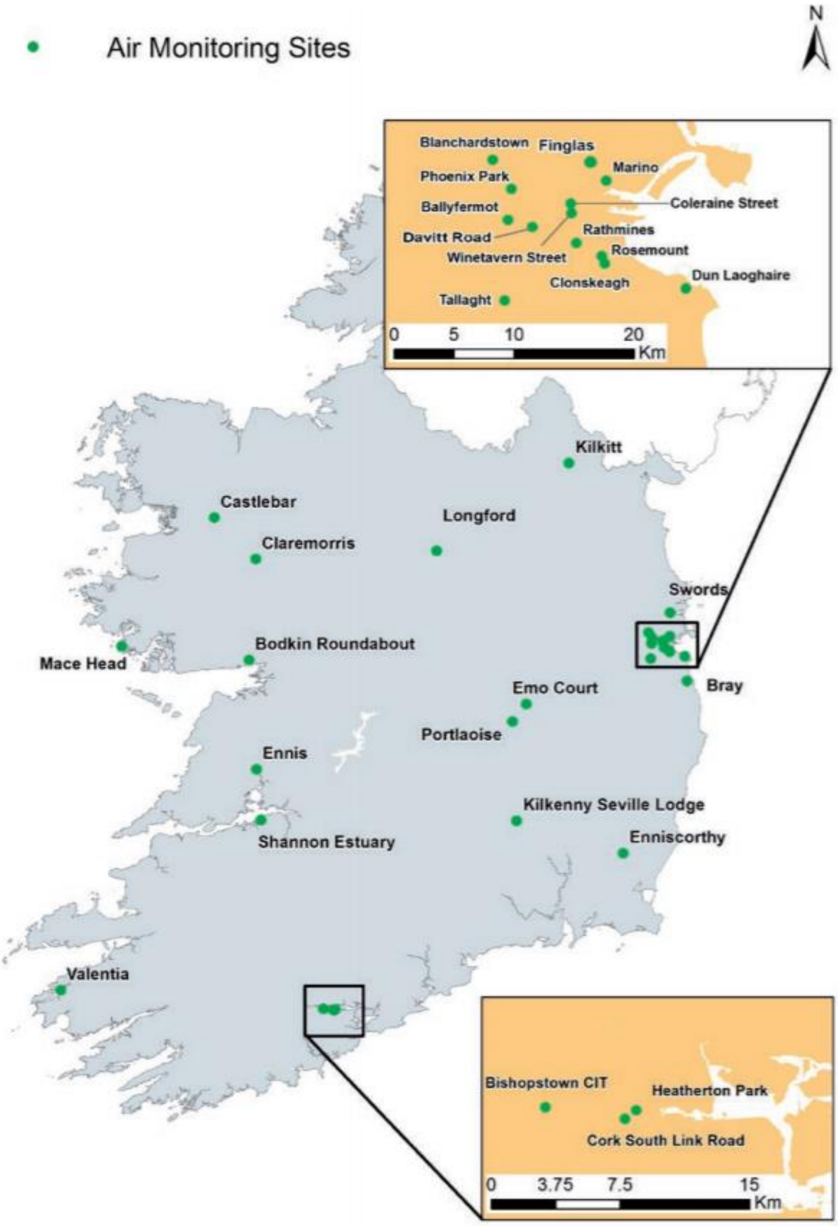
The EPA's work is guided by the national ambient air quality monitoring programme (AAMP), which has a statutory footing. Alongside the AAMP, the national clean air strategy (NCAS) is being developed, which will eventually encompass the AAMP as a national strategy, linked with policy.[7] The NCAS will be Ireland's first clean air strategy, the aim of which is to provide the framework for cross-government policies and actions. In this respect, the focus on action to address poor air quality will be higher in the NCAS than in the AAMP, which is intended as an information gathering mechanism to improve monitoring and inform policy. Until the NCAS is released, the AAMP guides national policy for air quality in Ireland. The AAMP covers five objectives[8]:

- Provide enhanced real-time air quality information to the public across Ireland
- To provide air quality forecasting and modelling
- Place monitoring on a statutory footing
- Progress citizen engagement
- Increase source apportionment resources

At present, all of the EPA's air quality monitoring is undertaken through a network of stations, which includes station coordinated by partnerships with local authorities and third-party organisations. The 2008 Directive has guided the current network's formation and operation, and as the new National Ambient Air Quality Monitoring Programme (AAMP) network expands, the Clean Air for Europe (CAFE) network increases its resolution in urban and rural areas. The EPA is planning to make the network fully autonomous and add 38 additional stations to the current 29. The AAMP began in 2017 and will run until 2022, by which point Ireland should have a high-resolution real-time national perspective on air quality. The development of the current network is indicated in the two figures below.

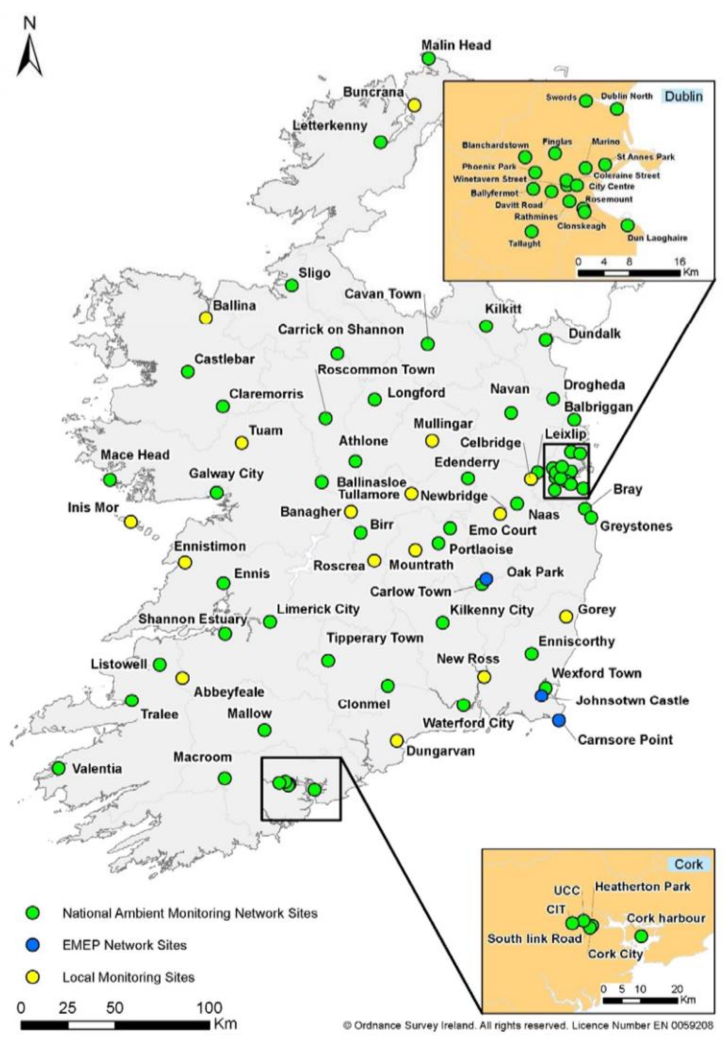
[7] Department for Communications Climate Action and Environment, 'National Clean Air Strategy'.
[8] Environmental Protection Agency, 'National Ambient Air Quality Monitoring Programme 2017-2022'.

Figure 1 - 2 Clean Air for Europe Air Monitoring Network 2016 (EPA, 2017)



Ireland's pre-2017 network of monitoring sites, while meeting the requirements of EU Directives, as shown in Figure 1, left large rural and urban areas without any assessment. Certain larger urban areas (such as Cork) did not have high densities of monitoring stations. Efforts under the AAMP intend to increase the number of monitoring stations, as shown in Figure 2- 2.

Figure 2- 2 - Proposed air quality monitoring network under the AAMP (EPA, 2017)



The EPA's CAFE stations monitor Ozone, CO, NO_x, SO_2, $PM_{2.5}$, PM_{10}, Benzene (C_6H_6), Lead (Pb) and PAH (Polycyclic Aromatic Hydrocarbons)[9]. The stations are able to provide real-time data for most of these pollutants, which are published online. Results are summarised in annual EPA publications of air quality for Ireland, which provide trend analysis for pollutants.

2.2.2 Air quality in Ireland

Ireland's air quality is determined by a range of human and natural factors. The country's prevailing weather patterns bring relatively clean Atlantic air from the south-west, which generally prevents the build-up of pollution[10]. Ireland also has a low population density, and few large urban areas, which generally prevents concentrations of pollutants forming which exceed EU limits. According to the most recent European Environment Agency Country Factsheet on Ireland[11] none of Ireland's urban monitoring stations recorded pollutant concentrations above the EU's limit values from 2012 - 2016.

[9] Environmental Protection Agency, 'Air Quality: What We Monitor'.

[10] Department for Communication, Climate Action and Environment, 'Air Quality Overview'.

[11] Ireland – air pollution country fact sheet 2018, accessed 19 December 2018, https://www.eea.europa.eu/themes/air/country-fact-sheets/ireland

It is difficult to ascribe any change in air quality in Ireland directly to the impacts of the AAQ Directives however, in interview, the Irish EPA noted the AAQ Directives have primarily been used to improve the assessment of air quality in regional areas (Zones C and D) where monitoring infrastructure was lacking prior to the implementation of the Directives. They note that the Directives provided the impetus to assess air quality in these regions and act where it needs improving. The Department of Communications, Climate Action & Environment (DCCAE) noted in interview that this impetus for improvement of monitoring is key as, without it, it is not possible to identify areas, which need to be targeted. So far, no breaches of limit values have been recorded in Zones C and D.[12] As depicted in Figure 1 and Figure 2- 2 Ireland is planning to significantly expand its rural monitoring network as part of its 2017 – 2022 Ambient Air Quality Monitoring Programme to provide a more spatially extensive and accurate view of exceedances occurring in areas currently underserved by monitoring.

In 2009, in response to exceedances NO_2, the four local authorities in Dublin produced a regional air quality management plan for the 2009-2012 period to bring NO_2 back within EU limit values. The plan implemented a range of measures including;

- Regional planning guidance for the greater Dublin Area to reduce emissions;
- a Dublin Bike Rental Scheme; and
- a Dublin HGV Management Strategy.

Since 2009, no exceedances of the EU limit value for NO_2 have been recorded. This is covered in more detail in Section 2.4.

Data published by the EPA shows pollutant concentrations in relation to EU limit values. These are discussed together below.

Although changes in weather patterns can cause accumulations, in 2017 no monitoring stations in Ireland recorded any exceedance of any EU legislative limit values for protecting human health and vegetation[13].

However, WHO air quality guidelines were exceeded at particular monitoring sites for PM_{10} and $PM_{2.5}$, Ozone and NO_2. PM_{10} 24-hour guidelines were exceeded at 11 monitoring sites. $PM_{2.5}$ 24-hour guidelines were exceeded at nine monitoring sites, and the annual monitoring guideline exceeded at 1 monitoring site[13]. European Environment Agency (EEA) reference level[14] for PAH wes breached at four monitoring sites. Ireland was closest to breaching EU limit values for the concentration of NO_2 in urban areas, a trend that is attributed to the level of vehicle use.

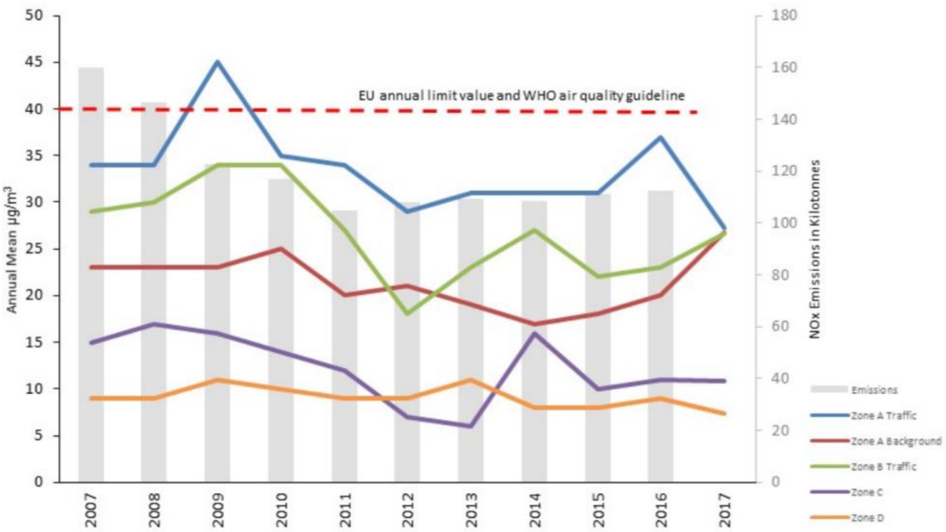
Since 2010, concentrations of NO_2 recorded at monitoring stations in Ireland have been consistently under the EU annual limit value (Figure 2-3), though it is noted by the EPA that increases in traffic and unfavourable weather patterns could expose certain areas to build ups.

[12] Environmental Protection Agency (2018) Air Quality In Ireland 2017, Wexford, Ireland, 2018, http://www.epa.ie/pubs/reports/air/quality/Air%20Quality%20In%20Ireland%202017.pdf

[13] Environmental Protection Agency, 'Air Quality In Ireland 2017.Pdf'.

[14] The EEA estimated reference levels for pollutants for which the WHO did not establish air quality guidelines.

Figure 2-3 - Trend in NO2 concentrations for zones in Ireland 2007-2017

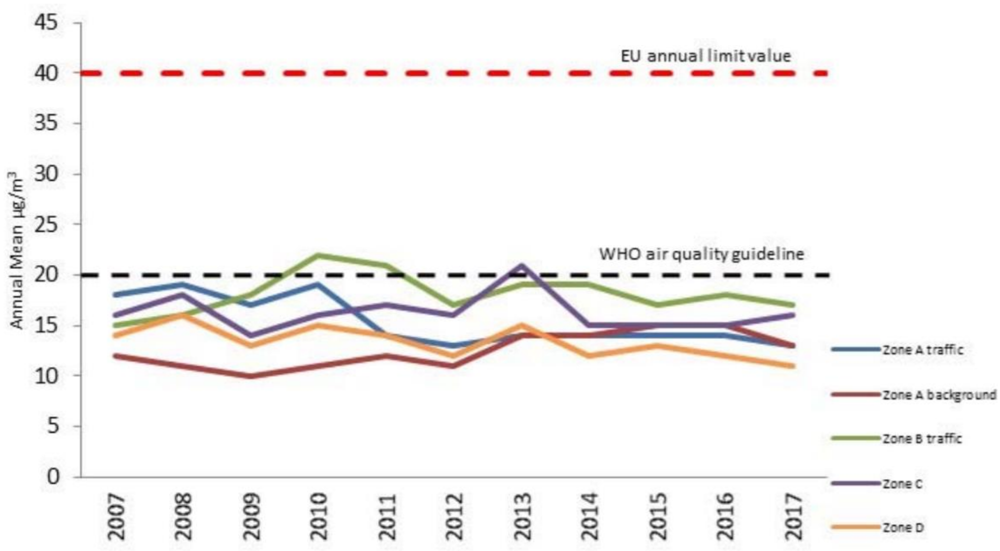


Source: EPA, 2017

Particulate matter can be differentiated according to particle diameter, the two main categories are 10 micrometres and 2.5 micrometres. PM_{10} concentrations are contributed to by the burning of fuels, engine combustion, dust and pollen. $PM_{2.5}$ concentrations, the finer particles, are primarily from residential solid fuel combustion. As Figure and Figure 2-4 below indicate, concentrations of $PM_{2.5}$ are more frequently exceeding WHO air quality guidelines, and in previous years have come closer to breaching EU annual limit values than PM_{10}.

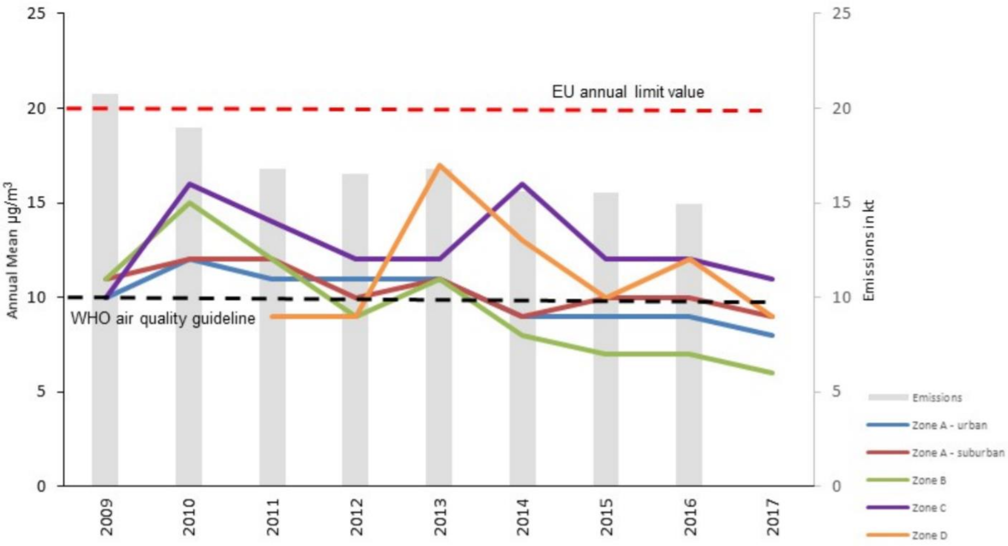
Ireland was noted by the EEA's 2018 Air Quality in Europe report[15] as being one of only four EU countries that has not recorded any exceedance the long-term WHO air quality guidelines for PM_{10}, emphasising the quality of its air in the context of the EU. However, there were breaches of $PM_{2.5}$.

Figure 2-5 - Annual mean PM10 concentrations 2007 – 2017 (EPA, 2017)



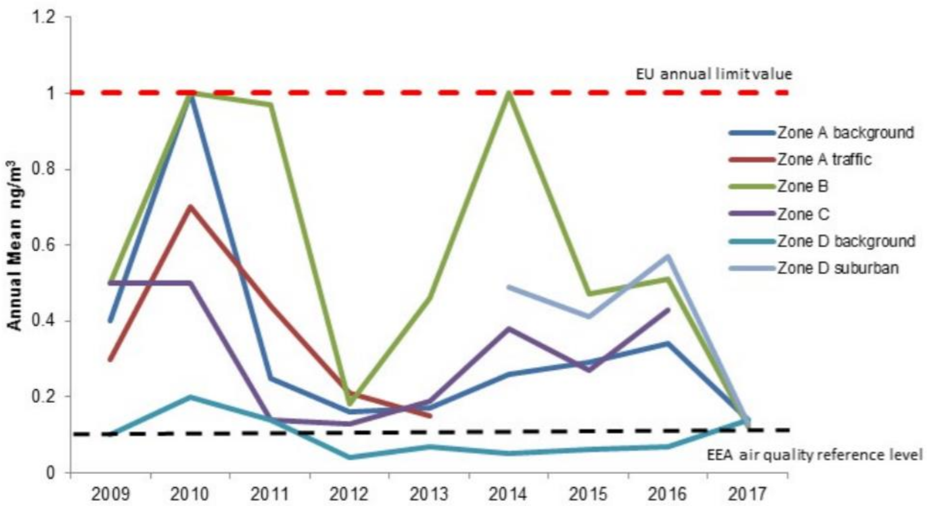
[15] European Environment Agency, 'Air Quality in Europe — 2018 Report'.

Figure 2-4- Annual mean PM2.5 concentrations 2009 – 2017 (EPA, 2017)



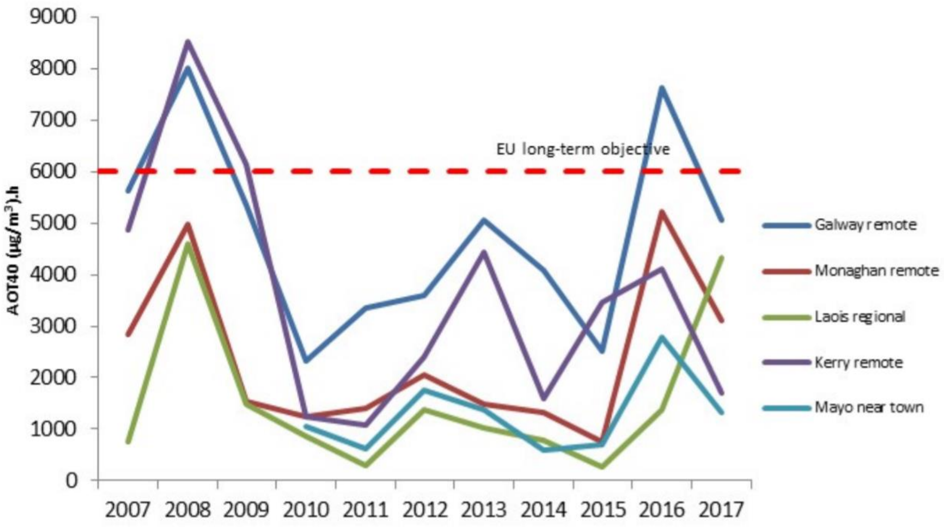
Polycyclic aromatic hydrocarbons (PAH) are chemical compounds, primarily emitted from the combustion of solid fuels (predominantly for residential heating) and incomplete combustion of fuels from vehicles. PAH frequently pollute water, as precipitation can wash the particles from the atmosphere into surface waters where they are retained. Although monitoring across Ireland shows that concentrations are primarily below EU annual limit values, in previous years they have been far higher than EEA air quality reference levels, as can be seen in Figure 2-5.

Figure 2-5 - Annual mean PAH concentrations 2009 – 2017 (EPA, 2017)



Ozone (O_3) is formed as a secondary pollutant from chemical reaction between NO_x, CO and volatile organic compounds. Concentrations are higher in rural areas, as in urban areas O_3 reacts with traffic-related pollutants, reducing concentrations. Across Ireland, O_3 monitoring in 2017 showed that no sites recorded an exceedance of EU annual limits, though nine sites recorded breaches of the WHO guideline values, these were primarily rural monitoring sites. Figure 2-6 shows a number of rural monitoring sites, of which Galway is records the highest concentration of O_3.

Figure 2-6 - Ozone monitoring at rural stations in Ireland 2007 – 2017



Source: EPA, 2017

2.3 Allocation of responsibility

The governance structure for air quality in Ireland is a network of key actors from the local to the national level. Across these partnerships, there are defined roles and responsibilities for the management and coordination of monitoring, data collection, communications and reporting. These roles are outlined below.

National Government

The Irish Government is developing a National Clean Air Strategy which will provide a framework for creating, integrating and promoting air quality policies. The Government, through the Department of Communications, Climate Action and Environment, has provided funding to upgrade the monitoring network through the ambient air quality monitoring programme - AAMP.

The Environmental Protection Agency (EPA) is broadly responsible for improving and protecting the environment for the people of Ireland. It operates independently under the Department of Communications, Climate Action & Environment - DCCAE and is responsible for national environmental enforcement and regulation.

With regards to AAQ Directives, the EPA is the national competent authority for the implementation of the 2008 Directive. The EPA is also the National Reference Laboratory meaning it ensures all instrumentation is compliant with the directives, that third party operators are compliant and that it meets strict sampling and reporting requirements. Additionally, the EPA regulates the country’s greenhouse gas emissions, including the implementation of the Emissions Trading Directive and preparation of Ireland’s greenhouse gas inventories and projections. Under the Environmental

Protection Agency Act 1992, the EPA is also responsible for the Industrial Emissions Directive (IED) licensing of large or complex industries with significant polluting potential.

The EPA thus has a number of statutory roles including:[16]

- Leading the coordination and management of all air quality monitoring activities in Ireland. There is a total of 31 monitoring stations throughout the country which monitor air quality under the 2004 and 2008 directive. Although, the EPA is planning to expand this network to 80 stations.[17]
- Operation of the national ambient air quality monitoring programme (AMMP).
- Together with Met Éireann – the national meteorological service and Teagasc – the Agriculture and Food Development Authority, the EPA manages the national element of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP). This involves a network of EMEP monitoring sites across the country.
- Responsible for gathering, analysing and disseminating air quality data.
- Providing technical support and guidance to stakeholders, third parties and local authorities involved in air quality monitoring. A key aspect of this is hosting forums, workshops and annual conferences as well as engaging with partners to trial appropriate technologies.
- Reviews the performance of local authorities in relation to enforcing clean air legislation.
- Disseminating information to the public. This includes pollution exceedance alerts.

County and City Management Association (CCMA)

The CCMA represents local government. Its members are Chief Executives of the county and city councils. The body works in partnership with key stakeholders, such as the EPA, to develop and implement effective legislation. Moreover, the CCMA was a key partner in developing the AMMP and ran a programme of engagement with local authorities to encourage involvement in the network.

Local Authorities and City Councils

Under the Air Pollution Act 1987 (as amended), local authorities hold primary responsibility for addressing local air pollution. Further division of responsibilities between the EPA, local authorities and city councils is flexible and depends upon the site and what air pollutant is being monitored, as well as local capacity/resources. Local authorities support local monitoring stations and provide data to the EPA national network. They play a role in assessing compliance with the relevant legislation, dealing with complaints regarding air pollution, licensing certain categories of industry, enforcing the ban on certain solid fuels and supporting research and education regarding air pollution. Local Authorities can also enforce penalties if the Act is infringed. In addition, local authorities can designate special control areas in order to prevent or limit air pollution.

City councils such as Dublin City Council and Cork City Council, conduct monitoring on behalf of local authorities within their jurisdiction.

[16] EPA (2017) National Ambient Air Quality Monitoring Programme 2017-2022, November 2017,https://static.rasset.ie/documents/news/2017/11/epa-air-quality-programme-2017-22.pdf
[17] DCCAE (2017) Clean Air Strategy Public Consultation

Met Éireann

Met Éireann is the national meteorological service in Ireland. It is responsible for coordinating air quality data collection from a number of sites, and can issue warnings and forecasts for certain atmospheric conditions, such as ground-level ozone.

2.4 Legal and policy framework and air quality measures

There is a variety of European and Irish legislation settting standards to reduce emissions from a range of sources, and to limit the exposure to pollution in ambient air. EU legislation has been transposed into national law, or complimented where appropriate, such as regarding residential solid fuel use, which is the primary source of fine particulate matter air pollution in Ireland but for which there is no current EU legislation.

Key legislation

The AAQ Directives have been transposed into Irish legislation. Directive 2008/50/EC was transposed into Irish legislation by the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011).[18]Directive 2004/107/EC was transposed into Irish legislation by the Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air Regulations 2009 (S.I. No. 58 of 2009).[19]

The Air Pollution Act (APA), 1987, and the Environmental protection Agency Act, 1992 are the main national legislative provisions addressing air pollution in Ireland. The Act defines air pollution and devolves the power to ensure compliance to the EPA and local authorities. It introduces the regulation of emissions from a variety of industrial sources, for which enforcement powers also lie with the EPA and local authorities. Although the APA was amended in 2015, the Act has not significantly changed since its introduction, other than the revision downwards of air quality limits[20]. A number of key aspects are outlined below:

- Owners of certain industrial plants must obtain a license to operate from the relevant local authority or the EPA.
- Persons guilty of offence can be fined or imprisoned at the discretion of the national court or the local authority in question.
- The Act enables the Minister for Environment to regulate fuel quality. This has been applied to regulating the marketing, sale, distribution and use of bituminous 'smoky' coal as well as setting a maximum limit on the Sulphur content of solid fuels. This has been key for tackling 'smog' especially in larger cities.
- Local authorities have the power to take immediate steps, to declare special control zones and to make Air Quality Management Plans and Standards to prevent air pollution and to preserve or improve air quality.

[18] Government of Ireland (2011) Air Quality Standards Regulations 2011
[19] Government of Ireland (2009) S.I. No. 58/2009 - Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons In Ambient Air Regulations 2009, accessed 19 December 2018, http://www.irishstatutebook.ie/eli/2009/si/58/made/en/print
[20] DCCAE (2017) Clean Air Strategy Public Consultation

Strategic frameworks

As previously outlined, the national government is developing the National Clean Air Strategy (NCAS). This will set specific air quality goals and targets for the country. The plans highlight that the NCAS will maximise synergies with the national mitigation plan (NMP), as designed under the Climate Action and Low Carbon Development Act 2015. The NMP is intended to be a cross-government approach to tackling greenhouse gas emissions by tracking measures currently underway and identifying new measures.

Furthermore, in 2017 the EPA completed consultation on the new AMMP, proposed under Section 65 of the EPA Act. The programme seeks to improve its capacity and ability to provide more comprehensive, localised air quality information focusing on:

- Enhancing the provision of real-time air quality information.
- Strengthening air quality forecasting and modelling.
- Increasing the statutory weight of ambient air monitoring, with an aim to ensure the commitment and alignment of resources nationwide.
- Improving citizen engagement and access to health advice linked to air quality information.
- Expanding the network of air monitoring stations.
- Increasing source apportionment targets.[21]

The AMMP provides a roadmap for the development of ambient air quality monitoring from 2017-2022.

Air quality management plans

Under Section 46 of the 1987 Air Pollution Act, local authorities can devise air quality management plans for specific areas, updating them at least every five years.[22] Two or more authorities are also able to create a joint plan. Different air quality standards can apply to different areas, time periods or circumstances, as well as to particular pollutants.

For instance, the four local authorities in Dublin produced a regional air quality management plan for the 2009-2012 period. The primary objective of the plan was to preserve good air quality in the region, with particular attention to the risk faced by the most vulnerable members of the population.[23]

The plan focuses on specific local conditions, particularly regarding nitrogen dioxide levels. It outlines the underlying factors which influence the pollutant concentration and identifies multifaceted interventions. Ultimately, traffic emissions were identified as the primary cause of the high nitrogen dioxide levels experienced in Dublin. Thus, the plan centres on urban planning and transport measures to reduce these emissions. The strategies include:[24]

[21] EPA (2017) National Ambient Air Quality Monitoring Programme 2017-2022, November 2017, https://static.rasset.ie/documents/news/2017/11/epa-air-quality-programme-2017-22.pdf

[22] Government of Ireland (1987) Air Pollution Act, 1987, accessed 12 December 2018, http://www.irishstatutebook.ie/eli/1987/act/6/enacted/en/print%23partv

[23] Dublin City Council (2016) Dublin Regional Air Quality Management Plan 2009-2012, February 2016, http://www.dublincity.ie/sites/default/files/content/WaterWasteEnvironment/AirQualityMonitoringandNoiseControl/Documents/Dublin_Regional_Air_Quality_Management__Plan_2009_2012.pdf

[24] Dublin City Council (2009) Air Quality Management Plan for Improvement in levels of Nitrogen Dioxide in ambient Air Quality

- **Regional planning guidance for the greater Dublin area** – This emphasizes compact urban form, mixed use development and investment in high quality public transport in order to reduce car usage, congestion and pollution. The transport measures centre on enhancing rail, light rail and bus infrastructure and initiatives such as Smarter Travel Initiatives, Bike to Work scheme, Personal Travel Plans, and Dublin Bikes. Moreover, local authorities are required to implement the Dublin Transportation Initiative plan for a network of cycle ways, Park and Ride Facilities and Quality Bus Corridors.
- **The Dublin bike rental scheme** - This was launched in 2009 and enables Dublin City Council to fund the provision of public cycling amenities. Around 450 bikes and 40 stations have been provided, and to date, 2.6 million bicycle journeys have been taken on the scheme. There are plans to expand the scheme.
- **Dublin HGV Management Strategy -** This involves a ban on 5+ axle vehicles during 07:00-19:00 seven days a week from designated areas within Dublin City and Dun Laoghaire Rathdown. The HGV Strategy has resulted in dramatic reductions of 5+ axle vehicles of between 80 - 94% on different routes within the cordon area.
- Local authorities continue to provide a complaint service for citizens with regards to air quality, as well as educational programmes.
- Strengthening evidence-based decision-making through the improvement of information sharing on air quality.

It is noted that levels of nitrogen dioxide in Dublin were above the limit value in 2009, but there have been no exceedances since.[25]

2.5 Information to the public

Pursuant to Article 26 of the Directive 2008/50/EC, Member States shall ensure that the public is adequately, and in good time, informed about ambient air quality and other issues specified in the above cited Article. Section 18 of the Air Quality Standards Regulations 2011 outlines the action which the EPA must take with regards to alert thresholds. Where exceedance occurs, the EPA is required to make information available to prescribed bodies and the public, through means such as radio, television, newspapers or the internet.[26] Section 21(6) further requires local authorities to freely provide the results of investigations and information regarding air pollution action plans to the public as well as health care bodies, environmental organisations and so forth. There are a number of ways in which information dissemination is being addressed. These include;

- the Air Quality Index for Health (AQIH), including colour coded maps of the index across Ireland;
- real time monitoring data;
- annual AQ reports, including trend analyses for key pollutants and breaches of limits where these have occurred NO_2, O_3 and PM_{10};
- historic AQ data from monitoring stations; and
- information web-developers can access for 3rd party reporting solutions.

[25] Irish Environmental Protection Agency (EPA) (2018) Air Quality in Ireland 2017, 2018, http://www.epa.ie/pubs/reports/air/quality/epaairqualityreport2017.html
[26] Government of Ireland (2011) S.I. No. 180/2011 - Air Quality Standards Regulations 2011, accessed 12 December 2018, http://www.irishstatutebook.ie/eli/2011/si/180/made/en/print

2.6 Use of EU funding to fund air quality improvements

The EPA's Environmental Research programme is the primary funding mechanism for air quality research and projects in Ireland. Through the programme's Climate theme, over 50 air quality related projects have been funded since 2007, with a budget of over €11 million.[27] The appendix to the case study report summarises ongoing EPA funded air quality projects. Furthermore, the EPA funds scientific projects through a variety of national and international partnerships, such as with the Science Foundation Ireland and Irish Research Council Science Foundation Ireland (SFI). The EPA's Research Programme 2014-2020 for instance, funded a project on Irish Nationwide Health and Air Quality Linkage, at University College Cork.[28]

Furthermore, in April 2018 the EPA launched its annual Research Call, making available up to €9.5m for research projects across three key areas: Water Climate and Air, and Environmental Sustainability. The funding, managed by the EPA and provided by DCCAE, will support the implementation of environmental policies, including the Clean Air Strategy. The EPA Research Programme has allocated €2.8m for Climate research, which is further structured into four thematic areas, [29] including one on *"Air Science".* Successful projects will begin by April 2019, and thus named air quality research projects are currently unavailable.

The EPA also has key linkages with the European Commission Horizon 2020 programme which funds research. One such example is the iSCAPE project, coordinated by Trinity College Dublin. It aims to advance and integrate the control of carbon emissions and air quality in European cities through developing remediation strategies, policy interventions and behavioural change initiatives. The project is also looking to deploy a network of air quality and meteorological sensors to monitor impacts.[30] [31]

The EU LIFE Programme provides further funding, for which the DCCAE is Ireland's application administrator. For 2014-2020, the LIFE budget was €3.4567 billion (€2.5925 billion for Environment, €864.2m for Climate Action).[32] Air Quality and Emissions form a Thematic Priority for funding under the Environment Sub-programme. Thematic areas included:

- Nature and Biodiversity;
- Water, including the marine environment;
- Waste;
- Resource Efficiency, including soil and forests and green and circular economy;
- Environment and Health, including chemicals and noise;
- Air Quality and Emissions, including the urban environment; and
- Information and Governance

[27] Department of Communications, Climate Action and Environment (2017) Cleaning Our Air: Public Consultation to inform the development of a National Clean Air Strategy

[28] Environmental Protection Agency (EPA) (2018) EPA Research Awards 2017, accessed 17 December 2018, http://www.epa.ie/researchandeducation/research/epafunding/researchawards/

[29] EPA (2018) EPA Research – Climate Research Call 2018 Technical Description

[30] Environmental Protection Agency (EPA) (2018) International Linkages, accessed 17 December 2018, http://www.epa.ie/researchandeducation/research/internationallinkages/%23.VpfPN7Gvncs

[31] Trinity College Dublin (2018) iSCAPE: Improving the Smart Control of Air Pollution in Europe, accessed 17 December 2018, https://www.tcd.ie/civileng/research/environment/air/iscape.php

[32] Thighearnáin, S.N. (2014) LIFE Programme 2014-2020: Opportunities for Environment & Climate Action Projects

It is unclear what portion of funds goes directly to Air Quality and Emissions in relation to the other thematic priorities listed.

3 FINDINGS

Chapter 3 presents detailed findings regarding the experience and lessons learnt in the implementation of the AAQDs in Ireland. Specifically, the chapter focuses on the challenges and successes encountered in the implementation of the Directives. Additionally, the relevance of the AAQDs, and their air quality standards, has been explored. Finally, the chapter identifies the factors underlying compliance with and effectiveness of the AAQDs and provides an overview of the costs and benefits associated with the implementation of the Directives.

3.1 Relevance of the AAQ Directives

Ireland's air quality is generally considered as good, with recorded concentrations of all relevant pollutants at monitoring points within the limit values of the AAQ Directives in 2017. Despite this, both the EPA and DCCAE commented in interview that limit values are one of the most important requirements of Directive in relation to the needs of Irish citizens but highlighted the importance of the levels at which limits are set. In their response to the targeted questionnaire, the EPA scored the relevance of the AAQ Directives in addressing the current needs of Irish citizens as three out of five. They noted that limit values for NO_2, ozone and PAH are still very relevant, due to their near alignment with WHO air quality guidelines. For $PM_{2.5}$ and PM_{10}, they also highlighted the discrepancies between EU limit values and WHO guideline values suggesting they are therefore less relevant as Irish authorities now refer to the WHO Air Quality Guideline values due to their stringency. Ireland is below the lower assessment threshold for $PM_{2.5}$ though exceeds WHO guidelines. The EPA commented in their questionnaire response that they would welcome the adoption of stricter standards across Europe for these pollutants, and that limit values should decrease over time.

With regards to the relevance of pollutants included, it was suggested by the EPA in their questionnaire response that the AAQDs should be expanded to include PM_1, which would hold greater relevance for Ireland. Support for inclusion of PM_1 was also given by DCCAE in interview. The EPA also noted that academic research has suggested that Ammonia and Black Carbon should also be included.

In terms of redundancy of pollutants, the EPA and Dublin City Council noted that SO_2 is not particularly relevant to Ireland as there is not a large amount of industry and so concentrations are relatively low. The EPA additionally suggested that CO might not be relevant due to low concentrations.

Despite Ireland's lower levels of air pollution relative to EU limit values, WHO air quality guidelines were exceeded at monitoring sites for O_3 and NO_2, and both the EPA and DCCAE noted in interview that there is scope for improvement, which the AAQ Directives promote, given that there is no safe level of exposure to pollutants such as particulate matter. Ireland is subjected to considerable economic and life quality burdens as a result of air pollution. The health-related costs of air pollution are estimated at EUR 2 billion per year with 382 000 work days lost due to air pollution-related sickness, costing employers EUR 65 million per year.[33] Alongside the economic impact, it is estimated that air pollution in Ireland results in approximately 1,200 premature deaths per year.[34]

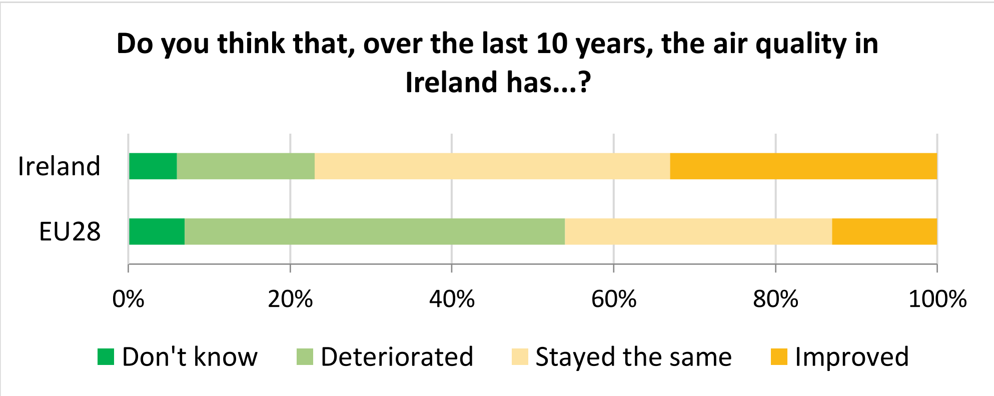
[33] European Commission (2017) EU Environmental Implementation Report - Ireland, accessed 12 December 2018, http://ec.europa.eu/environment/eir/pdf/report_ie_en.pdf

[34] http://www.epa.ie/irelandsenvironment/air/

All interview respondents reported that the AAQ Directives' goals and objectives will be incorporated into Ireland's first National Clean Air Strategy, which is currently under development, and are also incorporated within all air quality plans as well as local strategies such as transport policies. The EPA also noted the AAQ Directives have been relevant as they drive the need for improvement of air quality in Ireland, and have led to the development of the National Strategy. The EPA further noted in their response to the targeted questionnaire that while large urban areas such as Dublin were relatively well served in terms of monitoring, the introduction of the AAQ Directives was the impetus to assess air quality in more rural locations.

Despite the considerable health impacts associated with air pollution in Ireland, the Eurobarometer data (Figure 3-1) shows that Irish citizens hold the most positive perceptions of air quality of the EU28. Only 17% believe that air quality has deteriorated in the last 10 years, while 33% suggest it has improved, the highest proportion in the EU.

Figure 3-1 Results of the 2012 study into Attitudes of Europeans towards Air Quality for Ireland



Source: Eurobarometer 2012 - Attitudes of Europeans towards Air Quality [35]

3.2 Implementation successes

Key implementation successes can be summarised as follows:

- Good information provision
- Good collaborative working
- Development of National Ambient Air Quality Monitoring Programme 2017-22
- Development of first National Clean Air Strategy
- Development of local plans

3.2.1 Good information provision to the public on the state of air quality

The EPA makes available to Irish Citizens information on air quality via a range of media. The details and strengths of these are covered in more detail below.

Air Quality Index for Health (AQIH)

Developed by the EPA, the AQIH uses numbers from one to 10 to indicate the current air quality in a particular region and whether it has health implications, both for adults and children. One to ten correspond with good to very poor. The AQIH is calculated every hour. Readings are displayed

[35] Public Opinion - European Commission, accessed 19 December 2018, http://ec.europa.eu/commfrontoffice/publicopinion/index.cfm

on an interactive colour-coded map and on Twitter. Using the index involves identifying the appropriate AQIH region, of which there are six, and reading the health advice for the current AQIH for the selected region. The AQIH is based on data from air quality monitoring stations.[36] With the planned expansions to the monitoring network, the EPA aims to generate a more localised, and thus improved, dataset.

Furthermore, the AQIH can be used by health professionals to advise patients who are sensitive to air pollution. The health advice provided is based on WHO guidelines and is categorised according to two groups: the general population and those at risk from air pollution.

Periodic Air Quality bulletins and reports

As Ireland's air quality monitoring network increases its coverage, localised high-resolution data will increasingly be available. The EPA collates the data into annual reports on air quality, which contain trend analyses for NO_x, O_3, PM_{10} and $PM_{2.5}$, PAH and other trace pollutants. The reports contextualise Ireland's situation in relation to EU limit values (annual and hourly) and the more stringent WHO guidelines. Data will often be displayed for the previous 10 years, showing trends for different pollutants. The reports include discussions on sources of different pollutants, and make some points on how these could be addressed.

The EPA also publish air quality bulletins, which include information on any breaches of pollutant limits at each monitoring station. Stations are described as being urban, suburban, or rural and levels of traffic are indicated. The number of breaches is displayed for each station, as well as the EU stipulation for the allowed number of breaches. The EPA only publish bulletins for NO_2, O_3 and PM_{10}.

Citizen engagement and citizen science (CE&CS)

The EPA reports that as part of the 2017 – 2022 AAMP it is increasing its activities in relation to public engagement and education. In particular, through collaboration with partners in education. For example, AMMP aims to grow CE&CS resources, develop more CE&CS programmes and build on previous successful partnerships with the National College of Art and Design and INTEL in order to trial new technologies. In addition, the EPA reported in interview that it already uses social media (Twitter) to interact with and engage citizens.

Historic Air Quality data from monitoring stations

For Ireland's monitoring network, historic data can be accessed for all of the pollutants the monitoring station measures, from the date the measurements began. This is made available in datasheets per pollutant, that each cover three months. The datasets are broken down into daily concentrations. Data is made available through the EPA's Secure Archive for Environmental Research Data (SAFER-Data) portal.

[36] Environmental Protection Agency (EPA) (2018) What is the Air Quality Index for Health?, accessed 12 December 2018, http://www.epa.ie/air/quality/index/

Information web-developers can access for 3rd party reporting solutions

Developers are able to access data in a JSON format, which is a dynamically generated feed of the Air Quality Index for Health. This JSON feed can be freely used, and integrated into applications or software (with recognitions that the EPA is the source). The feed is re-calculated on an hourly basis.

This data feeds into publicly accessible apps such as BreezoMeter,[37] which formats the data into clear indicators for people to use in a similar fashion to weather forecasts. A number of websites also use the JSON feed combined with weather data to forecast air quality for several days in advance. Although the forecasting is not provided by the EPA, making data available in a format which allows third parties to provide forecasting services is an important step on from relying on point-in-time data. Through the use of forecasts, those who are particularly vulnerable to air pollution (possibly due to age or illness) are able to plan several days in advance, thus avoiding areas with severe forecasts.

Real-time localised Particulate Matter Monitoring data

In interview, the EPA reported that the number of sites that are capable of monitoring and publishing real-time PM data was increased during 2017 and that the 2017-2022 AAMP will provide real-time PM measurements at all but one station.

3.2.2 Good collaborative working

Interviewees all reported a strong and productive culture in Ireland of collaborative partnership working on air quality between Irish Authorities and institutions at multiple levels. At an international level, DCCAE reported in interview that Ireland has dialogues with neighbouring countries on air quality and attend meetings organised by the European Commission regarding broader air quality work including Long-range Transboundary Air Pollution (LRTAP) and the EPA reported that they have good links with other relevant national authorities through the European Monitoring and Evaluation Programme (EMEP) network. Additionally, Dublin City Council is a part of EEA's Air Implementation Pilot.

At a national level, the EPA and DCCAE reported in interview that working in partnership functions well in Ireland, with the two organisations working together extensively to develop national-level strategy, conduct stakeholder consultation and keep the public informed of policy changes and progress on implementation. The EPA also works with Met Éireann and academic institutions on modelling and research. Additionally, DCCAE and the EPA are collaborating with other government departments to ensure an integrated approach is taken to air quality improvement through avoiding conflicts between department priorities in the development of the NCAS. This is in part facilitated by DCCAE's National Air Pollution Control Programme which exists to foster coordination between NEC Directive, the AAQ Directives and climate change policies.

At a sub-national level, the EPA reported that development of the 2017-2022 National AAMP has involved all local authorities and DCCAE working together. Dublin City Council reported in interview that they have provided detailed input through the public consultation on the AAMP, and are having ongoing discussions with EPA and DCCAE.

On a more routine basis, the EPA and Dublin City Council reported in interview that LAs across Ireland and the EPA collaborate extensively to establish monitoring networks locally, develop

[37] https://breezometer.com/

plans to tackle local Air Quality problems, and execute these plans. This work is substantially co-ordinated by the NIECE network - Ireland's Network for Enforcement and Compliance. This involved collaborating through asset sharing, supporting on location selection, and two-way data sharing according to Dublin City Council. Local authorities, including Dublin City Council, are also engaging in collaborative research activities with their local research institutions.

3.2.3 Development of National Ambient Air Monitoring Programme 2017-22

As mentioned in section 2.4, the EPA has recently completed consultation on a new Ambient Air Monitoring Programme which sets a roadmap for improvement of the assessment of air quality from 2017 – 2022. It will expand the network of monitoring stations which is intended to provide the capacity for real-time air quality information to inform forecasting and modelling which will supplement monitoring for assessment of air quality. DCCAE commented in interview that the development of modelling capacity is intended to increase the spatial resolution of assessment, in order to provide more accurate information on exposure.

Additionally, the EPA commented in interview that the new programme also aims to improve citizen engagement, in part through access to health advice linked to air quality information.

3.2.4 Development of first National Clean Air Strategy

As mentioned in section 2.4, the Department of Communications, Climate Action and Environment is currently leading development Ireland's first National Clean Air Strategy (NCAS). The DCCAE reported in interview that this plan will incorporate AAQ Directives' goals and objectives alongside other sectoral policies related to air quality, including;

- industrial emissions;
- domestic emissions;
- transport; and
- agriculture.

As part of developing this plan, DCCAE are coordinating with other departments within Irish government to ensure an integrated approach is taken to air quality improvement. Detail on exactly how policies will be coordinated to integrate well with other government priorities was not available as the NCAS has yet to be completed.

3.2.5 Development of Local plans

As detailed in Section 2.4, the four local authorities in Dublin produced a joint regional air quality management plan for the 2009-2012 period after NO_2 breached EU limit values in 2009. The plan contained a number of measures to redress NO_2 exceedances including;

- Regional planning guidance for the greater Dublin area; which cover public transport planning as well as built environment guidance to reduce concentrations and exposure;
- The Dublin bike rental scheme, which funds the provision of public cycling amenities;
- The Dublin HGV management strategy; which bans 5+ axle vehicle in areas vulnerable to air pollution.

Since 2009 have been no exceedances of EU limit values for NO2 have been detected in Zone A, though in 2016 they were close to the limit value and so Dublin City Council has continued to take mitigation action, including promotion of public transport, active travel (bicycle schemes), and introduction of some traffic-calming measures.

3.3 Implementation challenges

Key implementation challenges can be summarised as follows:

- Limited resource availability for developing monitoring network
- Challenges related to selection of monitoring sites
- Conflict with climate policies

3.3.1 Limited resource availability for developing monitoring network

The DCCAE reported in interview that the development of Ireland's monitoring networks for assessment has been costly to set up, and funding issues was highlighted by all interviewees as a barrier to effective implementation. Both the EPA and Dublin City Council noted that the Irish economy was in recession at the time of implementation of the Directives, and so national funds were limited between 2008 and 2011. Dublin City Council highlighted that Dublin has only recently recovered from the financial crisis. DCCAE reported in interview that this lack of national funds has been exacerbated by difficulty accessing EU funds experienced by Irish authorities. DCCAE attributed this to a knowledge gap as to what finances are available and how to effectively apply for them. The EPA also noted in interview that there is variation across Member States in their proficiency in securing EU funds and suggested that EU guidelines to access funds would be helpful for those Member States who are typically less successful in securing funds.

3.3.2 Challenges related to selection of monitoring sites

All interview respondents noted that a particular challenge is the selection of monitoring locations to ensure accurate information is gathered representative of, inter alia, the highest levels of exposure as required by the AAQ Directives. The DCCAE and Dublin City Council, in interview, and the EPA, in their targeted questionnaire response, noted that while the Directives provide very good documentation describing methods for monitoring and the number of sampling points required, further and more prescriptive guidance is desired on the siting of monitoring stations to eliminate remaining ambiguity. In particular they noted criteria for classifying traffic environments such as junctions. The DCCAE suggested in interview that such guidance from EU would increase consistency in monitoring across different regions in the country.

Related to this, Dublin City Council in their targeted questionnaire response highlighted a concern that there may not be sufficient spatial resolution in monitoring to identify exposure above limit values, suggesting that hotspots could go unidentified and population exposure not accurately quantified. They also expressed a desire that detailed guidance be provided even on such parameters as the height that monitoring equipment is installed at, providing the example that equipment 1 meter above the ground may not accurately capture the concentration of the pollutant microenvironment for vulnerable receptors such as children in buggies/pushchairs.

3.3.3 Conflict with climate policies

The DCCAE suggested in interview that there is currently uncertainty as to the degree to which some climate change policies interact with, and potentially counteract, air quality policy. An example which Irish authorities have identified is that policies on renewable heating which encourage use of biomass solid fuels are considered favourable from a carbon emissions-reduction perspective but burning of these fuels is associated with higher particulate matter emissions. DCCAE has indicated that to mitigate the growth of residential biomass heaters, the forthcoming Support Scheme for Renewable Heat (SSRH) will only apply to commercial operators and not to residential operators. The EPA reported that this is recognised in Ireland. The EPA highlight that this potential challenge should be addressed in the National Clean Air Strategy being developed, which is set to identify the key conflicts between the AAQ Directives' and Climate Change objectives.

3.4 Factors underlying compliance and effectiveness of the AAQ Directives

The following section provides an overview of the factors underlying and hindering compliance with and effectiveness of the AAQ Directives in Ireland. The factors have been identified through stakeholder consultation conducted in the context of the case study.

3.4.1 Factors underlying compliance and effectiveness

Public and political attention to air quality problems

The EPA reported in interview that public and political attention to air quality problems has been a key factor underling compliance with the AAQ Directives. The DCCAE also commented in interview that the framing of air quality as a public health issue has meant that there has been significant pressure on public authorities to improve it. This was corroborated by Dublin City Council who said that health considerations and advocacy for public health improvements have been a key factor contributing to compliance. The EPA commented in interview their Open Data/Reporting Policy which includes publication of the Air Quality Index for Health has helped to drive public interest.

Improvements in AQ Assessment

Ireland has recently approved a new Ambient Air Monitoring Programme which sets a roadmap for improvement of the assessment of air quality from 2017 – 2022. The EPA commented in interview that it sees effective monitoring as key to effective implementation of the Directives overall, noting that it is essential for identification of areas need to be targeted for air quality improvement and see it as the main transformational change that the Directives have brought about which has facilitating the achievement of air quality objectives. DCCAE also noted in interview that it is supportive of the development of modelling capacity with the aim of increasing the spatial resolution of assessment in order to provide more accurate information on exposures.

Introduction of measures to tackle local AQ problems

DCCAE noted that actions taken at a local level, spurred by additional requirements for air quality improvements applied by the AAQ Directives, have been crucial in achieving the goals of the AAQ Directives to improve air quality where it is not good. Dublin City Council in interview highlighted their work over the last decade, including integrating air quality objectives within city master plans for land use planning and housing development such that residential areas are sited away from polluted locations. They also highlighted public transport as an area in which significant progress has been made including on low emission bus fleets, the main government bus supplier having shifted toward low-emission non-diesel vehicles.

3.4.2 Factors hindering compliance and effectiveness

Limited resource

As was discussed in section 3.3, the impact of the 2008 financial crisis which left Ireland's economy in recession, on the availability of national funds was a significant hindrance to implementation of the Directives, in particular with regards to expanding the Irish monitoring network. This economic downturn also resulted in resulted in a number of major strategic transport projects being postponed in Dublin. On top of this, a lack of knowledge of the funding mechanisms available to support implementation of the directives, and a lack of expertise in compiling successful grant applications, has further constrained resources available for implementation.

Changing public behaviour

Dublin City Council reported in interview that a key barrier hindering effective implementation, in particular improving air quality where it is not good, is difficulty in engaging the public in behaviour change required. In particular they highlighted a resistance towards shifting from personal transport to public transport and active travel, which Dublin City Council has spent the last decade trying to reverse through encouraging use of active travel, car sharing, public transport and through active travel and public transport infrastructure. Both the EPA and Dublin City Council noted in interview that behind this problem of engagement is a lack of understanding of what citizens want/need in order to encourage behaviour change. The EPA recommended that further use of social media and awareness campaigns such as were run successfully around 30 years ago around the time of Ireland's smoky coal ban would be a start to facilitating greater public engagement.

3.5 Costs and benefits of the AAQ Directives

3.5.1 Costs of implementation

The EPA and Dublin City Council provided estimates of the costs of AAQ Directive implementation. The EPA stated in their response to the targeted questionnaire that the above costs represent the total cost of implementation of the AAQ Directives. 3-1 details the cost data provided.

Table 3-1 Costs of implementation of the AAQ Directives, as reported by the Irish EPA and Dublin City Council

Cost item	Cost	Cost incurred by
EPA Annual capital replacement cost	€380,000 p.a.	EPA
EPA Annual staff cost for AAQ Directives	€493,000 p.a.	EPA
Staff are involved in the other public sector-run portion of the monitoring network	2 FTEs p.a.	Not stated
EPA Annual current cost (excluding staff)	€458,735 p.a.	EPA
Dublin City Council monitoring infrastructure capital cost	€160,000	Dublin City Council
Dublin City Council monitoring infrastructure operating cost	€15,000 p.a.	Dublin City Council
Costs of time spent by the relevant persons involved in making measurements, calculations, predictions or estimations in Dublin	€300,000 p.a.	Dublin City Council

The sum of annual costs reported by the EPA and Dublin City Council is €1,806,735.

In addition, Dublin City Council reported that the total capital cost of additional monitoring infrastructure required in order to meet the requirements of the Directives since 2008 in Dublin is €160,000.

Dublin City Council reported in interview that Dublin's air quality monitoring network was developed gradually started before the AAQ Directives, and the EPA noted in their targeted questionnaire response that major urban areas such as Dublin were well served by Local Authorities carrying out monitoring prior to the Directives. As a result, additional costs incurred as a result of the implementation of the 2008 AAQD were reduced. The total capital cost of the monitoring infrastructure in Dublin, including that not required by the AAQ Directives, was estimated by Dublin City Council in their targeted questionnaire response at €400,000 with an operating cost €40,000 per year. The EPA did not provide cost estimates for all monitoring infrastructure including that not required by the AAQ Directives.

3.5.2 Costs of non-implementation

Ireland does not have an implementation gap in terms of exceedances or the sufficiency of its monitoring network.

3.5.3 Benefits of the AAQ Directives

Currently, there is no national analysis of the valorised health benefits from implementation of the AAQDs.

An important benefit of the AAQ Directives, as noted by the EPA in their response to the targeted questionnaire, that they have driven the assessment of air quality in areas of the country where there was no monitoring prior to the implementation of the Directives. While large urban areas such as Dublin were relatively well served in terms of monitoring, the introduction of the AAQ Directives was the impetus to assess air quality in the regions. This has facilitated the design of policy which takes into account the varying needs and vulnerabilities of rural and urban populations.

Another important benefit of the Directives, noted by the EPA in their response to the targeted questionnaire, is that they have focused the attention of the public and policy makers on air quality issues, and their causes, in particular related to health. The EPA note that without the Directives there would be much less public interest in air quality in Ireland and much less demand to maintain it or improve it.

4 CONCLUSIONS

The present chapter outlines the summary of the main findings of the case study regarding the main implementation challenges the potential for improving the implementation of the Directives in Ireland. Finally, a summary of the evaluation of the AAQDs is presented.

4.1 Identified problems and potential for improving the implementation of the Directives

The case study identified the following challenges in the implementation of the AAQ Directives:

- Limited resource availability for developing monitoring network, in particular difficulty expressed by Irish authorities regarding accessing the funding sources available particularly regarding how best to apply for them;
- Challenges related to selection of monitoring sites, noting that more prescriptive guidance and oversight is desirable to reduce ambiguity but that existing knowledge sharing platforms;
- Conflict with climate policies, noting that there is uncertainty as to the full range of conflicts but that action has been taken on some conflicts related to climate change policies targeting renewable heating.

4.2 Assessment of the AAQ Directives

The following section presents a summary of the findings of the case study in relation to the relevance, effectiveness, efficiency, coherence and EU added value of the AAQDs.

4.2.1 Relevance

A Despite Ireland's good performance relative to EU limit values, WHO air quality guidelines were exceeded at monitoring sites for O_3 and NO_2, with national authorities perceiving scope for improvement and desiring a move to stricter and more challenging targets, given the considerable economic and life quality burdens that result from air pollution in Ireland. Additionally, air quality is a concern to Irish citizens, with 17% believing it has deteriorated over the last decade, though this is the lowest of any EU Member State.

Regarding the relevance of air quality standards and limit values, it was suggested that the AAQDs should be expanded to include PM_1, which would hold greater relevance for Ireland and that SO_2 is not particularly relevant to Ireland as there is not a large amount of industry and so concentrations are relatively low.

Overall, although some pollutants and limit values are seen as less relevant to Ireland, the objectives and aims of the Directives are still relevant to the needs of Irish citizens.

4.2.2 Effectiveness

The findings of the case study indicate effectiveness of the AAQDs in maintaining and improving air quality in Ireland. According to the most recent European Environment Agency Country Factsheet on Ireland[38] none of Ireland's urban population was exposed to pollutant concentrations above the EU's limit values from 2014 – 2016 for NO_2, O_3, BaP or particulate matter. Ireland's

[38] Ireland – air pollution country fact sheet 2018, accessed 19 December 2018, https://www.eea.europa.eu/themes/air/country-fact-sheets/ireland

authorities now refer in reports such as annual air quality reports to WHO guidelines for most pollutants as these are more relevant to concentration levels in Ireland.

The findings indicate that the factors underlying compliance with the AAQDs in Ireland include: 1) public and political attention to air quality problems in particular driven by attention to health impacts and a desire to protect and improve public health, 2) improvements in AQ Assessment in particular in Zones 3 and 4, which have allowed air quality policies to be effectively implemented alongside potential conflicting policies and 3) introduction of measures to tackle local AQ problems including integrating air quality considerations into broader planning policies and reducing emission from local transport. In contrast, the case study identified two key factors hindering compliance, including: 1) difficulty changing public behaviour in particular related to home heating fuel choices as well as update of public transport and active travel and 2) lack of resources and staff, in particular driven by difficulty accessing EU funding streams.

