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OECD Environmental Performance Reviews: Germany 2023

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Foreword

The principal aim of the OECD Environmental Performance Review programme is to help member and selected partner countries improve their individual and collective performance in environmental management by:

- helping countries assess progress in achieving their environmental goals
- promoting continuous policy dialogue and peer learning
- stimulating greater accountability from governments towards each other and public opinion.

This report reviews the environmental performance of Germany since the previous review in 2012. Progress in achieving domestic objectives and international commitments provides the basis for assessing the country's environmental performance. Such objectives and commitments may be broad aims, qualitative goals or quantitative targets. A distinction is made between intentions, actions and results. Assessment of environmental performance is also placed within the context of Germany's historical environmental record, present state of the environment, physical endowment in natural resources, economic conditions and demographic trends. The analysis is complemented by the *Environment at a Glance* country profile of Germany illustrating key environmental trends with interactive figures and cross-country comparison.

The OECD is indebted to Germany's Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) for its co-operation in providing information, for the organisation of the review mission in Berlin (10-14 October 2022) and policy mission (24 January 2023) as well as for facilitating contacts inside and outside government institutions. Thanks are also due to all government ministries and agencies, as well as to the non-government organisations, that participated in the virtual missions and/or provided information and comments. The OECD is grateful to the representatives of the two examining countries: Sarah Voirin (France) and Megan Bickle (United Kingdom).

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The OECD Working Party on Environmental Performance at its meeting on 12 April 2023 approved the Assessment and Recommendations.

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Reader's guide

Signs

The following signs are used in figures and tables:

.. : not available

– : nil or negligible

. : decimal point

Country aggregates

OECD Europe: This zone includes all European member countries of the OECD, i.e. Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

OECD: This zone includes all member countries of the OECD, i.e. the countries of OECD Europe plus Australia, Canada, Chile, Colombia, Costa Rica, Israel*, Japan, Korea, Mexico, New Zealand and the United States.

Country aggregates may include Secretariat estimates.

Cut-off date

This report is based on information and data available up to 15 March 2023.

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Basic statistics of Germany

2021 or latest available year (OECD values in parentheses)*

PEOPLE AND SOCIETY				
Population (million)	83	(1374)	Population density per km ²	232 (36)
Share of population by type of region (a):		(0)	Population compound annual growth rate, latest 5 years	0.19 (0.49)
Predominantly urban (%)	44		Income inequality (Gini coefficient)	0.30
Intermediate (%)	41		Life expectancy	81 (81)
Rural (%)	16			
Poverty rate after taxes and transfers, Poverty line 50%	0			
ECONOMY AND EXTERNAL ACCOUNTS				
Total GDP (National currency, billion)	3602		Imports of goods and services (% of GDP)	40 (29)
Total GDP (USD, billion, current prices and PPPs)	4891		Main exports (% of total merchandise exports)	
GDP compound annual real growth rate, latest 5 years	0.7	(1.6)	Machinery and transport equipment	45
GDP per capita (1 000 USD current PPPs)	59	(49)	Chemicals and related products, n.e.s.	18
Value added shares (%)			Manufactured goods	12
Agriculture, forestry and fishing	1	(2)	Main imports (% of total merchandise imports)	
Industry including construction	30	(24)	Machinery and transport equipment	35
Services	70	(74)	Chemicals and related products, n.e.s.	15
Exports of goods and services (% of GDP)	47	(29)	Miscellaneous manufactured articles	13
GENERAL GOVERNMENT				
Percentage of GDP (b)				
Expenditure	51	(46)	Education expenditure	4.6 (5.3)
Revenue	48	(39)	Health expenditure	8.4 (8.8)
Gross financial debt	77	(124)	Environment protection expenditure	0.7 (0.6)
Fiscal balance	-4	(-8)	Environmental taxes: (% of GDP)	1.7 (1.4)
			(% of total tax revenue)	4.4 (4.6)
LABOUR MARKET, SKILLS AND INNOVATION				
Unemployment rate (% of civilian labour force)	4	(6)	Patent applications in environment-related technologies (% of all technologies, average of latest 3 years) (c)	14 (11)
Tertiary educational attainment of 25-to-64 year-olds (%)	31	(40)	Environmental management	5 (3)
Gross expenditure on R&D, % of GDP	3	(3)	Climate change mitigation technologies	12 (10)
			Climate change adaptation technologies (% of all technologies, average of latest 3 years)	0.9 (1.3)
ENVIRONMENT				
Energy intensity: TES per capita (toe/cap.)	3.5	(3.8)	Road vehicle stock (vehicle/100 inhabitants)	62
TES per GDP (toe/1 000 USD, 2015 PPPs)	0.07	(0.09)	Water stress (abstraction as % of available resources)	12 (8)
Renewables (% of TES)	15.6	(11.6)	Water abstraction per capita (m ³ /cap./year)	249 (735)
Carbon intensity (energy-related CO ₂):			Municipal waste per capita, (kg/capita)	647 (534)
emissions per capita (t/cap.)	7.9	(8.3)	Material productivity (USD, 2015 PPPs/DMC, kg)	3.6 (2.5)
emissions per GDP (t/1 000 USD, 2015 PPP)	0.16	(0.19)	Land area (1 000 km ²)	349
GHG intensity (d):			% of arable land and permanent crops	34 (11)
emissions per capita (tCO ₂ eq/cap.)	8.8	(10.5)	% of permanent meadows and pastures	14 (23)
emissions per GDP (tCO ₂ eq/1 000 USD, 2015 PPP)	0.18	(0.26)	% of forest area	33 (33)
Mean population exposure to air pollution (PM _{2.5}), µg/m ³	12	(13.9)	% of other land (built-up and other land)	15 (33)

* Values earlier than 2016 are not taken into consideration. a) OECD value is a simple average of available countries. b) OECD value: where the OECD aggregate is not provided in the source database, a simple OECD average of the latest available data is calculated. c) Higher-value inventions that have sought patent protection in at least two jurisdictions. Average of latest three years. d) Excluding emissions/removals from land use, land-use change and forestry.

Source: Calculations based on data extracted from databases of the OECD, IEA/OECD, EUROSTAT and the World Bank.

Executive summary

Germany responded swiftly to the global energy crisis and its energy transition is underway. The German economy has weathered the global energy crisis much better than expected at the outset of the crisis. Germany is quickly cutting its dependence on Russian energy and managed to broaden the supply base of its energy. Germany has a legally binding goal to phase out coal by 2038. In the context of Germany's nuclear exit, renewables need to grow even faster, if the country does not intend to increase its reliance on fossil fuels.

Germany needs to address the triple crisis of energy, climate and biodiversity in an integrated way. In practice, the federal government faces several trade-offs. With a view to avoiding severe energy shortages, the federal government temporarily postponed the phase-out of several coal plants. Fuel price support may have been necessary but also impacts progress on climate goals. These are temporary setbacks in Germany's energy transition, but the long-term impact can be moderate if these emergency measures remain time-bound. Energy savings and energy efficiency need to remain the top priority.

Energy policy reforms are expected to boost renewables. The Easter Package 2022 lays out ambitious targets and makes significant changes to the country's regulatory framework, including measures to introduce higher auction volumes and accelerate permitting procedures. The 2023 Renewable Energy Sources Act sets a new legally binding target to increase the share of renewable energy sources to 80% of electricity consumption by 2030 (previously at 65%). Bottlenecks such as grid expansion and skilled labour shortage need to be addressed.

Germany has ambitious climate targets with the aim to reach climate neutrality by 2045 and achieve negative emissions after 2050. National targets are enshrined in the Federal Climate Change Act, which was approved in 2019 and amended in 2021. Some Länder such as the state of Baden Württemberg, have set more ambitious subnational targets. Germany is still among the ten largest greenhouse gas (GHG) emitters in the world. In 2020, the country managed to reduce its emissions by 40% compared to 1990 levels, one of the largest percentage emission reductions since 1990 in the OECD area. However, emission reductions related to the COVID-19 pandemic proved to be only temporary and have quickly been reversed.

Bold action is needed to promote green mobility within an integrated strategy. Many opportunities such as broader use of speed limits, tolls for passenger and light duty vehicles, as well as congestion charges in urban areas have not been taken; others, such as, increased parking fees, are slowly materialising. The share of electric vehicles (EVs) is rapidly growing but remains modest in the total vehicle stock. Germany still has a way to go to reach the federal government's goal of 15 million EVs and 1 million charging points by 2030. It needs to move from individual policy measures mainly focused on "making cars cleaner" to an integrated sustainable mobility strategy. The digital *Deutschlandticket* is an important step towards making train trips more financially competitive for citizens.

Germany has reduced several environmental pressures, despite an important industry base and dense population. It improved air quality, and is one of the best performing countries in environmentally sound waste management in Europe. However, the country made little progress to reduce the level of

municipal waste and needs to strengthen waste prevention. It is working towards a more circular economy and more sustainable supply chains. Water quality remains a concern and water infrastructure needs to become more climate resilient. Sustainable farming is progressing, but nitrogen surpluses remain a challenge. Despite progress, ambition in the agricultural sector will need to be further raised to reverse the loss of species and improve the sector's climate balance.

Taxes need to be better aligned with the polluter pays principle. Germany's environmentally related tax revenue (ERTR) has declined over the past decades. The ratio of tax to gross domestic product (GDP) and the share of ETRT in total tax revenues are both far below the OECD Europe average. The ETRT downward trend is not driven by a decrease of environmental pressures, but mainly by the devaluation of ETRT. In line with good practice, Germany should consider introducing annual inflation adjustments. The level of transport-related taxes is far below the OECD average. Germany is one of the rare countries that does not tax vehicle purchase or registration. Federal government support often sets the wrong incentives at the expense of sustainable transport modes (e.g. company car privilege, commuter allowance). Little progress has been made on developing a fair and efficient road pricing system.

Close to 90% of Germany's GHG emissions are priced, but carbon prices are low in non-road sectors. Introducing a common carbon price floor across sectors would improve the effectiveness of abatement decisions. Moreover, Germany would need to further reduce the number of exemptions and expand carbon pricing to sectors that are not yet covered. In 2021, the federal government introduced a national ETS, mainly targeting the transport and heating sectors.

Germany should improve policy coherence and phase out potentially environmentally harmful support. The amount of environmentally harmful subsidies has been growing during the past decade. Subsidies with negative effects on the environment were estimated at EUR 65 billion in 2018 compared to EUR 48 billion in 2008. As already highlighted in the 2012 Environmental Performance Review, many long-term subsidies (e.g. diesel discount) are no longer justified on economic or social grounds and should be phased out. Little progress has been made in phasing out potentially environmentally harmful support in agriculture. The federal government should follow through on its intention to systematically screen existing and proposed subsidies to identify economic, environmental and social inefficiencies.

Germany's exposure to the impacts of climate change is growing. In the past two decades, the country experienced a considerable number of extreme weather events, notably floods, storms, droughts and heatwaves, all of which had a significant impact on livelihoods, the environment and the economy. Due to increasing climate change, these extreme events are on the rise in many regions of the country. The flood disaster of 2021 contributed to increasing citizen acceptance for stronger climate action and recalls the urgent need to prevent future loss and damage from these types of extreme climate events.

Extreme weather events cause significant loss and damage. The direct damage recorded from climate-related hazards per unit of GDP from 2005 to 2021 is among the highest in the OECD countries. Floods pose a particularly significant climate-related risk in Germany. Between 2000 and 2021, flash floods – floods and extreme precipitation – caused 230 fatalities and more than EUR 71 billion in total damages. Sea-level rise and storms pose a high risk for the 3.2 million people who live in areas at risk of coastal flooding. Germany is increasingly exposed to heat stress. Between 2018 and 2020, nearly 20 000 heat-related deaths, mainly of elderly people, were recorded.

Germany needs to expand coverage of localised climate risk assessments nationwide and prioritise adaptation investment in the most vulnerable areas to ensure that no one is left behind. Adaptation remains driven by voluntary action. Länder would need to play a more active role in supporting vulnerable local authorities. The use of comparable data and methods across levels of government would allow greater comparability at national level. To date, Germany has a broad range of different indicators, criteria and thresholds to analyse climate-related hazards and related risks.

The federal government is scaling up its engagement on climate change adaptation across all government levels. A new Federal Climate Adaptation Act, under preparation, is meant to guide the federal government and Länder in the development and implementation of a national adaptation strategy. The implementation capacity of subnational governments needs to be further strengthened. Germany is preparing concrete adaptation indicators and targets across different economic sectors, an exercise that will be relevant for other OECD countries. Adaptation funding needs are set to grow substantially, and lack of funding already constitutes a major barrier to building climate resilience.

Germany's biodiversity has degraded over the past few decades. Despite efforts to protect biodiversity, the fundamental loss of biodiversity has not been reversed. Progress towards many national targets adopted under the Convention on Biological Diversity (CBD) has been insufficient. Key pressures include intensive farming and forestry, landscape dissection and urban sprawl, soil sealing and pollutants. About 30% of forest area is affected by high tree death rates and tree crown defoliation, a key indicator for tree vitality. Urban development has increased rates of soil sealing, leading to greater risk of flooding, higher vulnerability to heat stress, and significant biodiversity loss in urban areas.

The EUR 4 billion Federal Action Programme on Nature-based Solutions for Climate and Biodiversity (*Aktionsprogramm Natürlicher Klimaschutz, ANK*) could become a game changer. It is set to contribute significantly to Germany's LULUCF targets while promoting biodiversity and ecosystem health, resilience to climate impacts and sustainable land management. The Länder could become key partners in delivering the ANK programme. For the programme to deliver short-term results (2023-26), stakeholders should rapidly agree on key priorities, eligibility criteria and delivery, funding and accountability mechanisms. The short timeframe and large scope of the ANK represent a major challenge. ANK funding needs to be aligned and co-ordinated across sectors and government levels.

Assessment and recommendations

This section presents the main findings of the OECD Environmental Performance Review of Germany. They identify 28 recommendations to help the country make further progress towards its environmental objectives and international commitments. The OECD Working Party on Environmental Performance discussed and approved the Assessment and Recommendations at its meeting on 12 April 2023.

1. Towards sustainable development

Addressing key environmental challenges

Germany, one of the world's strongest, export-oriented economies, continued to improve its environmental performance over the past decade. The country reduced many environmental pressures, despite its important industry base and dense population. Germany improved air quality and is one of the best performing countries in terms of sustainable waste management in Europe. It is working towards a more circular economy and more sustainable supply chains. Despite remarkable growth in the share of renewables, the country's energy mix still depends largely on fossil fuels, which accounted for about three-quarters of total energy supply in 2020. Germany has an ambitious climate policy and aims to reach climate neutrality by 2045 and achieve negative emissions after 2050.

Germany faces multiple pressures on nature and water, threatening biodiversity and natural capital. The Baltic Sea and North Sea face acute problems with eutrophication. Nitrate water pollution from agriculture remains a serious concern. Germany needs to strengthen efforts to improve water quality. About one-third of forests have near-natural conditions and more than 90% of peatlands have been drained (BMUV, 2022^[1]). The conservation status of species and habitats shows deteriorating trends. Climate change increasingly affects the country as witnessed by the 2021 flood catastrophe. Germany is scaling up efforts to adapt and become more climate resilient (Chapter 2).

Like other members of the European Union (EU), Germany has a large number of environmental and climate policies that fall under EU legislation. Drawing on Germany's leadership in Europe, it has contributed to shaping new EU policy (e.g. European Green Deal, Fit-for-55 package, REPowerEU, EU CAP¹). At the same time, Germany has also benefited from implementing more environmentally rigorous EU directives. At the international level, Germany has pushed for strong multilateral alliances for more ambitious environmental and climate policy, notably within its G7 presidency in 2022. Germany is committed to implementing Agenda 2030 at home and abroad, ranking sixth of 163 assessed countries (Sachs, J.D. et al., 2022^[2]). The 2022 spending review lays the groundwork to increase the focus on performance-based budgeting for sustainable development.

The economic downturn caused by the COVID-19 pandemic hit the economy hard, with gross domestic product (GDP) contracting by 3.7% in 2020. The economy recovered in 2021 (+2.6%) and was then again affected by the economic consequences of the Russian war in Ukraine, which resulted in a lower-than-expected real GDP growth of 1.9%. It is projected to recover slowly (0.3% in 2023 and 1.7% in 2024) (OECD, 2023^[3]). In 2022, Germany recorded a high inflation rate of 8.8%. The crisis revealed structural weaknesses of Germany's energy supply due to strong dependency on Russian oil and gas, obliging the federal government to rethink its energy strategy. However, the German economy has weathered the global energy crisis much better than expected (OECD, forthcoming^[4]). As part of its energy crisis response, Germany has taken a series of measures, which are historic in size and scope. They are set to accelerate massively its green energy transition in the coming years.

Germany's green energy transition is underway but needs to be accelerated while addressing the triple crisis of energy, climate and biodiversity simultaneously

Germany's green energy transition (*Energiewende*), initiated in the early 2010s, aims at moving away from nuclear and fossil fuels towards renewables while promoting better energy efficiency. The country has decoupled energy demand and carbon dioxide (CO₂) emissions from economic growth and is one of the G20 and EU-27 countries with the highest levels of energy efficiency (Brüggemann, 2018^[5]). The share of renewables has achieved remarkable growth over the past decade (Figure 1). The 2020 Act on the Phase-out of Coal-fired Power Plants committed Germany to phase out coal by 2038. In addition, the federal government committed to accelerating the process and completing the coal exit, ideally, by 2030.

Despite progress, Germany will need to advance its energy transition at a much faster pace. More particularly, it needs to address three major challenges: i) ensuring energy security; ii) achieving national environmental and climate goals; and iii) ensuring the country's economic competitiveness. In practice, the federal government faces several trade-offs. For example, some energy emergency measures negatively impact progress on climate goals (e.g. re-opening of coal energy plants, fuel price support, suspended step increase of CO₂ price). Meanwhile, despite efforts, it has not yet been possible to reverse biodiversity loss. Given the pressing environmental and climate challenges, the country cannot afford any further delays in designing pathways towards a sustainable energy transition. Germany needs to address the triple crisis of energy, climate and biodiversity in an integrated and holistic manner.

Germany responded swiftly to the global energy crisis...

The federal government has greatly accelerated its pace of policy making in the energy sector. Measures include filling up gas storage tanks, negotiating liquified natural gas (LNG) trade deals, temporarily re-opening coal plants and raising public awareness on energy saving. Gas storages had been fully filled in October 2022 and stood at 77% in early February 2023, notably thanks to a relatively mild winter (OECD, forthcoming^[4]). With a view to avoiding severe energy shortages, the federal government extended the three remaining nuclear plants until April 2023. It also temporarily postponed the phase-out of several coal plants. These are temporary setbacks in Germany's energy transition, but the long-term impact can be moderate if these emergency measures remain time-bound.

In addition, two new public LNG terminals were built within less than one year. In total, six LNG terminals should be operational by winter 2023-24. While Germany should be commended for acting swiftly, the rapid construction of terminals cost EUR 6.6 billion, more than double the initial budget. The federal government should assess import needs to avoid overcapacity and ensure that energy emergency responses are consistent with climate objectives and do not create lock-in effects (G7, 2022^[6]). The LNG Acceleration Act underlines that LNG infrastructure use beyond 2043 should be allowed only for facilities that produce climate-neutral hydrogen and its derivatives.

The crisis triggered opportunities to accelerate the country's green transition. These include legislation and funding programmes targeting the switch away from fossil fuels with an ambitious roll-out of renewable energy and the faster coal phase-out in the state of North Rhine-Westphalia by 2030, eight years earlier than initially scheduled. The federal government is adjusting rapidly to new realities by diversifying its energy supply sources. Direct imports from Russia to Germany through Nord Stream 1 and 2 gas pipelines have stopped (Bundesnetzagentur, 2023^[7]).

...but needs to better target support and promote transformational change

Like in many other countries, consumer support measures need to be better targeted to protect the most vulnerable populations (OECD, forthcoming^[4]). For example, Germany lowered taxes on fuels, which helped citizens but discouraged fuel savings. While implementation of general measures is easier, fuel price cuts are untargeted and disproportionately benefit larger energy consumers, who often have higher incomes. Moreover, a EUR 300 tax bonus was granted to all employees regardless of their level of vulnerability; income tax progressivity ensures some social balance of the support measure. The lump sum was extended to pensioners; students received compensation of EUR 200. Both groups are among the hardest hit by the energy price shocks but certain members of each group suffer more than others. Financial vulnerability of households should also be assessed according to location, building standards, household composition and access to public transport (OECD, 2022^[8]).

In September 2022, the federal government announced a EUR 200 billion energy relief plan, including gas and electricity price brakes.² The plan aims to shield all households and businesses against soaring energy prices while maintaining incentives for energy savings. The federal government should develop a targeted

and socially just transfer system to mitigate high energy costs through time-bound support that is disconnected from energy consumption levels. A more suitable cash-transfer system is being developed at the federal level. Implementation will require stronger administrative capacities and a better understanding of vulnerabilities (OECD, forthcoming^[4]).

Energy savings and energy efficiency are top priorities

Over the past decade, the country significantly enhanced energy efficiency in the commercial, public service and residential sectors. Private households reduced their energy consumption by over 10% (IEA, 2021^[9]), mainly thanks to technological improvements. However, absolute levels of primary energy consumption decreased only slightly as rising energy demand offset technical efficiency gains.

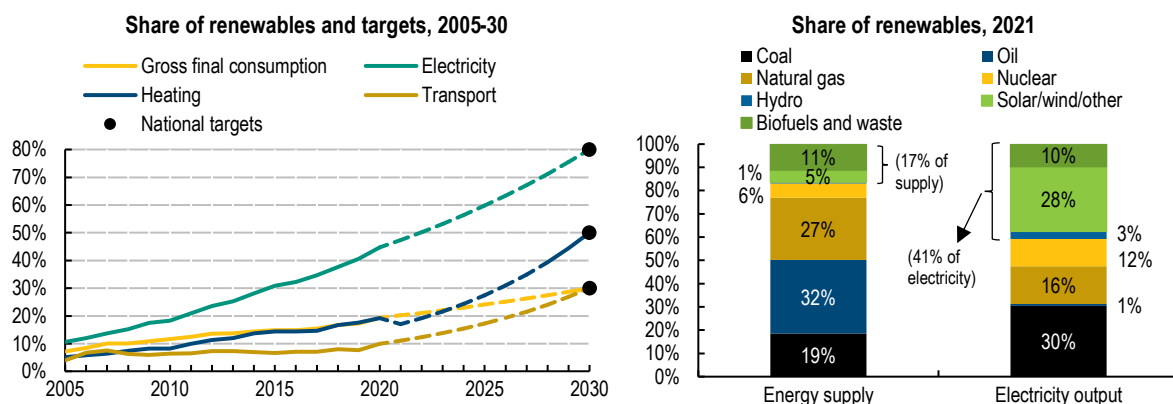
The federal government has set a goal of “making Germany the most energy-efficient economy in the world” (BMWK, 2020^[10]). Within Germany’s Energy Efficiency Strategy 2050, ambition was further raised with a new goal of reducing energy consumption by 30% in 2030 and by 50% in 2050, compared to 2008 levels. The National Energy Efficiency Action Plan (NAPE 2.0) bundling measures required until 2030 and a cross-sector stakeholder dialogue, have been part of this strategy. The updated climate goal for reaching net zero by 2045 has also impacted this process. Furthermore, a national Energy Efficiency Law is underway, in parallel to the now concluded EU process on the Energy Efficiency Directive (EED). In order to secure the supply of heat during the colder weather periods in 2023 and 2024, the federal government has introduced additional energy saving measures on the basis of the Energy Security of Supply Act (*Energiesicherungsgesetz*, EnSiG) in August 2022. Germany could harness behaviour-related efficiency potential to a much greater extent (e.g. incentives for shared mobility, reduced heating temperatures in buildings) (ERK, 2022^[11]).

Energy policy reforms are expected to boost renewables

While the share of renewables in total energy supply remains modest (17%), the share in electricity outputs reached 41% in 2021 (Figure 1). Solar energy has been boosted across the country since the early 2010s. Germany has the biggest wind onshore capacity in Europe. The total installed capacity was 57 gigawatts (GW) onshore and 7.8 GW offshore in 2022. The federal government aims to double wind onshore capacity to 115 GW and reach a 30 GW offshore wind target in 2030. The renewable energy forecasts for 2022-27 project major increases in solar photovoltaic and onshore wind (IEA, 2022^[12]).

The Easter Package 2022 lays out ambitious targets and makes significant changes to the country’s regulatory framework, including measures to introduce higher auction volumes and accelerate permitting procedures. The 2023 Renewable Energy Sources Act sets a new legally binding target to increase the share of renewable energy sources to 80% of electricity consumption by 2030 (previously at 65%). In addition, the share of renewables should reach 30% of gross final energy consumption, 50% of heating, and 30% of transport (Figure 1). The Federal Ministry for Economic Affairs and Climate Action is working on measures to accelerate decarbonisation of heating and cooling, aiming to increase the share of carbon-neutral heating to 50% by 2030. Germany must also respond to rising electricity demand due to the ongoing electrification of the transport and building sectors. The development of renewable energy becomes an “overriding matter of public interest” (BMWK, 2022^[13]).

Figure 1. Germany has set ambitious targets for renewables



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Bottlenecks such as grid expansion and skilled labour shortage need to be addressed

Reaching the renewable energy targets will require massive investment in the modernisation and expansion of electricity grids and energy infrastructure. The 2019 Grid Expansion Acceleration Act set targets, including major power lines such as north-south connections to channel energy surpluses from wind power in the north to the major power consumption regions in the west and south. However, progress has been slow, mainly due to complex planning and approval procedures. Farmers' concern about soil damage and related compensation claims have also slowed down grid expansion. Additional measures aim to simplify and accelerate planning, while ensuring more equally distributed onshore wind power. This would greatly help ease pressure on the power grid by favouring local usage. Digitalisation will also play a key role in better managing electricity flows over space and time.

Germany needs to urgently address the shortage of skilled labour across the renewable energy sector, which lacks more than 200 000 workers (electricians, heating and air-conditioning technicians, IT specialists) (Monsef and Wendland, 2022^[14]). A new Skilled Immigration Act is under discussion. It aims to further simplify and accelerate administration, while making working and living conditions more attractive to facilitate immigration of skilled workers at a much larger scale. It is also crucial to expand adult learning opportunities and support the labour market integration of women.

Germany has ambitious climate targets but needs to accelerate climate action

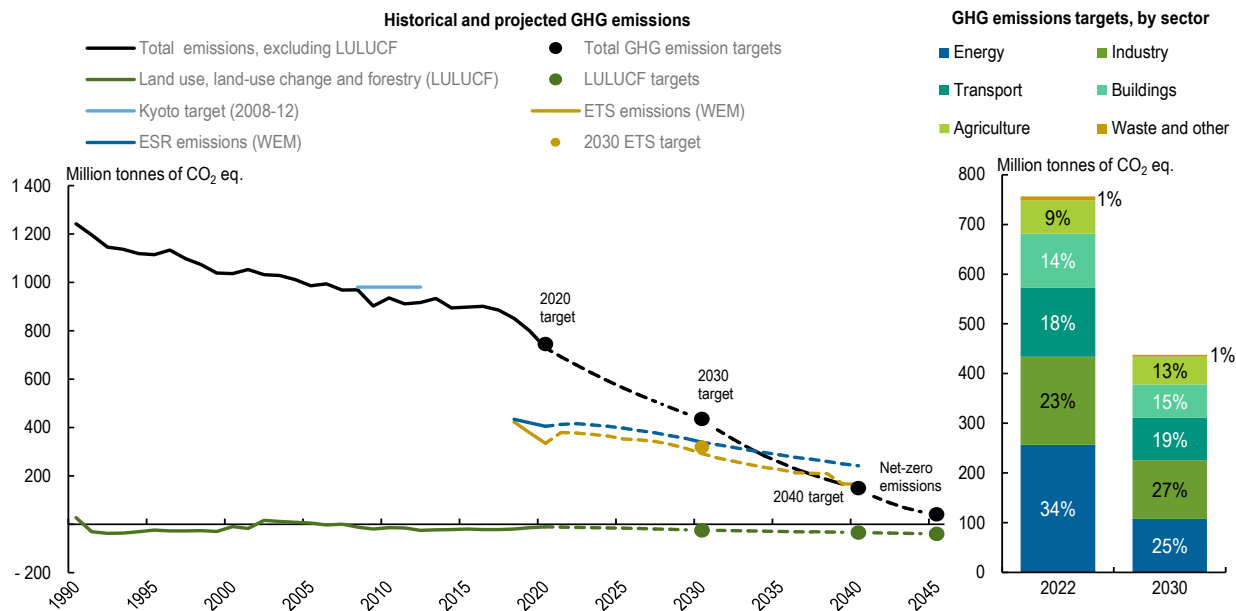
Germany has set an economy-wide target to reduce greenhouse gas (GHG) emissions by at least 65% by 2030 and by at least 88% by 2040, compared to 1990 levels. It aims to reach climate neutrality by 2045 (five years earlier than the EU target) and achieve negative emissions after 2050 (Figure 2). National targets are enshrined in the Federal Climate Change Act, which was approved in 2019 and amended in 2021. Some Länder such as the state of Baden Württemberg, have set more ambitious subnational targets.

On the international scene, Germany encourages stronger alliances for progress on climate protection. Within its G7 presidency in 2022, the country initiated an international Climate Club³ to help define common standards for emission measurements and carbon pricing, among other goals. Germany is also a major provider of international climate finance.

The country has set up annual CO₂ emission budgets for six sectors until 2030, along with a monitoring and policy adjustment mechanism (OECD, 2022^[15]). Nearly all sectors achieved their sector-specific

annual emissions targets in 2021, except buildings and transport. In parallel, Germany aims to increase the contribution of the land use, land-use change and forestry (LULUCF) sector.

Figure 2. Germany needs to accelerate climate action to reach its 2030 and 2045 climate targets



Note: ESR = effort sharing regulation. ETS = emissions trading system. WEM = with existing measures. Dashed lines represent projections (linear to targets in the case of total emissions and LULUCF).

Source: EEA (2022), *Member States' Greenhouse Gas Emission Projections* (database), www.eea.europa.eu/data-and-maps/data/greenhouse-gas-emission-projections-for-8; EEA (2022), *European Union Emissions Trading System (EU ETS) data*, www.eea.europa.eu/data-and-maps/data/european-union-emissions-trading-scheme-17; OECD (2022), *Greenhouse gas emissions by source*, *OECD Environment Statistics* (database).

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Germany produces about 2% of global emissions and is still among the ten largest GHG emitters in the world. In 2020, the country managed to reduce its emissions by 40% compared to 1990 levels, narrowly meeting its target (OECD, 2021^[16]). This is one of the largest percentage emission reductions since 1990 in the OECD area. However, the federal government will need to accelerate the implementation of new climate measures to achieve its ambitious 2030 targets. Against the background of the global energy crisis, it will need to assess the short and medium-term impact of energy measures, update GHG projections and develop additional climate measures to fill the gaps on its pathway towards net zero.

Germany's climate policy is aligned with EU climate legislation, including the EU Emissions Trading System (ETS), the Effort Sharing Regulation and transport and land-use legislation. Emissions reduction targets under the EU Effort Sharing Regulation (covering the non-ETS sector) are legally binding. Within the Europe's Fit-for-55 package, its national emissions reduction targets in non-ETS sectors shall be raised from -14% in 2020 to -50% by 2030, compared to 2005 levels. Between 2013 and 2020, Germany missed climate targets in key sectors. A lack of sector-specific progress will demand acquiring offsets, which will have significant financial consequences (OECD, 2022^[15]).

Germany's youth has been a driving force in advancing public climate action. Most prominently, *Fridays for Future*, a youth-led climate strike movement, has played a key role in raising public awareness on climate change. Their claim for more intergenerational justice led to the amendment of the Federal Climate Change Act in 2021 with more ambitious targets following a ruling of the Federal Constitutional Court.

Beyond 2030, Germany should develop a long-term vision that provides a clear roadmap towards a net zero and climate-resilient future. To date, many policy measures only focus on the next couple of years; however, investment decisions are based on much longer lifecycles of buildings, equipment and products. Businesses and households need better foresight to achieve post-2030 goals.

Bold action is needed to promote green mobility within an integrated strategy

The decarbonisation of Germany's transport sector is not on track. The sector missed its 2021 CO₂ emission reduction targets by 3 million tonnes of CO₂-equivalent (eq). Road transport is responsible for nearly all transport-related emissions. Passenger cars represent the bulk of transport-related emissions at 60%; freight accounts for about one-third. Emission reduction efforts have been counterbalanced by the rising number of cars and more traffic from heavy duty trucks. The independent Council of Experts on Climate Change judged the federal government's proposal for an immediate action programme to be "insufficient" (ERK, 2022^[17]). Germany faces gaps both for ambition and implementation. Many opportunities such as broader use of speed limits, tolls for passenger and light duty vehicles, congestion charges in urban areas etc. have not been taken; others, such as, increased parking fees, are slowly materialising. Plans to expand federal motorways (e.g. from six to eight lanes) need stronger consideration of environmental concerns. While electric mobility will play a key role in decarbonising transport, Germany should not aim to replace each petrol and diesel-fuelled car with an electric vehicle.

Germany will need to take bold action to move from individual policy measures mainly focused on "making cars cleaner" to an integrated mobility strategy for net-zero systems by design (OECD, 2021^[18]). This requires a long-term vision that integrates all transport modes with a view to building synergy. On an average day, urban dwellers in Germany travel 19 km, compared to less than 6 km in Greece (Eurostat, 2021^[19]). Urban planning needs to better reflect sustainable mobility priorities by creating functional urban areas that shorten distances between home, work and leisure activities. Integrating land-use planning and promoting densification also play an important role. An annual report on sustainable mobility could help track progress on various elements of Germany's transport transformation. The country needs to reduce car dependency by better internalising the social costs of road transportation through road pricing and by providing sustainable alternatives.

The share of electric vehicles (EVs) is rapidly growing but remains modest in the total vehicle stock. Between 2020 and 2021, EV sales doubled, reaching about 25% of newly purchased vehicles by the end of 2021. Germany is the largest market in terms of number of EVs sold in Europe. It also offers some of the highest subsidies (IEA, 2022^[20]). The country surpassed the 1 million EV mark in 2022 (including hybrid vehicles), two years after its 2020 goal. However, the country has a way to go to reach the federal government's goal of 15 million EVs and 1 million charging points by 2030. In May 2022, Germany had about 60 000 charging points, which means it would need to build about 300 new ones per day to reach its target (PwCNetwork, 2022^[21]). Policy makers should think more strategically about how to build a coherent, spatially balanced, user-friendly network of fast-charging points across the entire territory. More particularly, low-density areas will require public financial support to establish and maintain public charging stations in areas that lack a commercial market.

Public transport and active transport modes require strong public investment

Despite efforts to scale up use of public transport (9-euro ticket, reduced VAT), car use often remains the cheapest and sometimes only option in low-density areas. Rail infrastructure has suffered from several decades of chronic underinvestment and the federal government should prioritise and allocate more resources to rail infrastructure, particularly for connecting rural areas to large metropolitan regions. Investment decisions also need to become more transparent (OECD, forthcoming^[4]) and set the right incentives to ensure efficient maintenance. The most recent Bahn reform aims at developing faster, better

co-ordinated and more reliable connections (*Deutschlandtakt*). Federal support for the overhaul of the most important rail corridors is essential.

Following the success of the 9-euro ticket in summer 2022,⁴ the digital *Deutschlandticket* is an important step towards making train trips more financially competitive for citizens. The digital ticket offers an introductory price of EUR 49 per month for local public transport throughout Germany. This initiative is welcome and should considerably simplify the complex tariff structures of local public transport. In addition, public transport services need to become more reliable, better developed in low-density areas and more easily accessible for disabled travellers, the elderly and young children. A systematic expansion of park-and-ride facilities could help fill the missing links. Germany's National Cycling Plan 3.0 includes many good measures. However, implementation will require increased funding to build a coherent, high-quality network without weak links in the chain. Cycle infrastructure planning must also become faster and easier.

Financial assistance needs to target worst-performing buildings and vulnerable households

Improving energy efficiency in buildings is essential as the sector represents close to a third of Germany's energy demand (BMWK, 2020^[10]). Progress has been slow; generous support measures did not sufficiently target the worst-performing buildings. The building sector has missed its sectoral climate targets for two years in a row. Nearly half of all buildings urgently need renovation (OECD, forthcoming^[4]). More than 10 million heating systems are over ten years old and heavily rely on oil. The federal government's plan to make Germany's building stock virtually climate-neutral by 2045 requires a massive transformation. The recent switch in emphasis from new buildings to retrofits is therefore a step in the right direction. Germany has earmarked EUR 56.3 billion for 2023-26 to support climate-friendly renovations.

The coalition agreement foresees to advance the transition to renewable-based heating systems. As of 2024, every newly installed heating system shall be required to run on 65% renewable energy. This could significantly accelerate emission reduction in the building sector. However, the technical feasibility is under discussion considering major bottlenecks related to the production and installation of heat pumps.

Furthermore, the federal government provided tax incentives, financial support and information services to convince owners to take the necessary renovation measures. Discussions at EU level are underway to enforce mandatory renovation for the worst-performing public and commercial buildings. Socio-economic selection criteria could help provide more targeted support for the most disadvantaged households (DUH, 2022^[22]). The 2022 CO₂ Cost Sharing Act regulates the sharing of costs for CO₂ emissions regarding heating and hot water supply between landlords and tenants. This could have a positive impact; it provides an incentive for property owners to invest in energy-efficient building refurbishments, while encouraging tenants to behave in more energy-efficient ways.⁵

Sustainable farming is progressing; nitrogen surpluses remain a challenge

High livestock concentration and intensive land use affect agricultural areas in the north-west and south-east. Diffuse agriculture pollution places pressure on surface and groundwater bodies. More particularly, nitrogen surpluses remain a major problem in some areas. In 2017 and 2020, the federal government has revised the fertiliser legislation comprehensively and expects a significant reduction of nitrogen surpluses, as well as of ammonia and nitrous oxide emissions. However, it will take several years before the impact of these measures will become visible.

Agriculture represented about 9% of national GHG emissions in 2020. Emissions have been relatively stable during the past decade. Livestock accounts for about half of agriculture emissions. The Climate Action Programme includes ten key measures, with an earmarked budget of EUR 2.1 billion for 2020-25. The new EU Common Agricultural Policy 2023-27 could support Germany in making its agriculture greener

and more sustainable. Despite progress, ambition in the agricultural sector will need to be further raised to reverse the loss of species and improve the sector's climate balance.

Germany aims at reducing its livestock over time by supporting farmers to develop alternative income options. This would decrease emissions and free up a considerable amount of agricultural land so far used to produce animal feed. Animal welfare has gained increasing public attention (e.g. new mandatory labelling system, discussion on a meat tax and a state-funded long-term animal welfare premium).

Promoting expansion of organic farming is one of the federal government's top climate measures for the agriculture sector. Organic farming has nearly doubled in the past decade, representing 11% of total agricultural area in 2021 (Eurostat, 2022^[23]). Germany would need to significantly accelerate efforts to reach its new target of 30% by 2030.

Air quality has improved, but urban areas need to do better

Emissions of air pollutants are trending down and are decoupled from GDP growth. Germany complied with EU emission reduction commitments for all pollutants in 2020 (EC, 2022^[24]). Emission intensities per unit of GDP and per capita are all lower than the OECD average. The country projects to meet the EU emission reduction commitments for major air pollutants without additional measures, except for ammonia between 2020 and 2029. However, meeting emission reduction commitments for nitrogen oxides and particulate matter (PM_{2.5}) will be challenging (EC, 2022^[24]).

Air pollution is still a major health concern for citizens. In 2020, nearly 29 000 premature deaths were attributable to concentrations of PM_{2.5}, 10 000 to nitrogen dioxide (NO₂) concentrations and 4 600 to ozone concentrations (EEA, 2022^[25]). Five air quality zones still exceeded the EU limit value for NO₂ in 2020 (EC, 2022^[24]). People in bigger cities are much more exposed to PM_{2.5} than the national average. The tightening of emission values of existing low emission zones could help reduce air pollution. Ultra-low and zero emission zones have proven to be effective in other countries (OECD, 2022^[26]). Cities and municipalities need to be empowered to play a leading role in improving air quality. Germany is still far from achieving the global air quality guideline of the World Health Organization for PM_{2.5}.

Germany has good waste management but produces too much waste

Germany is one of the best performing OECD countries in terms of environmentally sound waste management. The country has one of the highest recovery rates and the second highest recycling rate in the OECD area. About two-thirds of municipal waste are recycled or composted. A ban of municipal waste landfilling has been in place since 2005. Nevertheless, the country still has room to shift reusable and recyclable waste away from incineration (EC, 2022^[24]). As of 2023, suppliers of takeaway food and drinks must offer products in reusable packaging at no extra cost. This measure will greatly help reduce use of disposable plastic packaging.

However, the country made little progress to reduce municipal waste and needs to strengthen waste prevention. On average, a German citizen produced 632 kilogrammes (kg) of waste in 2020, compared to 505 kg within the OECD Europe area (OECD, 2022^[27]). About 11 million tonnes of food is thrown away every year. Efforts should focus on both retail and household behaviour. Cutting household food waste in half, for example, could save 6 million tonnes of CO₂-eq (BMEL, 2022^[28]). The public awareness raising campaign "Too Good for the Bin!" has been in place for a decade. Germany has had a national strategy to reduce food waste since 2019. Beyond dialogue platforms, binding measures with intermediate targets may be needed.

Water quality remains a concern and the sector needs to become more climate resilient

Germany's water resources are relatively abundant, and water consumption by industry and households has fallen considerably over the past decades. Total annual water abstractions as a share of total available renewable water resources decreased from 20% in 2001 to 13% in 2016 (OECD, 2022^[29]). Water abstraction per capita is well below the OECD Europe average. Nevertheless, Germany is still above the 10% threshold making it a moderate water stressed country (OECD, 2022^[29]). Water leakage levels are traditionally among the lowest in Europe (DVGW et al., 2020^[30]). Germany is also one of the best performing OECD countries when it comes to wastewater management, with nearly universal coverage of plants with tertiary ("advanced") treatment (OECD, 2022^[31]). Water tariffs are levied at Länder level and ensure recovery of financial costs.

Water quality remains a serious concern for Germany. The Baltic Sea and North Sea face acute problems with eutrophication. Only 8.1% of all surface water bodies reach "good ecological status" in line with the definitions of the EU Water Framework Directive (WFD) (EC, 2022^[24]). No single surface water body in Germany achieved good chemical status. This can be explained by persistently high levels of nutrients, primarily phosphates, as well as contamination with mercury (German Federal Government, 2016^[32]). Groundwater pollution due to diffuse agriculture pollution, remains a major challenge. Therefore, Germany needs to strengthen efforts to adequately monitor and address groundwater pollution, particularly in intensive farming areas. Germany still has a way to go to fully meet its obligations under the EU Water Framework Directive and the EU Nitrates Directive. The promotion of nature-based solutions (NbS) has great potential to make progress in this area, alongside economic incentives to reduce the use of fertilisers.

Germany's water sector will be increasingly impacted by climate change. Prolonged dry periods and heatwaves may amplify and trigger seasonal, localised water shortages. They will also lead to dried-up rivers impeding inland waterway transport, receding groundwater levels and soil moisture loss, with major economic impacts. For example, due to the record dry summer in 2019, water levels in the Rhine River sank to their lowest since 1881 (Gustafsson, A., 2019^[33]). Disruptions in inland waterways heavily impacted the industry and contributed to increased energy prices. Many companies such as BASF, a chemical giant, invest heavily in low-water vessels to ensure adequate supply of raw materials during times of drought. Modernising the water sector and adapting to climate change will require large investments. Germany will also need to invest heavily in flood prevention measures. NbS could play a key role in building natural water retention features by increasing the absorption capacity of land close to water bodies.

In response to these challenges, Germany's National Water Strategy, approved in March 2023, develops a comprehensive vision for 2050 and aims to develop a greater awareness of the value and sustainable use of water as a resource. The strategy highlights the need to prevent water scarcity and conflicts of use, adapt water infrastructure to climate change, make water cleaner and healthier, and create a broader finance base. A two-year nationwide water dialogue, which is seen as exemplary, laid the groundwork for implementation at all governance levels and across different sectors.

Environmental governance and management

Co-ordination mechanisms are good, but there is still room for improvement

Germany has a sophisticated, well-developed institutional system that ensures vertical and horizontal co-ordination. German governance, which is based on federalism, aims to ensure that social and political issues are addressed by the lowest level of federal government possible. In practice, there is still room for improvement at various levels, especially to reduce administrative silos and encourage a more pragmatic and flexible application of shared responsibilities between different governance levels.

Implementation of environmental policies and programmes is mainly managed by the 16 Länder within Germany's federal system, creating varying results. The federal government should systematically ensure

that federal laws enable over-performance. It should also develop mechanisms that oblige poor performers at subnational level to move faster as in the onshore wind sector with binding area targets for all federal states (Wind-on-Land Law).

Local authorities are best placed to advance local policy issues. However, federal laws tend to place a heavy administrative burden on local administrations, which sometimes lack capacity. For example, cities and municipalities should be able to create bicycle lanes and set local speed limits more easily. They also need more flexibility in public procurement and approval processes, as well as sufficient funds for public investments (Dettling, 2022^[34]). Local financial autonomy has been shrinking due to increased social expenditure, despite federal government support.

Germany has a solid regulatory framework for environmental management. Environmental law is generally strictly enforced. Germany has no centrally managed information on compliance handling or environmental offences. Public access to information on compliance monitoring and enforcement could be improved through a more centralised information system. This would provide better federal oversight and allow citizens to play a more active role in compliance monitoring.

Faster permitting processes in the renewable energy sector should not be achieved at the expense of biodiversity and nature conservation

While faster and less cumbersome permitting processes are urgently needed, biodiversity considerations should not be overlooked. As elsewhere, it has proven difficult to reconcile bird protection and wind power. The federal government defined a nationwide list of collision-prone breeding bird species with a view to accelerating risk assessments in the permitting process. On the one hand, it aims to streamline and harmonise processes across 16 Länder and provide legal certainty to wind farm developers. On the other, it intends to secure ecological protection standards required by EU law. Training to ensure consistent application and adequate staffing within local administrations are also needed.

The overriding “public interest” principle should not be used as a pretext to weaken environmental impact assessment, which must remain an essential part of the planning phase. Spatial planning processes for transport infrastructure and other major facilities require an integrated analysis of current and potential environmentally harmful impacts. The impact of accelerated permitting processes, including cumulative environmental effects, should also be carefully analysed through *ex post* analysis. Findings could be systematically shared and inform planning to facilitate mutual learning across the 16 Länder. The federal government plans to adopt key points for standardisation in species protection in the rail sector.

Economic instruments and investment for green growth

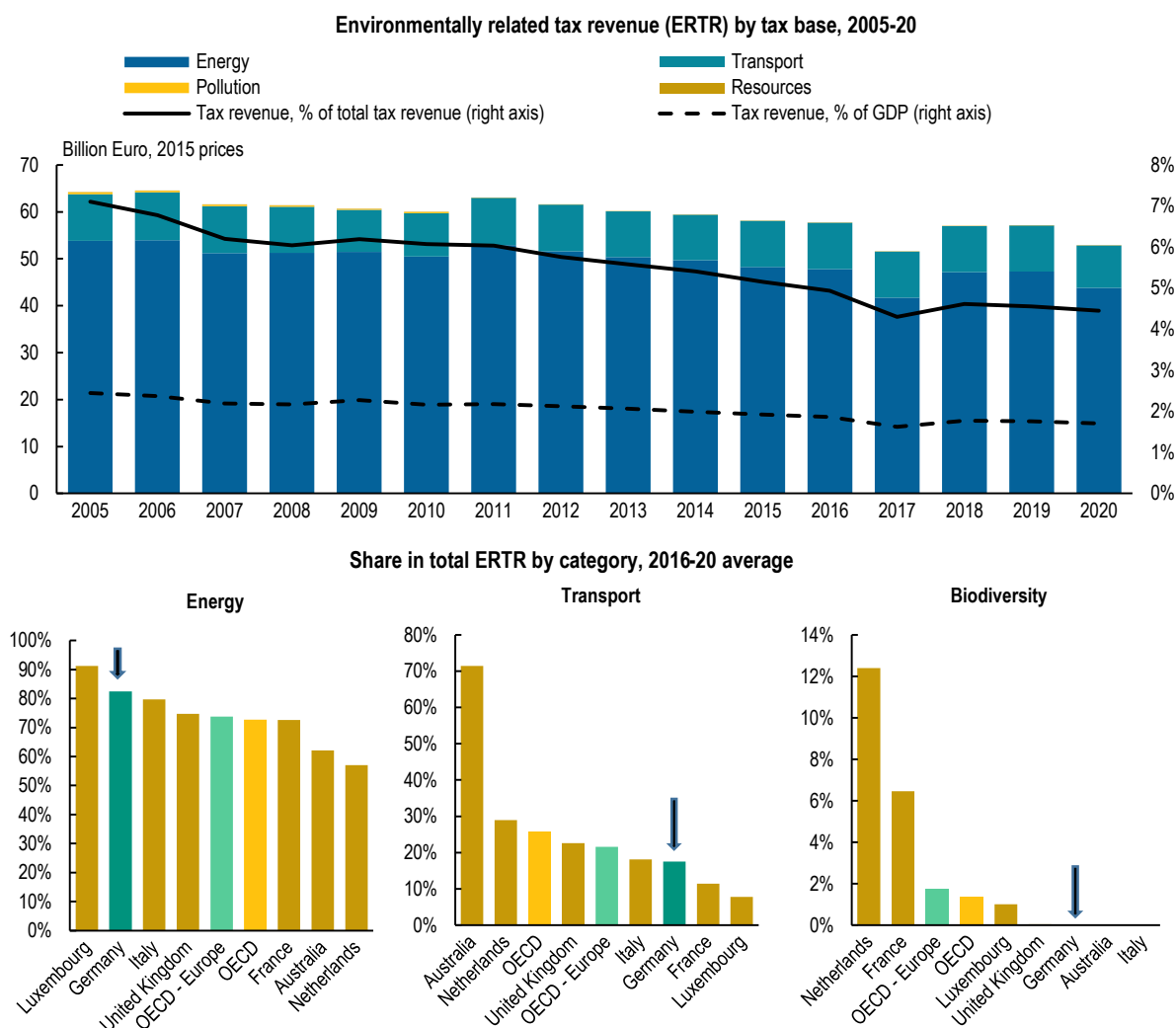
Germany’s recovery had a green focus, but its impact remains unclear

About 42% of Germany’s recovery measures (EUR 140 billion) support the country’s climate objectives (Wuppertal Institut, 2021^[35]). The German Resilience and Recovery Plan (GRRP, 2021-26) includes grants worth EUR 25.6 billion from the EU Recovery and Resilience Facility, mainly focusing on hydrogen development, eco-friendly mobility, and renovation and construction. With the plan’s extension related to adoption of the new REPowerEU chapter, scheduled for 2023, Germany should benefit from an additional EUR 4.7 billion. While the GRRP is clearly future-oriented with a strong emphasis on hydrogen (EUR 10.5 billion), it pays relatively little attention to already available technologies that could make a difference in the short term. Like other countries, Germany needs to ensure that recovery funds are spent efficiently (OECD, 2021^[36]). More particularly, the independent Council of Experts on Climate Change could play a role in assessing the impact and effectiveness of recovery measures and their contribution to transformative change.

Taxes need to be better aligned with the polluter pays principle


Germany's environmentally related tax revenue (ERTR) has declined following a peak in 2003 in the context of the eco-tax reform (OECD, 2012^[37]). The tax-to-GDP ratio and the share of ERTR in total tax revenues are both far below the OECD Europe average. While Germany has decoupled GHG emissions from economic growth, the current ERTR downward trend is not driven by a decrease of environmental pressures. Tax rates are poorly aligned with the polluter pays principle. Excise duties on energy products have remained virtually unchanged during the past decade. Moreover, tax rates are typically levied in nominal terms (e.g. per litre of fuel). In line with good practice in many northern European countries, Germany should consider introducing annual inflation adjustments to prevent further devaluation of ERTR. This could be introduced at a timely moment when energy prices are no longer skyrocketing.

Figure 3. Environmentally related tax revenue has been shrinking



Note: Data on pollution revenues not available after 2010 (top panel). Bottom panel: OECD countries with the highest shares and Germany's neighbouring countries.

Source: OECD (2022), Environmentally related tax revenue, OECD Environment Statistics (database).

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As in other OECD countries, energy represents the lion's share of taxes in Germany, followed by transport-related tax revenue. Taxes on pollution and natural resources are virtually absent (Figure 3). Waste streams and water resources are mainly managed at the subnational level through a complex system of local fees and charges. As highlighted in the 2012 OECD Environmental Performance Review, Germany has significant scope to expand use of payments for ecosystem services and other market-based instruments (OECD, 2012^[37]). Germany could also make stronger use of environmentally motivated subsidies to foster biodiversity conservation.

Germany prices most CO₂ emissions

Close to 90% of Germany's emissions are priced, but carbon prices vary and are low in non-road sectors. Introducing a common carbon price floor across sectors would improve the effectiveness of abatement decisions (OECD, forthcoming^[4]). Moreover, Germany would need to further reduce the number of exemptions and expand carbon pricing to sectors that are not yet covered. The European Union Emissions Trading System (EU ETS) covers about half of national GHG emissions. The new agreement on the EU Carbon Border Adjustment Mechanism (EU CBAM) will help reduce carbon leakage and should be followed by phasing out free allocation in the industry sector.

In 2021, the federal government introduced a national ETS (nETS), mainly targeting the transport and heating sectors. This is commendable as only few European countries have started pricing non-ETS sectors, and the scheme anticipates the introduction of an EU-wide system under the Fit-for-55 initiative. However, the starting level of the national carbon price was low (EUR 25 per tonne of CO₂),⁶ higher levels would be needed to decarbonise non-ETS sectors effectively, particularly buildings (OECD, forthcoming^[4]).

The nETS provides a clear trajectory of future stepwise price increases to 2026 when auctions will start. Unlike excise taxes, which tax diesel at lower rates per tonne of CO₂ than petrol (OECD, 2022^[38]), the scheme applies the same carbon price per tonne of emitted CO₂ irrespective of the fossil fuel source or the sector. Moreover, to ease pressure in the context of soaring energy prices, the federal government froze the step increase in 2023. While the fuel price is still high (and thus maintaining the price signal), this measure will reduce expected revenues for climate action. It should thus be a priority to move back to the initial planning and implement outstanding step increases. The emission cap would also need to be aligned with the emissions reduction targets. Providing a long-term perspective on carbon pricing with reliable, predictable increases will reassure private investors.

Transport-related taxes require an overhaul to become future proof

Germany's large preference for car ownership is reflected in its tax system. The level of transport-related taxes is far below the OECD average (Figure 3). Germany is one of the rare countries that does not tax vehicle purchase or registration. For most passenger cars, the annual motor vehicle tax is assessed mainly based on CO₂ emissions. As of 2021, newly registered cars with high CO₂ emissions are charged an increased tax while EVs are exempted. This climate component in vehicle taxation should be further amplified. It could be complemented, for example, by a registration tax for heavy vehicles, as practised in other OECD member countries (e.g. Denmark, Norway).

Federal government support often sets the wrong incentives at the expense of sustainable transport modes. For example, company cars, which represent more than 60% of all new passenger cars, continue to benefit from a low taxation rate for private usage (1%). Forgone tax revenue was estimated at EUR 3.1 billion in 2018 (UBA, 2021^[39]). Similarly, the commuter allowance encourages users to pursue regular long-distance travel rather than providing targeted, time-bound support for developing viable alternatives. The allowance had a fiscal cost of EUR 6 billion in 2018 (UBA, 2021^[39]). Both subsidies, in place for over a decade, disproportionately benefited medium and higher income groups and people who drive to work; a mobility premium has been recently introduced for low-income employees.⁷ From a social perspective, the

subsidies remain insufficiently targeted; from an environmental viewpoint, they are harmful and should be replaced by more targeted support for people in need, privileging public transport.

Little progress has been made on developing a fair and efficient road pricing system, with the exception of heavy goods vehicles, which pay a toll (LKW Maut) since 2005. Following a failed attempt in 2015 to broaden use of road charges,⁸ the LKW Maut may eventually be expanded to all heavy goods vehicles (3.5 tonnes and more) in 2024. A nationwide toll system for all motorway users, including passenger vehicles, would be a first step towards sharing the financial burden of road maintenance, infrastructure development and other externalities, which represent a significant cost for society. Urban toll rings with environmentally differentiated rates could reduce traffic during peak hours and air pollution.

Germany's transport-related tax base is set to shrink. With the ongoing electrification of vehicles, revenues stemming from taxes on motor vehicles and motor vehicle fuels will drop sharply in the next decade. In addition, new vehicle emissions standards at the EU level are under discussion. If plans go through, this would ban the widespread sale of petrol and diesel cars and vans in the EU-area by 2035. To prepare a more sustainable transport-related tax system, the federal government should make stronger use of road pricing to make drivers pay more directly according to use and damage. The introduction of a place-based road use tax system would be welcome. In such a system, tax rates would depend on where and when the driving takes place, and on the type of vehicle.

Germany should improve policy coherence and phase out environmentally harmful subsidies

Germany provides substantive financial assistance and tax concessions for environmental and climate protection. However, it undermines the effectiveness of such measures through exemptions and many perverse incentives for environmentally harmful activities. This contradiction between positive and negative measures has been aggravated over time; the amount of environmentally harmful subsidies has been growing during the past decade. Subsidies with negative effects on the environment were estimated at EUR 65 billion in 2018 compared to EUR 48 billion in 2008 (UBA, 2021^[39]).

As already emphasised in the 2012 OECD Environmental Performance Review, many long-term subsidies are no longer justified on economic or social grounds and should be phased out (OECD, 2012^[37]). For example, diesel is still taxed less than petrol despite stronger air pollution impacts. Revenue forgone resulting from the diesel discount was estimated at EUR 7.3 billion in 2019 (Transport & Environment, 2020^[40]). Little progress has been made in phasing out environmentally harmful subsidies in agriculture. The federal government should follow through on its intention to systematically screen existing and proposed subsidies to identify economic, environmental and social inefficiencies. The Federal Ministry of Finance produced 28 issues of its subsidy report with an increasingly climate-focused narrative. This provides a good starting point for advancing the phase-out of already identified harmful subsidies.