4.2.3 Efficiency

There are currently no economic analyses of the costs of implementation of the AAQDs in Ireland, however, Dublin City Council were able to provide an estimate that €160,000 of capital cost has been incurred for monitoring infrastructure required for compliance with the AAQ Directives, and that this has created an additional €15,000 of operating costs per year for the monitoring infrastructure in Dublin.

Given the lack of sufficient cost data, a more detailed assessment of efficiency cannot be undertaken at this time.

4.2.4 Coherence

The AAQ Directives have prompted the roll out of monitoring infrastructure into urban areas other than Dublin and in rural areas which will be expanded with the implementation of the new 2017 – 2022 AAMP to develop a comprehensive national system employing common methods for assessing air quality.

The case study has highlighted a strong and productive culture of collaborative partnership working on air quality between Irish Authorities and institutions at an international, national and subnational level. This has facilitated the integration of air quality objectives into a broad range of linked policy areas including urban planning and climate change, suggesting that the AAQ Directives have been cohesive with other areas of policy.

4.2.5 EU added value

As outlined above, the EPA, in their response to the targeted questionnaire, noted that the role that the AAQ Directives have had in driving the assessment of air quality in areas of the country where there was no monitoring prior to the implementation of the Directives is seen as a key part of their added value. This has facilitated the design of policy which takes into account the varying needs and vulnerabilities of rural and urban populations.

Another important benefit of the Directives, noted by the EPA in their response to the targeted questionnaire, is that they have focused the attention of the public and policy makers on air quality issues, and their causes, in particular related to health. The EPA note that without the Directives there would be much less public interest in air quality in Ireland and much less demand to maintain it or improve it.

APPENDIX A INTERVIEWS

Organisation	Date of the interview
Department of Communications, Climate Action & Environment	26/11/2018
Department of Communications, Climate Action & Environment	26/11/2018
Dublin City Council	27/11/2018
Dublin City Council	27/11/2018
Environment Protection Agency, Ireland	29/11/2018

APPENDIX B PILOT INTERVIEW GUIDE

General questions

- What challenges have been encountered when implementing the AAQ Directives?
- How have these challenges been overcome? What has proved to work well and what turned out to work less well? Are there any relevant lessons learned that other Member States could learn from?
- Where do you see the greatest potential to improve further the implementation of the Directives?
- Have any specific initiatives/measures been introduced to support the implementation of the AAQ Directives in the Member State (e.g. national guidance, arrangements for information exchange, etc.)?
- What systems are in place to provide information to the public on air quality, exceedances and alerts, and the implementation of plans and measures?

Specific questions

The table below outlines the specific themes discussed during the interviews.

Evaluation question	Questions
RELEVANCE	
(1) How relevant are the goals and objectives of the AAQ Directives to the needs of citizens; do the AAQ Directives still address the most relevant pollutants and set relevant standards and obligations to protect human health and the environment; and are the AAQ Directives sufficiently adapted or adaptable to evolving technical and scientific progress?	To what extent do the goals of the Directives correspond to the needs of the citizens (in your country)? Which of the Directives' requirements are in your opinion the most important in relation to the citizens' needs? To what extent have the goals of the Directives been integrated in the strategic documents (on environmental protection) in your country?
(2) How far are the Directives aligned with key EU priorities? Which elements in the Directives are essential to deliver on these priorities, have elements become redundant?	
EFFECTIVENESS	

Evaluation question	Questions
(3) What factors have contributed to meeting the objectives of the AAQD or to failing to meet these objectives, in terms of: 1) defining common methods to monitor and assess air quality; 2) assessing ambient air quality in order to monitor trends; 3) establishing standards of air quality to achieve across the EU; 4) ensuring that information on air quality is made public; 5) maintaining good air quality, improving it where it is not good; to what level can these factors be attributed to provisions of the AAQ Directives?	What are the main factors that contribute to compliance with/effective implementation of the air quality Directives; hereunder: • air quality standards • reporting requirements • requirements regarding the establishment and implementation of air quality plans and programmes • requirements regarding provision of information to public? • requirements regarding monitoring stations? What are the main barriers (at national/regional/local) level preventing effective implementation of the air quality Directives? Please consider each of the items listed above separately. What would it take to overcome the barriers?
EFFICIENCY	
(4) What are the costs and benefits (monetary and non-monetary) associated with implementation of the AAQ Directives in the Member States, and in the EU; have the benefits (improved air quality) been achieved in a cost-effective manner and to what extent have costs been equitably distributed across different sectors?	What are the costs of implementation of the AAQ Directives? What is the cost of implementation (monitoring, reporting, and planning) for different levels of government, including the use of external expertise on, per year (in FTE)? What is the cost of implementation for different sectors of the industry per year (capital and operating costs of equipment in EUR)? What specific factors contribute to the efficiency/inefficiency of the implementation of the AAQ Directives? What are the costs of non-implementation of the Directives (e.g. environmental and health costs, uncertainty and market distortion, litigation costs for Member States)? What are benefits associated with the implementation of the Directives in the Member State/air quality zone (e.g. health and environmental benefits, economic benefits, eco-innovation, etc.)?
(5) Where there are significant cost differences between Member States and/or between different sectors and/or as regards costs to stakeholders (including social costs as a consequences of poor implementation), what is causing them; and are the costs of compliance proportionate to the benefits brought by the directives?	
(6) How efficient are monitoring, reporting and assessment regimes, what are the administrative costs to the Member States and to the Commission; taking account of the objectives and benefits of the directives is there evidence that they have caused unnecessary or excessive administrative burden?	
(7) Has the implementation of the AAQ Directives supported or hampered EU competitiveness in the global economy; has the implementation of the AAQ Directives improved or been detrimental to economic, social and environmental sustainability?	
COHERENCE	

Evaluation question	Questions
(8) To what extent do the AAQ Directives complement or interact with other environmental policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as the NEC Directive and IED Directive as well as the EU climate legislation and policy; and how do these policies and legislation support or hamper the implementation of the EU air quality legislation?	How and to what extent is the implementation of the AAQ Directives coordinated with the implementation of other EU instruments in the environmental and climate domain (e.g. the National Emissions' Ceiling Directive, the Industrial Emissions' Directive, Large Combustion Plants Directive, etc.)?
(9) To what extent do the AAQ Directives complement or interact with sectoral policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as energy, transport, agriculture, cohesion, fiscal policies); and how do these policies support or hamper the implementation of the EU air quality legislation?	How and to what extent is the implementation of AAQ Directives coordinated with other relevant legislation and policy (e.g. in the area of energy, transport and agriculture)? Are air quality plans coordinated with planning initiatives promoted by EU sectoral legislation (e.g. Sustainable Urban Mobility Plans, TEN-T investments)? Are air quality plans coordinated with national emission reduction plans and measures under the NEC Directive? Are air quality plans coordinated with climate change mitigation policies and plans (for GHG emission reductions)? To what extent are air quality plans integrated or linked with municipal/urban/regional level planning e.g. in the area of land use and spatial planning, energy management, transportation and climate? To what extent are EU funds used to finance measures (e.g. abatement programmes) to maintain good air quality/improve air quality?
ADDED VALUE	
(10) To which degree have the AAQ Directives, including common EU air quality standards and comparable air quality assessment, management and information approaches enabled Member States and their competent authorities to take successful action to improve beyond what would have been possible without EU action?	Have AAQ Directives triggered transformational changes that have enabled the achievement of air quality objectives? Have AAQ Directives contributed to improvements in monitoring? Have AAQ Directives contributed to improvements in public information and public participation? What are the wider economic, social and environmental impacts of the Directives in the Member State/air quality zone?
(11) What has been the EU added value of the AAQ Directives, do the Directives and their means of implementation create synergies or overlaps with other Community objectives, and how has the distribution of responsibilities between EU, Member State, regional and local levels impacted on air quality management?	How is the implementation of the AAQ Directives coordinated in the Member State (division of responsibilities, coordination across different activities)? To what extent is the implementation of AAQ Directives coordinated in the region (to address transboundary pollution)?

APPENDIX C EU FUNDED PROJECTS

Project Number	Project Title	Organisation
2013-EH-FS-7	Development of a spatially- and temporally-resolved emission inventory for Ireland	University of Dublin, Trinity College (TCD)
2013-CCRP-FS.15	CRiMsON (Consolidation of IRelands Greenhouse Gas and Transboundary MOnitoring Network)	National University of Ireland Galway (NUIG
2013-EH-MS-14	Assessment of the impact of ammonia emissions from intensive agriculture installations on SACs and SPAs	University College Dublin (UCD)
2013-EH-MS-15	Source Apportionment of Particulate Matter in Rural and Urban Residential Areas (SAPPHIRE)	University College Cork (UCC)
CCRP-09-FS-4-2	Research support for integrated atmospheric studies at Mace Head	National University of Ireland Galway (NUIG)
2011-CCRP-MS-4.5	Emission Factors for Domestic Solid-Fuel Appliances (EFDOSOF)	University College Dublin (UCD)
2012-CCRP-MS.7	Critical Loads and Dynamic Soil-Vegetation Modelling	Trent University
2012-EH-FS-6	Air quality modelling	University of Dublin, Trinity College (TCD)
2013-CCRP-MS.14	Integrated Modelling Project -GAINS Ireland	APEnvEcon
2014-CCRP-MS.19	On-Line BioAerosol Sampling (OLBAS)	University College Cork (UCC)
2015-CCRP-MS.26	National mapping of GHG and non-GHG emissions sources	Aarhus University
2015-CCRP-FS.24	Exploiting the vast remote sensing capabilities at Mace Head to understand Irish air quality	National University of Ireland Galway (NUIG)
2015-CCRP-MS.29	Particulate Matter from Diesel Vehicles: Emission and Exposure in Ireland.	University of Dublin, Trinity College (TCD)
2016-CCRP-MS.31	AEROSOURCE	National University of Ireland Galway (NUIG)

Publications Office

CASE STUDY REPORT
ITALY

Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

Written by Tony Zamparutti
March 2019

Contents

Appendices

1 INTRODUCTION

This report summarises the findings and conclusions of the **case study for Italy**. The case study had a focus on the Sicily region.

The report is one of seven case studies carried out for the Fitness Check of the EU Ambient Air Quality Directives. Its main purpose is to examine, in more detail, the situation regarding the experience and lessons learnt in the implementation of the air quality legislation. The case studies provide a basis for a more detailed examination of the questions of the fitness check and include a review of implementation and integration successes and problems, the costs of implementation and of non-implementation of the legislation and the administrative burden of implementation and opportunities for improving implementation without compromising the integrity of the purpose of the Directives. As such, the case study complements the information gathered through other sources, such as desk review, targeted questionnaire, open public consultation, interviews, focus groups and stakeholder workshops.

The Member States for detailed case studies have been selected to cover a range of geographies, governance structures and sizes. This has led to the selection of the following **seven case study Member States: Slovakia, Germany, Spain, Sweden, Ireland, Bulgaria and Italy**.

The case study report is structured in four chapters, namely:

- **Chapter 1 – Introduction**
- **Chapter 2 – Background and context**, presents general information about the context of the case study
- **Chapter 3 – Findings**, presents detailed findings regarding the relevance of the AAQ Directives, the implementation successes and problems, the factors underlying compliance with the Directives, the costs and benefits.
- **Chapter 4 – Conclusions**, presents a summary of the main findings.

The case study findings rely on extensive desk research and a series of interviews that took place over the period October and November 2018. An overview of the interviews carried out is provided in Appendix A.

The case study has been shared with the interviewed stakeholders in January 2019 for validation of findings and correction of factual mistakes. Feedback received from the stakeholders was integrated in the case study report.

2 BACKGROUND AND CONTEXT

The present chapter contains general information about the air quality framework in Italy.

2.1 Italy and air quality zone characteristics

2.1.1 Scope of the case study

The case study covers *the entire territory of Italy and focuses in particular on the Sicily region.*

Italy's territory is divided into *21 agglomerations and 81 zones*[1] *for the purpose of assessing air quality for PM_{10} and NO_2.*

Italy's regions (plus the two autonomous provinces) play a key role in implementing the AAQD: according to national legislation, they are responsible for the assessment of air quality and the implementation of air quality measures (see section 2.3 below for further information on responsibilities). The agglomerations and zones are identified within Italy's regions and autonomous provinces and do not cross their boundaries.

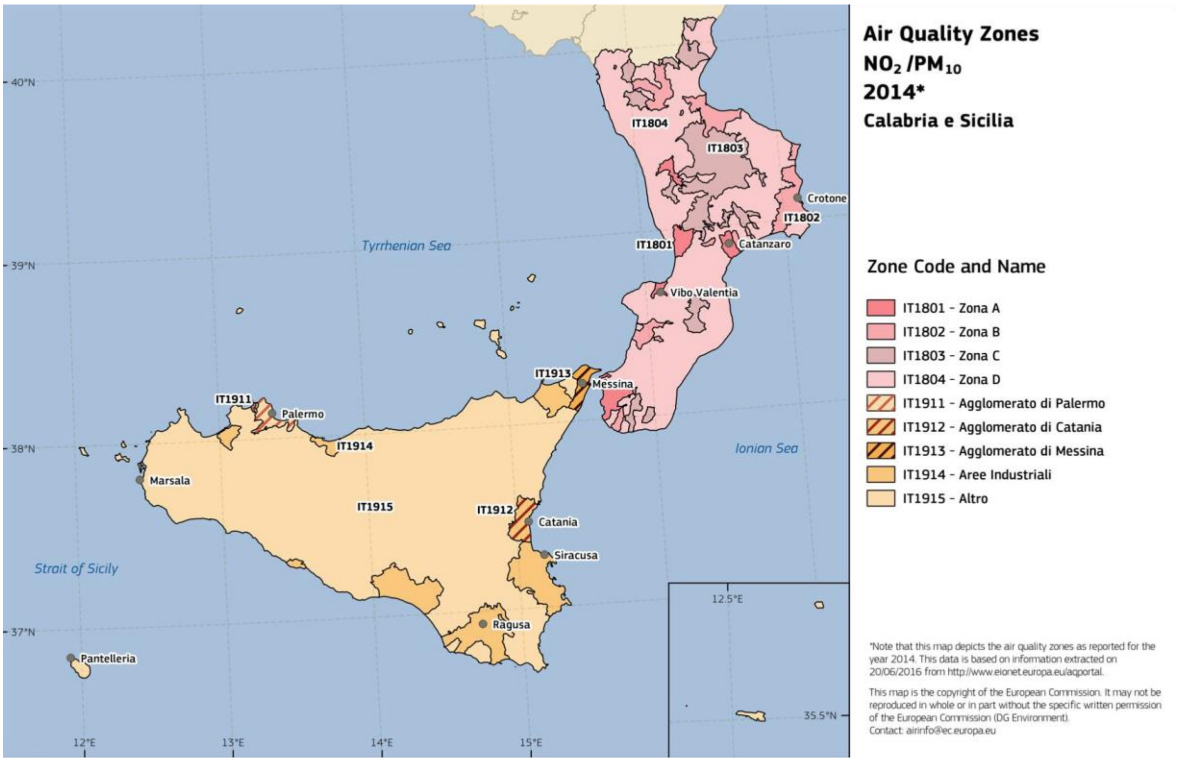
Sicily is one of Italy's 20 regions. Its population is 5.1 million (Eurostat data for 2017). Sicily contains three agglomerations and two zones for the purposes of the AAQD for PM_{10} and NO_2 (see Figure 2-2 below; please note that the figure also presents the Calabria region, which is not a focus here). Please also see Text box 2-1 below for details on Sicily.

Figure 2-1 Air quality zones for NO_2 and PM_{10}, 2014

Source: ISPRA, *Analisi dei trend dei principali inquinanti atmosferici in Italia (2008-2017),* Rapporti 203/2018, published February 2019
Notes: dark lines represent regional boundaries, light lines represent zone/agglomeration boundaries

[1] Data (reference year 2017) sent by ISPRA.

Figure 2-2 Air quality zones for Sicily (and Calabria), NO_2 and PM_{10}



Source: European Commission, DG Environment, Atlas of air quality zones and monitoring stations (2013 & 2014): Italy.
Note: the map covers both the Sicily and the Calabria regions.

2.1.2 Geomorphology

Italy's complex geomorphology encompasses two major mountain ranges, the Alps and the Apennines and two large islands (Sardinia and Sicily). Approximately 35% of Italy's land area is mountainous, over 600m above sea level; a similar share is hilly (up to 600m)[2]. Settlements are found mainly in the plains, in valleys and along the coastline.

In northern Italy, the Po Valley, in particular its large alluvial plain, is largely surrounded by mountains, which together with frequent temperature inversions trap air pollution. The Po Valley is the site of intensive agricultural, industrial and economic activities, as well as extensive urban sprawl. All these factors exacerbate air quality problems[3]. In other parts of Italy as well, major urban areas such as Florence and Naples have sprawled across plains and are at least partially surrounded by mountains. During summer across nearly all of Italy, high temperatures which enhance the rate of ozone formation are often associated with slow-moving, high-pressure weather systems, leading to major episodes of high ozone concentrations.

The Sicily region has one major island whose interior is hilly and mountainous. Most of the region's urban areas are found on the coast, including Palermo in the north, Trapani on the west coast, Agrigento on the south and Syracuse, Catania and Messina on the east coast. The region also

[2] Nicolini G. et al, The Italian mountains, Unasylva (Vol. 53 no. 1, 2002 International Year of Mountains) FAO, available at: http://www.fao.org/docrep/004/Y3549E/y3549e16.htm
[3] Masetta M. et al, Urbanization Affects Air and Water in Italy's Po Plain, EOS Earth and Space Science News, 23 October 2015. Available at: https://eos.org/project-updates/urbanization-affects-air-and-water-in-italys-po-plain
NASA, Smog or Fog? Actually, a Bit of Both, NASA Earth Observatory, 2014. Available at: https://earthobservatory.nasa.gov/images/84701/smog-or-fog-actually-a-bit-of-both

includes several minor islands, including the Aegadian Islands to the west of the main island, the Aeolian Islands to the north, and Pantelleria and Lampedusa to the south.

The detailed characteristics of Italy and of the Sicily region are presented in the text box below.

Text box 2-1 Italy and the Sicily region

Italy	
GDP per capita in PPS (100=EU28 avg) (2017)	96
GDP per capita growth (% 2008-2016)	-6.4%
Population (1 January 2018)	60.5 million
Governance structure	Unitary / regionalised[4]
Zones defined as agglomerations (%)	26%
Sicily region	
Number of inhabitants:	5 056 641 (Sicily region)
GDP per capita in PPS (100=EU28 avg) (2017)	60
Area:	25 833 km² (Sicily region)

Characteristics of the Sicily region:

For implementation of the AAQD, Sicily has been divided into three agglomerations and two zones.

The agglomeration of **Palermo** (IT1911) contains the city of Palermo and surrounding municipalities. Its total population (2016) is 811,121. Road traffic is a key source of air pollution emissions. Among other sources is Palermo's port.

The agglomeration of **Catania** (IT1912) contains this city and 10 surrounding municipalities. Its total population (2016) is 497,303. As in Palermo, road traffic is a key source of air pollution emissions. Other sources include particulates from Etna, the volcano.

The agglomeration of **Messina** (IT1913) contains the territory of this city, with a total population (2016) of 252,503.

The **industrial areas zone** (IT1914) zone contains 31 municipalities characterised by high levels of industry. The municipalities are found across 7 non-contiguous groups. The main industrial facilities are mainly large plants and include refineries, power stations and cement kilns.

The **other zone** (IT1915) contains the remaining regional territory.

Source: Eurostat, GDP per capita in Purchasing Power Standards (PPS) expressed in relation to the European Union (EU28) average set to equal 100; Eurostat, Real GDP per capita, growth rate and totals; Eurostat, Population on 1 January; ARPA Sicilia, *Relazione annuale sullo stato della qualità dell'aria nella Regione Siciliana anno 2017 (Annual report on the state of air quality in the Sicily Region, 2017)*, June 2018; ARPA Sicilia, *Piano Regionale di Tutela della Qualità dell'Aria (Regional plan for the protection of air quality)*, July 2018

[4] For further details see: Committee of the Regions, at: https://portal.cor.europa.eu/divisionpowers/countries/MembersLP/Italy/Pages/default.aspx

2.2 Air quality monitoring and air quality

The following section presents briefly the arrangements made in Italy for air quality monitoring and provides a short overview of air quality achievements in Italy, including the most recent annual monitoring results published at national level. Further information regarding air quality, as reported in the EEA database[5], is presented in Appendix D to this report.

2.2.1 Air quality monitoring

Italy's regions and autonomous provinces are responsible for monitoring; their environment agencies lead this work. At *national level*, ISPRA – Italy's national Institute for Environmental Protection and Research (ISPRA, *Istituto Superiore per la Protezione e la Ricerca Ambientale*) – within the framework of the recently established *National Environmental Protection System* (see section 2.3 below), provides technical guidance and coordinates the work of the regional environmental authorities (ARPAs).

Monitoring stations in cities are operated by several types of entities, including the regional environment agencies, municipal governments and, in major industrial areas, the operators of large industrial facilities, which operate some stations for the purposes of monitoring under the AAQD[6]. This reflects the system that grew up in previous decades, where municipalities had a leading role in monitoring air quality. In recent years, based on national guidance, the *regions have worked to address gaps in the monitoring networks*, establish common methods across monitoring stations operated by different entities and ensure that the stations are linked into a network.

Sicily reported a total of 47 monitoring stations in 2013 and 2014, according to the European Commission's Atlas. From 2015 on, however, the regional environment agency (ARPA) has used a more limited number – 35 stations – for its air quality network for data reported to the EU level, according to an interview with an ARPA official. One key reason is that some existing stations established by lower authorities (provinces and municipalities) on the basis of old legislation were assessed as redundant for the needs of Italy's current requirements and those of the AAQD (Italian Legislative Decree 155/2010, transposing Directive 2008/50/EC). At the same time, new stations and capacity to monitor additional pollutants have been needed. The existing monitoring network, for example, contained a high number of stations in traffic areas and an insufficient number of urban and suburban background stations[7].

To address these issues, *ARPA together with the regional government prepared a programme to improve the region's air quality network*. The upgrade is to be carried out via a *Project to improve the regional air quality monitoring network and its relative evaluation programme*[8]. The project, developed in 2014, foresees a total of 54 stations in the regional network. Of these, 38 were in place in 2015; however, 3 of the 38 were not operating[9]. Of the 35 stations in operation, the regional environment agency managed 8 stations, local governments operated 24 and a power

[5] http://cdr.eionet.europa.eu/it/eu/aqd
[6] Industrial facilities also monitor their emissions as per requirements under the EU Industrial Emissions Directive and national or regional legislation.
[7] ARPA Sicilia, *Piano Regionale di Tutela della Qualità dell'Aria* (Regional plan for the protection of air quality), July 2018
[8] Regione Sicilia e ARPA Sicilia, 2014, Project to improve the regional air quality monitoring network and its relative evaluation programme at: http://pti.regione.sicilia.it/portal/pls/portal/docs/27562382.PDF.
[9] Arpa Sicilia, Annuario 2015, Qualita' dell'aria, at: http://pti.regione.sicilia.it/portal/pls/portal/docs/27562382.PDF http://www.arpa.sicilia.it/wp-content/uploads/2017/01/capitolo-02-Qualita-dellaria.pdf

company operated 3 stations (these three, however, did not transmit data directly to the regional network).

The project calls for: the establishment of new stations, including two for regional background monitoring; the update of existing stations to monitor additional pollutants; the repositioning of a few stations to better meet requirements (i.e. those set in national Legislative Decree 155/2010, transposing Directive 2008/50/EC); the modernisation of the system to acquire and transmit data from the monitoring stations, linking them in a common network[10].

The project is to be co-funded by Sicily's Operational Programme. It was launched in June 2017 and should have been completed in 2018. As of late 2018, however, funding for the project had not yet been released (see also section 3.2.1). A representative of ARPA explained that the contract needed to be revised – as preliminary work showed that the conditions of some stations were not as good as expected – and as a result in 2018 the project was at a temporary standstill (see also section 2.3); the representative expected that the issues would be resolved in the first quarter of 2019, in which case the improvements to the regional network would be completed by 2019.

The table below compares the monitoring stations in place in 2013/14 (according to information reported to the European Commission) with the stations planned under the project and thus shows the intended changes in the monitoring network. As noted, however, the project was at a temporary standstill in 2018: as a result, these changes had not yet been undertaken.

Table 2-1 Sicily's monitoring network: stations reported in 2013/14 vs. planned network improvements

Agglomeration or zone	Monitoring stations: 2013 / 14 *	Planned changes: total stations **
Palermo (IT1911)	9	7
Catania (IT1912)	5	5
Messina (IT1913)	0	2
Industrial zone (IT1914)	26	31
Other zone (IT1915)	7	9
Total	**47**	**54**

Sources: European Commission, DG Environment, Atlas of air quality zones and monitoring stations (2013 & 2014): Italy; ARPA Sicilia, *Piano Regionale di Tutela della Qualità dell'Aria* (Regional plan for the protection of air quality), July 2018

Notes: * As explained in the text, not all stations reported for 2013/14 were used for the regional monitoring network and for reporting air quality monitoring results to the EU.
** Includes stations that will be upgraded and new stations.

2.2.2 *Air quality in Italy*

Many agglomerations and zones in Italy, in particular urban areas in northern Italy (i.e. in the Po Valley), see *exceedances of EU target values and limit values* for air pollutants.

[10] ARPA Sicilia, *Piano Regionale di Tutela della Qualità dell'Aria* (Regional plan for the protection of air quality), July 2018

According to EEA data[11], the limit value (days of exceedance in a calendar year) for *PM_{10} was exceeded* in 31 zones and agglomerations: mainly in the Po valley, though also around several zones and agglomerations in central and southern Italy. The annual limit value for *$PM_{2.5}$ was exceeded* in 13 zones and agglomerations in 2017, all in the Po Valley. The annual limit value for *NO_2 was exceeded* in 25 zones and agglomerations in 2017, mainly in the Po Valley but also in major urban areas in central and southern Italy including Florence, Rome and Naples.

The daily *target value for ozone was exceeded* in 50 zones and agglomerations in 2017[12], and the long-term objective for ozone was exceeded in 58 zones and agglomerations that year. These exceedances occur throughout Italy.

The *target value for BaP was exceeded* in 19 zones and agglomerations, including major urban areas in the Po Valley, as well as some mountain areas in northern and central Italy. EEA data does not indicate exceedances for other pollutants in 2017.

ISPRA reports that pollutant concentrations have fallen slowly over the past decade[13]: nationwide, PM_{10} levels fell an average of 16% from 2007 to 2015, and NO_2 levels fell 19% over the same period; $PM_{2.5}$ levels fell 5% from 2009 to 2015.

Despite some improvements, data show that a *high share of Italy's population is still exposed to air quality above limit values.* In 2013, according to the European Commission's Environmental Implementation Review of Italy[14], over 60% of Italy's urban population lived in areas exposed to PM_{10} concentrations over the daily limit value, compared to an EU average of 16%. This proportion decreased in 2016, when 44% of Italy's urban population lived in areas exposed to PM_{10} concentrations over the daily limit value[15].

ISPRA reports[16] that critical loads for eutrophication depositions were exceeded across the Po Valley, and northern Italy also has locations with high levels of Cadmium deposition on cropland. Ozone pollution can also affect rural areas: a study of urban areas in southern Europe, including two in Italy, noted that high levels of sunshine contribute to the formation of ozone; frequent sea-land breezes transport ozone from urban areas to inland regions[17].

While ambient levels of pollutants have fallen slowly, emissions of air pollutants have fallen significantly in Italy since 1990. ISPRA reports emissions of SOx have fallen over 90% from that year to 2015 and those for NOx, over 60%. Emissions of VOCs fell by over 50%. Emissions of Benzene fell by over 90%, in particular due to changes in vehicle fuels. Emissions on ammonia, however, have fallen more slowly, by about 20% from 1990 to 2015.

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[11] European Air Quality Portal, Attainment Tables (accessed January 2019) at: http://eeadmz1-cws-wp-air.azurewebsites.net/products/attainment-viewers/attainment-tables-v2/
[12] Data for O_3 and other pollutants downloaded from the European Air Quality Portal, Attainment Tables (accessed January 2019) at: http://eeadmz1-cws-wp-air.azurewebsites.net/products/attainment-viewers/attainment-tables-v2/
[13] ISPRA and SNPA, *Dati sull'ambiente: annuario dei dati ambientali 2017*, December 2017 http://annuario.isprambiente.it/
[14] European Commission, The EU Environmental Implementation Review Country Report – ITALY, SWD(2017) 47 final, February 2017. Available at: http://ec.europa.eu/environment/eir/pdf/report_it_en.pdf
[15] EEA, Italy – air pollution country fact sheet 2018.
[16] ISPRA, *Qualità dell'ambiente urbano – XIII Rapporto,* 2017. Available at: http://www.isprambiente.gov.it/it/pubblicazioni/stato-dellambiente/xiii-rapporto-qualita-dell2019ambiente-urbano-edizione-2017
[17] ETC/ACM, Ozone in southern Europe - Assessment and effectiveness of measures, ETC/ACM Technical Paper 2017/3; and EEA, Air quality in Europe – 2018 report, EEA Report No. 12/2018. Available at: https://www.eea.europa.eu/publications/air-quality-in-europe-2018

2.2.3 Air quality in Sicily

In its most recent report on the urban environment[18], ISPRA indicated that NO_2 limit values had been exceeded in 2016 in two agglomerations in Sicily, Catania and Palermo. Daily limit values for PM_{10} were exceeded in 2016 in Palermo. The long-term objective for ozone was exceeded at monitoring stations in three Sicilian cities: Catania; and Enna and Trapani, both in the other zone (IT1915).

According to EEA data[19], the annual mean limit value for NO_2 was exceeded in three Sicilian zones and agglomerations in 2017: Catania, Palermo and the industrial areas. The long-term objective for ozone was exceeded in three zones and agglomerations: Catania, industrial areas and the 'other' zone. The target value for ozone was exceeded in the Messina agglomeration and the industrial areas zone.

In Sicily's 2018 air quality plan, the Regional Environment Agency presents the contribution of *main emissions sources* for the region as a whole and for two agglomerations and one zone, the industrial areas[20].

Across the whole regional territory, *traffic* is the source of 55% of NOx emissions and 10% of PM_{10} and $PM_{2.5}$ emissions. *Agriculture* is the source of 82% of ammonia emissions. Other and natural sources bring about 60% of PM_{10} and $PM_{2.5}$ emissions: these include *forest fires*, Etna and, to a lesser extent, dust from the Sahara.

In the Palermo agglomeration (ITI1911), *road transport* is the source of about 75% of NOx emissions, about 45% of VOCs and about 25% of PM_{10} and $PM_{2.5}$ emissions (ARPA, based on 2012 data): ARPA estimates that about 80% of road transport emissions come from *diesel vehicles*. *Non-industrial combustion* (mainly boilers) is the source of about 60% of PM_{10} and $PM_{2.5}$ emissions: here, a key source is household wood combustion, which is the largest single source of PM_{10} and $PM_{2.5}$ emissions. The category of other mobile sources and machinery is the source of about 70% of SO_x emissions: this category includes Palermo's sea port, and ships at the port are a key source of SO_x emissions.

In the Catania agglomeration (ITI1912), as in Palermo, road transport is the main source of NOX emissions in the agglomeration, over 60% (2012 data), and contributes between 17% of PM10 and 16% of $PM_{2.5}$ emissions. As in Palermo, diesel vehicles are the main sources of PM_{10} and $PM_{2.5}$ emissions. An assessment of vehicle types in the agglomeration has shown that heavy vehicles (greater than 3.5 tonnes, including buses) are the source of about 50% of vehicle emissions of NOx and about 40% of vehicle emissions of PM10 and PM2.5. Non-industrial combustion, mainly boilers, is the source of just over 40% of PM10 and PM2.5 emissions. Other and natural sources bring over 30% of PM10 and PM2.5 emissions: these include fires, in particular forest fires, and Etna, the volcano.

In the industrial areas zone (IT1914) taken as a whole, industrial processes are the source of over 60% of NOx emissions and over 90% of SO_x emissions, as well as over 35% of PM10 and PM2.5 emissions.

[18] ISPRA, *Qualità dell'ambiente urbano – XIII Rapporto,* 2017. Available at: http://www.isprambiente.gov.it/it/pubblicazioni/stato-dellambiente/xiii-rapporto-qualita-dell2019ambiente-urbano-edizione-2017
[19] Data downloaded from the European Air Quality Portal, Attainment Tables (accessed January 2019) at: http://eeadmz1-cws-wp-air.azurewebsites.net/products/attainment-viewers/attainment-tables-v2/
[20] ARPA Sicilia, Piano Regionale di Tutela della Qualità dell'Aria (Regional plan for the protection of air quality), July 2018

Emissions of several air pollutants in Sicily declined in the period from 2005 to 2012, according to data from the regional environment agency: SO_x emissions by 70%, NOx emissions by 26%, VOCs by 23% and $PM_{2.5}$ by 7%. Emissions of ammonia, however, increased by 20% over this period.

2.2.4 Compliance with EU ambient air quality standards

Over the evaluation period, the Commission undertook several infringement procedures against Italy concerning air quality[21]. Five of these procedures have been closed. These covered: monitoring of PM in Civitavecchia (closed in 2009); air quality assessment and management in Messina (closed in 2009); sulphur oxide exceedances (closed in 2009); designation of air quality zones (closed in 2010); PM_{10} exceedances (closed in 2013) and monitoring and related issues (closed in 2017).

At the time of writing, two infringement procedures remained open. In 2017, the European Commission issued a reasoned opinion to Italy for failing to address air pollution limits for nitrogen dioxide (NO2) in 12 air quality zones, including Rome, Milan and Turin[22]. The same year, the Commission issued a reasoned opinion concerning exceedance of PM_{10} limit values, as daily limit values were exceeded in 30 air quality zones and annual limit values in 9 zones[23]. The Commission followed this reasoned opinion in May 2018 by referring Italy and other Member States to court against for PM_{10} exceedances[24].

2.3 Allocation of responsibility

Pursuant to Article 3 of the AAQ Directive, Member States shall designate – at the appropriate levels - the competent authorities and bodies responsible for the assessment of ambient air quality and the implementation of other obligations laid down by the AAQ Directive.

National level

In Italy, the national Ministry of Environment, Land and Sea is the lead authority for air quality policy, coordinating the work of other bodies.

ISPRA, the national Institute for Environmental Protection and Research, is a technical body with roles for coordination, research and monitoring. ISPRA compiles air quality data, prepares guidance on monitoring and on air quality plans.

ENEA, the National Agency for new technologies, energy and sustainable economic development, supports the Ministry, notably on air quality modelling.

Regional level

Italy's regions (specifically, 19 regions and 2 autonomous provinces) are responsible for monitoring air quality and for preparing air quality plans. Each region has an environment agency (ARPA,

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[21] European Commission, Infringement decisions, web page, at: http://ec.europa.eu/atwork/applying-eu-law/infringements-proceedings/infringement_decisions/?lang_code=en
[22] European Commission, Press release: Commission warns Germany, France, Spain, Italy and the United Kingdom of continued air pollution breaches, 15 February 2017, at: http://europa.eu/rapid/press-release_IP-17-238_EN.htm
[23] European Commission, Press Release: Air quality: Commission urges Italy to take action against small particulate matter (PM10) to safeguard public health, 27 April 2017, at: http://europa.eu/rapid/press-release_IP-17-1046_en.htm
[24] European Commission, Press Release: Air quality: Commission takes action to protect citizens from air pollution, Brussels, 17 May 2018, at: http://europa.eu/rapid/press-release_IP-18-3450_en.htm

Agenzia regionale per l'ambiente) that operates, and coordinates monitoring networks, ensure quality and collects and publishes regional air quality data

ISPRA and the ARPAs work together in the National system for environmental protection (SNPA, *Sistema nazionale della protezione dell'ambiente*), established in 2016 to ensure coordination and cooperation, including on air quality monitoring and planning.

Local level

Each region (or autonomous province) works with local government bodies – including municipalities, metropolitan areas and provinces – on monitoring and on the implementation of measures for air quality, such as traffic restrictions.

2.4 Legal and policy framework and air quality measures

Legal framework

The Ambient Air Quality Directives (2008/50/EC and 2004/107/EC) were transposed in Italy by *Legislative Decree 13 August 2010, n. 155*. This Legislative Decree constitutes the main national legal text on air quality, repealing the previous legislation (Legislative Decree 311/99, Ministerial Decree 60/2002, Legislative Decree no.183 / 2004, D.Lgs.152 / 2007, Ministerial Decree 261/2002).

According to national air quality legislation, the regions and the autonomous provinces are responsible for the assessment of air quality and the implementation of air quality measures. To coordinate the activities of the regions and the autonomous provinces, an *institutional coordination body* was created according to Article 20 of Legislative Decree 155/2010, hereinafter the *Art. 20 Coordination Body*. Its members include the national ministries of the environment and health, the regions and the autonomous provinces, the Union of Italian Provinces (UPI), the National Association of Italian Municipalities (ANCI) and national technical agencies and institutes with competences in environmental matters (ISPRA, ENEA, CNR[25]). In the context of this coordination, common guidelines are identified, and tools are developed that help the regions tackle air pollution in compliance with the European rules.

Strategic framework

In December 2017, Italy's previous government approved a *National Sustainable Development Strategy* to implement the UN 2030 Agenda for Sustainable Development and the 17 Sustainable Development Goals[26]. Italy's national strategy includes among its targets, to *reduce negative environmental impacts in cities by 2030*, with particular attention to air quality as well as solid waste management. The Strategy also calls for improving knowledge on the qualitative and quantitative status of natural, cultural and landscape resources, including air[27].

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[25] The Superior Public Health Institute (ISS) is involved in the activities of Art. 20 Coordination Body ad hoc under request of the Ministry of Health.
[26] Ministero dell'Ambiente e della Tutela del Territorio e del Mare, *Sviluppo sostenibile e rapport internazionali* (web pages): http://www.minambiente.it/pagina/sviluppo-sostenibile-e-rapporti-internazionali; http://www.minambiente.it/pagina/la-strategia-nazionale-lo-sviluppo-sostenibile
[27] Ministero dell'Ambiente e della Tutela del Territorio e del Mare, *Strategia Nazionale di Sviluppo Sostenibile*, 2017.Available at: http://www.minambiente.it/sites/default/files/archivio_immagini/Galletti/Comunicati/snsvs_ottobre2017.pdf

Air quality plans

Legislative Decree 155/2010, (Article 9.1) states that *regions and autonomous provinces should prepare a plan for air quality* if the levels of one or more pollutants among the regulated ones (sulphur dioxide, nitrogen dioxide, benzene, carbon monoxide, lead, PM10 and PM2.5 particulate matter) exceed the corresponding limit value or target value. (The 2010 Decree updates a provision in place in 1999.)

The main steps for these plans – as per Legislative Decree 155/2010 – are programming, evaluation, implementation and monitoring. Their preparation involves various public and private entities and includes: the analysis of the regulatory framework, the characteristics of the territory, the sources of emissions of pollutants in air (inventories of emissions), climatic and meteorological conditions typical of the territory, assessment of air quality, definition of modelling of emission scenarios and air quality, and finally the identification and implementation of rehabilitation measures.

In accordance with Legislative Decree 155/2010 (article 19.3) – and to implement Commission Decision 2011/850/EC (Art. 13) – the regions and the autonomous provinces must transmit the information relative to the air quality plans to the Ministry of the Environment and to ISPRA within 18 months of the year in which the exceedances were registered. Until 31 December 2013, this information was sent according to the procedures established by Decision 2004/224 / EC, i.e. by completing a questionnaire; while, since January 2014, the new reporting requirements established by Decision 2011/850 / EU must be followed.

In 2016, Italy reported[28] information regarding the plans prepared in 2012 by the following regions: the two autonomous provinces (Trento and Bolzano); and the regions of Emilia-Romagna, Lombardia, Puglia, Valle d'Aosta, Veneto, Umbria, Liguria, Piemonte, Toscana. According to ISPRA[29], by February 2019, all the remaining regions have also prepared air quality plans, except for Molise (for which the new plan is in the process of approval) and Basilicata; in addition, some regions have updated previous plans.

While the main planning responsibility is with the regions, at *national level*, the Ministry of Environment prepared a *planning document* in 2014 which summarises information regarding the trends of NO2 concentrations detected, the pressures and the rehabilitation measures adopted both at national and regional level[30].

The regions of the Po Valley share common air quality problems (see section 2.2). In 2013, the national government and the regions and autonomous provinces in the Po Valley signed an *agreement for coordinated and joint measures to address air quality*. An updated agreement was signed in 2017. In 2018, the national government signed further agreements with the Lazio (November) and Umbria regions (December), and other agreements are under development with Campania, Sicily and Tuscany regions.

[28] EIONET, CDR, Information on air quality plans (Article 13), at: http://cdr.eionet.europa.eu/it/eu/aqd/h/envv2e5mw/
[29] Information provided by a representative of ISPRA via email.
[30] National planning document, at: http://www.minambiente.it/pagina/gestione-della-qualita-dellaria

In **Sicily**, the regional government approved the air quality plan in July 2018 with Resolution no. 268 of 18/07/2018[31]. The plan was prepared by the regional environment agency: this is a departure from the normal practice, as the regional agencies do not have a policy-making or planning role; in Sicily's case, after years of inaction[32], the regional government's minister[33] for environment named the director of the regional environment agency as emergency commissioner responsible for preparing the plan, in the place of the regional government's Department of the Environment. The plan prepared by the agency was adopted in July 2018 (see section 3.2.1 below for further information on air quality management in Sicily).

The plan is based on modelling of three scenarios to 2027: current regional trends; (implementation of) the 2013 National Energy Strategy and related regional plans; implementation of the air quality plan's measures.

Sicily's air quality plan identifies 25 measures to be undertaken. It notes that the implementation of these measures will require decisions and actions to be taken by regional and local authorities. Among the measures to reduce emissions are the following[34]:

- M1. Reduction of traffic volumes in Palermo, Catania, Messina and Syracuse: 40% reduction by 2022 and 60% reduction by 2027 (interventions to be undertaken by the municipal governments)
- M2. Application of lower emissions limits in the integrated permits of refineries, chemical and cement plants (action to be taken by national and/or regional authorities)
- M3. Actions to attach ships berthed in the ports of Palermo, Catania and Augusta to the electricity network (to be undertaken by the regional government)
- M5. Reduce the extent of forest fires (to max. 2000 ha/year by 2027) (regional government)
- M7. Raise awareness for the uptake of actions to replace traditional heating with advanced systems (increase of advanced systems of 5% in 2022 and 10% in 2027) (regional government)
- M8. Providing resources to take back old commercial vehicles from small and micro enterprises (Euro 0 to 3 diesel and Euro 1 and 1 petrol vehicles) (regional government)
- M13. Increase of urban green areas by 20% (municipalities).

While the plan sets specific targets to be achieve, it provides only qualitative indications of the cost of some measures. Due to time and resource restrictions, only a limited consultation was carried out of the draft plan. Its measures, however, call for a range of entities, including various departments of the regional government, municipalities and the port authorities to take action. The plan includes a link to the implementation of Sustainable Urban Mobility Plans, but these have not yet been put in place in Sicily.

[31] ARPA Sicilia, *Approvato il piano regionale di tutela della qualità dell'aria* (press release), July 2018: https://www.arpa.sicilia.it/news/approvato-il-piano-regionale-di-tutela-della-qualita-dellaria/
[32] ARPA Sicilia, Decree of the Director General, at: http://www.arpa.sicilia.it/wp-content/uploads/2016/01/2016-01-26-ddg-37-affidamento-servizi-supporto-redazione-piano-qualit---aria.pdf .
[33] i.e. the *assessore*
[34] ARPA Sicilia, Piano Regionale di Tutela della Qualità dell'Aria (Regional plan for the protection of air quality), July 2018

2.5 Information to the public

Pursuant to Article 26 of the AAQ Directive, Member States shall ensure that the public is – adequately and in good time - informed about ambient air quality and other issues specified in the above cited Article. In Italy, Article 18 of Decree 155/2010 specifies the measures to be implemented to ensure information to the public about air quality.

Public information about air quality is publicly available on several levels. First, each *region* has a dedicated section on its website about *air quality levels in real time* and several have *forecast tools* (48-72 hours forecast), as seen in the box below. To meet the obligations of the Directive, regions have developed modelling tools for forecasting and evaluation phase, although some regions still struggle with the provision of real-time data (see the box below).

Text-box 2-1 Comparison of air quality information provided to the public across three regions

While all of Italy's regional environment agencies provide information to the public on air quality levels, the presentation, extent and timeliness of information varies.

Eight regional environmental agencies provide forecasts (48-72 hours):

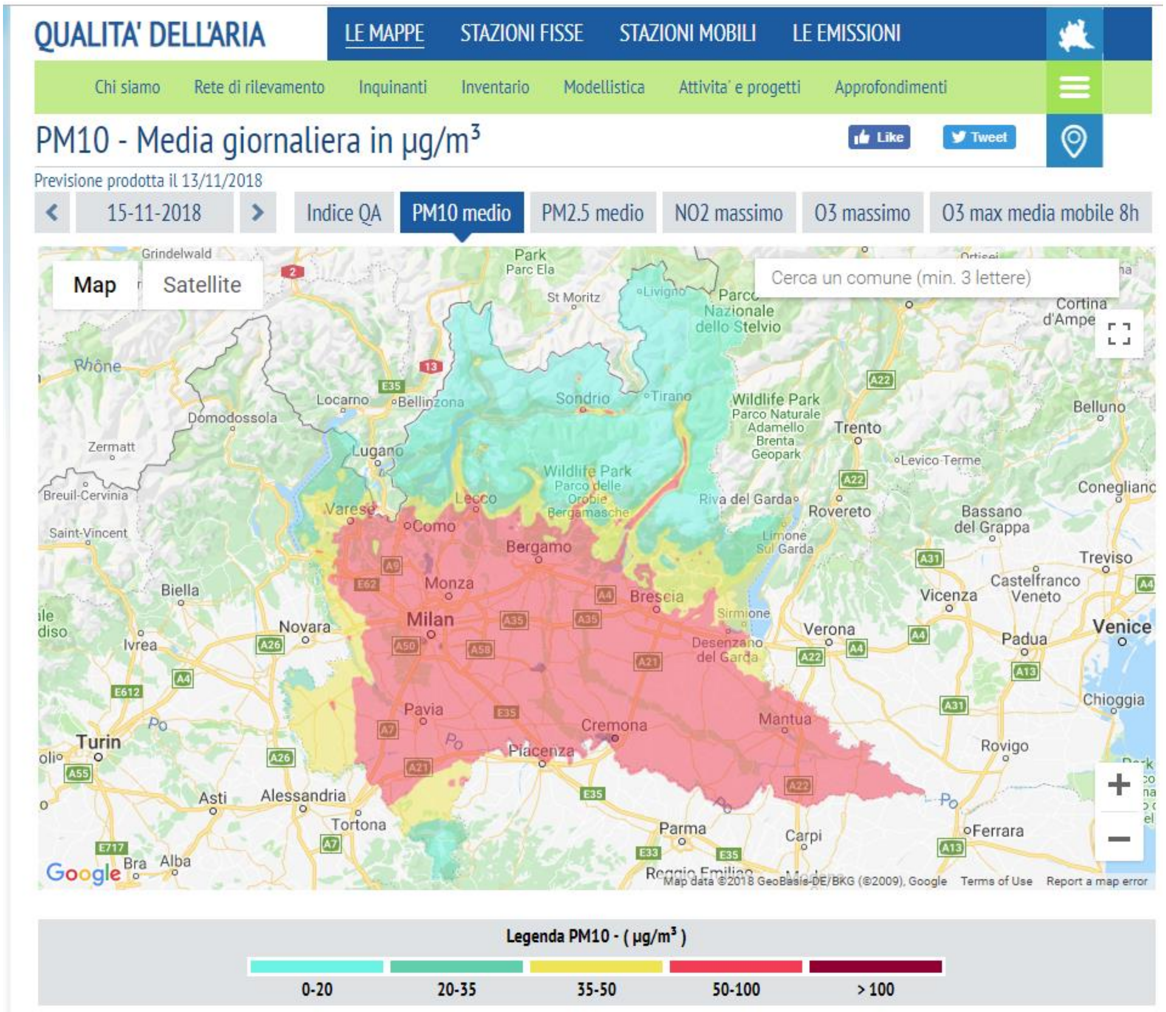
- Valle d'Aosta: link
- Veneto: link
- Friuli Venezia Giulia: link
- Lombardia: link
- Emilia Romagna: link
- Umbria: link
- Lazio: link
- Basilicata: link

Example of differences of information provided for three regions:

- In Lombardy, the environment agency's web site provides a map-based display of air quality, with forecasts provided for the coming 48 hours (the example below shows the forecast for PM_{10} on 15/11/2018, provided on 13/11/2018).
- In Emilia-Romagna, the environment agency provides tables showing air quality in major cities up to the current day, with forecasts provided for the coming 48 hours.
- In Sicily, the environment agency's web site presents tables showing air quality in major cities; however, a check in November 2018 found that most data was at least 30 days old. In March 2019, monitoring data for the previous day was found for some but not all stations[35].

[35] http://www.arpa.sicilia.it/storage/#titoloinizio

Figure 2-3 Example of the forecast for PM10 (daily average) available on the Lombardia ARPA website



Sources: Lombardy: http://www.arpalombardia.it/sites/qaria/_layouts/15/qaria/imodelli.aspx

Emilia-Romagna: https://www.arpae.it/index.asp?idlivello=134

Sicily: https://www.arpa.sicilia.it/storage/index.php?dt=5/10/2018#titoloinizio

Almost all of Italy's *regions transmit data for publication at EU level* on EEA's air quality maps[36], based on a review of the EEA interactive map in November 2018; at the time, based on the EEA interactive map as well as interviews at national and regional levels, Sicily was among the few regions that did not do so. According to interviewees at both national and regional level, it was expected that data will be transmitted to EEA once the project upgrading the region's monitoring systems is in place.

In addition to web-based data presentations, information is consolidated on regional sites in annual reports. On the basis of data transmitted by the regions, *ISPRA* develops at national level, the main indicators on air quality[37] and publishes each year the *Report on the Quality of the Urban Environment* (analysis of 120 urban areas) which includes a specific chapter on air quality[38].

[36] EEA: https://www.eea.europa.eu/themes/air/air-quality-index/index; and https://www.eea.europa.eu/data-and-maps/explore-interactive-maps/up-to-date-air-quality-data
[37] http://annuario.isprambiente.it/
[38] http://www.areeurbane.isprambiente.it/it/pubblicazioni

In addition, regional data are analysed and elaborated for the publication of technical reports, (e.g. air quality and the transport sector[39]).

According the representatives of ISPRA and the Ministry of the Environment, by late 2018 nearly all regions complied with the Directive's obligations regarding information to the public. As described above and in other sections, Sicily is one of the regions that has not yet fulfilled these obligations.

2.6 Use of EU funding to fund air quality improvements

EU Structural and Investment Funds have been used in Italy to finance *air quality interventions*. In the 2007-2013 programming period, the direct investments under ERDF for air quality (Priority code 47) in Italy were EUR 25.4 million: the Operational Programmes of four regions – Tuscany, Sicily, Campania and Calabria region – contained investments under this code[40]. In particular, these regions used *EU funds to finance improvement of their air quality monitoring networks*[41]. In addition, EUR 43 million EUR were allocated to integrated prevention and pollution control investments (Priority code 48), which could include actions to reduce air pollution: The Operational Programmes of five regions – Umbria, Sicily, Puglia, Campania and Calabria – made these allocations.

In the 2014-2020 programming period the use of EU funds for air quality investments fell considerably, as none of the regions allocated ERDF resources for investments under the intervention code 83 (Air Quality measures). A total of EUR 30.7 million (less than three-quarters of the amount in the previous period) was allocated to IPPC intervention code investments: allocations were made in the regional OPs for Basilicata, Calabria, Campania and Puglia[42].

In addition to the allocations for the priority themes directly related to air quality, Italy's Operational Programmes made allocations for renewable energy, energy efficiency and sustainable transport: investments in these areas can have positive impacts on air quality. For example, several regions are currently using *EU funds to promote a renewal of public transport systems* to ensure and maintain good air quality levels. ERDF funds are used to support the preparation and the implementation of Sustainable urban mobility plans[43].

The regional *Rural Development Programmes (RDPs),* co-financed by the European Agricultural Fund for Rural Development (EAFRD), supports measures that reduce agricultural emissions of air pollutants[44]. The RDPs are identified as a key source of *funding for agriculture measures* in, for example, the 2013 and 2018 air quality plans for Lombardy and the Sicily. Data on the overall EU resources allocated air pollution in Italy are not available, however[45].

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[39] http://www.isprambiente.gov.it/it/pubblicazioni/rapporti/trasporti-strumenti-europei-e-nazionali-per-il-risanamento-della-qualita-dellaria
[40] Data source: data on final spending from ERDF and CG for the period 2007-2013 obtained from DG Regional and Urban Policy in September 2018
[41] Database of projects available at: https://opencoesione.gov.it/it/progetti/?q=&selected_facets=ciclo_programmazione:1&selected_facets=tema:05&selected_facets=is_pubblicato:true
[42] Data source: data on final spending from ERDF and CG for the period 2007-2013 obtained from DG Regional and Urban Policy in September 2018
[43] For example, the Emilia Romagna region has prioritised ERDF funds to this aims.
[44] Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R1305
[45] Air quality Plans for Lombardy and Sicily.

The *EU LIFE Programme* has also supported air quality actions. As an example, the *PREPAIR Project (Po Regions Engaged to Policies of AIR)*[46], currently underway, supports the implementation of measures foreseen in regional plans in the Po Valley and in the Po Valley agreement, to strengthen the sustainability and durability of results: the project's geographical coverage is the Po Valley with the regions and cities that mainly influence air quality in the basin. Its actions are also extended to Slovenia in order to assess and reduce pollutants transportation across the Adriatic Sea. The project will last for 7 years (from 2017 to 2024). The total budget is EUR 16.8 million, of which EU co-financing totals EUR 10.0 million. The recently completed OPERA project (see section 3.4.3 below), also financed by LIFE, developed a modelling tool to estimate costs and benefits of air quality measures[47]: this tool, RIAT+, will be used in the PREPAIR project to estimate the results of ongoing air quality plans in the Po basin.

In **Sicily**, *structural funds* in the 2007-2013 programming period were used for the *design and implementation of interventions aimed at improving the air quality monitoring system*, including the purchase of stationary equipment (7 projects planned for total amount of EUR 10.8 million), new mobile laboratories and related technical assistance service and maintenance (1.9 million EUR)[48]. However, the financing of these projects has been blocked due to administrative issues (see section 3.2.1 below), causing substantial delays in the development of Sicily's monitoring network.

The preparation of the air quality plan was a precondition for the utilisation of structural and investment funds for the period 2014-2020. As noted above, Sicily's plan was adopted in August 2018. The funds will be used for investments in several areas[49], including the upgrade of the air quality monitoring network.

[46] http://www.lifeprepair.eu/index.php/project/?lang=en
[47] http://www.operatool.eu/html/eng/index.html
[48] http://www.ignaziocorrao.it/wp-content/uploads/2016/10/fondi-europei.pdf
[49] Sicily OP 2014-2020

3 FINDINGS

Chapter 2 presents detailed findings regarding the experience and lessons learnt in the implementation of the AAQDs in Italy and in the Sicily region. Specifically, the chapter focuses on the challenges and successes encountered in the implementation of the Directives. Additionally, the relevance of the AAQDs, and their air quality standards, has been explored. Finally, the chapter identifies the factors underlying compliance with and effectiveness of the AAQDs and provides an overview of the costs and benefits associated with the implementation of the Directives.

The findings presented in this chapter rely primarily on input provided by stakeholders interviewed in the context of the case study. These were, as relevant, supplemented by additional desk research. An overview of the interviews carried out is provided in Appendix B.

3.1 Relevance of the AAQ Directives

The European Commission's 2017 Environmental Implementation Review of Italy states that '*air quality in Italy continues to give cause for concern'*, citing the exceedance of limit values for several pollutants and the high share of the urban population exposed to PM_{10} levels above the daily limit values. The Review calls on Italy to continue reducing air pollutant emissions in order to achieve compliance with air quality limit values and reduce impacts on health, environment and economy[50].

A majority of Italian citizens responding to the 2017 Special *Eurobarometer survey on environment* perceived that *air quality had deteriorated in the past 10 years* (61% of respondents); the second-largest group (31%) perceived that air quality stayed the same[51]. (As noted in section 2.2 above, air quality in Italy as a whole has improved slightly in recent years.) When asked in the Eurobarometer survey at which level (of government) the issue of air pollution can be best addressed, the largest share of respondents in Italy (43%) nominated the EU level; the second-largest share (38%) the national level; and the third (13%), the regional or local level[52].

In the *Open Public Consultation*, 5 of the 8 respondents from Italy perceived that *air pollution*, to a very large extent, *poses a concern for public health*; a further 2 indicated that it does to a large extent. In addition, 5 of the 8 respondents indicated that air pollution, to a very large extent, *poses a concern for the environment* and a further 3 indicated that it does so to a large extent.

One response to the evidence-gathering a questionnaire was received from Italy. The respondent, at an academic institution, cited the *high level of premature deaths due to air pollution in Italy* estimated in the EEA's reports on air quality.

In Sicily as well, ongoing air quality issues indicate that the AAQD remain relevant. The regional air quality plan proposes additional pollutant limits to address concerns in the region's industrial areas, however, including hourly limits for benzene and hydrocarbons as well as limits for odours: it was felt that *the provisions of the AAQD did not fully address the concerns of citizens near these industrial areas*.

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[50] European Commission, The EU Environmental Implementation Review Country Report – ITALY, SWD(2017) 47 final, February 2017.
[51] European Commission, Special Eurobarometer 468: Attitudes of European citizens towards the environment (Survey conducted by TNS political & social), October 2017.
[52] Based on detailed statistics available at: EU Open Data Portal, Special Eurobarometer 468: Attitudes of European citizens towards the environment, released 2017.

3.2 Implementation successes

The present section highlights the key implementation successes of AAQDs in Italy.

These include the recent improvements in monitoring and reporting systems across most of Italy's regions and improvement in regional/local cooperation.

3.2.1 Improvements in monitoring and reporting across most of Italy's regions

Before Directive 2008/50/EC was adopted, Italy had a large monitoring network which, however, needed substantial improvements to comply with the directive's requirements once it entered into force. Italy had many monitoring stations – over 800, more than required by the Directive – but regional networks were fragmented and typically included stations managed by different entities, such as local governments as well as the regions themselves: there were issues in terms of lack of common methods as well as communication of data. In general, the regional networks were focused on air quality in high-traffic areas and not on average population exposure.

To comply with the Directive's requirements, Italy started an *ambitious reorganisation of the monitoring network*. The Art. 20 Coordination Body developed *national guidelines*. Based on these, the regions prepared programmes to update their monitoring networks: these were then sent to the Ministry of Environment to be evaluated with the support of ISPRA and ENEA.

The reorganisation process started in 2008 and more than *10 years later the upgrade of the regional networks is almost complete*. One factor that slowed down the work to rationalise monitoring networks, according to an interviewee, was *the strong public opposition*: citizens and environmental NGOs did not understand the reasons for closing or moving stations that were considered not necessary for assessing exposure of the population to air pollution and reacted with protests, warnings and legal actions.

The regions where a relatively strong network was already in place upgraded their networks more quickly, introducing monitoring for additional pollutants; other *regions*, mainly *in the south of Italy, faced greater efforts to upgrade their networks* because they had to fill gaps in stations and in many cases establish new stations. Among the last regions, in Campania, for example, opened new stations in 2016. As noted in section 3.2.1, however, as of late 2018 the upgrade of monitoring stations and the monitoring network in Sicily still needed to be completed, as the contract for this work needed to be review (as noted above, if the update to the contract is in place in early 2019, the upgrade of Sicily's monitoring network should be completed by the end of 2019).

Legislative decree 250/2012 defines reporting mechanisms. At present there is no decree that transposes implementing decision 2011/850/EU, although all activities put in place by Art. 20 Coordination Body contribute to its implementation. *Reporting is challenging for Italy* because it is managed at the regional level, so there were 21 systems (19 regions, 2 autonomous provinces) that had to be adapted to the new obligations and it was a very complex process from an IT point of view. Regions report via ARPA and communicate data to the Ministry through ISPRA, which is the national collector. While reporting of the consolidated data has not been problematic, the transmission of the updated data and real time data to the EU level started only in March 2018. An external company was subcontracted to handle this problem and ISPRA put a lot of effort in collecting, checking quality and sorting data from each region and send it to EEA. Up to late 2018, only 3 or 4 regions (including Sicily) had not yet provided data streams to be reported in near real time to EEA.

3.2.2 Strengthening cooperation: actions at national level and in the Po Valley

Coordination between the Ministry and the regions is complex but has improved significantly over the years, according to an interviewee. In 2003 the Ministry organised the first coordination meeting with all regional authorities which was then formalised with the creation of *Art. 20 Coordination Body*. The members of Art. 20 Coordination Body meet regularly several times a year. Since the first meeting, important progress has been made, according to the interviewee, and the competent authorities have learned to dialogue, initially on a technical level, then on a strategic level. Over time, they have dealt with several issues: initially the activity was focused on the homogenization of the instruments (zoning, preparation of the monitoring network). The Art. 20 Coordination Body has first provided regions with technical guidelines and tools for the implementation of the directive, such as modelling tools to gather information on emission scenarios; cooperation then moved to a more strategic phase which consisted in the agreement and identification of appropriate measures, through the air quality plans; more recently its focus has been on better reporting.