Within its G7 presidency, Germany facilitated the building of a common understanding of “inefficient” fossil fuel subsidies. G7 countries committed to end inefficient subsidies for oil, gas and coal by 2025. However, in practice, progress has been slow. Hard coal subsidies were phased out by 2018. Consumer subsidies for fossil fuels are on the rise again with the energy crisis, especially in Europe. Many measures are poorly targeted and should be time-bound and consistent with the transition to carbon neutrality.

Recommendations on sustainable development

Climate and energy

- Prioritise energy saving and energy efficiency measures at all levels (public administrations, private sector, households); provide targeted support for worst-performing buildings and most vulnerable households; harness the potential for efficiency through incentives to change behaviour (e.g. provide incentives for shared mobility solutions, reduced heating temperatures in private and public buildings, monitor impacts of awareness-raising campaigns).
- Pursue efforts to develop a targeted and socially just transfer system to mitigate high energy costs through time-bound support that is disconnected from energy consumption levels.
- Expedite the expansion of Germany's electricity grid and renewable energy infrastructure by ensuring coherent spatial planning processes to better respond to power needs; introduce time-variable grid charges to better align the grid capacity with shifts in renewables supply; engage in early public consultations and promote citizen-driven energy action; monitor the environmental impact of a fast-tracked permitting process for the expansion of renewable energy sources and share lessons across Länder; ensure that an expedited permitting process is not achieved at the expense of biodiversity and nature conservation (e.g. adequate resources for staffing and training).
- Accelerate implementation of existing climate measures and take new ones, particularly for sectors that have not met their sectoral targets; ensure that earmarked budget for climate action is disbursed and measures are implemented efficiently in a timely manner.
- Pursue efforts to advance the transition towards more environmentally and climate-friendly farming methods; pursue efforts to improve measuring of farm-level emissions (e.g. estimates of GHG emissions based on farm practices) and consider exploring the introduction of an agricultural emissions pricing mechanism; monitor the impact of fertiliser legislation and take further measures to reduce nitrogen surpluses and ammonia; provide positive incentives to accelerate organic farming, particularly in Länder with low shares of organic farm areas.
- Assess the impact and effectiveness of measures implemented within the German Resilience and Recovery Plan and publish results; systematically provide information on funding sources at project level.

Transport

- Develop an integrated national mobility strategy for net-zero systems by design, including intermediary targets at subnational levels (e.g. share of active transport modes and related investment levels); regularly assess nationwide progress through an annual sustainable mobility report covering key priorities (e.g. progress in reducing car dependency, increased use of public transport and active transport modes, and related investments; improvements in spatial planning to reduce distances in people's daily lives).
- Revise the road traffic regulations with a view to removing obstacles to sustainable mobility and empower local authorities to play a leading role in promoting sustainable mobility (e.g. allocation of parking spaces, car bans, simplified procedures for new bicycle lanes).
- Shift public investment priorities towards sustainable transport modes: further increase public investment in rail, notably in short-distance local transport to improve the connections of low-density areas to urban agglomerations; implement and monitor the impact of the *Deutschlandticket* and other measures to make public transport more attractive, simplify the train ticketing system and accelerate digitalisation of the control and signalling systems; develop

park-and-ride facilities; ensure adequate financing and accelerate implementation of the National Cycling Plan 3.0.

- Encourage private investment to support the uptake targets of EVs; build a coherent, spatially balanced, user-friendly network of fast-charging points across the entire territory; provide targeted public support for low-density areas.
- Conduct a comprehensive reform of the transport-related tax system to make it environmentally and fiscally sustainable: increase the use of road pricing (e.g. nationwide toll system for all motorway users; urban toll rings; higher parking fees in urban areas); progressively move towards a place- and time-based road pricing system; abolish the company cars' privilege; replace the commuter allowance with more targeted support for people in need, privileging public transport.

Economic instruments for green growth

- Introduce tax indexation to annually adjust environmentally related tax revenue and prevent further devaluation.
- Better align taxes with the polluter pays principle and internalise costs related to pollution, overuse of natural resources and biodiversity loss (e.g. phase out excise tax rebates for diesel and other energy tax exemptions, particularly in agriculture and industry); explore opportunities to use market-based instruments to protect biodiversity.
- Align the nETS emission cap with emissions reduction targets; implement the nETS stepwise price increases according to schedule and monitor its climate mitigation impact.
- Systematically screen actual or proposed subsidies, including tax provisions to identify those unjustified on economic, social and environmental grounds; develop a plan to phase out support for fossil fuel consumption and use, as well as other environmentally harmful subsidies and define quantified, time-bound targets; assess the distributional and economic implications of removal of fossil fuel support and design alternative policies to achieve the same objectives in line with climate and environmental goals.

2. Climate change adaptation and nature-based solutions

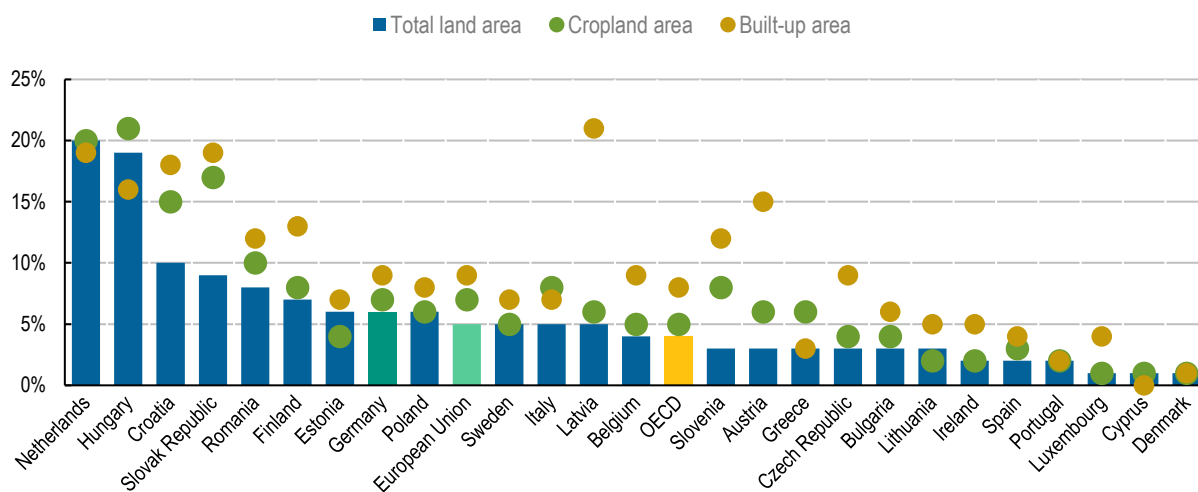
Climate impacts and risks

Germany is significantly exposed to the impacts of climate change

In the past two decades, Germany experienced a considerable number of extreme weather events, notably floods, storms, droughts and heatwaves, all of which had a significant impact on livelihoods, the environment and the economy. Due to increasing climate change, these extreme events are on the rise in many regions of the country. In Germany, temperatures have increased faster than the global average. The current decade is 2°C warmer than pre-industrial times and precipitation levels have increased by 8.7% since 1881, with particularly high increases in the winter (+25%). About 9% of built-up area and 7% of cropland area are at risk of a 100-year return flood (Maes, M. et al., 2022^[41]). Exposure to flood risk is much higher in harbour cities such as Bremen (40%) (Maes, M. et al., 2022^[41]). Mean sea levels have risen by about 15-20 cm since 1921, putting 3.2 million people (about 4% of the population) at risk of coastal flooding (UBA, 2021^[42]). At the same time, drought conditions have notably increased. The mean number of days with low soil moisture values⁹ has increased on average by 4.8 days since 1961 (UBA, 2019^[43]) (Figure 4). Climate change is projected to increase the incidence of extreme weather events and to increase pressures on biodiversity, giving rise to new types of risks such as disruptions to supply chains and new levels of risk intensity.

Figure 4. About 9% of built-up area and 7% of cropland area are exposed to flooding

Percentage of surface area in 2020 exposed to river flooding with a 100-year return period



Source: OECD (2023), "Air and climate: River flooding", OECD Environment Statistics (database).

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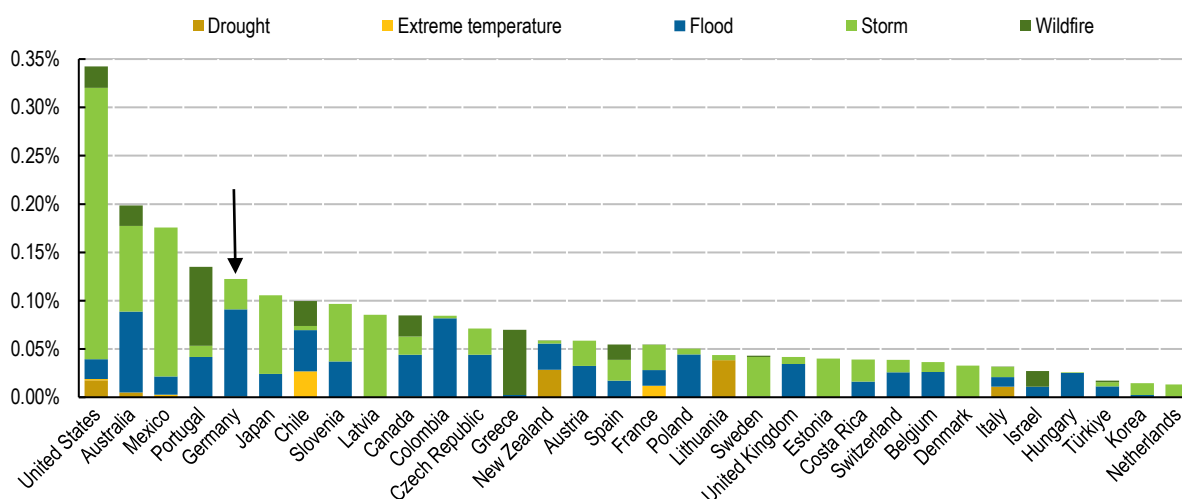
As an export country that relies heavily on imported raw materials, Germany's economy is also vulnerable to climate impacts in other regions. Many of Germany's trading partners such as the People's Republic of China are vulnerable to climate change. This could increasingly create climate change-related disruptions in global supply chains with economic consequences affecting Germany's trade. A broader diversification of operational value chains can reduce potential exposures to climate risks and strengthen resilience of the German economy (UBA, 2021^[44]).

Extreme weather events cause significant loss and damage, signalling urgent need to better prepare for climate risks

Between 2018 and 2020, Germany recorded nearly 20 000 heat-related deaths, especially among elderly people (Winklmayr et al., 2022^[45]). More particularly, extreme flood events have caused significant loss and damage. The 2021 flood catastrophe of North Rhine-Westphalia and Rhineland-Palatine killed 180 people and injured 800 inhabitants. It was the deadliest water-related disaster in Germany for the past 60 years. Direct economic damages were estimated at EUR 33.1 billion, with an additional EUR 7.1 billion of indirect damages. These are stark outliers from an annual average of documented losses of EUR 6.6 billion¹⁰ (Prognos, 2022^[46]).

Figure 5. Germany's damages from climate-related disasters are among the highest in the OECD

Damages from climate-related hazards per unit of GDP in OECD countries, 2005-21



Note: Ireland, Luxembourg, Norway and Slovakia did not record any or only minimal climate-related hazards. The 2015 constant USD GDP has been converted to 2021 constant USD GDP using a cumulative price increase of 14.33% (average inflation rate of 2.26% per year). The EM-DAT database does not consider indirect damage, which is why total recorded damage differs between both sources.

Source: (Centre for Research on the Epidemiology of Disasters, 2022^[26]).

StatLink  <https://stat.link/76cz35>

Between 2005 and 2021, direct damage from climate-related hazards per unit of gross domestic product (GDP) is among the highest in the OECD area. While on average such damage amounts to only 0.12% of Germany's GDP annually (Disasters, 2022^[47]), this is expected to change significantly. By 2050, EUR 280-900 billion in damage is expected from the impacts of extreme weather events¹¹ (Flaute, Reuschel and Stöver, 2022^[48]). This would translate to up to 1.8% of annual GDP in losses.

Extreme weather-related disasters can also have lasting negative impacts on the environment, which diminishes natural protection against climate risks. For example, extended periods of droughts will increase the impacts of floods due to soil sealing. The degradation of ecosystems reduces their capacity to protect people and natural assets against climate risks and hence worsens risk of loss and damage.

Recent extreme weather events unleashed unprecedented engagement by all levels of government. For instance, in the aftermath of the 2021 floods, the federal government and Länder approved a reconstruction fund totalling EUR 30 billion to partially compensate for incurred loss and damage (Osberghaus, 2021^[49]). However, a stronger focus should be placed on prevention. Germany needs to scale up and accelerate its adaptation actions to prevent significant human, economic and environmental loss and damage.

Risk assessments are getting more comprehensive but need to better measure climate risk exposure and vulnerability

The Climate Impact and Risk Assessment 2021 (*Klimawirkungs- und Risikoanalyse, KWRA*) for Germany provides a comprehensive and integrated assessment of a broad range of sectors, including land, water, infrastructure, economy and health. It provides regional climate hazard models for heat, drought, extreme temperature and precipitation changes, allowing it to identify hot spots prone to climate hazards. For selected types of hazards, such as for floods, detailed exposure maps are available, assessing how certain elements (e.g. number of people) and economic activities are exposed to the hazard (BfG, 2019^[50]). This is still missing for other hazards.

The KWRA identifies and discusses sectors especially vulnerable to the impact of climate risks, including ecosystems, species, assets or people. While information on climate vulnerability remains rudimentary, work is underway to shed more light on it. For example, researchers – including those funded by government – are assessing climate change impacts on different social groups (Flaute, Reuschel and Stöver, 2022^[48]; Jacob, 2022^[51]). The federal government is on the right path to developing more information on climate vulnerability with preparation of “Regional information for climate action” (RegIKlim). This information system on current and future climate risks will include local-scale vulnerability data (German Government, 2021^[51]).

Climate risk assessments at Länder level could capitalise on local analysis and should be better communicated

Germany has made progress in downscaling climate risk assessments at subnational level. In all, 9 of 16 Länder have developed climate risk assessments, but the regional assessments tend to be less detailed than their national counterpart. All include downscaled temperature and precipitation projections, and each Land’s competent authority has developed flood and extreme precipitation risk maps in accordance with the EU flood directive (Directive 2007/60/EC). However, many Länder often fail to assess the frequency and intensity of other hazards such as heatwaves, droughts or wildfires. Exposure analysis is inconsistent across the Länder that do have climate hazard information. The climate atlas of North Rhine-Westphalia serves as a positive example. It maps hazard risk in relation to cropland and population density (Klimaatlas, 2023^[52]). While some Länder evaluate the vulnerability of individual sectors (King, 2022^[53]), vulnerability has not consistently been assessed.

While local climate risk assessments are often of excellent quality, they remain scarce and need to be scaled up. For example, the metropolitan region of Stuttgart assesses the vulnerability of its citizens to climate risks based on age, health status or access to green areas. It further assesses the vulnerability of ecosystems, such as the capacity of forest types to survive projected heat stress. This assessment allows the city to identify hotspots, where adaptation actions are most urgently needed (Verband Region Stuttgart, 2015^[54]).

Germany needs to ensure nationwide coverage of localised climate risk assessments, a process in which the Länder play a key role. According to the Basic Law, the federal government cannot oblige cities and municipalities to assess local climate risks. However, it could mandate the Länder to do so. Developing nationwide coverage would also require additional funding for cities and municipalities that may lack adequate resources for such risk assessments. Existing federal support programmes could be extended; however, Länder would need to play a more active role in supporting local authorities in need. In this process, the use of comparable data and methods across levels of government is recommended to allow greater comparability at national level. To date, Germany has a broad range of different indicators, criteria and thresholds to analyse climate-related hazards and related risks.

Access to climate risk information is critical to trigger action. To date, information on climate risks at different government levels can be found on line, either in dedicated reports or through interactive mapping

tools. However, the information is scattered across a number of websites maintained by national or subnational agencies, research institutes, non-governmental organisations (NGOs) and think tanks. The Centre for Climate Adaptation (*Zentrum KlimaAnpassung, ZKA*) was established to fill this gap and provide a one-stop shop for information on climate adaptation. Nevertheless, access to information needs to be easier and more user friendly, and information should be disseminated to key target groups. An information gateway such as the research project RegIKlim, which will act as a component for risk monitoring, could address this issue (RegIKlim, 2021^[55]).

To date, it is not possible to assess to what extent climate risk information triggers action by relevant actors. Selected studies shed some light on this, suggesting more work is needed to communicate climate risk information effectively. With regards to health risks related to climate change, about a third of German citizens have reported being insufficiently informed (WIdO, 2021^[56]).

Towards a new strategic framework for climate change adaptation

The policy framework for adaptation is robust, but implementation must be accelerated

Germany's 2008 National Adaptation Strategy (DAS) laid out an overarching framework to enable adaptation actions across all relevant agencies, government levels and non-government stakeholder groups. Building on this strategy, the Federal Ministry of Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) developed regular climate risk assessments, adaptation action plans, and monitoring and evaluation reports. These have enabled Germany to progressively strengthen its adaptation policies. However, as the repeated and devastating loss and damage from climate-extreme events demonstrate, Germany still has major gaps in building resilience and responding to climate change in a timely manner.

The federal government has limited competence to enforce adaptation actions at subnational levels

Climate change adaptation is a shared responsibility between the federal and subnational levels. This considerably limits the scope of possible actions by the central co-ordination unit of the BMUV. It can steer the national adaptation policy agenda and monitor national action plans, but sectoral government bodies and subnational governments lead investment in and implementation of adaptation measures.

The BMUV has actively provided technical support, guidance documents and policy recommendations to enable actions by other key stakeholders (local authorities, NGOs, research institutes) at national and subnational levels. Through the KomPass Competence Centre on Climate Impacts and Adaptation, the BMUV has promoted information and technical assistance. In 2021, it also created the ZKA, which provides information and tailored advice to local authorities to access adaptation funding, training for local adaptation managers and knowledge exchange and networking platforms for subnational adaptation experts. However, since activities are voluntary, the ZKA has limited power to scale up adaptation action in areas where demand (or capacity) to engage are lower.

The Federal Ministry for Housing, Urban Development and Building (*Bundesministerium für Wohnen, Stadtentwicklung und Bauwesen, BMWSB*) helps municipalities adapt to climate change and climate protection. For example, municipalities can receive financial support from the ministry to implement climate protection and adaptation measures. For its part, the Federal Programme on Adaptation of Urban Areas to Climate Change promotes climate-adapted development of parks and green spaces, unsealing of areas, measures for rainwater management, greening of open and traffic areas, and strengthening of biodiversity. Meanwhile, the Urban Energy Redevelopment – Climate Protection and Climate Adaptation in Neighbourhoods programme provides loans and reduced interest rates for green infrastructure, heating and cooling supply, energy-efficient water and wastewater disposal, and climate-friendly mobility.

The new Federal Climate Adaptation Act is an opportunity to build a more effective and coherent adaptation architecture

The 2021 coalition agreement sets out to reinforce public engagement in climate change adaptation through the Federal Climate Adaptation Act (*Bundes-Klimaanpassungsgesetz*) – a goal reiterated in the 2022 Immediate Programme on Climate Adaptation (*Sofortprogramm Klimaanpassung*). The coalition agreement also sought to give a mandate to the BMUV to develop a new national adaptation strategy and a mandatory adaptation reporting system. These aim to accelerate action on climate change adaptation throughout Germany. The formulation process of the strategy provides an opportunity to reflect upon the roles and responsibilities of key stakeholders. The coalition agreement recognises the need to strengthen adaptation finance and investment environment; and use adaptation measurement to understand progress in building climate resilience through adaptation actions. However, a new approach to climate adaptation financing would require reassessing responsibilities and burden-sharing between federal and Länder levels. Instruments of joint financing are provided for by Germany's Basic Law, which would have to be amended to allow for this - representing a complex and lengthy process.

Adaptation is increasingly mainstreamed across sectors, but outcomes need to be better monitored

With the creation of the Inter-ministerial Working Group on Climate Change Adaptation (*Interministerielle Arbeitsgruppe Anpassung an den Klimawandel, IMAA*) in 2009, Germany recognised at an early stage that adaptation needs to be integrated into all sectors. Over the past decades, the IMAA, co-ordinated by the BMUV, has facilitated cross-ministerial dialogue on adaptation. Through its statutory meetings twice a year, it helped raise awareness about climate risks. However, there is room for moving beyond dialogue to collaborate jointly and accelerate adaptation action in sectoral policies.

In the water, agriculture and forestry sectors, adaptation issues are increasingly integral to long-term planning. The Forest Strategy 2050 sets forest conversion plans for the 2.85 million hectares (ha) of forest that are threatened by climate-induced droughts (BMEL, 2021^[57]). The Arable Farming Strategy 2035 acknowledges the need for region-specific strategies throughout Germany, but they have yet to be developed (BMEL, 2021^[58]). The National Water Strategy fosters cross-sectoral measures to tackle key climate risks, such as by making the water infrastructure climate-fit. Similarly, other sectors increasingly consider adaptation at the strategic level. However, some sectors are assessing climate risks but have not yet developed adaptation strategies.

A systematic review of adaptation integration into different sectors, respective funding levels and impacts could help Germany identify gaps. Germany's Council of Experts on Climate Change (*Expertenrat für Klimafragen*), for example, has a mandate to assess annual GHG emissions trends and the effectiveness of measures taken under the Federal Climate Change Act (*Bundesklimaschutzgesetz*). It could be expanded to monitor sectoral mainstreaming of adaptation.

Spatial and environmental planning, as well as regulatory measures, have been recognised as key instruments to promote integration of adaptation into all key investments and economic activities. Environmental impact assessments require projects to evaluate their vulnerability to climate risks; guidelines are available to help project evaluators in their work. Within the broader EU framework, nationwide spatial planning regulations were issued in specific sectors. Since 2021, for example, all land-use decisions need to incorporate flood risk assessments and prevention measures, such as the creation of floodplains and retention areas. Such instruments can greatly foster climate resilience in new developments. However, appropriate monitoring and enforcement – such as linking compensation for loss and damage of assets to the integration of climate risk-proofing measures – are important to ensure their effectiveness.

The implementation capacity of subnational governments needs to be strengthened

Subnational governments have a critical role in understanding local climate risks, in identifying adaptation needs and in implementing adaptation measures. However, to date, there is no nationwide obligation for municipalities to adapt to climate change; action depends on the commitment of Länder and municipalities.

While all Länder have developed adaptation strategies and policies, their quality varies. Only about one-third of German municipalities have an adaptation plan (King, 2022^[53]). This leads to an uneven level of climate preparedness and may reinforce vulnerabilities to climate risks. Highly vulnerable communities may not necessarily be best placed or supported by their respective Land to build climate resilience.

Lack of resources to prepare and implement adaptation strategies is an important barrier for adaptation investments. In addition, lack of experience, lack of good quality data and the unwillingness of municipal leaders to take adaptation action have equally inhibited progress. Some municipalities have dedicated adaptation managers, such as those supported by several federal initiatives (e.g. ZKA). Even so, they often lack the capacity, mandate or resources to implement local adaptation plans or strategies (UBA, 2019^[59]; Bundesregierung, 2020^[60]).

The coalition agreement, including the Federal Climate Adaptation Act, is an opportunity to build local climate resilience with a view to leaving no one behind. Through innovative finance instruments, municipalities could be encouraged to jointly invest in adaptation measures that cross municipal borders. For highly climate-vulnerable municipalities, with limited adaptation capacities, the federal government could encourage Länder to play a stronger role through co-financing and implementation support. Co-funding instruments could lead subnational governments to accelerate action, and perhaps also result in sectoral investments in adaptation.

Germany needs to rethink its adaptation finance

Investments in climate adaptation measures are significantly cheaper than addressing loss and damage from extreme weather events. Yet significant subnational – and federal – funding is made available only after a disaster. This gives rise to important considerations for adaptation finance.

In light of an observed and projected upward trend in extreme weather events, Germany's adaptation funding needs are considerable and set to grow. Increasing adaptation spending is crucial to avoid more costly recovery and rehabilitation spending for public authorities. By 2050, the implementation of adaptation measures¹² could reduce economic costs that arise from the impacts of climate change by 62 to 100% compared to a scenario without adaptation, considering a strong to weak climate change scenario (Flaute, Reuschel and Stöver, 2022^[48]). Revenue-raising instruments could be introduced to cover increased budget needs. This could include local tax instruments or beneficiary contributions.

Improving spending oversight is essential for better understanding adaptation spending by federal and subnational government agencies, including the funding gap. To that end, the BMUV is designing a uniform classification framework on adaptation spending. It is working with the Länder to document their adaptation investment needs.

Access to adaptation funding needs to be made easier. To date, local governments must navigate a complex mosaic of funding programmes at both federal and Länder levels. This limits potential investments in adaptation. The ZKA focuses much of its efforts to help municipalities identify appropriate funding sources and support for applications to receive additional funding. The federal government should streamline procedures and reporting mechanisms to make it easier for eligible actors to access funding. An effective funding system needs to provide targeted support to ensure that nobody is left behind.

The funding architecture should create incentives for all actors to invest in adaptation. The federal government could reward, *ex ante*, adaptation investments and provide financial assistance for covering loss and damage from extreme weather events; for example, by considering them in the *ex post* allocation

of recovery funding. In doing so, the funding architecture should also consider the role of private households and business in investing in adaptation. This should include how climate risk insurance could encourage private adaptation investments.

Less than half of German households are insured against natural hazards, with significant variation across Länder (Osberghaus, 2021^[49]; Prognos, 2022^[46]). The federal government should consider mandating insurance against natural hazards. In so doing, it would help protect assets to the expected increase in the exposure of buildings against extreme weather events.

Measuring progress in implementing national adaptation policies can help accelerate adaptation actions

The federal government recognises the need to monitor and evaluate progress in implementing adaptation policies. For the most recent evaluation of the DAS, Germany developed the “impact model” (*Wirkungsmodell*). This examined whether measures and instruments in the DAS are suitable for achieving its overall goal to reduce climate risks and increase resilience of natural, societal and economic systems (UBA, 2019^[61]). Further development and use of this model could enhance the usefulness of adaptation measurement. For example, it could help users better understand links between implemented adaptation measures and climate impacts; and apply the impact evaluation to an increasing number of measures.

The German Environment Agency develops a monitoring report every four years that summarises observed climate variability and extreme events and impacts. It also discusses implementation of selected adaptation measures. However, the report does not analyse how these measures influence trends observed in climate impacts. In some cases, this is due to the need for longer time series to infer statistically significant climatological trends. The measurement efforts of Germany have been descriptive, providing limited understanding of which actions work – or not – in building climate resilience.

As part of the development of the new National Adaptation Strategy, Germany is preparing concrete adaptation indicators and targets in consultation with sectoral stakeholders. Setting measurable targets is challenging, involving a complex, normative debate around how to set targets that best reflect the values of German society. It is encouraging to see that Germany has started taking up this challenge through a broad-based consultation process, involving all sectors. Germany is breaking new ground in this area and the outcomes of this experience could inspire many other OECD countries. Indicators and measurable targets will allow Germany to better gauge progress in implementation of adaptation policies and to improve effectiveness.

Promoting nature-based solutions for climate and biodiversity

Germany’s biodiversity has been degraded over the past decades

Germany experienced a marked acceleration in biodiversity degradation in the past decades, affecting different ecosystems, as well as species loss. Key pressures include intensive farming and forestry, landscape dissection and urban sprawl, soil sealing and pollutants (e.g. acidifying chemicals and nutrients) (CBD, 2022^[62]). Forest surface area has grown by 1 million ha (about 10%) in the past 40 years to 11.4 million ha in 2021. However, a third of this area is where the proportion of damage, tree death rates and tree crown defoliation of deciduous trees – a key indicator for tree vitality – have risen sharply since 1984. (BMEL, 2021^[63]). This is mainly due to climate change, especially drought, which causes premature leaf fall and mass reproduction of bark beetles. Storms and wildfires brought on by climate change are another factor in tree loss and damage (BMEL, 2021^[64]). Germany has 1.8 million ha of peatland soils, of which 92% have been drained of water to make them arable. Carbon dioxide equivalent (CO₂-eq) emissions from peatland amount to 6.7% of total CO₂-eq emissions, at around 53 million tonnes (Mt) CO₂-eq annually (BMUV, 2022^[1]). Moreover, urban development has contributed to increased rates of soil

sealing, leading to greater risk of flooding; higher vulnerability to heat stress by reducing groundwater recharge and soil moisture; and significant biodiversity loss in urban areas.

A significant share of species is threatened despite efforts to avert biodiversity loss

More than one-third of species are endangered, making Germany one of the worst performers across the OECD area. Bird species typical of agricultural landscapes (covering about half of total area) have declined by about 30% on average since 1990 (Heinrich Böll Stiftung, 2019^[65]). Moreover, the loss of meadows, fallows and land have contributed to biodiversity loss. Urban sprawl, landscape dissection, soil sealing, hydraulic engineering and watercourse maintenance and construction measures further increase pressures. Gradual changes in temperature and precipitation, as well as extreme weather events, have also had an impact (UBA, 2021^[42]). About 44% of settlement and transport areas are sealed (UBA, 2022^[66]). Germany is not on track to achieve its objective to reduce land take to less than 30 ha per day by 2030.

Nevertheless, the Red List index, a measure of change in aggregate extinction risk across groups of species, has remained at 0.98 (low extinction risk) since 1991 compared to the global average (IUCN, 2022^[67]). While Germany has kept all species from risk of extinction, regeneration of threatened species is not evident yet. Despite multiple efforts to increase and protect biodiversity, no fundamental reversal in the loss of biodiversity has been achieved. Many national targets adopted under the Convention on Biological Diversity (CBD) have not progressed sufficiently (e.g. Target 8, 10 and parts of Target 1) (CBD, 2019^[68]). Concomitantly, Germany has also failed to achieve several goals of the 2007 National Biodiversity Strategy.

Agricultural and environmental policies should be more closely linked to avert biodiversity loss. Germany has, for instance, identified and assessed the types and magnitudes of incentives in place that harm biodiversity or the environment more broadly (FOES, 2021^[69]; UBA, 2021^[39]). Environmentally harmful subsidies should be reduced to prevent further harm to biodiversity. Reflecting the true values of biodiversity and hence the costs of its damage (e.g. pesticide use) across the economy could help incentivise behavioural change and more sustainable consumption patterns. Introducing payments for ecosystem services could be further encouraged (Matthews and Karousakis, 2022^[70]).

With the revision of its 2007 National Biodiversity Strategy to contain concise objectives and quantified indicators as well as nature-based measures, Germany is on the right path to address biodiversity loss. To give the implementation of biodiversity goals stronger leverage, interdisciplinary co-operation will be crucial. To that end, the federal government should move forward with its new strategy and mainstream biodiversity goals in relevant sectors (e.g. accounting for biodiversity in welfare indicators). In addition, the legal framework for nature conservation could be strengthened by including a habitat improvement imperative (RNE, 2022^[71]). Germany fills important gaps in monitoring biodiversity trends by developing indicators for species biodiversity and landscape as part of the new strategy. Annual reporting on progress towards Germany's biodiversity goals could strengthen accountability and action to achieve national biodiversity targets and the goals agreed upon at COP15.

Protected areas need to ensure effective protection

Between 2000 and 2016, Germany increased areas designated as nature reserves from about 3% to 4.4% of total surface area (German Environment Agency, 2019^[72]). In these reserves, strict regulations ensure conservation and development of rare and endangered species and biotopes. About 60% of nature reserves are smaller than 50 ha (BfN, 2020^[89]), which impacts their effectiveness in protecting biodiversity. Overall, Germany protects 38% and 45% of its terrestrial and marine surface area, respectively,¹³ compared to OECD country averages of 15% and 21% (OECD, 2022^[73]). However, strict terrestrial nature reserves, wilderness areas and national parks, as defined by the European Union, comprise only 1% of

total surface area. They must be expanded to contribute to achieving the EU member states' collective goal of achieving 10% of terrestrial surface area by 2030 in line with the EU Biodiversity Strategy (EC, 2022^[74]).

Germany is not on track to achieve its emission targets in the LULUCF sector

With the amendment of the Federal Climate Change Act in 2021, Germany has increased its ambition for the land use, land-use change and forestry (LULUCF) sector to reduce carbon emissions and enhance its carbon sink capacity. The LULUCF sector should contribute to the climate goals by absorbing at least -25 MtCO₂-eq by 2030, -35 MtCO₂-eq by 2040 and -40 MtCO₂-eq by 2045. In 2020, net removals in the LULUCF sector amounted to -11.3 MtCO₂-e. However, emission balance projections expect Germany to fall short of these targets by about 7 MtCO₂-eq in 2030 and 22 MtCO₂-eq in 2040 (UBA, 2021^[75]). These projections are based on already adopted LULUCF policies and expected land and land-use changes in the sector until 2040. It would be useful to update projections to include the expected impact of new climate and biodiversity measures.

To reach its LULUCF emissions targets, Germany needs to significantly accelerate action. It has significant potential to sequester carbon by expanding and maintaining near-natural forests, which store 1.3 billion tonnes of CO₂-eq and sequester an additional 62 Mt annually (Thünen-Institut, 2017^[76]). Rewetting drained peatlands could significantly reduce CO₂ emissions, estimated at 53 Mt CO₂-eq in 2020 and enhance its carbon sink capacity (BMUV, 2022^[77]). There is considerable potential to address climate change through NbS in the LULUCF sector, as well as through spatial planning and coastal management.

The Federal Action Plan on NbS for Climate and Biodiversity provides an unprecedented opportunity to enhance ecosystem health and address the climate crisis

In response to the double crisis of climate change and biodiversity loss, Germany aims to accelerate investments in NbS to address biodiversity loss, enhance ecosystem quality and tackle the climate crisis. A new and ambitious national NbS programme (*Aktionsprogramm Natürlicher Klimaschutz, ANK*) has been under development since 2022. The programme is set to contribute significantly to Germany's LULUCF targets while promoting biodiversity and ecosystem health, resilience to climate impacts and sustainable land management.¹⁴

Besides identifying new measures, the ANK aims to contribute to climate and biodiversity targets by also accelerating the implementation of existing NbS. Specifically, it aims to remove policy and institutional barriers to accelerate implementation of NbS measures. The BMUV consulted broadly with the public, engaging citizens, community-based and non-profit organisations, and agencies across government to inform the design of the programme. The consultation has contributed to raising awareness of ANK objectives among key stakeholders, and thus lays the ground for implementation.

For the programme to deliver short-term results (2023-26), stakeholders should rapidly agree on key priorities, eligibility criteria and delivery, funding and accountability mechanisms. The short timeframe and large scope of the ANK represents a major challenge for the BMUV. However, the unprecedented amount of funding also provides an opportunity to greatly upscale NbS and change long-standing, harmful practices that have degraded Germany's biodiversity. To help ensure long-term impact, Germany should consider the following ways to secure funding for maintaining measures beyond the initial timeframe.

The Länder could become key partners in delivering the ANK programme

Instead of creating new delivery mechanisms for the entire ANK, Germany's Länder could implement some of the programme. In many cases, they may already have a comprehensive understanding of the NbS potential in their regions. They also have the relevant networks of government and non-government agencies, which could greatly facilitate implementation. Furthermore, they are closer to those who will be

directly affected by these measures, such as municipalities, landowners or farmers. This could help identify and address potential implementation barriers more easily.

The delivery mechanisms need to consider the complex landscape of regulations at the subnational, federal and EU levels and address ways to overcome potential barriers in that regard. Delivering parts of the programme directly through citizens, companies and organisations under public or private law is itself progressive and may lead to innovative suggestions in NbS. However, the size of the programme would not allow it to be fully deliverable through private stakeholders alone.

The ANK programme needs to measure progress and sustain benefits over time

Long-term effectiveness of NbS and possible trade-offs should be considered in planning. The ability of ecosystems to act as carbon sinks, reduce impacts of climate change and enhance biodiversity is directly affected by the exposure and vulnerability of ecosystems themselves to climate impacts. Continued warming, heat stress or extreme precipitation can reduce the effectiveness of NbS.

For the programme to deliver on its high ambitions, it should identify clear objectives and targets and build in frameworks that can monitor progress, and to the extent possible, impacts. A range of existing data and indicators could be explored in this regard. For example, the national forest inventory (*Bundeswaldinventur*) monitors and assesses forest cover and quality, as well as carbon sequestered by forests. The German Environment Agency has monitored peatland size, quality and emissions.

ANK funding needs to be aligned and co-ordinated across sectors and government levels

While the ANK's initial funding envelope of EUR 4 billion marks a step change in available funding for NbS, its activities should be aligned with existing NbS funding. The ANK should thus fund genuinely new measures as opposed to projects that would be covered by existing programmes. The federal government and Länder governments provide another EUR 800 million from 2020 to 2023 through the Joint Task for the "Improvement of Agricultural Structures and Coastal Protection" (*Gemeinschaftsaufgabe Verbesserung der Agrarstruktur und Küstenschutz, GAK*). Appropriate funding mechanisms should be established that make use of and co-ordinate with existing funding channels to Länder and sectors (e.g. GAK) within the constraints of the provisions of the Basic Law and related budgetary requirements. It will be important to secure long-term funding for maintaining ANK measures beyond 2026.

Building synergies for effective long-term climate action

There is a large untapped potential to foster synergies between climate, biodiversity and water-related action

Forest and water strategies increasingly identify synergies with climate mitigation, adaptation and biodiversity, but these need to be translated into practice. For example, the Forest Strategy 2050 sets measures to enhance biodiversity and nature protection; provides financial incentives for forest owners to foster biodiversity and nature protection; and establishes a monitoring system for forest ecosystems. The impact of these synergies in practice should be monitored and evaluated. Similarly, the National Water Strategy considers synergies between climate mitigation, adaptation and NbS measures. The ANK is a unique opportunity to both foster synergies and demonstrate how this is done in practice. As it sets out to address climate change and biodiversity loss through NbS, the ANK can thereby identify projects and demonstrate how they harness such synergies effectively. In doing so, the ANK's monitoring system should identify indicators that evaluate each NbS impact on different objectives.

ANK measures could benefit from emphasising adaptation synergies more explicitly. NbS projects financed by the ANK need to demonstrate their contribution to climate mitigation but also their own exposure and vulnerability – and contribution to building the resilience – to the impacts of climate change. For example, new

trees planted as part of ANK efforts to increase carbon storage need to be adapted to expected changes in temperature or precipitation. Failure to do so risks undermining its impact over time.

Germany has benefited from and largely contributed to raising ambitions in international co-operation on climate change and nature-based solutions

Germany has contributed to – and benefited from – strong EU and international co-operation on adaptation. In line with reporting requirements, Germany has increased efforts to measure adaptation as demonstrated by ongoing initiatives to quantify adaptation spending. Targeted EU funding has helped scale up implementation of adaptation initiatives, especially at subnational level. EU platforms have also facilitated cross-border adaptation planning and investments. Germany is among the first countries to assess its exposure and vulnerability to climate risks emanating outside of its territory, thereby responding to a key priority of the EU Adaptation Strategy. This early awareness is needed to tackle climate risks that have not materialised but that will become more significant (e.g. climate-induced international migration).

Germany has promoted the use and scaling up of NbS at international level, making it one of its key commitments under its presidency of the G7 in 2022. As a result, the G7 committed to protecting at least 30% of land and 30% of the ocean nationally and globally by 2030. Mirroring Germany's domestic policy objectives, the G7 also recognised the need to transform agriculture by creating synergies between biodiversity, climate change and food security (G7, 2022^[6]). Conversely, as recognised by the ANK and the National Peatland Strategy, Germany's own success in implementing the ANK programme will depend on certain international legislation. This includes phasing out peat products' horticulture in support of measures which, without an EU-wide ban, would lead to shifting peat extraction abroad.

Germany is a major development partner focusing on climate adaptation and biodiversity

In line with the OECD-DAC Declaration of 2021, Germany aims to align its official development assistance (ODA) with the goals of the Paris Agreement (OECD, 2021^[78]). It supports developing countries' efforts to fight climate change, biodiversity loss and environmental degradation by channelling a substantial part of its ODA to these purposes (OECD, 2021^[79]).

With total ODA (USD 32.2 billion) representing 0.74% of gross national income, Germany is the second largest bilateral provider of ODA (OECD, 2022^[80]). This reflects a large increase, more than double the amount spent a decade ago (USD 12.7 billion in 2010) (OECD, 2012^[37]). It makes Germany the largest provider of environment- and biodiversity-focused ODA globally. According to the Rio Markers, about 37% of Germany's bilateral ODA had an environmental focus in 2019-20, with about 16.8% spent on mitigation; 13.1% on climate adaptation; and 10.8% on biodiversity (OECD, 2022^[80]). Germany has also been the largest donor of the Adaptation Fund, a key multilateral instrument for climate adaptation financing.

Germany's International Climate Initiative (*Internationale Klimaschutzinitiative, IKI*) is a key instrument of the federal government for funding international climate action and biodiversity conservation. Since 2008, it has supported developing countries in formulating and implementing their respective Nationally Determined Contributions under the Paris Agreement. IKI approved EUR 5 billion for more than 950 climate and biodiversity projects in over 150 countries between 2008 and 2021 (IKI, 2022^[81]).

Despite progress, there is room for greater exchange of experience in the implementation of climate, biodiversity and NbS programmes. This includes reciprocal knowledge exchanges between Germany's sectoral agencies and its development co-operation agencies implementing adaptation action abroad. There is also a huge opportunity to improve the sharing of good practices and lessons learnt more systematically across different countries and regions.

Recommendations on climate change adaptation and nature-based solutions

Climate risk assessment

- Conduct regular climate risk exposure and vulnerability assessments in all 16 Länder; consider encouraging Länder to make municipal and city-level climate risk assessment mandatory with a view to ensuring that all cities and municipalities have a solid understanding of climate-related hazards, exposure and vulnerability at local level.
- Harmonise standards and encourage the use of comparable data and methods across governance levels to allow greater comparability of risk assessments at national level.
- Increase and further facilitate access to climate risk information for all relevant actors and regularly evaluate whether this contributes to raising awareness levels and triggers action.

Climate change adaptation

- Ensure systematic integration of adaptation into all sectoral and subnational development policies and investments; develop and enforce measurable targets that hold sectoral agencies and subnational governments to account for their adaptation actions.
- Strengthen subnational adaptation capacity; propose measures to increase local adaptation capacity and incentives for municipalities to implement adaptation measures jointly to address resource constraints.
- Strengthen proactively the climate resilience of highly vulnerable communities so as to leave no one behind; consider stronger federal and Länder government support to advance implementation at the local level.
- Reform adaptation finance and place stronger emphasis on prevention; monitor adaptation spending *ex ante* and *ex post*, in response to climate-extreme events; identify ways that simplify information about – and access to – different adaptation funding programmes; consider an increase in dedicated adaptation funding at all levels of government; identify ways that reward adaptation investments by all government and non-government actors (e.g. increasing loss and damage compensation or lowering insurance premiums for those that had invested in risk-reducing measures).

Biodiversity and nature-based solutions

- Further reduce GHG emissions from land use and increase carbon removals in the LULUCF sector, focusing on expansion and maintenance of forests and redevelopment of peatlands to enhance their natural carbon sink function.
- Increase terrestrial and marine ecosystem protection to avert continued biodiversity loss and implement swiftly additional measures to contribute to meeting the targets of the Kunming-Montreal Global Biodiversity Framework; consistently identify measures that enhance biodiversity as part of land use and construction permit decisions.
- Rapidly agree upon delivery mechanisms, including eligibility criteria, funding and accountability mechanisms for the ANK to start delivering results within a short timeframe (2023-26); consider the critical role of the Länder to support implementation of the ANK.
- Avoid duplication and communicate clearly about the ANK support in relation to existing programmes for NbS; secure long-term funding for sustaining outcomes of ANK beyond 2026;

consider trade-offs in NbS; ensure that NbS themselves are designed to withstand and adapt to climate impacts, such as heat stress.

Linkages and synergy

- Ensure that all ANK projects consider their impact on biodiversity, water and broader ecosystem health in addition to their climate change mitigation and adaptation objectives.
- Strengthen exchanges of adaptation insights and knowledge generated by Germany's national adaptation engagement, as well as its EU and international partnerships.

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Notes

¹ The European Green Deal (2020) sets out the main policy initiatives of the European Commission to help Europe become a climate-neutral continent by 2050. The Fit-for-55 package was released in two parts in July and December 2021. It includes drafts of EU climate and energy legislation to support its climate objective. The REPowerEU (2022) is the Commission’s response to global energy market disruptions. The EU CAP lays out the priorities of the new Common Agricultural Policy for 2023-27.

² The price caps apply to all households and businesses in Germany from January 2023-April 2024. For households and small and medium-sized enterprises, the cap is fixed at 80% of the previous year’s energy consumption. For industry, the cap is applied at 70%. In practical terms, this means that 70-80% of energy consumption will be subsidised, while the remainder will need to be paid at market price.

³ The international Climate Club is a high-ambition intergovernmental forum for discussion focusing on three pillars: 1) Advancing ambitious and transparent climate change mitigation policies; 2) Transforming industries; and 3) Boosting international climate co-operation and partnerships.

⁴ Over 50 million Germans purchased the EUR 9-Ticket between June and August 2022. The nationwide ticket offered unlimited access to Germany's local and regional rail system for EUR 9 per month. Capitalising on this experience, the government was to introduce in 2023 the EUR 49-Ticket, which was expected to become more financially sustainable. The federal state agreed to cover half of related costs.

⁵ The landlord's cost participation obligation is calculated using a 10-stage model, with values ranging from 0-90%: the higher the CO₂ emission of the building, the higher the share of the CO₂ costs that the landlord has to bear.

⁶ The national carbon price for transportation and buildings will be raised from EUR 30 per tonne of CO₂ in 2022 to EUR 55 in 2025; in 2026, auctions will be introduced alongside a price collar of EUR 55-65 per tonne of CO₂.

⁷ As of 2022, anyone travelling more than 20 km to work can deduct 35 cents per km from his/her income tax.

⁸ The proposed measure targeted only users of foreign cars. Cars registered in Germany were set to benefit from a deduction of the road charge from their annual vehicle tax bill. This 1:1 deduction of the vehicle tax from the road charge would lead to a de facto exemption from the charge for cars registered in Germany. The European Commission launched an infringement procedure against the introduction of this discriminatory PKW-Maut.

⁹ Days with soil moisture below 30% of usable field capacity for winter wheat and sandy clay.

¹⁰ Considering direct and indirect damages of a total of 619 extreme climate-related events including flash floods, floods, extreme precipitation, heatwaves, storms, hail and snow that caused damages of at least EUR 100 million.

¹¹ The exact amount is dependent on the climate scenario assumed (weak, medium, strong); numbers are measured in terms of cumulative changes in real GDP.

¹² Measures included in the calculation are those set out in the latest Adaptation Action Plan (III) (assuming a "realistic" implementation) as well as potential adaptation opportunities identified for 29 key climate impacts assessed in the KWRA 2021.

¹³ Data are based on definition of protected area from the IUCN (World Database on Protected Areas).

¹⁴ Findings in this report were developed on the basis of a draft version of the ANK that was published in September 2022.

Annex 1. Actions taken to implement selected recommendations from the 2012 OECD Environmental Performance Review of Germany

Recommendations	Actions taken
	Policy-making environment
Further promote the policy co-ordination approaches and implementation tools embedded in the National Sustainable Development Strategy.	Under the co-ordination of the Federal Chancellery, Germany applies a whole-of-government approach to support implementation of the National Sustainable Development Strategy. The State Secretaries' Committee on Sustainable Development serves as the central co-ordination tool. The Committee's meetings are attended at permanent state-secretary level by all ministries. The resolutions of the meetings are published on the federal government's website. A dialogue group, composed of 15 institutions and organisations, prepares focus topics. The 2022 spending review lays the groundwork to increase the focus on performance-based budgeting for sustainable development. The federal government started introducing agile project teams operating across ministries, along with transformation teams for the six transformative areas of the German Sustainable Development Strategy, as well as in international co-operation as a lever of transformation.
Further integrate the results of environmental assessments and sustainability checks on legislation in decision making; strengthen support for the more effective implementation of Environmental Impact Assessment and Strategic Environmental Assessment, particularly at the local level; reinforce the quality and independence of the economic assessment of environment-related policies.	Every draft regulation or law requires the ministries to conduct an <i>ex ante</i> sustainability impact assessment. The targets and indicators of the Sustainable Development Strategy provide the reference framework for this assessment. A computer-assisted tool – the electronic sustainability impact assessment eNAP (<i>elektronische Nachhaltigkeitsprüfung</i>) – was developed in 2018 and updated in 2021 to improve the quality of regulatory impact assessments. The use of eNAP for sustainability impact assessments is mandatory for all regulatory projects. Moreover, eNAP has been integrated into the platform e-legislation, establishing a closer link with the electronic legal impact assessment (eGFA). In 2017, the Environmental Impact Assessment Act (EIA Act) was amended to transpose the EU Directive 2014/52/EU into national law. Specifically, EIA rules were streamlined to ensure faster implementation by public authorities and project developers.
Promote the use of independent mechanisms to monitor and report on how federal environmental legislation is implemented by the Länder, with a view to benchmarking and disseminating good practice approaches.	Federal government-Länder Working Groups (<i>Bund-Länder-Arbeitsgemeinschaften, BLAGs</i>) play a key role in disseminating best practices and evaluating the implementation of federal environmental legislation at Länder level. These are set up by the German Conference of Environment Ministers (<i>Umweltministerkonferenz, UMK</i>). In 2022, there were nine BLAGs. In many cases, BLAGs provide guidelines on how to facilitate and enforce implementation. The BLAGs can set up committees open to individual Länder to address issues of specific interest. The success of a Land on a specific issue is generally communicated within respective BLAGs, although there is no formal process. The need to amend a federal law is usually first discussed within BLAGs.
Continue to deepen and broaden the participation of stakeholders in environmental decision making; review provisions for access to justice in environmental matters in order to ensure consistency with the Aarhus Convention.	The Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) explores innovative approaches in public participation in environmental decision-making processes. For example, the National Water Strategy benefited from a two-year dialogue with over 200 stakeholders. Other recent examples include the draft Action Plan on Nature-based Solutions for Climate and Biodiversity, or the national dialogue on the safety of nuclear disposal. Key outcomes and comments are published through the ministry's website, such as the dialogue platform (<i>BMUV im Dialog</i> , https://dialog.bmu.de) and printed publications. EIA-Portals have been launched by the federal government and at Länder level. The Environmental Appeals Act has been amended to extend access to justice of associations.
Further promote synergies and coherence among policies related to resource productivity (e.g. waste, raw material, energy, climate and innovation policies).	Since the adoption of the German Resource Efficiency Programme (ProgRes) in 2012, the federal government must provide reports on resource efficiency trends to the national assembly (<i>Bundestag</i>) every four years, triggering an update of the programme. Two update reports were adopted in 2016 and 2020.
Build upon the ongoing assessment of the economics of ecosystems and biodiversity to guide implementation of the National Strategy on Biological Diversity and to strengthen inter-institutional co-operation in this area.	"The Economics of Ecosystems and Biodiversity" (TEEB), implemented between 2012-18, resulted in four national reports on "Natural Capital Germany, TEEB.DE". The Federal Statistical Office has started developing a comprehensive ecosystem accounting approach as part of the national environmental accounting system. The implementation of the corresponding Target 14 of the Kunming-Montreal Global Biodiversity Framework will be covered in the update of the National Biodiversity Strategy.

Towards green growth

Consider creating an effective carbon tax in the sectors not covered by the EU Emissions Trading System and ensure that other, non-carbon related, externalities are adequately priced.

Reduce perverse incentives for car use by revising the tax treatment of company cars and the commuting allowance; consider extending the current system of road tolls to light duty vehicles and eventually passenger cars; consider adjusting the rates of the annual motor vehicle tax and complementing it with a vehicle purchase tax.

Introduce a mechanism to systematically screen existing and proposed subsidies against their potential environmental impact, with a view to phasing out environmentally harmful and inefficient subsidies.

Strengthen the incentive effect of wastewater charges and promote water abstraction fees in all Länder and all sectors, including mining; consider introducing taxes on agricultural inputs.

Strengthen coherence between agriculture and water policies, including by: ensuring effective cross-compliance with environmental requirements (Pillar 1 of agriculture payments); and expanding nature protection payments (Pillar 2 payments).

Strengthen waste prevention, for instance by: broadening and strengthening extended producer responsibility systems; expanding the use of economic instruments to promote primary resource substitution (e.g. incineration tax); and expanding knowledge networks and dissemination of best practices.

Maintain a strong, balanced commitment to environment within an expanded volume of official development assistance, in line with international commitments.

The federal government introduced a national emissions trading system (nETS) in 2021 for emissions from combustion of fossil fuels, which are not covered under the EU ETS. The nETS covers all fuels that fall under the Energy Tax Act, including petrol, diesel, heating oil, natural gas, liquefied gas and non-sustainable biomass. The system started with a fixed price phase to provide planning security for all stakeholders during the introduction phase of national emissions trading. Auctions will start in 2026.

Little progress has been made in this area. Transport-related taxes are far below the OECD average. The 1% tax rate for the treatment of company cars as non-cash benefits is still in place. In the context of the nETS, the commuter allowance was further increased in 2021 until 2026, including a mobility premium for low-income employees. Road tolls only apply to heavy duty vehicles. Germany does not apply a vehicle purchase tax. As of 2021, newly registered cars with high CO₂ emissions are charged an increased tax while EVs are exempted.

The Federal Ministry of Finance produced 28 issues of its subsidy report with an increasingly climate-focused narrative. This provides a good starting point for advancing the phase-out of already identified harmful subsidies. While hard coal subsidies were phased out by 2018, progress in phasing out potentially environmentally harmful support in agriculture has been slow.

To date, 13 of 16 federal states charge for water abstraction. Moreover, the federal government intends to restructure wastewater charges and to introduce extended producer responsibility measures to create stronger incentives for reducing water pollution from municipal and industrial wastewater. In the agricultural sector, policy attention has mainly focused on regulatory measures.

The federal government intends to strengthen coherence between agriculture and water policies through a more co-ordinated interaction between conditionality, eco-schemes and natural protection payments. Measures are mainly focused on incentivising voluntary efforts. The German Strategic Plan of the EU Common Agricultural Policy 2023-27 provides an opportunity to make further progress. The National Water Strategy, adopted in March 2023, aims at strengthening policy coherence between agriculture and water issues. Germany has had a national strategy for food waste reduction since 2019, but there is room for improvement. Germany has had a five-point plan since 2018 to reduce plastic waste and support international efforts to reduce marine litter. Germany made little progress to reduce municipal waste and needs to strengthen waste prevention. The public awareness-raising campaign "Too Good for the Bin!" has been in place for a decade. A broader waste prevention programme is under development.

Germany is the largest bilateral provider of environment- and biodiversity-focused development assistance. It has also been the largest donor of the Adaptation Fund and for the eighth replenishment of the Global Environment Facility. Germany's International Climate Initiative (*Internationale Klimaschutzinitiative, IKI*) is one key instrument of the federal government for funding international climate action.

Economic innovation

Establish a clear, predictable policy framework that provides continuous innovation incentives, e.g. by providing a clear signal about the long-term future taxation of energy carriers; promote coherence between policies for environment-related innovation and sectoral policies, particularly transport policy.

Carefully design instruments aimed to financially support environment-related innovation so as to achieve policy objectives efficiently and effectively, promote diversity, avoid picking winners and maximise the leverage of private capital; adjust the subsidy component of financing instruments in light of market developments, and phase out subsidies as technologies become commercially viable.

Systematically assess the effectiveness and efficiency of environmental and innovation policies in terms of measurable outcomes (e.g. environmental benefits, patented inventions, rate of mobilisation of private capital).

In the context of the Fit for 55 package, the European Commission also proposed a revision of the EU Energy Tax Directive. Fuels should be taxed according to their energy content and environmental performance rather than according to their volume. The proposed minimum rates shall be adjusted annually to reflect the most recent prices. Kerosene used as fuel in the aviation industry and fuels used in the maritime industry should no longer be fully exempt from energy taxation for intra-EU travel. The negotiations are still ongoing.

The federal government strongly emphasises technology-neutral approaches. As the electric vehicle market is maturing, the federal government started scaling back support for electric vehicles (EVs) in 2023 (a maximum of EUR 4 500 instead of EUR 6 000 for the purchase premium). As of September 2023, only private consumers can benefit from the scheme. Support for hybrid vehicles has been abolished.

There is still room to improve mainstreaming of impact assessment across all government levels. For example, the recovery package is not part of Germany's regular annual budget cycle and draws on different funding sources at national and European level. This makes a coherent monitoring and impact assessment more complex.

Assess possible shortages in high-skilled labour needed for the development and diffusion of environment-related innovation, and develop measures to fill gaps.

Make further efforts to improve policy co-ordination at the EU level and beyond to strengthen incentives and support for environment-related innovation (e.g. labour mobility, energy pricing and infrastructure development).

A new Skilled Immigration Act is under discussion. It aims to further simplify and accelerate administration, while make working and living conditions more attractive. A new points system may open the door to third-country nationals with "good potential" to come to Germany to seek a job. In addition, Germany introduced a monitoring system to analyse future labour market developments, including projections for the next decade and beyond.

Germany's national efforts are aligned with the objectives of the European Green Deal. The German Recovery and Resilience Plan (GRRP, 2021-26) is clearly future-oriented with a strong emphasis on hydrogen. Within Horizon Europe, the EU's research and innovation programme (2021-27), the federal government intends to further leverage national public and private investment to foster new technologies, sustainable solutions and innovation.

Climate change

Strengthen mechanisms to identify policy adjustments needed to stay on track to achieve climate targets, e.g. by explicitly benchmarking progress, presenting an annual report to the Bundestag, and enhancing mechanisms for stakeholder and civil society participation in policy making.

Contribute to discussion at EU level about possible measures to maintain an effective carbon price signal in the EU Emissions Trading System in line with overall medium and long-term EU emission reduction targets.

Use energy taxation to effectively complement the EU Emissions Trading System and to provide a consistent carbon price signal across the economy; gradually phase out energy tax exemptions that are not needed to avoid double taxation or pricing.

Review the taxation of diesel and petrol with a view to internalising their environmental external costs.

Continue to monitor the costs of feed-in tariffs; ensure that the mechanisms to control for the impact of unpredictable developments in the renewable energy market on these costs are effective and efficient.