The establishment of the *National System for Environmental Protection (SNPA)* in 2016 (under Law 132 of 28 June 2016) has further advanced cooperation on air quality as well as other environmental themes. The SNPA, which started its activities in January 2017, was created to ensure common approaches and effective actions for environmental monitoring, to support environmental and health prevention policies and to protect public health.

The SNPA brings together ISPRA and the regional ARPAs into one single body to coordinate environmental monitoring and assessment, related research activities and technical support activities for administrations responsible for the collection, organization and dissemination of environmental data. Under the coordination of ISPRA and through the organisation of regular meetings, the ARPAs work on the basis of common standards, (called 'essential levels of technical environmental performance' - LEPTAs) throughout the territory[53].

In the *Po Valley district,* an extended area facing serious air quality issues (see section 2.2 above), cooperation between the regions took a step forward with the *signature of an agreement in 2013*, bringing together the regions as well as several national ministries; the agreement was updated in 2017 (see Text box 3-1).

[53] http://www.isprambiente.gov.it/files/snpa/NasceilSNPA.pdf

Text box 3-1 The Po Valley Agreement and its update

The 2013 Action Plan was signed by five national ministries and by six regions and the two autonomous provinces in the Po Valley. The agreement had great political relevance and marked a milestone in cross-sectoral cooperation for air quality management in Italy as it was the first time that all relevant ministries sat at the same table[54].

The Agreement indicated that national ministries would take a range of strategic measures including the following:

- Ministry of Environment, Land Sea: set levels for dust and nitrogen oxide emissions under integrated industrial permits below BREF levels where technically feasible (for facilities under its competence)
- Ministry of Economic Development: plan a fund for energy efficiency in buildings and update provisions on biomass combustion
- Ministry of Transport and Infrastructure: promotion of electric vehicles
- Ministry of Agricultural, Food and Forestry Policies: guidelines to address manure management and promote agricultural practices that reduce air emissions

Among the actions undertaken by the regions and autonomous provinces were the following:

- Strengthen enforcement of uncontrolled burning of waste and agricultural residue
- Implement more stringent integrated industrial permits (for facilities under their competence)
- Cooperate on public awareness activities

The 2017 Action Plan was signed by the Ministry of Environment and by four regions. This second agreement did not involve sectoral ministries. A representative for the Ministry of Environment explained that the agreement, unlike the one from 2013, had more technical relevance, focusing on the commitment of the regions for the identification and implementation of concrete measures in their air quality plans, including:

- Common requirements to ban diesel and commercial vehicles at lower Euro standards in winter months (see section 3.2.1 above)
- Promotion of non-biomass renewable energy in zones that where PM_{10} and Benzo(a)pyrene limit values are exceeded, and a ban on using ESIF funding for biomass in these areas
- Introduce more stringent standards for household biomass burners

Among the actions for the Ministry of Environment were:

- Discuss updating vehicle taxation with the Ministry of Economy and Finance
- Discuss updating vehicle speed limits with the Ministry of Infrastructure and Transport
- Coordinate with the Ministry of Agricultural, Food and Forestry Policies on the use of EU funding

Following the example of the regions of the Po Valley, the Ministry of Environment has signed *agreements with other regions*: Lazio in November 2018 and Umbria in December 2018, and soon in 2019 will follow the agreements with Toscana, Campania e Liguria.

3.2.3 Improvements in regional/local cooperation via the air quality plans

The process of preparing air quality plans has *strengthened cooperation between regions*, which are responsible for the preparation and adoption of the plans (see section 2.4 above), *and the municipalities* in their territories.

Before implementation of Directive 2008/50/EC and the preparation and adoption of regional air quality plans, in general regional and municipal levels did not always have a structured approach to addressing air quality issues: municipalities often carried out actions under their own initiative, including ad hoc measures to address high pollution periods – for example, partial traffic block

[54] Interview with a representative of the Ministry of Environment.

limitations and bans on household biomass combustion. Their effectiveness was limited, in particular in the Po Valley, where neighbouring cities might undertake different approaches. The adoption of regional air quality plans and the development of greater coordination, also at national level, introduced *common measures and coordination mechanisms* to address high pollution events at regional level and also at interregional level in the Po Valley.

The development of *Sustainable Urban Mobility Plans (SUMPs)* in Italian cities may further strengthen regional and local cooperation, as these plans should refer to the regional air quality plans: as noted above (see section 3.2.1), the mobility plans for Milan and Ferrara indeed reference the regional air quality plans (this has not been the case for SUMPs in Sicily, as the regional air quality plan has only recently been approved).

3.3 Implementation challenges

The following section presents the main AAQD implementation challenges.

Each of the challenges, the factors driving them and the extent to what these challenges can be linked to the provisions of the AAQDs is presented below.

3.3.1 Ongoing exceedances of limit values and issues related to air emissions from traffic and from heating

According to several interviewees, compliance with air quality standards has been the most difficult obligation for Italy to fulfil, despite some improvements in air quality over the years have been observed. This is a problem in particular in the Po Valley (especially for PM_{10}, $PM_{2.5}$ and NO_2 as well as ozone), due to its geography and the concentration of population and economic activity (see section 2.2), but also other parts of Italy, especially in urban areas, including Palermo and other zones and agglomerations in Sicily which saw exceedances of NO_2 in 2017 (Palermo also saw exceedances of PM_{10} in 2016). Exceedances of the daily target value for ozone are seen in more than half of Italy's zones and agglomerations.

ISPRA has observed a *decreasing trend in PM_{10}, $PM_{2.5}$ and NO_2 concentrations over the last 10 years, but exceedances of limit values continue*. A representative from the Ministry of the Environment noted that PM_{10} is very complex pollutant: only in the last 10 years it was recognised by policy makers that several sources need to be addressed in tackling PM_{10} levels. The interviewee also explained that it has been difficult for policy makers to identify the right measures, as the reduction of emissions necessary to comply with the PM_{10} limit values in the timeframe foreseen by the Directive 2008/40/EC would have required stringent actions that risked being unsustainable on social and economic levels, for example with severe restrictions on the movement of goods and citizens.

Levels of NO_2 remain a problem in Italy due to the high number of diesel vehicles. It also plays a major role in the atmospheric reactions that produce ground-level ozone. Since nitrogen dioxide is a traffic-related pollutant, emissions are generally highest in urban rather than rural areas. However, nitrogen dioxide, together with benzo(a)pyrene (BaP), is also found in areas away from traffic and industrial plants due to biomass combustion.

Emissions from traffic are one of the main sources of air pollution in Italy, mainly due to emissions from diesel vehicles (in particular for PM_{10} and NO_2). Emissions from biomass consumption also contribute to continuous exceedances of limit values in Italy, including those for particulates (PM_{10} and $PM_{2.5}$) and BaP. In Sicily, as noted above (see section 2.2), road transport is a leading source of air pollution and household biomass combustion is also a key source, including in agglomerations such as Palermo.

Over the years, the Italian government planned various measures to reduce these two pollution sources, but not enough resources were available to make the measures effective, according to interviews carried out. More details are given in the following paragraphs.

Emissions from traffic

The Ministry for Environment has provided *incentives for the replacement of older, more polluting vehicles*, but an interviewee from the Ministry acknowledged that this funding has not proved to be sufficient: EUR 200 million have been allocated for the replacement of 10-15,000 old diesel (Euro 0-3) vehicles with new, less polluting vehicles; overall, however, this represents a small share of the total number of vehicles circulating in Italy (45 million, among which diesel vehicles increased from 4 to 16 million in recent years). The interviewee also stressed that, especially for NO_2, the *measures adopted at Community level have also been ineffective* as it has been only recently recognised that diesel vehicles Euro 3 have not performed up to the desired levels and this has greatly influenced the process of reaching the limit values.

The interviewee also acknowledged that, while the *incentives* helped to raise citizens' awareness about the problem, they *did not make a large contribution in terms of air quality improvements*, according to interviewees. Many urban areas in the north, such as Turin, Milan and Bologna, offer efficient tram, metro and train public transport systems that have been built over many years. However, these cities also attract commuters from neighbouring municipalities (in the case of Milan, some come from more than 80km distance) which are less served by public transport; moreover, Italy has seen a significant urban sprawl over many decades (as noted in section 2.1). Consequently, *an important share of mobility is still undertaken by private cars*. Southern urban areas, Rome included, moreover have historically had a less developed public transport system. In general, a 2013 OECD report[55] concluded that, while there had been progress in prior years in developing integrated urban transport systems in Italy, 'in most Italian cities and metropolitan areas *local public transport systems remain insufficiently developed* (in terms of infrastructure and service quality) to provide an alternative to the use of private vehicles'. (A major national program for the improvement of sustainable public transport is being implemented from 2018 to 2033, aiming to address these gaps.)

Traffic restrictions are put in place during periods of high pollution levels, and these can be effective in the short term, especially for particulate concentrations, although they also often face citizens' resistance[56]. Since October 2018, new permanent traffic restrictions are being established in the regions participating in the new Po Basin Action Plan[57]: Emilia-Romagna, Lombardia, Piemonte and Veneto. The plan calls on the regions to ban, in towns and cities, the circulation of vehicles that do not meet specific levels of European standards on weekdays in the winter: from October through March, diesel automobiles with Euro 3 certification or lower are banned from 8.30 to 18.30; in 2020, this will be extended to Euro 4 diesel vehicles and in 2025, to Euro 5 vehicles[58].

To be effective, such measures must be integrated in regional air quality plans and implemented in concert by municipal administrations via implementing decisions. Despite the common approach

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[55] OECD, Environmental Performance Reviews: Italy, 2013. Available at: http://www.oecd.org/environment/country-reviews/find-a-review.htm
[56] Interviewee
[57] 2017, Nuovo accordo per la qualità dell'aria nel bacino padano, available here: http://www.arpa.veneto.it/temi-ambientali/aria/file-e-allegati/pm10-2017_informazione-al-pubblico/DGR%20836_2017.pdf
[58] https://motori.ilmattino.it/ecologia/nord_italia_stop_vecchi_diesel_primo_ottobre_fermi_1_1_mln_di_auto_emilia_divieto_fino_euro_4-4007784.html

agreed at the Po basin inter-regional level, different regions and different municipalities may follow different approaches in terms of which types of vehicle are restricted, the schedules and the exemptions: in the Emilia-Romagna Region, for example, the restrictions applied to Euro 4 diesel automobiles started from October 2018. When this region's restrictions were first put in place, according to interviewees, information was not available on a common inter-regional platform, and many citizens were reportedly not aware of them[59].

In addition, several Italian cities have put in place *low emission zones* that ban the use of high polluting motor vehicles at all times. In Milan, the low emission zone system has several areas: for the city centre, pre-Euro 4 diesel automobiles are prohibited, and all other vehicles must pay a congestion charge (EUR 5 per day). As a result of these measures, traffic in the centre has fallen about 30%; moreover, the use of bicycles, including *public and private bike-sharing schemes*, has increased.[60]

Emissions from biomass

Emissions from biomass combustion, notably in household stoves, also contribute to continuous exceedances of limit values in Italy. Biomass combustion is a source of particulates, VOCs, CO and PAHs such as Benzo(a)pyrene[61]. An EU LIFE project found that biomass consumption contributed to high levels of particulates in Florence and Milan (the two cities studied in Italy): notably, biomass combustion contributed about one-quarter of $PM_{2.5}$ in Milan, the second source after traffic[62]. As noted in section 2.2, household wood combustion is a key source of air pollutants in Palermo, Sicily.

A representative from the Ministry of Environment noted that many *citizens and even the local administrators are* not aware of this problem. A recent trend has seen citizens moving from gas heating system to biomass combustion systems, possibly also as it is a more climate friendly option, but *not aware of the fact that this causes higher emissions of PM_{10} and $PM_{2.5}$*.

To tackle this problem Italy has introduced a *classification system for wood stoves*, anticipating the implementation of the requirements of the Ecodesign Directive[63]. Since 2016 the national government has offered *incentives and tax reductions for the purchase of certified wood stoves*[64]. Moreover, Ministerial Decree 186/2017[65] establishes requirements, procedures and responsibilities for issuing environmental certifications for heat generators fed with firewood, charcoal and another combustible biomass. It also identifies the reference emissions performance for five quality classes, the related test methods and the checks to be carried out for the purpose of issuing the environmental certification, as well as specific requirements relating to the indications to be provided regarding the correct methods of installation and management of heat generators that have obtained environmental certification. As of early 2019, six regions already prohibited the

[59] https://motori.ilmattino.it/ecologia/nord_italia_stop_vecchi_diesel_primo_ottobre_fermi_1_1_mln_di_auto_emilia_divieto_fino_euro_4-4007784.html
[60] EEA, Europe's urban air quality — re-assessing implementation challenges in cities, EEA Report No. 24/2018
[61] ISPRA, Qualità dell'ambiente urbano, XII Rapporto, Focus su inquinamento atmosferico nelle aree urbane ed effetti sulla salute, December 2016.
[62] Querol, X., et al, Biomass burning in southern Europe, AIRUSE (LIFE 11 ENV/ES/584) Report no. 8, December 2016. Available at: http://airuse.eu/wp-content/uploads/2013/11/R08_AIRUSE-Biomass-Burning-SE-ATH-TR.pdf
[63] Ministerial Decree 28/12, in force since 2016, offers incentives and tax detractions to substitute wood stoves with certified ones, at: https://www.mise.gov.it/images/stories/normativa/DM_Conto_Termico_28_dic_2012.pdf

[65] Ministerial Decree 186/2017: http://www.gazzettaufficiale.it/eli/id/2017/12/18/17G00200/sg

installation of stoves below class 3 (i.e. the most polluting classes) and two further regions were expected to soon follow[66]. The Ministry of Environment moreover reached an agreement in June 2018 with the industry association for biomass to *raise awareness and promote good practices in the use of biomass energy* and to support the association's voluntary certification for low-emission combustion equipment[67].

Some local actions plan to go further: for example, the city of Milan, where biomass combustion is the source of about one-quarter of PM_{10} emissions, plans to ban residential stoves that do not meet eco-design requirements and raise public awareness of the correct use of stoves[68].

3.3.2 Difficulties establishing shared solutions with sectoral authorities

According to one interviewee, at the beginning of implementation of Directive 2008/50/EC, the national Ministry of Environment experienced difficulties in terms of the involvement of sectoral authorities, i.e. Ministry of Transport, Ministry of Energy and Ministry of Agriculture. Initially it was challenging to gather all these sectoral authorities in coordination meetings. Particularly difficult was the *integration of air quality measures with the climate and transport policy measures*: for some time diesel vehicles were incentivised to act against climate change and their adverse effect on air quality was not considered. At a strategic level, air quality plans were not coordinated with other sectoral plans.

Intersectoral cooperation on air quality has improved over the evaluation period, according to an interviewee: one notable step was that key ministries participated in the development of the first Po Basin Action Plan in 2013. As a result, in particular of this agreement, according to an interviewee at national level, intersectoral dialogue has improved at national level and consequentially, also coherence between sectoral plans.

A related issue, noted above in terms of the challenge of ongoing exceedances, is the extensive use of automobiles for private transport, including daily commuting: the limited efficiency of public transport in many parts of Italy contributes to the high use of private automobiles. A 2013 OECD report[69] noted that local and regional governments faced financial constraints for public transport investments. The Italian government has provided financing for public transport and continues to do so, for example with the national programme initiated in 2018 for the replacement of older buses with low-emissions models (see section 3.4); however, interviews noted that this financing has been and remains insufficient to make fast improvements in air quality.

Many Italian urban areas are preparing *Sustainable Urban Mobility Plans (SUMPs),* which are promoted by the *EU's 2013 Urban Mobility Package*: these plans should strengthen coordination at local level on mobility and air pollution in coming years; indeed, a review of the SUMPs for Ferrara and Milan found that they referred to air quality goals (see the box below for further details).

[66] Interview with a representative of the Ministry of the Environment.
[67] Ministero dell'ambiente e della tutela del territorio e del mare and Associazione Italiana Energie Agroforestali (AIEL), Protocollo di Intesa per la promozione di azioni e di iniziative finalizzate alla riduzione delle emissioni degli impianti termici alimentati a biomasse legnose, available at: http://www.minambiente.it/sites/default/files/archivio/allegati/inquinamento_atmosferico/Protocollo_Intesa_MATTM_AIEL.pdf
[68] EEA, Europe's urban air quality — re-assessing implementation challenges in cities, EEA Report No. 24/2018
[69] OECD, Environmental Performance Reviews: Italy, 2013. Available at: http://www.oecd.org/environment/country-reviews/find-a-review.htm

Text box 3-2 SUMPs in Italy

SUMPs in Italy

As part of the first agreement with the Po Valley, a working group was set up which coordinated the update of the guidelines for the preparation of the SUMPs. Subsequently in May 2016, the Ministry of Transport set up a working group aimed at the preparation of guidelines that would be applicable to whole territory and with Decree 397/2017 set up a technical group with the task of monitoring the state of implementation of the guidelines.

As of October 2018, 35 Italian cities had recently approved or adopted SUMPs, while 72 cities had plans in preparation[70]. These plans are strategic documents that 'orient mobility in a sustainable direction over a medium-long time horizon (10 year)', according to the SUMP for the city of Ferrara[71]. As strategic documents, the SUMPs provide indications that need to be implemented via further decisions. A further issue is that the SUMPs are typically prepared at municipal level, while large agglomerations cover several municipalities[72]. Nonetheless, the SUMP for Milan, prepared by the city government and city transport company, also considers the surrounding urban area[73].

Milan's 2016 SUMP (amended in 2017) identifies the reduction of air pollution among its goals (along with reduction of energy efficiency, road accidents and road congestion) and states that its areas of action to address traffic emissions reflect the Lombardy Region's 2013 air quality plan. Ferrara's SUMP also refers to the regional air quality plan (for Emilia-Romagna) and to EU Directive 2008/50.

In Sicily, six cities and urban areas have approved or adopted SUMPs – Agrigento, Bagheria, Gela, Marsala, Sciacca and Siracusa – and four cities have plans in preparation, including Palermo. The plan for Agrigento[74], for example, was approved in November 2015: this plan does refer to air quality. For the city of Messina, a SUMP has not yet been approved but a preparatory document[75] analyses the city's air quality and the role of traffic.

3.3.3 Issues with air quality plans and air quality monitoring in Sicily

Sicily is one of the regions that has lagged in terms of improving its monitoring system. As in other regions, before implementation of Directive 2008/50, regional air quality monitoring involved stations managed by different entities: the regional environment agency, municipalities and also private, industrial operators (for monitoring of air quality near major industrial facilities). There were *gaps in terms of monitoring pollutants*: for example, no monitoring stations in the region's three agglomerations measured $PM_{2.5}$ levels. These stations were not integrated into a common network using comparable measuring procedures, according to interviewees. Moreover, by 2018 the minimum number of stations required by the AAQD was not operational in all zones or agglomerations: for example, the monitoring station operated by the city of Agrigento had been closed due to lack of municipal resources for its maintenance.

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[70] Endurance: Osservatorio PUMS, L'Osservatorio – I PUMS in Italia: stato dell'arte (web page), accessed November 2018. Available at: http://www.osservatoriopums.it/osservatorio/pums
[71] Comune di Ferrara, PUMS: Piano Urbano della Mobilità Sostenibile – Linee di Indirizzo, June 2016. Available at: http://servizi.comune.fe.it/3172/attach/mobilita/docs/pums_ferrara_lineeindirizzo.pdf
[72] Eltis: the urban mobility observatory, Italy (web page), accessed November 2018: http://www.eltis.org/mobility-plans/member-state/italy
[73] Comune di Milano and AMAT, *Piano Urbano Mobilità Sostenibile Milano – Documento di Piano*, November 2016 (Amended June 2017)
[74] Comune di Agrigento, *Piano Urbano della Mobilità Sostenibile della città di Agrigento e connessa Valutazione Ambientale Strategica*, November 2015. Available at: https://www.comune.agrigento.it/download/anno_2016/PUMS_2016_DG_108_16/001%20Relazione%20Generale.pdf
[75] Comune di Messina, Linee guida per la "Pianificazione strategica della mobilità urbana finalizzata all'aggiornamento del Piano Urbano della Mobilità in coerenza con le politiche e pratiche europee (PUMS)", prepared by Prof. Ing. Domenico Gattuso, March 2018. Available at: https://www.pumsmessina.it/2018/04/26/approvato-il-documento-finale-delle-linee-guida-pums/

In 2014, the region prepared a project[76] to update the network, adding *new monitoring stations and increasing the range of pollutants monitored in many existing stations*[77] (see section 2.2). The project also will integrate existing and new stations into a fully connected network. Although the 2018 Air quality plan for Sicily[78] states that the project will be completed by the end of 2018, interviewees said that, in late 2018, it was at a temporary stand-still: although a key contract had been awarded in 2016 via a public tender[79], when works started the contractor found that the conditions of several existing stations were different from those expected (in particular, conditions of several stations were poorer than expected); consequently, a variation to the contract was prepared based on an updated analysis of the stations; the procedures required for the approval of this variation have *delayed implementation of the overall project*.

In part to address gaps in monitoring data, in 2018 ARPA has subcontracted a company to estimate via modelling levels of pollutants that were not fully monitored between 2015-2017[80].

Substantial delays were encountered in Sicily also in the preparation of the regional air quality plan. The first regional air quality plan was prepared and approved in 2007[81], but environmental groups brought the regional government to court for its *lack of analysis* and it was not implemented[82]. Subsequently, in 2009, the regional environmental department contracted an external consultancy company to draw up an air quality plan based on the approach set out in national Ministerial Decree No. 60 2/4/2002. While the contractor had started the work, in 2010 national Legislative Decree 155 came into force and the regional government put on hold the preparation of the plan to focus on the revision of air quality zoning and of the regional monitoring network, implementing the new approaches set out in the decree[83]. After five *years of inaction* regarding the preparation of an air quality plan, in 2015 the regional minister (*assessore*) for environment designated the regional environmental agency (ARPA) as responsible for the preparation of a new plan, instead of the regional government's Department of Environment[84]. *The plan was adopted in August 2018* (see section 2.4).

The 2018 plan identifies the actors that need to implement its measures. These include the regional government, municipal governments and also private actors, in particular the operators of

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[76] Project for the upgrade of the air quality monitoring network in Sicily, available at: http://pti.regione.sicilia.it/portal/pls/portal/docs/27562382.PDF
[77] D.D.G. n.449/2014, http://pti.regione.sicilia.it/portal/pls/portal/docs/27562381.PDF
[78] Air quality plan for Sicily, available at: https://www.arpa.sicilia.it/wp-content/uploads/2018/07/Piano-Aria_.pdf
[79] Open tender for the realization and adaptation of the regional air quality monitoring network of Sicily, available at: https://www.arpa.sicilia.it/bandi/appalto-a-procedura-aperta-per-la-realizzazione-e-ladeguamento-della-rete-regionale-di-monitoraggio-della-qualita-dellaria-di-arpa-sicilia/
[80] Air quality modelling service for the years 2015-2017 for the implementation of the Infoaria platform, available at: https://www.arpa.sicilia.it/bandi/servizio-di-applicazione-modellistica-annuale-e-meteo-e-di-qualita-dellaria-per-gli-anni-2015-2016-2017-al-fine-della-implementazione-della-piattaforma-infoaria/
[81] Gazzetta Ufficiale, http://www.gurs.regione.sicilia.it/Gazzette/g07-43/g07-43-p10.html
[82] The environmental group Legambiente accused the regional government of directly copying parts of the 2007 plan from an earlier air quality plan of the Veneto Region. This accusation was followed by a judicial investigation against several of the officials responsible for the plan. http://www.inuovivespri.it/2017/05/18/possibile-che-in-sicilia-panifici-e-pizzerie-inquinano-di-piu-delle-automobili/ . The events were presented in the European Parliament in 2009, in a written question from the MEP Giusto Catania to the Commission: http://www.europarl.europa.eu/sides/getDoc.do?type=WQ&reference=E-2009-0548&language=EN
[83] ARPA Sicilia, Decree of the Director General, http://www.arpa.sicilia.it/wp-content/uploads/2016/01/2016-01-26-ddg-37-affidamento-servizi-supporto-redazione-piano-qualit---aria.pdf and Info news: http://www.gds.it/28877-dopo-otto-anni-e-ben-tre-governi-via-libera-al-piano-di-tutela-dell-aria.htm.
[84] Specifically, the Director of the Agency was designated as responsible for the preparation of the new plan, at: https://www.arpa.sicilia.it/news/attivita-svolta-da-arpa-sicilia-in-merito-alla-qualita-dellaria/; http://www.arpa.sicilia.it/wp-content/uploads/2016/01/2016-01-26-ddg-37-affidamento-servizi-supporto-redazione-piano-qualit---aria.pdf.

major industrial facilities. The plan indicates the types of costs to be incurred; it does not, however, provide estimates of the costs of the measures.

The monitoring of the implementation of the Regional Air Quality Plan is responsibility of the Regional Environmental Department (DRA). As of February 2019, none of the 25 measures had been initiated except for the update of the Emissions Inventory, for which a Convention was signed between ARPA Sicily and the DRA, which entrusts ARPA with the updating of the Inventory[85].

3.4 Factors underlying compliance with and effectiveness of the AAQ Directives

The following section provides an overview of the factors underlying and hindering compliance with and effectiveness of the AAQ Directives in Italy and the Sicily region. The factors have been identified through stakeholder consultation conducted in the context of the case study. The views have been correlated with information gathered through desk research.

3.4.1 Factors underlying compliance and effectiveness

The findings of the case study indicate that the main factor underlying compliance with the AAQDs in Italy consists in the overall coordination and guidance provided at the national level by Art. 20 Coordination Body to the regions.

Greater public and political attention to air quality problems

Italian NGOs have raised air quality issues at both local and national levels: examples at national level include reports by the groups Greenpeace and Legambiente on air quality problems.

In many cities and regions, in particular in the Po Valley, there has been a long-standing political attention to air quality issues. As described in section 3.2.2, and as noted by interviewees, during the evaluation period the national government worked to bring together and improve coordination among the regions of the Po Valley and to address the persistent air pollution problems found there (notably via the Po Basin agreements).

It was also noted in interviews that public attention has not always led to changes in personal behaviour: for example, low-income inhabitants who rely on driving to reach work and other destinations are reluctant to pay for new vehicles to replace their older, more polluting automobiles and, at the same time, many continue to prefer driving to using public transport.

At national level, interviewees said, sector ministries – such as those for economic development and agriculture – have given greater attention to air quality issues in recent years. This has been an important change over the evaluation period, and is necessary as policies for transport and energy are led by other ministries. The Ministry of Environment has also involved some private actors, notably the industry association for biomass combustion (*Associazione italiana energie agroforestali)*, in actions to address air quality (as noted above in section 3.2.1).

In Sicily, air quality has not been the leading environmental issue for public and NGO attention, with waste management issues considered a priority, according to an interviewee at regional level. Residents near major industrial areas, however, have organised to protest ongoing air quality

[85] Correspondence with a representative of ARPA Sicily, who also noted that a group of private companies affected by one of the measures of the plan appealed to the regional administrative court (TAR Palermo) against the regional government's approval of the plan. This legal action could further delay the plan's implementation.

problems (including issues that extend beyond pollutants in the AAQD to cover those addressed under the IED as well as odour problems). At political level, attention to air quality has grown in recent years: the previous regional government in 2016 acted to overcome the delays in planning by giving shifting the task to prepare the regional air quality plan from the regional government's Department of Environment to the regional environment agency; the current government adopted the plan in August 2018 (see section 3.2.1).

Greater coordination

The monitoring of air quality and the preparation of the air quality plan is responsibility of the regions, but Art. 20 Coordination Body plays a role both downstream and upstream the process.

Art. 20 Coordination Body prepared several national guidelines to ensure a uniform implementation of the Directive and to avoid regional fragmentation. The regions prepared regional zoning plans and monitoring programmes following the national guidelines. National guidelines for the preparation of air quality plans have also been prepared, supporting the regions in this work and promoting common approaches.

To ensure homogenous implementation of the rules established by the implementing decree of the Directive, ISPRA assumed all the data quality control and verification functions which were previously responsibility of each single ARPA. Specific procedures to guarantee network quality were also established at national level by Legislative Decree 155/2010 which provided for a revision of the zoning and a review of the monitoring networks. All ARPAs had to use the same rules to ensure quality measurement. The zoning review projects are submitted to the approval of the ministry with the support of ISPRA and ENEA. Art. 20 Coordination Body also developed common modelling approaches to complement air quality monitoring and promoted their use across the regions.

ISPRA also participates in the preparation of the regional air quality plans through the SEA procedure: the regions prepare the plans with the support of the ARPA's technicians; the draft plans are subject to SEA and examined by the Technical Commission for environmental impact assessment (under the Ministry of Environment), whose work is supported by ISPRA's technicians.

ISPRA organizes periodic meetings to discuss how to meet quality objectives. Thanks to all these new arrangements, the ability to respect the Directive's data quality objectives has certainly improved.

At regional level, as noted above, the air quality plans have strengthened cooperation among municipalities and the coordination of their responses in periods of poor air quality. The agreements for the Po Valley have improved coordination among regions in Northern Italy.

3.4.2 Factors hindering compliance and effectiveness

Lack of resources

A key problem has been the lack of resources. The cost of measures to fully address Italy's air quality problems appears to be beyond current means, according to some interviewees at national level: for example, while the national government has provided incentives to replace older, diesel vehicles, these can only cover a small share of vehicles in circulation.

In Sicily, for example, the regional environment agency has had difficulty providing sufficient personnel for its air quality monitoring and assessment tasks, as well as those to transfer air quality data to national and EU levels; the agency has also had to devote personnel to the preparation of the regional plan. Cities in the region have reduced their monitoring activities due to budgetary shortfalls. In late 2018, the regional environment agency did not have in place a contract for the maintenance of its monitoring stations, as this is foreseen after the upgrade project (which as described has been delayed).

Administrative delays

Interviewees at both national and regional levels have indicated that administrative delays have slowed Italian action on air quality. In many regions, delays in preparing and awarding public contracts slowed the process of upgrading monitoring networks and improving monitoring stations (for example, to expand monitoring of $PM_{2.5}$).

This has been an issue in particular in Sicily, where administrative issues (noted in section 3.2.1 above) have slowed the preparation of the regional air quality plan, adopted only in 2018, as well as the upgrade of the monitoring network.

3.5 Costs and benefits of the AAQ Directives

3.5.1 Costs of implementation

Overall estimates of the cost of implementation of the AAQD have not been found.

Estimates of monitoring costs vary across Italy's regions. One estimate provided by an interviewee is that the *annual average operating cost for a monitoring station was roughly EUR 20,000* (e.g. in Emilia Romagna and Lombardia), although the cost reached about EUR 32,000 per station on average in Tuscany. In Italy there are 250 monitoring stations, implying *total operating costs for monitoring were approximately EUR 5 million a year*. Another interviewee suggested that if all costs are taken into account, including acquisition of instrumentation, management, maintenance and personnel, the annual average cost for a monitoring network ranges from EUR 2 million in a medium-sized region to EUR 4 million in a large region. Estimates for modelling costs were not found, but these would be additional to the monitoring costs.

In Sicily, an interviewee indicated that the *project to update the regional monitoring network would cost an estimated EUR 6 million*, including the construction of new stations and improvement of existing stations. It was also estimated that, once the network is completed, the annual *maintenance costs will amount up to EUR 300,000 per year* for the regional environment agency (this figure covers only the agency's monitoring stations, not all those in the network).

Costs for the implementation of the measures to improve air quality are higher than monitoring costs, although they are difficult to estimate as they depend on the measures that are financed by different sources and implemented by a variety of sectors and entities. One interviewee noted that until recently, relatively few Italian air quality plans have made estimates of the total costs of their measures.

An example of a plan that provides cost information is the 2018 update of the Lombardy region's air quality plan. This update indicates the following costs for its measures over the three-year period 2018-2020:

- Stationary sources and energy efficiency: EUR 152.69 million
- Road transport and mobility (excluding highways and high-speed rail): EUR 2,420 million

- Agricultural and forestry activities: EUR 52.30 million

The 2018 updated plan for Lombardy notes that spending in these areas overlaps with sectoral spending plans, for example for public transport (i.e. some measures are set out under both the air quality plan and sectoral plans). Moreover, the plan notes that overall government financing for public transport has declined with the country's economic difficulties, though the regional government has recently increased its support for this sector.

For many measures, the plan identifies funding sources: for example, Lombardy's Rural Development Programme is identified as a source for most of the agricultural and forestry measures.

The updated regional plan for Lombardy also notes that this region and three neighbouring regions signed the *New Agreement for the Po Basin in 2017*, together with the national Ministry of Environment, which indicated that *national funding of EUR 4 million* (to be co-financed by the regions) would be available for the implementation of measures under the agreement. The Ministry of Environment has also allocated *EUR 4 million for the implementation of the measures* identified by the *agreements with Lazio and Umbria regions*.

While the Ministry of Environment does not provide funding specifically for air quality, other national ministries have *programmes whose spending is expected to support air quality objectives*. These include the following:

Table 3-1 Programmes to support air quality objectives

Sectoral programme/fund	EUR / period	Ministries responsible
National strategic fund for sustainable mobility[86]	3.7 billion from 2016 to 2033	Ministry for Economic Development and Ministry of Infrastructure and Transport
National energy efficiency fund[87]	400 million to 2020	Ministry for Economic Development and Ministry of Environment, Land and Sea
Boiler fund (providing incentives to buy certified, energy efficient heating systems)[88]	900 million / year	National energy company (GSE), under the Ministry for Economic Development
Fund for the replacement of public buses[89]	Over 800,000 for 2014	Ministry of Infrastructure and Transport
Test home-school and home-work mobility plan[90]	35 million in 2016	Ministry of Environment, Land and Sea

[86] National strategic fund for sustainable mobility: Art. 1(613 and 615) of Law 232/2016, http://www.gazzettaufficiale.it/eli/id/2016/12/21/16G00242/sg
[87] National energy efficiency fund, Art. 15(1) of Legislative Decree 102/2014: https://www.sviluppoeconomico.gov.it/index.php/it/energia/efficienza-energetica/fondo-nazionale-efficienza-energetica
[88] Boiler fund, Ministerial Decree 28/12/2012: https://www.gse.it/servizi-per-te/efficienza-energetica/conto-termico
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[90] Ministerial Decree 208/2016: http://www.pdc.minambiente.it/it/news-ed-eventi/bando-progetti-di-mobilita-sostenibile-casa-scuola-e-casa-lavoro; and http://www.minambiente.it/sites/default/files/archivio/allegati/mobilita_sostenibile/dm_28_07_2016_208_mobilita_programma_sperimentale.pdf

Sectoral programme/fund	EUR / period	Ministries responsible
Marebonus[91], to shift goods from road to sea transport	200 million	Ministry of Infrastructure and Transport
Ferrobonus[92], to shift goods from road to rail transport	160 million per year plus funds of Liguria, Lombardy and Piedmont regions	Ministry of Infrastructure and Transport

3.5.2 Costs of non-implementation

An analysis of the costs of non-implementation of the AAQ Directives was not found.

3.5.3 Benefits of the AAQ Directives

Interviewees referred in particular to *health benefits stemming from the implementation of the AAQ Directives.*

One interviewee at national level noted that *few air quality plans in Italy have been assessed in terms of their costs and benefits.* This was also indicated by an interviewee in an academic institution.

A ex-post modelling analysis was recently undertaken of *Lombardy's 2013 air quality plan* (see the box below). This assessment found that *direct benefits outweighed the costs of the plan*, and it also noted that the plan would have further, *indirect benefits*, for example for *climate change*.

[91] Art. 1 (647 and 649) Law 208/2015: http://www.mit.gov.it/documentazione/ferrobonus-e-marebonus-contributi-ed-incentivi-per-lintermodalita
[92] Art. 1 (647 and 649) Law 208/2015: http://www.mit.gov.it/documentazione/ferrobonus-e-marebonus-contributi-ed-incentivi-per-lintermodalita

Text box 3-3 Cost-benefit analysis of Lombardy's 2013 air quality plan

An independent cost/benefit analysis was prepared of the Lombardy's 2013 air quality plan[93]. The analysis used a model and software, RIAT+, developed by an EU LIFE project, Opera[94].

Lombardy's 2013 plan (*Piano Regionale degli Interventi per la qualità dell'Aria,* PRIA) contained 66 measures:

- 26 measures for road transport and mobility
- 27 for stationary sources and energy efficiency
- 13 for agricultural and forestry activities

The model was used to estimate the costs of these measures along with their direct benefits of the plan (primarily linked to reduce fuel consumption) and their health benefits. The results presented benefits for the actions specifically in 2020 in terms of four sectors where the plan acted. The study notes that for transport and heat generation, the estimated direct benefits exceed the costs; for electricity generation, this is not the case. Notably, for electricity generation were considered to have low health benefits as power plants in the region already had advanced pollution controls as well as high chimneys dispersing remaining pollutants.

Table 3-2 Estimated costs and direct benefits of Lombardy's 2013 air quality plan (in 2015 and 2020)

Measures	2020: Costs	2020: Direct benefits	2020: Health benefits
Private transport	208	966	57
Measures	2020: Costs	2020: Direct benefits	2020: Health benefits
Public transport and other modes	846	1454	<0.1
Electricity generation	2590	2058	<0.1
Heat generation	3781	8688	37
Total	7425	13166	80

The study notes that many measures had objectives in addition to air quality, such as for urban mobility and for the reduction of greenhouse gas emissions, and their implementation should also lead to benefits in these areas. The study emphasised that this interaction with other policy objectives shows that 'Perhaps there is little use in trying to devise and evaluate a "pure" air quality plan'.

Under the LIFE PREPAIR project[95] (see section 2.6), the RIAT+ model mentioned in the box will be used to estimate the costs and benefits of current regional plans in the Po Valley region.

[93] Carnevale, C., et al, Assessing the Economic and Environmental Sustainability of a Regional Air Quality Plan, *sustainability*, Vol. 10, 2018, doi:10.3390/su10103568; University of Brescia, Politecnico di Milano, TerrAria srl, Progetto VALUTA Convenzione ARPAL – POLIMI – UNIBS, 2014
[94] ARPA Emilia Romagna et al, Opera: RIAT+. ARPA Emilia Romagna et al, Opera: The project (web page): http://www.operatool.eu/html/eng/project.html
[95] http://www.lifeprepair.eu/?lang=en

4 CONCLUSIONS

4.1 Identified problems and potential for improving the implementation of the Directives

The case study identified the following challenges in the implementation of the AAQ Directives:

1. Ongoing exceedances of limit values and issues related to air emissions from traffic and from heating
2. Difficulties in establishing shared solutions with sectoral authorities
3. Delays in implementation of improved monitoring approaches and in the preparation of air quality plans in some regions (including Sicily)

4.2 Assessment of the AAQ Directives

The following section presents a summary of the findings of the case study in relation to the relevance, effectiveness, efficiency, coherence and added value of the AAQDs.

4.2.1 Relevance

The objectives of AAQDs have been and remain relevant to the needs of citizens in Italy, in particular as air quality continues to pose a threat to the health of citizens and to the environment.

One issue discussed by interviewees in national government is *whether the current limit values are appropriate or whether more stringent WHO values should be considered.* On the one hand, it was noted that Italy continues to struggle to meet the AAQD requirements and thus it would not be practical to implement more stringent limit values; on the other hand, it was noted that the WHO guidelines should be considered for the long-term protection of human health and the environment. National assessments, such as ISPRA's annual data report, also provide results in terms of population exposure to pollutant levels above current WHO guidelines.

According to the 2017 Eurobarometer results (see section 3.1), Italian citizens are concerned about air quality: about 61% of respondents perceive that air quality has worsened in the past 10 years (see section 3.1), though ISPRA data suggests that across the country as a whole there has been a slight improvement. Moreover, 43% of Eurobarometer respondents indicated that air quality should be addressed at EU level, though a nearly similar share, 38%, cited the national level.

4.2.2 Effectiveness

The information gathered shows that *the AAQD have played an important role in strengthening the **monitoring** of air quality in Italy:* while some regions already had extensive air quality monitoring, the AAQD's requirements prompted the national and regional governments to upgrade monitoring stations and integrate into an integrated network with common quality control approaches. The AAQD also prompted the use of modelling to address gaps. For regions with less advanced systems such as Sicily, the AAQD should have an even stronger impact – though as described in the previous sections, delays in implementation continued in Sicily in 2018.

Already before the AAQD, Italy carried out regular air quality **assessments** at national level and in many regions. *The AAQD strengthened the information base for these assessments and their implementation has ensured that all regions prepare annual assessments.*

Implementation of the AAQD has also led *to improvements in public information on air quality levels*, in particular the presentation of map data and air quality projects in some regions, as seen in the example of Lombardy presented in section 2.5 above.

The Directives moreover prompted improvements in actions to address air quality problems, notably via the preparation of air quality plans to address air quality issues. Italy's implementation of the Directives has included requirements that all regions prepare such air quality plans, the development of common guidelines for the plans and the preparation of inter-regional agreements for the Po Valley.

Little information was found, however, on the implementation of these plans and their actual results: for example, ex-post evaluations have not been found.

In terms of results, in fact, *many zones continue to exceed the AAQD limit values.* As indicated, air quality overall has improved in Italy but only slowly.

4.2.3 Efficiency

There is *limited information on the costs of measures in air quality plans:* for example, the plans for the Lombardy region indicate costs of many but not all measures; for the 2018 air quality plan for Sicily, costs have been estimated. As noted, ex-post evaluations of the regional plans have not been identified, nor information on the actual costs incurred for their implementation.

4.2.4 Coherence

Over the evaluation period, several national policies have incorporated air quality as a goal. Here, the AAQD appear to have played an important role in spurring cooperation.

As noted above, t*he AAQD have strengthened the integration of monitoring stations into regional networks and the linking of regional networks into a national system with common methods.*

The development of regional air quality plans, following AAQD requirements, has spurred coordination with mobility plans, rural development programmes and energy efficiency initiatives. The plans have also strengthened coordination between regional and municipal levels and among municipal governments.

Italy has used EU funding to address air quality. Notably, a current project under the LIFE Programme, PREPAIR, is supporting the implementation and coordination of air quality plans in the Po Valley; this and a previous project has supported modelling of the costs and benefits of air quality plans. In addition, air quality plans have been linked to actions under the Rural Development Programmes financed by EAFRD. It is not clear if there has been a strong link to ERDF funding, which in fact is used to address air pollution in the 2014-2020 programming period.

EU policy also promotes the development of Sustainable Urban Mobility Plans (SUMPs). By late 2018, 35 Italian cities had approved or adopted such plans and a further 70 had plans in preparation. Many SUMPs reviewed, such as those for Ferrara and Milan, refer to the objectives of regional air quality plans.

Several interviewees raised concerns, however, about a lack of coherence with EU policies for fuel taxation, which allow lower taxation of diesel fuel, and for renewable energy, as the latter have promoted biomass combustion.

4.2.5 EU added value

Before the evaluation period, *Italy had in place pollution concentrations limits for all the pollutants regulated by the AAQD, with one exception: Directive 2008/50/EC introduced target and limit values for $PM_{2.5}$.* National Decree 155/2010, transposing the Directive, aligned these limits to those of the AAQD.

Air quality monitoring and assessment has been in place for a long period. The AAQD have established a common European approach; *moreover, the Directives have prompted Italy to establish national guidelines and QA,* ensuring greater harmony across the country.

Information on air quality was provided in many but not all urban areas in Italy before the AAQD; the Directives ensured a minimum common level of access (though full implementation of the monitoring and reporting requirements has not yet been achieved in Sicily).

In addition, the AAQD established requirements for air quality plans and prompted the development of national guidelines for these plans. Here too, the Directives prompted a more uniform approach across the country for a problem that had been tackled on a more piecemeal and less coordinated basis.

A review of selected case law[96] in Italy has not found evidence that the AAQD has changed access to justice, however. The largest share of air pollution case law focuses on emissions rather than air quality. Case law concerning air quality often involves local restrictions on traffic and the examples reviewed do not contain direct references to EU legislation.

The requirements of the AAQD are seen, however, as having a catalytic effect in Sicily: without EU legislation, all the interviewees felt that actions to improve monitoring systems and develop an air quality plan would not have been taken.

[96] As found on the Lexambiente.it web site

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Ministero dell'Ambiente e della Tutela del Territorio e del Mare, *Strategia Nazionale di Sviluppo Sostenibile*, 2017.Available at: http://www.minambiente.it/sites/default/files/archivio_immagini/Galletti/Comunicati/snsvs_ottobre2017.pdf

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OECD, Environmental Performance Reviews: Italy, 2013. Available at: http://www.oecd.org/environment/country-reviews/find-a-review.htm

Querol, X., et al, Biomass burning in southern Europe, AIRUSE (LIFE 11 ENV/ES/584) Report no. 8, December 2016. Available at: http://airuse.eu/wp-content/uploads/2013/11/R08_AIRUSE-Biomass-Burning-SE-ATH-TR.pdf

Regional air quality web pages:

- Lombardy: http://www.arpalombardia.it/sites/qaria/_layouts/15/qaria/imodelli.aspx
- Emilia-Romagna: https://www.arpae.it/dettaglio_generale.asp?id=2921&idlivello=1637
- Sicily: https://www.arpa.sicilia.it/storage/index.php?dt=5/10/2018#titoloinizio

Carnevale, C., et al, Assessing the Economic and Environmental Sustainability of a Regional Air Quality Plan, *sustainability*, Vol. 10, 2018, doi:10.3390/su10103568; University of Brescia, Politecnico di Milano, TerrAria srl, Progetto VALUTA Convenzione ARPAL – POLIMI – UNIBS, 2014

APPENDIX B INTERVIEWS

Organisation	Name and position	Date of the interview
National Ministry of Environment, Land and Sea	Fabio Romeo	19/09/2018
Greenpeace Italia	Andrea Boraschi	04/10/2018
ISPRA (national Institute for Environmental Protection and Research)	Giorgio Cattani	05/10/2018
ARPA (Regional Environment Agency) Sicilia	Ana Abita	09/10/2018
Regional assembly, Sicily	Giampiero Trizzino	09/10/2018

APPENDIX C PILOT INTERVIEW GUIDE

General questions

- What challenges have been encountered when implementing the AAQ Directives?
- How have these challenges been overcome? What has proved to work well and what turned out to work less well? Are there any relevant lessons learned that other Member States could learn from?
- Where do you see the greatest potential to improve further the implementation of the Directives?
- Have any specific initiatives/measures been introduced to support the implementation of the AAQ Directives in the Member State (e.g. national guidance, arrangements for information exchange, etc.)?
- What systems are in place to provide information to the public on air quality, exceedances and alerts, and the implementation of plans and measures?

Specific questions

The table below outlines the specific themes discussed during the interviews.

Evaluation question	Questions
RELEVANCE	
(1) How relevant are the goals and objectives of the AAQ Directives to the needs of citizens; do the AAQ Directives still address the most relevant pollutants and set relevant standards and obligations to protect human health and the environment; and are the AAQ Directives sufficiently adapted or adaptable to evolving technical and scientific progress?	To what extent do the goals of the Directives correspond to the needs of the citizens (in your country)? Which of the Directives' requirements are in your opinion the most important in relation to the citizens' needs? To what extent have the goals of the Directives been integrated in the strategic documents (on environmental protection) in your country?
(2) How far are the Directives aligned with key EU priorities? Which elements in the Directives are essential to deliver on these priorities, have elements become redundant?	
EFFECTIVENESS	
(3) What factors have contributed to meeting the objectives of the AAQD or to failing to meet these objectives, in terms of: 1) defining common methods to monitor and assess air quality; 2) assessing ambient air quality in order to monitor trends; 3) establishing standards of air quality to achieve across the EU; 4) ensuring that information on air quality is made public; 5) maintaining good air quality, improving it where it is not good; to what level can these factors be attributed to provisions of the AAQ Directives?	What are the main factors that contribute to compliance with/effective implementation of the air quality Directives; hereunder: • air quality standards • reporting requirements • requirements regarding the establishment and implementation of air quality plans and programmes • requirements regarding provision of information to public? • requirements regarding monitoring stations? What are the main barriers (at national/regional/local) level preventing effective implementation of the air quality Directives? Please consider each of the items listed above separately. What would it take to overcome the barriers?
EFFICIENCY	
(4) What are the costs and benefits (monetary and non-monetary) associated with implementation of the AAQ Directives in the Member States, and in the EU; have the benefits (improved air quality) been achieved in a cost-effective manner and to what extent have costs been equitably distributed across different sectors? (5) Where there are significant cost differences between Member States and/or between different sectors and/or as regards costs to stakeholders (including social costs as a consequences of poor implementation), what is causing them; and are the costs of compliance proportionate to the benefits brought by the directives? (6) How efficient are monitoring, reporting and assessment regimes, what are the administrative costs to the Member States and to the Commission; taking account of the objectives and benefits of the	What are the costs of implementation of the AAQ Directives? What is the cost of implementation (monitoring, reporting, and planning) for different levels of government, including the use of external expertise on, per year (in FTE)? What is the cost of implementation for different sectors of the industry per year (capital and operating costs of equipment in EUR)? What specific factors contribute to the efficiency/inefficiency of the implementation of the AAQ Directives? What are the costs of non-implementation of the Directives (e.g. environmental and health costs, uncertainty and market distortion, litigation costs for Member States)?

Evaluation question	Questions
directives is there evidence that they have caused unnecessary or excessive administrative burden?	What are benefits associated with the implementation of the Directives in the Member State/air quality zone (e.g. health and environmental benefits, economic benefits, eco-innovation, etc.)?
(7) Has the implementation of the AAQ Directives supported or hampered EU competitiveness in the global economy; has the implementation of the AAQ Directives improved or been detrimental to economic, social and environmental sustainability?	
COHERENCE	
(8) To what extent do the AAQ Directives complement or interact with other environmental policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as the NEC Directive and IED Directive as well as the EU climate legislation and policy; and how do these policies and legislation support or hamper the implementation of the EU air quality legislation?	How and to what extent is the implementation of the AAQ Directives coordinated with the implementation of other EU instruments in the environmental and climate domain (e.g. the National Emissions' Ceiling Directive, the Industrial Emissions' Directive, Large Combustion Plants Directive, etc.)?
(9) To what extent do the AAQ Directives complement or interact with sectoral policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as energy, transport, agriculture, cohesion, fiscal policies); and how do these policies support or hamper the implementation of the EU air quality legislation?	How and to what extent is the implementation of AAQ Directives coordinated with other relevant legislation and policy (e.g. in the area of energy, transport and agriculture)? Are air quality plans coordinated with planning initiatives promoted by EU sectoral legislation (e.g. Sustainable Urban Mobility Plans, TEN-T investments)? Are air quality plans coordinated with national emission reduction plans and measures under the NEC Directive? Are air quality plans coordinated with climate change mitigation policies and plans (for GHG emission reductions)? To what extent are air quality plans integrated or linked with municipal/urban/regional level planning e.g. in the area of land use and spatial planning, energy management, transportation and climate? To what extent are EU funds used to finance measures (e.g. abatement programmes) to maintain good air quality/improve air quality?
ADDED VALUE	
(10) To which degree have the AAQ Directives, including common EU air quality standards and comparable air quality assessment, management and information approaches enabled Member States and their competent authorities to take successful action to improve beyond what would have been possible without EU action?	Have AAQ Directives triggered transformational changes that have enabled the achievement of air quality objectives? Have AAQ Directives contributed to improvements in monitoring? Have AAQ Directives contributed to improvements in public information and public participation? What are the wider economic, social and environmental impacts of the Directives in the Member State/air quality zone?

Evaluation question	Questions
(11) What has been the EU added value of the AAQ Directives, do the Directives and their means of implementation create synergies or overlaps with other Community objectives, and how has the distribution of responsibilities between EU, Member State, regional and local levels impacted on air quality management?	How is the implementation of the AAQ Directives coordinated in the Member State (division of responsibilities, coordination across different activities)? To what extent is the implementation of AAQ Directives coordinated in the region (to address transboundary pollution)?

APPENDIX D POLLUTANT CONCENTRATION DATA FOR ITALY, 2013-17

Table 4-1 Highest pollutant concentrations in exceedance of EU air quality objectives for protection of health in Italy in 2013-2017 - extract from reporting (Dataflow G).

Pollutant	Averaging period	Objective type and value	Date for achieving objective	Parameter shown	2013	2014	2015	2016	2017
PM_{10}	Calendar year	LV: 40 µg/m^3	1 January 2005	Annual mean, µg/m^3	NA	NA	56	45	49
	1 day	LV: 50 µg/m^3 not to be exceeded on more than 35 days per year	1 January 2005	Days above	NA	NA	126	89	118
NO_2	Calendar year	LV: 40 µg/m^3	1 January 2010	Annual mean, µg/m^3	NA	NA	75	70	80
	1 hour	LV: 200 µg/m^3 not to be exceeded on more than 18 hours per year	1 January 2010	Hours above	NA	NA	57	28	25
SO_2	1 day	LV: 125 µg/m^3 not to be exceeded on more than 3 days per year	1 January 2005	Days above	NA	NA	-	-	-
	1 hour	LV: 350 µg/m^3 not to be exceeded on more than 24 hours per year	1 January 2005	Hours above	NA	NA	-	-	-
CO	Maximum daily 8-hour mean	LV: 10mg/m^3	1 January 2005	Days above	NA	NA	-	-	-
C_6H_6	Calendar year	LV: 5 µg/m^3	1 January 2010	Annual mean, µg/m^3	NA	NA	-	-	-
Pb	Calendar year	LV: 0.5 µg/m^3 (measured as content in PM_{10})	1 January 2005	Annual mean, µg/m^3	NA	NA	-	-	-
O_3	Maximum daily eight-hour mean	TV: 120 µg/m^3 not to be exceeded on more than 25 days per calendar year averaged over three years	1 January 2010	Days above	NA	NA	139	170	109

Pollutant	Averaging period	Objective type and value	Date for achieving objective	Parameter shown	2013	2014	2015	2016	2017
	Maximum daily eight-hour mean within a calendar year	LTO: 120 µg/m³	Not defined	Days above	NA	NA	97	144	117
$PM_{2.5}$	Calendar year	LV: 25 µg/m³	1 January 2015 (target value until 1 January 2010)	Annual mean, µg/m³	NA	NA	33	36	34
	(calculated as Average Exposure Indicator, assessed as a 3-year running annual mean)	ECO: 20 µg/m³	2015	AEI, µg/m³	NA	NA	NA	NA	NA
As	Calendar year	TV: 6 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	NA	NA	-	-	8
Cd	Calendar year	TV: 5 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	NA	NA	-	5	6
Ni	Calendar year	TV: 20 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	NA	NA	-	21	-
BaP	Calendar year	TV: 1 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	NA	NA	3	4	2

Source: COWI calculations based on Member State reporting, data flow G. Downloaded in November 2018.

Note: LV: limit value; TV: target value; LTO: Long term objective; ECO: exposure concentration obligation; The values show the maximum exceedance reported in the Member State (if no exceedances are reported in any of the zones of the Member State, the table shows "-")

<u>Legend:</u> "NA": not available in data flow G, *"-":* no reported exceedance

Publications Office

European Commission

CASE STUDY REPORT SLOVAKIA

Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

COWI

Written by Sandra Fisker
March 2019

Contents

Appendices

1 INTRODUCTION

This report summarises the findings and conclusions of the **case study for Slovakia**. The case study had a focus on Košice region.

The report is one of seven case studies carried out for the Fitness Check of the EU Ambient Air Quality Directives. Its main purpose is to examine, in more detail, the situation regarding the experience and lessons learnt in the implementation of the air quality legislation. The case studies provide a basis for a more detailed examination of the questions of the fitness check and include a review of implementation and integration successes and problems, the costs of implementation and of non-implementation of the legislation and the administrative burden of implementation and opportunities for improving implementation without compromising the integrity of the purpose of the Directives. As such, the case study complements the information gathered through other sources, such as desk review, targeted questionnaire, open public consultation, interviews, focus groups and stakeholder workshops.

The Member States for detailed case studies have been selected to cover a range of geographies, governance structures and sizes. This has led to the selection of the following **seven case study Member States: Slovakia, Germany, Spain, Sweden, Ireland, Bulgaria and Italy**.

The case study report is structured in four chapters, namely:

- **Chapter 1 – Introduction**
- **Chapter 2 – Background and context**, presents general information about the context of the case study
- **Chapter 3 – Findings**, presents detailed findings regarding the relevance of the AAQ Directives, the implementation successes and problems, the factors underlying compliance with the Directives, the costs and benefits.
- **Chapter 4 – Conclusions**, presents a summary of the main findings.

The case study findings rely on extensive desk research and a series of interviews that took place over the period October and November 2018. An overview of the interviews carried out is provided in Appendix A.

The case study has been shared with the interviewed stakeholders in January 2019 for validation of findings and correction of factual mistakes. Feedback received from the stakeholders was integrated in the case study report.

2 CASE STUDY BACKGROUND

Chapter 1 provides general information about Slovakia and the Košice region.

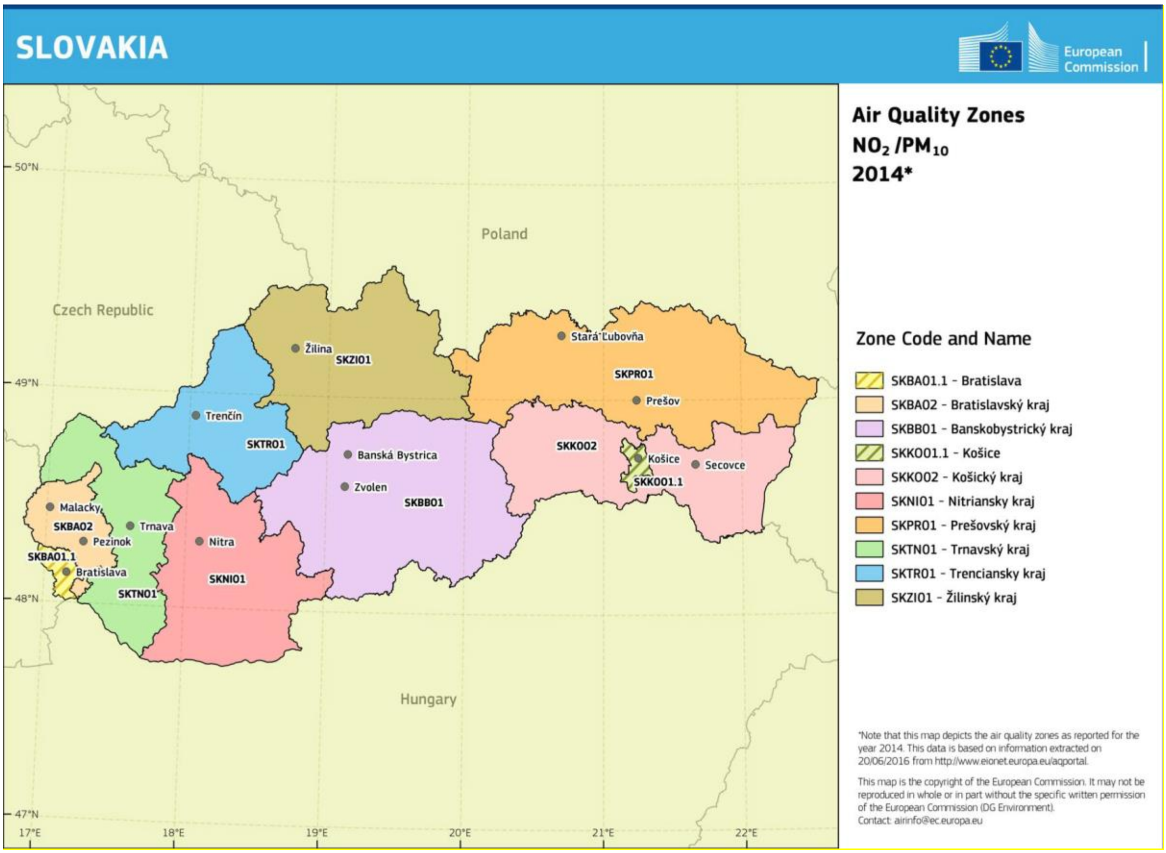
2.1 Italy and air quality zone characteristics

2.1.1 The scope and focus of the case study

The case study covers the entire territory of Slovakia and *focuses in particular on the Košice region* and the Košice agglomeration.

As shown in in the figure below, the territory of the Slovak Republic is divided into 8 zones and 2 agglomerations (Bratislava and Košice) for the purpose of assessing air quality. The air quality zones correspond to administrative divisions of Slovakia.