Ensure that the energy and climate fund targets projects that are justified environmentally and economically by: establishing appropriate criteria for eligible projects; applying instruments to provide targeted support and to leverage private resources; and establishing an independent mechanism to assess progress.

Further improve the energy efficiency of buildings in the rental market, e.g. by introducing an energy-efficiency rental index.

Further extend low-emission zones and use them to test the introduction of incentives to reduce vehicle use in urban areas.

Review support policies for biofuels in light of a comprehensive assessment of their costs and benefits, including their impact on land use, biodiversity and water.

The Federal Climate Change Act introduced a mandatory emissions monitoring mechanism in which sectoral emissions are assessed annually and compared to sectoral targets. If a sector fails to meet its annual target, the responsible ministry must prepare an immediate action programme (*Sofortprogramm*), which is reviewed by the independent Council of Experts on Climate Change and then presented to the *Bundestag*. However, at a coalition meeting in March 2023, government parties agreed to soften the policy adjustment mechanism of annual sectoral targets.

The federal government has played an active role in shaping EU policies, specifically in support of an ambitious EU ETS reform: emissions in the ETS sectors must be cut by 62% by 2030; free allowances to industries in sectors that fall under the Carbon Border Adjustment Mechanism will be phased out from 2026 and disappear by 2034. Meanwhile, the EU ETS will be expanded to include shipping. An ETS II for fuel emissions from the building and road transport sectors, as well as process heat within smaller industries currently outside the EU ETS, shall be introduced as of 2027.

Close to 90% of Germany's emissions are priced. As indicated above, the federal government introduced a nETS in 2021 for emissions from land transport and buildings not covered under the EU ETS. Little progress has been made in phasing out energy tax exemptions in the agricultural sector.

Tax rates continue to be poorly aligned with the polluter pays principle. Excise duties on energy products have remained virtually unchanged during the past decade.

The feed-in tariff, initially introduced in 2000, was reformed several times and contributed significantly to financing renewable energy development. The scope of issues that can be regulated by means of a statutory ordinance was widened to facilitate an adequate and swift reaction to unpredictable market developments. In response to soaring energy prices, the federal government reduced the Renewable Energy Sources Act Surcharge (EEG levy) to zero. The EEG levy was completely abolished as of 1 January 2023.

In 2022, the Energy and Climate Fund was transformed into a new Climate and Transformation Fund (*Klima- und Transformationsfonds, KTF*), with a budget of about EUR 178 billion for 2023-26, including EUR 36 billion for 2023. The fund mainly focuses on the building sector, electric mobility, hydrogen development and energy efficiency. Better use of spending reviews and policy impact evaluation would increase the fund's efficiency.

The federal government has earmarked EUR 56.3 billion for 2023-26 to support climate-friendly renovations. The 2022 CO₂ Cost Sharing Act introduced a cost-splitting between landlords and tenants depending on a building's energy and climate performance.

As of 2023, Germany has over 50 low-emission zones comprising more than 70 cities. Vehicles are required to use an official German emissions sticker. However, emission levels would need to be tightened. Urban mobility remains heavily car-dominated, representing about 70% of daily travel distances.

The federal government intends to support development of synthetic fuels and has earmarked EUR 1.9 billion to support the rollout of e-fuels and "advanced biofuels" by 2026. Costs and impact of support measures are regularly analysed by the federal government and its specialised agencies, in line with EU requirements. Data on biodiversity exist but without attribution to bioenergy.

Source: OECD Secretariat based on country submission.

1 Towards sustainable development

This chapter provides an overview of Germany's green energy transition, the impact of the global energy crisis, key environmental trends and progress towards net zero. It assesses the environmental effectiveness and economic efficiency of the environmental policy mix, including regulatory and voluntary instruments; fiscal and economic instruments; and public and private investment in environment-related infrastructure. Finally, it examines the interaction between the environment and other policy areas with a view to highlighting opportunities and barriers to environmentally friendly and socially inclusive growth.

1.1. Addressing key environmental challenges

Germany continued to improve its environmental performance over the past decade. Despite its important industry base and dense population, the country reduced several environmental pressures. Germany improved air quality and is one of the best performing countries in terms of sustainable waste management in Europe. It is working towards a more circular economy and more sustainable supply chains. It has decoupled economic growth from total energy supply and carbon dioxide (CO₂) emissions generated by fuel combustion. However, the country's energy mix still depends largely on fossil fuels, which accounted for about three-quarters of total energy supply in 2020. Germany has an ambitious climate policy and aims to reach climate neutrality by 2045 and achieve negative emissions after 2050.

Despite progress, the country faces multiple pressures on nature and water, threatening biodiversity and natural capital. Nitrate water pollution from agriculture remains a serious concern. The Baltic Sea and North Sea face acute problems with eutrophication. Many German water bodies failed to meet environmental objectives. Germany needs to strengthen efforts to improve water quality. Only about one-third of Germany's forests have near-natural conditions and more than 90% of peatlands have been drained (BMUV, 2022^[1]). The conservation status of species and habitats shows deteriorating trends. The impacts of climate change increasingly affect the country as demonstrated by the 2021 flood catastrophe. Germany is scaling up efforts to adapt and become more climate resilient (Chapter 2).

The economic downturn caused by the COVID-19 pandemic hit the economy hard, with gross domestic product (GDP) contracting by 3.7% in 2020. The economy recovered in 2021 (+2.6%) and was then again affected by the economic consequences of Russia's unprovoked war of aggression in Ukraine, which resulted in a lower-than-expected real GDP growth of 1.9%. It is projected to recover slowly (0.3% in 2023 and 1.7% in 2024) (OECD, 2023^[2]). In 2022, Germany recorded a high inflation rate of 8.8%. The crisis revealed structural weaknesses in Germany's energy supply due to strong dependency on Russian oil and gas, obliging the federal government to rethink its energy strategy. However, the German economy has weathered the global energy crisis much better than expected (OECD, forthcoming^[3]). As part of its energy crisis response, Germany has taken a series of measures, which are historic in size and scope. They are set to massively accelerate the green energy transition in the coming years.

1.1.1. Progress towards sustainable development goals

Germany ranked 6th of 163 assessed countries on the implementation of the 2030 Agenda for Sustainable Development (Sachs, J.D. et al., 2022^[4]). The country has made progress in implementing the Sustainable Development Goals (SDGs) but faces many challenges, particularly related to SDG12 on responsible consumption and production, and SDG13 on climate action (Figure 1.1).

Germany has a high political commitment to support implementation of Agenda 2030 at home and abroad. In 2016, Germany incorporated the SDGs in the German Sustainable Development Strategy, including environmental indicators. The updated Sustainability Strategy of 2021 identifies six cross-cutting transformative areas, including climate action. It is one of few countries, which achieved the international target of dedicating 0.7% of gross national income to official development assistance (Section 2.4.3).

Under the co-ordination of the Federal Chancellery, Germany applies a whole-of-government approach to support implementation of Agenda 2030. Every draft regulation or law requires the ministries to conduct an *ex ante* sustainability impact assessment (Federal Government, 2021^[5]). Moreover, 11 Länder have adopted their own sustainable development strategies. Germany was one of the first countries to prepare Voluntary National Reviews within the broader Agenda 2030 process (2016 and 2021). Some Voluntary Local Reviews have also been elaborated. The 2022 Spending Review lays the groundwork to increase the focus on performance-based budgeting for sustainable development, which the government intends to develop in the coming years under the leadership of the Ministry of Finance (Section 1.3.5).

Figure 1.1. Germany is making progress in implementing Agenda 2030, but challenges remain



Note: The full title of each SDG is available here: <https://sdgs.un.org/goals>.

Source: Sachs J. D. et al. (2022), The Decade of Action for the Sustainable Development Goals, Sustainable Development Report 2021, <https://dashboards.sdgindex.org>.

1.1.2. Green energy transition

Initiated in the early 2010s, Germany's green energy transition (*Energiewende*) aims at moving away from nuclear and fossil fuels towards renewables while promoting better energy efficiency. The transition is underway: Germany has decoupled economic growth from energy demand and CO₂ emissions, and is one of the G20 and EU-27 countries with the highest levels of energy efficiency (Brüggemann, 2018^[6]). The share of renewables has achieved remarkable growth over the past decade. The coal phase-out has been enshrined in the 2020 Act on the Phase-out of Coal-fired Power Plants. This contains a legally binding commitment for phasing out coal by 2038 at the latest, including targeted support to coal regions for the transition. In addition, the federal government committed to accelerating the process and completing the coal exit, ideally, by 2030. The three remaining nuclear power plants went off the grid in mid-April 2023, completing Germany's decade-long nuclear exit (Box 1.2).

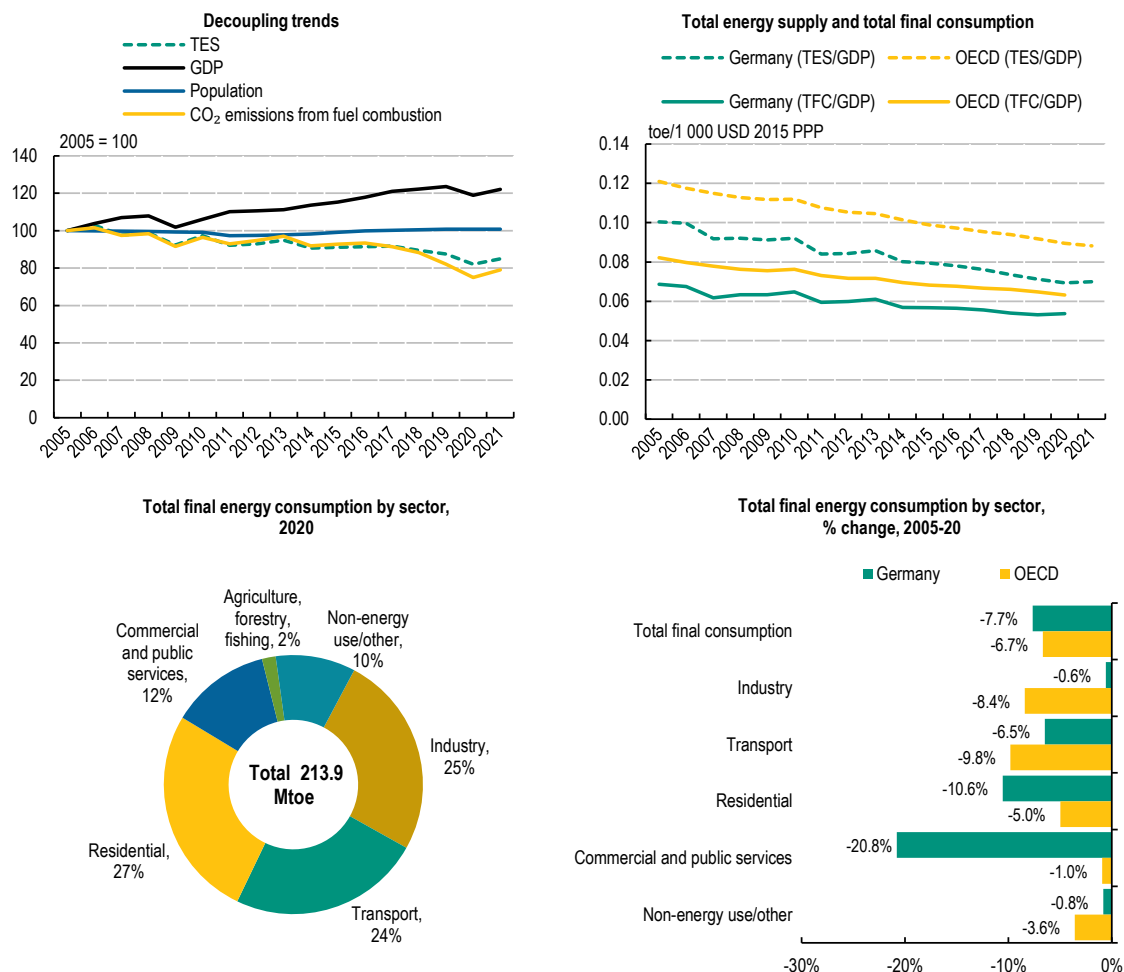
Despite progress, Germany will need to advance its energy transition at a much faster pace to secure a future that is "secure, environmentally friendly and economically successful" (BMWK, 2022^[7]). More particularly, it needs to address three major challenges: i) ensuring energy security; ii) achieving national climate goals; and iii) developing the country's economic competitiveness. Supply security has become a top priority of the government since the Russian invasion of Ukraine and the subsequent global energy crisis. Climate change is an overall leitmotif of the federal government's coalition treaty; and rising economic competitiveness is at the heart of the country's industry policy. However, Germany needs to find ways to advance the country's structural transformation by addressing the triple crisis of energy, climate and biodiversity in an integrated way.

In practice, Germany faces several trade-offs. For example, emergency measures aimed at tackling energy price shocks and preventing gas supply shortage partly impede progress on climate and environmental goals (e.g. re-opening of coal energy plants; fuel price cuts; suspended 2023 increase of CO₂ price for transport and buildings). While emergency measures are needed to ensure supply security and system stability, some of the government's responses to the energy price shocks have reduced the impact of national climate policies. Given the pressing environmental and climate challenges, the country cannot afford any further delays in designing pathways towards a sustainable energy transition.

Reducing energy use

Improving energy efficiency has been a key pillar of the *Energiewende*. Germany has decoupled economic growth from energy demand and CO₂ emissions. Total energy supply and final energy consumption are both decreasing while GDP has been growing (until COVID-19, Figure 1.2). In line with the OECD average, this resulted in a further decline in energy intensity. Energy use declined sharply in 2020 due to the pandemic and is expected to rebound in the coming years.

Figure 1.2. Germany has decoupled economic growth from energy demand and CO₂ emissions



Note: TES = total energy supply. TFC = total final consumption. Gross domestic product (GDP) is expressed at 2015 prices and purchasing power parities; Toe = tonnes of oil equivalent.

Source: IEA (2022), *IEA World Energy Statistics and Balances* (database); IEA (2022), *IEA World Greenhouse Gas Emissions from Energy* (database).

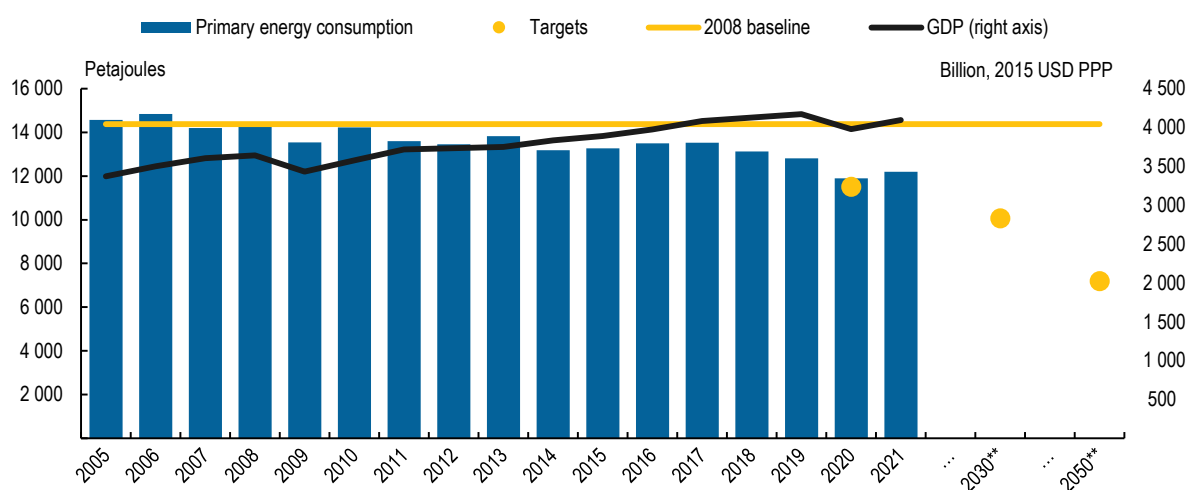
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The global energy crisis triggers an opportunity to advance energy efficiency. Energy savings of firms and households have been considerable: gas use in January 2023 was about 23% below the 2018-21 average (OECD, forthcoming^[3]). Reducing energy consumption through technical improvements and behavioural measures is more critical than ever to help avoid mismatches between demand and supply (IEA, 2022^[8]). To secure the supply of heat during the cold weather periods in 2023 and 2024, the federal government introduced additional energy saving measures on the basis of the Energy Security of Supply Act (*Energiesicherungsgesetz*, EnSiG) in August 2022.

Over the past decade, Germany significantly enhanced energy efficiency in the commercial, public services and residential sectors. Private households reduced their energy consumption by over 10%, mainly thanks to technological improvements (Figure 1.2). Some energy savings were also made in the transport sector. Meanwhile, energy consumption in the industry sector remained stable, which can be partially explained by increased energy consumption in the chemical industry. As a result, total final energy consumption decreased by 7.7% since 2005, above the OECD average of 6.7% (IEA, 2021^[9]).

Figure 1.3. Germany has set ambitious energy saving targets

Primary energy consumption and total final consumption, 2005-20



Source: IEA (2021), World Energy Balances; Eurostat (2022).

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Germany did not meet its 2020 efficiency target of cutting primary energy usage by 20% relative to the 2008 level (Figure 1.3). However, it only narrowly missed the mark thanks to a sharp consumption drop in 2020 related to COVID-19. Technical efficiency gains were offset by rising energy demand (e.g. economic growth, higher traffic volume, changes in lifestyle and consumption patterns). More efforts will be needed to sustainably reduce energy consumption in absolute terms to meet Germany's national climate and energy targets. To close the energy savings gap, new measures need to focus on current bottlenecks such as the renovation of building stock (Section 1.3.2). The electrification of the transport sector will also greatly contribute to efficiency gains.

The federal government has set itself the goal of “making Germany the most energy-efficient economy in the world” (BMWK, 2020^[10]). Germany's Energy Efficiency Strategy 2050 sets out a long-term pathway for strengthening German energy efficiency policy (BMWK, 2020^[10]). Ambition was further raised with a new goal of reducing energy consumption by 30% in 2030 and by 50% in 2050, compared to 2008 levels. The national strategy includes primary and final energy targets, and is supported by a nationwide dialogue process. Targets should be compatible with national climate goals and will need to be adjusted to the revised EU Energy Efficiency Directive. The federal government advanced work on a national Energy Efficiency Law in parallel to the now concluded EU process. Many measures and instruments under the National Energy Efficiency Action Plan (NAPE 2.0) contribute to cutting CO₂ emissions, including private sector networks (Box 1.1).

Box 1.1. Policies in practice: Energy efficiency and climate action networks

Building on a Swiss initiative, Germany has developed a network approach to promote systematic information-sharing and mutual learning on energy efficiency and climate action in a simple and non-bureaucratic way. A network (*Effizienznetzwerk*) typically brings together 8-15 businesses, which set joint energy and climate targets and work together towards achieving them.

To date, more than 350 energy efficiency networks bring together industry, trade and skilled crafts from over 3 000 companies across the country. This is fewer than the 500 networks announced for 2020 in 2014. However, these networks have been instrumental in working together towards achieving joint energy and climate targets. By 2025, some 300-350 networks shall work together towards saving 9-11 terawatt hours, as well as 5-6 million tonnes of CO₂-eq emissions.

Many networks outperformed initial goals and its members benefit from experience from other companies and greater visibility, making changes more socially acceptable. The initiative compiled a series of success stories from various sectors across the country. Other countries are now developing similar initiatives.

Source: Effizienznetzwerke: www.effizienznetzwerke.org.

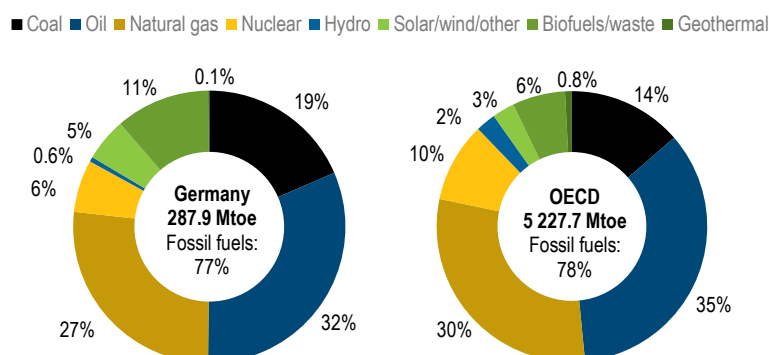
Mandatory measures, such as energy audits or energy management schemes, will apply to businesses. Data centres will be required to re-use 40% of their waste heat. The federal government provides EUR 1 billion for energy-efficient measures, including for digital modernisation across its public administration and within companies. Public authorities at all government levels are required to participate more strongly in saving energy according to their respective size. Households receive energy saving tips through an information campaign called “80 million together for energy change”.

The systematic approach of introducing energy-saving measures at all levels goes in the right direction and will help Germany reduce energy losses while reducing reliance on fossil fuels. However, more targeted support will be needed to promote system change such as helping vulnerable households to replace natural gas heating systems and gas boilers with climate-friendly alternatives (Section 1.3.2). Germany could also harness behaviour-related efficiency potential to a much greater extent (e.g. incentives for shared mobility, reduced heating temperatures in buildings) (ERK, 2022^[11]).

Decarbonising the energy mix and the nuclear exit


Despite massive investments in renewables, Germany's energy mix remains dominated heavily by fossil fuels, representing about three-quarters of total energy supply (Figure 1.4). This is about the same share as a decade ago. Oil and gas remain the main sources of Germany's total energy supply. The expansion of renewables mainly contributed to fill the gap created by advancing the nuclear power phase-out (Box 1.2). As a result, Germany will need to expand renewables at a much broader scale to further decarbonise its energy mix (Box 1.3).

Figure 1.4. Total energy supply remains carbon intensive despite increases in renewables



Note: Data refer to 2021. The breakdown of energy supply excludes heat and electricity trade, but percentages shown reflect ratios calculated on total energy supply. Biofuel and waste include negligible quantities of non-renewable waste.

Source: IEA (2022), *IEA World Energy Statistics and Balances* (database).

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Box 1.2. Germany's nuclear exit

Germany's energy transition places great emphasis on phasing out nuclear power by 2022, as stipulated in an amendment to the Atomic Energy Act. The decision in 2011 following the Fukushima Daiichi nuclear power plant accident in Japan. The nuclear exit has received widespread public support and political consensus to some degree. However, Germany's nuclear phase-out has been and will continue to be debated in light of energy supply and security challenges. For instance, in response to the global energy crisis, the federal government temporarily extended operations of the three remaining nuclear power reactors (Isar 2, Neckarwestheim 2 and Emsland) to offset reduced gas supply from the Russian Federation. The three plants were shut down in mid-April 2023, effectively completing Germany's decade-long nuclear phase-out.

Germany will still need to deal with a sizeable amount of nuclear waste. The country has licensed the former Konrad mine in Salzgitter in the state of Lower Saxony as a repository for low- and intermediate-level waste from the spent nuclear fuel of its past nuclear programme. The site is scheduled to start operations in 2027. For high-level waste, Germany is seeking a final repository since the Gorleben salt dome was ruled out as a potential site.

Phasing out of nuclear energy leaves Germany the challenge of ensuring a stable and reliable, low-carbon energy supply in both the short and long term. Without more reliance on fossil fuels, the country's shift towards renewable energy sources such as wind and solar power will pose significant challenges for the stability and security of the power grid.

Germany's nuclear phase-out takes place in a changing context for nuclear energy worldwide. Several countries continue to invest in the expansion of nuclear power. For example, Japan recently moved to promote use of nuclear energy to achieve net zero by 2050. It intends to restart as many reactors as possible and extend the lifespan of existing reactors beyond 60 years. Similarly, in February 2023, 11 countries of the European Union (Bulgaria, Croatia, the Czech Republic, Hungary, Finland, France, the Netherlands, Poland, Romania, Slovakia and Slovenia) launched a nuclear alliance. They aim to promote nuclear energy as an important tool for achieving net-zero objectives in the European Union. In 2022, France committed to building at least six large reactors.

Source: NEA (2023), www.oecd-neo.org.

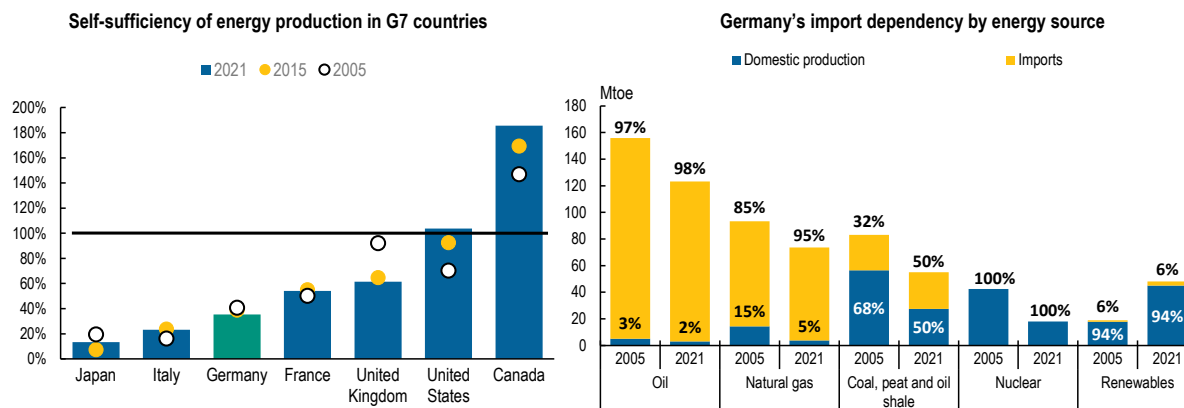
Energy security

Germany relies heavily on fossil fuel imports, which represent more than 60% of its total energy supply, slightly above the European average (Figure 1.5). The country completely depends on imports for critical minerals and metals for development of renewable energy sources. This makes it vulnerable to economic fluctuations and geopolitical issues (Box 1.10). At the crossroads of European energy infrastructure, Germany advocates for common European solutions to address the European-wide energy crisis. It would greatly benefit from deeper integration of the European market.

The Russian invasion of Ukraine on 24 February 2022 and the successive global energy crisis obliged the German government to rethink its energy strategy. The energy crisis revealed structural weaknesses of Germany's energy supply due to strong dependency on Russian oil and gas. The country's past energy policy has been criticised for being "short-sighted" because it underestimated the supply security risks related to the geopolitical realities of its policy on the Russian Federation.

However, the federal government has quickly adjusted to new realities by diversifying its supply sources to ensure security of supply (Box 1.3). Measures include filling up gas storage tanks (with the highest storage obligations in the EU), negotiating liquefied natural gas (LNG) trade deals, temporarily re-opening coal plants and raising public awareness on energy saving. Gas storages had been fully filled in October 2022 and stood at 77% in early February 2023, thanks notably to a relatively mild winter (OECD, forthcoming^[3]). Direct imports from Russia to Germany through Nord Stream 1 and 2 gas pipelines have stopped.

Figure 1.5. Germany depends heavily on imported fossil fuels



Note: Self-sufficiency is defined as energy production divided by total energy supply, e.g. how much of the energy supply is produced domestically.
Sources: IEA (2022), *World Indicators* (database); IEA (2023), *World Energy Balances* (database); BGR (2022).

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Box 1.3. Moving away from fossil fuels

Reducing oil dependency

Oil remains Germany's most important primary energy source covering nearly a third of the country's energy mix (IEA, 2023^[12]). The country has almost no domestic oil production and depends heavily on imports. Prior to its war in Ukraine, the Russian Federation delivered most of Germany's oil supply via the Druzhba pipeline. Overall, the oil market is more globalised than the gas market and it is thus easier to diversify supply sources. Germany will need to further enlarge the range of oil suppliers while reducing demand through transport electrification, alternative fuels and energy efficiency measures.

Alternative gas supplies – Liquefied natural gas

Gas represents about a quarter of Germany's energy mix and is the second most-consumed energy source after oil. Over 90% of gas is used in Germany's heating sector. About 44% of private households use gas to heat their homes (BMWK, 2023^[13]). In response to the energy crisis, the federal government adopted legislation to ensure minimum levels of gas in storage. It commissioned two public LNG terminals that were built within less than a year; in total, six LNG terminals should be operational by winter 2023-24 (LNG Acceleration Act). The total import capacity of these units represents about one-third of previous gas imports from the Russian Federation. While Germany should be commended for acting swiftly, the rapid construction of terminals came at a price (EUR 6.6 billion), more than twice as much as initially scheduled. Against the backdrop of Germany's energy transition, there is a risk of stranded assets. The federal government should therefore carefully assess import needs to avoid overcapacity. It should also lead a transparent discussion on costs, conditions and length of contracts. This would ensure that Germany implements this emergency response in a manner consistent with its climate objectives and without creating lock-in effects (G7, 2022^[14]). The LNG Acceleration Act underlined that LNG infrastructure use beyond 2043 should be allowed only for facilities that produce climate-neutral hydrogen and its derivatives.

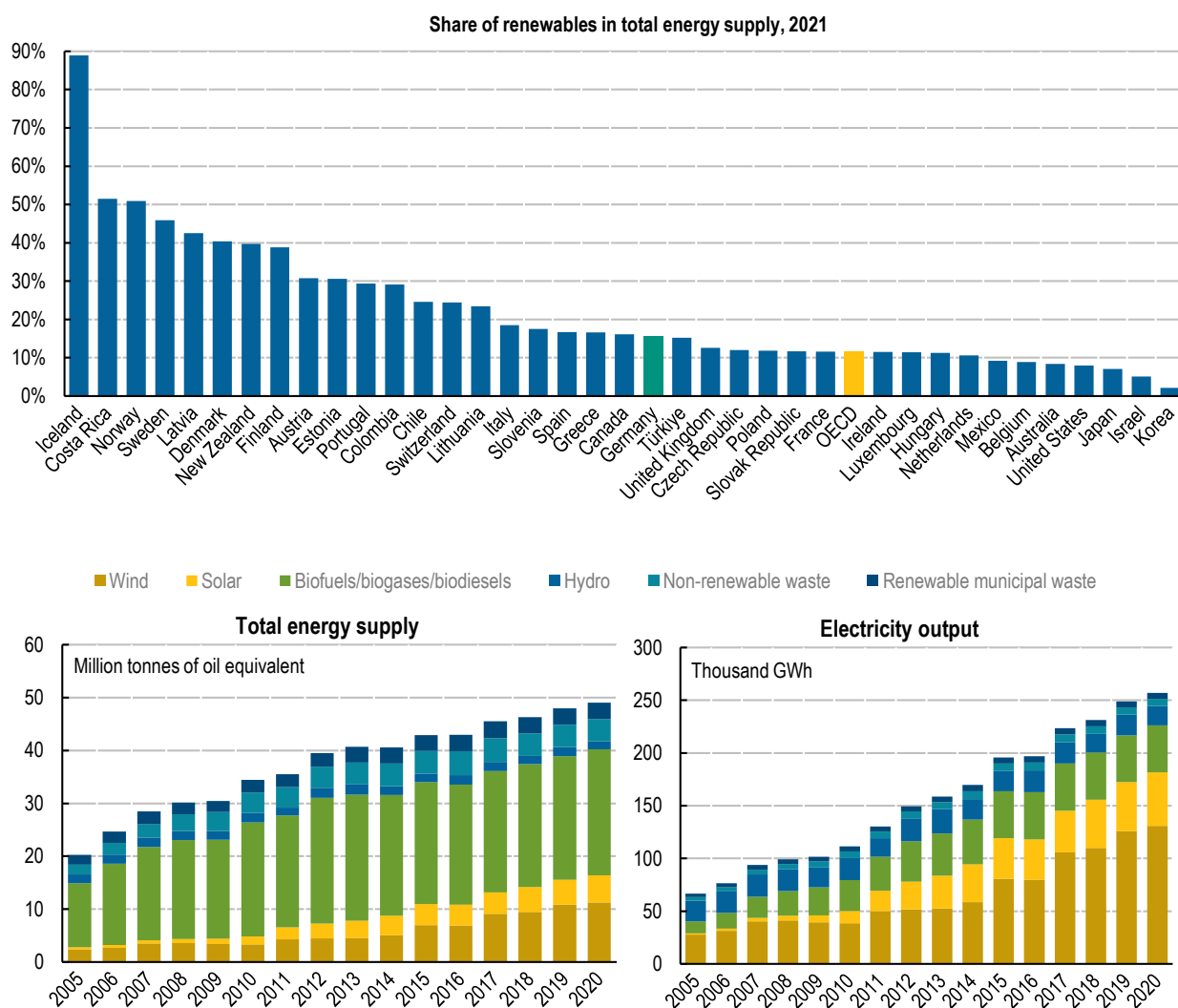
Coal phase-out

Germany has a legally binding goal for coal phase-out by 2038 at the latest. In response to the energy crisis, the federal government agreed on a temporary market return of 10.4 gigawatts of hard coal, lignite and oil-fired reserve capacity. Two lignite power plants of RWE, Germany's biggest power producer, will remain on the market until March 2024, 15 months longer than originally scheduled. This will contribute to increasing the country's CO₂ emissions in the short term. In turn, the federal government brought forward the lignite phase-out in the western coal mining area of the state of North Rhine-Westphalia to 2030 – eight years ahead of the national commitment of 2038. This partly delivers on the coalition treaty's promise to accelerate the phase-out of coal and achieve it "ideally" by 2030. According to government sources, the early anticipation of coal phase-out in this area would contribute to saving 280 million tonnes of CO₂. Coal remains, however, a major source of electricity generation in Germany. The country is one of the world's biggest coal users, with the largest per capita consumption. Germany's coal phase-out also has major social impacts on employment (OECD, forthcoming^[3]).

Expansion of renewables

While the share of renewables in total energy supply remains modest (17%) (Figure 1.6), Germany has achieved remarkable growth in renewable electricity over the past decade; it represented 41% of electricity outputs in 2021 (Figure 1.7). To date, bioenergy still represents the largest part of renewables in total energy supply. Solar energy has been boosted across the country since the early 2010s. Wind energy has nearly tripled since 2010. Germany has the biggest wind onshore capacity in Europe. The total installed capacity was 57 gigawatts (GW) onshore and 7.8 GW offshore in 2022. The federal government aims to double wind onshore capacity to 115 GW and reach a 30 GW offshore wind target in 2030 (Table 1.1). The renewable energy forecasts for 2022-27 are optimistic, projecting major increases in solar photovoltaic and onshore wind (IEA, 2022^[15]).

Figure 1.6. Germany's share of renewables has been growing and is above the OECD average



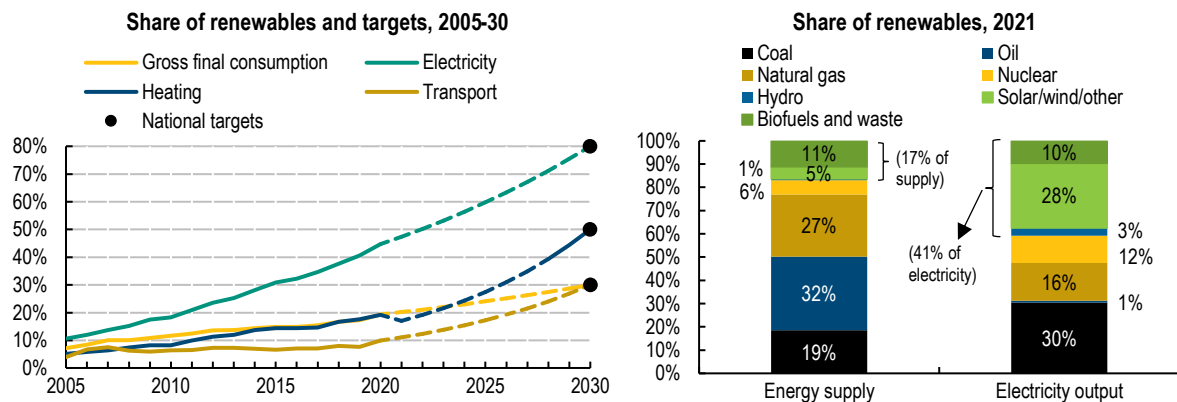
Note: Biofuels/biogas/biodiesels include biogasoline, biodiesels, other liquid biofuels and solid biofuel excluding charcoal, biogas and bio jet kerosene.

Source: IEA (2022), IEA Renewables Information (database).

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The Easter Package 2022 lays out ambitious targets and makes significant changes to the country's regulatory framework. This includes measures to introduce higher auction volumes and accelerate lengthy and complex permitting procedures, a major barrier for onshore wind development. The 2023 Renewable Energy Sources Act (EEG 2023) sets a new legally binding target to increase the share of renewable energy sources to 80% of electricity consumption by 2030 (previously at 65%). In addition, the share of renewables should reach 30% of gross final energy consumption, 50% of heating, and 30% of transport (Figure 1.7). The Federal Ministry for Economic Affairs and Climate Action is working on measures to accelerate the decarbonisation of heating and cooling, aiming to increase the share of carbon-neutral heating to 50% by 2030 (NAPE 2.0).

Figure 1.7. Germany has set ambitious targets for renewables



Note: Data refer to 2021. The breakdown of energy supply excludes heat and electricity trade, but percentages shown reflect ratios calculated on total energy supply. Biofuel and waste include negligible quantities of non-renewable waste.

Source: IEA (2022), *IEA World Energy Statistics and Balances* (database); Eurostat (2023) *Energy database*.

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Table 1.1. New targets and measures for the expansion of solar and wind power

Source	Target for production capacity	Measures
Onshore wind	Current: 57 GW in 2022	Revised law on spatial planning: at least 2% of the country's surface area must be dedicated to onshore wind; to date, 1% of surface area is developed and only 0.5% in use. Specific targets at Länder level: <ul style="list-style-type: none"> 1.4% of respective surface areas by 2027 (0.25% for city states) 1.8-2.2% depending on respective Länder targets must be reached by 2032 (0.5% for city states). New distance rules between wind turbines and to military areas. Streamlined compliance with environmental laws. Financial benefits from wind parks are shared with local communities.
	Target: 115 GW in 2030 Technical feasibility: 165 GW, if 2% of surface areas is used.	
Offshore wind	Current: 7.8 GW in 2022 Targets: > 30 GW in 2030 > 40 GW in 2035 > 70 GW in 2045	Increase in the volumes up for auction. Streamlined environmental assessments and participation process. More rapid clearance of offshore grid connections within spatial development plans.
Solar PV installations	Current: 60 GW in 2021 Target: 215 GW in 2030	Citizen-led energy initiatives are exempt from the tender scheme. Mandatory installation of solar roofs for all new residential buildings in some federal states (e.g. Baden-Württemberg); financial benefits from ground-mounted solar PV are shared with local communities.

Source: Easter Package (2022) and draft laws.

These are ambitious goals. In addition to doubling use of green electricity, Germany must also respond to rising electricity demand due to the ongoing electrification of the transport and building sectors. The development of renewable energy becomes an “overriding matter of public interest” (BMWK, 2022^[16]). This means that renewable energy will be given priority in decisions. In parallel, the federal government will need to address bottlenecks related to the electricity grid, the skills gap and supply chain risks.

Building a climate-neutral electricity grid

Reaching the renewable energy targets will require massive investment in the modernisation and expansion of electricity grids and energy infrastructure. Some EUR 32 billion and EUR 110 billion would be needed by 2030 and 2050, respectively, to expand and modernise Germany’s electricity grid (E.ON, 2020^[17]). Without substantive long-term investment, Germany will face blockages related to overloaded networks that can no longer absorb electricity from renewable energy sources. Grid-stabilising costs could triple from EUR 1.4 billion in 2017 to EUR 4.2 billion per year by 2050 (E.ON, 2020^[17]).

Building a climate-neutral electricity grid is complex, given the large and growing number of small, decentralised power plants and new needs related to e-mobility and climate-friendly heating systems. A spatially more equally distributed deployment of onshore wind power would help ease pressure on the power grid by favouring local usage. Digitalisation (e.g. smart meters) will also play a key role in better managing electricity flows over time and space.

The 2019 Grid Expansion Acceleration Act set targets, including connections to channel energy surpluses from wind power in the north to the major power consumption regions in the west and south. However, progress has been slow, mainly due to complex planning and approval procedures. According to the Federal Network Agency, less than 2 000 kilometres (km) of the planned 12 250 km length of priority grid expansion projects were operational at the third quarter of 2021. The large majority of expansion projects (9 700 km) were still in the planning and approval phase (BMWK, 2022^[16]). Grid expansion raised concerns – among others – over soil damage and related compensation measures for farmers and citizens.

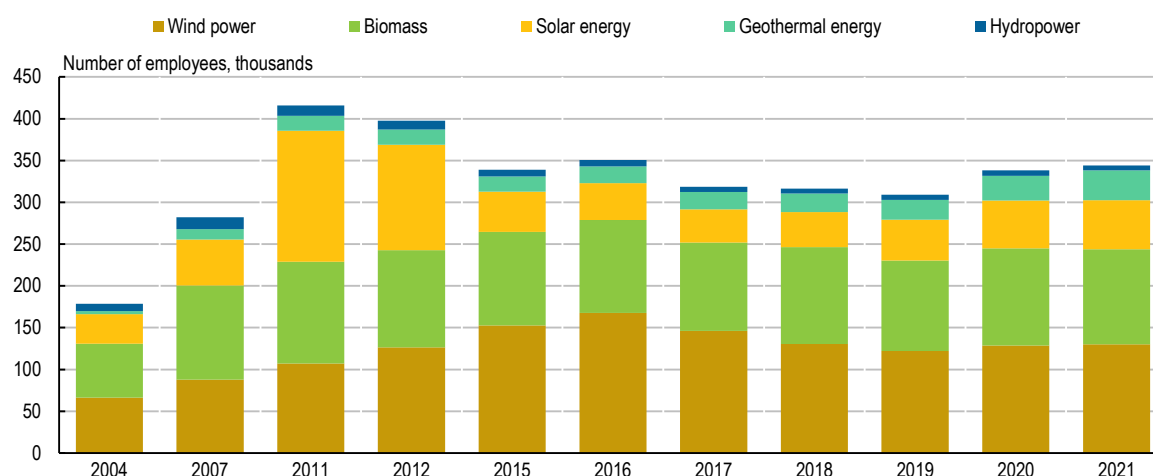
In 2022, the federal government approved new measures to simplify and accelerate planning, while ensuring more equally distributed onshore wind power (Table 1.1). Planning responsibility was transferred from state to federal level to streamline the process and avoid fragmentation of tasks. All new power network planning must contribute to building a climate-neutral grid. Getting citizens on board through increased local participation and community benefits from wind farm development, could help gain local support and reduce the number of legal appeals.

Addressing the skills gap

Germany also needs to urgently address the shortage of skilled labour across the renewable energy sector, which lacks more than 200 000 workers (electricians, heating and air-conditioning technicians, IT specialists) (Monsef and Wendland, 2022^[18]). The number of employees in the renewable energy sector decreased by 17% between 2011-21 (Figure 1.8). Green jobs have mainly been lost in the solar industry due to global competition, notably with Asia. Despite massive public investment in innovation to build the German solar industry, the country has no longer any major solar panel or cell manufacturer. A similar trend occurred in the wind power industry a couple of years later. To date, skilled workers are mainly missing in the building sector to advance climate-friendly solutions.

The trend in green employment was reversed as of 2020 thanks to the Skilled Immigration Act, which entered into force in March 2020. It provides the legal framework to facilitate immigration of skilled workers from non-EU countries, including a fast-track procedure. However, many administrative hurdles remain, such as recognition of qualifications and language requirements.

Figure 1.8. The number of employees in the renewable energy sector is slowly growing again



Notes: data for 2021 is preliminary.

Source: German Environment Agency (2023), Environmental Indicators.

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A new Skilled Immigration Act is under discussion. It aims to further simplify and accelerate administration, while make working and living conditions more attractive to facilitate immigration of skilled workers at a much larger scale. A new points system may open the door to third-country nationals with “good potential” to come to Germany to seek a job. To date, foreigners need a contract offer. An online portal, “Make it in Germany”, provides information for qualified skilled workers from abroad. It is also crucial to expand adult learning opportunities and support the labour market integration of women. The gender divide in green jobs is particularly strong in Germany. Women make up 26.9% of workers in green-task jobs, compared to 28.3% across the OECD (OECD, 2023_[19]).

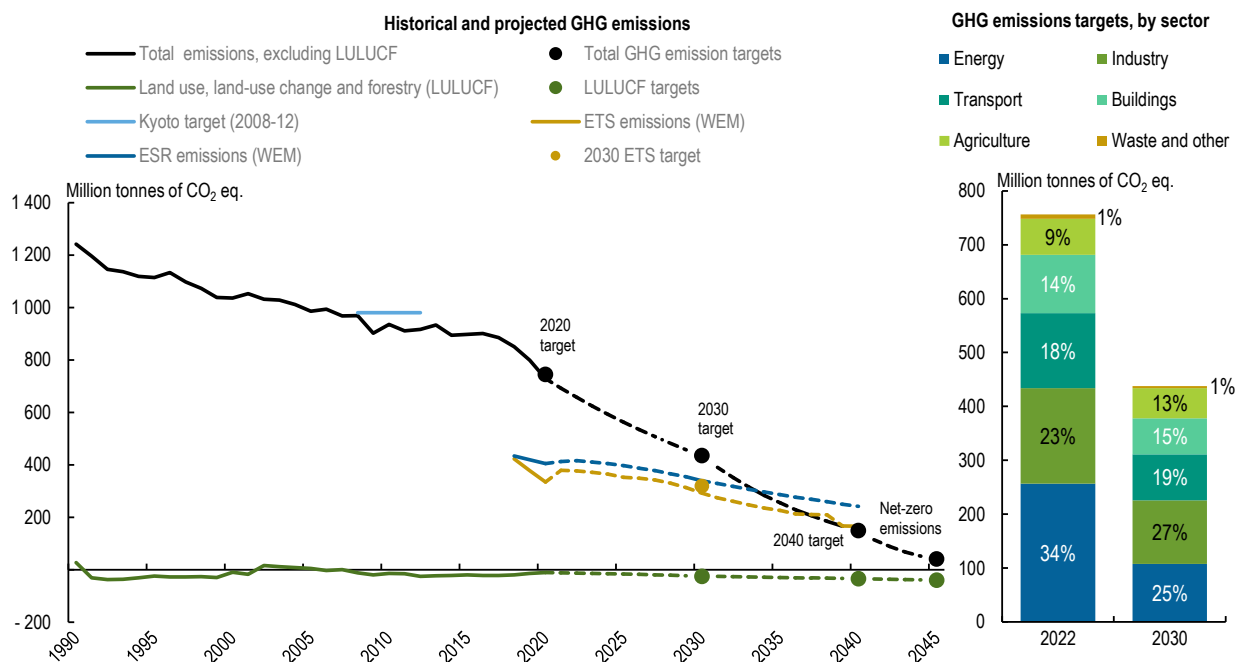
1.1.3. Progress towards net zero

National and international climate targets

Germany has ambitious climate policies, and the federal government has recently further raised these ambitions. The federal government intends to massively expand renewable energy, increase energy efficiency and develop a climate-neutral industrial policy. Germany has set an economy-wide greenhouse gas (GHG) emission reduction target of at least 65% by 2030 and at least 88% by 2040. The country aims to be climate neutral in 2045 (five years earlier than the EU target) and achieve negative GHG emissions after 2050 (Figure 1.9). National targets are enshrined in the Federal Climate Change Act, which was approved in 2019 amended in 2021. In parallel, the federal government also aims to increase the contribution of the land use, land-use change and forestry (LULUCF) sector to reach carbon removals of at least -25 million, -35 million and -40 million tonnes of CO₂-equivalent (Mt CO₂-eq.) by 2030, 2040 and 2045, respectively (Section 2.3.2). Moreover, some Länder have set more ambitious subnational climate goals. For example, the state of Baden-Württemberg aims to become climate neutral in 2040. To that end, it approved a Land-level Climate Protection Act in February 2023, covering mitigation and adaptation efforts.

Germany's climate policy is aligned with EU climate legislation, including the EU Emissions Trading System (ETS), the Effort Sharing Regulation, and transport and land-use legislation. Emissions reduction targets under the EU Effort Sharing Regulation (covering the non-ETS sector) are legally binding. Within the Europe's Fit-for-55 package, its national emissions reduction targets in non-ETS sectors shall be raised from -14% in 2020 to -50% by 2030, compared to 2005 levels.

Figure 1.9. Germany needs to accelerate climate action to reach its 2030 and 2045 climate targets



Note: ESR = effort sharing regulation. ETS = emissions trading system. WEM = with existing measures. Dashed lines represent projections (linear to targets in the case of total emissions and LULUCF).

Sources: EEA (2022), Member States' Greenhouse Gas Emission Projections (database), www.eea.europa.eu/data-and-maps/data/greenhouse-gas-emission-projections-for-8; EEA (2022), European Union Emissions Trading System (EU ETS) data, www.eea.europa.eu/data-and-maps/data/european-union-emissions-trading-scheme-17; OECD (2022), Greenhouse gas emissions by source, OECD Environment Statistics (database); Federal Climate Change Act (2021), GHG annual emission budgets by sector.

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On the international scene, Germany encourages stronger alliances for progress on climate protection. Within its G7 presidency in 2022, the country initiated an international Climate Club to help define common standards for emission measurements and carbon pricing, among other goals (Box 1.4). Moreover, Germany is a major provider of global climate finance, contributing to fulfilling the collective USD 100 billion goal (Section 2.4.3).

Box 1.4. The international Climate Club

Upon Germany's initiative, G7 countries proposed in December 2022 the terms of reference for an open and co-operative international Climate Club. Work will be led by a Task Force, chaired by Germany and Chile, with an interim secretariat assumed in tandem by the OECD and the IEA. The Climate Club is set to be formally launched in 2023. The Climate Club will provide a "high-ambition intergovernmental forum for discussion and serve as an enabling framework for increased co-operation, improved co-ordination and potential collective action" (G7 Germany, 2022^[20]). It advocates for a socially just transition of industries towards climate neutrality. Beyond G7 countries, developing and emerging countries are invited to join the initiative.

The Climate Club is built on three thematic pillars:

- Advancing ambitious and transparent climate change mitigation policies
- Transforming industries
- Boosting international climate co-operation and partnerships.

Initial focus will be placed on the second pillar to unlock potential for the decarbonisation of hard-to-abate industrial sectors and counter the risk of carbon leakage. The Club intends to accelerate work on joint standards, methodologies and strategies for industrial sectors. For example, climate-friendly commodities, such as green steel, could enter the market more quickly and be ramped up globally.

Source: (G7 Germany, 2022^[20]).

Climate governance and finance

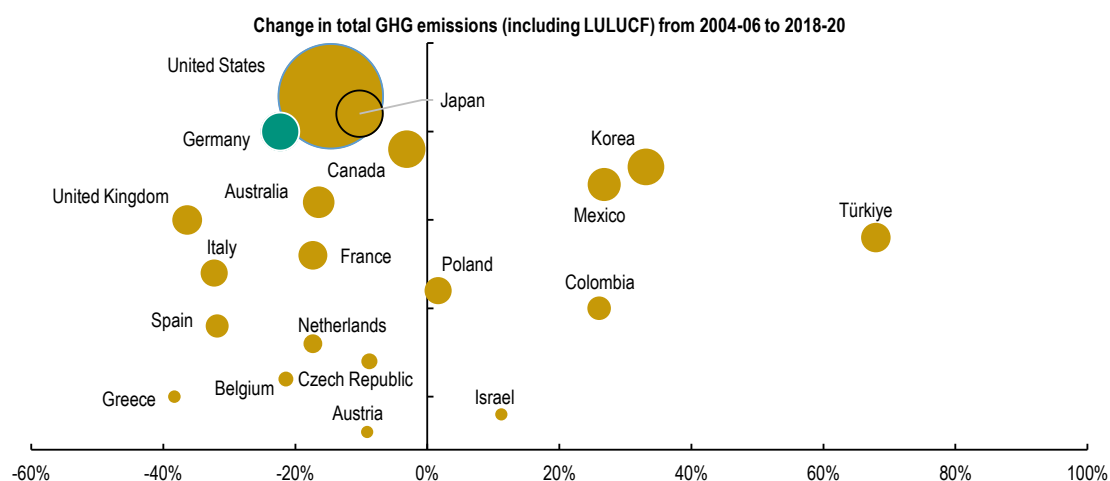
Since end 2021, four key federal ministries have shared the main responsibilities for climate action at the federal level: the Ministry for Economic Affairs and Climate Action (BMWK), the Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), the Foreign Office, and the Ministry for Economic Co-operation and Development (BMZ). Climate mitigation has received increased policy attention through its integration into the BMWK, while climate change adaptation remains a core responsibility of the BMUV. The Federal Foreign Office is responsible for climate change negotiations; and the BMZ manages Germany's global climate finance for emerging and developing countries. However, climate action is mainstreamed in all government sectors and many other ministries and local governments take part in the implementation of climate action in respective work areas. A Climate Cabinet facilitates inter-ministerial co-ordination and monitors the effectiveness, efficiency and target accuracy of new measures. Climate measures are mainly implemented at Länder level. Implementation is also supported by the German Environment Agency (*Umweltbundesamt*), and research institutes. An independent Council of Experts on Climate Change (*Expertenrat für Klimafragen*), created in 2019, assesses annual GHG emission trends and the effectiveness of measures. It also advises the federal government on implementation of the Federal Climate Change Act.

According to the Ministry of Finance, over EUR 80 billion was earmarked for climate action investment under the Climate Action Programme and the economic stimulus package for 2020 and 2021. In 2022, the Energy and Climate Fund was transformed into a new Climate and Transformation Fund (*Klima- und Transformationsfonds, KTF*), with a budget of about EUR 178 billion for 2023-26, including EUR 36 billion for 2023. The fund mainly focuses on the building sector, electric mobility, hydrogen development and energy efficiency. The federal government underlines the need for a specific instrument to respond more flexibly to its climate protection target and finance climate change mitigation efforts. However, this means that climate action is financed through various funding sources (e.g. federal budget, KTF, sector-specific programmes, Länder-level funds, EU funds). Spending efficiency could be raised through better use of spending reviews and policy impact evaluation (OECD, forthcoming^[3]).

Box 1.5. Policy framework for Germany's climate action, 2014-23

- 2014 Climate Action Programme 2020, focusing on its national goal to reduce GHG emissions by at least 40% in 2020 compared to 1990 levels.
- 2016 Climate Action Plan 2050 (*Klimaschutzplan 2050*), including sector-specific mitigation targets.
- 2019 Federal Climate Change Act (*Bundes-Klimaschutzgesetz, KSG*) with legally binding emission goals by 2030 under the EU Effort Sharing Regulation and in line with the Paris Agreement. It introduced so-called immediate action programme (*Sofortprogramme*) and a Council of Experts on Climate Change (*Expertenrat für Klimafragen*).
- 2019 Climate Protection Package 2030 (*Klimaschutzprogramm 2030*) to translate the goals of the Climate Action Plan 2050 into practice; it includes, among other climate policies, a carbon pricing system for transport and heating.
- 2019 Creation of a “Climate Cabinet” (*Klimakabinett*) by the German Chancellery bringing together ministries of the environment, economics, finance, transport, agriculture and the interior.
- 2021 Germany's Federal Constitutional Court rules parts of the Federal Climate Change Act unconstitutional arguing that emission reduction targets “lack sufficient specifications for further emission reductions from 2031 onwards”.
- 2021 German Parliament (*Bundestag*) approves amendment to the Federal Climate Change Act, increasing annual reduction targets per sector from 2023-30 and enshrining annual reduction targets for 2031-40 into law (Box 1.6)
- 2021 Immediate Climate Action Programme for 2022, supported by an additional EUR 8 billion.
- 2023 Approval of EUR 4 billion Federal Action Programme on Nature-Based Solutions for Climate and Biodiversity
- 2023 Federal Climate Change Adaptation Act (under development) (Chapter 2).

Figure 1.10. Germany has decreased emissions but remains among the top OECD emitters



Note: Total GHG emissions including Land Use, Land-Use Change and Forestry (LULUCF), top 20 OECD emitters. Data is expressed as averages of the periods 2004-06 and 2018-20.

Source: OECD (2022), Greenhouse gas emissions by source, OECD Environment Statistics (database).

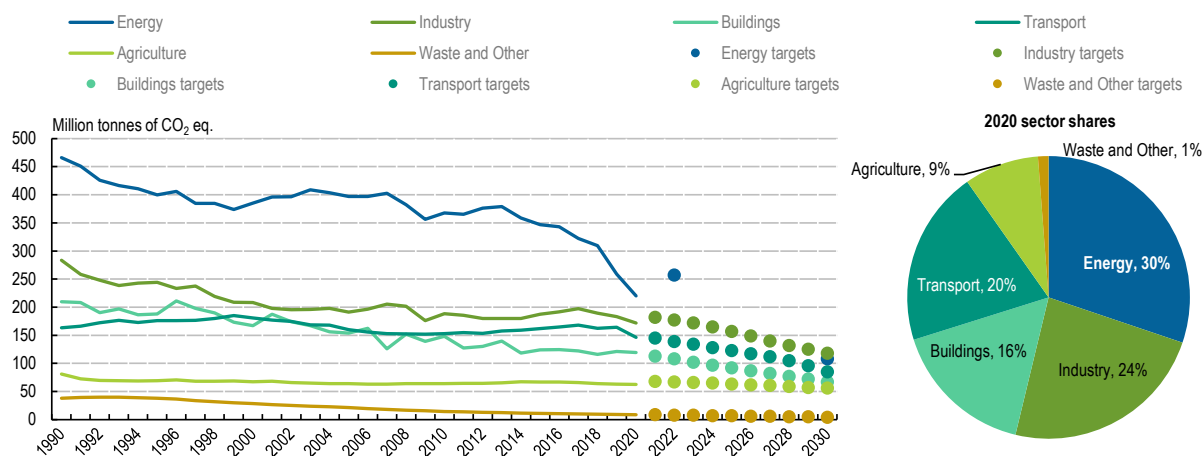
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Mitigation trends and sectoral targets

A historic emitter, Germany produces about 2% of global emissions and is still among the ten largest GHG emitters in the world (Figure 1.10). In 2020, the country managed to reduce its emissions by 41.3% compared to 1990 levels (or 729 Mt CO₂-eq), meeting its 40% target for 2020. This is one of the strongest records of emission reductions in the OECD. However, emission reductions related to the COVID-19 pandemic proved to be only temporary and have quickly been reversed. Moreover, the temporary increase of coal-fired electricity generation will further increase the gap between recorded emissions and targets. The federal government aims to get back on track from 2024 and will need to accelerate new climate measures to achieve its ambitious 2030 targets. To that end, it will need to assess the short- and medium-term impact of energy emergency measures, update GHG projections and develop additional climate measures to fill the gaps on its pathway towards net zero.