Figure 2-1 Air quality zones for NO_2 and PM_{10}, 2014

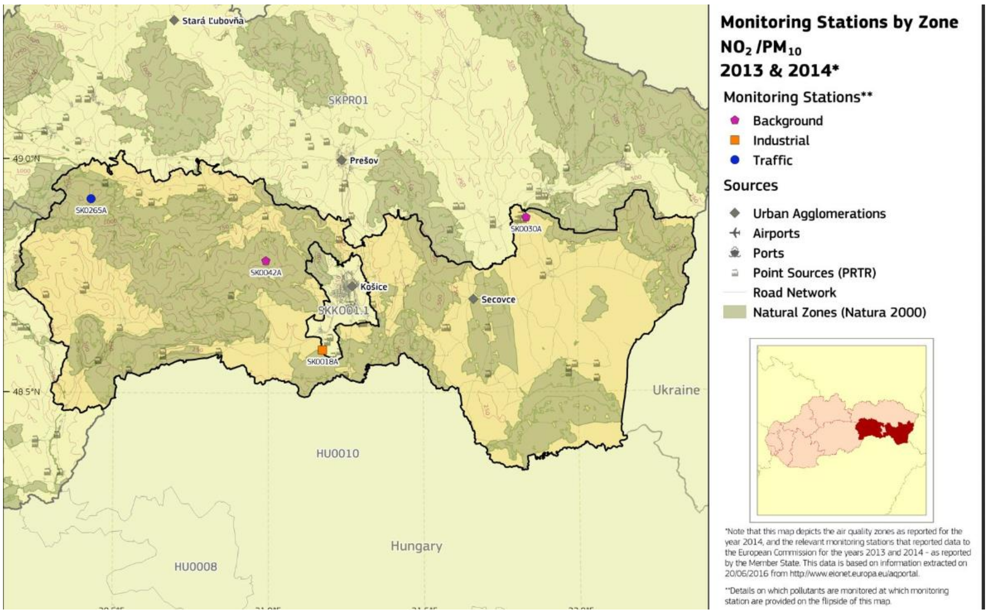


Source: European Commission, DG Environment, Atlas of air quality zones and monitoring stations (2013 & 2014), Slovakia.

As shown in the figure above, the Košice region is one of eight Slovak administrative regions. The region is located in the south-eastern Slovakia and the entire region (including the Košice agglomeration) has the population of nearly 800,000 inhabitants (approximately 14.7% of the total population of Slovakia).[1] About one third of the region's population lives in the agglomeration of Košice. The region is the centre of heavy industry (in particular non-ferrous and ferrous metallurgy) and is characterised by relatively high concentrations of PM_{10} and BaP in the ambient air.

[1] https://web.vucke.sk/files/dokumenty/pub/regionalny_rozvoj/phsr/2015/prilohy/priloha_1_podrobna_analyza_kosickeho_kraja.pdf

Figure 2-2 Košický kraj



Source: Source: European Commission, DG Environment, Atlas of air quality zones and monitoring stations (2013 & 2014), Slovakia.

In addition to defining zones and agglomerations as required in the AAQDs, Slovakia's Act on Air Protection, Article 9(3) provides for defining *smaller* areas of air quality management (i.e. an agglomeration or an air quality zone zone) that meet specific air quality criteria: exceedance of the "(1) *the limit value of one substance or more pollutants increased by the tolerance limit, (2) the limit value of one substance or more pollutants, if no tolerance limit is determined, (3) the target value for ozone, particles* $PM_{2,5}$*,arsenic, cadmium, nickel, or benzo(a)pyrene*".[2] The areas of air quality management are identified by the Slovak Hydrometeorological Institute (SHMI) based on an evaluation of air quality for the previous calendar year.[3] In 2016, 12 areas of air quality management have been identified within the Slovak territory, out of these two were located in the Košice region/agglomeration (the territory of cities Košice, Bočiar, Haniska, Sokoľany and Velka Ida and the territory of city Krompachy). Appendix D provides an overview of the areas of air quality management as defined in 2016.

Pursuant to Article 11 of the Act on Air Protection, the district office in the seat of the region is required to elaborate air quality plans or integrated air quality plans for each area of air quality management within its competence (see below) with the view of achieving good air quality. As such, the areas of air quality management correspond to some extent the areas specified in Article 23 of Directive 2008/50/EC (i.e. areas for which air quality plans should be drafted), but, in addition to the pollutants covered by the Directive 2008/50/EC, cover also pollutants for which target values have been set by the Directive 2004/107/EC.

2.1.2 Geomorphology

The Slovak territory has a complex geomorphology. There are many hills, but also many low-lying areas, such as valleys, with bad dispersion conditions. Under certain weather conditions, pollutants can become trapped in such areas. Similarly, from a geomorphologic point of view, the

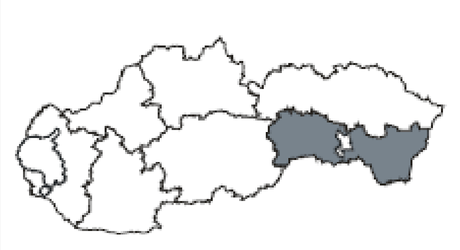
[2] See Article 9(2) of the Act on air protection. The Law on air protection continues to refer to target value, rather than a limit value for $PM_{2.5}$

[3] Art. 9 (3) of the Act No 137/2010 Coll. on Air protection.

territory of Eastern Slovakia is rugged and varied. Mountainous areas, as well as lowland areas are situated within this region. Western and Eastern Carpathians meet here.[4]

The detailed characteristics of Slovakia and of the Košice region/agglomeration are presented in the text-box below.

Text box 2-1 Slovakia and the Košice region

Slovakia	
GDP per capita in PPS (2016)	77
GDP per capita growth (% 2008-2016)	16%
Population (1 January 2017)	5,4 million
Governance structure	Unitary
Zones defined as agglomerations (%)	18%
Košice region & Košice agglomeration	
Number of inhabitants:	558 962 (Košice region) 239 141 (Košice agglomeration)
Area:	6 511 km² (Košice region) 244 km² (Košice agglomeration)

Characteristics of the Košice region:
The section below provides a short summary of the main characteristics of the region, focusing on the towns of Krompachy, Strážske and Veľká Ida.

Krompachy

[4] http://www.arr.sk/file/projekty_file99.pdf

Slovakia
The town Krompachy is located in a valley system with good local air circulation. The southern part of the town lies in the Slovinka River valley surrounding by hills with an elevation of 350 m. The northern part of the city is placed in the valley of the Hornád River with an east-west orientation determining airflow. The main source of air pollution in Krompachy is ferrous metal plant Kovohuty ((PM, SO_2 and CO)[5]) and local heating systems as well. **Strážske** The town Strážske is located to the east of Vihorlat hills in the northern part of the Eastern Slovak lowland in so called Brekov Gate area – with the orographically increased air flow, mainly from the north. The local chemical industry in the town represents the main source of air pollution (SO_2, NO_X, PM, CO). **Veľká Ida** The town is located at the border line of the Košice Basin and the Moldava Lowland. The area is surrounded by the Abov hills in the south, by the Slovak Kras from the west and the Slovak Rudohorie from the north. Towards the west lies the valley of the Hornad River. The main air pollution (PM, SO_2, NO_X and CO) source is the nearby ferrous metallurgy complex and large dumps from extracted ores.
Characteristics of the Košice agglomeration: The city of Košice spreads out in the valley of Hornád River and the surrounding area. The composition of the mountains surrounding the city affects the climatic conditions of the area. The main share of air pollution in the area comes from heavy industry, in particular engineering, non-ferrous and ferrous metallurgy, as well as limestone processing. Energy sources, including the city heating plants and local boiler houses emit less amounts of pollutants (PM_{10} and $PM_{2.5}$, SO_2, NO_X, VOC and benzo(a)pyrene).

Source: Eurostat, GDP per capita in Purchasing Power Standards (PPS) expressed in relation to the European Union (EU28) average set to equal 100; Eurostat, Real GDP per capita, growth rate and totals; Eurostat, Population on 1 January; Eionet data and the report Air pollution in the Slovak republic, 2016.

2.2 Air quality monitoring and air quality

The following section presents briefly the arrangements made in Slovakia for air quality monitoring and provides a short overview of air quality achievements in Slovakia, focusing in particular on the period 2014-2016. Detailed information regarding the exceedances reported in the EEA database[6] is presented in Appendix E to this report.

2.2.1 Air quality monitoring

The national air pollution monitoring network in Slovakia is maintained by the Slovak Hydrometeorological Institute (SHMI). Air quality monitoring has a long history in Slovakia. The SHMI has been monitoring the level of air pollution since 1971, when the first two manual stations were put into operation. Over the next years, the measurements were gradually extended to the most polluted cities and industrial areas.

At the end of 2007, the monitoring network consisted of 34 monitoring stations.[7] As of 2016 the network included 38 monitoring stations, 4 of them are rural stations belonging to the EMEP monitoring network. Out of the 38 monitoring stations, 8 are placed in the Košice region.[8] In addition to the national network, the largest emission sources are obliged to build, operate and measure air pollution resulting from these sources. These monitoring stations are operated independently from the SHMI.

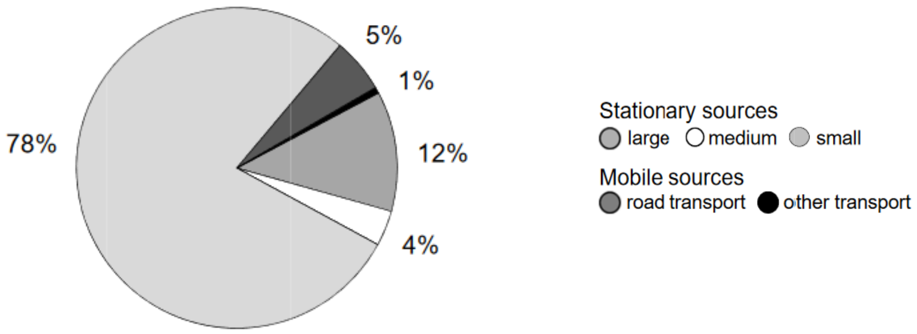
[5] http://www.shmu.sk/File/oko/rocenky/Air_pollution_in_the_SR_2016.pdf
[6] http://cdr.eionet.europa.eu/sk/eu/aqd/ and http://www.shmu.sk/File/oko/hodnotenie/2016_Hodnotenie_KO_v_SR.pdf
[7] http://www.shmu.sk/File/oko/hodnotenie/2007_Hodnotenie_KO_v_SR.pdf
[8] http://europa.eu/rapid/press-release_MEMO-17-3494_en.htm

The shortcomings in the Slovakian monitoring network in terms of number and type of sampling points are currently subject to infringement proceedings.[9] The conclusions of the Clean Air Dialogue between Slovakia and the European Commission indicate that Slovakia is committed to upgrade its monitoring network by the end of 2019. The conclusions further specify that this upgrade will include "*improvements in the inventories of air pollutant emissions, air quality modelling as well as more and better quality fixed air quality measurements*"[10] and the addition of 14 new sampling points to the monitoring network.[11]

2.2.2 Air quality in Slovakia

Particulate matter concentrations in the ambient air continue to be the greatest challenge for air quality and health in Slovakia. Domestic solid fuel combustion is the main source of particulate matter emissions. Overall, industry, domestic heating, road traffic, together with long range transport are among the main pollution sources.[12]

Figure 2-3 Emissions of particulate matter in 2016



Source: Air pollution in the Slovak republic, 2016.

In 2004 there were 17 air quality management areas (i.e. areas in which a limit or target value for one or more pollutants has been exceeded, see above) while, in 2016 there were only 12. Moreover, the total area of air quality management has, according to the information provided by the MoE decreased by 52%, and the number of inhabitants living in these areas by 54%.[13]

As far as emissions of various pollutants are concerned, a reduction was reported as between 1990 and 2015. However, the speed of this reduction after 2000 slowed down significantly. In 2015 a reduction of NO_X and CO emissions has been reported compared to 2014. In contrast, for other pollutants annual increases were recorded. This is the case especially for particulate matter $PM_{2.5}$ and PM_{10} (slight increase) and for SO_2 (large increase).[14]

[9] http://europa.eu/rapid/press-release_MEMO-17-3494_EN.htm
[10] Conclusions of the Clean Air Dialogue between Slovakia and the European Commission, taking place in Bratislava on 24 -25 April 018
[11] Ibid.
[12] OECD, Environmental Performance Reviews, Slovak Republic, 2011.
[13] Ministry of Environment, Additional information on progress made in Air Quality in Slovakia. Published by the EEB.
[14] State of Environment Report (2016), http://enviroportal.sk/spravy/detail/6961.

Figure 2-4 Emissions of basic pollutants in the Slovak republic within 2009-2016

			2009	2010	2011	2012	2013	2014	2015	2016
PM	Stationary sources – NEIS	LS [1]	4.966	4.936	5.139	5.283	5.417	5.449	4.916	4.183
		MS [1]	1.554	1.474	1.404	1.348	1.306	1.271	1.213	1.234
		SS [2]	27.083	26.214	28.507	28.745	29.298	28.405	29.623	26.959
	Mobile sources	RT	2.509	2.683	2.203	2.510	2.398	2.431	2.158	1.897
		OT	0.221	0.225	0.219	0.177	0.199	0.208	0.223	0.206
	Total		**36.334**	**35.532**	**37.472**	**38.063**	**38.618**	**37.765**	**38.133**	**34.479**
SO_2	Stationary sources – NEIS	LS [1]	59.739	64.798	64.321	54.235	49.013	42.118	64.191	23.835
		MS [1]	0.991	0.906	0.839	0.894	0.945	0.906	0.952	0.915
		SS [2]	3.116	3.424	3.102	3.169	2.802	2.168	2.326	2.199
	Mobile sources	RT	0.188	0.029	0.027	0.028	0.027	0.028	0.029	0.028
		OT	0.209	0.223	0.209	0.073	0.110	0.127	0.188	0.163
	Total		**64.243**	**69.379**	**68.498**	**58.399**	**52.897**	**45.347**	**67.686**	**27.140**
NO_x	Stationary sources – NEIS	LS [1]	31.333	31.466	31.199	27.465	25.818	24.759	24.425	21.246
		MS [1]	3.389	3.485	3.716	3.978	4.259	4.356	4.667	4.770
		SS [2]	7.990	8.076	8.215	8.241	8.334	7.737	8.235	7.809
	Mobile sources	RT	42.990	41.574	32.813	34.361	32.445	32.945	26.977	22.703
		OT	7.235	7.058	7.118	4.649	5.074	4.729	4.983	4.864
	Total		**92.937**	**91.659**	**83.061**	**78.693**	**75.930**	**74.527**	**69.287**	**61.392**
CO	Stationary sources – NEIS	LS [1]	106.635	125.475	136.615	133.264	130.608	146.879	145.606	147.139
		MS [1]	4.104	4.446	4.680	4.913	5.098	4.894	4.812	4.644
		SS [2]	36.181	35.953	37.710	38.172	38.113	35.701	37.487	34.507
	Mobile sources	RT	99.627	89.828	58.752	56.572	50.369	43.552	39.163	35.245
		OT	18.937	18.923	19.354	19.485	19.847	20.853	19.501	18.081
	Total		**265.485**	**274.625**	**257.111**	**252.407**	**244.035**	**251.880**	**246.570**	**239.616**

LS - large sources, MS - medium sources, SS - small sources, RT - road transport, OT - other transport

[1] According to the Decree of MŽP SR No. 410/2012 Coll. as amended
[2] According to the Decree of MŽP SR No.144/2000 Coll. (2001 – 2003), according to the Decree of MŽP SR No. 53/2004 Z. z. (2004 – 2009), according to the Decree of MPŽPaRR No. 362/2010 Z. z.(since 2010)

Source: Slovak Hydrometeorological institute, Air pollution in the Slovak republic 2016.

2.2.3 *Compliance with EU ambient air quality standards*

In 2014 exceedances of standards set for the protection of human health were reported as to NO_2, O_3, PM_{10}, $PM_{2.5}$ and SO_2 and of standards set for the protection of vegetation as regards O_3.[15] As for PM_{10} in 2014 the limit value for human health protection for 24-hour concentration was exceeded at 10 monitoring stations (Bratislava – Trnavské Mýto, Košice – Štefánikova, Banská Bystrica – Štefánikovo náb., Jelšava – Jesenského, Veľká Ida – Letná, Krompachy – SNP, Prešov – arm. gen. Ľ. Svobodu, Trenčín – Hasičská, Ružomberok – Riadok a Žilina – Obežná).

In 2015 exceedances of standards set for the protection of human health were reported for NO_2, O_3, $PM_{2.5}$ and PM_{10} and of standards set for the protection of vegetation as regards NO_X as NO_2 and O_3. As for PM_{10} exceedances were recorded at 5 monitoring stations (Bratislava - Trnavské Mýto, Banská Bystrica - Štefánikovo náb., Jelšava Jesenského, Veľká Ida - Letná, Trenčín - Hasičská).

In 2016 the Slovak authorities have communicated exceedances above EU air quality standards of PM_{10} in one quality zone, located in the Košice region. Furthermore, the target values and long-term objectives regarding ozone concentrations were exceeded in Bratislava. Finally, the target values for BaP have been exceeded in one air quality zone, located in the Košice region (monitoring station Veľká Ida).[16]

In 2017, the PM_{10} the limit value for human health protection for 24-hour concentration was again exceeded at all 10 monitoring stations, and also in Riadok a Žilina for the annual limit value. The target values and long-term objectives regarding ozone concentrations were like in the previous

[15] Attainments of (air quality) environmental objectives reported by countries (data flow G) https://www.eea.europa.eu/data-and-maps/data/aqereporting-8.
[16] Ibid.

year exceeded in Bratislava. For $PM_{2.5}$ exceedances were experienced in Banská Bystrica and Riadok a Žilina. Finally, exceedances for BaP were found in Bratislava.

The breaches of air quality requirements regarding PM_{10} were being followed up by the European Commission through infringement procedures.[17] As of May 2018 the European Commission informed that the measures being put in place or planned in Slovakia, as communicated to the Commission, "*appear to be able to appropriately tackle the identified gaps, if correctly implemented. For this reason, the Commission will continue to closely monitor the implementation of these measures as well as their effectiveness in redressing the situation as soon as possible.*"[18]

Clean air dialogue

In April 2018, the Commission held a "Clean Air Dialogue" with Slovakia to promote actions to improve air quality and contribute to Slovakia's compliance with EU air quality rules. The dialogue focused on the main challenges Slovakia faces –emissions from the burning of solid fuel in homes, emissions from agriculture, transport and industry. In addition, the need for robust air quality monitoring and air pollution data, and integrated policy making across levels of governance were also discussed.[19]

2.3 Allocation of responsibility

Pursuant to Article 3 of the AAQ Directive, Member States shall designate – at the appropriate levels - the competent authorities and bodies responsible for the assessment of ambient air quality and the implementation of other obligations laid down by the AAQ Directive. In the Slovak Republic, the allocation of responsibilities is prescribed in Article 22 of the Act on Air protection. Specifically, the air quality protection authorities in Slovakia include the Ministry of Environment, the Slovak Environmental Inspectorate, district offices in the seat of the region, district offices and municipalities (see below).

The main responsibility for ambient air quality, including the transposition and implementation of the AAQ lies with the *Ministry of Environment* as the central authority. The day-to-day monitoring of air quality and modelling has been delegated to the *Slovak Hydrometeorological Institute (SHMI).*

The SHMI is a state-subsidised organisation operating under the Slovak Ministry of Environment. The SHMI's activities include monitoring of quantitative and qualitative parameters of the air in Slovak territory, collecting, verifying, interpreting and archiving data and information on the condition and regime of air, describing developments in the atmosphere, issuing forecasts, warnings and other information regarding the atmosphere.[20]

District offices in the seat of the region elaborate, among other things, air quality plans and short-term action plans.[21] The district offices in the seat of the region have responsibility for ensuring air quality not only in its own district, but in all districts within the region. The district offices fall under the responsibility of the Ministry of Internal Affairs, but the Ministry of Environment is responsible for the methodological management.

[17] http://europa.eu/rapid/press-release_IP-18-348_en.htm.
[18] http://europa.eu/rapid/press-release_IP-18-3450_en.htm
[19] lhttps://ec.europa.eu/info/news/clean-air-dialogue-between-commission-and-slovakia-promotes-actions-cleaner-air-2018-apr-26_en
[20] http://www.shmu.sk/en/?page=1793
[21] See Article 25 of the Act on Air protection.

Text box 2-2 District office in Košice

The district office in Košice is responsible for air quality management in the entire Košice region (consisting of 8 districts). The district office elaborates air quality plans, short term action plans, is responsible for informing the public and fulfils other obligations as laid down in Article 25 of the Act on air protection. In addition, the district office drafts and publishes reports on air quality in the region.

Source: Interview, district office in the seat of the Košice region; and Act on air protection.

The Slovak Environmental Agency is responsible for the coordination of reporting to the EU in the areas of environment. The monitoring information is supplied by the SHMI.

2.4 Legal and policy framework and air quality measures

Legal framework

The Ambient Air Quality Directives (2008/50/EC and 2004/107/EC) were transposed in the *Act No 137/2010 Coll. on Air protection* and a number of implementing regulations of the Ministry of Environment.[22]

Strategic framework

The principles and priorities in air quality are laid down in a number of strategic instruments, including the 1993 *National Environmental Policy* (1993)[23] and *the National Strategy for Sustainable Development of the Slovak Republic* (2001).[24]

In 2012, the Slovak Government issued a *Policy Statement for the period 2012-2016*.[25] The statement foresees, among other things, the introduction of measures to reduce emissions from industry, energy and mobile sources.

As mentioned above, particulate matter is the main challenge for air quality in Slovakia. The exceedances of the limit values for PM_{10} triggered the adoption of a strategy dedicated specifically to tackling PM_{10} emissions. The strategy was prepared in cooperation between a number of different actors, including civil society organisations and published in 2013.[26] The strategy outlined a number of strategic priorities and specific measures to be implemented to tackle PM_{10} pollution. These include:

- Measures in monitoring and identification of sources of pollution;
- Local heating;
- Transport;
- Soil;
- Information to public;
- Legislative action.

While the strategy provided a variety of measures, it did not include an implementation framework – an action plan, interim targets, budget and institutional responsibilities. The MoE and the civil

[22] http://www.minzp.sk/sekcie/temy-oblasti/ovzdusie/ochrana-ovzdusia/pravne-predpisy/
[23] http://www.minzp.sk/dokumenty/strategicke-dokumenty/strategia-zasady-priority-statnej-environmentalnej-politiky.html
[24] https://www.thegef.org/sites/default/files/ncsa-documents/Slovakia_NSSD_Final.pdf
[25] http://www.vlada.gov.sk/data/files/2008_programove-vyhlasenie-vlady.pdf
[26] http://www.enviroportal.sk/uploads/files/ovzdusie/Strategia-pre-redukciu-PM-10-1.pdf

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society association CEPTA pointed to that the lack of such a framework was a major reason for why the vast majority of measures foreseen in the strategy remain unimplemented.

The Slovak Republic is currently preparing a new air quality strategy (*The Strategy for the Improvement of Air Quality in Slovakia*) to be published in the late spring 2019.[27] In contrast to the 2013 PM_{10} strategy, the measures proposed in the new strategy will be accompanied by a set of indicators. The selection of measures will be informed by an economic analysis and an analysis of how each of the measures will contribute to the reduction of the concentration of different pollutants. The cost-effectiveness assessment underpinning the strategy is being prepared in cooperation with the World Bank.

Finally, the *National Air Pollution Control Programme* will provide measures to reduce national emissions so as to comply with the requirements (national emission ceilings) as per the revised NEC Directive.[28] The programme is expected to set coordinated directions for policies and actions on air quality, renewable energy, energy renovation and eradication of energy poverty.[29] The Programme is planned to be approved by the government and shared with the EU Commission in 2019.

There is also a number of other measures that address the issue of air quality – e.g. measures related to mobility (e.g. subsidy for electromobiles, development of cyclotourism, scrapping of cars), biomass boilers, renewable energy, insulation of buildings. In other words, there is a number of measures which do not focus directly on air quality, but which nonetheless contribute to the achievement of the air quality objectives. For example, air protection is indirectly supported within the national project Green Households. The primary objective of the project is to increase the share of renewable energy sources used in households. The contribution provided so far is over EUR 35 million and for 2018 the planned budget is EUR 45 million.[30]

Air quality measures: air quality plans and action plans

Air quality plans provide long-term measures to improve air quality. With the exception of Bratislava (2016) and Nitra (2014), the latest versions of air quality plans are from 2013. The latest amendment of the Act on air protection (November 2017) introduced the obligation to review air quality plans every three years and, if necessary, to take further measures to improve air quality.

In the Košice region, three air quality plans were adopted and published for: (1) Košice, Bočiar, Haniska, Sokoľany and Velka Ida; (2) Krompachy and (3) Strážske.[31] As indicated above, all three plans were adopted in 2013. The district office in the Košice region indicates that an update of the plans is foreseen in the foreseeable future to accommodate, among other things, most recent monitoring and modelling data.

A number of short-term action plans has been adopted to tackle short-term exceedances of PM_{10} in the Košice region: action plans (for (1) Košice, Bočiar, Haniska, Sokoľany and Velka Ida; (2) Krompachy and (3) Strážske).[32] Similarly as for the Air quality plans, an update of these Action Plans is foreseen.

[27] More information on http://www.minzp.sk/strategia-ochrany-ovzdusia.html
[28] http://www.minzp.sk/strategia-ochrany-ovzdusia.html
[29] http://www.minzp.sk/files/oblasti/ovzdusie/conclusions-clean-air-dialogue-between-sk-ec-final.pdf
[30] Additional information on progress made in Air Quality in Slovakia.
[31] http://enviroportal.sk/ovzdusie/zlepsenie-kvality-ovzdusia
[32] http://enviroportal.sk/ovzdusie/akcne-plany-na-zabezpecenie-kvality-ovzdusia

2.5 Information to the public

Pursuant to Article 26 of the AAQ Directive, Member States shall ensure that the public is – adequately and in good time - informed about ambient air quality and other issues specified in the above cited Article. In Slovakia Article 13 of the *Act No 137/2010 Coll. on Air protection* specifies the measures to be implemented to ensure information to the public about air quality.

Pursuant to Articles 13(1) and 13(3) information about air quality is being published on the website of the Slovak Hydrometeorological Institute (http://www.shmu.sk/sk/?page=991.) and the websites of the district offices at the seat of the different regions. The information published includes near-real-time concentrations (most recent hourly and daily values), annuals report on air quality and air quality assessments.[33]

Text box 2-3 Information to the public

The SHMI provides up-to-date information about the pollution (hourly, daily concentrations of different pollutants). Every year a report on the Air pollution in the Slovak Republic is being published. This includes information on the share of different pollution sources. These reports have been published also prior to the implementation of the AAQ. The reports are also available on the websites of the district offices in the seat of the region. In addition, articles providing updates on specific situations (e.g. New Year) are being published.

The district office processes the information and puts it on its website (every week). Moreover, the district office publishes warnings regarding exceedances. These warnings are accompanied by recommendations to the citizens.

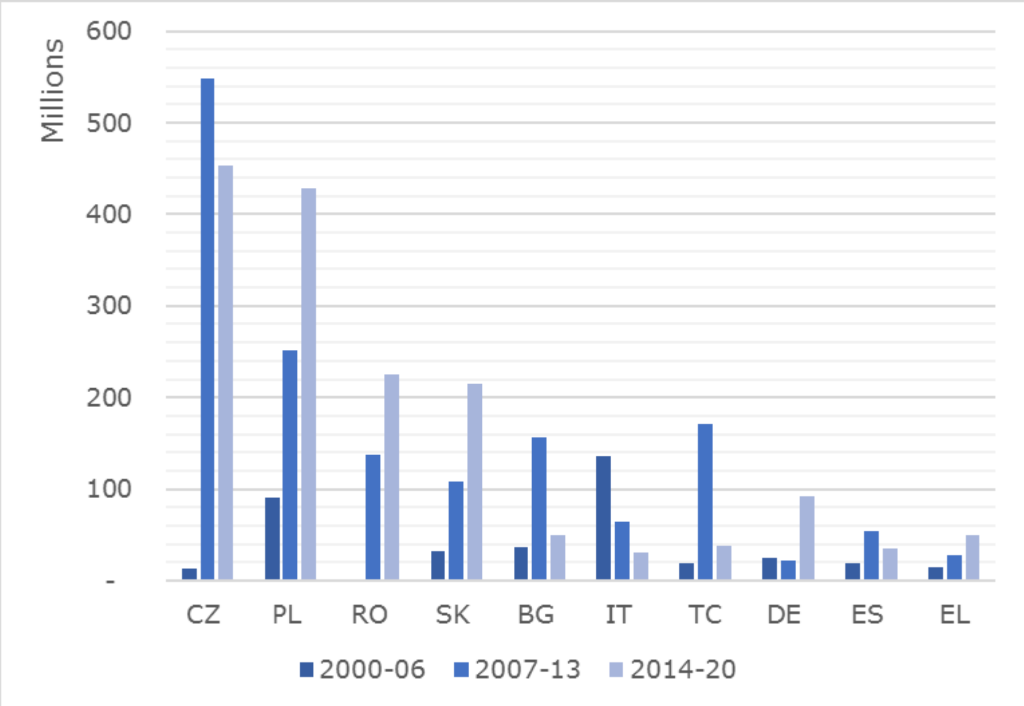
Source: Interview with the SHMI, district office in the seat of the Košice region; and desk review.

2.6 Use of EU funding to fund air quality improvements

EU Structural funds are used and have been very helpful in Slovakia. For example, in the 2007-2013 programming period, the direct environmental investments (allocation in EUR) from cohesion policy resources for Slovakia was EUR 1,82 billion. This corresponds to approximately 19% of the total allocation.[34] Out of these, EUR 107 million (ca. 6% of the environmental investments) have been used to finance air quality improvements. For the 2014-2020 programming period the allocation to air quality is somewhat higher (ca. EUR 215 million) and correspond approximately to 9.5% of the direct environmental investments (of EUR 2.25 billion).[35]

[33] http://www.shmu.sk/sk/?page=997
[34] Ex post evaluation of Cohesion Policy programmes
2007-2013, focusing on the European Regional Development Fund (ERDF) and the Cohesion Fund (CF), 2016.
[35] COWI, Milieu, Integration of environmental concerns in Cohesion Policy Funds (ERDF, ESF, CF), Results, evolution and trends through three programming periods, 2017.

Figure 2-5 Allocations (EU amount in EUR million) for air quality under ERDF and CF by Member State across the three financing periods



Source: COWI, Milieu, Integration of environmental concerns in Cohesion Policy Funds (ERDF, ESF, CF), Results, evolution and trends through three programming periods, 2017, based on (2000-2006, 2007-2013, 2014-2020) DG Regional and Urban Policy (2016) for 2000-2006; DG Regional and Urban Policy (2016) for 2007-2013; InfoRegio, ESIF categorisation (2016) for 2014-2020.

In the programming period 2007-2013 within the Operational Programme (OP) Environment air protection has been addressed through Priority Axis 3 – air protection and minimisation of adverse impacts of climate change. In the following programming period (2014-2020) air quality is addressed in the OP on the Quality of Environment under the Priority Axis 1 – sustainable use of natural resources through the development of environmental infrastructure. Specific objective 1.4.1. includes the objective of reducing air pollution and improving its quality. The supported activities include: 1) technological and technical measures to reduce air emissions from air pollution sources, in particular with the view of meeting the NEC and the AAQ Directives requirements; 2) improvements of air monitoring; and 3) greater awareness of air protection.

The SHMI informed that EU funding has been, among other things, used on investments in the monitoring network (i.e. modernisation of the existing monitoring stations and establishment of additional monitoring stations), upgrade of hardware and software solutions and to address large sources of pollution.

Moreover, under the 7th call, 10 contracts were awarded to provide a non-repayable financial contribution in the total amount of approximately EUR 64.2 million (out of which EUR 35.3 million from the Cohesion Fund). In 8 cases the funding was provided to U.S. Steel Košice, in one case to Žilinská teplárenská a.s. and in one case to Schüle Slovakia s.r.o. Finally, in the framework of the 14th call, 8 contracts were concluded to provide non-repayable contribution in the total amount of EUR 80.2 million (out of which EUR 68.1 million from the Cohesion Fund). In 7 cases to U.S. Steel Košice and in on ecase to KOSIT a.s.). U.S. Steel Košice, which is a large integrated steel producer in the Košice region, specified that EU resources have been used to finance technological improvements allowing further reduction of emissions (i.e. emissions further below the limits provided in the applicable BAT conclusions).

3 FINDINGS

This chapter presents detailed findings regarding the experience and lessons learnt in the implementation of the AAQDs in Slovakia and the Košice region in particular. Specifically, the chapter focuses on the challenges and successes encountered in the implementation of the Directives. Additionally, the relevance of the AAQDs, and their air quality standards, has been explored. Finally, the chapter identifies the factors underlying compliance with and effectiveness of the AAQDs and provides an overview of the costs and benefits associated with the implementation of the Directives.

The findings presented in this chapter rely primarily on input provided by stakeholders interviewed in the context of the case study. These were supplemented by additional desk research. An overview of the interviews carried out is provided in Appendix B.

3.1 Relevance of the AAQ Directives

Firstly, the case study explored the extent to what the AAQ Directives, and the air quality standards set within, correspond to citizens' needs.

The 1st Environmental Implementation Review indicated that air quality in Slovakia continues to give cause for concern. For example, for 2014 the EEA estimated 5160 premature deaths due to $PM_{2.5}$[36] and 4344 premature deaths due to O_3 pollution.[37]

Similarly, the findings of 2017 Special Eurobarometer confirm that air quality is a concern to Slovak citizens. 43 % of respondents to the Eurobarometer considered that air quality in Slovakia has remained the same over the last 10 years, while the same amount of respondents though it has deteriorated. In contrast, only 5% of respondents were of the opinion that air quality in Slovakia has improved.

The consultation carried out in the context of the case study (for an overview of the interviews carried out see Appendix B) showed that the objectives of the AAQDs are relevant in relation to the citizens' needs. The stakeholder consultation furthermore indicated that, while all the objectives are relevant, obtaining information on ambient air quality in order to help combat air pollution and nuisance and to monitor long-term trends and improvements, and ensuring that information on ambient air quality is made available to public are particularly important.

The objective of promoting increased cooperation between the Member States in reducing air pollution was also mentioned as an important objective, however, the civil society association CEPTA suggested that this objective is less important from the citizens' perspective. It was put forward that citizens need to be able to see concrete results (i.e. improvements to their surrounded air quality) and, as such, air quality measures that can be directly linked to such results are those most relevant for citizens.

As far as the air quality standards laid down by the AAQ Directives are concerned, CEPTA suggested that the standards do not reflect the needs of the citizens. The main argument for this assertion was that the standards set by the Directive do not correspond to the guideline values recommended by the WHO (the WHO AQG). It was highlighted that the WHO AQG are based on scientific analyses and not on a political compromise and, as such, are better suited for the protection of human health. It was put forward that while the current standards laid down in the AAQDs may contribute to a decrease of the concentrations of different pollutants, the problem

[36] Counterfactual concentration of 0 µg/m.
[37] EEA, Air Quality Report 2017.

(=negative health effects) remains largely unsolved as concentrations are still high. CEPTA also suggested that measures that are being implemented now in Slovakia, but also throughout the Europe, seek to achieve no exceedance of the current standards. It was put forward that had more ambitious standards been set, the measures to reach such more ambitious standards would also be more ambitious in terms of reducing the existing pollutant concentrations.

This view regarding the air quality standards has not been fully shared by the Ministry of Environment (MoE) and the SHMI. Specifically, while the MoE and the SHMI agreed on that the protection of the health of the citizens is the main goal of the AAQ Directives (and of the Slovak legislation that transposes the Directive), they stressed the need to look at what is possible to achieve - technically and practically. For example, in Slovakia, background concentrations of number of pollutants are high[38] and some of the pollution comes from sources abroad. Accordingly, in the view of the MoE and SHMI, the setting of more ambitious standards may not necessarily be the way forward.

3.2 Implementation successes

The present section focuses on implementation successes. These include the recent revision of the Slovak smog warning system and improvements in cooperation between sectors.

3.2.1 Smog warning system

Recently, Slovakia has revised its warning system for smog situations enabling the public and, in particular, vulnerable groups of the public, to become aware of possible longer lasting pollutant exposures. The revision came into force as of 1 December 2017.

The information and alert thresholds for the activation of the smog warning system have now been harmonised with the Czech Republic and, as far as PM_{10} is concerned, are stricter compared to some of Slovakia's neighbours (e.g. in Poland the information threshold for PM_{10} is 200 μg/m³ and the alert threshold is 300 μg/m³ while in Slovakia the thresholds are 100 and 150 μg/m³ respectively).[39] . Furthermore, prior to the revision of the system the main focus of the system was on the pollutants regulated in Annex XVI to the Directive, but with the revision the provisions regarding information on PM_{10} exposures have been strengthened. The revised system is perceived by the stakeholders – the MoE, SHMI and CEPTA – as a major improvement to the availability of information to public.

The success of the revised system is related in particular to the variety of channels used to communicate the relevant information to the public so as to ensure that the information reaches those affected. Moreover, the harmonisation of the thresholds with the neighbouring Czech Republic is a good step forward since, as the MoE has informed, there was a degree of confusion among the general population, in particular the part living close to Slovakia's borders, about the safe levels of pollution.

The (revised) smog warning system is described below.

A "*smog situation*" is defined as a situation when the air pollution by PM_{10}, SO_2, NO_2 or O_3 exceeds the information or the alert threshold laid down in the Order 244/2016 Coll. The smog situation

[38] For example, the background concentration of sulphur dioxide recalculated in sulphur was 0.27 μg.m3 on the Chopok station and 0.49 μg.m on the Starina station, in 2016. Background level of concentrations of oxides of nitrogen, recalculated in nitrogen (presented 072 μg.m3 on the Chopok station and 1.33 μg.m3 on the Starina station, in 2016, http://www.shmu.sk/File/oko/rocenky/Air_pollution_in_the_SR_2016.pdf.
[39] Levegö Munkacsoport, Air Pollution Emergency Schemes (Smog Alerts) in Europe, 2017.

can thus be of two degrees of severity: a smog situation (information threshold exceeded) or a severe smog situation (alert threshold exceeded).

Table 3-1 Information and alert thresholds

Pollutant	Information threshold in µg/m³	Alert threshold in µg/m³
PM_{10}	100 1)	150 1)
SO_2	-	500 2)
NO_2	-	400 2)
O_3	180 3)	240 4)

Source: Order 244/2016 Coll. on air quality.
Notes: 1) As an average over 12 consecutive hours.
2) As an hourly average over 3 consecutive hours at locations representing air quality over an area of minimum 100 km² or for an entire zone or agglomeration, whichever is smaller.
3) As an hourly average.
4) As an hourly average over 3 consecutive hours.

If the information threshold is exceeded, the SHMI informs the population of the smog situation. The information threshold reflects the level beyond which there is a risk to human health from brief exposure for particularly sensitive sections of the population. In case of exceedance of the alert threshold the SHMI informs the population that there is a case of serious smog situation. The alert threshold reflects a level beyond which there is a risk to human health from brief exposure for the general population.

At the same time the SHMI informed the relevant district office, municipality, the Slovak Environmental Protection Agency and the media. The municipality is required to inform the public without delay and, at the latest, within 6 hours from the time it had been informed by the SHMI. The municipality is obliged to use all communication channels available, including its information board, local radio and website. Public media are obliged to inform the public within 2 hours from the time it had been informed by the SHMI. If the smog situation continues an update of the situation must be provided at least two times a day. If the smog situation concerns a zone or an agglomeration close to a state border, the MoE must inform the neighbouring Member State as well.

3.2.2 Coordination between sectors

As mentioned in section 2.3, the Slovak republic is currently preparing a new air quality strategy (*The Strategy for the Improvement of Air Quality in Slovakia*).[40] Other sectors are actively involved in the preparation in the strategy and it is envisaged that they will be also involved in the implementation of the strategy. Sixteen working groups have been established to elaborate the strategy to discuss different air quality issues (e.g. industrial emissions, transport, agriculture, etc.), including representatives of various sectors. While the preparation of the 2013 PM_{10} strategy also included extensive consultation, the different sectors were less involved.

The active involvement of other sectors in the preparation of the strategy is likely to have a positive impact on increasing the ownership of the various sectors of the measures proposed and has therefore a potential to increase the likelihood of the measures being brought to life. So far, the MoE highlighted, as a particular success, of the work that there is now a constructive dialogue

[40] More information on http://www.minzp.sk/strategia-ochrany-ovzdusia.html

with other ministries and an agreement between the ministries that initiatives that worsen air quality should not be set as a priority.

3.3 Implementation challenges

The following section presents the main AAQD implementation challenges.

Unless provided otherwise, the challenges apply to the entire Slovak territory, including the Košice region. Furthermore, the section provides an assessment of the extent to what these challenges can be linked to the way the AAQ Directives have been designed or the specific requirements of the Directives.

Implementation challenges identified in the case study have been grouped into the following four categories:

1 Challenges in developing, implementing and enforcing effective air quality measures and ensuring integration of air quality in local planning and decision making;
2 Challenges in tackling small sources of pollution;
3 Challenges in ensuring compliance with the AAQ monitoring requirements of the AAQ;
4 Challenges in ensuring public awareness, in particular about the surrounding air quality, health effects of poor air quality and sources of air pollution.

Each of the challenges and the factors driving them and the extent to what these challenges can be linked to the provisions of the AAQDs is presented below.

3.3.1 Developing, implementing and enforcing effective air quality measures and ensuring integration of air quality in local planning and decision making

With the exception of the interviewed industry representative, who did not experience any particular challenge in this respect, all stakeholders interviewed in the context of the case study suggested that developing, implementing and enforcing effective measures to address air pollution is a great challenge for Slovakia and its different regions/air quality zones, including the Košice region. Stakeholders suggested that the consequence of this is that most measures implemented are very simple and lack quantified targets to assess the implementation progress and, as such, do not necessarily make a major difference in improving air quality.

The primary responsibility for air quality lies with the Ministry of Environment. The problem – pollution sources – is however divided between different sectors. These include the Ministry of Economy (for industry), the Ministry of Transport, the Ministry of Finance, the Ministry of Transport and Construction. The Ministry of Environment and the civil society association CEPTA point out that each of these Ministries/sectors has its own priorities and the protection of air quality is not necessarily on top of the list. Moreover, the Ministry of Environment does not have the competences to ensure that air quality measures (e.g. such as those laid down in the 2013 PM_{10} strategy) are brought into life by the other sectors. This is supported by findings in the recent report on air quality by EUROSAI, where it was indicated the need of better information flow between relevant ministries and the government, more precisely about the status of air quality in Slovakia. The report highlighted that the interdepartmental cooperation on the air quality management system is insufficient and dependent on the human resources' capacity. In the same time, the coordination of health and economic policies with an air quality policy has not yet been effective enough and has not taken place at the required level.[41]

[41] Joint report on air quality, Eurosai, 2019, available at: https://english.rekenkamer.nl/publications/reports/2019/01/30/joint-report-air-quality

As for regions and municipalities, the Košice district office suggested that the current allocation of responsibilities, conflicting priorities and a (lack of) coordination are also an issue. As mentioned above, district offices in the seat of Slovak regions are responsible for elaborating air quality plans. The district offices lack competences to ensure that the measures laid down in such plans (e.g. establishment of low emission zones) are implemented on the ground. This is because such measures cannot be enforced against other municipalities within the region, the state or against private actors. For example, district offices do not have competences to inspect and to intervene in the activities of industrial enterprises, nor in relation to transport (e.g. to regulate traffic). Accordingly, ensuring that air quality concerns are integrated into local planning and decision making, in particular in relation to transport (e.g. integration of low emission zones in transport and urban planning) is a challenge. The challenge is also connected with a lack of resources. For example, CEPTA pointed out that municipalities typically do not have the financial resources in their budget necessary to finance more ambitious air quality improvements and are not sufficiently motivated to implement such improvements.

Developing measures that are effective in addressing air pollution is a challenge in itself. For example, the Košice district office indicated that it struggles when defining measures to be included in the air quality plans. More specifically, the Košice district office and CEPTA noted that emission inventories and projections do not always provide a sufficient basis for drafting effective measures.[42] It was also pointed out by the Košice district office that while the office is sometimes informed about what has been implemented at the local level and what is being planned for the future. Finally, the Košice district office highlighted that it is not sufficiently involved in the different structures at the local, national and EU levels. For example, the district office is not involved in different working groups or coordination meetings in which the MoE participates. This limits the opportunities for the district offices to benefit from the information that is being shared there (e.g. regarding air quality measures implemented in other regions, but also in other Member States).

The process of developing air quality plans and short-term action plans is described in the text box below.

Text box 3-1 Development of air quality plans and short-term action plans (Košice region)

When developing an air quality plan, the district office approaches other relevant organisations. This includes e.g. other district offices in the region, Regional Public Health Office in Košice, the Slovak Road Administration, and the National Motorway Company. These organisations suggest various measures to be implemented. The district office uses these suggestions as a basis for the elaboration of the air quality plan, adds additional measures (where relevant) and finalises the plan.

Moreover, the district office in Košice cooperates with other district offices in the region and the SHMI in determining who the largest polluters in the region are. These polluters are included in the air quality plans with specific measures.

As far as short-term action plans are concerned the polluters identified are required to report on the measures they envisage to introduce. Typically, this includes simple measures such as sprinkling of roads, but also a temporary boiler shut-down.

Source: Interview, Košice district office.

The implementation challenge described above is driven by a number of factors – mainly at the Member State level. As elaborated on below, a number of these factors can nonetheless be linked to the specific provisions of the AAQDs.

[42] For example, the Košice district office mentioned that while BaP, which is a particular issue in the Košice region, is being measured, there is still a lack of information about the sources. As such, it is difficult to develop effective measures to tackle the problem.

First of all, the way responsibilities in air quality management are allocated between different actors may pose challenges in the implementation of the Directives in itself. This challenge is further amplified by the – in some areas – limited coordination between the different actors in Slovakia. Having regarding to the principle of subsidiarity, Directive 2008/50/EC does not specify the way responsibilities in air quality monitoring, assessment and management should be allocated within the Member States. Article 3 of Directive 2008/50/EC nonetheless lays down the obligation for Member State authorities to "*designate at appropriate levels the competent authorities and bodies responsible for the following: (a) assessment of ambient air quality; (b) approval of measurement systems (methods, equipment, networks and laboratories); (c) ensuring the accuracy of measurements; (d) analysis of assessment methods; (e) coordination on their territory if Community-wide quality assurance programmes are being organised by the Commission; and (f) cooperation with the other Member States and the Commission.* The provision refers mainly to tasks related to air quality monitoring and assessment, but not specifically to the *management* of air quality. The provision of the AAQ Directive could potentially be strengthened in this respect so as to include air quality management related tasks as well.

Since there are no performance indicators implemented in Slovakia, the government should establish and further adopt binding indicators for measuring the effectiveness and efficiency of measures for combating air pollution. This would need to be supported by regular evaluation of these indicators and further propositions of actions for improving air quality in Slovakia.[43]

Secondly, the implementation challenge is driven by the (lack of) legal status of the adopted air quality plans. Article 23 of Directive 2008/50/EC provides that in zones and agglomerations where the levels of pollutants in ambient air exceed any limit value or target value (plus any relevant margin of tolerance) Member States "*shall ensure that air quality plans are established for those zones and agglomerations in order to achieve the related limit value or target value specified in Annexes XI and XIV*". The provision does not specify the legal status of the air quality plans and nor does it address the issue of access to legal recourse against potentially insufficient air quality plans. There is thus a room for improvement in this respect.

Text box 3-2 Legal recourse against adopted air quality plans

In 2017 a group of citizens in Bratislava together with the NGOs CEPTA, ClientEarth and Cyklokoalícia brought a claim against the Slovak government for insufficient protection of air quality in Bratislava to the district court in Bratislava. The claim suggest that the air quality plan for Bratislava is insufficient, lack concrete measures and targets and is not compliant with the Slovak, as well as European legislation. The district office in Bratislava that has drafted the plan argued that, pursuant to the current laws, it is not competent to require other subjects to implement measures to improve air quality and to enforce such measures/impose sanctions in case of non-compliance. The district office further argued that the public was consulted and had the opportunity to comment on the proposed air quality plan.[44]

Finally, the third major factor driving the challenge is the lack of information, including information about the measures being implemented and best practices to tackle air pollution. This factor is to some extent linked to the problem of coordination, as described above. At the same time, the findings of the case study indicate that there is a need for additional guidance and knowledge sharing (at EU level).

Section A of Annex XI to the Directive provides an overview of the elements to be included in an air quality plan, but, at least in Slovakia, more detailed guidance on how to elaborate air quality plans is missing. This can be provided at national level and some work – in connection with the

[43] Joint report on air quality, EUROSAI, 2019, available at: https://english.rekenkamer.nl/publications/reports/2019/01/30/joint-report-air-quality
[44] No decision has been published on the matter so far.

preparation of the new Slovak Air Quality Strategy – is already ongoing.[45] At the same time there would, however, appear to be a clear benefit from EU level guidance, e.g. as regards the lessons learned and best practices in air quality plan development and implementation in other Member States.

3.3.2 Tackling small sources of pollution

The majority of stakeholders interviewed suggest that large polluters [46] are subject to strict control, a system of fees and fines, and generally tend to comply with the applicable emission standards set pursuant to the Industrial Emissions Directive. As such, stakeholders suggest that the more pressing problem from the Slovak perspective, and in particular the Košice region, are small sources of pollution: medium/small polluters and in particular individuals/households.

Domestic solid fuel combustion has been identified as one of the major sources of particulate matter and BaP pollution.[47] For example, in 2014 it was estimated that domestic solid fuel combustion constituted approximately 81% of the total $PM_{2.5}$ emissions 84% of polycyclic aromatic hydrocarbon emissions.[48] The issue is that different types of solid materials (including e.g. waste and wet wood) are being burned, sub-standard solid fuel stoves and boilers are being used, and there are currently no means of imposing an effective control over these practices and enforce any measures (e.g. it is not possible to get access to private properties). The MoE noted that the issue is difficult to tackle as it relates to the problem of energy poverty, which is prominent in particular in Roma settlements. The issue is being discussed in the context of the new Air Quality Strategy, to be published in the late spring 2019. Current measures include information to public about clean domestic heating and the adverse effects of air pollution caused by domestic solid fuel combustion.[49]

The implementation challenge cannot be directly linked to any of the provisions of the AAQ Directives as it driven in particular by the lack of public awareness about the health impacts of residential solid fuel combustion and clean operation techniques, and generally, also the issue of energy poverty.

Nonetheless the tackling of the challenge can benefit from sharing of best practices in addressing similar issues in other Member States. Additionally, the potential to make full use of EU resources (e.g. the Operational programmes under the Structural Funds, the European Fund for Strategic Investments, the Rural Development Programme, etc.) to support transition to cleaner residential heating technologies could be further explored.

3.3.3 Ensuring compliance with the AAQ monitoring requirements

The MoE and the SHMI suggested that monitoring of air quality and, in this connection, living up to all the detailed requirements of the AAQDs, is a challenge and is costly for such a small country with complex geomorphology as Slovakia. For example, the SHMI highlighted that in applying the

[45] https://www.enviroportal.sk/clanok/bratislava-program-na-ochranu-ovzdusia-je-v-sulade-so-zakonom-reaguju-uradnici

[46] For the purpose of the case study polluters are categorised in line with the Report on air pollution is Slovakia: large (stationary) sources are technological units containing combustion plants having total rated thermal input more than 50 MW and other technological units with a capacity above the defined limit; medium (stationary) sources are technological units containing combustion plants having total rated thermal input between 0.3 -50 MW and other technological units with a capacity under the defined limit for the large sources but over the defined limit for the medium sources; and small (stationary) sources are domestic heating equipment for combustion of solid fuels and natural gas with total rated thermal input less than 0.3 MW. http://www.shmu.sk/File/oko/rocenky/Air_pollution_in_the_SR_2016.pdf

[47] See, e.g. https://ec.europa.eu/info/news/clean-air-dialogue-between-commission-and-slovakia-promotes-actions-cleaner-air-2018-apr-26_en

[48] lhttp://vykurovanie.enviroportal.sk/emisie.aspx

[49] http://vykurovanie.enviroportal.sk/

criteria for sampling points siting, as laid down by the AAQ Directives, it is difficult to ensure quality/representativeness of the measurement since, given the complex geomorphology of Slovakia, pollutants tend to become trapped in low lying areas. The SHMI and CEPTA also suggested that communication and negation with municipalities is an issue. For example, the SHMI may identify a location for a sampling point that lives up with the requirements of the Directive 2008/50/EC (e.g. regarding the distance from a road), but this location may not be acceptable for the municipality on whose territory the sampling point is to be placed or the municipality places various conditions for the establishment of the sampling point. Currently, there is no legal instrument that can be used to make municipalities accept.

As elaborated on above, the challenge is driven by a number of factors, including the geomorphology of Slovakia, the allocation of powers within Slovakia in relation to the establishment of the monitoring network, but can also be linked to the detailed siting criteria laid down by the AAQ Directives (e.g. regarding distance to roads and ensuring representativeness).

3.3.4 Challenges in ensuring public awareness

CEPTA suggested that – despite recent improvements to the smog warning system (see below) – ensuring that the Slovak population is sufficiently informed about the surrounding air quality, the negative (health) effects associated with poor air quality and the sources of air pollution continues to be a challenge for Slovakia. It was pointed out – and this view was shared by the SHMI – that currently the information is not particularly user-friendly and citizens need to connect different pieces of information to get a full picture of how they are being affected.

Article 26 of Directive 2008/50/EC lays down the general provisions regarding ensuring information to public. Pursuant to the first paragraph, Member States shall ensure that "the public as well as appropriate organisations such as environmental organisations, consumer organisations, organisations representing the interests of sensitive populations, other relevant health-care bodies and the relevant industrial federations are informed, adequately and in good time, of the following:(a) ambient air quality in accordance with Annex XVI; (b) any postponement decisions pursuant to Article 22(1); (c) any exemptions pursuant to Article 22(2); (d) air quality plans as provided for in Article 22(1) and Article 23 and programmes referred to in Article 17(2)." Moreover, paragraph 2 of the same Article provides the obligation for the Member State to ensure availability of annual reports for all pollutants covered by the Directive. In terms of adverse effects of poor air quality Annex XVI paragraph 2 specifies that the information on ambient concentrations shall "also provide a short assessment in relation to the air quality objectives and appropriate information regarding effects on health, or, where appropriate, vegetation."

As such, Directive 2008/50/EC already contains requirements to share the information on adverse health effects of air pollution to public. The implementation of the provision could be further strengthened by sharing of good practices in the implementation between the Member States. Alternatively, in addition, the EU air quality index, which provides information on the current air quality across Europe's cities and regions, could be potentially expanded with additional information.***Factors underlying compliance with and effectiveness of the AAQ Directives***

The following section provides an overview of the factors underlying and hindering compliance with and effectiveness of the AAQ Directives in Slovakia, and the Košice region. The factors have been identified through stakeholder consultation conducted in the context of the case study. The views have been correlated with information gathered through desk research.

3.4.1 Factors underlying compliance and effectiveness

The findings of the case study indicate that main factors underlying compliance with the AAQDs in Slovakia include: 1) an understanding that there is problem, 2) precise data on the levels of pollution and sources, 3) responsibility and financial resources and 4) follow-up on cases of non-compliance.

Understanding that there is a problem

The findings of the case study indicate that an understanding of that there is a problem and why the problem needs to be solved is crucial for the effective implementation of the AAQDs in Slovakia. For example, CEPTA highlighted that is important that the citizens understand the aims of the Directive in order for them to create pressure on politicians to take action and, at the same time, to accept and support the measures that are being implemented. For example, when traffic restrictions are being introduced, it is important that it is communicated that this is done in the interest of protecting the citizens' health and not simply "because the EU calls for it".

Data on the levels of pollution and on pollution sources

Moreover, the findings of the case study show that it is important to have precise and up-to-date information. Information is needed not only to ensure an effective implementation of the Directive and, specifically, to elaborate effective air quality measures, but also to communicate the problem to the citizens. Thus, for example, the new Air Quality Strategy will be underpinned by a detailed analysis of causes of air quality deterioration (and evaluation of sector share of sources for air pollution.

Responsibility, coordination and financial resources

The findings of the case study show that the effective implementation of the AAQDs requires that responsibility for the implementation/air quality improvements, action is well-coordinated and financial resources allocated: at the level of the Member State, regional and local level. As mentioned above, the work on the new Air Quality Strategy is already showing improvements to coordination of sectoral priorities.

Follow-up on cases of non-compliance

Finally, the follow-up by the Commission on cases of non-compliance via infringement has been identified as an important factor contributing to effectiveness/compliance with the Directives. For example, the MoE and CEPTA highlighted the positive impact of the infringement proceedings initiated in 2012 regarding PM_{10} on taking immediate action (e.g. the elaboration of a dedicated strategy to tackle the PM_{10} problem).

3.4.2 Factors hindering compliance and effectiveness

On the other hand, the case study identified the following factors hindering compliance 1) lack of information about the problem; 2) lack of detailed information about the levels of pollution, its chemical composition, sources and effects; 3) lack of motivation to take action, 5) lack of competences and insufficient coordination, 6) lack for personnel and 7) insufficient information sharing.

Lack of information about the problem

First of all, the case study identified the lack of information about the problem and, in particularly, about the effects and causes of air pollution among the citizens as one of the major factors hindering effectiveness of the Directives. For example, CEPTA highlighted that from the citizens' perspective the problem is that – as air pollution is not visible – citizens do not know about the pollution and about the effects of air pollution (health effects, effects on the quality of life, but also the expenses for health care) and, as consequence, do not fully mobilise the political will to introduce more far reaching measures to improve air quality.

Lack of detailed information about the levels of pollution, its chemical composition and sources

As mentioned above, up-to-date information about the scope of the problem and its sources is crucial to develop effective air quality measures and thereby achieve air quality improvements called for by the AAQDs. Information on air pollution sources is part of the Annual Reports on Air Quality in Slovakia. However, CEPTA, but also the SHMI and the Košice district office indicated that there is a room for further improving the current knowledge about the sources, but also about economic and health impacts of air pollution. As mentioned above, some activities in this respect are already on-going as part of the preparation of the new Air Quality Strategy.

Lack of motivation to take action

The findings of the case study suggest that – despite recent improvements – there is still a potential to the lack of motivation to introduce far-reaching actions to improve air quality improvements among the different sectoral and local actors. This is closely linked to the hierarchy of priorities and to the issue of competences, discussed below.

Lack of competences and insufficient coordination

Furthermore, the findings show that the allocation of responsibilities and the somewhat limited coordination between different actors constitute a major barrier to the effective implementation of the AAQDs in Slovakia and in the Košice region. As discussed above, while in principle it may be possible to elaborate effective measures for the air quality plans, but it is not always possible to bring such matters to life. For example, it may be known that a city bypass would likely improve air quality, but in practice it is difficult to get such a bypass built because the district office, elaborating the measure, does not have the powers necessary to make the development decision.

Lack of personnel

Furthermore, the findings suggest that a sufficient amount of qualified personnel, with a strong insight into air quality issues, is crucial for the effective implementation of the AAQ Directives. In this connection the MoE noted that other countries typically have a larger a team of people dedicated to air quality issues (for example, in the Czech Republic the air quality unit at the MoE has 20 full-time employees), in the Slovak republic the number is considerably lower (8 full-time employees at the MoE). The main reason for this is the lack of financial resources.

Insufficient information sharing

Finally, the findings of the case study suggest that communication and knowledge sharing within the country, but also with other Member States is important. However, as discussed above, shortcomings have been identified in particular in relation to the sharing of information at the local level (i.e. between the different district offices, but also between district offices and the MoE regarding the developments and best practices at EU level).

3.5 Costs and benefits of the AAQ Directives

3.5.1 Costs of implementation

There are currently no economic analyses of the costs of implementation of the AAQ Directives in Slovakia. A number of rough estimates was gathered via stakeholder consultation.

The MoE estimated that the total costs of implementation of the AAQ Directives are likely in the tens of millions EUR per year, but a more precise estimate/break-up of the costs could not be provided. As far as labour costs are concerned, the Air Quality Unit at the Ministry of Environment consists of 8 FTEs (Full Time Equivalents). The Air Quality Unit is responsible solely for the implementation of the AAQ Directives, but implementation other EU Directives related to air quality (including the NEC Directive and the Industrial emissions Directive),[50] long-range air pollution and the protection of ozone layer. In addition, there are 9 FTEs working with air quality issues (i.e. not exclusively the AAQ Directives) in the regions. In the SHMI there are approximately 27 employees responsible for monitoring, modelling and reporting.

According to SHMI the costs of operating the current monitoring network, consisting of 38 monitoring stations, are in the order of magnitude 1 to 1.2 million EUR per year. As mentioned above, air quality in Slovakia has been monitored also in the years prior to the introduction of Directive 2008/50/EC and its predecessor. The findings of the case study nonetheless indicate that all the monitoring stations in the monitoring network are necessary for the fulfilment of the monitoring requirements of the Directives and even that additional sampling points need to be added to the network in order to comply with the requirements.

No estimate of total costs incurred by the industry could be provided. U.S. Steel Košice, which is a large integrated steel producer in the Košice region, informs that air quality improvements are being financed both from internal budgets and from EU sources.

Text box 3-3 Use of EU funding to fund air quality improvements (U.S. Steel Košice)

As far as EU sources are concerned, U.S. Steel Košice has used approximately in between 2017 and 2020 80 mil EUR on further upgrading its technologies from EU budgets.

There was an ad hoc scheme for the support of the Košice region in which all enterprises in the Košice region could apply for support. 90% of financing came from EU and 10% from the U.S. Steel's own resources. In addition, from the same operational programme there was in 2016 a call for entire Slovakia. 55% of the resources were received from the fund and 45% from U.S. Steel's own resources. EU funding has been used to further improve existing technologies and, as such, further reduce emissions of harmful substances in the surrounding air.

Source: Interview, U.S. Steel Košice.