Energy industries remain the largest GHG emitter but have managed to halve emissions since 1990 (Figure 1.11). Reductions were due to a shift towards a less carbon-intensive energy mix and gains in energy efficiency. Emissions from transport, the second largest emission source, have increased by about 3% since 2005, accounting for 20% of Germany's GHG emissions in 2020. Road transport remains the primary driver of transport emissions. Emissions from agriculture (9% in 2020) have been relatively stable during the past decade, recording only a slight decrease. Methane from animal husbandry and nitrous oxide from agricultural soils are the main sources of emissions. Livestock represents about half of Germany's agriculture emissions. The building sector has missed its sectoral target for the second time in 2021. About three-quarters of emissions come from residential buildings. Germany developed a long-term renovation strategy in 2020 to accelerate building renovation (Section 1.3.2).

Figure 1.11. Germany is on track to meet its sectoral GHG targets, except transport and buildings



Source: UNFCCC (2022), Inventory submissions.

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Under the EU Effort Sharing Regulation, adopted in 2018, Germany needs to comply with binding annual targets for emissions outside EU emission trading (agriculture, buildings, small industries installation, transport and waste management). This means that if Germany misses these binding targets, it may need to purchase surplus emission rights from other countries. Between 2013 and 2020, Germany missed climate targets in key sectors, notably transport and buildings. To comply with its commitment, Germany had to purchase emission allowances under the EU Effort Sharing legislation. A lack of sector-specific progress will demand acquiring offsets, which will have significant financial consequences (OECD, 2022^[21]).

In addition, the federal government has set up national annual CO₂ emission budgets for six sectors until 2030, along with a monitoring and policy adjustment mechanism (OECD, 2022^[21]) (Box 1.6). Four sectors

(energy, industry, agriculture, waste and other) achieved sector-specific annual reduction targets in 2021; transport and buildings did not meet their respective national annual budgets. The federal government prepared immediate action programmes to correct the trajectories of these two sectors. However, additional measures will be necessary to make faster progress in these two sectors (Sections 1.1.4 and 1.3.2).

Box 1.6. Policies in practice: Germany's annual sectoral emissions targets

The Federal Climate Change Act defines quantified, annual greenhouse gas (GHG) emissions reduction targets for six individual sectors: energy, (small) industry, buildings, transport, agriculture, and waste and others. The targets are set in line with the European GHG reduction plans, following a linear trajectory. The pace of emissions reductions varies by sector, and the amendment of 2021 tightened targets for each sector until 2030 (Table 1.2). Some federal states have also set sector-specific targets at Länder level.

The Federal Climate Change Act introduced a mandatory emissions monitoring mechanism in which sectoral emissions are assessed annually. If a sector fails to meet its annual target, the responsible ministry must prepare an immediate action programme (*Sofortprogramm*), which is assessed by the independent Council of Experts on Climate Change and then presented to the German Parliament. The policy adjustment mechanism aims to ensure that corrective action is taken on time and that all ministries play their part in national climate efforts. However, at a coalition meeting in March 2023, government parties agreed to soften the policy adjustment mechanism of annual sectoral targets. In future, sectoral targets may become less stringent, as long as total annual GHG emission budgets across sectors are being met. This means that lack of progress in one sector can be counterbalanced by strong emission reductions in another sector.

While climate action has been mainstreamed in nearly all policy areas, some sectors face more difficulties to reconcile sectoral objectives with climate targets. A sector-based approach is thus useful to monitor and measure progress towards achieving annual emissions reduction targets at sector level. Sector-specific climate action also contributes to much-needed transformative change with broader environmental benefits. However, harmonised carbon prices could be an even more efficient way to address significant differences in abatement costs across sectors. If Germany sets a cap in its non-ETS sectors in line with its overall target to reduce emissions, the sectoral targets may be less critical because the emission reduction will occur where abatement costs are lowest (OECD, forthcoming^[3]).

Source: OECD (2022), Germany's annual sectoral emissions targets, IPAC Policies in practice.

Table 1.2. Permissible annual emission budgets per sector

Annual emission budgets in millions of tonnes of CO₂-eq

Sector	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Reduction (%)
Energy	280		257								108	-61.4
Industry	186	182	177	172	165	157	149	140	132	125	118	-36.6
Buildings	118	113	108	103	97	92	87	82	77	72	67	-43.2
Transport	150	145	139	134	128	123	117	112	105	96	85	-43.4
Agriculture	70	68	67	66	65	63	62	61	59	57	56	-20.0
Waste and other	9	9	8	8	7	7	6	6	5	5	4	-55.6

Source: Federal government (2021), Federal Climate Change Act.

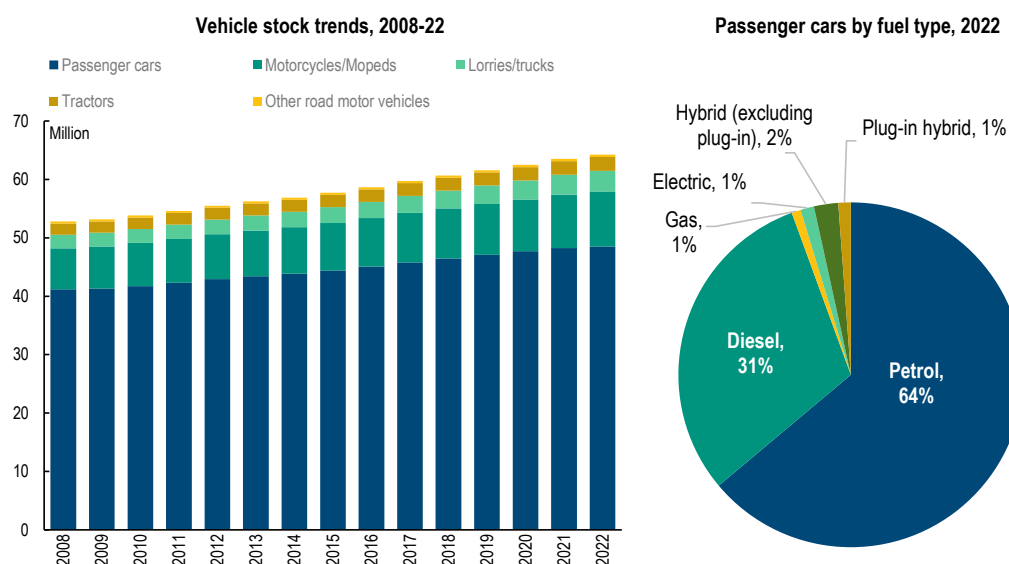
1.1.4. Sustainable mobility

The decarbonisation of Germany's transport sector is not on track. Road transport is responsible for nearly all transport-related emissions. Passenger cars represent the bulk of transport-related emissions at 60%; freight accounts for about one-third. Emission reduction efforts have been counterbalanced by the rising number of cars (Figure 1.12) and more traffic from heavy duty trucks. The sector missed its 2021 CO₂ emission reduction targets by 3 Mt CO₂-eq. The independent Council of Experts on Climate Change judged the proposed immediate action programme to be “insufficient” (ERK, 2022^[11]).

Germany faces gaps both for ambition and implementation. Many opportunities such as broader use of speed limits, tolls for passenger and light duty vehicles, congestion charges in urban areas have not been taken; others, such as increased parking fees, are slowly materialising. A general speed limit of 120 km/h or 130 km/h on federal motorways would reduce emissions by 2.6 and 1.9 MtCO₂-eq. per year, respectively (UBA, 2020^[22]). While electric mobility will play a key role in decarbonising transport, Germany should not aim to replace each petrol- and diesel-fuelled car with an electric vehicle.

Germany will need to take bold action to move from individual policy measures mainly focused on “making cars cleaner” to an integrated mobility strategy for net-zero systems by design (OECD, 2021^[23]). This requires a long-term vision that integrates all transport modes with a view to building synergy. An annual report on sustainable mobility could help track progress on various elements of Germany's transport transformation. The country needs to reduce car dependency by better internalising the social costs of road transportation through road pricing and by providing sustainable alternatives (public transport, cycling infrastructure and walking).

Figure 1.12. The vehicle stock keeps increasing and remains dominated by fossil fuel cars



Source: Destatis (2022), Statistics of motor vehicles and trailers; German Federal Statistical Office.

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Germany has one of the densest road infrastructure networks worldwide. Plans to expand federal motorways (e.g. from six to eight lanes) need to give more attention to environmental concerns. A clear priority to investment in public transport and a shift from new roads to the maintenance and improvement of existing infrastructure would help advance the modal shift (Box 1.7).

Box 1.7. Policies in practice: Strict environmental criteria for new road building in Wales

The government of Wales developed a Sustainable Transport Hierarchy of walking and cycling; public transport; ultra-low emission vehicles; and other private motor vehicles. This guides future investment, giving priority to managing and upgrading existing transport infrastructure.

In line with this approach, the Welsh government has set strict environmental criteria for building roads. According to the Wales Transport Strategy 2021, any new road project should focus on “minimising carbon emissions, not increasing road capacity, not increasing emissions through higher vehicle speeds and not adversely affecting ecologically valuable site” (Welsh Government, 2021^[24]). Consequently, major road building projects have been scrapped over environmental concerns. The Welsh approach is based on a Roads Review, undertaken by an independent panel.

The Roads Review proposes four tests to justify building roads:

- To support modal shift and reduce carbon emissions (prevent increase in demand for private car travel; targeted approaches depending on location).
- To improve safety through small-scale changes (to address specific safety rather than wider road improvements and increases in road capacity. Speed limits should be considered as one of the primary tools for improving safety).
- To adapt to the impacts of climate change (ensure roads can continue to function and contribute meaningfully to modal shift).
- To provide access and connectivity to jobs and centres of economic activity in a way that supports modal shift (new and existing access roads will be necessary to connect new developments, including Freeports, to the existing network).

Source: Welsh Government (2021). National Transport Delivery Plan 2022 to 2027.

Germany is the European country with the longest distances of daily urban travel. On an average day, urban dwellers in Germany travel 19 km, compared to less than 6 km in Greece (Eurostat, 2021^[25]). Less than a third of this daily urban travel is related to work. Urban mobility remains heavily car-dominated representing about 70% of daily travel distances. Local public transport, cycling and walking represent 8%, 6% and 4%, respectively. Urban planning needs to better reflect sustainable mobility priorities by creating functional urban areas that shorten distances between home, work and leisure activities. Integrating land-use planning and promoting densification also play an important role.

Electric mobility

The share of electric vehicles (EVs) is rapidly growing but remains modest in the total vehicle stock. Between 2020 and 2021, EV sales doubled, reaching about 25% of newly purchased vehicles by end 2021. Germany is the largest market in terms of number of EVs sold in Europe. It also offers some of the highest subsidies (IEA, 2022^[26]). The purchase premium mostly benefited companies that decided to renew and modernise their vehicle stock while also gaining tax exemptions. The federal government started scaling back support in 2023 (a maximum of EUR 4 500 instead of EUR 6 000 for the purchase premium). As of September 2023, only private consumers can benefit from the scheme. Support for hybrid vehicles has been abolished. As the electric vehicle market is maturing, it makes economic sense to gradually scale back public support.

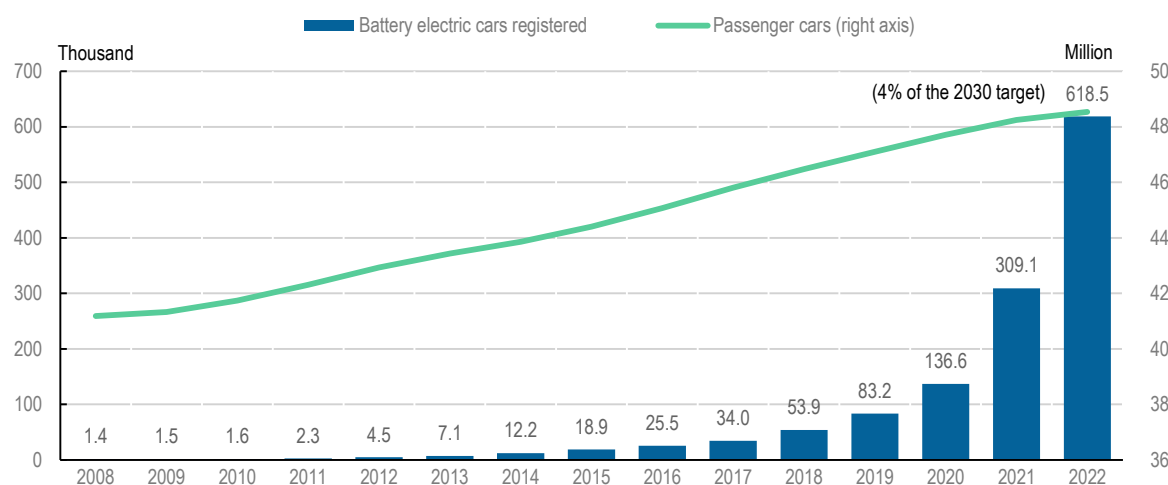
The country surpassed the 1 million EV mark in 2022 (including hybrid vehicles), two years after its 2020 goal. However, the country has still a way to go to reach the federal government’s goal of 15 million EVs and 1 million charging points by 2030. A new master plan (*Ladeinfrastruktur II*) aims to boost the expansion

of charging infrastructure. In May 2022, Germany had about 60 000 charging points, which means it would need to build about 300 new ones per day to reach its target (PwCNetwork, 2022^[27]).

While a more dense and reliable charging infrastructure is a prerequisite for further expansion of electric mobility, the large majority of charging processes take place at home or at work. Policy makers should think more strategically about how to build a coherent, spatially balanced, user-friendly network of fast-charging points across the entire territory. More particularly, low-density areas will require public financial support to establish and maintain public charging stations in areas that lack a commercial market. This requires strong co-ordination between the federal government and federal states.

Many other bottlenecks impede the uptake of EVs: the purchase price is still perceived as high, although EVs are already cheaper than fossil fuel vehicles from a life cycle perspective given the much lower operational costs. In addition, shorter waiting periods, a broader and more attractive product range, as well as improved battery range and charging speed would help convince a larger number of customers to make the switch. Easy access to local charging points at home, at work or in commercial centres are also important factors.

Figure 1.13. The share of electric vehicles has been growing fast in recent years



Source: Statista (2022), (database), www.statista.com; Destatis (2023), Statistics of motor vehicles and trailers (German Statistical Office).

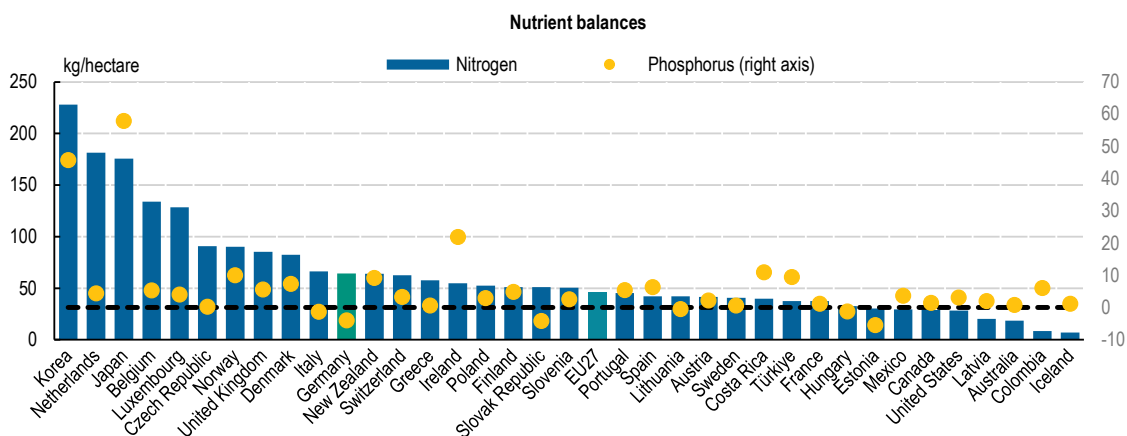
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The transition to electric mobility involves a massive transformation of the German automotive industry with heavy impacts on future employment in the car sector. The number of directly employed people working in the car industry could – in a worst-case scenario – be halved from over 800 000 in 2021 to 400 000 by 2030 (NPM, 2020^[28]). Less pessimistic estimates suggest around 90 000 job losses by 2030 (VDA, 2022^[29]). Moreover, a large number of small and medium-sized supply companies will no longer be needed. Large-scale job losses are inevitable. However, the impact can be softened through early anticipation and strategic workforce planning (e.g. reduced recruitment, vocational training, upskilling and early retirement schemes). In the context of new challenges related to electromobility, digitalisation and autonomous driving, the car industry needs to take an active part in the transformation of transport and proactively shape its future.

1.1.5. Sustainable farming

The environmental performance of agriculture varies largely across regions. High livestock concentration and intensive land use affect agricultural areas in the north-west and south-east. Diffuse agriculture pollution places pressure on surface water and groundwater bodies (Section 1.1.9). More particularly, nitrogen surpluses remain a major problem in some areas. In 2017 and 2020, the federal government revised the fertiliser legislation comprehensively and expects a significant reduction of nitrogen surpluses, as well as of ammonia and nitrous oxide emissions. Within the new EU Common Agricultural Policy (EU CAP) (Box 1.8), an eco-scheme encourages farmers to renounce the use of plant protection (e.g. chemical-synthetic pesticides at plot level). However, it will take several years before the impact of these measures will become visible. In turn, tighter regulations would require enhanced compliance control, which would also be challenging.

Figure 1.14. Nitrogen surpluses remain a major problem in some areas



Note: The gross nutrient balances (N and P) are calculated as the difference between the total quantity of nutrient inputs entering an agricultural system (mainly fertilisers, livestock manure), and the quantity of nutrient outputs leaving the system (uptake of nutrients by crops and grassland); the dashed line represents the zero value of the right axis (phosphorous).

Source: OECD (2023), *Agri-Environmental indicators: Nutrients, Environment Statistics* (database).

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Agriculture represented about 9% of national GHG emissions in 2020 (Section 1.1.3). Emissions have been relatively stable during the past decade. Methane from animal husbandry and nitrous oxide from agricultural soils are the main sources of emissions. In many countries, the agriculture sector is considered to be a “difficult” sector for advancing decarbonisation, especially as agriculture pollution is diffuse and emissions are not easily attributable to individual farmers. It is therefore tricky to measure emissions. As in other countries, direct monitoring of farm-level emissions is not yet practical, but emissions can be estimated indirectly using farm-level data. Therefore, Germany should pursue efforts to improve measuring of farm-level emissions (e.g. estimates of GHG emissions based on farm practices) and consider exploring the introduction of an agricultural emissions pricing mechanism (e.g. New Zealand) (OECD, 2022^[30]). A stronger focus could also be placed on promoting energy-efficient agriculture (Section 1.3.4) and activities for enhanced carbon sequestration in agriculture, including pastures (OECD, 2022^[31]). The sector could thereby not only reduce GHG emissions from agriculture but also unlock its green potential as a carbon sink.

The new EU CAP 2023-27 could support Germany in making its agriculture greener and more sustainable. The federal government is also committed to promoting climate-friendly food systems worldwide by supporting COP27 targets for agriculture and policy dialogue within the Global Forum for Food and Agriculture. However, despite progress, ambition in the agricultural sector will need to be further raised to reverse the loss of species and improve the sector’s climate balance (Section 2.3.1).

Box 1.8. Germany's CAP Strategic Plan

Towards an economically sustainable, greener and fairer CAP

Within the new Common Agricultural Policy (CAP) 2023-27, Germany's CAP Strategic Plan aims to support the transition to a sustainable, resilient and modern agricultural sector. Overall, the new strategic plan has tightened up environmental and climate-focused requirements and increased opportunities for additional payments for farmers willing to deliver voluntary environmental services (e.g. eco-scheme measure for non-productive land; premiums for the cultivation of protein crops; support for conversion to, and/or maintenance of, organic farming).

The strategy is built around three objectives:

- **An economically sustainable and fairer CAP:** continued income support to keep farms viable and raise the attractiveness of the sector (EUR 2.5 billion of basic income support); stronger focus on small and medium-sized farms; specific support for mountainous regions and other disadvantaged areas (EUR 1 billion); support for modernisation (EUR 933 million) and the uptake of agricultural insurance schemes (EUR 177 million).
- **A greener CAP:** farmers' support more strongly conditioned to mandatory climate and environmental practices; introduction of new requirements for drainage in peatlands and wetlands; additional support schemes – at federal and Länder levels – for various practices beneficial for the climate and environment moving beyond the mandatory standards.
- **A socially sustainable CAP:** targeted support for over 800 young farmers; support for investment in line with Länder-specific needs (e.g. investment in processing and marketing capacities in rural areas); creation of more than 20 000 new jobs and support for 40 000 rural businesses.

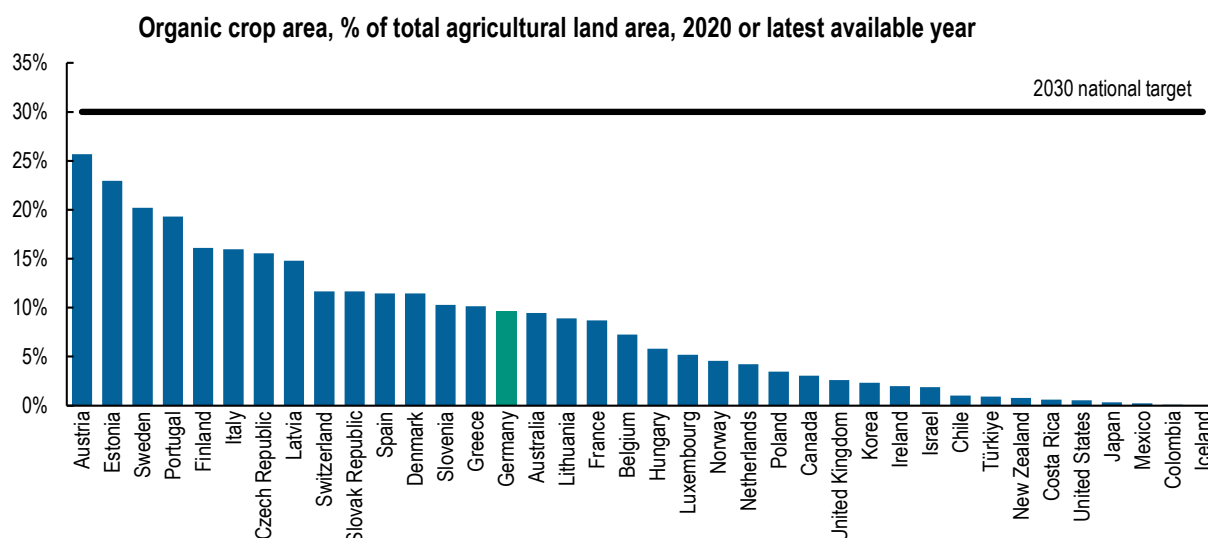
Source: EC (2022), At a glance: Germany's CAP Strategic Plan.

The Federal Ministry of Food and Agriculture (BMEL) focuses on ten key climate action measures to advance the decarbonisation of the agricultural sector. Current programmes notably aim to reduce the use of nitrogen fertilisers, and promote organic farming and carbon sequestration. Within the Investment and Future Programme 2021-24, Germany foresees spending EUR 816 million. This will be allocated to investments in agricultural machinery for precision agriculture, storage capacity of farm manure and small-scale facilities for manure separation, as well as related planning and advisory services.

Germany aims at reducing its livestock over time by supporting farmers to develop alternative income options. This would decrease emissions and free up a considerable amount of agricultural land so far used to produce animal feed. Within the 2022 Climate Action Programme, the federal government also supports the construction of low-emission storage facilities for liquid manure, the retrofitting of storage facility covers and the construction of low-emission livestock stables. Animal welfare has gained increasing public attention (e.g. new mandatory labelling system, discussion on a meat tax and a state-funded long-term animal welfare premium).

Promoting expansion of organic farming is one of the federal government's top climate measures for the agriculture sector. It estimates an emission reduction potential between 1.9-7.5 Mt CO₂-eq. annually.¹ In line with a European-wide trend, organic farming has nearly doubled in the past decade, representing 11% of total agricultural area in 2021 (Figure 1.15). More than 36 000 farms were certified as operating according to organic farming standards. However, Germany would need to significantly accelerate efforts to reach its new target of 30% by 2030 and could also reduce regional disparities. There is scope to increase organic farming and related demand in all agricultural areas.

Figure 1.15. Germany's share of organic farming is increasing but needs to triple to reach the 2030 target



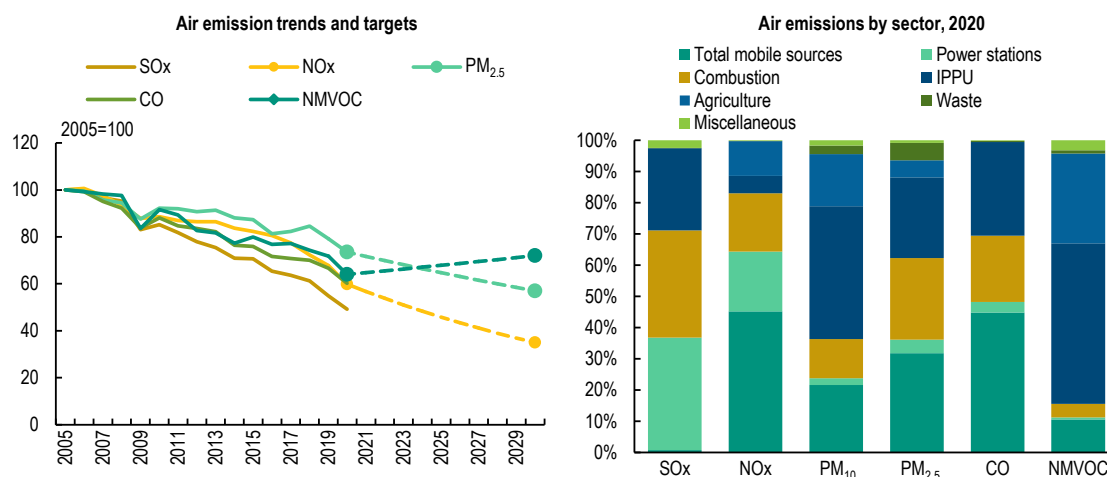
Source: OECD (2023), *Agri-Environmental indicators* (database).

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1.1.6. Atmospheric emissions and air quality

Emissions of air pollutants are trending down and are decoupled from growth of GDP (Figure 1.16). Germany complied with EU emission reduction commitments for all pollutants in 2020 (EC, 2022^[32]). Germany also reached its 2020 Gothenburg Protocol objectives for sulphur dioxide and nitrogen oxides, non-methane volatile organic compounds and ammonia emissions. Emission intensities per unit of GDP and per capita are all lower than the OECD average. The country projects to meet the EU emission reduction commitments for major air pollutants without additional measures, except for ammonia between 2020 and 2029.

Figure 1.16. Air emission reductions are on track overall



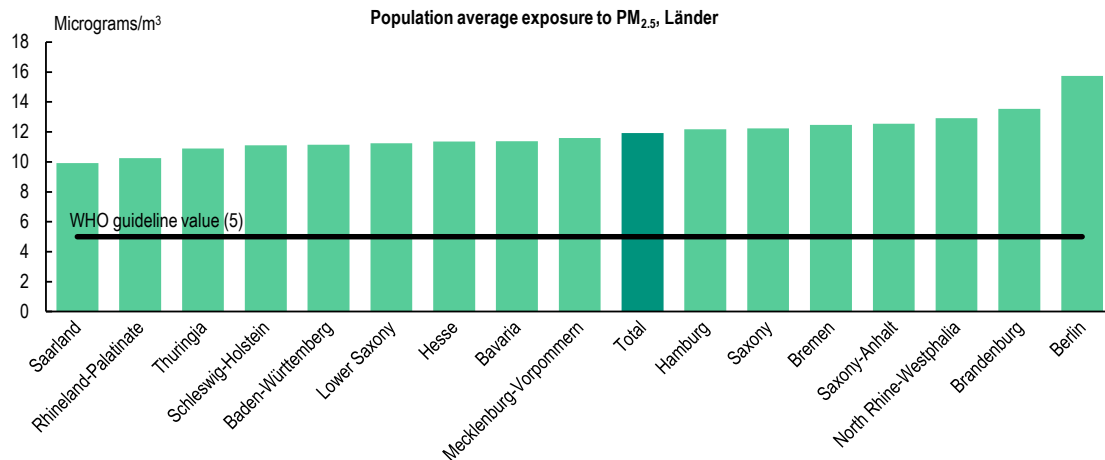
Note: In the left panel, the markers in 2020 represent the 2020-29 targets and the markers in 2030 the 2030 targets, as defined in the European Union Directive 2016/2284. SO_x = sulphur oxides. NO_x = nitrogen oxides. PM = particulate matter. CO = carbon monoxide. NMVOC = non-methane volatile organic compounds. IPPU: Industrial processes and product use.

Source: OECD (2022), *Air Emissions by Source* (database).