3.5.2 Costs of non-implementation

There is currently no national analysis of the costs of non-implementation of the AAQ Directives.

At EU level it was estimated that the health-related external costs from air pollution in Slovakia are above EUR 3 billion/year (income adjusted, 2010), which include both the intrinsic value of living a full health life and the direct costs to the economy. The direct economic costs relate to 1.3 million workdays lost each year due to sickness related to air pollution, with associated costs

[50] http://www.minzp.sk/sekcie/temy-oblasti/ovzdusie/ochrana-ovzdusia/pravne-predpisy/pravne-predpisy-eu/pravne-predpisy-eu-2.html

for employers of EUR 123 million/year (income adjusted, 2010), for healthcare of above EUR 10 million/year (income adjusted, 2010), and for agriculture (crop losses) of EUR 35 million/year (2010).[51]

For 2014, the EEA has estimated the number of premature deaths due to $PM_{2.5}$ to be 5160 (counterfactual concentration of 0 µg/m) and 4520 (counterfactual concentration of 2.5 µg/m). For NO_2 100 and 1,330 premature deaths were estimated (using the counterfactual concentration of 10 and 20 µg/m). Finally, 4344 premature deaths were estimated due to O_3 pollution.[52]

3.5.3 Benefits of the AAQ Directives

The case study identified a number of benefits stemming from the implementation of the AAQ Directives. These benefits cannot be quantified, as there are currently no quantitative assessments of benefits the AAQ Directives in Slovakia, but can be described in qualitative terms.

A number of provisions of the AAQ Directives have been identified as key, in delivering air quality improvements. These include, more generally, the establishment of a harmonised approach throughout the EU towards monitoring, assessment and management of air quality. Overall, the following provisions of the AAQ Directive were cited as those most important include: 1) the setting of air quality standards; 2) providing information to public and 3) cooperation with the European Commission and between Member States.

The benefits of the AAQ Directives for Slovakia are summarised below.

Maintaining/improving air quality, positive impacts on the eco-system and improvements to citizens' health

All stakeholders interviewed noted that despite the fact that there are new sources of air pollution, the number of cars has increased, there was an economic crisis, air quality has not gotten worse and the number of exceedances has decreased over the years. This finding is confirmed through desk study (see section 2.2 above).

Establishment of common methods and criteria for monitoring

Another benefit of the AAQDs, highlighted in particular by the SHMI, is the possibility to assess ambient air quality on the basis of common methods and criteria that allow for comparison of across Member States.

Improved monitoring

Furthermore, another benefit of the AAQDs relates to the shift of focus of monitoring from industrial areas to areas where most population lives. In this connection, the SHMI informed that prior to the implementation of the AAQ Directives monitoring was concentrated in industrial areas, close to large pollution sources. Over time, additional monitoring stations were added into the monitoring network. These included stations in areas with a lower concentration of industrial pollution sources (e.g. urban background monitoring stations).

[51] The figures are based on the Impact Assessment for the European Commission Integrated Clean Air Package (2013), as cited in COM (2017) 63 final.
[52] EEA, Air Quality Report 2017.

Increased visibility of the issue and interest in solving the problem of air pollution

In particular CEPTA highlighted as an important benefit of the Directives the fact that the problem of air pollution became more visible. It was noted that the Slovak media had started to be more interested in the issues and in the solutions. According to the MoE and CEPTA, the infringement proceedings initiated against the Slovak republic had a major role in this.

Clear effort from the industry to reduce emissions

The findings of the case study also show that there has been a major improvement in the technologies to reduce emission sin the air. For example, U.S. Steel Košice highlighted that this would not have happened without the EU air policy (the AAQ Directives, the NECD and other instruments dealing with industrial emissions, the 2012 Conclusions on BAT,[53] etc.).

Establishment of good communication and knowledge sharing in the EU

Communication within the EU, through coordination meetings but also by means of bilateral exchanges, was also identified as very important and beneficial in terms of knowledge and best practice sharing.

Establishment of level playing field for EU industries

Finally, as EU legislation provides the same rules for all companies in the EU it also lays ground to fair competition on the internal market. This latter point was emphasised in particular by the industry representative U.S. Steel Košice.

[53] Commission Implementing Decision establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU on industrial emissions for iron and steel production.

4 CONCLUSIONS

This chapter presents the summary of the main findings of the case study regarding the main implementation challenges the potential for improving the implementation of the Directives in Slovakia. Finally, a summary of the evaluation of the AAQDs is presented.

4.1 Identified problems and potential for improving the implementation of the Directives

The case study identified the following challenges in the implementation of the AAQ Directives.

Developing, implementing and enforcing effective air quality measures and ensuring integration of air quality in local planning and decision-making. As described in section 3.3 this is a complex challenge driven by a number of factors – mainly at the Member State level. First of all, the way responsibilities in air quality management are allocated between different actors may pose challenges in the implementation of the Directives in itself (see section 2.3 above). This challenge is further amplified by the – in some areas – limited coordination between the different actors in Slovakia (see section 3.3 above). Provisions of Directive 2008/50/EC addressing the allocation of responsibility refer mainly to tasks related to air quality monitoring and assessment, but not specifically to the *management* of air quality. The provision of the AAQ Directive could potentially be strengthened in this respect so as to include air quality management related tasks as well. Furthermore, Article 23 of Directive 2008/50/EC does not specify the legal status of the air quality plans and nor does it address the issue of access to legal recourse against potentially insufficient air quality plans. Finally, the third major factor is the lack of information, including information about the measures being implemented and best practices to tackle air pollution. This driver is to some extent linked to the problem of coordination, as described above. At the same time, the findings of the case study indicate that there is a need for additional guidance and knowledge sharing (at EU level), e.g. as regards the lessons learned and best practices in air quality plan development and implementation in other Member States.

Furthermore, in the recent Joint Report on air quality by EUROSAI was stressed that even if the number of monitoring stations and their location corresponds with the pre-set criteria, the National Air Quality Monitoring System is inadequate due to the complexity of the territory of Slovakia and thus the National Air Quality Monitoring System is not representative of the whole Slovakia.[54]

Challenges in tackling small sources of pollution. The challenge is driven in particular by the lack of public awareness about the health impacts of residential solid fuel combustion and clean operation techniques, and generally, also the issue of energy poverty. As such, the implementation challenge cannot be directly linked to any of the provisions of the AAQ Directives. Nonetheless the tackling of the challenge can benefit from sharing of best practices in addressing similar issues in other Member States. Additionally, the potential to make full use of EU resources to support transition to cleaner residential heating technologies could be further explored.

Challenges in ensuring compliance with the AAQ monitoring requirements of the AAQ. The findings of the case study indicate that monitoring of air quality and, in this connection, living up to all the detailed requirements of the AAQ, is a challenge and is costly for such a small country with complex geomorphology as Slovakia. The challenge is driven by a number of factors, including the allocation of powers within Slovakia in relation to the establishment of the monitoring

[54] Joint report on air quality, Eurosai, 2019, available at: https://english.rekenkamer.nl/publications/reports/2019/01/30/joint-report-air-quality

network, the geomorphology of Slovakia, but can also be linked to the detailed siting criteria laid down by the AAQ Directives (e.g. regarding distance to roads and ensuring representativeness).

Challenges in ensuring public awareness. Finally, the findings of the case study suggest that – despite recent improvements to the smog warning system – ensuring that the Slovak population is sufficiently informed about the surrounding air quality, the negative (health) effects associated with poor air quality and the sources of air pollution continues to be a challenge for Slovakia. It was pointed out – and this view was shared by the SHMI – that currently the information is not particularly user-friendly, and citizens need to connect different pieces of information to get a full picture of how they are being affected. Directive 2008/50/EC already contains requirements to share the information on adverse health effects of air pollution to public. The implementation of the provision could be further strengthened by sharing of good practices in the implementation between the Member States. Alternatively, the EU air quality index, which provides information on the current air quality across Europe's cities and regions, could be potentially expanded with additional information.

4.2 Assessment of the AAQ Directives

The following section presents a summary of the findings of the case study in relation to the relevance, effectiveness, efficiency, coherence and added value of the AAQDs.

4.2.1 Relevance

The findings of the case study indicate that the objectives of AAQDs are relevant to the needs of citizens in Slovakia as *air quality continues to pose a concern to the health of Slovak citizens and the environment.* The consultation carried out in the context of the case study showed that while all the objectives of the AAQDs are relevant, obtaining information on ambient air quality in order to help combat air pollution and nuisance and to monitor long-term trends and improvements, and ensuring that information on ambient air quality is made available to public are particularly important. As far as the air quality standards laid down by the AAQDs are concerned, there is some disagreement between the stakeholders as to whether the existing air quality standards are too lenient.

4.2.2 Effectiveness

The findings of the case study indicate effectiveness of the AAQDs in maintaining air quality where it is good and improving it in other cases. For example, while in 2004 there were 17 air quality management areas (i.e. areas in which a limit or target value for one or more pollutants has been exceeded, see above) while, in 2016 there were only 12. *The findings of the case study indicate that main factors underlying compliance with the AAQDs in Slovakia include:* 1) an understanding that there is problem, 2) precise data on the levels of pollution and sources, 3) responsibility and financial resources and 4) follow-up on cases of non-compliance. In contrast, the case study identified the following factors hindering compliance 1) lack of information about the problem; 2) lack of detailed information about the levels of pollution, its chemical composition, sources and effects; 3) lack of motivation to take action, 5) lack of competences and insufficient coordination, 6) lack for personnel and 7) insufficient information sharing.

4.2.3 Efficiency

There are currently *no economic analyses of the costs of implementation of the AAQ Directives* in Slovakia. A number of rough estimates was gathered via stakeholder consultation. For example, the MoE estimated that the total costs of implementation of the AAQ Directives are *likely in the tens of millions EUR per year.* As far as labour costs are concerned, the Air Quality Unit at the Ministry of Environment consists of eight FTEs (Full Time Equivalents). The Air Quality Unit is responsible solely for the implementation of the AAQ Directives, but implementation other EU Directives related to air quality. In addition, there are nine FTEs working with air quality issues (i.e. not exclusively the AAQ Directives) in the regions. In the SHMI, there are approximately 27 employees responsible for monitoring, modelling and reporting. The costs of operating the current monitoring network, consisting of 38 monitoring stations, are in the order of magnitude 1 to 1.2 million EUR per year.

The case study identified a number of benefits stemming from the implementation of the AAQ Directives. These benefits cannot be quantified, as there are currently no quantitative assessments of benefits the AAQ Directives in Slovakia but can be described in qualitative terms. The identified benefits include: 1) maintaining/improving air quality, 2) establishment of common methods and criteria for monitoring and improved monitoring, 3) increased visibility of the issue and interest in solving the problem of air pollution, 4) effort from the industry to reduce emissions, 5) establishment of good communication and 6) knowledge sharing in the EU and 7) establishment of level playing field for EU industries.

4.2.4 Coherence

The IED and the relevant BAT Conclusions contribute to the fulfilment of the objective of the AAQ Directive to maintain air quality where it is good and improve it in other cases.

As far as other sectoral policies that affect air quality are concerned*, there is a potential for further improving coordination* and, in particular, for ensuring that air quality concerns and efforts are integrated into local planning.

4.2.5 EU added value

The monitoring requirements of the *AAQ Directives have stimulated a number of improvements in the monitoring of air quality.* While monitoring had taken place already before the introduction of the AAQ, the added value of the AAQ is in shifting the focus of monitoring to the areas where most of the population lives, improving the quality of the monitoring data and allowing for a comparison across the EU. Another *major area of EU added value of the Directives lies in increased visibility of the air quality issue and the awakening of the interest to solve the problem of air pollution.*

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APPENDIX B INTERVIEWS

Organisation	Date of the interview
Ministry of Environment, Climate Change and Air Quality Protection Section	11 July 2018
Slovak Hydrometeorological Institute, Unit for air quality	11 July 2018
CEPTA - Centre for Sustainable Alternatives, civil society association	10 July 2018
District Office in the seat of the region, Košice region	19 July 2018
U.S. Steel, Košice	17 July 2018

APPENDIX C PILOT INTERVIEW GUIDE

General questions

- What challenges have been encountered when implementing the AAQ Directives?
- How have these challenges been overcome? What has proved to work well and what turned out to work less well? Are there any relevant lessons learned that other Member States could learn from?
- Where do you see the greatest potential to improve further the implementation of the Directives?
- Have any specific initiatives/measures been introduced to support the implementation of the AAQ Directives in the Member State (e.g. national guidance, arrangements for information exchange, etc.)?
- What systems are in place to provide information to the public on air quality, exceedances and alerts, and the implementation of plans and measures?

Specific questions

The table below outlines the specific themes discussed during the interviews.

Evaluation question	Questions
RELEVANCE	
(1) How relevant are the goals and objectives of the AAQ Directives to the needs of citizens; do the AAQ Directives still address the most relevant pollutants and set relevant standards and obligations to protect human health and the environment; and are the AAQ Directives sufficiently adapted or adaptable to evolving technical and scientific progress?	To what extent do the goals of the Directives correspond to the needs of the citizens (in your country)? Which of the Directives' requirements are in your opinion the most important in relation to the citizens' needs? To what extent have the goals of the Directives been integrated in the strategic documents (on environmental protection) in your country?
(2) How far are the Directives aligned with key EU priorities? Which elements in the Directives are essential to deliver on these priorities, have elements become redundant?	
EFFECTIVENESS	
(3) What factors have contributed to meeting the objectives of the AAQD or to failing to meet these objectives, in terms of: 1) defining common methods to monitor and assess air quality; 2) assessing ambient air quality in order to monitor trends; 3) establishing standards of air quality to achieve across the EU; 4) ensuring that information on air quality is made public; 5) maintaining good air quality, improving it where it is not good; to what level can these factors be attributed to provisions of the AAQ Directives?	What are the main factors that contribute to compliance with/effective implementation of the air quality Directives; hereunder: • air quality standards • reporting requirements • requirements regarding the establishment and implementation of air quality plans and programmes • requirements regarding provision of information to public? • requirements regarding monitoring stations? What are the main barriers (at national/regional/local) level preventing effective implementation of the air quality Directives? Please consider each of the items listed above separately. What would it take to overcome the barriers?
EFFICIENCY	
(4) What are the costs and benefits (monetary and non-monetary) associated with implementation of the AAQ Directives in the Member States, and in the EU; have the benefits (improved air quality) been achieved in a cost-effective manner and to what extent have costs been equitably distributed across different sectors?	What are the costs of implementation of the AAQ Directives? What is the cost of implementation (monitoring, reporting, and planning) for different levels of government, including the use of external expertise on, per year (in FTE)? What is the cost of implementation for different sectors of the industry per year (capital and operating costs of equipment in EUR)?
(5) Where there are significant cost differences between Member States and/or between different sectors and/or as regards costs to stakeholders (in-	

Evaluation question	Questions
cluding social costs as a consequences of poor implementation), what is causing them; and are the costs of compliance proportionate to the benefits brought by the directives?	What specific factors contribute to the efficiency/inefficiency of the implementation of the AAQ Directives? What are the costs of non-implementation of the Directives (e.g. environmental and health costs, uncertainty and market distortion, litigation costs for Member States)? What are benefits associated with the implementation of the Directives in the Member State/air quality zone (e.g. health and environmental benefits, economic benefits, eco-innovation, etc.)?
(6) How efficient are monitoring, reporting and assessment regimes, what are the administrative costs to the Member States and to the Commission; taking account of the objectives and benefits of the directives is there evidence that they have caused unnecessary or excessive administrative burden?	
(7) Has the implementation of the AAQ Directives supported or hampered EU competitiveness in the global economy; has the implementation of the AAQ Directives improved or been detrimental to economic, social and environmental sustainability?	
COHERENCE	
(8) To what extent do the AAQ Directives complement or interact with other environmental policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as the NEC Directive and IED Directive as well as the EU climate legislation and policy; and how do these policies and legislation support or hamper the implementation of the EU air quality legislation?	How and to what extent is the implementation of the AAQ Directives coordinated with the implementation of other EU instruments in the environmental and climate domain (e.g. the National Emissions' Ceiling Directive, the Industrial Emissions' Directive, Large Combustion Plants Directive, etc.)?
(9) To what extent do the AAQ Directives complement or interact with sectoral policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as energy, transport, agriculture, cohesion, fiscal policies); and how do these policies support or hamper the implementation of the EU air quality legislation?	How and to what extent is the implementation of AAQ Directives coordinated with other relevant legislation and policy (e.g. in the area of energy, transport and agriculture)? Are air quality plans coordinated with planning initiatives promoted by EU sectoral legislation (e.g. Sustainable Urban Mobility Plans, TEN-T investments)? Are air quality plans coordinated with national emission reduction plans and measures under the NEC Directive? Are air quality plans coordinated with climate change mitigation policies and plans (for GHG emission reductions)? To what extent are air quality plans integrated or linked with municipal/urban/regional level planning e.g. in the area of land use and spatial planning, energy management, transportation and climate? To what extent are EU funds used to finance measures (e.g. abatement programmes) to maintain good air quality/improve air quality?
ADDED VALUE	

Evaluation question	Questions
(10) To which degree have the AAQ Directives, including common EU air quality standards and comparable air quality assessment, management and information approaches enabled Member States and their competent authorities to take successful action to improve beyond what would have been possible without EU action?	Have AAQ Directives triggered transformational changes that have enabled the achievement of air quality objectives? Have AAQ Directives contributed to improvements in monitoring? Have AAQ Directives contributed to improvements in public information and public participation? What are the wider economic, social and environmental impacts of the Directives in the Member State/air quality zone?
(11) What has been the EU added value of the AAQ Directives, do the Directives and their means of implementation create synergies or overlaps with other Community objectives, and how has the distribution of responsibilities between EU, Member State, regional and local levels impacted on air quality management?	How is the implementation of the AAQ Directives coordinated in the Member State (division of responsibilities, coordination across different activities)? To what extent is the implementation of AAQ Directives coordinated in the region (to address transboundary pollution)?

APPENDIX D AREAS OF AIR QUALITY MANAGEMENT

Table 4-1 Areas of air quality management (2016)

Agglomeration/Zone	The are of air quality management	Pollutant	Area (km²)	Amount of inhabitants
BRATISLAVA	The area of the capital city Bratislava	PM_{10}, NO^2, BaP	368	425 923
KOŠICE Košice region	The areas of the city Košice and municipalities Bočiar, Haniska, Sokoľany, Veľká Ida	PM_{10}, BaP	302	245 873
Banskobystrice region	The area of the city Banská Bystrica	PM_{10}	103	78 735
	The area of the city Jelšava and municipalities Lubeník, Chyžné, Magnezitovce, Mokrá Lúka, Revúcka Lehota	PM_{10}, $PM_{2,5}$	109	6 647
Košice region	The area of the city Krompachy	PM_{10}, $PM_{2,5}$, BaP	23	8 848
Prešov region	The area of the city Prešov and municipality Ľubotice	PM_{10}, NO^2	79	92 892
Trenčian region	The area of the city Prievidza	BaP	43	46 830
	Municipality Bystričany	PM_{10}	38	1 791
	The area of the city Trenčín	PM_{10}	82	55 593
Trnava region	The area of the city Trnava	NO^2, BaP	72	65 536
Žilina region	The area of the city Ružomberok and municipality Likavka	PM_{10}	145	30 134
	The area of the city Žilina	PM_{10}	80	81 041

Source: SHMÚ, Hodnotenie kvality ovzdušia v Slovenskej republike (Evaluation of Air Quality), 2016.

APPENDIX E EXTRACT FROM REPORTING (DATAFLOW G)

Table E-1 Number of zones with exceedances

	2013	2014	2015	2016
NO_2	-	1	3	-
PM_{10}	-	1	1	-
SO_2	-	-	-	-
C_6H_6	-	-	-	-
CO	-	-	-	-
Pb	-	-	-	-
O_3	2	1	2	2

Source: Member State reporting, data flow G.

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CASE STUDY REPORT
SPAIN

Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

Written by Marta Ballesteros
March 2019

Contents

Appendices

Appendix A Interview

1 INTRODUCTION

This report summarises the findings and conclusions of the **case study for Spain**. The case study had a focus on the municipality of Madrid.

The report is one of seven case studies carried out for the Fitness Check of the EU Ambient Air Quality Directives. Its main purpose is to examine, in more detail, the situation regarding the experience and lessons learnt in the implementation of the air quality legislation. The case studies provide a basis for a more detailed examination of the questions of the fitness check and include a review of implementation and integration successes and problems, the costs of implementation and of non-implementation of the legislation and the administrative burden of implementation and opportunities for improving implementation without compromising the integrity of the purpose of the Directives. As such, the case study complements the information gathered through other sources, such as desk review, targeted questionnaire, open public consultation, interviews, focus groups and stakeholder workshops.

The Member States for detailed case studies have been selected to cover a range of geographies, governance structures and sizes. This has led to the selection of the following **seven case study Member States: Slovakia, Germany, Spain, Sweden, Ireland, Bulgaria and Italy**.

The case study report is structured in four chapters, namely:

- **Chapter 1 – Introduction**
- **Chapter 2 – Background and context**, presents general information about the context of the case study
- **Chapter 3 – Findings**, presents detailed findings regarding the relevance of the AAQ Directives, the implementation successes and problems, the factors underlying compliance with the Directives, the costs and benefits.
- **Chapter 4 – Conclusions**, presents a summary of the main findings.

The case study findings rely on extensive desk research and a series of interviews that took place over the period September, October and November 2018. An overview of the interviews carried out is provided in Appendix A.

The case study has been shared with the interviewed stakeholders in January 2019 for validation of findings and correction of factual mistakes. Feedback received from the stakeholders was integrated in the case study report.

2 CASE STUDY BACKGROUND

This chapter provides general information about Spain and the municipality of Madrid in relation to air quality and the implementation of the above-mentioned Directives. It relies primarily on desk research, with the intention of establishing the context for the more detailed findings presented in Chapter 3. Where necessary, the findings from desk research were supplemented by interviews.

2.1 Spain and air quality zone characteristics

2.1.1 The scope and focus of the case study

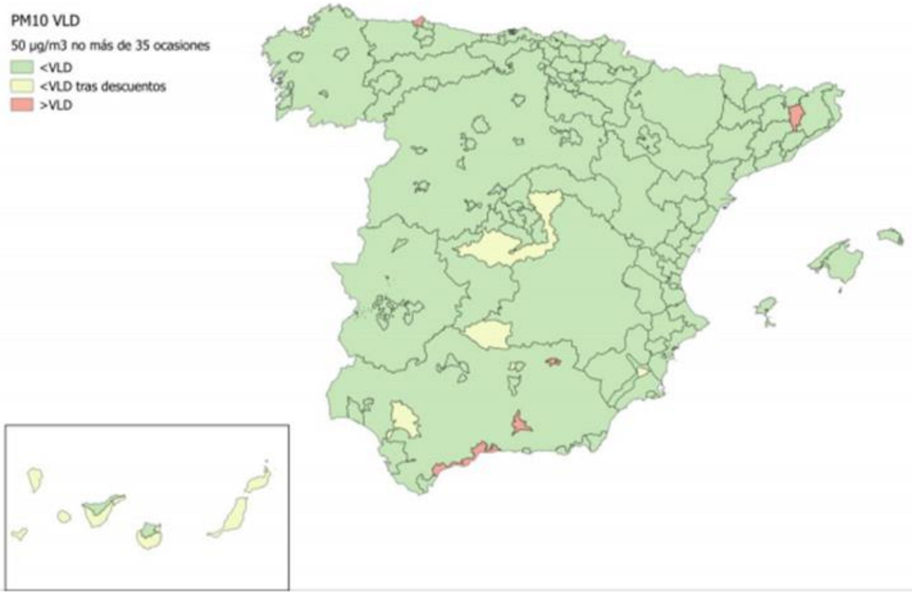
The case study covers the territory of Spain, with a particular focus on the municipality of Madrid.

The responsibility for monitoring and ensuring implementation of the AAQ Directives in Spain rests with the Sub-Directorate General of Air Quality and Industrial Environment of the Ministry of Environment (currently the Ministry for Ecological Transition, MITECO), with data provided by the 17 autonomous communities and certain local entities. As required by Article 4 of Directive 2008/50/EC, zones and agglomerations have been established in the territory of Spain in order to assess air quality and ensure air quality management. Given the division of responsibilities in Spain, each autonomous community has separated its territory into different zones and agglomerations depending on the pollutant (e.g. NO_2 and PM_{10}). Figures 2.1 and 2.2 below show some examples.

Figure 2-1 Air quality zones for NO_2, 2017

Source: MITECO, Report on the Evaluation of Air Quality in Spain, 2017.

Figure 2-2 Air quality zones for PM_{10}, 2017



Source: MITECO, Report on the Evaluation of Air Quality in Spain, 2017.

Each of the zones has a specific number of measurement stations, which vary depending on the existing levels, the type of zone and the population. In the whole territory of Spain there are more than 600 measurement stations[1].

The municipality of Madrid is a zone within the Region of Madrid. With three million inhabitants, Madrid is the most populated city in Spain and one of the most populated capitals in Europe. It welcomes more than two million visitors every day[2]. The municipality of Madrid has its own network of air quality sampling points, distinct to that of the Region. This network covers a population of 3,182,981 inhabitants (6.83% of the Spanish population) and a territory of 604 km (0.12% of the Spanish territory)[3]. This network is the basis of the system for monitoring, predicting and providing information on air quality. It aims to ensure that air quality in the city is controlled in order to protect public health and minimise risk to the greatest extent possible. The system provides information on the concentrations of pollutants continuously and in real time.

According to the preamble of the Protocol for action in case of incidences of pollution caused by NO_2 in the Madrid municipality[4], the alert threshold for NO_2 has never been exceeded in the municipality of Madrid; however, the hourly limit value (which should not be exceeded for more than 18 hours per year in any of the stations within the network) has been exceeded on several occasions and at several of the network's stations.

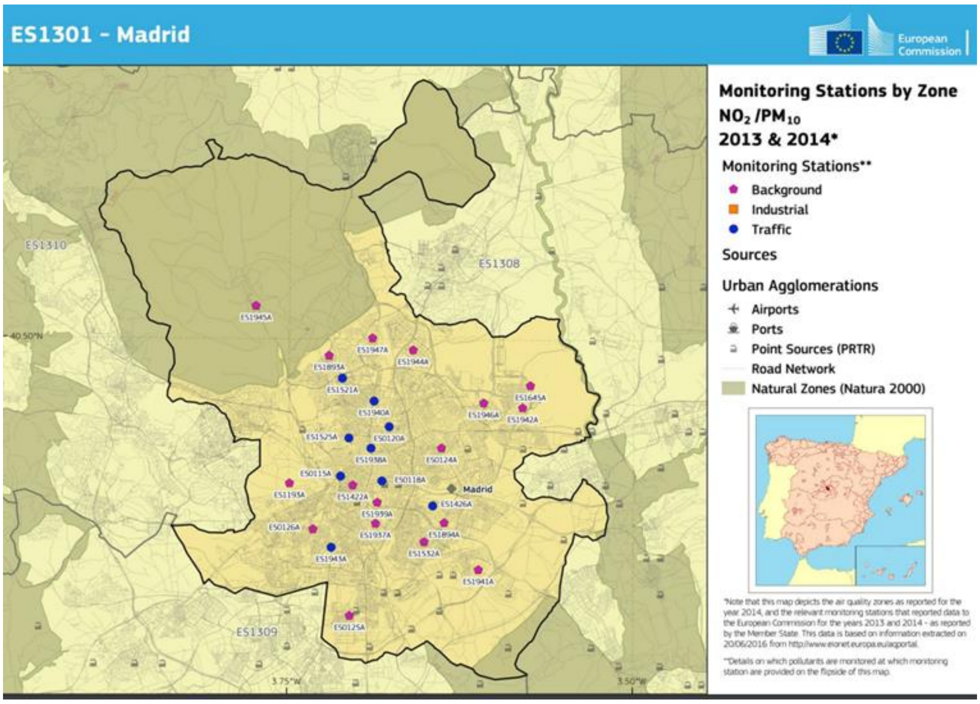
[1] Ministerio para la Transición Ecológica (MITECO), Redes de vigilancia de calidad del aire (Website of the Ministry of Environment, page on air quality monitoring networks), available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/evaluacion-datos/redes/default.aspx

[2] Preamble of the Municipal Ordinance of Sustainable Mobility 2018/45: Ayuntamiento de Madrid, Ordenanza de Movilidad Sostenible, Municipal Ordinance of Sustainable Mobility 2018/45 of 23 October 2018, https://sede.madrid.es/portal/site/tramites/menuitem.5dd4485239c96e10f7a72106a8a409a0/?vgnextoid=5ccdb732cef96610VgnVCM2000001f4a900aRCRD&vgnextchannel=6b3d814231ede410VgnVCM1000000b205a0aRCRD&vgnextfmt=default

[3] Ministerio para la Transición Ecológica, Evaluación de la calidad del aire en España, 20176, available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/informe-evaluacioncalidadaireespana2017_tcm30-481655.pdf

[4] Ayuntamiento de Madrid, Protocolo de actuación para episodios de contaminación por Dióxido de nitrógeno en la ciudad de Madrid, 2018, Available at: https://transparencia.madrid.es/UnidadesDescentralizadas/Sostenibilidad/CalidadAire/Ficheros/ProtocoloNO2AprobFinal_201809.pdf

Figure 2-3 Air quality zone of Madrid (for NO_2 and PM_{10})



2.1.2 Geomorphology

Spain has certain geomorphological specificities which influence its performance on ambient air quality insofar as particles and O_3 are concerned. Spain has always presented high levels of particles, partly due to its situation close to African air mass which triggers a natural increase of PM_{10} and $PM_{2.5}$. As a result, public authorities began to measure and quantify the levels of particles by taking into account the contributions to pollutants in ambient air from these natural sources (African air mass), and to deduct those quantities when assessing compliance with air quality limit values for particles occurring due to human activity[5]. Spain's main sources of particles from human activity are combustion from non-industrial sources (for PM_{10} and $PM_{2.5}$), road traffic (PM_{10}) and agriculture ($PM_{2.5}$). PM_{10} is registered in diverse areas: cities, industrial and rural zones.

Similar to much of southern Europe, O_3 constitutes a widespread general issue in Spain, due to high levels of solar radiation, which affects the entire country, although with markedly lower levels in the North. The speed and level of generation of ozone (O_3) are magnified by increased solar radiation, human emissions of precursors and the biological cycle of biogenic emissions of volatile organic compounds (VOCs). Levels of O_3 are higher in spring and summer. They are also higher at the peripheries of large cities, in rural areas and at weekends, especially on Sundays.

The city of Madrid has a continental Mediterranean climate, characterised by an average temperature (at its hottest) above 22ºC, dry and fresh winters (with average temperatures around 8º C) and average minimums between 1.6 and 4.2ºC in the different seasons. The average annual temperature exceeds 14ºC. The summers are very hot, with average highs above 30ºC. There is little rainfall annually, typically less than 500 mm per year, falling mainly in spring and

[5] Ministerio de Agricultura, Alimentación y Medio Ambiente, Procedimiento para la identificación de episodios naturales de PM10 y PM2,5, Y la demostración de causa en lo referente a las superaciones del valor límite diario de PM10, 2013. Available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/metodologiaparaepisodiosnaturales-revabril2013_tcm30-186522.pdf; Ministerio para la Transición Ecológica, Efectos en la salud y ecosistemas (Website of the Ministry of Environment, page on health and ecosystem impacts), available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/salud/

autumn, with a markedly dry period in summer. Snow days are scarce (average of four per year). Frost is more common in winter and autumn, reaching a very different average according to the different seasons. This is due to the heat island effect produced by the city itself (i.e. the high intensity of traffic and heating)[6].

The surface of the municipality is characterised by soft forms, in which hills and plains alternate, with an altitude oscillating between 543 and 846 metres as it is located in a plain. The rock face gives erosion different characteristics, ranging from the sharper slopes in the north to the milder forms in the south. From a topographical perspective the Manzanares River fractures the municipality, with its corresponding alluvial plain and fluvial terraces. The presence of the mountainous relief of the Sierra de Guadarrama, has a very important influence on the climate of Madrid. It exerts a barrier effect which prevents clouds and humid winds from advancing towards the interior, making rainfall (and precipitation generally) more scarce in the city[7]. In addition, buildings and pavements modify the relief and influence the climate (together with traffic and heating), creating the recognised climatic effect of a 'heat island', i.e. an abnormal increase in temperature from the outskirts to the centre of the city, caused by the heat given off by urban activity. The asphalt accumulates a lot of heat during the day and gives off that heat at night, preventing the city from cooling normally[8].

The detailed characteristics of Spain and the municipality of Madrid are presented in the text box below.

Text box 2-1 Spain and Madrid

Spain	
GDP per capita in PPS (EU-28 avg: 100) (2017)	92
GDP per capita growth (% 2008-2016)	-2.46%
Population (1 January 2018)	46.7 million
Governance structure	Regionalised[9]
Zones defined as agglomerations (%)	Information not found/not available
Autonomous community of Madrid	
Number of inhabitants:	6,507,184
GDP per capita in PPS (EU-28 avg: 100) (2017)	125
Area:	8,028 km²
Characteristics of the Madrid region: The autonomous community of Madrid is divided into six zones for air quality monitoring. One such zone is the municipality of Madrid, which has its own monitoring network independent from that of the autonomous	

[7] Ayuntamiento de Madrid, Plan de Calidad del Aire y Cambio Climático de la Ciudad de Madrid, 2017. Available at: https://www.madrid.es/UnidadesDescentralizadas/UDCMedios/noticias/2017/03Marzo/13Lunes/NotasdePrensa/Plan%20Calidad%20Aire/ficheros/PlanACalidadAire2017.pdf
[8] Ayuntamiento de Madrid, Plan de Calidad del Aire y Cambio Climático de la Ciudad de Madrid, 2017. Available at: https://www.madrid.es/UnidadesDescentralizadas/UDCMedios/noticias/2017/03Marzo/13Lunes/NotasdePrensa/Plan%20Calidad%20Aire/ficheros/PlanACalidadAire2017.pdf
[9] For further details see: Committee of the Regions, https://portal.cor.europa.eu/divisionpowers/countries/MembersLP/Spain/Pages/default.aspx

community (as explained further below). Madrid is the most populous city in Spain, with 3,182,981 inhabitants in an area of 604 km^2.

Source: Eurostat, GDP per capita in Purchasing Power Standards (PPS) expressed in relation to the EU-28 average (set to equal 100); Eurostat, Real GDP per capita, growth rate and totals; Eurostat, Population on 1 January; INE, Statistics on population in Spain.

2.2 *Air quality monitoring and air quality*

The following section presents briefly the arrangements made in Spain for air quality monitoring and provides a short overview of the air quality situation in Spain.

2.2.1 *Air quality monitoring*

Spain uses different control and monitoring air quality networks, managed by different competent authorities. All 17 autonomous communities and, specifically, the municipalities of Madrid and Saragossa, have their own networks to monitor the main pollutants. In addition, there is a national network (the EMEP/VAG/CAMP network), which monitors the background air quality in remote rural areas[10]. Spain has more than 600 fixed measurement stations[11].

Each network divides its territory into zones and monitors the concentrations of certain pollutants in the air. When any of the pollutants is at risk of exceeding one or more alert thresholds, the network develops a short-term action plan. Networks are also responsible for drafting Air Quality Plans to keep pollutants below the limit values or target values. Data gathered by the networks are sent to MITECO, which manages and maintains the Air Quality Database, develops national plans to improve air quality, compiles annual reports on air quality, and sends data to the European Environmental Agency (EEA)[12].

The methodology used to monitor air quality follows the AAQ Directives and is based on the information collected by each network according to common criteria relating to the size of agglomerations and ecosystems exposed to air pollution[13]. Based on these data, the competent administrations divide their territory into zones or agglomerations according to population density[14]:

- The zones are portions of territory defined by the competent administration and used for the evaluation and management of ambient air quality.
- The agglomerations are defined as extended urban areas of population with more than 250,000 inhabitants or, where the population is equal to or less than 250,000 inhabitants, with a population density per km^2 that, according to the competent administration, justifies the evaluation and control of ambient air quality.

The autonomous communities and local entities define their corresponding zones and agglomerations based on homogenous criteria for emissions and concentrations of pollutants. The zoning

[10] Ministerio para la Transición Ecológica, Evaluacion de la calidad del aire in España, año 2017 https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/informe-evaluacioncalidadaireespana2017_tcm30-481655.pdf
[11] Ministerio para la Transición Ecológica, Redes de vigilancia de calidad del aire (Website of the Ministry of Environment, page on air quality monitoring networks), available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/evaluacion-datos/redes/
[12] Ministerio para la Transición Ecológica, Evaluacion de la calidad del aire in España, año 2017. https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/informeevaluacioncalidadaireespana2017_tcm30-481655.pdf
[13] Ibid
[14] Ibid

of the Spanish territory depends on the pollutant, thus each pollutant has its own zoning map. The zoning is carried out as follows:

- For all of the pollutants evaluated (except for ozone), zoning is carried out in accordance with the upper and lower assessment thresholds as established in Annex II of Royal Decree 102/2011, of 28 January, which transposes both Directives 2004/107/EC and 2008/50/EC. These thresholds are set to guarantee the equivalence of the evaluation of ambient air quality, regardless of the territorial scope considered.

- For O_3, zoning is carried out in relation to the long-term objective value also established by Royal Decree 102/2011 of 28 January

Values in the Royal Decree are the same as those in the Directives it transposes.

The zoning may undergo modifications over time depending on the evolution of legislation on the levels of pollutants. Ambient air quality is evaluated using the information provided by the different air quality networks, in line with the following criteria:

- Evaluation for all pollutants, with the exception of O_3

Measurements of these pollutants are first carried out in the ambient air, in fixed places in those zones and agglomerations where the levels exceed the upper evaluation thresholds. Fixed measurements may be complemented with modelling or indicative measurements to obtain adequate information on the spatial distribution of ambient air quality.

In those areas and agglomerations where the level of pollutants is below the lower evaluation threshold, modelling techniques for the evaluation of the ambient air quality can be used without the need to carry out fixed measurements.

- O_3 evaluation:

In the case of O_3, it is mandatory to carry out continuous fixed measurements in areas and agglomerations in which O_3 concentrations exceeded a long-term objective during any of the previous five years.

Where data are available for a period of less than five years, the competent authorities complete the data with short-term measurement campaigns in the periods and places where the probability of observing high levels of contamination is high, in accordance with the results obtained from emissions inventories and modelling.

In the remaining zones and agglomerations, continuous fixed measurements can be supplemented with information from modelling and/or indicative measurements.

- Determination of the classification of the area with respect to the legislated values:

The classification of an area with respect to the legislated values for all pollutants is determined by the situation of the worst station or the highest levels of a model.

Monitoring stations for air pollution can be classified according to the type of area in which they are located (i.e. urban, suburban and rural) or according to the typology of the main emissions source, which determines predominant pollutants (e.g. traffic, industrial or background).

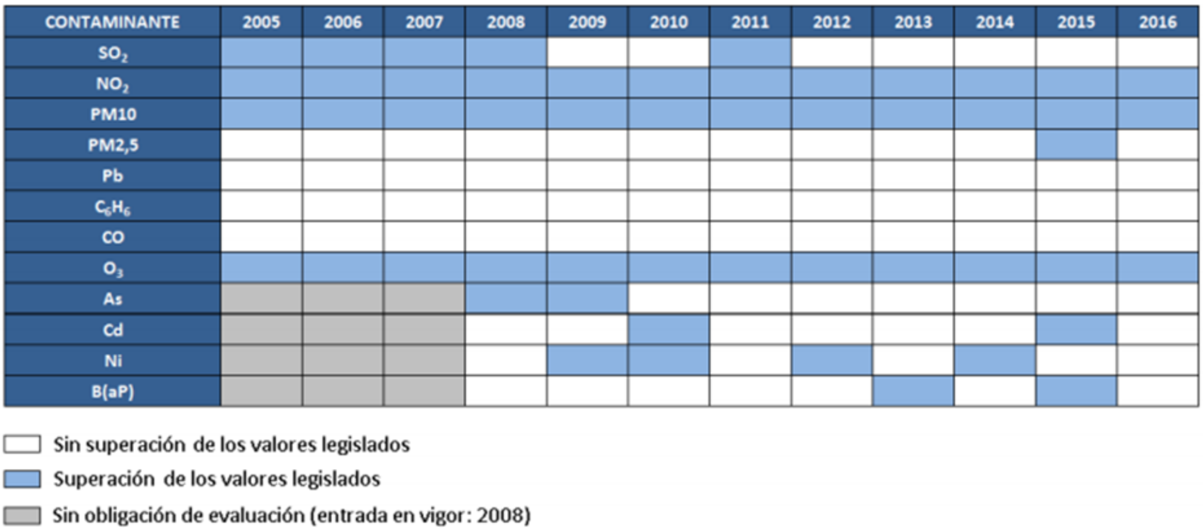
The **municipality of Madrid** has in place the so-called Integral System of Air Quality, which provides information on the level of air pollution in its territory at any time. The system is composed by three sub-systems (for monitoring, prediction and information)[15]:

- Monitoring system: composed by 24 automatic remote stations that measure the levels of pollutants (gases and particles). There are three types of stations: background urban stations, traffic stations and sub-urban stations (depending on the location). The system also disposes of monitoring mobile units for specific measuring campaigns.
- Prediction system: it provides information on the evolution of the levels of air quality and generates a hourly prediction of the concentrations of nitrogen, ozone and particles PM10 for the next 24 hours.
- Information system: provides information on air quality to the public.

2.2.2 Air quality in Spain

The data provided below (for the period 2005-2016) were included within the report on the National Plan for Air Quality 2017-2019 (Plan Aire II)[16] and can also be found in the latest national report on air quality with data from 2017[17]. It shows an improvement of the situation on SO_2. Of all pollutants, three (**NO_2, PM_{10} and O_3**) have exceeded the established legal value in all years during the period 2005-2016, and in 2017. In other cases, the exceedance of the value occurred at a particular point in time (see Figure 2-4).

Figure 2-4 Exceedances of legal values in Spain (2005-2016)



Source: MITECO, Plan Nacional de Calidad del AIRE 2017-2019 (Plan Aire II).

[15] Ayuntamiento de Madrid, Plan de Calidad del Aire y Cambio Climático de la Ciudad de Madrid, 2017. Available at: https://www.madrid.es/UnidadesDescentralizadas/UDCMedios/noticias/2017/03Marzo/13Lunes/NotasdePrensa/Plan%20Calidad%20Aire/ficheros/PlanACalidadAire2017.pdf
[16] Ministerio para la Transición Ecológica, Plan Nacional de Calidad del AIRE 2017-2019 (Plan Aire II), 2017. Available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/planaire2017-2019_tcm30-436347.pdf
[17] Ministerio para la Transición Ecológica, Evaluación de la calidad del aire en España: Año 2017, Available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/informeevaluacioncalidadaireespana2017_tcm30-481655.pdf

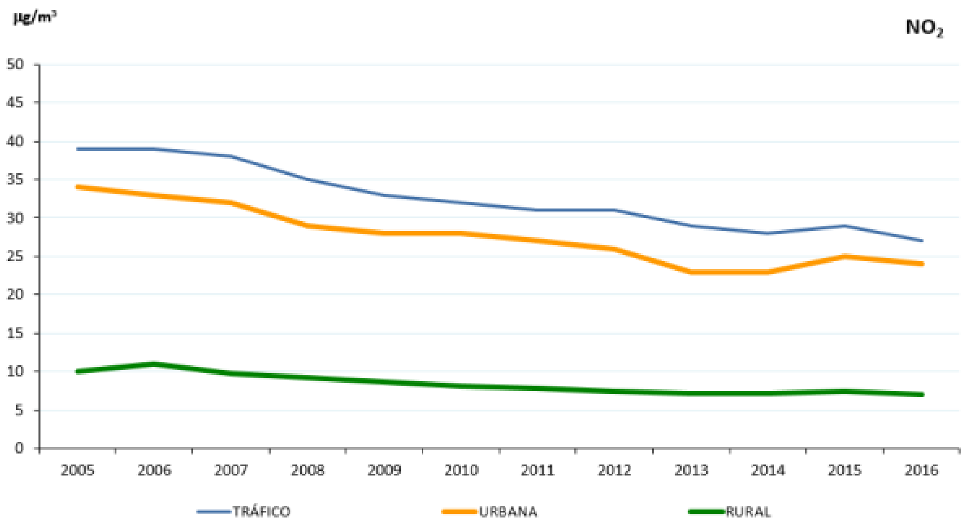
Further, the analysis of the period 2012-2016 shows that the average concentrations of the pollutants in question (SO_2, NO_2, PM_{10}, $PM_{2,5}$, O_3) decreased between 2012 and 2014, increased in 2015 and decreased again in 2016[18].

According to the 2017 Evaluation Report on Air Quality in Spain (published in September 2018), the 2017 results are worse than those of 2016, as the number of air quality zones exceeding the legislated values for NO_2 and PM_{10} increased[19]. For NO_2, the number of urban agglomerations that exceeded the legislated values increased. More specifically, in 2017, the hourly limit value was exceeded in the same area of Madrid as it was in the previous year. In addition, exceedances occurred in large cities such as Madrid and surroundings, Barcelona and surroundings, Granada and its metropolitan area, and Bilbao and its surroundings, largely due to traffic emissions[20].

Per pollutant, the evolution of **NO_2** in the period 2005-2016 shows a continuous decrease in all type of stations (traffic, urban and rural) with a small rise in each in 2015. NO_x is known to be the sum of $NO+NO_2$. The main source of this pollutant is transport, which represents more than 50% of the total NO_x emissions. The levels of NO_2 have continuously decreased since 2005, with a small rise in 2015.

In 2017, **the hourly limit value of NO_2** was exceeded only in Madrid (similar to previous years), while the **NO_2 annual limit value** was exceeded in seven zones (compared to six in 2016): Bajo Nervión (Basque Country), Barcelona and Vallès-Baix Llobregat (Catalonia), Corredor del Henares and Urbana Sur (in the community of Madrid), Granada and its metropolitan area (in Andalusia), and in the municipality of Madrid.

Figure 2-5 Annual mean NO_2 level, 2005-2016, by type of station and area



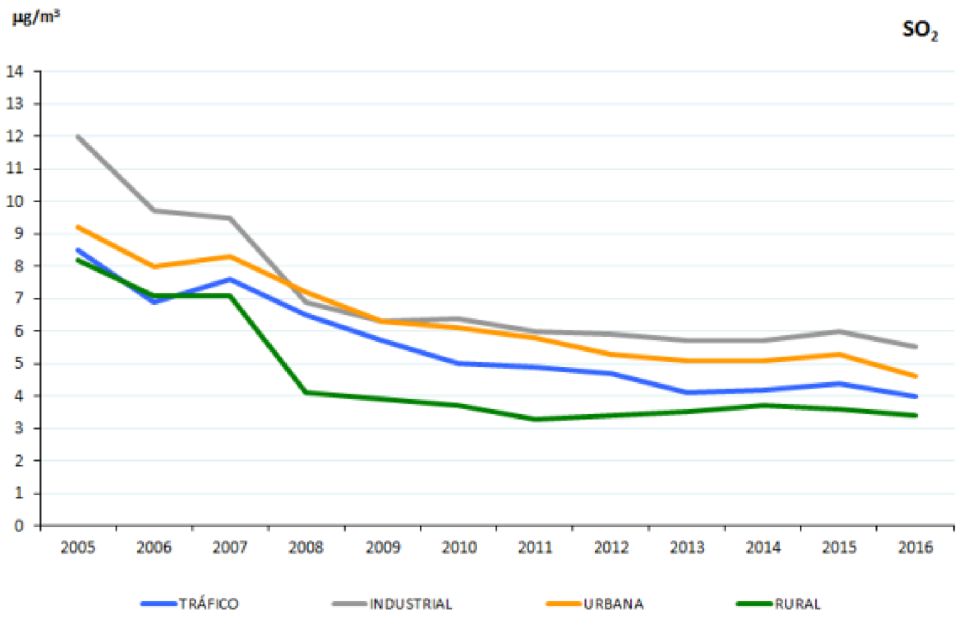
Source: MITECO, Plan Nacional de Calidad del AIRE 2017-2019 (Plan Aire II).

A similar trend of decrease is evident for levels of **SO_2** in the period 2005-2016. In 2015, the main source of such emissions was energy production, followed by industrial processes using combustion. Between 2011 and 2017, limit values were not exceeded in any zone. The exceeding

[18] Ministerio para la Transición Ecológica, Plan Nacional de Calidad del AIRE 2017-2019 (Plan Aire II), 2017. available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/planaire2017-2019_tcm30-436347.pdf
[19] Ministerio para la Transición Ecológica, La calidad del aire en España en 2017 baja levemente con respecto al año anterior (webpage). Available at: https://www.miteco.gob.es/es/prensa/ultimas-noticias/La-calidad-del-aire-en-Espa%C3%B1a-en-2017-baja-levemente-con-respecto-al-a%C3%B1o-anterior/tcm:30-481677
[20] *Idem.*

emissions before 2012 came mainly from industrial stations in rural areas. However, this is no longer a problem. The link with the Industrial Emissions Directive has been positive and the best available techniques references (BREF) are ambitious. It is worth noting the particular problem in Asturias, where a station has been placed inside an industrial facility and the problems of exceedances of the SO_2 limit values continued for 10 years. The Directive does not permit a station to be moved for three years from the time a limit value has been exceeded. Having explained this case to the Commission, however, Spain is set to move the station[21].

Figure 2-6 Annual mean of SO_2 level 2005-2016, by type of station and area



Source: MITECO, Plan Nacional de Calidad del AIRE 2017-2019 (Plan Aire II).

Levels of **PM_{10}** have progressively decreased since 2005. However, the situation changed in 2014, which noted an increase until 2016, at which time values were again similar to those of 2013 (the minimum in the period). The sources of emissions chiefly related to combustion in non-industrial sectors (especially residential combustion), as well as agriculture and the cattle industry. The daily and annual values of PM_{10} exceeded the limits in 19 zones at some point during the period 2012-2016.

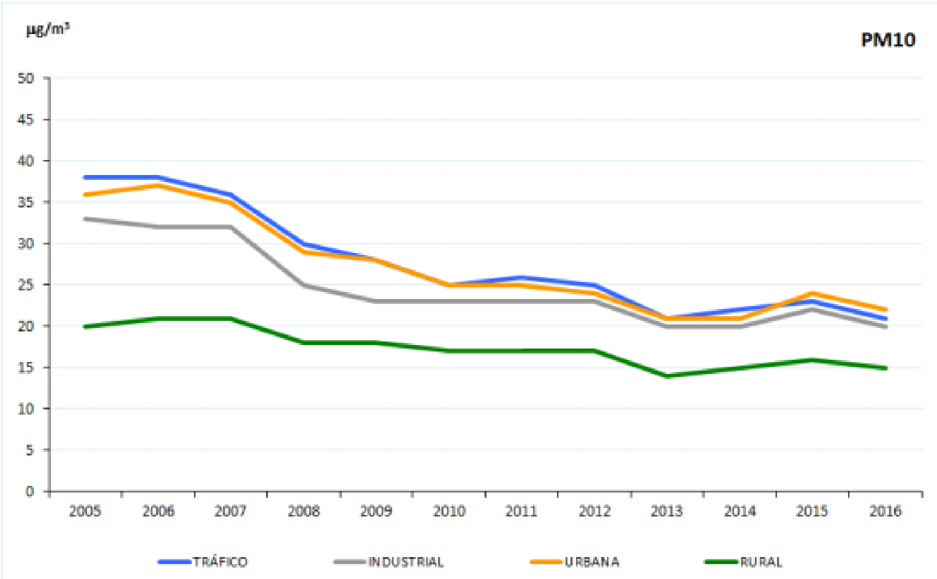
In 2017, the **PM_{10} daily limit value** (excluding particles of natural origin) was exceeded in five zones, while the **annual limit value** was exceeded in one single zone. This evidences an increase in the number of areas exceeding the daily limit value, which has gone from three areas in 2016 to five in 2017: Granada and the Metropolitan Area, Malaga and Costa del Sol, Villanueva del Arzobispo, Avilés, and Plana de Vic. The **PM_{10} annual limit value** evaluation data indicate that the situation remains similar to previous years with Avilés as the single zone which continues to show exceedances[22].

It is worth mentioning the case of Villanueva del Arzobispo, which, according to the information collected within the framework of this project, is an area with industrial production (Jaen, olive groves) where biomass is regularly burned. Although the problem of emissions from industrial activity was solved by changing the means of energy production and the use of filters for smoke

[21] Information from the interview with the Ministry of Environment, 24 September 2018.
[22] Ministerio para la Transición Ecológica, La calidad del aire en España en 2017 baja levemente con respecto al año anterior (webpage). Available at: https://www.miteco.gob.es/es/prensa/ultimas-noticias/La-calidad-del-aire-en-Espa%C3%B1a-en-2017-baja-levemente-con-respecto-al-a%C3%B1o-anterior/tcm:30-481677

treatment, the boom in domestic biomass burning has created a new, more complex problem. The lack of prioritisation of gas distribution at local level saw gas arrive to the village of Villanueva del Arzobispo only in 2018. Up until now, the use of biomass has been promoted without ensuring the use of certified efficient stoves or boilers, resulting in air quality problems. The Ministry of Industry has now approved subsidies to support behavioural change in homes[23].

Figure 2-7 Annual mean of PM_{10} level 2005-2016, by type of station and area

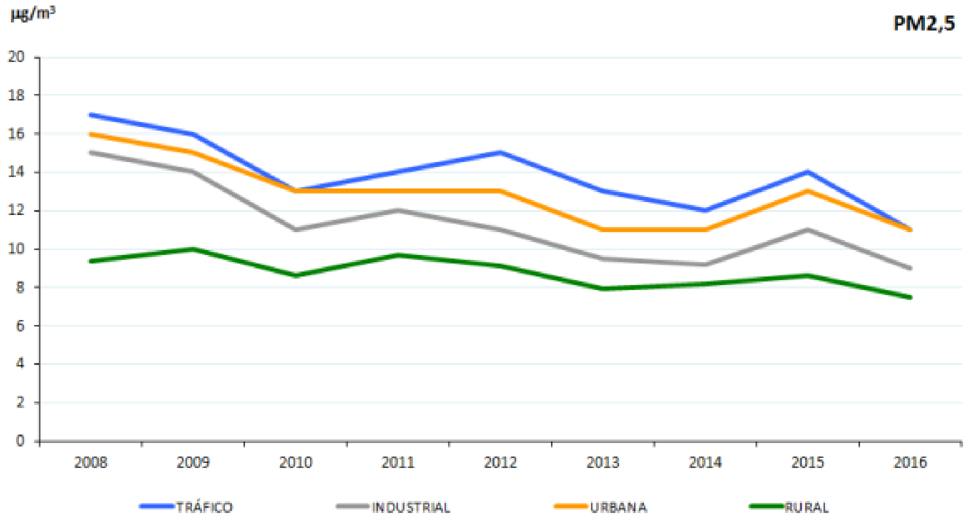


Source: MITECO, Plan Nacional de Calidad del AIRE 2017-2019 (Plan Aire II).

The general levels of **$PM_{2.5}$** have been also reduced, despite some increases in 2011, 2012 and 2015. The biggest source of pollution was combustion in non-industrial sectors, at more than 60% of the total. The number of areas exceeding the limit was considerably reduced in 2016.The limit value of $PM_{2.5}$ (which entered into force in 2015) was exceeded that year (before it was a target value but was not exceeded) but the situation reverted to normal in 2016. In 2017, the annual limit value had good results after applying the new methodology (excluding particles of natural origin). The objective is to reduce this particle by 15% by 2020, compared to the value in 2010. However, in 2017 the results were slightly worse than the previous year (9.9% reduction in 2017, compared to 12.1% in 2016).

[23] Information from the interview with the Ministry of Environment, 24 September 2018.

Figure 2-8 Annual mean of $PM_{2.5}$, 2008-2016, by type of station and area



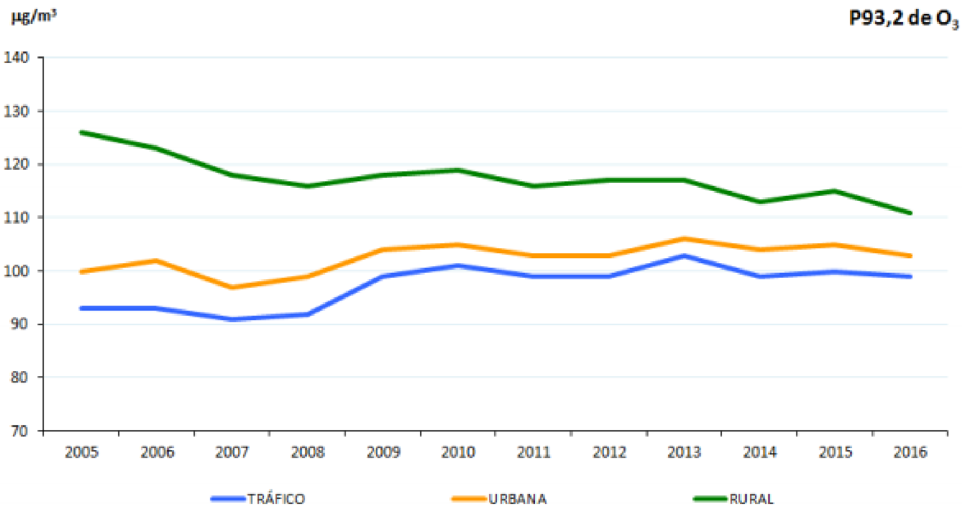
Source: MITECO, Plan Nacional de Calidad del AIRE 2017-2019 (Plan Aire II).

O_3 values were reduced in rural stations, reaching the minimum in 2016, but increased continuously in traffic and urban stations (despite a decrease in 2016). O_3 is a secondary pollutant formed through photochemical reactions from precursor gases. The speed and level of formation of O_3 is influenced by solar radiation, making it a widespread general issue in Spain. In 2015, the main sources of emissions were related to the use of solvents and agriculture.

In 2017, of Spain's 126 zones measuring this pollutant, **36 zones (Southern part of the peninsula) reported values higher than the target value**, 78 showed values between the target value and the long-term target, while 12 reported values below the long-term target.

The annual reports prepared by the Ministry also contain information on the levels of other pollutants: benzo(a)pyrene (B(a)P), carbon monoxide (CO), lead (Pb), benzene (C6H6), arsenic (As), cadmium (Cd) and nickel (Ni). Target or limit values of these pollutants were not exceeded in any zone in 2017. Royal Decree 102/2011 also requires all agglomerations of more than 500,000 inhabitants to ensure measuring ammonia (NH_3), despite not been covered by the Ambient Air Quality Directives.

Figure 2-9 Annual mean of the 93.2 percentiles of O_3, by type of station and area



Source: MITECO, Plan Nacional de Calidad del AIRE 2017-2019 (Plan Aire II).

2.2.3 Air quality in Madrid

The data trend for NO_x by activity sector since 1999 shows that road transport has the biggest impact on NO_x emissions. However, emissions have diminished from 19,226 tonnes in 1999 to 7,012 tonnes in 2014[24].

Statistics on SO_2 emissions show a general drop for all activity sectors, largely caused by a reduction in the sulphur content of fuels and the reduction in the consumption of coal and fuel oil. Again, the sharpest decline occurred in the road transport sector (down from 1,136 tonnes in 1999 to 14 tonnes per year between 2012 and 2014).

A drop is also evident in non-methane volatile organic compounds (NMVOC) during the period 1999-2014. These are found in solvents and other products, as well as emissions from nature.

Road transport emissions of carbon monoxide (CO) represent more than half of CO emissions. They have dropped very significantly, from 90,200 tonnes in 1999 to 6,234 tonnes in 2014. A similar trend is found when analysing the levels of particles (PM_{10} and $PM_{2.5}$), with road transport again the primary source, responsible for 61.3% and 55% of the totals, respectively.

The 2017 national report on air quality[25] includes a section on the municipality of Madrid, which shows that the hourly and annual limit values for NO_2 and the target value for O_3 were exceeded, being the only zone with exceedances in the terms of the hourly limit value for NO_2 and therefore on the three values at the same time. Road transport is the main cause of the NO_2 levels. During the period analysed in the report (2011-2017), there were constant breaches of the limit values for NO_2 and the target value of O_3.

[24] Ayuntamiento de Madrid, Plan de Calidad del Aire y Cambio Climático de la Ciudad de Madrid, 2017. Available at: https://www.madrid.es/UnidadesDescentralizadas/UDCMedios/noticias/2017/03Marzo/13Lunes/NotasdePrensa/Plan%20Calidad%20Aire/ficheros/PlanACalidadAire2017.pdf

[25] Information from the interview with the Madrid municipality, 21 September 2018 and with the Ministry of Environment, 24 September 2018. And Ministerio para la Transición Ecológica, Evaluación de la calidad del aire en España: Año 2017, Available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/informeevaluacioncalidadaireespana2017_tcm30-481655.pdf

The municipality of Madrid also publishes annual reports. The latest from 2017[26], shows that values for SO_2 were very low in all stations. The same was true of PM_{10} and $PM_{2.5}$, whose limit values were kept below those set out in the AAQ Directives. However, some stations exceeded the guide value established by the World Health Organization (WHO).

Clean air dialogue

In October 2018, the Commission held a Clean Air Dialogue with Spain[27], at which it was concluded that good governance including better coordination among the different administrations and different ministries is essential to improve the clean air policy.. The Commission urged Spain to implement measures to ensure better coordination and thereby improve policies and maximise benefits. In addition, the involvement of the stakeholders concerned and transparency are key to ensure effective implementation of mitigation measures and public acceptance. Additional actions to comply with NO_2 limit values such as those demonstrated in other Member States, should be considered in Spain, e.g. access restrictions for transport, fiscal incentives to promote cleaner cars, or incentives to promote public transportation and non-motorized transport opportunities. The current imbalance in taxation between petrol and diesel is not justified from an environmental perspective[28].

Further action is needed in order to meet PM_{10} limit values and achieve the reduction commitments for $PM_{2.5}$ in all Spanish regions. Such actions could include: establishing requirements on the quality of solid fuels used in households; further incentives to accelerate scrapping of substandard solid fuel stoves and boilers and promoting systematic transfer to cleaner heating sources; continuous awareness-raising among the public of the health impact of residential solid fuel combustion and operation techniques in private households; and activities on energy efficiency. A ban on open field burning of agricultural waste was also raised, together with the promotion of policies on energy renovation of buildings. Due to the cross-cutting nature of air quality, efforts in this area can be included in both climate and energy-related policies[29].

Finally, the dialogue highlighted the need to reduce NH_3 emissions, for which agricultural activity is the key source. Experiences from other Member States could be applied in Spain. O_3 values are also an important issue in Spain and some effort has already been expended in improving knowledge to create more targeted policy responses.

2.3 Allocation of responsibility

Pursuant to Article 3 of the AAQ Directives, Member States shall designate – at the appropriate levels - the competent authorities and bodies responsible for the assessment of ambient air quality and the implementation of other obligations laid down by the AAQ Directives.

In Spain, Article 5 of Law 34/2007 of 15 November on air quality and the protection of the atmosphere makes a list of the competences attributed to the administrations of the state, the

[26] Madrid, Dirección General de Sostenibilidad y Control Ambiental, Calidad del Aire 2017, available at: http://www.mambiente.munimadrid.es/opencms/export/sites/default/calaire/Anexos/Memorias/Memoria2017.pdf

[27] European Commission and Ministerio para la Transición Ecológica, Conclusions of the Clean Air Dialogue between Spain and the European Commission, taking place in Madrid on 8-9 October 2018, October 2018. Available at: http://ec.europa.eu/environment/air/pdf/shared conclusions from clean air dialogue w Spain.pdf

[28] European Commission and Ministerio para la Transición Ecológica, Conclusions of the Clean Air Dialogue between Spain the European Commission taking place in Madrid on 8 – 9 October 2018, October 2018. Available at: http://ec.europa.eu/environment/air/pdf/shared conclusions from clean air dialogue w Spain.pdf

[29] Ibid

autonomous communities and local entities. Article 3 of Royal Decree 102/2011 on the improvement of air quality further specifies the responsibilities of different institutions. According to these provisions, the administration of the state (generally MITECO through its Directorate-General on Environmental Quality and Evaluation), alone or with the participation of the autonomous communities, is charged with, among other tasks: defining and establishing the air quality objectives, the alert and information thresholds and the emission limit values; defining the minimum requirements for stations, networks, methods and other systems; defining methodologies; preparing plans and programmes; preparing and periodically updating the Spanish emissions inventories; and coordinating the Spanish system of information, monitoring and prevention of air pollution.

The State Meteorological Agency (attached to the Ministry of Environment) is responsible for the management of the EMEP/VAG/CAMP network of air pollution and for implementing a quality control and quality assurance system for guaranteeing the results of the network.

The National Centre for Environmental Health of the Carlos III Health Institute, under the Ministry of Economy, Industry and Competitiveness, acts as a national reference laboratory.

The autonomous communities – and local entities where appropriate – are competent to assess air quality, establish stricter air quality targets and limit values than those established by the state, adopt air quality improvement plans and programmes, adopt control and inspection measures, and impose sanctions. To discharge these responsibilities they need to: designate competent bodies, laboratories, institutes and technical-scientific bodies responsible for the application of the standards on ambient air quality; delimit and classify zones and agglomerations; compile data on their territories; adopt measures to ensure that concentrations of regulated pollutants do not exceed the air quality objectives and to reduce them if necessary, including by taking emergency measures; and approve the measurement systems, consisting of methods, equipment, networks and stations.

In the case of the region of Madrid, two administrative entities are competent for these functions, the autonomous community, through its Department of Air Quality within the Ministry of Environment of the Region, and the municipality of Madrid, which has its own control and monitoring air quality network, separate to that of the autonomous community. Article 6 of the Autonomous Statute of the Community of Madrid states that Madrid will have its own special regime due to its position as capital of the state.

Within the municipality of Madrid, the Department of Environment and Mobility is responsible for ambient air quality. The municipality has in place the so-called Integral System of Air Quality, which allows it to know the level of air pollution in its territory at any given time. The system comprises three sub-systems (for monitoring, prediction and information)[30]. They lead to important measures such as the development of a map of the monitoring network which provides information on the concentration levels per station, date and time[31].

2.4 Legal and policy framework and air quality measures

Legal framework

The legal framework for air quality in Spain is composed of Law 34/2007 of 15 November on air quality and the protection of the atmosphere, and Royal Decree 102/2011 on the improvement

[30] Ayuntamiento de Madrid, Plan de Calidad del Aire y Cambio Climático de la Ciudad de Madrid, 2017. Available at: https://www.madrid.es/UnidadesDescentralizadas/UDCMedios/noticias/2017/03Marzo/13Lunes/NotasdePrensa/Plan%20Calidad%20Aire/ficheros/PlanACalidadAire2017.pdf, p. 37
[31] Idem

of air quality. In addition, Articles 99 and 100 of Law 2/2011 of Sustainable Economy establish the principles and objectives of a policy on sustainable mobility.

Law 34/2007 provides the legal basis for the prevention, monitoring and reduction of air pollution in Spain. Its ultimate goal is to achieve optimal levels of air quality to prevent or reduce the potential negative effects of air pollution on human health, the environment and other goods of any nature. Through the Law, the Central government exercises its competence to define and establish air quality objectives and the minimum requirements of air quality assessment systems, and it also serves as a regulatory framework for the preparation of national, regional and local plans for the improvement of air quality. It sets out a system for the management and evaluation of air quality based on air quality objectives and the zoned territory, prevention and control of emissions, planning and public participation, incentives, inspections and monitoring through networks of monitoring stations, and an enforcement policy with infringement and sanctions.

Royal Decree 102/2011 transposes the AAQ Directives (2008/50/EC and 2004/107/EC). It was amended by Royal Decree 678/2014 to update the carbon sulphide quality objectives, and again by Royal Decree 39/2017 to transpose Directive 2015/1480 into Spanish law, which establishes standards for reference methods, data validation and location of measurement points for the evaluation of ambient air quality, and incorporating the new requirements for exchange of information set out in Decision 2011/850/EU.

At a municipal level, the Madrid government updated the regulatory framework from 2005[32] and adopted a new Municipal Ordinance for Sustainable Mobility[33] in 2018. The main objective of this Ordinance is to regulate certain activities to ensure the protection of human health through the substantial improvement of air quality. Together with Law 34/2007, the Royal Decree provides the legal framework to develop Plan A for Air Quality and Climate Change, published in the official journal of 26 September 2017[34]. It also aims to influence environmental sustainability through the promotion of public transport and the use of collective public transport, pedestrian and cyclist mobility, the development of electric mobility, less polluting mobility and shared-use vehicles, and to better rationalise the different uses of urban public roads and spaces, including parking space both on the surface and in municipal car parks. It introduces the use of an environmental classification for cars, developed by the State General Directorate of Traffic as a tool to manage sustainable mobility based on environmental criteria and promoting the use of less polluting cars.

The new Ordinance thus introduces measures that were not in place previously, such as the general obligation for cars and motorbikes to circulate at 30 km/h maximum unless the streets have several lanes in each direction (e.g. in large avenues) or multiple lanes in a single direction. The cycle lanes in the main avenues remain as before, i.e. lanes marked horizontally with bicycle symbols and limited to 30 km/h.

The new Ordinance only allows scooters without engines on footpaths provided that they do not exceed 50hm/h (those with engines are forbidden on footpaths in all cases). It also introduces a

[32] Ayuntamiento de Madrid Municipal Ordinance for mobility in Madrid of 2005 (ANM 2005/48), available at: https://www.madrid.es/UnidadesDescentralizadas/UDCMovilidadTransportes/SER/Ficheros%20nuevo%20SER%202014/Ordenanza%20de%20Movilidad.pdf

[33] Ayuntamiento de Madrid, Ordenanza de Movilidad Sostenible, Municipal Ordinance of Sustainable Mobility 2018/45 of 23 October 2018, https://sede.madrid.es/portal/site/tramites/menuitem.5dd4485239c96e10f7a72106a8a409a0/?vgnextoid=5ccdb732cef96610VgnVCM2000001f4a900aRCRD&vgnextchannel=6b3d814231ede410VgnVCM1000000b205a0aRCRD&vgnextfmt=default

[34] Ayuntamiento de Madrid, BOAM 7999 26 September 2017, available at: **Error! Hyperlink reference not valid.**https://sede.madrid.es/portal/site/tramites/menuitem.b4c91589e7f6a5d829da39e5a8a409a0/?vgnextoid=02c9dee6398be510VgnVCM1000001d4a900aRCRD&vgnextchannel=257865dd72ede410VgnVCM1000000b205a0aRCRD&vgnextfmt=default

minimum age of 15 years to drive an electric scooter. Those aged under 16 must also wear a helmet. Scooters are forbidden in bus lanes and in specific sections of the M30 avenue.

With the new Ordinance, all cars and motorcycles accessing the city of Madrid (including those coming from other municipalities and regions) must carry the environmental distinctions of the Directorate-General of Traffic (DGT). The badge excludes the most polluting, those registered before the year 2000 or diesel engines prior to 2006. The City Council intends to use the label to apply its new protocol against pollution.

Motorbikes will continue to be able to park on footpaths if they leave a space of three meters, with some exceptions: in the centre, they cannot park where there is a parking belt on the road and must instead go to areas reserved for motorbikes. The City Council is seeking to extend this restriction throughout the city.

The Ordinance also creates the so-called 'Madrid Central' area (see below for further explanation).

The Madrid municipality's Protocol for action in the case of instances of NO_2 pollution was adopted by agreement on 10 December 2018 (Decree 428 of 11 December). It contains extraordinary and temporary measures of total or partial restriction of traffic, prohibition on parking and limitation of speed within the municipal area of Madrid, once proper signs are set[35]. It follows the Protocol adopted by the Agreement of 21 January 2016.

On the other hand, Decree 140/2017 of November 21 of the Governing Council approved the Framework Protocol for action during instances of high pollution by nitrogen dioxide (NO2) in the Community of Madrid, in other words at regional level. It determines that 'the municipalities in their protocols may establish the concentrations of NO_2 and define the levels of action, but in no case can these concentrations be higher than those established by the Community in this Protocol'. It requires the local action protocols, as well as that approved by the Madrid municipality, to be framed within the framework of regional planning [...], with local action to be adjusted to the principles of mutual information, cooperation and collaboration.

Strategic framework

The state has also the competence to develop national plans to improve air quality for those pollutants with similar behaviours regarding sources, dispersion or levels in several zones or agglomerations.

The government thus approved **Plan AIRE 2013-2016,** which was a reference framework for the improvement of air quality in Spain. It established specific measures and coordination with other sectoral and regional plans, which it tried to complement. The Plan included horizontal measures related to awareness-raising; provision of information to citizens, administration, research and taxation; and sectoral measures targeting industry, construction, transport, agriculture and livestock, or the residential, commercial and institutional sectors.

One of the main purposes of the AIRE Plan was to make information about air quality more accessible, transparent and easy to understand. In addition, the AIRE Plan contemplated some measures to reduce emissions where the state assumes direct competence, such as in ports, airports and roads, where significant emissions are generated.

[35] Ayuntamiento de Madrid, Protocolo de actuación para episodios de contaminación por Dióxido de nitrógeno en la ciudad de Madrid, 2018, Available at: https://transparencia.madrid.es/UnidadesDescentralizadas/Sostenibilidad/CalidadAire/Ficheros/ProtocoloNO2AprobFinal_201809.pdf

Finally, it included measures to research the situations of more widespread air pollution, such as the high formation of O_3 in periods of greater solar radiation, or the high concentration of particles in the air. Also important were efforts to improve pollution prediction models, which allow episodes of pollution to be anticipated with sufficient time to adopt measures and thus improve the effectiveness of the information offered to citizens.

The Plan was updated in 2017 - **Plan AIRE 2017-2019 (Plan AIRE II) -** which added particles $PM_{2,5}$ to the list of parameters included in the previous Plan (SO_2, NO_2, particle PM_{10} and O_3). The objective of the Plan remains unchanged, i.e. to implement a series of measures at state level to improve ambient air quality. The general objectives are: to ensure compliance with legislation on air quality; to implement measures to reduce the levels of emission into the atmosphere of the most relevant pollutants; to promote available information on air quality and raise awareness; to implement measures to ensure compliance with the emission reduction commitments; and to reinforce actions for the control of registered tropospheric ozone values, given the generalised exceeding of the objective value for the protection of health in a large part of the country.

The current Plan comprises a total of 52 measures in the areas of information, taxation, improvements in mobility, research, agriculture and livestock, residential sector, industrial sector, road, air and rail transport and ports.

Infringement procedures

In 2015, the Commission initiated an infringement procedure against Spain for non-compliance with the NO_2 standards of the AAQ Directives. The reasoned opinion was published by the Commission in early 2017 and triggered the adoption of stronger measures in Spain to ensure compliance with the AAQ Directives. One of the regions involved in the infringement (for its failure to respect air quality limit values for NO_2) was Madrid. After the adoption of the reasoned opinion, on 12 May 2017, Madrid issued a report analysing the situation and proposing measures to comply with the limit values established in the AAQ Directives for NO_2 and PM_{10} and $PM_{2.5}$. This report was followed by regular updates and the adoption of specific measures.

Air quality plans

Royal Decree 102/2011 states the need to approve action plans in those zones or agglomerations exceeding the regulated levels of pollutants in the air. Several autonomous communities and local entities subsequently approved air quality plans. The website of the Ministry includes the list of plans at local and regional level approved in 2016 in those areas were limits were exceeded[36].

A total of 54 air quality plans were approved across almost all of the autonomous communities: Andalusia (15 plans), Aragon (two plans: one approved by the Community and one by the Municipality of Saragossa), Asturias (three plans), Balearic Islands (one plan), Basque Country (nine plans), Canary Islands (two plans), Cantabria (one plan), Castilla La Mancha (two plans), Castilla y Leon (three plans), Catalonia (two plans), Galicia (one plan), La Rioja (one plan), Madrid (nine plans: seven approved by the Community and two by the municipality of Madrid), Murcia (one plan) and Valencia (three plans).

The 2017 Annual Report on Air Quality in Spain includes a short-term action plan to reduce the levels of C_6H_6 in Trubia (Asturias).

[36] Available at: MITECO, Planes de mejora de la calidad del aire (web page), https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/planes-mejora/

In its 2017 report, the NGO 'Ecologistas en acción'[37] states that there are several plans on air quality or short-term action but that a series of flaws have been identified in those plans, namely: they do not have an execution timeline; they do not establish reduction objectives nor quantitative indicators to evaluate them; there is no budget assigned to the measures (nor they are not sufficiently broken down); most of the measures only focus on providing information to the public or raising awareness, which, while necessary, is not enough; some measures included were already approved in the past and are already in place (therefore, nothing new is approved); some so-called plans are really guidance or studies and not plans in the sense required by the legislation; and there is sometimes no monitoring procedure in place. For the short-term plans in particular, the NGO highlighted several areas where these plans should have been approved but were not.

In the autonomous community of Madrid, the administration approved seven plans and the municipality of Madrid approved two, the plan 2011-2015 and the last one, the so-called Plan A. **Plan A** was adopted on 21 September 2017 and published in the Official Journal on 26 September 2017[38]. The main objective is to ensure that the limit values established by the legislation on air quality at national and EU level for NO_2, and the WHO guide values for PM_{10} and $PM_{2.5}$ are complied with as soon as possible and, in any case, by 2020. To this end it has ringfenced EUR 543.9 million from the municipality budget. Plan A has 30 specific measures designed to reduce air pollution or emissions causing climate change. Among those measures are:

- Madrid Central Low Emissions Zone – this aims to develop a closed perimeter in the Centre of Madrid with limited access to traffic and increased pedestrian zone. The aim is to promote a low emissions mobility which prioritises pedestrians, cyclists and public transport and limits traffic and parking to residents. Cameras will be used to enforce the system, using vehicle registration plates. It is further developed by the Sustainable Mobility Ordinance, published on 23 October 2018[39] .

- The infrastructure measures target the main urban axes by promoting the use of public transport through the design of specific access roads reserved for public transport driving from the suburbs to Madrid. Several roads are planned but only one is fully working and set up to date. The establishment of this infrastructure supporting public transport is the competence of the Autonomous Community, highlighting some tensions between governments at local and regional level.

- Madrid has created tax incentives for less polluting cars including taxes for circulation and for parking.

- Car parking is regulated using air quality criteria. This includes parking restrictions based on pollution levels, regulated through the use of car traffic cards that have been developed taking into account of cars' environmental performance. Electric cars benefit from an exemption to parking tax. The objective is to reduce diesel cars in the short-term and thereby reduce the exceedance of limit values of NO_2.

[37] Ecologistas en Acción, La calidad del aire en el Estado español durante 2017, June 2018. Available at: https://www.ecologistasenaccion.org/wp-content/uploads/2018/06/informe-calidad-aire-2017.pdf

[38] Ayuntamiento de Madrid, BOAM 7999 26 September 2017, available at: **Error! Hyperlink reference not valid.**https://sede.madrid.es/portal/site/tramites/menuitem.b4c91589e7f6a5d829da39e5a8a409a0/?vgnextoid=02c9dee6398be510VgnVCM1000001d4a900aRCRD&vgnextchannel=257865dd72ede410VgnVCM1000000b205a0aRCRD&vgnextfmt=default

[39] Ayuntamiento de Madrid, Ordenanza de Movilidad Sostenible, Municipal Ordinance of Sustainable Mobility 2018/45 of 23 October 2018, https://sede.madrid.es/portal/site/tramites/menuitem.5dd4485239c96e10f7a72106a8a409a0/?vgnextoid=5ccdb732cef96610VgnVCM2000001f4a900aRCRD&vgnextchannel=6b3d814231ede410VgnVCM1000000b205a0aRCRD&vgnextfmt=default

- The short-term plan has been adopted as a Protocol to Plan A to reduce the risk, duration or severity of the NO_2 exceedance. Under the Protocol, information on exceedance of alert thresholds or critical levels, as well as on the measures to be adopted, is systematically shared with the public through the web, app "Aire de Madrid", twitter, sms, visual panels on the roads, access roads to Madrid, bus canopies or stations, and main streets. Some of the measures require cars to be banned to ensure traffic reduction or speed limits.

Plan A also includes measures to promote renewable energy and energy efficiency through tax incentives for buildings. There is a specific measure to improve the management of the waste treatment plant in Valdemingómez to reduce emissions. The plant operates as an incinerator and landfill, but the treatment of composting has been improved to include a separated collection for organic waste. It also uses methane gas as part of its improved energy-use system.

2.5 Information to the public

Pursuant to Article 26 of the AAQ Directive, Member States shall ensure that the public are – adequately and in good time - informed about ambient air quality and other issues specified. In Spain, Article 8 of Law 34/2007 and Article 28 of Royal Decree 102/2011 oblige public administrations to take any necessary measures to guarantee the provision of information to the public regarding air quality, the environmental indicators developed by the Ministry, and plans and programmes for the protection of the atmosphere[40].

According to the legislation, information must be provided in a clear and comprehensive way through easily accessible means, including the Internet. The following information must be provided in all cases:

- The situation of air quality in relation to the current quality objectives for each pollutant, together with periodic information on background contamination (rural background pollution shall be updated every month). This includes periodic information on:
  - Concentrations in the ambient air of SO_2, NO_2 and NOx, particles, Pb, C6H6, CO, ozone, As, Cd, mercury (Hg), Ni, B(a)p, and other aromatic hydrocarbon polycyclic substances, including, at least, enzo (a) anthracene, benzo (b) fluoranthene, benzo (j) fluoranthene, benzo (k) fluoranthene, indene (1,2,3-cd) pyrene and dibenzo (a, h) anthracene.
  - The information on concentrations of SO_2, NO_2, particulates, PM_{10} at least, O_3 and CO in the ambient air shall be **updated**, at least every day, and, where feasible, every hour.
  - Information on concentrations of Pb and C6H6 shall be **updated** at least once a quarter and, where feasible, once a month.
  - Deposit levels of As, Cd, Hg, Ni, B(a)p, and other polycyclic aromatic hydrocarbons, at least, enzo (a) anthracene, benzo (b) fluoranthene, benzo (j) fluoranthene, benzo (k) fluoranthene, indene (1,2,3-cd) pyrene and dibenzo (a, h) anthracene.

[40] The plans at national and regional level are available at: MITECO, https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/planes-mejora/

- All of this information is provided at the website of the Ministry, which is available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/visor/

- In cases where discounts are established for certain pollutants (due to emissions from natural sources) for the calculation of non-compliance with quality objectives, the methodology followed and the justification for the application of such discounts shall be adequately reported.

  The website of the Ministry includes a page on natural sources, with links to the methodology (procedure for the identification of natural episodes of PM_{10} and $PM_{2.5}$) and a list of yearly reports on natural episodes. This is available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/evaluacion-datos/fuentes-naturales/

- The information on air quality that Spain sends annually to the European Commission in compliance with the obligations set out in the Community regulations on air quality. The website of the Ministry includes a page with links to this information: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/evaluacion-datos/datos/

- Studies on air quality and health

  All publications are available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/documentacion-oficial/ and general information per pollutant is provided at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/salud/

- Autonomous communities are obliged to provide periodic information on the levels of pollution, specifically when air quality objectives are exceeded. The list of networks of the different autonomous communities are available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/evaluacion-datos/redes/

The Royal Decree also states that in all cases the public shall be informed when **concentrations exceed air quality objectives**, including limit values, target values, alert thresholds, information thresholds and long-term objectives, their causes and the affected area. Specific information must be provided when alert and information thresholds are exceeded (see Article 28(4) Royal Decree). That information will also include a brief evaluation in relation to air quality objectives, as well as adequate information on the impact on health and, where appropriate, vegetation. Finally, a description of the methodology followed in the sampling and analysis will also be provided.

The criteria for evaluation of air quality are available at the website of the Ministry: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/Cap3_Criterios%20evaluacion_tcm30-186479.pdf

Public administrations must also provide the public with annual reports on all pollutants. On its website, the Ministry includes the list of annual reports and historic data[41]. It is also obliged to approve a National Index of Air Quality, which is not yet available[42].

At municipal level, in Madrid, Plan A establishes the development of **awareness-raising and communication actions** across the various action lines of the Plan, with the aim of raising awareness of the need to change citizens' behaviours so that they can contribute to improving air quality and fighting climate change in the city.

In addition, Annex II to the Madrid municipality's Protocol for emergency action in case of instances of pollution by NO_2, adopted by agreement on 10 December 2018, establishes the specific information measures to be activated from the moment any of the alert scenarios of NO_2 concentrations exceedance are reached or anticipated[43]. It provides the framework for the short-term plan to be implemented in exceptional circumstances and establishes the information to be addressed to the population, with simultaneous notice to political leaders, municipal departments and organisations working in health and the environment. Information will include the forecast pollution value that can be reached or the value reached, the time and place at which the levels were registered and a forecast of their evolution. Likewise, information should include the traffic restrictions and public transport promotion measures envisaged, as well as the estimated time for their implementation, in accordance with the levels of pollution that are registered or that are expected to be registered, based on the weather forecast. The Protocol highlights the need to take the greatest efforts to adequately inform the public through widely spread media (press, radio, television) and social networks. Other communication resources will also be used, such as the website of the municipality and traffic information panels.

In addition, the Alert System on Environmental Health will be activated in order to ensure maximum reach of the health recommendations to the population, including information on health protection and minimising environmental exposure.

All information on air quality from the municipality of Madrid is available from a dedicated website, which has an associated smartphone app with updated information on air quality. The website (and the app) are available at: http://www.mambiente.madrid.es/opencms/opencms/calaire

2.6 Use of EU funding for air quality improvements

Spain does not typically use EU Structural funds to promote compliance with the AAQ Directives. According to the interviews carried out within the framework of this project[44], this is more due to the lack of knowledge and awareness of the available funding possibilities among those responsible for air quality in the relevant abovementioned bodies.

[41] Available at: MITECO, https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/calidad-del-aire/evaluacion-datos/datos/historico_calidad_aire.aspx
[42] EFE, Teresa Ribera anuncia la creación de un Índice Nacional de Calidad del Aire, 15 October 2018. Available at: https://www.efe.com/efe/espana/sociedad/teresa-ribera-anuncia-la-creacion-de-un-indice-nacional-calidad-del-aire/10004-3780639
[43] Ayuntamiento de Madrid, Protocolo de actuación para episodios de contaminación por Dióxido de nitrógeno en la ciudad de Madrid, 2018, Available at: https://transparencia.madrid.es/UnidadesDescentralizadas/Sostenibilidad/CalidadAire/Ficheros/ProtocoloNO2AprobFinal_201809.pdf
[44] Ministry of Environment on 24 September

The promotion of air quality is indirectly referenced within some of the objectives included in the Operational Programmes (OPs). For instance, the **National OP** of the European Regional Development Fund (ERDF)[45] includes as a priority and specific objective, 'actions to improve the environment in cities', which includes the improvement of air quality among the results expected to be obtained. One of the indicators to measure the results achieved will be the number of days per year when limits on air quality are exceeded. Among the examples of actions to be taken, it includes the design and implementation of plans to improve urban air quality, provided that they imply investments, such as the implementation of measuring stations for air quality indicators in cities. The total budget foreseen is EUR 24,880,555.

The **OP for Madrid**[46] includes some priorities and specific objectives from which measures to improve air quality could be derived. This is the case for two investment priorities: 4c, support for energy efficiency, smart energy management and the use of renewable energy in public infrastructures, including public buildings, and in housing; and 4e, promotion of carbon reduction strategies for all types of territories, especially urban areas, including the promotion of sustainable multimodal urban mobility and adaptation measures with mitigation effects. These investment priorities contain the following specific objectives: to improve energy efficiency and reduce CO_2 emissions in buildings and public infrastructures and services; to increase the use of renewable energies for the production of electricity and thermal uses in buildings and public infrastructures, in particular favouring small-scale generation in points close to consumption; and the promotion of **sustainable urban mobility** through a clean urban transport, collective transport, urban-rural connection, road network improvements, cycling, pedestrian transport, electric mobility and the development of clean energy supply systems.

The **OPs of Andalusia** (EUR 5,304,756), **Ceuta** (EUR 240,000) and **Extremadura** (EUR 4,020,000) also include the possibility to develop projects on air quality.

In practice, the only project identified in the **national and Madrid ERDP OP**s directly related to air quality policy is the update and improvement of the air quality monitoring system of the Instituto Universitario de Medio Ambiente (IUMA) of the University of A Coruña for an amount of EUR 147,525.[47]

[45] Ministerio de Hacienda y Administraciones Públicas, PROGRAMA OPERATIVO EN EL MARCO DEL OBJETIVO DE INVERSIÓN EN CRECIMIENTO Y EMPLEO, Available at: http://www.idae.es/uploads/documentos/documentos_PO_CrecimientoSostenible_FEDER_2014-2020_cb50c638.pdf
[46] Ministerio de Hacienda, Programas Operativos Plurirregionales (web page). Available at: http://www.dgfc.sepg.hacienda.gob.es/sitios/dgfc/es-ES/ipr/fcp1420/p/Prog_Op_Plurirregionales/Paginas/inicio.aspx
[47] Ministerio de Hacienda, Lista de Operaciones FEDER 2014- 2020 (web page). Available at: http://www.dgfc.sepg.hacienda.gob.es/sitios/dgfc/es-ES/loFEDER1420/Paginas/inicio.aspx

3 FINDINGS

Chapter 3 presents detailed findings on the experiences and lessons learned in the implementation of the AAQ Directives in Spain, and in the municipality of Madrid in particular. More specifically, the chapter focuses on the challenges and successes encountered in the implementation of the Directives, and explores the relevance of the AAQ Directives and their air quality standards. Finally, the chapter identifies the factors underlying compliance with and effectiveness of the AAQ Directives and provides an overview of the costs and benefits associated with their implementation.

The findings presented in this chapter rely primarily on input from the stakeholders interviewed in the context of the case study. These were supplemented by additional desk research, as appropriate. An overview of the interviews carried out is provided in Appendix B.

3.1 Relevance of the Ambient Air Quality Directives

Firstly, the case study explored the extent to which the AAQ Directives, and the air quality standards set therein, correspond to citizens' needs.

The 1st Environmental Implementation Review adopted by the Commission in April 2017 indicated that air quality in Spain continues to give cause for concern[48]. For example, for 2013, the EEA estimated that about 23,940 premature deaths in **Spain** were attributable to fine particulate matter concentrations, 1,760 to O_3 concentrations, and over 4,280 to NO_2 concentrations[49]. The persistent breaches of air quality requirements (for PM_{10} and NO_2), which have severe negative effects on health and the environment, are being followed up by the European Commission through infringement procedures against Spain (among other Member States). The aim is to put adequate measures in place to bring all zones into compliance. The main suggestions in the report include:

- Reduce NH_3 emissions to comply with currently applicable national emissions ceilings, for example by introducing or expanding the use of low emission agricultural techniques.
- Reduce NO_x emissions to comply with currently applicable national emissions ceilings and/or to reduce NO_2 (and O_3 concentrations), inter alia, by reducing transport-related emissions - in particular in urban areas.
- To reduce PM_{10} emissions and concentrations, including by reducing emissions relating to energy and heat generation using solid fuels, transport and agriculture.

The targeted consultation carried out as part of the case study showed that while the objectives of the AAQ Directives are considered relevant in relation to citizens' needs, stakeholders interviewed find that the scientific evidence behind the WHO recommendations to ensure human health requires the limit levels of the AAQ Directives to be increased to similarly ambitious levels. This perspective was shared by all stakeholders in both the public sector and environmental and health NGOs[50]. For an overview of the interviews carried out, see Appendix A.

The stakeholders from the public authorities interviewed within the framework of this project, stressed that scientific information on the impact of other pollutants, such as O_3 or B(a)P, on the

[48] EU Environmental Implementation Review, Country Report: Spain, SWD (2017) 42 final, available at: http://ec.europa.eu/environment/eir/pdf/report_es_en.pdf
[49] EEA, Air quality in Europe — 2017 report, 2017. Available at: https://www.eea.europa.eu/publications/air-quality-in-europe-2017
[50] Targeted questionnaire from the Spanish Ministry and Spanish environmental NGOs.

environment and human health point to the need to review the Directives' target levels and develop emissions level targets. They also recognised the scientific evidence with respect to additional pollutants that have important impacts on the environment and human health but which are not reflected in the current AAQ Directives, such as tare black carbon and ultrafine particulates[51]. The targeted stakeholder consultation also highlighted greater citizens' awareness of the impact of poor air quality on public health, and the consequent demand for the authorities to take action to ensure appropriate levels of air quality, including more stringent limit values.

The NGOs stated their belief that, without the AAQ Directives, no measures on air quality would have been taken in Spain. The Directives are necessary but currently insufficient to ensure the protection of air quality and human health. Some pointed to causes such as: the differentiation between pollutants with target values and limit values when their toxicity is similar; the establishment of more relaxed legal standards than those recommended by the WHO and, therefore, below a sufficient level to protect human health; insufficiency of fixed measures to assess air quality (for instance, stations are not well located); lack of reference methods for the modelling of pollutant concentrations; insufficiency of air quality plans in order to meet legal standards (late development, lack of proper monitoring and lack of coercive measures for enforcement); lack of efficient short-term plans; inefficiency in public information; and lack of coherence of sectoral policies (agriculture, energy, etc.).

One health NGO stated that some pollutants should be added, for instance, pesticides (glyphosate, phosphorates, piretines and organoclorades) or mercury. They also highlighted the need to start measuring air quality inside domestic homes. Waste management should also be improved in order to control pollutant emissions.

In addition, the findings of the 2017 Special Eurobarometer[52] confirmed that air quality is a concern for Spanish citizens, with 68% of respondents stating that air quality in the country has deteriorated in the last 10 years. This represents the second highest rate in the EU (behind Cypriot respondents). 23% considered air quality to have remained the same, while 4% felt that it has improved.

According to the Spanish Organisation of Consumers and Users (OCU), 81% of the Spaniards consider that a measure banning or reducing the use of the most polluting cars should be adopted and 77% thinks that cars should be banned on days of pollution exceedance; 70% of drivers would reduce the use of the car if the public transport would improve and 60% of the Spanish citizens would support higher taxes for more polluting cars[53].

3.2 Implementation successes

The present section highlights the key implementation successes of AAQDs in Spain generally, and specifically in Madrid. They were identified through desk research and stakeholder interviews. The section also provides an assessment of the extent to which these challenges can be linked to the design of the AAQ Directives or, indeed, to their specific requirements.

[51] Information from the interview with the Spanish Ministry on 24/09/2018.
[52] European Commission, Special Eurobarometer 468: Attitudes of European citizens towards the environment, November 2017. Available at: http://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/ResultDoc/download/DocumentKy/81259
[53] europa press, El 81% de los españoles cree que se debería prohibir la circulación de vehículos muy contaminantes, 23 May 2018. Available at: https://www.europapress.es/motor/coches-00640/noticia-81-espanoles-cree-deberia-prohibir-circulacion-vehiculos-muy-contaminantes-20180523114000.html

This section focuses on measures adopted in Spain, and sometimes specifically by the Madrid municipality, showing some implementation success.

3.2.1 Strategic planning as a reaction to enforcement of the AAQ Directives at EU level

The enforcement of the AAQ Directives by the European Commission has been instrumental in ensuring that Spain takes action on air quality and, in particular, Madrid's adoption of measures to tackle air pollution. While slow, it has been a key element in improving ambient air quality.

At present, there are infringement procedures open against Spain for breaches of NO_2 and PM_{10} limit values in several cities, e.g. Barcelona and Madrid for NO_2[54]. PM pollution is also an issue in Catalonia, Asturias and Andalusia. However, the problem has been recognised and efforts are underway to address it, through, for example, the national plan for air quality (Plan AIRE II) and the local plan for Madrid (Plan A).

Plan AIRE II

At national level, the government approved the so-called Plan Aire II for the period 2017-2019 as a continuation of the first Plan 2013-2016. The objectives of Plan II are:

- Ensure compliance with legislation on air quality in all areas: national, European and international.
- Implement general measures that help to reduce the levels of emissions into the atmosphere of the most relevant pollutants with the greatest impact on health and ecosystems, especially in the areas most affected by pollution.
- Promote the information available on air quality and thus promote awareness among citizens.
- Implement measures to ensure compliance with the emissions reduction commitments established by Directive (EU) 2016/2284.
- Reinforce the actions for the control of registered tropospheric O3 values, given the generalised exceedances of the objective value for the protection of health in a large part of the country.

Plan A

Madrid has adopted Plan A (the air quality and climate change plan for the city of Madrid) that includes short-term and long-term measures (as required under Articles 23 and 24 of Directive 2008/50/EC) to reduce emissions and comply with the AAQ Directives and climate change objectives. Madrid submits regular reports to the Commission on its progress on the implementation of the Directives, including an annual report and monthly reports where progress on Plan A is described.

Plan A's specific objectives are to:

- Comply with European and national legislation on air quality.

[54] European Commission, Air quality: Commission takes action to protect citizens from air pollution (press release), 27 May 2018. Available at: http://europa.eu/rapid/press-release_IP-18-3450_en.htm

- Achieve levels of air quality for particles in suspension that are in line with WHO guide values.
- Achieve, by 2030, a reduction of more than 40% of the total GHG emissions of the municipality of Madrid compared to 1990, contributing to the objectives of the Paris Agreement and the EU Climate Agenda and online as the new Alliance of Mayors for Climate and Energy.
- Fulfil the commitment to reduce by 50% the GHG emissions caused by urban mobility in 2030, compared to 2012.
- Develop a strategy of adaptation to the effects of climate change, reducing urban vulnerability to the risks associated with global warming.

In order to reach these objectives, Plan A promotes a series of measures organised in four blocks: sustainable mobility; urban regeneration; climate change adaptation; and citizen awareness. Enforcement measures are applied, including police controls (at the level of individual cars) where limitations on the use of cars or speed limits are set. Currently, the controls are manual but will be automated through the use of a reader mounted on the windshield of the car.

While Spain has a National Air Quality Plan, only a third of the measures have been implemented and there are no performance indicators for measuring policy effectiveness[55].

3.2.2 Central Area Zero Emissions

There are 30 measures included in Plan A, one of which is the so-called 'central area zero emissions' (*Área Central Cero Emisiones*), aimed at reducing the negative effects of road transport in the centre of the city and incentivising collective transport and non-engine related vehicles. Previously, the city had the so-called Residential Priority Areas model, which restricted access to vehicles belonging to non-residents. However, these areas were conceived as isolated areas whereas the new model intends to give continuity to the restricted areas by establishing a larger area to optimise the positive effects produced in those areas. The delimitation of the area was carried out taking into account several elements, such as the road network, promoting sustainable modes (more cycling routes, increase pedestrian areas, modal interchange, taxi stops, optimisation of urban distribution of goods), improving the parking slot system (dynamic information system for parking, etc.), and establishing access criteria. Cameras are used to enforce the system on the basis of car registration plates.

During the development of Plan A, the municipality of Madrid carried out a process of consultation and participation.

According to one NGO interviewed, this measure generated a lot of controversy. While the Madrid Federation of Consumers and Users supports the plan, which it considers absolutely critical to reduce pollution in Madrid[56] other sectors announced their intention to file complaints in court[57]. The municipality postponed its implementation in order to gain more support and undertook a PR and information campaign throughout Madrid. At the Time of writing, the measure was being

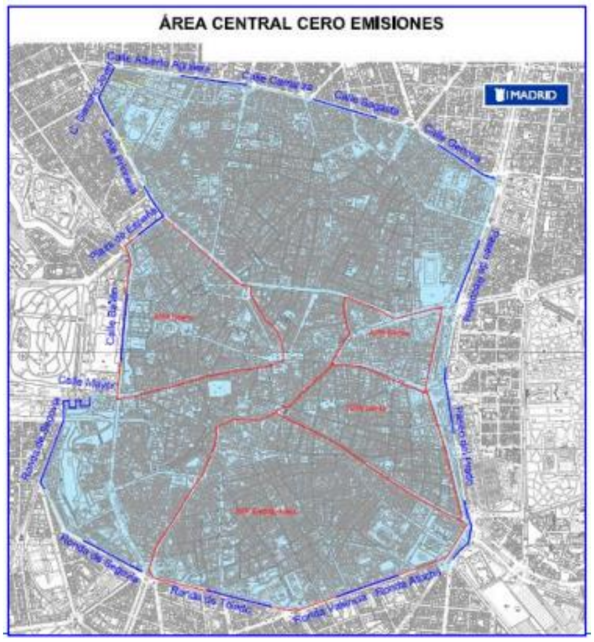
[55] Joint report on air quality by Court of Auditors, Eurosai, 2019, p. 40 and 41 at: https://www.eurosai.org/en/databases/audits/Joint-Report-Air-Quality/

[56] Confederación de Consumidores y Usuarios de Madrid, CECUMadrid considera absolutamente necesario el Plan Madrid Central contra la contaminación (press release), 27 November 2018, available at; http://cecumadrid.org/images/13_-_Madrid_Central.pdf

[57] The Madrid autonomous community and the Conservative Party filed a case before the High Court of Justice of Madrid (Tribunal Superior de Justicia de Madrid) against the measure, based on the following arguments: interference with the competence of the Community in the area of transport and environment; the lack of prior consultation involving the Madrid autonomous community (such as on the development of the economic and regulatory impact assessments); and the lack of public information and public hearing for this specific measure.

implemented. Effectiveness of the measure has been analysed through the publication of the impact assessment: the data on traffic reduction and emissions in December 2017 (when the measure was provisionally implemented and tested) was the lowest since 2000. Records in Madrid fell, compared to values recorded in 2010 and 2015[58]. However, the regional authority claims that Madrid Central will not be effective because it does not involve the most polluted areas of the city, nor does it include measures to allow effective application of the project (for instance, priority access of inter-city buses to the main access points of the city or the establishment of dissuasive car parks)[59].

With respect to the implementation of the Plan, the participatory approach sets the basis for the effectiveness of the measure. There is a Commission for Air Quality and a Technical Platform[60], which are consultation bodies whose aims are: to participate in monitoring the implementation of the Plan and the accomplishment of its objectives; to establish periodic coordination mechanisms; and to collaborate on the revisions foreseen in Plan A. The Commission and the Platform are composed of representatives competent in different areas (environment, air quality, trade, tax, etc.) from the municipality, the region of Madrid, the state and environmental and neighbourhood associations. Representatives from interested groups are also expected to participate in the meetings on the implementation of Plan A, such as university experts, SMEs, citizens' associations, etc.



In order to monitor the implementation of the Plan, different impact indicators have been developed, associated with specific objectives of the Plan, as well as process indicators per measure, for each of the four blocks into which the Plan is divided.

Revisions are planned in 2020 and 2025, based on annual reports, input from the participative process, international agreements, new scientific and technological studies and the incorporation of the new legislative framework.

3.2.3 Ensuring public awareness

Most of the stakeholders interviewed confirmed that the AAQ Directives promoted the use of information and public awareness measures on air quality in Spain in general and Madrid in particular.

During the development of **Plan A**, the municipality of Madrid carried out a consultation process promoting participation in the decision-making process on the measures constituting the plan.

[58] Evaluación del efecto del plan de calidad del aire y cambio climático de la ciudad de Madrid, September 2017

[59] For example: eldiario.es, La Comunidad cumple su amenaza de llevar Madrid Central a los tribunales y argumenta que afecta a sus competencias, 27 November 2018. Available at: https://www.eldiario.es/madrid/Comunidad-Madrid-Central-tramitacion-competencias_0_838166707.html

[60] Ayuntamiento de Madrid, Decreto de 6 de julio de 2017 de la Alcaldesa por el que se crea la Comisión de Calidad del Aire de la Ciudad de Madrid y se regula su composición y funcionamiento. Available at: https://sede.madrid.es/portal/site/tramites/menuitem.b4c91589e7f6a5d829da39e5a8a409a0/?vgnextoid=a120bfe0d2c1d510VgnVCM1000001d4a900aRCRD&vgnextchannel=257865dd72ede410VgnVCM1000000b205a0aRCRD&vgnextfmt=default

That process was divided into different phases. In Phase 1, a technical team from city hall prepared a draft containing the general lines of the plan. In Phase 2, the strategic lines of the Plan were presented at a conference attended by political parties, media, the autonomous community of Madrid, the Ministry of Environment, environmental NGOs, neighbourhood associations and others.

In Phase 3, the municipality opened different channels through which citizens could express their opinions and establish a formal dialogue (called *Diálogo con los barrios*): a questionnaire hosted on a website[61], a campaign on social networks and digital media, and campaigns in the different District Municipal Boards (*Juntas Municipales de Distrito*). In this phase, the technical team of the municipality also planned a three-month series of meetings with the main social and economic agents in order to explain the plan and obtain input on possible improvements. In Phase 4, after all input was received, a document was developed and proposed publicly before being submitted for initial approval to the Governing Board of the city. Phase 5 was a process of public information in order to collect further input. The final text was then approved and published[62].

The public consultation on the measures of Plan A generated public awareness. In particular, the PR campaign on measure 1 of Plan A is another example of activities aiming to raise public awareness of the issue and the need to adopt specific measures.

In addition, the Protocol for alert thresholds exceedance in place both in the municipality and the autonomous community requires the authorities to broadly disclose information to the public on the pollutants whose levels exceed those recommended[63].

At national level, one of the 52 measures intended to be applied within Plan AIRE II is to provide information to the general public on air quality, which includes the development of clear indicators of air quality and easy access to them. Plan AIRE II also includes the development of a framework action protocol for episodes of high pollution, with the aim of offering a homogenous framework in each of the territories in which there is a need for one.

However, one of the main challenges recognised by cities like Madrid for the implementation of air quality measures include how to effectively communicate air quality issues to the public[64].

3.3 Implementation challenges

Several implementation challenges were identified in the course of the case study:

3.3.1 Non-compliance with limit values

Spain does not comply with the limit values set by the AAQ Directives in relation to PM_{10} and NO_2 in some air quality zones. The infringement procedure opened against Spain on breaches of the NO_2 limit value includes the cities of Barcelona and Madrid. The breaches of implementation of the AAQ Directives by Spain are longstanding. As early as 2002 the Commission had announced that a case against Spain was to be referred to the Court of Justice of the European Union (CJEU) for failure to transpose into national law the new air quality limits on SO_2, NO_2, particulates and

[61] Decide Madrid, Borrador de Plan de Calidad de Aire y Cambio Climático (web page), available at: https://decide.madrid.es/proceso/plan-calidad-aire
[62] Ayuntamiento de Madrid, Plan de Calidad del Aire y Cambio Climático de la Ciudad de Madrid, 2017. Available at: https://www.madrid.es/UnidadesDescentralizadas/UDCMedios/noticias/2017/03Marzo/13Lunes/NotasdePrensa/Plan%20Calidad%20Aire/ficheros/PlanACalidadAire2017.pdf
[63] http://www.mambiente.munimadrid.es/opencms/opencms/calaire/ServCiudadanos/ProtocolosInfo.html and http://gestiona.madrid.org/azul_internet/html/web/AlertasActivasAccion.icm?ESTADO_MENU=10
[64] EEA, Europe's urban air quality — re-assessing implementation challenges in cities, EEA Report No 24/2018, 2019. Available at: https://www.eea.europa.eu/publications/europes-urban-air-quality

Pb. In 1999, the Framework Air Quality Directive 1999/30/EC65 set limit values for several air pollutants which needed to be transposed into national law by 19 July 2001[66].

In relation to Directive 2008/50/EC, the Commission initiated infringement procedures for lack of compliance with limit values for NO_2 and PM_{10} that became binding in 2010 and 2005 respectively. Spain, according to some stakeholders, did not take any measures to ensure that the NO_2 limit values would be respected by 2010[67].

The latest national report on air quality with data from 2017[68] (published in September 2018) evidences that of all pollutants, three (**NO_2, PM_{10} and O_3**) have exceeded established legal limit or target values in all years during the period 2005-2016, and in 2017 in some air quality zones. According to the 2017 Evaluation Report on Air Quality in Spain, the 2017 results are worse than those of 2016, as the number of air quality zones exceeding the legislated values for NO_2 and PM_{10} increased[69]. For NO_2, the number of air quality zones that exceeded the legislated values increased. More specifically, in 2017, the hourly limit value was exceeded in the same area of Madrid as it was in the previous year. In addition for the annual limit value, exceedances occurred in large cities such as Madrid and surroundings, Barcelona and surroundings, Granada and its metropolitan area, and Bilbao and its surroundings, largely due to traffic emissions[70].

Infringement procedures started in 2010 (e.g. for failing to comply with PM_{10} limit values). In 2013, a new infringement procedure was opened for exceeding PM_{10} limit values in 3 regions (for daily limit) and in one region (for an annual mean), with the reasoned opinion sent in 2014 together with an additional letter of formal notice. The National Plan for 2013-2016 was adopted in response to these breaches. Another infringement procedure was initiated with a letter of formal notice in June 2015 for failure to comply with the NO_2 limit values. The reasoned opinion followed in February 2017[71].

In January 2018, Commissioner Vella announced that Spain would be subject to legal action before the CJEU if adequate, effective and timely measures were not taken[72]. The case was put on hold given the specific measures adopted[73] or proposed. However, the need to implement the Madrid Protocol for pollution peaks on a regular basis (particularly to establish the procedure for action in case of instances of NO_2 pollution) when it is meant to be a short-term plan to be implemented in exceptional circumstances, seems to evidence the existence of a structural problem.

[65] Directive 1999/30/EC of 22 April 1999 relating to limit values for sulfur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31999L0030
[66] European Commission, Air Quality: Commission pursues infringement proceedings against six Member States (press release), http://europa.eu/rapid/press-release_IP-02-1013_en.htm
[67] Interview with NGOs on 21 September 2018
[68] Ministerio para la Transición Ecológica, Evaluación de la calidad del aire en España: Año 2017, Available at: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/informeevaluacioncalidadaireespana2017_tcm30-481655.pdf
[69] Ministerio para la Transición Ecológica, La calidad del aire en España en 2017 baja levemente con respecto al año anterior (webpage). Available at: https://www.miteco.gob.es/es/prensa/ultimas-noticias/La-calidad-del-aire-en-Espa%C3%B1a-en-2017-baja-levemente-con-respecto-al-a%C3%B1o-anterior/tcm:30-481677
[70] *Idem.*
[71] European Commission, Infringement decisions, web page, at: http://ec.europa.eu/atwork/applying-eu-law/infringements-proceedings/infringement_decisions/?lang_code=en; and https://legal.cleanair-europe.org/legal/eu/infringement-procedure/
[72] http://europa.eu/rapid/press-release_IP-18-348_en.htm
[73] http://europa.eu/rapid/press-release_MEMO-18-3446_en.htm and http://europa.eu/rapid/press-release_IP-18-3450_en.htm and http://europa.eu/rapid/press-release_MEMO-18-6247_en.htm

3.3.2 Lack of policy consistency

Spain has one of the largest diesel fleets in Europe, having promoted these types of cars for years with fiscal and consumer benefits. Similarly to other countries, Spain has provided incentives to consumers for buying cars, including diesel cars on a continued basis, e.g. the Plan RENOVE (later re-named PIVE)[74].

The Central Government is working on a new plan which imposes an increased tax on diesel, with likely impacts on emissions reduction. The increase in the amount of tax collected from the additional diesel tax is expected to be about EUR 670 million, 30% of which will be dedicated to promoting cleaner mobility[75].

The Government introduced its Plan MOVEA (targeting companies buying electric cars) and Plan MOVALT (incentivising alternative energy vehicles (i.e. electric, natural gas), both of which were implemented in 2017/2018. The new plan MOVES on sustainable mobility aims at incentivising the purchase of alternative cars and infrastructure for charging electric cars and has a total budget of 45 million. The legal basis of this programme is established under Royal Decree 72/2019 of 17 February implementing Directive 2014/94/EU under the clean Mobility package[76].

According to the survey by the Organisation of Consumers and Users (OCU) 96% of the Spanish request measures to improve the public transport in general with specific reinforcement on days of high pollution and 81% of the Spanish support measures forbidding or reducing the use of polluting cars. Furthermore, 60% supports higher taxes for polluting cars. The OCU therefore advocates for higher taxes for higher polluters, irrespective of the type of fuel[77].

Some stakeholders argue that promoting energy alternative cars (including electric versus diesel) implies promoting the use of cars in any case which is not consistent with a traffic reduction policy[78].

The Madrid municipality has referred to the need for stricter standards for car emissions, and considered that while most cities have traffic problems and the car industry has the potential to develop cleaner technologies more quickly, the EU has not adopted the necessary legislation. The Euro 6 Regulation on pollutant emissions from passenger cars is expected to improve the situation but the Commission Regulation (EU) 2016/646 set the real driving emissions test limits on the basis of the limits defined for the Euro 6 standard to which it applied correction coefficients in order to take account of statistical and technical uncertainties of the laboratory tests[79]. Alongside the cities of Paris and Brussels, Madrid reacted against these measures to the CJEU because it considered that the Commission did not have the competence to adopt the relevant correction factors which rendered the Euro 6 emission limits less strict. In a first instance judgment, the General Court of the EU ruled that the provision prescribing the coefficient factor is invalid as its adoption is an infringement of Regulation No 71/2007 establishing emission limits for NO2. Appeal proceedings against this judgment are currently pending [80].

[74] http://www.planrenove.info/
[75] http://www.expansion.com/empresas/motor/2018/10/15/5bc48a8f468aebe1498b45cb.html
[76] https://www.miteco.gob.es/es/prensa/ultimas-noticias/el-gobierno-aprueba-la-distribuci%C3%B3n-territorial-del-programa-moves-para-favorecer-la-movilidad-sostenible/tcm:30-487788 and https://www.boe.es/boe/dias/2019/02/16/pdfs/BOE-A-2019-2148.pdf
[77] https://www.ocu.org/organizacion/prensa/notas-de-prensa/2018/movilidad230518
[78] Interview E-NGO 21 September 2018
[79] Commission Regulation (EU) 2016/646 amending Regulation (EC) No 692/2008 as regards emissions from light passenger and commercial vehicles (Euro 6)
[80] See pending cases (status as of 29 August 2019), Germany - Ville de Paris and Others v Commission (C-177/19 P), Hungary - Ville de Paris and Others v Commission (C-178/19 P) and Commission v Ville de Paris

3.3.3 Coordination between administrations

The main problem underlying Madrid's lack of compliance with the AAQ Directives' NO_2 limit values is the traffic. In Spain, the use of cars has been greatly promoted for many reasons: lack of awareness; low fuel prices; and strategic interest of the sector in Spain, as a car manufacturing country with a strong lobbying sector[81]. Some measures to reduce traffic in Madrid need coordinated action between the municipality and the regional government but they are not taken[82]. Cars driving into Madrid from areas outside the municipality create 40% of Madrid's traffic, pointing to the need for regional measures. Access to the city is through state-owned roads which do not always have priority bus lanes to avoid traffic jams. The number of buses linking the areas outside Madrid and the municipality do not operate with sufficient regularity to promote the use of public transport. Some of the entry roads have been improved and have even became paying highways but the problem of access to the city remains. Traffic jams affect the capacity to predict the time that it takes to arrive to Madrid by public transport, making it an unattractive alternative to privately owned vehicles[83].

As noted earlier, there is a coordination issue between the Madrid local government (municipality) and the regional government of Madrid (province) due to political and technical considerations. The municipality of Madrid complains that the region of Madrid does not support its compliance efforts.

The Clean Air Dialogue with Spain[84]concluded that improving coordination between the various levels and types of public administrations competent is important to ensure the implementation of the AAQ Directives in Madrid. Furthermore, the EEA report acknowledges that one of the main challenges faced by cities on their implementation of the air quality measures are related to the lack of coherent governance across the different administrative levels[85] .

The national Ministry for the Environment is responsible for coordinating the autonomous communities and the municipalities. In 2011 it established a coordination group to share lessons on the implementation of air quality measures. The Ministry organises regular meetings and thematic workshops, such as a workshop with network managers or on low cost microsensors. For example, the establishment of a national air quality index - in line with the European index - is currently being debated.

3.3.4 Ineffective and insufficient measures

Spain is taking measures to respond to the infringement procedures, as follows:

- Spain has developed a categorisation of cars based on environmental criteria, which is the basis for defining efficient cars and applying traffic reduction measures or car incentive measures. This categorisation has its origin in the National Plan for Air Quality and Protection of the Atmosphere 2013-2016 (Air Plan), which states that the main source of PM_{10} and NO_2 is traffic and proposes the classification of vehicles according to their levels of emissions and environmental impacts[86]. The purpose of this classification of cars is to positively discriminate

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and Others (C-179/19 P). Cases T-339/16 Ville de Paris v Commission, T-352/16 Ville de Bruxelles v Commission, T391/16 Ville de Madrid v Commission; https://curia.europa.eu/jcms/upload/docs/application/pdf/2018-12/cp180198en.pdf.

[81] Interview ministry representative

[82] Interview Madrid municipality

[83] Interview stakeholders

[84] European Commission and Ministerio para la Transición Ecológica, Conclusions of the Clean Air Dialogue between Spain the European Commission taking place in Madrid on 8 – 9 October 2018, October 2018. http://ec.europa.eu/environment/air/pdf/shared conclusions from clean air dialogue w Spain.pdf

[85] Europe's urban air quality — re-assessing implementation challenges in cities, EEA Report No 24/2018, 2019.

[86] page 12 of the Air Plan.

in favour of those vehicles that are most respectful of the environment and to be an effective instrument in the service of municipal policies, i.e. restricting traffic during high pollution episodes, and promoting new technologies through benefits. The system is implemented through car cards or badges whose display in Madrid remains voluntary up to 24 April 2019 when it will become mandatory.

- While car badges/cards are designated according to their environmental impact, for some stakeholders the categorisation is not strict enough to ensure an appropriate impact on air quality[87]. There are four environmental distinctions defined on the basis of the cars' environmental impacts, covering 50% of the most efficient fleet. The categories are: Zero emissions (blue colour – covers electric and hybrids cars); Eco (blue and green colour, includes hybrids and gas); C (green colour, includes petrol and diesel cars) B (yellow colour, covers gasoil and diesel cars). According to some stakeholders[88], the green label provides a confusing perception of an 'environmentally friendly' car when, in reality, it includes new diesel cars.

- While the implementation of the Madrid municipality's Protocol for action in case of instances of pollution by NO_2 (pollution peaks) is necessary, the impact of measures during adverse weather conditions seems to be very low, according to the NGOs interviewed[89]. They consider these measures to be effective only if they are applied preventatively.

The Protocol requires information to be disseminated when instances of pollution happen. However, the effectiveness of the information measures is not clear as the 2017 Eurobarometer points out that, of all Europeans, the Spanish show the highest numbers reporting being poorly informed about air quality. They are above average in considering air quality a major problem.

The Clean Air Dialogue with Spain[90] held in October 2018, concluded that additional measures in relation to PM_{10} and $PM_{2.5}$ should be considered, such as establishing requirements on the quality of solid fuels used in households; further incentives to accelerate scrapping of sub-standard solid fuel stoves and boilers and promoting systematic transfer to cleaner heating sources; continuous awareness-raising among the public of the health impact of residential solid fuel combustion and operation techniques in private households; and activities on energy efficiency. A ban on open field burning of agricultural waste was also raised, together with the promotion of policies on energy renovation of buildings.

Furthermore, the 2016 evaluation of the National Plan showed that it had not achieved its objective[91].

3.4 Factors underlying compliance with and effectiveness of the Ambient Air Quality Directives

The following section provides an overview of the factors promoting and hindering compliance with and effectiveness of the AAQ Directives in Spain in general, and Madrid in particular. The

[87] Interview of Environmental NGO 21 September 2018
[88] Interview of Environmental NGO 21 September 2018
[89] Interview 21 September 2018.
[90] European Commission and Ministerio para la Transición Ecológica, Conclusions of the Clean Air Dialogue between Spain the European Commission taking place in Madrid on 8 – 9 October 2018, October 2018. http://ec.europa.eu/environment/air/pdf/shared conclusions from clean air dialogue w Spain.pdf
[91] Joint report on air quality by Court of Auditors, Eurosai, 2019, p. 40 and 41 at: https://www.eurosai.org/en/databases/audits/Joint-Report-Air-Quality/

factors were identified through stakeholder consultations conducted in the context of this case study. The views expressed correlated with the information gathered through desk research.

3.4.1 Factors underlying compliance and effectiveness

The case study shows that the main factors promoting compliance with the AAQ Directives in Spain include: 1) an understanding that there is a problem; 2) harmonised methods and regular data on the levels of pollution and sources; 3) Coordination; and 4) effective enforcement at EU level in cases of non-compliance.

Understanding that there is a problem

The Competent authorities in Spain recognise the air quality issues in relation to certain pollutants such as NO_2, O_3, NO_X and PM_{10} and are willing to deal with it. The findings of the case study indicate that the Madrid authorities understand that effective solutions need to be implemented, even if they are controversial. As mentioned above, the measures of Plan A were preceded by broad public consultation which resulted in a public recognition of the importance of air pollution and the need to act. Furthermore, the constructive answer to EU level enforcement actions lies on the understanding that there is a need for urgent and effective measures. Madrid reports regularly to the Commission on its progress in implementing the Directives, through an annual report and monthly reports.

However, more could be done to educate citizens on the aims of the Directive and the measures taken to ensure air quality. Some measures are still unpopular and difficult to enact or implement. There is little pressure in Spain from NGOs or citizens in general requesting politicians to take action and, at the same time, little acceptance or support for the measures proposed or implemented.

Harmonised monitoring and measuring methods and regular data on the levels of pollution and on pollution sources

The authorities interviewed consider the Directives to have promoted a harmonised method for collecting data and measuring limit values and a process for monitoring some key pollution elements in all EU Member States. This has triggered a wealth of precise and up-to-date information on specific pollutants per zone, or per agglomeration, which allows the necessary measures to be adopted to ensure environmental and human health protection. As the information is harmonised, it can be compared both between regions within Spain but also between countries or villages with similar circumstances in different Member States. Lessons can be learned from the effectiveness of certain actions taken in different countries, such as closing access to traffic in central areas in large cities.

However, no systematic data on the impacts on heath from air pollution is collected, other than premature deaths, nor are any data systematically collected on the health incidence of the measures[92].

Coordination

While the competence for air quality rests at regional and local level, the Spanish Ministry has a coordination role that facilitates the effective implementation of the AAQ Directives. The local authorities interviewed within the framework of this project recognised the critical coordination

[92] Interview Health NGO on 24 September 2018 and European Court of Auditors, Special Report – Air pollution: Our health still insufficiently protected, 2018.

role of the Ministry is certain respects. For example, the national air quality index to inform the public is not yet harmonized, with each region applying its own. The Ministry is proposing to harmonise it with the European index. Additional activities beyond the requirements of the AAQ Directives are carried out by the Ministry which coordinates measures to gather data on other pollutants such as NH_3 or black carbon. The Madrid municipality has carried out some research on monitoring black carbon within the working group coordinated by the Ministry.

Enforcement

It is broadly recognized that without the enforcement actions at EU level, the implementation of the Ambient Air Quality Directives in Spain would be much less advanced[93].

The Commission has initiated infringement procedures against Spain (in relation to specific air quality zones) since 2010 for failing to comply with PM_{10} or NO_2 limit values. In 2013, a new infringement procedure was opened for exceeding PM_{10} limit values, with the reasoned opinion sent in 2014 together with an additional letter of formal notice. The Plan for 2013-2016 was adopted in response to these breaches. Another infringement procedure was initiated with a letter of formal notice in June 2015 for failure to comply with the NO_2 limit values. The reasoned opinion followed in February 2017[94]. The Madrid Plan A was adopted in September 2017. In 2018, the European Commission announced that it was taking legal action before the CJEU but the case was put on hold following Spain's commitment to adopt the necessary effective measures and to provide regular information to the Commission on the progress of the measures.

However, all stakeholders identified a need for quicker and more systematic enforcement measures at EU level[95].

3.4.2 Factors hindering compliance and effectiveness

The implementation challenge described above is driven by a number of factors, which are sometimes linked to the specific provisions of the AAQ Directives.

Insufficient coordination at local level

The allocation of responsibilities at local and regional level in air quality management may itself pose challenges to the implementation of the Directives. This challenge is further amplified by the limited coordination between the different authorities' levels in Spain. Under the principle of subsidiarity, Directive 2008/50/EC does not specify how responsibilities in air quality monitoring, assessment and management should be allocated within the Member States. Article 3 of Directive 2008/50/EC nevertheless lays down the obligation for Member State authorities to '*designate at appropriate levels the competent authorities and bodies responsible for the following: (a) assessment of ambient air quality; (b) approval of measurement systems (methods, equipment, networks and laboratories); (c) ensuring the accuracy of measurements; (d) analysis of assessment methods; (e) coordination on their territory if Community-wide quality assurance programmes are being organised by the Commission; and (f) cooperation with the other Member States and the Commission'.* The provision refers mainly to tasks relating to air quality monitoring and assessment rather than to the *management* of air quality specifically.

[93] All stakeholder interviews 21-24 September 2018
[94] European Commission, Infringement decisions, web page, at: http://ec.europa.eu/atwork/applying-eu-law/infringements-proceedings/infringement_decisions/?lang_code=en; https://legal.cleanair-europe.org/legal/eu/infringement-procedure/
[95] Special Report - Air pollution: Our health still insufficiently protected, European Court of Auditors, 2018, p. 30 at: https://www.eca.europa.eu/Lists/ECADocuments/SR18_23/SR_AIR_QUALITY_EN.pdf

As discussed above, particular shortcomings have been identified in relation to the adoption of the necessary measures to reduce pollution. There is a strong lack of information sharing at the different levels of responsibility - in relation to the measures needed or planned, their development and examples of best practices. This lack of coordination evidences the need to improve the communication and knowledge sharing between authorities within the country, which the Ministry is trying to promote. However, political considerations may jeopardize the adoption of the necessary measures.

Lack of motivation to take action

The findings of the case study suggest that, despite recent improvements, there has been a persistent lack of motivation and a certain negligence in taking action to ensure timely compliance with the requirements of the AAQ Directives. The absence of public awareness did not help to put pressure on the authorities to take action. This is closely linked to the hierarchy of priorities and the problem of competences and lack of coordination, as discussed above.

The fact is that while Spain has a National Air Quality Plan, only a third of the measures have been implemented and there are no performance indicators for measuring policy effectiveness[96]. The 2016 evaluation of the National Plan showed that it had not achieved its objective[97].

Some of the implementation problems in Spain stem from difficulties in understanding the mandatory nature of some of the Directives' provisions that require action prior to the deadlines. Limit values announced since 1999, which came into force in 2010, continue to be exceeded in 2017. Spain considered the earlier version of the Directive to represent recommendations up to the deadline – thus it did not set out a plan to ensure compliance with the limit values. Furthermore, there seems to be the understanding that target values are not mandatory.

This situation evidences the need for quicker and more systematic enforcement measures at EU level[98]. The deterrent effect of a quicker and more systematic EU enforcement policy would act as a stronger motivating element to take the necessary action on air quality in Spain.

3.5 Costs and benefits of the Ambient Air Quality Directives

3.5.1 Costs of implementation

As yet, there is no economic analysis of the implementation costs of the AAQ Directives in Spain. A number of rough estimates were gathered during the interviews with stakeholders for this study.

[96] Joint report on air quality by Court of Auditors, Eurosai, 2019, p. 40 and 41 at: https://www.eurosai.org/en/databases/audits/Joint-Report-Air-Quality/
[97] Idem, p. 47
[98] Special Report - Air pollution: Our health still insufficiently protected, European Court of Auditors, 2018, p. 30 at: https://www.eca.europa.eu/Lists/ECADocuments/SR18_23/SR_AIR_QUALITY_EN.pdf

Table 3-1 Information gathered and sent by the Ministry on 15 November 2018

Network maintenance costs (EUR)								
	Maintenance per station	**Maintenance all stations**	**Analysis**	**Other expenses**	**Administrative expenses**	**TOTAL/ year**	**Acquisition of new Equipment**	**No. of stations**
Red emep/vag/ camp		681,919	465,000			1,146,919	125,417 (2017) – 406,735 (2015)	13
Andalucía	15,000-20,000 estación/ año	1,000,000		1,500,000	200,000	2,700,000	VARIABLE	
Castilla y león. Ayto. Valladolid	68,894	344,471				344,471		5
Castilla y león	26,621	612,300				612,300		23
Comunidad valenciana	38,675	688,690	717,386	66,915	74,000	1,546,991	VARIABLE	74
Navarra		123,000	53,420	70,000	3,600	250,020		
Com. Madrid	24,300	583,200		100,000	100,000		211,200	24
La rioja	13,950	69,750			33,200	146,950	44,000	5
Baleares	69,666	100,000	25,000	5,000	150,000	418,000	100,000	6
Cantabria	300,000							
País vasco						1,000,000		
Extremadura	46,758	220,000	110,000		44,071	374,071		8
Ayto. Zaragoza		283,140						7
Asturias	18,400	290,000		20,000	70,000		80,000	25
Castilla-la mancha		115,633					309,980	
Galicia		529,958	337,739			867,697		

In addition, the municipality of Madrid provided the following information during the interview:

- Renewal of measuring equipment and maintenance of the network, which includes the value of the contract with the company (tendered). At the moment there are 10 people working on it. The estimated cost is about EUR 600,000. Each station has its own measuring equipment but the cost is not known.
- Plan A implementation: EUR 600,000.

- There are specific measures triggered by the peak pollution protocol, including the improvement of the transport public service, which are not estimated as they are part of the normal municipal budget.
- There is no estimate of the benefits regarding the improvement of air quality and the impact on public health of measures adopted in Madrid. A project will be launched in 2019 to obtain data on this issue.
- Contracts with laboratories: EUR 30,000 per year.
- Staff in the municipality: EUR 300,000 (four staff and two support staff).

3.5.2 Costs of non-implementation

One study by CE Delft provides some estimates on the health impacts and costs of diesel emissions in the EU in 2016, including Spain.

- Estimates vary depending on several factors. According to this study, the total cost of road traffic-related air pollution in 2016 (both health and non-health related) in Spain is between EUR 3,916 million and EUR 4,836 million (depending on whether it is based on COPERT emissions factors or on TRUE emission factors). Between 80-85% of emissions has its origin in diesel. Estimates of the total health-related air pollution costs borne by governments and compulsory health insurance varies from EUR 2,634 million to EUR 3,204 million.

3.5.3 Benefits of the AAQ Directives

The case study identified a number of benefits stemming from the implementation of the AAQ Directives. Without quantitative assessments of the benefits of the AAQ Directives in Spain, these can only be described in qualitative terms.

A number of provisions in the AAQ Directives have been identified as key in delivering air quality improvements. These include the establishment of a harmonised approach to monitoring, assessment and management of air quality throughout the EU. Overall, the following provisions of the AAQ Directive were cited as being the most important: 1) the setting of air quality standards; 2) providing information to the public and 3) cooperation with the European Commission and between Member States.

All stakeholders interviewed (institutions and NGOs) consider the AAQ Directives to have had a positive impact on air quality in Spain, stating that, without the Directives, efforts would have been considerably less.

The Ministry made special mention of the positive impact of promoting the monitoring and assessment of air quality in a harmonised way, ensuring the comparability of data. It pointed out that while air quality networks have existed for more than 20 years the main focus was controlling air quality problems due to traffic. There is now more social pressure and demand with respect to the issue.

According to a health NGO, the Spanish law and the implementing Royal Decree are complementary and establish an effective system to identify pollution problems. They could be used to include additional pollutants and ensure consistency with chemicals legislation.

The municipality of Madrid clarified that while the impact of the Plan A measures on the air quality has been assessed, there is no estimate of the benefits of the implementation of the Directives through the Plan Air or other measures with respect to the impact on health. A research project to obtain these data is planned for 2019.

4 CONCLUSIONS

Chapter 4 presents a summary of the main findings of the case study with respect to the main implementation challenges, the potential for improving the implementation of the Directives in Spain, and the aspects of the AAQ Directives that may have contributed to the present situation in Spain. Finally, a summary of the evaluation of the AAQ Directives is presented.

Identified problems and potential for improving the implementation of the Directives

The case study identified the following challenges in the implementation of the AAQ Directives:

Limits and pollutants

There was general agreement among the stakeholders that the Directives could be stricter on the limits for certain pollutants which are not yet in line with WHO standards. The distinction made between pollutants with target values and limit values was also criticised. Those criticisms were based on the existing scientific evidence on the impact on human health and the environment of the pollutants, which evidence is reflected, for instance, in the WHO recommendations. Other pollutants, similarly harmful to human health, could also be included, such as black carbon, ultrafine particulates or Hg, among others. It was also noted that the Directives are rigid and not sufficiently flexible to be adapted to advances in science.

Measuring limit values

The authorities interviewed believed that the Directives promote a harmonised method for collecting data and measuring emissions levels, as well as a process for monitoring them in all EU Member States. According to a recent study, practices on air quality management and in particular, the use of assessment tools and methods, have improved increasing understanding of the sources of air pollution[99].

However, NGOs remarked on the insufficiency of fixed measurement to assess air quality and, more specifically, criticised the location criteria of measuring points and the imbalance between the number of types of stations (e.g. between traffic and urban points). The lack of reference methods for the modelling of pollutant concentrations and the admission of measuring methods other than the reference methods was also criticised. It should be note, however, that the Directives allow for using other methods if their equivalence has been demonstrated. In addition, NGOs criticised that no regular data are collected on the impact of emissions on health, nor are any data systematically collected on health incidence of the measures.

Exceedance of limits & EU enforcement

In practice, Spain does not comply in certain air quality zones with the limit values set by the AAQ Directives in relation to NO_2 and PM_{10}. Of all pollutants, three (**NO_2, PM_{10} and O_3**) have exceeded the established limit or target value in all years during the period 2005-2016, and in 2017. According to the 2017 Evaluation Report on Air Quality in Spain (published in September 2018), the 2017 results are worse than those of 2016, as the number of air quality zones exceeding the legislated values for NO_2 and PM_{10} increased[100]. For NO_2, the number of urban agglomerations that exceeded the legislated values increased. More specifically in 2017, both the NO_2 annual mean and the hourly limit value was exceeded in Madrid, as it was in the previous

[99] EEA, Europe's urban air quality — re-assessing implementation challenges in cities, EEA Report 24/2018, 2019. Available at: https://www.eea.europa.eu/publications/europes-urban-air-quality

[100] Ministerio para la Transición Ecológica, La calidad del aire en España en 2017 baja levemente con respecto al año anterior (webpage). Available at: https://www.miteco.gob.es/es/prensa/ultimas-noticias/La-calidad-del-aire-en-Espa%C3%B1a-en-2017-baja-levemente-con-respecto-al-a%C3%B1o-anterior/tcm:30-481677

year. In addition, exceedances of NO_2 annual limit value occurred in other large cities such as Barcelona and surroundings, Granada and its metropolitan area, and Bilbao and its surroundings, largely due to traffic emissions[101].

The Commission has initiated infringement procedures against Spain since 2010 (e.g. for failing to comply with PM_{10} limit values). In 2013, a new infringement procedure was opened for exceeding PM_{10} limit values, with the reasoned opinion sent in 2014 together with an additional letter of formal notice. The Plan for 2011-2015 was adopted in response to these breaches. Another infringement procedure was initiated with a letter of formal notice in June 2015 for failure to comply with the NO_2 limit values. The reasoned opinion followed in February 2017[102]. In 2018, the European Commission announced that it was taking legal action before the CJEU but the case was put on hold following Spain's adoption of specific measures that could be effective. In the meantime, Spain committed to adopt the necessary measures and to provide regular information to the Commission on the progress of the measures.

As stated by the European Court of Auditors the lengthy enforcement procedure has not ensured compliance with the Directive[103]. Quicker and more systematic enforcement measures at EU level are needed to ensure their deterrent effect.

Planning

Spain has developed Air Quality Plans at national, regional and local level in order to promote the full implementation of the AAQ Directives. However, as evidenced by the EU infringement procedures and stakeholder reports, their implementation remains to be a challenge[104]. Additional actions to comply with NO_2 limit values such as those demonstrated in other Member States, could be usefully implemented in Madrid, i.e. access restrictions for transport, fiscal incentives to promote cleaner cars, or incentives to promote public transportation and non-motorized transport opportunities. The current imbalance in taxation between petrol and diesel is not justified[105].

While Spain has a National Air Quality Plan, only a third of the measures have been implemented and there are no performance indicators for measuring policy effectiveness[106]. The 2016 evaluation of the National Plan showed that it had not achieved its objective[107].

Concrete measures on energy efficiency (e.g. in buildings), measures promoting renewable energy, taxes targeting diesel or measures modifying the car environmental labels have been identified as still required to be implemented[108].

Other measures suggested as a result of the Clean Air Dialogue which have not been implemented yet are: establishing requirements on the quality of solid fuels used in households; further incentives to accelerate scrapping of sub-standard solid fuel stoves and boilers and promoting systematic transfer to cleaner heating sources; continuous awareness-raising among the public of the health impact of residential solid fuel combustion and operation techniques in private households;

[101] *Idem.*
[102] C:\Users\mb\Downloads\EU-infringements_2017.pdf and https://legal.cleanair-europe.org/legal/eu/infringement-procedure/
[103] Special Report - Air pollution: Our health still insufficiently protected, European Court of Auditors, 2018, p. 30 at: https://www.eca.europa.eu/Lists/ECADocuments/SR18_23/SR_AIR_QUALITY_EN.pdf
[104] Ecologistas en acción, 2017 report on air quality in Spain, p. 61
[105] European Commission and Ministerio para la Transición Ecológica, Conclusions of the Clean Air Dialogue between Spain the European Commission taking place in Madrid on 8 – 9 October 2018 at: http://ec.europa.eu/environment/air/pdf/shared_conclusions_from_clean_air_dialogue_w_Spain.pdf
[106] Joint report on air quality by Court of Auditors, Eurosai, 2019, p. 40 and 41 at: https://www.eurosai.org/en/databases/audits/Joint-Report-Air-Quality/
[107] Idem, p. 47
[108] Ibid, p. 62

and activities on energy efficiency. A ban on open field burning of agricultural waste was also raised, together with the promotion of policies on energy renovation of buildings. Due to the cross-cutting nature of air quality, efforts in this area can be included in both climate and energy-related policies[109].

At a municipal level, the measures of the Madrid Plan A aim at improving ambient air quality and complying with the limit values established for NO_2, WHO guide values for PM_{10} and target values for O_3.

The insufficiency of the air quality plans to meet legal standards was noted by NGOs, in particular their late development, lack of proper monitoring and lack of coercive measures for enforcement. In addition, the lack of short-term plans is deemed an issue of concern[110].

Coherence and sectoral policies

While coherence with other environmental measures such as those related to the IED is ensured, there is a lack of coherence with other sectoral policies. For instance, Spain is still incentivising the acquisition of diesel cars until 2020. Further the modification of the standards on NO_2 emission limit under the Euro 6 Regulation (EC) No 715/2007 through the Regulation EU 2016/646 were identified. Alongside the cities of Paris and Brussels, Madrid reacted against these measures to the CJEU because it considered that the Commission did not have the competence to adopt the relevant correction factors since it considered that this rendered the Euro 6 emission limits less strict. In a first instance judgment, the General Court of the EU ruled that the provision prescribing the coefficient factor is invalid as its adoption is an infringement of Regulation No 71/2007 establishing emission limits for NO2[111]. Appeal proceedings against this judgment are currently pending[112].

Coordination

The lack of coordination between competent administration levels in Madrid hinders compliance with the AAQ Directives' targets and limit values. This is an issue, for instance, in the policy to reduce the presence of cars in Madrid, where regional policies from the autonomous community are necessary in order to successfully apply the measures intended by the municipality of Madrid. This lack of coordination also translates into a lack of communication and knowledge sharing within the country. The Clean Air Dialogue held in October 2018 concluded that better coordination among the different administrations and different ministries is essential to improve the clean air policy. This will also maximise the co-benefits of action in other areas including transport, energy, climate change and agriculture[113].

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[109] European Commission and Ministerio para la Transición Ecológica, Conclusions of the Clean Air Dialogue between Spain the European Commission taking place in Madrid on 8 – 9 October 2018 at: http://ec.europa.eu/environment/air/pdf/shared conclusions from clean air dialogue w Spain.pdf

[110] Interviews NGO 21/09/2018 and Ecologistas en acción, 2017 report on air quality in Spain, p. 40 at: https://www.ecologistasenaccion.org/?p=13106 and https://www.ecologistasenaccion.org/wp-content/uploads/2018/06/informe-calidad-aire-2017.pdf

[111] Cases T-339/16 Ville de Paris v Commission, T-352/16 Ville de Bruxelles v Commission, T391/16 Ville de Madrid v Commission at: https://curia.europa.eu/jcms/upload/docs/application/pdf/2018-12/cp180198en.pdf

[112] See pending cases (status as of 29 August 2019), Germany - Ville de Paris and Others v Commission (C-177/19 P), Hungary - Ville de Paris and Others v Commission (C-178/19 P) and Commission v Ville de Paris and Others (C-179/19 P).

[113] European Commission and Ministerio para la Transición Ecológica, Conclusions of the Clean Air Dialogue between Spain the European Commission taking place in Madrid on 8 – 9 October 2018 at: http://ec.europa.eu/environment/air/pdf/shared conclusions from clean air dialogue w Spain.pdf

Public awareness

Traditionally, there has been a lack of awareness among citizens, which translated into a lack of pressure for public administration to comply with the objectives of the Directive. However, in recent years, public awareness of the issue has increased in Spain. The implementation of the Directives triggered the adoption of important measures such as the development of a map of the monitoring network which provides information on the concentration levels per station, date and time[114].

- For some NGOs, this is not enough. The Eurobarometer points out, for instance, that among all Europeans, the Spanish report the highest numbers of citizens feeling that they are not properly informed about air quality. This is confirmed by the report stating that one the main challenges recognised by cities like Madrid on their implementation of air quality measures is how to effectively communicate air quality issues to the public[115].

4.1 Assessment of the AAQ Directives

The following section presents a summary of the findings of the case study in relation to the relevance, effectiveness, efficiency, coherence and added value of the AAQ Directives.

4.1.1 Relevance

The findings of the case study indicate that the objectives of the AAQ Directives are relevant to the needs of citizens in Spain. All stakeholders consulted agreed on the need to retain the objectives of the Directive. However, there is also a general opinion that the Directives should be stricter, with new pollutants added and stronger limits imposed in some cases.

4.1.2 Effectiveness

The Directives have provided an incentive to establish policies to control air quality in Spain. According to some NGOs, without the Directives, measures would have been much slower to develop. It has also fostered increasing social pressure to solve the problem, e.g. Plan A of the municipality of Madrid. However, Spain still does not comply with the limits of NO_2 and PM_{10} in some zones; this lack of implementation affects the effectiveness of the Directives. The lack of coordination between public authorities also hinders the effectiveness of the application of the Directives.

4.1.3 Efficiency

As yet there is no economic analysis of the implementation costs of the AAQ Directives in Spain. A number of rough estimates were gathered via the interviews with stakeholders in the context of this study. These estimates relate to the network maintenance costs per autonomous community. With data from 10 of the 17 autonomous communities and the national network, the reported costs exceed EUR 9 million per year. The municipality of Madrid also provided some data, for instance, the cost of implementing Plan A (EUR 544,000).

The case study identified a number of benefits stemming from the implementation of the AAQ Directives. Without any quantitative assessments of the benefits of the AAQ Directives in Spain, these can be described solely in qualitative terms. Identified benefits include: 1) the establishment

[114] Ayuntamiento de Madrid, Plan de Calidad del Aire y Cambio Climático de la Ciudad de Madrid, 2017. Available at: https://www.madrid.es/UnidadesDescentralizadas/UDCMedios/noticias/2017/03Marzo/13Lunes/NotasdePrensa/Plan%20Calidad%20Aire/ficheros/PlanACalidadAire2017.pdf, p. 37

[115] EEA, Europe's urban air quality — re-assessing implementation challenges in cities, EEA Report 24/2018, 2019. Available at: https://www.eea.europa.eu/publications/europes-urban-air-quality

of a harmonised approach to monitoring, assessment and management of air quality throughout the EU; 2) positive impact on the improvement of air quality in Spain; 3) promoting the monitoring and assessment of air quality in a harmonised way; and 4) increased public awareness.

4.1.4 Coherence

In Spain there is a high level of coordination and consistency between the air quality policy and the Industrial Emissions Directive including the relevant best available techniques (BAT) conclusions. They contribute to the fulfilment of the objective of the AAQ Directive to maintain air quality where it is good and improve it in other cases.

At national level, there is a lack of coherence and coordination with other public policies. For instance, the incentives for diesel cars by the state, or the lack of coordination to implement policies between the autonomous community and the municipality of Madrid, which hinder the effectiveness of policies applied.

The Madrid municipality identified a problem of coherence between the European air quality requirements and emission standards for vehicles. Under the Regulation EU 2016/646 the European Commission proposed an amendment to the new Euro 6 Regulation regarding the cars' NO_2 emission limit which would affect compliance with ambient air quality limit values or targets[116]. It applied correction coefficients in order to take account of, statistical and technical uncertainties of the laboratory tests. Alongside the cities of Paris and Brussels, Madrid reacted against these measures to the CJEU because it considered that the Commission did not have the competence to adopt the relevant correction factors since it considered that this rendered the Euro 6 emission limits less strict. In a first instance judgment, the General Court of the EU ruled that the provision prescribing the coefficient factor is invalid as its adoption is an infringement of Regulation No 71/2007 establishing emission limits for NO_2[117]. Appeal proceedings against this judgment are currently pending[118].

4.1.5 EU added value

The monitoring requirements of the AAQ Directives have stimulated a number of improvements in the monitoring of air quality. While monitoring took place before the introduction of the AAQ Directives, the added value of the Directives comes from the shift in focus of monitoring to the areas where most of the population lives, improvements in the quality of the monitoring data, and harmonised data collection allowing for comparisons across the EU.

The enforcement actions at EU level to ensure implementation of the AAQ Directives are perceived as an EU added value inherent in the functioning of the EU system. According to some stakeholders, efforts would have been considerably less in Spain had the Directives not come into force and the Commission not monitored its implementation.

Another major area of EU added value of the Directives lies in the increased visibility of the air quality issue and the awakening of public and political interest to solve the problem.

[116] Commission Regulation (EU) 2016/646 amending Regulation (EC) No 692/2008 as regards emissions from light passenger and commercial vehicles (Euro 6): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32016R0646

[117] Cases T-339/16 Ville de Paris v Commission, T-352/16 Ville de Bruxelles v Commission, T391/16 Ville de Madrid v Commission at: https://curia.europa.eu/jcms/upload/docs/application/pdf/2018-12/cp180198en.pdf

[118] See pending cases (status as of 29 August 2019), Germany - Ville de Paris and Others v Commission (C-177/19 P), Hungary - Ville de Paris and Others v Commission (C-178/19 P) and Commission v Ville de Paris and Others (C-179/19 P). https://curia.europa.eu

APPENDIX A INTERVIEWS

Organisation	Name and position	Date of the interview
Madrid municipality		21/09/2018
Madrid municipality		21/09/2018
Ministry of Environment		24/09/2018
Ecologistas en accion		21/09/2018
Fundación Alborada		24/09/2018

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European Commission

CASE STUDY REPORT
SWEDEN

Supporting the Fitness Check of the EU Ambient Air Quality Directives (2008/50/EC, 2004/107/EC)

COWI

Written by Adriana R. Ilisescu
March 2019

Contents

Appendices

1 INTRODUCTION

This report summarises the findings and conclusions of the **case study for Sweden**. The case study had a focus on rural environment and ecosystem impacts.

The report is one of seven case studies carried out for the Fitness Check of the EU Ambient Air Quality Directives. Its main purpose is to examine, in more detail, the situation regarding the experience and lessons learnt in the implementation of the air quality legislation. The case studies provide a basis for a more detailed examination of the questions of the fitness check and include a review of implementation and integration successes and problems, the costs of implementation and of non-implementation of the legislation and the administrative burden of implementation and opportunities for improving implementation without compromising the integrity of the purpose of the Directives. As such, the case study complements the information gathered through other sources, such as desk review, targeted questionnaire, open public consultation, interviews, focus groups and stakeholder workshops.

The Member States for detailed case studies have been selected to cover a range of geographies, governance structures and sizes. This has led to the selection of the following **seven case study Member States: Slovakia, Germany, Spain, Sweden, Ireland, Bulgaria and Italy**.

The case study report is structured in four chapters, namely:

- **Chapter 1 – Introduction**
- **Chapter 2 – Background and context**, presents general information about the context of the case study
- **Chapter 3 – Findings**, presents detailed findings regarding the relevance of the AAQ Directives, the implementation successes and problems, the factors underlying compliance with the Directives, the costs and benefits.
- **Chapter 4 – Conclusions**, presents a summary of the main findings.

The case study findings rely on extensive desk research and a series of interviews that took place over the period October and November 2018. An overview of the interviews carried out is provided in Appendix A.

The case study has been shared with the interviewed stakeholders in January 2019 for validation of findings and correction of factual mistakes. Feedback received from the stakeholders was integrated in the case study report.

2 BACKGROUND AND CONTEXT

The present chapter contains general information about the air quality framework in Sweden.

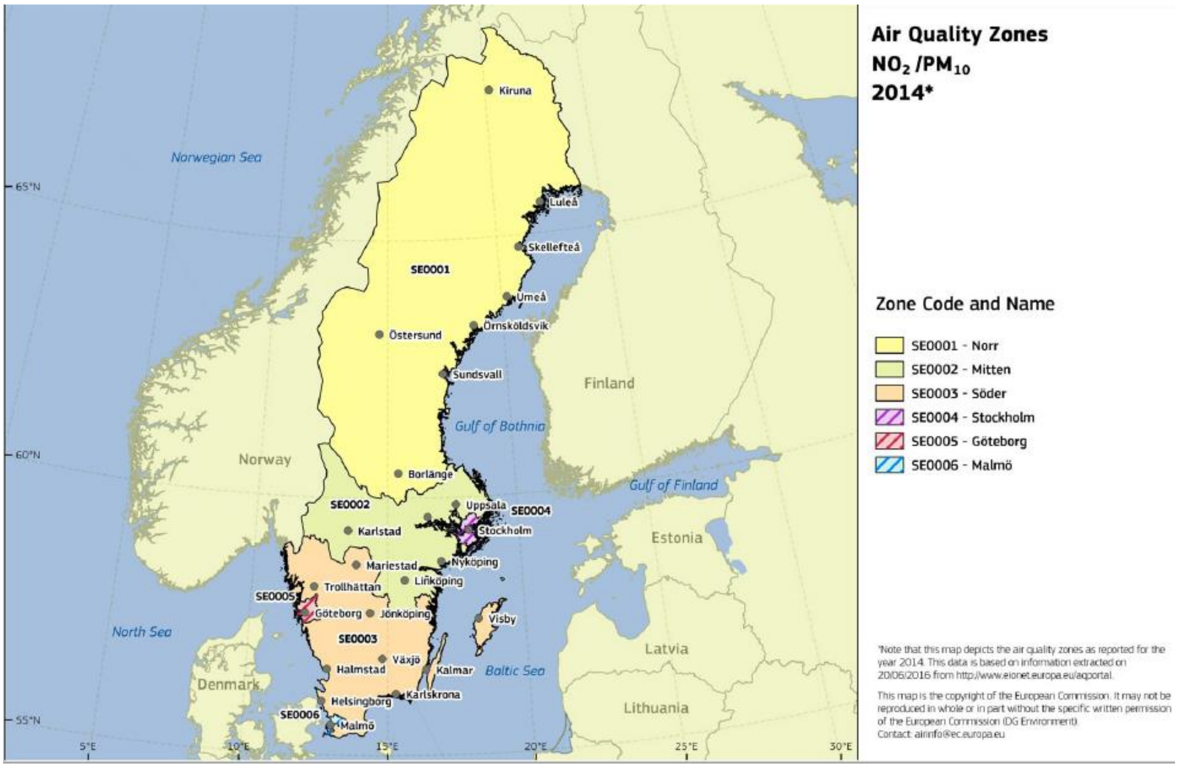
2.1 Sweden and air quality zone characteristics

2.1.1 Scope of the case study

The case study covers *the entire territory of Sweden and the implementation of the AAQDs*. In addition, the case study will present findings related to the effects of AAQDs on air quality and the implications it had on rural environment and ecosystem impacts.

As shown in the figure below, the territory of Sweden is divided into *6 zones and 3 agglomerations* (Stockholm, Malmo, and Goteborg).

Figure 2-1 Air quality zones for AAQ Directives



Source: European Commission, DG Environment, Atlas of air quality zones and monitoring stations (2013 & 2014), Sweden.

The table below presents an overview of the different zones and counties / municipalities that are included, type of zone and the number of inhabitants and area.

Table 2-1 Overview of air quality zones in Sweden

Zone	Zone name	Counties / municipalities	Type of zone	Number of inhabitants in 2017 (million inhabitants)	Area (km^2)
SE0001	North Sweden	Norrbotten (BD), Västerbotten (AC), Västernorrland (Y), Jämtland (Z), Dalarna (W), Gävleborg (X)	Other (Non-aglom.)	1.47	290,647
SE0002	Middle Sweden	Värmland (S), Örebro County (T), Västmanland (U), Uppsala (C), Stockholm County except Zone 4 (AB), Södermanland (D), Östergötland	Other (Non-aglom.)	2.28	69,344
SE0003	Southern Sweden	Västra Götaland except zone 5 (O), Jönköping (F), Kalmar (H), Gotland (I) Kronoberg (G), Halland (N), Blekinge (K), Skane except zone 6 (M)	Other (Non-aglom.)	2.99	81,762
SE0004	Stockholm's urban area	The municipalities Botkyrka, Danderyd, Ekerö, Haninge, Huddinge, Järfälla, Lidingö, Nacka, Salem, Sollentuna, Solna, Stockholm, Sundbyberg, Täby, Tyresö, Upplands Väsby, Vallentuna, Vaxholm, Österåker	Semi-urban area (Agglom.)	1.99	2,755
SE0005	Gothenburg urban area	The municipalities of Ale, Gothenburg, Härryda, Kungälv, Lerum, Mölndal, Partille, Öckerö.	Semi-urban area (Agglom.)	0.82	2,002
SE0006	Malmo urban area	The municipalities Burlöv, Lomma, Lund, Malmö, Staffanstorp, Vellinge.	Semi-urban area (Agglom.)	0.56	925
Total				**10.12**	**447,435**

Source: Swedish EPA, Sweden's air quality zones, http://www.naturvardsverket.se/Sa-mar-miljon/Klimat-och-luft/Statistik-om-luft/

2.1.2 Characteristics of air quality zones

Sweden is an elongated country with geographically diverse climate. This has an impact on the air pollution levels in several manners. In general, there is a north-south gradient in terms of pollution levels for background concentrations, with increased air quality in the northern parts of Sweden and decreased air quality in the southern parts. However, local variations can occur because of local emissions. The southern part of Sweden is located in the closer proximity of major pollution sources and densely populated parts of Europe and is affected by long-range trans-boundary air pollution happening in other countries.

Local climate and meteorological conditions are important and have an effect on the inter-annual variability in atmospheric composition and emission levels. For example, low temperatures can lead to increased air pollution levels because of general emissions from the increasing use of fuels in households for heating. This also has applicability for vehicles, as emissions increase in seasons with cold climate. Furthermore, the level of precipitation / rainfall also has an effect on the levels of air pollution in Sweden, in particular when it comes to particles and water-soluble air pollutants, such as sulphur dioxide.

The speed and direction of the wind has an important impact on the dispersion and concentration of air pollutants. In Sweden, western and southwest winds are commonly occurring which have a positive effect on air quality. Nevertheless, Sweden does get affected by transboundary pollution from other neighbouring countries.

Variations in topography also have an effect. Many communities in Sweden are located along watercourses or valleys or in the proximity of the sea and lakes, which can cause issues in terms of air pollution because of mixing of air due to ground inversion.

Text box 2-1 Sweden

Sweden	
GDP per capita in PPS (2017)	122
GDP per capita growth (% 2006-2017)	23.8
Population (1 January 2018)	10,120,242
Governance structure	Unitary and decentralised
Zones defined as agglomerations (%)	50%
Area:	447,435 km^2
Characteristics of Sweden: For the implementation of the AAQDs, Sweden is divided into 6 air quality zones, 3 of which are agglomerations. Sweden has a varied topography and climate, which have an impact on the concentrations and dispersion of air pollution in different regions. The main causes of air pollution in Sweden are NO_2 and PM_{10}. The main sources of pollutants are traffic, international shipping, and industry.	

Source: Eurostat, GDP per capita in Purchasing Power Standards (PPS) expressed in relation to the European Union (EU28) average set to equal 100; Eurostat, Real GDP per capita, growth rate and totals; Eurostat, Population on 1 January; EEA Air Quality e-Reporting.

2.1.3 Ecosystem effects and rural environment

Despite the fact that the impacts of air pollutants on ecosystems and biodiversity in Sweden have decreased in the past few decades, they continue to constitute an important source of concern. In the 1970s, acidification as a consequence of air pollution constituted an important issue in Sweden and measures have been taken since to tackle the root causes of acidification. In the 1980s, concerns grew related to forest damage, eutrophication and stratospheric ozone layer depletion. During the 1990s, heavy metals and persistent organic pollutants became a growing source of concern and in later years, increased emphasis was put on health issues (particulate matter) and the effects of air pollution on climate change. Compared to the 1980s and 1990s, some improvements were registered at pan-European level and in Sweden in terms of reductions of eutrophying and acidifying emissions to the air. In recent years, concentrations of NO_x and SO_2 in Sweden have been reduced but there are still exceedances of critical loads across ecosystems. Some emissions, in particular ammonia (NH_3) and nitrogen dioxide (NO_2) emitted from the agriculture and transport sectors, will remain an important source of concern when it comes to eutrophication cause by air pollution.

The ecosystem area at risk of eutrophication due to airborne nitrogen deposition has decreased. It is further expected to decrease up to 19% by 2020 compared to 30% in 2010.[1]

2.2 Air quality monitoring and air quality

The following section presents briefly the arrangements in Sweden in terms of air quality monitoring and presents information regarding exceedances reported.

2.2.1 Air quality monitoring

Air quality monitoring set-up

At national level, the Swedish Environmental Protection Agency (EPA) is responsible for monitoring concentrations of pollutants in air in rural background areas on a national level. The EPA is also responsible for transferring to the EU monitoring data. Furthermore, the EPA ensures the availability of information to the public. The data collected by the Swedish EPA is hosted by the Swedish Meteorological and Hydrological Institute (SMHI).

At regional level, the county administrative boards monitor concentrations of pollutants in air and precipitation in rural background areas on a regional level. This monitoring aims to follow up the Swedish environmental objectives, among others Clean Air, Natural Acidification Only and Zero Eutrophication (see section 2.4).

Monitoring in cities is the responsibility of local authorities (municipalities). The Swedish Environmental Protection Agency's regulations on air quality control specify how monitoring of air quality should be carried out (NFS 2016:9). According to section 26 of the Air quality ordinance (SFS 2010:477), each municipality must ensure monitoring of air quality through measurement, model calculation or objective observations in urban areas. Municipalities are responsible for assessing the air quality in order to follow up on the air quality standards in urban background areas and in traffic sites. Municipalities can join forces to set up areas of cooperation. For areas of cooperation between municipalities, a coordination programme to monitor the air quality standards and quality control and assurance programme must also be defined jointly.

Overall, the Swedish EPA is responsible for receiving, compiling, making available and storing air quality data from municipalities. The Swedish EPA also presents the data in annual charts, which are made publically available.

The delineation of the responsibilities for monitoring different type of pollutants in Sweden is presented in the table below. Overall, responsibility is split between the municipalities that keep control of air quality in cities (traffic and urban areas) and the Swedish Environmental Protection Agency that is responsible for ensuring control of air quality in rural areas (regional background).

[1] EEA (2018), Eutrophication of terrestrial ecosystems due to air pollution. Available at https://www.eea.europa.eu/airs/2018/natural-capital/eutrophication-of-terrestrial-ecosystems#tab-based-on-data.

Each municipality must check in urban areas that the levels of NO_x, SO_x, CO, PM_{10}, $PM_{2.5}$, Benzene, BaP, As, Cd, Ni, Pb is within the set limits. On the other hand, the Swedish EPA is responsible for monitoring pollutants such as $PM_{2.5}$, nitrogen doxide, sulphur doxide and ground-level ozone.

Table 2-2 Monitoring of air quality in Sweden

Air quality norm	Where?*	Responsible
Nitrogen dioxide	Traffic/Urban areas	Municipalities
Nitrogen oxides	Regional background (Rural)	Environmental Protection Agency
Sulphur dioxide	Traffic/Urban areas	Municipalities
Sulphur dioxide	Regional background (Rural)	Environmental Protection Agency
Carbon monoxide	Traffic/Urban areas	Municipalities
Ozone	Cities / suburbs / rural areas / regions	Environmental Protection Agency
Benzene	Traffic/Urban areas	Municipalities
PM_{10}	Traffic/Urban areas	Municipalities
$PM_{2.5}$	Urban areas	Municipalities
$PM_{2.5}$	Exposure reduction / Urban areas	Environmental Protection Agency
BaP	Traffic/Urban areas	Municipalities
Arsenic	Traffic/Urban areas	Municipalities
Cadmium	Traffic/Urban areas	Municipalities
Nickel	Traffic/Urban areas	Municipalities
Lead	Traffic/Urban areas	Municipalities

*Measurement in traffic stations can also correspond to other sources such as heating sources or industries.
Source: Swedish EPA (2016), Air quality Guide

The *scope of monitoring*, i.e. whether it should be conducted in the form of continuous fixed measurement, indicative measurement, model calculations or objective estimation as well as the number of measuring points required is defined in the national legislation. Continuous measurements are done for concentrations above the lower assessment threshold and with a specific number of inhabitants as indicated below.

Table 2-3 Assessment procedures

Assessment level	Assessment procedure which as a minimum shall be applied in a municipality or a collaboration area
The concentrations exceed or risk exceeding the environmental quality standard	Continuous measurements in the exceeding municipalities
The concentrations are between the upper assessment threshold (UAT) and the environmental quality standard	Continuous measurements (Objective estimation if less than 10,000 inhabitants)
The concentrations are between the lower assessment threshold (LAT) and the upper assessment threshold (UAT)	Indicative measurements, modelling or objective estimation are required (applies mostly on smaller municipalities in northern Sweden) or objective estimation if less than 10,000 inhabitants.
The concentrations are below the lower assessment threshold (LAT)	Model calculation or objective estimation

Source: Swedish Environmental Protection Regulations on Assessment of Air Quality

Table 2-4 Sampling locations in a municipality or collaborative area

Number of inhabitants, thousands	A. At concentrations above the upper assessment threshold				B. At concentrations between the lower assessment thresholds and the upper assessment threshold			
	NO, SO, Pb, CO, Benzene	PM_{10} and $PM_{2.5}$	As, Cd, Ni	BaP	NO, SO, Pb, CO, Benzene	PM_{10} and $PM_{2.5}$	As, Cd, Ni	BaP
10-249	1	2	1	1	1	1	1	1
250-499	2	3	1	1	1	2	1	1
500-749	2	3	1	1	1	2	1	1
750-999	3	4	2	2	1	2	1	1
1,000-1,499	4	6	2	2	2	3	1	1
1,500-1,999	5	7	2	2	2	3	1	1
2,000-2,499	6	8	2	3	3	4	1	1
2,500-2,999	7	10	2	3	3	4	1	1
3,000-3,500	8	11	2	3	3	6	1	1

The total number of sampling locations for PM_{10} and $PM_{2.5}$. If PM_{10} and $PM_{2.5}$ are measured at the same sampling location, these shall be counted as two separate sampling locations.
Source: Swedish EPA

The national legislation also stipulates that continuous measurements need to be done, as a basic rule, by each municipality who exceeds the lower threshold. However, municipalities can form collaborative areas[2] which would then allow them to have sampling points covering more than one municipality, thus implicitly reducing the number of sampling points in place.

[2] Collaborative areas are geographical areas where the assessment of air quality is carried out in collaboration between two or more municipalities.

In line with the AAQD, the national legislation stipulates that modelling or indicative measurements can supplement continuous measurements at concentrations above the upper assessment threshold so that sufficient information is obtained on the spatial distribution of air pollutants.

The measuring methods are defined in cooperation with the *Reference Laboratory for Urban Air Measurement (Reflab) and the Reference Laboratory for modelling*, which has been set up as a result of the implementation of the AAQDs. The Reflab provides on assignment by the Swedish EPA advice to municipalities on measuring methods and instruments to be used. The Reflab measurements also support the EPA in making recommendations for decisions for approval of measuring methods. In 2016, the Reflab developed a national manual outlining the various procedures and tasks to be performed as part of the air quality control process in Sweden. The manual for the harmonisation of quality assurance and quality control for air quality measurement in Sweden[3] covers guidance on:

- Choice of location for measurement
- Selection of measuring instruments
- Installation of measuring equipment
- Maintenance and maintenance of measuring equipment, including calibration and service
- Data management, including control of compliance with data quality goals
- Reporting and availability of data
- Training.

Monitoring of air quality pollutants effects on the ecosystem and rural environment has been defined in line with the NEC Directive and international commitments of Sweden (e.g. the Convention of Long Range Transboundary Air Pollution). The monitoring program is designed to fit the purpose of the NECD with the main pressure being air pollution. However, the monitoring system has not changed or been affected by the implementation of the AAQDs.

The monitoring design covers large spatial gradients combined with high intensity monitoring sites for improved process understanding.

[3] Harmonisation of QA / QC for air quality measurement in Sweden. Available at: http://www.aces.su.se/reflab/kvalitetssakring/harmoniserad-qaqc-manual/.

- Terrestrial ecosystems: the monitoring network consists of a combination of sites covering the spatial gradients of Sweden and a few monitoring locations with high temporal resolution with measurements in both terrestrial and aquatic environments. Additionally, four intensively monitored Integrated Monitoring sites are included.

- Ozone monitoring network: the monitoring network consist of 10 sites where hourly measurements of O_3 and monthly measurements of NO_2 are performed. The monitoring is combined with modelling to assess the potential effects of ozone on forests and crops in Sweden.

- Freshwater ecosystems: monitoring of lakes and streams.

Concentrations in Sweden are well below the critical levels for NOx and SO_2 and target value for ozone set out in the AAQDs.

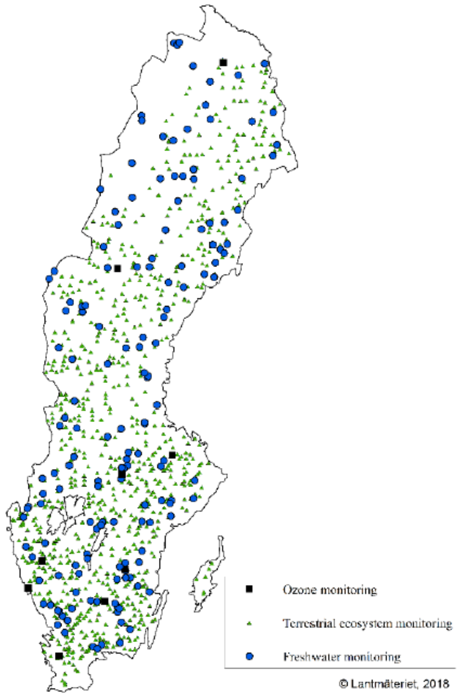


Figure 2-2 Monitoring network for ozone, terrestrial ecosystems, freshwater monitoring

Air quality monitoring effectiveness

Sweden was monitoring air quality even before the implementation of the AAQDs but the added value of the Directives in terms of air quality is that it ensures more harmonised and standardised measurements within and across countries. In Sweden, the implementation of the AAQDs also led to more emphasis on traffic measurements and monitoring of PM_{10} levels.

Evidence collected in the context of the case study shows that *monitoring is compliant with the AAQ Directives but limited* in some cases. The Swedish EPA works actively with municipalities to improve the effectiveness of the monitoring. In some instances, monitoring could be improved and the provisions of the AAQD be further strengthened. For example, interviews with the authorities conducted in the context of this case study highlighted that Sweden complies with the requirements of the sampling points but has a limited amount of sampling points. This is partly a consequence of the possibility of municipalities to monitor jointly air quality by setting up cooperative areas.

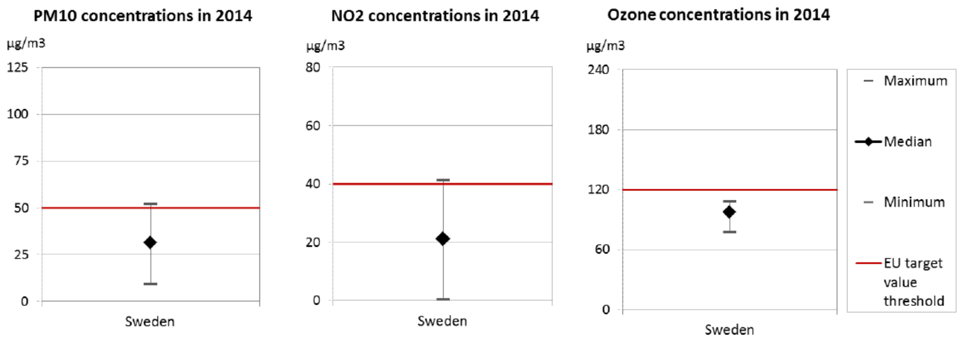
In addition, measurement *focus is on monitoring particulate matter and NO_2* emissions but to a lesser extent on other pollutants. For example, the location of monitoring sites for BaP was questioned by the Swedish EPA interviewees indicating that BaP is a very local problem in areas with no district heating and substantive log combustion and that sampling and siting point should take this into consideration. As such, monitoring in traditional stations and in some cities in a few background stations may not provide a clear idea of the scale of the problem. In rural areas, where BaP may constitute a problem, monitoring does not take place.

2.2.2 Air quality in Sweden

Although the emissions of several air pollutants have decreased significantly in Sweden, there are still some sources of concern for *air quality levels* in Sweden. Between 1990 and 2014 reductions in the levels of emissions have been registered in relation to sulphur oxides (-77%), nitrogen oxides (-51%), ammonia (-5%) and volatile organic compounds (-50%). The reductions registered ensured that air emissions for these pollutants are within the currently applicable ceilings.[4]

However, air quality continues to be a *source of concern* in Sweden in particular in relation to *particulate matter (PM_{10}) and nitrogen dioxide (NO_2) concentrations*. Local emissions play an important role in contributing to concentrations of these types of pollutants. Exceedances of air quality standards related to the annual mean concentration of NO_2 have been registered in two air quality zones (Gothenburg and Stockholm) and related to the daily concentration of particulate matter (PM_{10}) in two air quality zones (Stockholm and Middle Sweden). Additionally, ozone concentrations have also been an issue in several air quality zones.

Figure 2-3 Pollutant concentrations (2014)



Source: EC (2017), the EU Environmental Implementation Review[5]

The *main sources of air pollution* are road traffic, shipping, industry and domestic air pollution. Local emissions also play an important role in air pollution in Sweden. The location of Sweden in the close proximity of countries with high emissions also contributes to concentration levels. The table below provides an overview of the main sources of pollution per type of pollutant.

[4] European Commission (2017) The EU Environmental Implementation Review, Country Report – Sweden, SWD (2017) 35 final. Available at: http://ec.europa.eu/environment/eir/pdf/report_se_en.pdf.

[5] The graphs show concentrations as measured and reported by the Member States at different locations, specifically they show (a) for PM10 the 90.4 percentile of daily mean concentration, which corresponds to the 36th highest daily mean, (b) for NO_2, the annual mean concentration and (c) for O3, the 93.2 percentile of maximum daily 8-hour mean concentration values, which corresponds to the 26th highest daily maximum. For each pollutant, they depict both the lowest and highest concentration reported, as well as the median values (i.e. note that 50% of the stations report lower concentrations than the respective median value, the other 50% report higher concentrations). The air quality standards as set by EU legislation are marked by the red line.

Figure 2-4 Primary sources of pollutants for various pollutants

Pollutant	Sources
PM_{10}	Road traffic when using studded tires
$PM_{2.5}$	Long-distance transport, small-scale wood burning, electricity and heat production, industrial emissions, road traffic, shipping
NO_x	Road traffic, electricity and heat production, industrial emissions, small-scale wood burning, shipping, long-haul transport
SO_2	Long-distance transport, electricity and heat production, industrial emissions, shipping
*O_3	Long-distance transport, road traffic, smalls-scale wood burning, households, industrial emissions
CO	Road traffic, small-scale wood burning, small work machines, electricity and gas heat generation, industrial emissions, shipping,
VOC	Households, road traffic, small-scale wood burning, small work machines, industrial emissions, shipping
PAH	Small scale word burning, industrial emissions
Metals	Metal industrial emissions, long-distance transport

Source: Swedish EPA, Air quality Guide

*O3 is a secondary pollutant, it is not directly emitted from a source but it is created through chemical reactions of other pollutants.

On average, air quality in Sweden is good but there are periods with higher pollution levels. During spring and winter, NO_x and PM levels rise due to increased combustion, tear from transportation and meteorological conditions. High levels of ozone occur during summer months. Transboundary air pollutants, especially from forest and agricultural fires play an important role in Sweden's air quality.[6] Sweden has put in place measures to tackle such issues, which are further explained in section 3.2.

2.2.3 Compliance with EU ambient air quality standards

In 2016, Sweden was one of the countries in breach of PM and NO_2 limit values.7 The table below present exceedances in municipalities in Sweden in 2016.

[6] UNEP (2015), Sweden Air Quality Policies. Available at http://wedocs.unep.org/xmlui/bitstream/handle/20.500.11822/17118/Sweden.pdf?sequence=1&isAllowed=y

[7] ECA Report

Table 2-5 Exceedances in municipalities in Sweden 2016 (NO_2, PM_{10})

Pollutant	Environmental Quality Standard (µg /m³), max allowed exceeded (day, hours)	Municipality	Station	Exceedance measured since the year
NO_2	Hour> 90 max 175h	Gothenburg	Gårda	2003
NO_2	Day> 60 max 7 days	Gothenburg	Gårda	2003
NO_2	Hour> 90 max 175h	Gothenburg	Haga	2015
NO_2	Day> 60 max 7 days	Gothenburg	Haga	2015
NO_2	Years> 40 µg / m³	Gothenburg	Haga	2016
NO_2	Hour> 90 max 175h	Mölndal	Göteborgsvägen	2016
NO_2	Day> 60 max 7 days	Mölndal	Göteborgsvägen	2016
NO_2	Hour> 90 max 175h	Sollentuna	E4 Häggvik	2016
NO_2	Day> 60 max 7 days	Sollentuna	E4 Häggvik	2016
NO_2	Hour> 90 max 175h	Stockholm	Hornsgatan	1999
NO_2	Day> 60 max 7 days	Stockholm	Hornsgatan	1999
NO_2	Years> 40 µg / m³	Stockholm	Hornsgatan	1999
NO_2	Day> 60 max 7 days	Stockholm	Lille Essingen	2015
NO_2	Day> 60 max 7 days	Stockholm	Norrlandgatan	2006
NO_2	Hour> 90 max 175h	Stockholm	Sveavägen	2006
NO_2	Day> 60 max 7 days	Stockholm	Sveavägen	1999
NO_2	Hour> 90 max 175h	Umeå	Västra Esplanaden	2006
NO_2	Day> 60 max 7 days	Umeå	Västra Esplanaden	2006
NO_2	Hour> 90 max 175h	Örnsköldsvik	Centralesplanaden	2014
NO_2	Day> 60 max 7 days	Örnsköldsvik	Centralesplanaden	2013
PM_{10}	Day> 50 max 35 days	Gotland	Norra Hansegatan, Visby	2014

Source: Swedish EPA (National Data Host for Air Environment Data). Available at: https://www.naturvardsverket.se/Stod-i-miljoarbetet/Vagledningar/Luft-och-klimat/Miljokvalitetsnormer-for-utomhusluft/Overskridanden-av-miljokvalitetsnormerna-2016/.

Information on pollutant concentrations in Sweden is also provided in more detail in Appendix E

The percentage of the urban population exposed to concentrations above EU standards has decreased compared to 2012and findings suggest that the AAQ Directives have contributed to this. The table below shows the percentage of urban population exposed to concentrations above EU standards for selected air pollutants.

Table 2-6 Urban population exposed to concentrations above EU standards (%)

		2012	2013	2014	2015	2016
O_3	Percentile 93.15	0.0	0.0	0.0	0.0	0.0
$PM_{2.5}$	Annual mean	0.0	0.0	0.0	0.0	0.0
NO_2	Annual mean	0.5	0.4	0.7	0.4	0.3
PM_{10}	Percentile 90.41	0.2	1.2	0.3	0.0	0.0

Source: EEA (2018), Sweden Air Pollution country factsheet 2018. Available: https://www.eea.europa.eu/themes/air/country-fact-sheets/sweden

2.3 Allocation of responsibility

Pursuant to Article 3 of the AAQ Directive, Member States shall designate – at the appropriate levels - the competent authorities and bodies responsible for the assessment of ambient air quality and the implementation of other obligations laid down by the AAQ Directive.

At national level, overall responsibility for supervision and planning of air quality is assumed by the Swedish Environmental Protection Agency at central level. As presented in section 2.2, the Swedish EPA is also responsible for overall monitoring of air quality and transmission of data on air quality to the EU level.

At regional and local level, the control function of air quality in urban areas is decentralised. As such, municipalities (local authorities) control the air quality standards to ensure that the limit and target values as per the AAQDs and the national legislation are met. In terms of assessment regimes, the approach towards the control depends on the amount of population and, whether or not, the municipality is part of collaborative areas or not. The controls are primarily carried out in urban and in the most polluted areas.

When an environmental quality standard is exceeded, the municipality concerned informs the Swedish EPA. The Swedish EPA assesses whether there is a need to establish an air quality plan. In cases where an action plan is needed, the county administrative board or the municipality (by delegation) coordinates its drafting and the implementation of the most appropriate and most cost-effective measures. The affected municipalities and authorities are responsible for sharing the responsibility for implementing the measures or instruments set out in the action plan.

In addition, in Sweden there are 12 air quality associations formed of counties, regions as well as companies and government agencies. Several of the associations were set up in the 1980s and follow counties' borders. Initially, they were set up due to the fact that acidification was a key issue related to air pollution in Sweden and the associations were tasked to address the issue. Presently, several of the associations have an important role in monitoring air quality in a regional background and coordinating urban monitoring. The concrete work of the air quality associations is to provide inventories of emission sources, measurement of air quality and meteorology, models for spreading and depositing air pollutants. The difference with the regional and local authorities is that such associations involve more stakeholders including companies.

2.4 Legal and policy framework and air quality measures

Legal framework

The AAQDs have been implemented in Swedish legislation through the *Environmental Code* (SFS 1998: 808), the *Air Quality Ordinance* (SFS 2010:477) and the Swedish Environmental Protection Agency Regulations on air quality control (NFS 2016:9). An *"Air Quality Guide"* (Luftguiden) has been published by the Swedish Environmental Agency.

The Air Quality Directives have been transposed into national legislation through the Swedish Environmental Code (1998: 808) which set *environmental quality standards* [8]that are legally binding. The standards were imposed to remedy the environmental impact of diffuse emission sources, such as road traffic and agriculture. The Environmental Code is a framework that contains different instruments to achieve the overall objective of sustainable development. Provisions on environmental standards are mainly contained in chapter 5.

Swedish Air Quality Ordinance[9] transposed into national legislation the provisions of the AAQDs on the limit value. These are presented in the comparative table below.

Figure 2-5 Air quality limits per pollutant

Pollutant	Average	WHO (Guideline 3)	SE Environmental objective Ambient air[10]	EU Limit / (L) Target / (T)	SE Environmental quality standards Limit / (L) Target / (T)
NO_2	1 hour	200 µg/m³	60 µg/m³ Cannot exceed more than 175 times / year	200 µg/m³ (L) Cannot exceed more than 18 time/year	90 µg/m³ (L) Cannot exceed more than 175 times/year provided that 200 µg/m³ is not exceeded more than 18 times / year
	Day	-	-	-	60 µg/m³ (L) Cannot exceed more than 7 times/year
	Year	40 µg/m³	20 µg/m³	40 µg/m³ (L)	40 µg/m³ (L)
NO_x regional background	Year	-		30 µg/m³ (L)	30 µg/m³ (L)
SO_2	10 min	500 µg/m³	-	-	-
	1 hour	-	-	350 µg/m³ (L) Cannot exceed more than 24 times / year	200 µg/m³ (L) Cannot exceed more than 175 times / year, provided that 350 µg/m³ is not exceeded more than 24 times / year

[8] Environmental quality standards specify the level of pollution or disturbance to which the population may be exposed without any risk of significant detriment or to which the environment or nature may be exposed without any risk of substantial detriment.
[9] Air Quality Ordinance, SFS 2010:477, 8 June 2010.
[10] Kvävedioxid, PM10: Naturvårdsverket rapport 4995, 1999, Institutet för miljömedicin (IMM), Karolinska Institutet, Review of evidence on health aspects of air pollution-REVIHAAP Project, WHO Europe,2013; PM2,5, WHO Air Quality Guidelines Global Update 2005; Ozon Health risks of ozone from LRTAP WHO 2008.

Pollu-tant	Average	WHO (Guideline 3)	SE Environmental objective Ambient air[10]	EU Limit / (L) Target / (T)	SE Environmental quality standards Limit / (L) Target / (T)
	Day	20 µg/m³	-	125 µg/m³ (L) Cannot exceed more than 3 times / year	100 µg/m³ (L) Cannot exceed more than 3 times / year
SO_2 regional background	Interim Winter	-	-	20 µg/m³ (L)	20 µg/m³ (L)
	Year	-	-	20 µg/m³ (L)	20 µg/m³ (L)
PM_{10}	Day	50 µg/m³	30 µg/m³ (L) Cannot exceed more than 35 times / year	50 µg/m³ (L) Cannot exceed more than 35 times / year	50 µg/m³ (L) Cannot exceed more than 35 times / year
	Year	20 µg/m³	15 µg/m³	40 µg/m³ (L)	40 µg/m³ (L)
$PM_{2.5}$	Day	25 µg/m³	25 µg/m³	-	-
	Year	10 µg/m³	10 µg/m³	25 µg/m³ (T) 25 µg/m³ (L)	25 µg/m³ (T) 25 µg/m³ (L)
CO	Highest 8h value	10 µg/m³	-	10 µg/m³ (L)	10 µg/m³ (L)
	1 hour	30 µg/m³	-	-	-
	30 min	60 µg/m³	-	-	-
	15 min	100 µg/m³	-	-	-
Benzen	Year	1.3 µg/m³ (IMM*)	-	5 µg/m³ (L)	5 µg/m³ (L)
Ozone	Highest 8h value	100 µg/m³	70 µg/m³	120 µg/m³ (T) Cannot exceed more than 25 days / year	120 µg/m³ (T)
Pb	Year	0.5 µg/m³	-	0.5 µg/m³ (L)	0.5 µg/m³ (L)
As	Year	-	-	6 µg/m³ (L)	6 µg/m³ (L)
Cd	Year	5 µg/m³	-	5 ng/m³ (L)	5 ng/m³ (L)
Ni	Year	-	-	20 ng/m³ (L)	20 ng/m³ (L)
B(a)P	Year	0.1 ng/m³ (IMM*)	-	1 ng/m³ (L)	1 ng/m³ (L)

*Institute of Environmental Medicine, Karolinska Institute.

Strategic framework

In addition to the strategic legal framework set by the Environmental Code, the Swedish Parliament adopted an overarching generational goal supported by *16 environmental quality objectives* and a number of milestone targets. These are closely related to the objectives set in the Environmental Code. The 16 environmental objectives are presented in the box below.

Text box 2-2 Sweden's environmental quality objectives

The Swedish Parliament has adopted 16 objectives for environmental quality in Sweden:

1. Reduced climate impact
2. Clean air
3. Natural acidification only
4. A non-toxic environment
5. A protective ozone layer
6. A safe radiation environment
7. Zero eutrophication
8. Flourishing lakes and streams
9. Good-quality groundwater
10. A balanced marine environment, flourishing coastal areas and archipelagos
11. Thriving wetlands
12. Sustainable forests
13. A varied agricultural landscape
14. A magnificent mountain landscape
15. A good built environment
16. A rich diversity of plant and animal life

Several of the environmental objectives relate to the issue of air quality and pollutants, in particular, the environmental objective of Clean Air, which states that 'the air must be clean enough not to represent a risk to human health or to animals, plants or cultural assets'.[11] As such, the government gives priority to improving air quality and reducing emissions to ensure a toxic-free environment, ecosystems and biodiversity.

Furthermore, the environmental quality objective on Natural Acidification Only and Zero Eutrophication are also linked to air quality and deposition. Sweden aims at reducing eutrophication caused by excessive levels of nitrogen and phosphorus in soil and water generated by emissions to air from road traffic, industry and international shipping. Similarly, Sweden's objectives also focus on reducing the acidifying effects of deposition of sulphur dioxide, nitrogen oxides and ammonia.

Air quality measures: air quality plans and air quality plans[12]

Drafting Air Quality Plans

If the monitoring of air quality indicates that specific standards are exceeded or at risk of being exceeded, the municipality is obliged to immediately notify the Swedish EPA. The *relevant county board or municipality (by delegation) will then develop an air quality plan.*

The purpose of the Air Quality Plans is to identify the most appropriate and cost-effective measures to ensure compliance with the air quality standards. The Air Quality Plans normally

[11] Swedish EPA, Sweden's Environmental Objectives. Available at: http://www.swedishepa.se/Documents/publikationer6400/978-91-620-8620-6.pdf?pid=6759.
[12] Swedish EPA, Action Programmes. Available at: https://www.naturvardsverket.se/Stod-i-miljoarbetet/Vagledningar/Luft-och-klimat/Miljokvalitetsnormer-for-utomhusluft/Atgardsprogram-for-luft/.

include different authorities to build ownership and ensure their implementation, for example public authorities in the transport sector, which is a main contributor to exceedances of air quality standards. Air Quality Planss are reviewed as necessary and at least every six years.

According to Chapter 5 of the Environmental Code and Section 6 of the Air Quality Ordinance 2010: 477, the action programs have to include:

- where the exceedance of an environmental quality standard has occurred
- the type, size, weather conditions and object worthy of the protection of the are concerned
- the type of air pollution and how it has been observed
- the origin of the pollution
- the analysis of the situation which has been made
- improvement measures implemented and their effects
- ongoing improvement measures
- publications and other documents

The Air Quality Ordinance Section 27 also requires that the authorities responsible make publically available and free of charge to the public the information on the action programme.

Today there are air quality plans for NO_2 and PM_{10} in 9 municipalities in the country. Work on developing plans in other municipalities is ongoing. In the case of 4 municipalities, previous air quality plans were considered to be completed and the environmental quality standards were assessed to be achieved. These are Gothenburg (PM_{10}, 2012), Norrkoping (PM_{10}, 2015), Helsingborg (NO_2), Malmo (NO_2, 2017) and Jönköping (PM_{10}, 2019).[13]

Enforcement of Air Quality Plans

The *enforcement of* Air Quality Plans is generally an effective manner of tackling exceedances and ensure that air quality standards are met. However, their effectiveness depends on the extent to which the measures are actually enforced.

Collaboration between local and national authorities is considered to be key in enforcing air quality plans. For example, the Gothenburg region had 2 air quality plans for NO_2. The implementation of the first air quality plan was assessed to be effective only to a limited extent due primarily to the fact that many of the measures included in the plan required action at Government or national level (for example, measures to tackle pollution from state roads and ports). However, the support from the Government level was not strong enough to enable the implementation of some measures. The implementation of the current air quality plan for NO_2 (2017) is expected to lead to better results as it contains measures that would require a change in laws or action to be taken by authorities at national level. The drafting of the air quality plan was done in cooperation with various authorities including amongst others the County Administrative Board, the Swedish Transport Administration, the Gothenburg Region Municipal Association, the authority for public transportation. Such cooperation is important to build ownership and enable measures that address the sources of pollutants. For instance, in Gothenburg, pollution from state roads is main source of concern. As such, the involvement of the Swedish Transport Administration, responsible for state roads, is essential.

[13] See: Action Programmes available at: http://www.naturvardsverket.se/Stod-i-miljoarbetet/Vagledningar/Luft-och-klimat/Miljokvalitetsnormer-for-utomhusluft/Atgardsprogram-for-luft/.

2.5 Information to the public

Member States are required (pursuant to Article 26 of the AAQ Directive) to ensure that the public is informed adequately and in good time about air ambient air quality and other issues specified.

At national level, legal requirements of section 38 of the Swedish Air Quality Ordinance[14] specifies the measures to be implemented to ensure that the public is informed about air quality. As per section 38, municipalities are required to provide information free of charge, through the Internet or in other suitable manner on concentrations of NO_2, SO_2, CO, Benzene PM, BaP, As, Cd, Ni, Pb. Municipalities are required to provide information on any exceedances of the levels of air quality standards, any exceedances of the alert thresholds with regard to SO_2 and NO_2, information related to what actions municipalities take with regard to such exceedances and the potential consequences to health. The legislation requires that the information on exceedances be updated every day for concentrations of NO_2, SO_2, CO, PM_{10}. The information for BaP, As, Cd, Ni needs to be updated at least every 12 months. For Benzene and Pb, the legislation requires that the information be given in the form of an average for the past 12 months and updated every 3 months.

The Swedish EPA makes available data on air quality measured hour by hour in a large number of Swedish urban areas for PM_{10}, $PM_{2.5}$, NOx and ground level ozone. Charts with data on the measurements for the last 24 hours are made available to the public.[15] The Swedish EPA's website also makes available statistics on the current year for the main pollutants. Data is available and easily accessible on: Nitrogen dioxide (daily average values), Ground-level ozone (eight-hour average values), Ground-level ozone (daily maximum eight-hour average values), Particles (PM_{10}) (daily average values) Particles ($PM_{2.5}$) (daily average values), black carbon (daily average values). [16] Charts with data trends for the last 15-20 years are also available on the Swedish EPA's website.[17] Furthermore, the Swedish EPA makes available information on exceedances of limit values as per the requirements of the national legal framework. Additionally, information on air quality plans is available both on the Swedish EPA's website and on the municipalities or counties administrations websites[18].

At regional level, some municipalities and cities have considered additional information dissemination means. For example, Stockholm proposed a mobile app for air quality but in the end decided not to have one. The rationale behind that was that the municipality wanted to have control of the data due to the fact that such data could be subject to misinterpretation. Another example is the city of Gothenburg where an app can be downloaded and used by the wider public called 'Air in Gothenburg' - 'Luften i Göteborg'.

2.6 Use of EU funding to fund air quality improvements

According to stakeholders interviewed and desk research, Sweden has made *limited use of EU funding for air quality improvements*. For example, research suggests that Sweden has not made in the programming period 2014-2020 use of ESI funds to support air quality measures.

[14] Air Quality Ordinance, SFS 2010:477, 8 June 2010. Available at: http://www.sea.gob.cl/sites/default/files/migration_files/Normas_secundarias/Anexo_documental/Reino_de_Suecia/Aire/SUE-AI-03-SFS477.pdf.
[15] See: Air quality in real time and preliminary statistics. Available at: http://www.naturvardsverket.se/realtidsdataluft.
[16] See: Air quality preliminary statistics for the current year. Available at: http://www.naturvardsverket.se/realtidsdataluft.
[17] See: Air quality statistics quality controlled. Available at: http://www.naturvardsverket.se/luftenisverige
[18] See for example: Air quality programs. Available at: http://www.naturvardsverket.se/Stod-i-miljoarbetet/Vagledningar/Luft-och-klimat/Miljokvalitetsnormer-for-utomhusluft/Atgardsprogram-for-luft/.

The *LIFE Programme* supported air quality actions in Sweden. A list of actions is presented in the Appendix to the case study. For example, the project *CLEANTRUCK - CLEAN* and energy efficient TRUCKs for urban goods distribution had as primary objective to demonstrate the commercial and technical viability of alternative fuels and new technologies for vehicles for the distribution of goods. The aim of the project was the overall reduction of GHG emissions but also other forms of pollution. The innovations introduced by the project were envisaged to achieve annual reductions of CO_2 emissions by 1,500 tonnes, NO_x, pollution by 17 tonnes, noise pollution and the reduction of generation of the breathable fraction of fine particles (up to 2.5 µm) by 240 kg. [19]

The Swedish EPA also indicated that EU funding could be attracted to deal with the issue of wood burning in households and support the transition to cleaner heating.

[19] See: CLEANTRUCK - CLEAN and energy efficient TRUCKs for urban goods distribution. Available at: http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3462.

3 FINDINGS

This chapter presents detailed findings regarding the implementation of the AAQ Directives in Sweden. Specifically, the chapter focusses on the challenges and success encountered in the implementation of the Directives. Additionally, the relevance of the AAQDs, and their air quality standards, has been explored. Finally, the chapter identifies the factors underlying compliance with and effectiveness of the AAQDs and provides an overview of the costs and benefits associated with the implementation of the Directives.

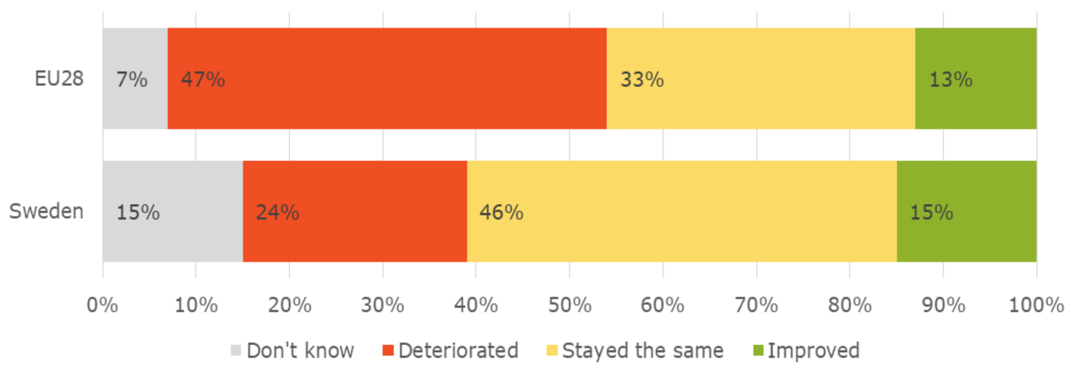
The findings presented in this chapter rely primarily on input provided by stakeholders interviewed in the context of the case study. These were supplemented as relevant by additional desk research. An overview of the interviews carried out is provided in Appendix B.

3.1 Relevance of the AAQ Directives

Although air pollution in Sweden is comparatively lower than in other EU countries, the AAQDs are still highly relevant. Stakeholders consider the AAQ Directives to be *relevant* due to the fact that they *establish a clear legal framework for regulation of air quality*, they *ensure that monitoring*, and *assessment of air quality is highly comparable and accurate*. Furthermore, the AAQDs incentivise action if issues are identified. Nevertheless, some stakeholders (i.e. Swedish EPA) considered that a weakness of the AAQDs is that there is a lot of detail when it comes to publishing data at EU level.

Eurobarometer data shows that air quality continues to be a source of concern for citizens. As presented below, 46% of respondents considered the air quality to have stayed the same over the past 10 years, although improvements in air quality have been registered in Sweden.

Figure 3-1 Do you think that, over the last 10 years, the air quality in (OUR COUNTRY) has…?



Source: Eurobarometer, 2017

Relevance of pollutants and binding targets

Evidence collected for the case study indicates that the pollutants regulated by the AAQDs are relevant for Sweden. However, Swedish authorities consider that the *air quality standards and limits set by the AAQDs are not sufficiently strict*. The limits could be reinforced for example through the i*mplementation of a binding $PM_{2.5}$ daily limit value.* The Swedish regulatory framework even goes beyond the requirements of the AAQDs by setting even stricter values for NO_2 (although there is a difference in the statistical indicator – number of allowed exceedances) and for

SO_2 and O_3. Since the standards in Sweden are stricter than the EU limit values, Sweden is having difficulties in reaching the national standards for these pollutants.

Sweden also has stricter national standards for SO_2 and O_3. The standards set by the AAQ Directives were considered to be relevant by stakeholders consulted and even not going far enough in setting strict values. Furthermore, enforcement of the air quality limits appears to be an issue as for example for NO_2, neither the Swedish nor the EU limit value are enforced. Enforcement issues are also generated by the absence of remedies in case of non-implementation of air quality plans which is not provided for in the Swedish legislation.

Ozone requirements have been challenging. The provisions in the Directive are quite complicated, open to interpretation and not well suited for the Swedish conditions (the Directives assumes high concentrations in cities but many cities in Sweden are sub-urban and substantive pollution comes from long-range transport of pollutants). As such, sub-urban stations to monitor ozone pollution would be needed. Sweden has found a pragmatic manner to monitor this as it conducts extensive modelling which is a good source of information on the levels of pollution from ozone.

Relevance of provisions to draft and implement air quality plans

The provisions requiring authorities to draft and implement air quality plans are also considered to be *relevant but not going far enough*. For example, some consulted stakeholders considered that the AAQ Directives air quality plans could be given legal status to ensure better enforcement.

Relevance of provisions on monitoring air quality

The AAQDs ensure that there is *monitoring and assessment that is highly comparable and accurate*. However, the requirements of the AAQDs are considered to impose a substantive burden on the authorities to publish data. Furthermore, monitoring varies across municipalities and regions. For example, monitoring in large cities is considered a priority whereas sampling points in medium sized and small cities is limited. This raises the question of whether monitoring requirements meet the needs of the citizens as they would prefer that monitoring be done as close to their location as possible for an accurate depiction of pollution levels.

3.2 Implementation successes

The present section highlights the key implementation successes of AAQDs in Sweden.

3.2.1 Guidance on the implementation of the AAQDs

As previously highlighted, Sweden has developed a *comprehensive Guide for air quality – Handbook for Environmental Quality Standards for ambient air* (version 4, 2019).[20] The guide is very comprehensive (approximately 300 pages) and contains all information on the planning, control and management of air quality in Sweden, reporting, modelling, publication of information on air quality. According to stakeholders interviewed (EPA), since the publication of the guide, the Swedish EPA received fewer questions concerning the implementation of the AAQDs.

Furthermore, in the last few years, more practical guides have been drafted by the Swedish EPA to ensure the implementation of the AAQDs, in particular: a Guide on objective estimation, three Guides on modelling (on how to model for Air quality plans, reporting for modelling data and on practical aspects of modelling) and a Guide on quality assurance and quality control (QAQC).

[20] Swedish Environmental Protection Agency, Guide for air quality – Handbook for Environmental Quality Standards for ambient air. Available at: http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-0182-7.pdf?pid=24067.

3.2.2 Reference Laboratory for modelling

The *Reference Laboratory for Urban Air Measurements* is a support function for the municipalities of Sweden on behalf of the Swedish EPA. The purpose of the Reflab is to serve as a national node when it comes to questions concerning air quality measurements made in the country. The decisive reason for establishing a reference laboratory for air quality measurements were the requirements of the AAQDs. The directive states that each Member State in the EU should have a national reference laboratory. In Sweden, the requirement was translated into a Reference Laboratory focussing on measurements and one focussing on modelling. Ensuring the quality of Sweden's air quality measurements could be done by securing that the methods and instruments that perform the measurements have sufficient high quality. The Reference Laboratory makes assessments of the application for approval of measuring instruments. The Swedish EPA uses the assessments as a basis for deciding which instruments are to be approved for air quality control in Sweden. In addition to this, Reflab also carries ongoing control of automated instruments that measure particulate matter (PM_{10} and $PM_{2.5}$) in order to verify that they work in the environment and in the conditions we have in Sweden. The Reflab drafted a Manual for Quality Assurance / Quality Control.

3.2.3 Dialogue between authorities

*Close dialogue between authorities i*s of great importance for the implementation of the requirements of the AAQDs. The EPA arranges meetings with municipalities and air quality associations on how to improve monitoring. For example, a 2-day seminar for municipalities took place, which dealt with both basics (for new employees) and the details of monitoring. The seminar was well received by participants and the EPA plans to hold such seminars regularly. The EPA also gets invited on an irregular basis to the municipalities, counties and associations for discussions and clarifications regarding the monitoring.

3.2.4 Availability of information to the public

Public awareness and information has a critical role in addressing air quality pollution. Research conducted for this case study indicated that the information provided by the Swedish authorities is easily accessible to the public and of good quality. As presented in section 2.5 of the case study, the Swedish EPA presents air quality measurements data for various pollutants, information on exceedances of pollutants as well as the air quality plans adopted. Some of the *information on air quality measurements is presented in real time*.

Furthermore, according to the Swedish EPA, 2-3 times a year a newsletter is sent to municipalities, other relevant authorities, air quality associations and some private parties to inform them of the air quality progress made, news regarding regulations and guidance etc.

3.2.5 Measures to regulate road traffic

Low emissions zones

According to the Traffic Ordinance (1998:1276), municipalities have the right to exclude heavy trucks and busses that do not comply with emission standards within designated environmental zones. *Low emission zones already exist in eight municipalities.* Recently, the Government introduced a new type of low emission zone setting standards for lighter trucks and cars and low emission zones for purely electric cars, fuel cell cars and gas cars that meet the emission standard Euro 6.[21]

[21] Government Office of Sweden. Available: http://ec.europa.eu/environment/archives/air/pdf/documents/pos_paper.pdf.

Table 3-1 Vehicles permitted in various types of low emission zones

Low emission zones	Light vehicles (cars, light lorries, light buses up to 3.5 tonnes)	Heavy vehicles
Class 1		Vehicles need to comply with the Euro 5 emission class and are allowed to drive in the environmental zone until the end of 2020
Class 2	As of 1 January 2020: Cars with compression ignition engines (diesel, hybrid, electric, plug-in hybrid) in Euro 5 or better Cars with spark-ignition engines (petrol, hybrid electric, plug-in hybrid, natural gas, E85) in Euro 5 or better Electric cars Fuel cell cars As of July 2022: Cars with compression ignition engines (diesel, hybrid, electric, plug-in hybrid) in Euro 5 or better Cars with spark-ignition engines (petrol, hybrid electric, plug-in hybrid, natural gas, E85) in Euro 5 or better Electric cars Fuel cell cars	Class 2 does not include heavy vehicles
Class 3	Electric cars Fuel cell cars Cars that run on natural gas Euro 6	Electric vehicles Fuel cell vehicles Plug-in hybrid vehicles

Source: Government Office of Sweden. Available: https://www.regeringen.se/pressmeddelanden/2018/03/regeringen-ger-besked-om-miljozoner/.

According to stakeholders consulted, although air quality rules on zones are in place, the extent to which they are used by politicians at local level varies. In some municipalities, it is assessed that such measures are not needed due to the development of cleaner engine for cars, which will reduce by default the emission problem from traffic.

The steps taken to reinforce further the implementation of low emission zones is considered to be a consequence of the AAQDs.

Measures to restrict the use of studded tires

The use of studded tires is considered to contribute to the formation of particles (PM), which has detrimental health effects. To reduce the use of studded tires, several measures were considered. Measures related to studded tires are considered to be a consequence of the implementation of the AAQDs in Sweden.
At national level, the Swedish Transport Authority has implemented changes in the rules for using studded tires. Since 2010, the season for the use of studded tire has been shortened by 14 days in the spring. Now, in the period 16th April to 30th September, the use of studded tires is banned unless it is a winter road.

Furthermore, since July 2013 there has also been a limitation imposed on the number of studded tires that are newly manufactured. The change resulted in an average reduction in the number of tires in the tires by approximately 15% compared with previously applicable rules.

Since 2009, some municipalities have decided to ban the use of studded tires for certain roads (Regulation 2009: 985). The measure is considered to be a result of the implementation of the AAQDs in Sweden. Such prohibitions have been announced for Hornsgatan, Fleminggatan and Kungsgatan in Stockholm, Odinsgatan / Friggagatan in Gothenburg and Kungsgatan in Uppsala. The purpose of the ban is to increase air quality on the specific streets. According to a study conducted on the implementation of the ban, the findings suggest that the proportion of vehicles with studded tires decreased from 40% to 30% after the implementation of the ban on Fleminggatan and Kungsgatan. Furthermore, traffic has decreased from 17,900 to 15,600 vehicles per day on Fleminggatan and from 14,800 to 13,700 vehicles per day on Kungsgatan. Calculations have indicated that the concentrations of PM10 on Fleminggatan and Kungsgatan have decreased by 21% and on Kungsgatan with 17% in January through May 2016. This was a result of the reduced use of studded tires and reduced traffic.22

In some cities (e.g. Stockholm), *information campaigns* have been carried out for several years to make drivers more aware of the consequences of use of studded tires and to discourage their use. Although the action by itself is not sufficient to meet the environmental standards for particles, it does positively contribute to raising awareness and influencing the behaviour of drivers.

Reduces speed on some streets

Emissions on roads generally increase with higher speeds. Therefore, by *regulating and reducing the speed on certain streets*, the levels of pollution in the air may decrease. This type of action has been taken amongst others in the cities of Stockholm, Gothenburg, and Uppsala and on the routes of the national roads E4 and E18. The measure has been implemented by the Swedish Transport Administration and is considered to have had a positive effect on reducing emissions levels on state roads.

Dust binding

The Swedish Transport Administration also implemented a number of measures with local and regional plan for better air quality. A saline solution, CMA – calcium magnesium acetate, is sprayed onto the roadway to keep it moist, thus preventing dust from being emitted and decreasing the particulate content (PM_{10}) in the air. *Dust binding to reduce particulate levels* is one of the measures that have been implemented in Stockholm, Gothenburg, Jönköping, Norrköping, Uppsala and Örnsköldsvik. In Stockholm, an evaluation of the efforts made to reduce PM_{10} levels through dust binding indicates that in 2015-2016, the limit value for PM_{10} was not exceeded for the 2015–2016 season for the third consecutive year, but the number of days with PM_{10} levels over the limit value was higher than in the previous season, which had a record low number of exceedances.[23]

[22] Michael Norman (2016), Evaluation of a studded tire ban on Kungsgatan and Fleminggatan. Available at http://slb.nu/slb/rapporter/pdf8/slb2016_008.pdf.
[23] Mats Gustafsson et al. (2016), Operational measures against PM_{10} pollution in Stockholm. Available at http://vti.diva-portal.org/smash/get/diva2:1111887/FULLTEXT01.pdf.

Improved weather cleaning after the winter season

An *intensified and timely sanding up after the winter season* is performed in, among others, Uppsala and Stockholm. In the immediate vicinity of sanding, the streets are then cleaned with vacuum suction or high-pressure washing to reduce the particulate content (PM_{10}) in the air.

3.3 Implementation challenges

The following section presents the main AAQD implementation challenges.

3.3.1 Division of responsibilities

One key implementation challenge is the fact that *Sweden has a decentralised system for assessing and managing air quality, which creates issues in terms of delineation of responsibilities* amongst authorities. Although de jure the Swedish Environmental Protection Agency Regulations on air quality control outlines fairly clearly the distribution of responsibilities, in practice there is confusion about the division of responsibilities for meeting air quality standards. The Swedish EPA provides guidance but it is up to municipalities to ensure that the provisions are respected. Nevertheless, municipalities claim to the Government that they do not have the tools needed to comply and that action should be taken at national level. As such, some stakeholders (i.e. Swedish EPA) suggest that a more centralised approach would improve efficiency of implementation. For example, more powers to coordinate to the Swedish EPA could also mean that the EPA would be able to control the exact amount of sampling points and ensure that the data from monitoring is accurate. Furthermore, in some cases, measures are developed by municipalities without the actual mandate for implementing them, as they would fall in the remit of responsibility of the Government.

As per Swedish legislation, municipalities can engage into 'collaborative areas' (or air quality associations) which are cooperation set-ups between mainly municipalities, but regional governance and businesses as well. The associations draft the strategies and renew them every year. The associations are mainly on the level of counties but sometimes they can be larger (e.g. Stockholm) or even smaller (e.g. Gothenburg). The strategies control the assessment of air quality. If there is an exceedance, the associations monitor the situation and the municipalities report to the EPA. However, it is up to the county board or municipality (by delegation) to produce an air quality plan. In theory, the system is good as it is aimed at improving efficiency. However, in practice, there may be cases where municipalities assume that the issue is dealt with by the collaboration area when in reality the issue is not addressed at any level.

3.3.2 Enforcement of air quality plans

Air quality plans are reported to EU by the Swedish EPA. As such, theoretically, the Swedish EPA should be amongst the stakeholders that are consulted when developing the action plan. The EPA normally comments on the plans – providing advice on modelling, source apportionment, quantitative information etc. However, in some occasions it was reported that the EPA had not been involved in the development of air quality plans.

Furthermore, *consulted stakeholders reported that sometimes air quality plans included measures that were not always relevant* – e.g. bike lanes in areas not affected by an exceedance. Such situations are an indication that air quality plans are sometimes used by municipalities to steer the broader environmental work and not necessarily to address the issue of air pollution, which also positively contributed to the improvement of air quality. Additionally, in some cases, measures proposed in the air quality plans fell outside the remit of responsibility of authorities that were enforcing them, which made their implementation unviable.

Air quality plans are sometimes perceived more as administrative burdens by the authorities. As a result, many tend to contain generally acceptable actions and the measures are not always effective and efficient.

3.3.3 Reporting requirements and human resources

EU reporting are considered to require *substantive resources to modernise information exchanges.* Authorities in Sweden consider the reporting requirements arising from the AAQDs as being too comprehensive and cumbersome. Mandatory data is considered to be not always necessary. As such, a need for a more flexible system was highlighted by authorities during interviews.

*Limited human resources and funds i*n municipalities to deal with the requirements of the AAQDs are another challenge. EU reporting requires a lot of resources to modernise the information exchange system to meet the reporting requirements. Reporting requirements are considered to be too comprehensive and in need to be streamlined, which in turn would reduce the amount of resources necessary.

3.4 Factors underlying compliance and effectiveness of the AAQ Directives

The following section provides an overview of the factors underlying and hindering compliance with and effectiveness of the AAQ Directives in Sweden. The factors have been identified through stakeholder consultation conducted in the context of the case study. The views have been correlated with information gathered through desk research.

3.4.1 Factors underlying compliance and effectiveness

The main factors underlying compliance and effectiveness of AQ measures and of the AAQDs in Sweden include amongst others.

Consequences of non-compliance

The commitment of Swedish authorities to ensure that air quality standards are respected is also incentivised by the risk of consequences for not complying with the standards. Pressures from the public to ensure air quality standards are also considered an important factor underlying compliance and effectiveness. For example, the action taken by the European Commission for exceedances of PM10 led to the introduction of measures to reduce daily exposure. The absence of enforcement mechanisms in Sweden was considered by stakeholders to have negative consequences on the levels of concentrations of pollutants in the air.

National implementation guidance

One important factor underlying compliance was the production of guidance and standards for ensuring that air quality standards are met. As presented in section 3.2, the Swedish EPA produced an Air Quality Manual (which has been recently updated) which contains detailed guidance on the air quality standards, performance of monitoring of air quality pollutants and other useful information for county administrations, municipalities and other authorities involved in air quality control.

Furthermore, the existence of a national Reference Laboratory for modelling and the guidance drafted by it (e.g. the Quality Assurance and Quality Control manual) contributed to a harmonised assessment of air quality levels across Sweden.

3.4.2 Factors hindering compliance and effectiveness

Insufficient monitoring stations

According to consulted stakeholders, for some types of pollutants, Sweden does not have enough monitoring stations. For example, some municipalities in the North of Sweden should have stricter monitoring requirements than they currently have in force for BaP levels due to the wood burning.

Availability of resources and staff

There are certain variations in terms of the level of commitment of municipalities to monitor air quality standards across Sweden. The variations are also dependent on the level of staffing and financial resources of the municipalities. In some municipalities and cities, additional resources would be important to ensure a better enforcement of the rules. For instance in Gothenburg, interviews with local stakeholders indicated that the air quality plan set in place in 2017 could have been improved (e.g. with more modelling) provided that more resources would have been available.

3.1 *Costs and benefits of the AAQ Directives*

3.1.1 Costs of implementation

Presently, there are no economic analyses of the costs of implementation of the AAQDs in Sweden. Furthermore, the decentralised Swedish system makes it very difficult to obtain accurate estimates of costs.

Overall, the Swedish *EPA reported that it has a budget for AAQ of 400,000 EUR per year.* The Swedish EPA estimated that approximately 200,000-300,000 of its AAQ budget goes to the implementation of the AAQD per year.

Estimates provided by the Swedish EPA concerning the *costs of assessment of ambient air quality (costs of measurement, calculation, predictions or estimations)* as required by the AAQDs is presented below.

Table 3-2 Total estimated annual cost for all fixed measurements

	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3
Total number of fixed AQD measurements	41	41	6	2	27
Total number of fixed EoI measurements that are relevant to include	7	15	2	1	0
Estimated annual cost per fixed measurement site (SEK)	135,000	135,000	135,000	135,000	135,000
Total estimated annual cost for fixed measurement per pollutant (SEK)	6,480,000	7,560,000	1,080,000	405,000	3,645,000
Total estimated annual cost for all fixed measurements (SEK)	**19,170,000**				
Total estimated annual cost for all fixed measurements (EUR)	**1,859,490**				

Source: Estimates provided via email by the Swedish EPA

According to the Swedish EPA, the majority of the requirements related to the number of fixed measurements were in place even before the 2008 AAQD. This means that the additional costs incurred as a result of the implementation of the 2008 AAQD were reduced.

The development and approval of the measurement system (e.g. standardised methods, calibrating equipment, engaging in networks and running laboratories) is primarily by the Reference Laboratory for Urban Air Measurement commissioned by the Swedish Environmental Protection Agency. Estimates of the contract of the Reference Laboratory with the Swedish EPA provided by the Swedish EPA suggest that the costs for relevant activities related to the development and approval of the measurement system are approximately EUR 1.5 million.

When it comes to estimates of the costs of data analysis and assessment methods, the Swedish EPA indicated that the national costs, for the Reference Laboratory to check the quality of reported monitoring data is approximately EUR 50,000 per year. However, data validation and ratification is the responsibility of the local and regional operators, so significant additional local and regional costs are not included in the afore-mentioned total.

The amount and scale of air quality modelling carried out in Sweden varies from one year to another. However, there is no concrete estimate of the total costs for this. The Swedish EPA conducts national modelling of regional background concentrations of ground-level ozone, nitrogen dioxide and sulphur dioxide. The *total annual cost for such modelling is estimated by the Swedish EPA to be approximately EUR 65,000,* but it also includes modelling of deposition, which is not required by the AAQD. Furthermore, modelling is carried out on an urban-scale at a local and regional level, but no concrete estimates of costs are available.

At regional level, some estimates on costs of monitoring were provided by the Gothenborg County Administrative Board on the regional monitoring done as part of the "The Swedish Throughfall Monitoring Network". The County Administration Board is responsible for four measurement stations in Västra Götaland: Hensbacka, Stora Ek, Storskogen and Humlered. The cost for these four stations is around EUR 30,000 [300,000 SEK] excl. VAT per year. The costs includes everything from sampling to reporting.[24] The County Administration Board also has regional monitoring of ground level ozone, which is part of a network in the south of Sweden. The part of the costs for the County Administrative Board of the network is about EUR 6,300 [65,000 SEK] excl. VAT per year. This includes everything from sampling to reporting.[25]

According to the Swedish EPA, without the EU legislation in place there would still be monitoring done in Sweden.

3.1.2 Costs of non-implementation

Although Sweden is one of the EU countries with lower background concentrations of air pollutants in urban areas, health impacts of exposure to ambient air pollution still represent an important issue, especially since the concentration levels of NO_2, PM_{10} and $PM_{2.5}$ exceed the air quality standards at street level in several urban areas.

The EEA estimates that *premature deaths* due to air pollution exposure in Sweden are below the EU average but they still constitute a source of concern. The table below presents the premature deaths attributable to PM2.5, NO_2 and O3 exposure in Sweden, EU-29 and total EEA-33 in 2015.

Figure 3-2 Premature deaths attributable to air pollutants (2015)

Country	Population (x1,000)	Annual mean (PM2.5)	Premature deaths (PM2.5)	Anual mean (NO2)	Premature deaths (NO2)	Somo35 (O3)	Premature deaths (O3)
Sweden	9,747	5.9	3,000	10.8	110	2,080	140
EU-28	506,030	12,9	391,000	18.9	76,000	4,250	16,400
EEA-33	538,278	14.1	422,000	18.8	79,000	4,310	17,700

Source: EEA (2018), Sweden Air pollution Country Factsheet 2018

In the Environmental Implementation Report – Sweden, it was estimated that the health-related external costs for air pollution in Sweden are above EUR 3 billion/year (income adjusted, 2010), which include not only the intrinsic value of living a full health life but also direct costs to the economy. These direct economic costs relate to 803 thousand workdays lost each year due to sickness related to air pollution, with associated costs for employers of EUR 111 million/year (income adjusted, 2010), for healthcare of above EUR 11 million/year (income adjusted, 2010), and for agriculture (crop losses) of EUR 48 million/year (2010).[26]

In a study conducted by the Swedish Environmental Research Institute and Umeå University estimated that every year over 5,000 people die prematurely due to air pollution in Sweden. The study focussed on the effects of NO_2, $PM_{2.5}$ and $PM_{10.}$ The study estimated that approximately 3,500 premature deaths per year were caused by exposure to $PM_{2.5}$ when assuming no division

[24] See: http://krondroppsnatet.ivl.se/
[25] See: http://ozonmatnatet.ivl.se/
[26] These figures are based on the Impact Assessment for the European Commission Integrated Clean Air Package (2013)

between sources and using an exposure-response coefficient of 6.2 per cent per 10 µg/m^3. Assuming a division between sources, it was estimated that non-local sources caused over 3,000 premature deaths per year (exposure-response coefficient 6.2% per 10 µg/m3), and that residential wood burning caused over 1,000 premature deaths per year. A higher exposure-response coefficient of 17% per 10 µg/m3 was used for these primary combustion particles. Additionally, it was estimated that approximately 1,300 premature deaths per year were caused by locally generated vehicle exhaust using NO_2 as indicator and approximately 200 premature deaths per year were caused by road dust. [27]

Furthermore, the study estimated that the *health effects* related to annual mean levels of NO_2 in 2010 were between SEK 7 and 25 billion (cca. EUR 700 million and EUR 2.4 billion), depending on whether a threshold of 5 µg/m^3 was included or not. Furthermore, welfare losses due to exposure to PM pollutants from road dust, residential wood burning and other sources were valued at SEK 35 billion (cca. EUR 3.3 billion), of which approximately SEK 6.5 billion (cca. EUR 630 million) were linked to productivity losses, i.e. days when people are limited in their normal activities causing a loss of work days. The amount of *work and study days lost* constituted about 0.3% of the total amount of such days in Sweden in 2010. Using the division between PM sources and NO2 (with a 5 µg/m3 cut-off) as an indicator of traffic combustion, the total annual socio-economic cost was estimated to be approximately SEK 42 billion (cca. EUR 4 billion).[28]

In 2018, the Swedish Environmental Research Institute and Umeå University updated the study with data for 2015. The findings of the new study indicated that neatly all Swedish population was exposed to concentrations below the environmental standards, and 97%, 78% and 77% was exposed to concentrations below the respective specifications of the environmental objective for NO_2, PM_{10} and $PM_{2.5.}$ Exposure to high concentrations was found in some polluted central parts of large cities. In contrast to the results of the 2010 assessment (see above), the findings showed an increase in mean population exposure to NO_2 and PM and a slight increase in the percentage of population exposed to concentrations above the objective for NO_2. Particles concentrations were found to show a decreasing trend in Sweden, resulting in reduced exposure to high PM concentrations in urban centres.

[27] Malin Gustafsson, Bertil Forsberg, Hans Orru, Stefan Åström, Haben Tekie, Karin Sjöberg (2014), Quantification of population exposure to NO2, PM2.5 and PM10 and estimated health impacts in Sweden 2010. Available at: https://www.ivl.se/download/18.343dc99d14e8bb0f58b76b7/1446478779885/B2197.pdf
[28] Ibidem.

Table 3-3 Calculated population exposure to NO2 and particles in ambient air in 2005, 2010 and 2015 respectively

		2005	2010	2015
Total population		8,899,724	9,546,546	9,839,105
Mean population weighted exposure (µg/m³)	NO_2	6.3	6.2	6.4
	PM_{10}	13.0	12.0	12.5
	$PM_{2.5}$	9.8	8.6	8.3
Percentage of population exposed to concentrations above the environmental objective	NO_2 (20 µg/m³)	2,3%	2,7%	2,9%
	PM_{10} (15 µg/m³)	38%	25%	22%
	$PM_{2.5}$ (10 µg/m³)	49%	28%	23%
Percentage of population exposed concentrations above the environmental quality standards	NO_2 (40 µg/m³)	0%	0%	0%
	PM_{10} (40 µg/m³)	0,4%	0,3%	0,3%
	$PM_{2.5}$ (25 µg/m³)	0%	0,6%	0,6%

Source: Malin Gustafsson et. al (2018), Quantification of population exposure to NO_2, PM2.5 and PM10 and estimated health impacts. Available at: http://projects.cowiportal.com/ps/A104859/Documents/Externals/Task%201%20and%205%20-%20Deliverables/4.%20Final%20Deliverables/Case%20studies/Final%20country%20reports%20to%20be%20submitted/Case%20Study%20Report_Bulgaria_FINAL.docx.

The findings of the study suggested that the number of *premature deaths due to air pollution was estimated to be higher in 2015 compared to 2010, i.e. 7,600*. The increase in comparison to the 2010 estimate is not due to changes in the estimated exposure, but resulting from a revision of assumed exposure-response relations. If for the 2010, the urban NO_2 contribution to increase mortality had assumed without any cut-off, the estimates would have been almost the same as in 2015. The study estimated that approximately 3,600 deaths per year were associated with exposure to regional background (long-distance transported) concentrations of $PM_{2.5}$. On average, each premature death represents over 11 years of life lost. The main sources for mortality were assumed to be locally emitted particles. Wood burning was estimated to cause more than 900 deaths per year, but the exposure estimate is uncertain.

The study also estimated that the health impacts from exposure to NO_2 and $PM_{2.5}$ could be conservatively estimated to cause *socio-economic costs of approximately SEK 56 billion* (cca. EUR 5,4 billion) in 2015. Just absence from work and studies can be estimated to cause socio-economic costs of approximately 0.4% of GDP in Sweden.

Table 3-4 Annual socio-economic costs of high long term air pollution levels in Sweden, 2015

	Socio-economic cost of health effect [million SEK2015/case]	Health effects from anthropogenic sources	Socio-economic cost of health effect [million SEK2015]
Total Sweden			**55,509**
Out of which:			
Value of prevented fatality (VSL*/VPF	5.66	7,412	41,938
RAD (age group 0-14, 65-)	0.001	2,590,006	1,378
RAD (15-64)	0.001	4,509,911	6,678
Chronic Bronchitis	2.20	723	1,589
MI incidence	0.43	774	332
Stroke incidence	2.03	874	1,772
MI illness	1.50	774	1,163
Stroke illness	0.76	874	661

VSL = Value of Statistical Life
Source: Malin Gustafsson et. al (2018), Quantification of population exposure to NO_2, PM2.5 and PM10 and estimated health impacts. Available at: http://naturvardsverket.diva-portal.org/smash/get/diva2:1242584/FULLTEXT01.pdf.

Another study focussing on the economic benefit of improvements in *children's health* resulting from reduction in air pollution calculated the benefit of a reduction in children's exposure of 1 µg/m³ of NO2 in Stockholm and Umeå. The calculation was done for two endpoints, i.e. that children having wheeze develop asthma and that asthmatic children are admitted to hospital due to respiratory symptoms. According to the study, a reduction in exposure in the Greater Stockholm area would generate a benefit to society of SEK 168 million (cca. EUR 16 million) per year because of fewer cases of child asthma, and SEK 47,000 (cca. EUR 4,500) due to fewer hospital admissions (for the price levels in 2000). For Umeå the benefits are smaller, SEK 8 million (cca. EUR 780,000) and SEK 2,000 (cca. EUR 200) per year.[29] Subsequently another report on Air & Environment pointed out the short and long-term health effects of air quality on children[30].

3.1.3 Benefits of the AAQ Directives

Several types of benefits were reported by stakeholders interviewed arising from the AAQDs implementation, in particular:

As presented above, *air quality in Sweden has improved considerably compared to previous decades and part of this improvement can be assessed to be a result of the enforcement of the AAQDs but also of stricter measures at national levels.* In addition to the AAQDs, other measures taken by Sweden as a result of both European (e.g. NEC Directive) and international commitments (e.g.

[29] Lena Nerhagen, Tom Bellander, Bertil Forsberg (2013), Air pollution and children's health in Sweden. An enquiry into how the economic benefit of improvements in children's health resulting from reductions in air pollution can be assessed. Available at: https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6585-0.pdf?pid=9678.
[30] Swedish EPA (2017), Air and Environment, Children's Health. Available at: https://www.naturvardsverket.se/Om-Naturvardsverket/Publikationer/ISBN/1300/978-91-620-1303-5/

CLRTAP) have also contributed to reducing emissions from pollutants, in particular pollutants affecting vegetation and ecosystems (SO2 critical level, NOx critical level, Ozone AOT40). For examples, Sweden registered improvements in terms of ozone levels as a result of reduced emissions in Europe.

In addition to improving the air quality, the AAQDs requirements were also considered to have brought positive effects when it comes to *political commitment of authorities to improve air quality*. Although there is a general awareness and commitment of the authorities to ensure good air quality, there are cases where it has been reported that the responsibility was not assumed by the relevant authorities (for instance, when there was a need to enforce a specific measure). In this sense, the AAQDs have helped incentivise political action by enabling the public to put pressure on the authorities. Furthermore, general stigma associated with infringement procedures is taken seriously by Swedish authorities and remedy action is taken to avoid such situations. This was the case with PM_{10}, where the European Commission took action against Sweden. This was considered to be an important incentive for political action at national level.

Exceedances on PM_{10} and NO_2 have led to the implementation of air quality plans and measures to prevent pollution from traffic. Such measures include a ban on studded tires, shortened season for studded tires, strengthened requirements for manufacturing studded tires, low emission zones.

According to consulted stakeholders, the need to set in place measures to mitigate pollution caused by actions in other sectors has also led to *increased cooperation and horizontal action in Sweden*. Although authorities in Sweden collaborated even before in the implementation of air quality measures (for example, municipalities and public transport authorities), more recently an increased involvement of the national level can be noted in the implementation of air quality plans and measures to ensure air quality (see section 3.2). For example, in the implementation of traffic control measures, the National Transport Administration has become more involved to enforce measures that would reduce air pollution on state and local roads.

As further presented in section 3.2, desk research and consultation of stakeholders indicates that the implementation of the AAQDs also meant *increased harmonisation of the approaches to monitoring.* Sweden also put in place Reference Laboratories for monitoring and modelling of air quality, which focusses on defining common methods for monitoring, modelling, and established clear quality control and quality assurance methods and rules outlined in a comprehensive manual.

The AAQDs and the 2011 Implementing Decision have incentivised Sweden *to set up a national system for real time data* (see section 2.5). This, in turn, means improved information flow to the public. Increased flow of information to the public also means that people are more aware of air quality, which leads to changes in their behaviour.

4 CONCLUSIONS

The present chapter contains e summary of the main findings of the case study regarding the main implementation challenges the potential for improving the implementation of the Directives in Sweden. Finally, a summary of the evaluation of the AAQDs is presented.

4.1 Identified problems and potential for improving the implementation of the Directives

The case study identified the following challenges in the implementation of the AAQ Directives in Sweden.

- The need to strengthen the air quality standards, in particular establishing a $PM_{2.5}$ hourly limit (see page 23);
- The minimum number of monitoring stations in the AAQ Directive and in Sweden to ensure more complete and adequate monitoring in some areas e.g. big cities and collaborative areas;
- Legal status of air quality plans in the AAQ Directives and actions for remediation in case of non-implementation of measures set in the air quality plans;
- Comprehensive requirements for monitoring and the minimum types of data, which is necessary for the analysis of emissions and the preparation of the air quality plans and which should be available free-of-charge and accessible for all stakeholders (in a machine readable format).

4.2 Assessment of the AAQ Directives

The following section presents a summary of the findings of the case study in relation to the relevance, effectiveness, efficiency, coherence and added value of the AAQDs.

4.2.1 Relevance

Air quality continues to be a source of concern for citizens, as the Eurobarometer 2017 shows that 46% of respondents perceive that air quality stayed the same in the past 10 years and 24% consider it has deteriorated, although data from the Swedish EPA indicates a slight improvement.

The European Commission's 2017 Environmental Implementation Review of Sweden cites the exceedances of the limit value of NO_2 and PM_{10} in several municipalities and calls for additional action in maintaining a downward emissions trend of air pollutants, reducing NOx emissions to comply with the currently applicable national emission ceilings and to reduce NO_2 and ozone concentrations. Furthermore, the review calls for the reduction of PM_{10} emissions and concentrations by reducing emissions of energy and heat generation using solid fuels.

The *air quality standards imposed by Swedish legislation go beyond those imposed by the AAQDs* and interviews with stakeholders on a national level consider that rules that are even more stringent should be put in place. For example, stakeholders interviewed called for the need to set a daily limit for $PM_{2.5}$.

Thus, in this context, the objectives of the *AAQDs are and remain relevant to respond to the needs of citizens in Sweden*, even if air quality in Sweden is considered to be better than in other EU countries.

4.2.2 Effectiveness

The findings of the case study indicate effectiveness of the AAQDs in maintaining and improving air quality in Sweden. *Exceedances are only registered when it comes to two types of pollutants – PM10 and NO_2 - and air quality plans are put in place as a result of the AAQDs*.

The findings indicate that the *factors underlying compliance* with the AAQDs in Sweden include: 1) the general air quality status in Sweden which is good compared to other countries and below limit and target values and a general awareness and understanding of the problem, 2) national implementation guidance which is published on the implementation of EU and national legislation on air quality – for example, a comprehensive Air Quality Manual, 3) the awareness of authorities of the consequences of non-compliance both in terms of poorer air quality but also in terms of remediation measures taken by the European Commission. In contrast, the case study identified a number of *factors hindering compliance,* including: 1) insufficient monitoring stations and 2) lack of resources and staff.

4.2.3 Efficiency

There are currently no economic analyses of the costs of implementation of the AAQDs in Sweden. Furthermore, the decentralised Swedish system makes it very difficult to obtain accurate estimates of costs. However, some estimates have been provided by the authorities.

The Swedish EPA reported that it has a budget for AAQ of 400,000 EUR per year. The Swedish EPA estimated that approximately 200,000-300,000 of its AAQ budget goes to the implementation of the AAQD per year.

When it comes to the *costs of assessment of ambient air quality* (costs of measurement, calculation, predictions or estimations) it is estimated that the costs of all fixed measurements are approximately EUR 1.8 million per year. According to the Swedish EPA, the majority of the requirements related to the number of fixed measurements were in place even before the 2008 AAQD. This means that the additional costs incurred as a result of the implementation of the 2008 AAQD were reduced. The development and approval of the measurement system (e.g. standardised methods, calibrating equipment, engaging in networks and running laboratories) was estimated to amount to approximately EUR 1.5 million.

When it comes to estimates of the costs of data analysis and assessment methods, the Swedish EPA indicated that the national costs, for the Reference Laboratory to check the quality of reported monitoring data is approximately EUR 50,000 per year. However, data validation and ratification is the responsibility of the local and regional operators, so significant additional local and regional costs are not included in the afore-mentioned total.

The amount and scale of national air quality modelling is carried out in Sweden varies from one year to another so estimates are difficult to obtain. Nonetheless, the total annual cost for such modelling is roughly estimated to be approximately EUR 65,000, but it also includes modelling of deposition, which is not required by the AAQD. Furthermore, modelling is carried out on an urban-scale at a local and regional level, but no concrete estimates of costs are available.

An extensive body of research has been conducted concerning the *cost of non-implementation of the AAQDs in particular concerning the costs on health and social welfare.* The findings of a study indicate that approximately 7,600 premature deaths can be estimated to be due to air pollution from NO_2, PM_{10} and $PM_{2.5.}$ The study also estimated that the health impacts from exposure to NO_2 and $PM_{2.5}$ can be conservatively estimated to cause socio-economic costs of approximately SEK

56 billion (cca. EUR 5,4 billion) in 2015. Just absence from work and studies can be estimated to cause socio-economic costs of approximately 0.4% of GDP in Sweden.

The *benefits of AAQD include amongst others*: 1) maintaining and improving air quality and positive ecosystem effects, 2) increased political commitment to improve air quality, 3) national and local measures to control traffic pollution, 4) incentivise cooperation between authorities, 5) establishment of harmonised approaches to monitoring, 6) availability of information to the public.

4.2.4 Coherence

As noted above, the *AAQD have strengthened the integration of monitoring stations into regional networks and the linking of regional networks into a national system with common methods.*

Furthermore, in the context of the implementation of air quality plans, collaboration between authorities working in different areas – for example, cooperation between municipalities, county administrative boards, and transport authorities – has been sought in the design of air quality plan and the implementation of the concrete measures. Given the important contribution of transport to air pollution, measures to tackle air pollution from such sources are taken at a national level by the Swedish Transport Administration and on a local level by public transport authorities. However, several interviewees indicated that further coordination and ownership of measures included in the air quality plans is necessary to ensure the viable implementation of actions tackling pollution at its source.

Sweden has also used EU funding to address air quality. Notably, the project CLEANTRUCK - CLEAN and energy efficient TRUCKs for urban goods distribution had as primary objective to demonstrate the commercial and technical viability of alternative fuels and new technologies for vehicles for the distribution of goods. The aim of the project was the overall reduction of GHG emissions but also other forms of pollution.

4.2.5 EU added value

Although Sweden had in place rules to monitor air quality, *the added value of the AAQDs was that it harmonised the approach to the standards and monitoring across the EU*. The monitoring requirements of the AAQ Directives have stimulated a number of improvements in the monitoring of air quality. While monitoring had taken place already before the introduction of the AAQ, although in a smaller scale, the added value of the AAQ is in shifting focus on PM_{10} and NO_2 concentrations and ensuring the harmonisation of measurements and methods for monitoring.

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APPENDIX B INTERVIEWS

Organisation	Date of the interview
Swedish Environmental Protection Agency	20-09-2018
Swedish Society for Nature Conservation	21-09-2018
AirClim – Air Pollution and Climate Secretariat	19-09-2018
Gothenborg County Administrative Board.	30-11-2018

APPENDIX C PILOT INTERVIEW GUIDE

General questions

- What challenges have been encountered when implementing the AAQ Directives?
- How have these challenges been overcome? What has proved to work well and what turned out to work less well? Are there any relevant lessons learned that other Member States could learn from?
- Where do you see the greatest potential to improve further the implementation of the Directives?
- Have any specific initiatives/measures been introduced to support the implementation of the AAQ Directives in the Member State (e.g. national guidance, arrangements for information exchange, etc.)?
- What systems are in place to provide information to the public on air quality, exceedances and alerts, and the implementation of plans and measures?

Specific questions

The table below outlines the specific themes discussed during the interviews.

Evaluation question	Questions
RELEVANCE	
(1) How relevant are the goals and objectives of the AAQ Directives to the needs of citizens; do the AAQ Directives still address the most relevant pollutants and set relevant standards and obligations to protect human health and the environment; and are the AAQ Directives sufficiently adapted or adaptable to evolving technical and scientific progress?	To what extent do the goals of the Directives correspond to the needs of the citizens (in your country)? Which of the Directives' requirements are in your opinion the most important in relation to the citizens' needs? To what extent have the goals of the Directives been integrated in the strategic documents (on environmental protection) in your country?
(2) How far are the Directives aligned with key EU priorities? Which elements in the Directives are essential to deliver on these priorities, have elements become redundant?	
EFFECTIVENESS	
(3) What factors have contributed to meeting the objectives of the AAQD or to failing to meet these objectives, in terms of: 1) defining common methods to monitor and assess air quality; 2) assessing ambient air quality in order to monitor trends; 3) establishing standards of air quality to achieve across the EU; 4) ensuring that information on air quality is made public; 5) maintaining good air quality, improving it where it is not good; to what level can these factors be attributed to provisions of the AAQ Directives?	What are the main factors that contribute to compliance with/effective implementation of the air quality Directives; hereunder: • air quality standards • reporting requirements • requirements regarding the establishment and implementation of air quality plans and programmes • requirements regarding provision of information to public? • requirements regarding monitoring stations? What are the main barriers (at national/regional/local) level preventing effective implementation of the air quality Directives? Please consider each of the items listed above separately. What would it take to overcome the barriers?
EFFICIENCY	
(4) What are the costs and benefits (monetary and non-monetary) associated with implementation of the AAQ Directives in the Member States, and in the EU; have the benefits (improved air quality) been achieved in a cost-effective manner and to what extent have costs been equitably distributed across different sectors?	
(5) Where there are significant cost differences between Member States and/or between different sectors and/or as regards costs to stakeholders (including social costs as a consequences of poor implementation), what is causing them; and are the costs of compliance proportionate to the benefits brought by the directives?	

Evaluation question	Questions
(6) How efficient are monitoring, reporting and assessment regimes, what are the administrative costs to the Member States and to the Commission; taking account of the objectives and benefits of the directives is there evidence that they have caused unnecessary or excessive administrative burden?	What are the costs of implementation of the AAQ Directives? What is the cost of implementation (monitoring, reporting, and planning) for different levels of government, including the use of external expertise on, per year (in FTE)? What is the cost of implementation for different sectors of the industry per year (capital and operating costs of equipment in EUR)? What specific factors contribute to the efficiency/inefficiency of the implementation of the AAQ Directives? What are the costs of non-implementation of the Directives (e.g. environmental and health costs, uncertainty and market distortion, litigation costs for Member States)? What are benefits associated with the implementation of the Directives in the Member State/air quality zone (e.g. health and environmental benefits, economic benefits, eco-innovation, etc.)?
(7) Has the implementation of the AAQ Directives supported or hampered EU competitiveness in the global economy; has the implementation of the AAQ Directives improved or been detrimental to economic, social and environmental sustainability?	
COHERENCE	
(8) To what extent do the AAQ Directives complement or interact with other environmental policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as the NEC Directive and IED Directive as well as the EU climate legislation and policy; and how do these policies and legislation support or hamper the implementation of the EU air quality legislation?	How and to what extent is the implementation of the AAQ Directives coordinated with the implementation of other EU instruments in the environmental and climate domain (e.g. the National Emissions' Ceiling Directive, the Industrial Emissions' Directive, Large Combustion Plants Directive, etc.)?

Evaluation question	Questions
(9) To what extent do the AAQ Directives complement or interact with sectoral policies that affect air quality, or that are affected by it, at EU level and at Member State level (such as energy, transport, agriculture, cohesion, fiscal policies); and how do these policies support or hamper the implementation of the EU air quality legislation?	How and to what extent is the implementation of AAQ Directives coordinated with other relevant legislation and policy (e.g. in the area of energy, transport and agriculture)? Are air quality plans coordinated with planning initiatives promoted by EU sectoral legislation (e.g. Sustainable Urban Mobility Plans, TEN-T investments)? Are air quality plans coordinated with national emission reduction plans and measures under the NEC Directive? Are air quality plans coordinated with climate change mitigation policies and plans (for GHG emission reductions)? To what extent are air quality plans integrated or linked with municipal/urban/regional level planning e.g. in the area of land use and spatial planning, energy management, transportation and climate? To what extent are EU funds used to finance measures (e.g. abatement programmes) to maintain good air quality/improve air quality?
ADDED VALUE	
(10) To which degree have the AAQ Directives, including common EU air quality standards and comparable air quality assessment, management and information approaches enabled Member States and their competent authorities to take successful action to improve beyond what would have been possible without EU action?	Have AAQ Directives triggered transformational changes that have enabled the achievement of air quality objectives? Have AAQ Directives contributed to improvements in monitoring? Have AAQ Directives contributed to improvements in public information and public participation? What are the wider economic, social and environmental impacts of the Directives in the Member State/air quality zone?
(11) What has been the EU added value of the AAQ Directives, do the Directives and their means of implementation create synergies or overlaps with other Community objectives, and how has the distribution of responsibilities between EU, Member State, regional and local levels impacted on air quality management?	How is the implementation of the AAQ Directives coordinated in the Member State (division of responsibilities, coordination across different activities)? To what extent is the implementation of AAQ Directives coordinated in the region (to address transboundary pollution)?

APPENDIX D USE OF EU FUNDS

Project Title	Project	Project Website	Year Of Finance	Type Of Beneficiary
HYPER BUS - Hyper Bus - Hybrid and plug-in extended range bus system	LIFE10 ENV/SE/000041	http://www.hyper-bus.se/,	2010	Development agency
GREENCIT - Green citizens of Europe - Innovative tools and methods for interactive and co-creative citizens	LIFE09 ENV/SE/000346	http://www.greencit.se/,	2009	Local authority
CLEANTRUCK - CLEAN and energy efficient TRUCKs for urban goods distribution	LIFE08 ENV/S/000269	http://www.stock-holm.se/cleantruck,	2008	Local authority
Biored - Multi-Stage Biological Reduction of EDTA in Pulp Industries	LIFE04 ENV/SE/000765	http://www.nordic-paper.com , http://www.bi-ored.se/,	2004	International enterprise
Basta - Phasing Out Very Dangerous Substances from the Construction Industry	LIFE03 ENV/S/000594	http://www.bastaonline.se/,	2003	International enterprise
Tanwater - Reduction of the nitrogen discharge from the leather industry	LIFE03 ENV/S/000595	http://www.tanwater.net/,	2003	International enterprise
New LS Lacquers - Low solvent lacquers based on new binder combinations	LIFE00 ENV/S/000851	http://www.arbor-itec.se,	2000	SME Small and medium sized enterprise

APPENDIX E POLLUTANT CONCENTRATION DATA FOR SWEDEN, 2013-17

Table 4-1 Highest pollutant concentrations in exceedance of EU air quality objectives for protection of health in Sweden in 2013-2017 - extract from reporting (Dataflow G).

Pollutant	Averaging period	Objective type and value	Date for achieving objective	Parameter shown	2013	2014	2015	2016	2017
PM_{10}	Calendar year	LV: 40 µg/m^3	1 January 2005	Annual mean, µg/m^3	-	-	-	-	-
	1 day	LV: 50 µg/m^3 not to be exceeded on more than 35 days per year	1 January 2005	Days above	56	36	38	-	45
NO_2	Calendar year	LV: 40 µg/m^3	1 January 2010	Annual mean, µg/m^3	46	41	42	43	-
	1 hour	LV: 200 µg/m^3 not to be exceeded on more than 18 hours per year	1 January 2010	Hours above	-	-	-	-	-
SO_2	1 day	LV: 125 µg/m^3 not to be exceeded on more than 3 days per year	1 January 2005	Days above	-	-	-	-	-
	1 hour	LV: 350 µg/m^3 not to be exceeded on more than 24 hours per year	1 January 2005	Hours above	NA	NA	-	-	-
CO	Maximum daily 8-hour mean	LV: 10mg/m^3	1 January 2005	Days above	-	-	-	2	2
C_6H_6	Calendar year	LV: 5 µg/m^3	1 January 2010	Annual mean, µg/m^3	-	-	-	-	-
Pb	Calendar year	LV: 0.5 µg/m^3 (measured as content in PM_{10})	1 January 2005	Annual mean, µg/m^3	-	-	-	-	-

Pollutant	Averaging period	Objective type and value	Date for achieving objective	Parameter shown	2013	2014	2015	2016	2017
O_3	Maximum daily eight-hour mean	TV: 120 µg/m³ not to be exceeded on more than 25 days per calendar year averaged over three years	1 January 2010	Days above	7	15	4	9	3
	Maximum daily eight-hour mean within a calendar year	LTO: 120 µg/m³	Not defined	Days above	-	-	-	-	-
$PM_{2.5}$	Calendar year	LV: 25 µg/m³	1 January 2015 (target value until 1 January 2010)	Annual mean, µg/m³	-	-	-	-	-
	(calculated as Average Exposure Indicator, assessed as a 3-year running annual mean)	ECO: 20 µg/m³	2015	AEI, µg/m³	NA	NA	NA	NA	NA
As	Calendar year	TV: 6 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	-	-	-	-	-
Cd	Calendar year	TV: 5 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	-	-	-	-	-
Ni	Calendar year	TV: 20 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	-	-	-	-	-
BaP	Calendar year	TV: 1 ng/m³ (measured as content in PM_{10})	31 December 2012	Annual mean, ng/m³	-	-	-	-	-

Source: COWI calculations based on Member State reporting, data flow G. Downloaded in November 2018.

Note: LV: limit value; TV: target value; LTO: Long term objective; ECO: exposure concentration obligation; The values show the maximum exceedance reported in the Member State (if no exceedances are reported in any of the zones of the Member State, the table shows "-") Legend: "NA": not available in data flow G, "-": no reported exceedance

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