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Air pollution is still a major health concern for citizens. In 2020, nearly 29 000 premature deaths were attributable to concentrations of small particulate matter (PM_{2.5}), 10 000 to nitrogen dioxide (NO₂) concentrations and 4 600 to ozone concentrations (EEA, 2022^[33]). Five air quality zones still exceeded the EU limit value for NO₂ in 2020 (EC, 2022^[32]). People in bigger cities are much more exposed to PM_{2.5} than the national average. The tightening of emission values of low emission zones could help reduce air pollution. Ultra-low and zero emission zones have proven to be effective in other countries (Box 1.9). Cities and municipalities need to be empowered to play a leading role in improving air quality. Germany is still far from achieving the global air quality guideline of the World Health Organization for PM_{2.5}.

Figure 1.17. German citizens are unevenly exposed to air pollution



Source: OECD (2022), Air quality and health: Exposure to PM_{2.5} fine particles – countries and regions, *OECD Environment Statistics* (database).

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Box 1.9. Policies in practice: London's congestion charges and low emission zones

London's Congestion Charge zone is one of the largest in the world. It was set up nearly two decades ago to discourage road traffic in central London, improve air quality and raise additional resources for public transport. A low emission zone for heavy goods vehicles was created in 2008. In addition, the city of London introduced the world's first 24-hour ultra-low emission zone (ULEZ) in 2019, covering 4 million people or about a third of the city's population. While traffic congestion in central London remains a challenge, carbon emissions and other air pollutants from transport have been reduced. According to the 2022 six-month assessment report of the expanded ULEZ, a larger share of vehicles in London is cleaner, contributing to London's commitment to becoming a zero-carbon city by 2030. Nearly 94% of vehicles driving in the ULEZ meet the emission standards on an average day. The city of London also recorded a sharp decline in the use of diesel cars driving in the ULEZ, resulting in cleaner air and important health benefits for Londoners. On average, there were 44 000 fewer diesel cars each day, representing a 20% reduction.

Source: OECD (2022), London's congestion charge and its low emission zones, IPAC Policies in practice.

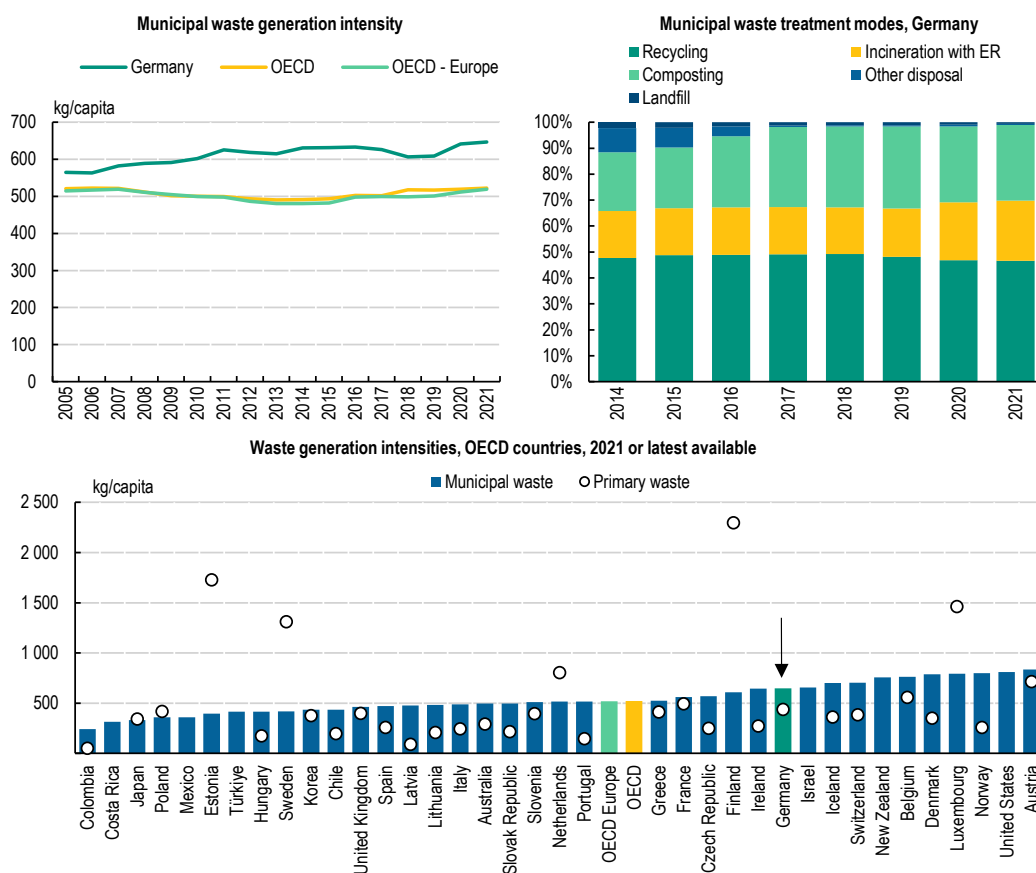
1.1.7. Waste management

Germany is one of the best performing OECD countries in terms of environmentally sound waste management. The country has one of the highest recovery rates and the second highest recycling rate in the OECD area. About two-thirds of municipal waste are recycled or composted. A ban of municipal waste landfilling has been in place since 2005.

Waste is managed at the subnational level. Regional waste management plans are conceived at Länder level and implemented by local authorities. Some Länder and municipalities have set up weight-based pay-as-you-throw pricing models. Waste separation is mandatory, using four different bins in nearly every house (light-weight packaging, paper waste, household waste and biowaste). Germany also has a nationwide deposit system for certain beverage bottles (*Pfandpflicht*).

As in other countries, packaging waste increased in relation to the COVID-19 pandemic. As of 2023, takeaway food and drinks suppliers such as restaurants, canteens, supermarkets or fuel stations must offer their products in reusable packaging, without any extra cost. This measure will greatly contribute to reducing the use of disposable plastic packaging. While being the largest exporter of plastic waste in the European Union, Germany has had a five-point plan since 2018 to reduce plastic waste and support international efforts to reduce marine litter. A broader waste prevention programme is under development.

Figure 1.18. Municipal waste management has greatly improved, but waste levels remain high



Note: values for OECD aggregates are estimates based on linear interpolations. The OECD aggregate excludes Canada.

Top right panel: ER = energy recovery.

Source: OECD (2023), Municipal waste - generation and treatment and Generation of waste by sector, *OECD Environment Statistics* (database).

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Germany made little progress to reduce municipal waste and needs to strengthen waste prevention. On average, a German citizen produced 632 kg of waste in 2020, compared to 505 kg within the OECD Europe area (OECD, 2022^[34]). In total, about 11 million tonnes of food along the food chain, is thrown away every year. Efforts should focus on the whole food supply chain from farm to fork, and notably target retail and household behaviour. Cutting household food waste in half, for example, could save 6 Mt CO₂-eq (BMEL, 2022^[35]).

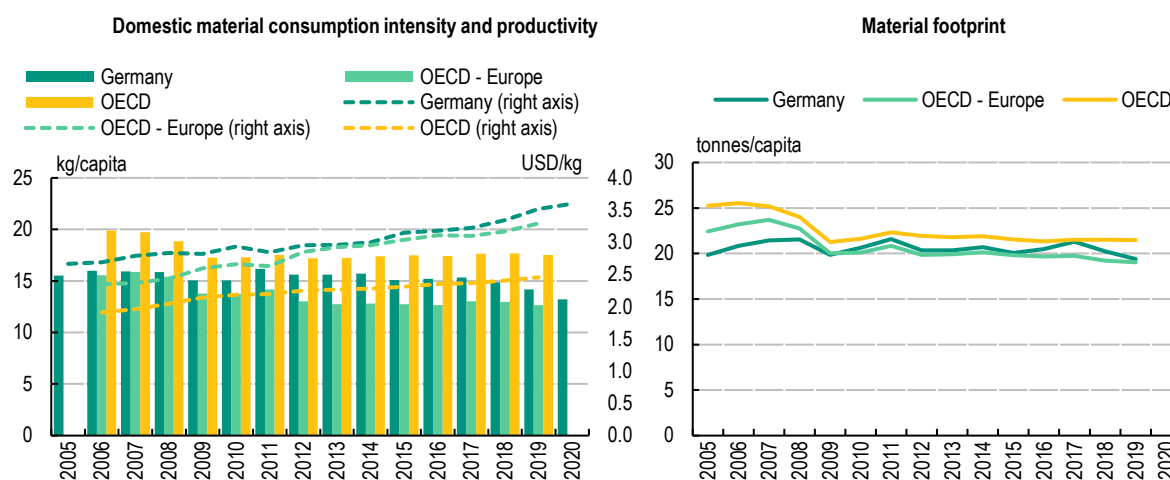
Germany has had a national strategy for food waste reduction since 2019. It aims to halve per capita food waste at retail and consumer levels and reduce food losses along the supply chains by 2030. The federal government has established several dialogue platforms. Discussions on voluntary agreements with business organisations are underway. The public awareness raising campaign “Too Good for the Bin!” has been in place for a decade. Beyond dialogue platforms, binding measures with intermediate targets may be needed.

There are multiple ways of making progress towards behavioural changes. Food and nutritional education are of paramount importance (e.g. the indicative value of best-before dates) and could also help prevent the progression of obesity. More than one in ten children in Germany is obese or overweight, generating considerable health risks. Germany has introduced the Nutri-Score, which indicates the nutritional value of food products through a five-colour nutrition rating system (from A to E). However, the scheme is not yet mandatory.

1.1.8. Towards a more circular economy and sustainable supply chains

The federal government is working on its first comprehensive circular economy strategy, drawing on many existing strategies and programmes that already deal with these issues. Circular use of materials in Germany increased from 11.4% in 2017 to 13.4% in 2020. This is below the EU average of 12.8%; and far behind the Netherlands (30.9%) (EC, 2022^[32]). However, Germany has reduced the resource intensity of its economy and has decoupled domestic material consumption from economic growth. Its material consumption per capita is below the OECD average.

Figure 1.19. Material consumption productivity is growing, but material footprint remains high



Note: In the left panel, domestic material consumption (DMC) refers to the amount of materials directly used in an economy, which refers to the apparent consumption of materials. DMC is computed as domestic extraction used minus exports plus imports; gross domestic product is expressed in 2015 PPP prices; productivity (the lines) are on the secondary axis. In the right panel, material footprint refers to the global allocation of used raw material extracted to meet the final demand of an economy.

Source: OECD (2022), Material Resources, *OECD Environment Statistics* (database).

Box 1.10. Policies in practice: A handbook for businesses operating in mineral supply chains

Business activities amplify global threats related to environmental degradation, which occurs often in the upstream segment of the supply chain. In mineral and metal supply chains, for example, sediments and process chemicals such as mercury may leak from mine workings into surface water or groundwater. Risk-based supply chain due diligence can help enterprises identify, anticipate and react to environmental threats and thus address harms to air, land, water and biodiversity. This is particularly relevant in the context of rising demand for structural minerals and metals in a physically growing world economy as well as for functional materials critical to the energy and digital transition, such as cobalt, copper and lithium. Therefore, companies need to meet relevant requirements in relation to environmental, local labour, corporate governance, criminal or anti-bribery laws, in line with OECD recommendations.

Many stakeholders highlighted the need for hands-on support on how the environment-related recommendations can be implemented in practice. Within the context of 2020 Raw Materials Strategy, BMUV initiated a process to develop a “Handbook on Environmental Due Diligence in Mineral Supply Chains” by the OECD’s Centre for Responsible Business Conduct, in collaboration with the German Environment Agency and the Federal Institute for Geosciences and Natural Resources.² It offers a six-step approach for suppliers:

1. Embed responsible business conduct into policies and management systems.
2. Identify and assess actual and potential adverse impacts associated with the enterprise’s operations, products or services.
3. Cease, prevent and mitigate adverse impacts.
4. Track implementation and results.
5. Communicate how impacts are addressed.
6. Provide for or co-operate in remediation when appropriate.

The handbook also explores opportunities to strengthen circular economy principles in the design, production, distribution, consumption and collection of products. It can be used by all types of businesses along the value chain, from mining to retail, to conduct due diligence on upstream impacts. The handbook will be launched at the 2023 OECD Forum on Responsible Mineral Supply Chains.

Source: (OECD, forthcoming^[36])

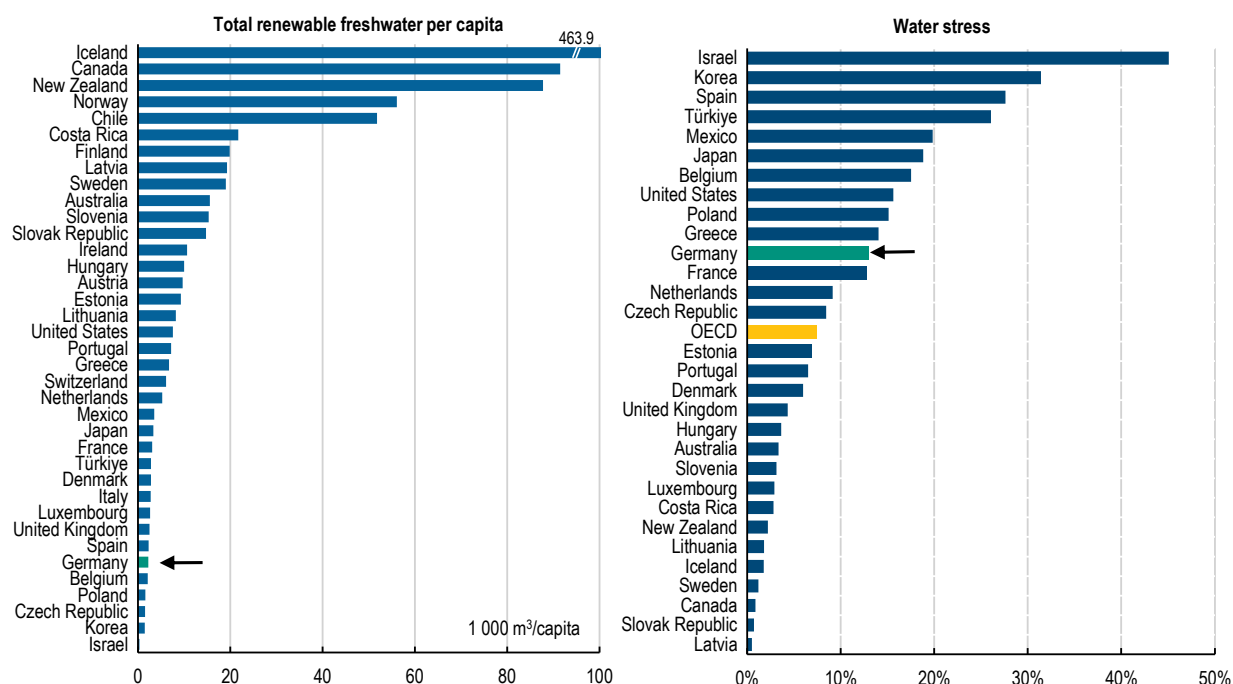
As typical for many other developed economies, material footprint originates in part from outside of Germany. Germany depends heavily on imports of raw materials. Therefore, the new Supply Chain Act is a welcome development away from purely voluntary corporate social responsibility towards binding human rights and environmental obligations for companies (Initiative Lieferkettengesetz, 2021^[37]). As of 2023, companies registered in Germany with more than 3 000 employees must comply with certain obligations for their entire supply chain, including human rights. Child labour, slavery and forced labour are explicitly banned. The law will be expanded to companies with more than 1 000 employees as of 2024. However, it applies only to the company’s own business operations and not to indirect suppliers, which remains a loophole. The law also regulates a few environmental obligations in relation to three international conventions (Persistent Organic Pollutants, Minamata and Basel Conventions), mainly aimed at protecting human health. It could have placed a stronger focus on environmental degradation that impact other countries abroad.

1.1.9. Management of water resources

Water resources

Germany is rich in water resources, counting over 11 000 water bodies (about 8 900 rivers, 700 lakes, 80 coastal waters, 1 300 groundwater basins) (UBA, 2021^[38]). About 2.2% of Germany's surface area is covered by water. Total annual water abstractions as a share of total available renewable water resources decreased from 20.1% in 2001 to 13% in 2016. Water abstraction per capita is well below the OECD Europe average. Nevertheless, Germany is still above the 10% threshold, making it a moderate water-stressed country (Figure 1.20). With the ongoing energy transition, Germany should be able to make additional water savings. Cooling related to electricity generation represented about half of total water abstractions. Public water supply accounted for nearly 20% in 2021. Irrigated agriculture is negligible, representing less than 1% (EC, 2022^[39]).

Figure 1.20. Despite water savings, Germany still faces moderate water stress



Note: Water stress is defined as gross freshwater abstraction as percentage of total renewable freshwater resources; 2020 or latest available year (no earlier than 2014). In the right panel data refer to 2020 or to the latest available year. They include provisional figures and estimates. Freshwater abstraction: for some countries, data refer to water permits and not to actual abstractions.

Source: OECD (2022), Freshwater resources and Freshwater abstractions, *OECD Environment Statistics* (database).

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Similarly, drinking water use declined over the past decades. A German citizen uses an average of 128 litres (L) of drinking water per day in 2022, compared to 147 L in 1990 (Statistisches Bundesamt, 2022^[40]). This is well below the European average of 150 litres (EurEau, 2021^[41]). Germany has generally good water infrastructure with a reliable water supply; water leakage levels are traditionally among the lowest in Europe (DVGW et al., 2020^[42]).

Over two-thirds of drinking water demand is covered by groundwater. However, groundwater abstractions vary considerably between federal states. While public water supply in Bremen, Hamburg, Saarland and

Schleswig-Holstein relies exclusively on groundwater and spring water, the states of Saxony and Thuringia benefit from larger surface water sources (BGR, 2023^[43]). Germany uses water registers to control water abstractions with a view to ensuring sufficient groundwater recharge. Water abstractions are also controlled through a permitting system, which is regularly reviewed, except for small abstractions that are not systematically registered. To date, the impacts of climate change on groundwater levels are small but they are projected to increase by the end of the century, notably in the North and the East (ClimateChangePost, 2023^[44]) (Section 2.1.1).

However, Germany's water sector will be increasingly impacted by climate change. Prolonged dry periods and heatwaves may amplify and trigger seasonal, localised water shortages. They will also lead to dried-up rivers impeding inland waterway transport, receding groundwater levels and soil moisture loss, with major economic impacts. For example, due to the record dry summer in 2019, water levels in the Rhine River sank to their lowest since 1881 (Gustafsson, 2019^[45]). Disruptions in inland waterways heavily impacted the industry and contributed to increased energy prices. Many companies such as BASF, a chemical giant, invest heavily in low-water vessels to ensure adequate supply of raw materials during times of drought.

Box 1.11. Germany's National Water Strategy

Germany's National Water Strategy provides a comprehensive long-term vision for 2050. It aims to raise awareness of the value and sustainable use of water as a resource. The strategy emphasises the need to develop the country's forecast capacity to better understand water needs and water availability to prevent localised water shortages and overuse in the future. As water is mostly managed at the Länder level, the strategy provides guidance and good practice examples with a view to developing uniform decision-making criteria and standards. Within the broader European context, the strategy sets goals for action and measures around four priorities:

- Prevent water scarcity and conflicts of use
- Adapt water infrastructure to climate change
- Make water cleaner and healthier
- Create a broader base to finance restructuring of the water sector.

The strategy draws on a two-year nationwide water dialogue, which is seen as exemplary. It gathered information from a broad range of stakeholders – public, private and civil society, including a council of randomly selected citizens from different regions. This also contributed to laying the grounds for implementation at all governance levels and across different sectors (e.g. agriculture, transport, water industry, research). The strategy was approved in March 2023.

Source: National Water Strategy, Federal Environment Ministry Draft Summary (2022).

In response to these challenges, Germany's National Water Strategy develops a comprehensive vision for 2050 (Box 1.11). Modernising the water sector and adapting to climate change will require large investments. The National Water Strategy proposes an Immediate Action Plan to invest EUR 1 billion over the next ten years for water development and adaptation of the water sector to climate change (BMU, 2021^[46]). Germany will also need to invest heavily in flood prevention measures. Nature-based solutions (NbS) could play a key role in building natural water retention features by increasing the absorption capacity of land close to water bodies (Section 2.3.3).

Water quality

Drinking water quality is good to very good depending on location. It is strictly monitored by regional and local public health authorities. Despite excellent tap water quality, a large number of Germans have the cultural habit to privilege bottled water. A second amendment of the Water Resources Act entered into force in January 2023. It aims to increase the number of drinking fountains in public spaces such as parks, shopping malls and pedestrian areas, and thereby protect urban citizens from the effects of heat waves. The “Trinkwasser unterwegs” app provides geolocalised information on how to find drinking fountains. Universal access to safe drinking water and sanitation has been guaranteed for a long time.

Nonetheless, water quality remains a serious concern for Germany. The Baltic Sea and North Sea face acute problems with eutrophication. While many water resources in Europe are under pressure from pollution and overuse, the situation is particularly challenging in Germany. Only 8.1% of all surface water bodies in the country reach “good ecological status” in line with the EU Water Framework Directive (WFD). Many German water bodies failed to meet environmental objectives in 2021. They would require significant improvement to meet 2027 targets under the third set of River Basin Management Plans (2022-27) (EC, 2022^[39]).

Moreover, no single surface water body in Germany achieved good chemical status. This can be explained by persistently high levels of nutrients, primarily phosphates, as well as contamination with mercury, notably in the Elbe River (Federal Government, 2021^[5]). However, a more detailed analysis is necessary to closely monitor progress in basins that are not formally compliant under the WFD. Germany also plays a major role in the management of transboundary rivers in Europe (Danube, Elbe, Rhine). Cross-border co-operation needs to be further enhanced to reduce pollution and ensure sustainable use of water resources across borders.

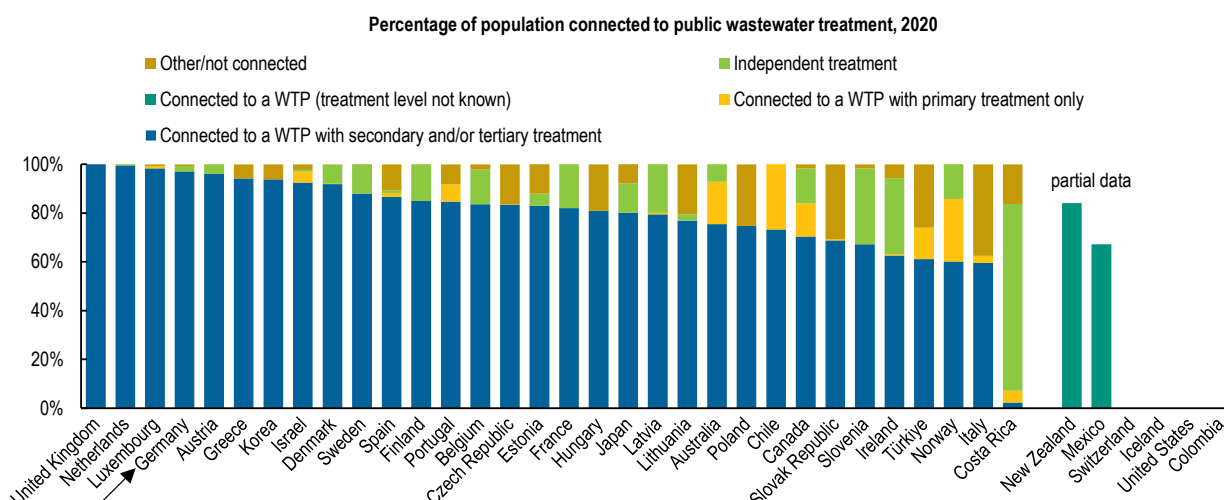
Groundwater pollution due to diffuse agriculture pollution remains a major challenge. The federal government is not on track to achieve its target of a maximum nitrate concentration of 50 mg/L at every groundwater monitoring point by 2030. The recent revisions of fertiliser application legislation in 2017 and 2020 intend to address damaging effects of nutrient inputs. However, it will take several years before the impacts may become visible as the nitrate value in groundwater can only be reduced slowly due to hydrological conditions. Therefore, Germany needs to strengthen efforts to adequately monitor and address groundwater pollution, particularly in intensive farming areas. Its move towards promoting organic farming and reducing livestock quantities (Section 1.1.5) goes in the right direction and will help counteract nutrient pollution. Germany still has a way to go to fully meet its obligations under the WFD and the EU Nitrates Directive. The promotion of NbS has great potential to make progress in this area (Section 2.3.3), alongside economic incentives to further reduce the use of fertilisers.

Wastewater treatment

Germany is one of the best performing OECD countries when it comes to wastewater treatment (Figure 1.21). The country has nearly universal tertiary (“advanced”) treatment. Only 3% of the population does not benefit from a connection and 2% has independent treatment systems. Sewage water represented about half of treated wastewater. Germany complies with the EU Directive on Urban Wastewater Treatment (EC, 2022^[39]). The revised directive is under discussion with a view to introducing new, tighter rules on treating urban wastewater. It provides an opportunity for Germany to advance its transition towards a more circular economy in the wastewater sector, including a better application of the polluter pays principle. Among others, this includes integrated planning obligations to better handle heavy rain, enlarging the scope to cover small cities, stricter thresholds for removing nutrients, additional treatment for micropollutants and health parameters to monitor pandemics (EC, 2022^[39]). These measures are all relevant to help Germany reduce harmful pollution and thus improve its water quality.

The number of accidents involving water-hazardous substances continued to decrease. However, about 2 000 accidents were recorded in 2021 and an estimated 1.4 million L of polluted water leaked causing permanent damage to the environment. This is less than half of the amount recorded in 2020 (3 million L) (Statistisches Bundesamt, 2022^[47]). Moreover, nearly a third of water treatment systems for water-hazardous substances inspected recorded some type of deficiencies, including 10% with significant problems, suggesting a need for enhanced pollution control.

Figure 1.21. Germany's wastewater treatment is excellent in international comparison



Note: "Other" includes connected without treatment; WTP = wastewater treatment plant

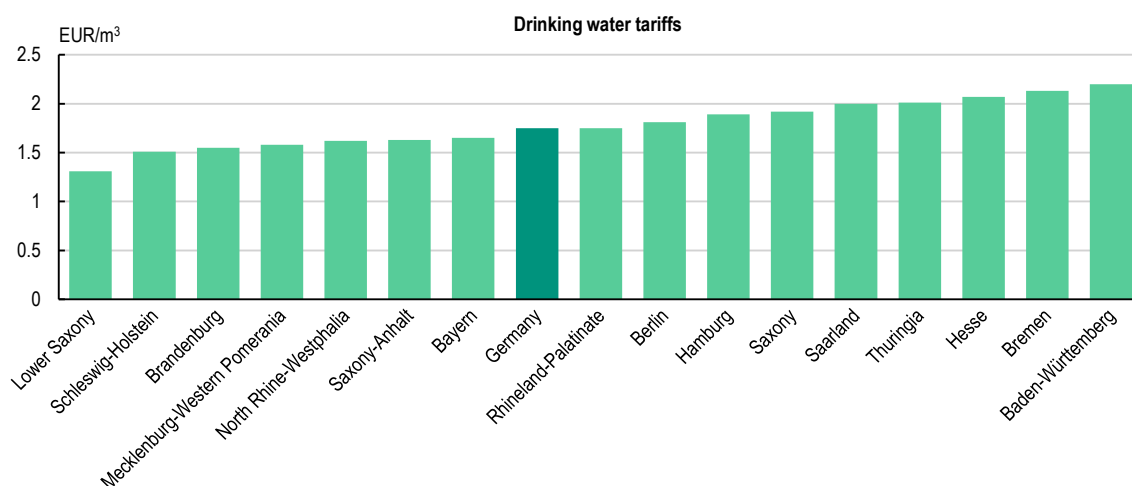
Source: OECD (2022), Wastewater Treatment, *OECD Environment Statistics* (database).

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Water pricing

Water is managed at the local level by public and private operators. Water tariffs are levied at subnational level and represent usually a rather minor share of household income. The cities of Stuttgart, Munich, Frankfurt and Cologne are among EU cities with the most expensive water tariffs (EUR 3 or more per cubic metre) (Water News Europe, 2021^[48]). The Local Rates Act and federal acts provide the framework for the calculation of tariffs, ensuring full cost coverage, which means that water tariffs include all actual costs incurred to companies, including capital costs (EurEau, 2021^[41]). Therefore, water tariffs vary largely across Germany (Figure 1.22).

Figure 1.22. There are large regional disparities in drinking water tariffs



Note: Data refer to 1 January 2019. Charge by cubic metres and basic charge, including value added tax. The charges are weighted by the number of inhabitants connected on 30 June 2016. The consumption-based charge must include all partial charges levied on final consumers such as water withdrawal charge, depreciation, investment contribution and other consumption-related charges.

Source: Destatis (2022), Environment and Environmental Economic Accounting data; German Federal Statistical Office.

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Thirteen Länder have introduced a Water Cent as a charge for water abstraction from surface water and groundwater. Raised revenue is mainly used to encourage water savings and compensate farmers for reducing the use of fertilisers and pesticides. Discussions are now underway to increase the amount of the Water Cent (e.g. 8 cent water charge proposal in Bayern, which has not yet introduced such a charge) and use some of the revenue for flood prevention measures (EEA, 2021^[49]). Moreover, the federal government intends to restructure wastewater charges to create stronger incentives for reducing water pollution from municipal and industrial wastewater (BMU, 2021^[46]). This would further enhance more sustainable use of water.

1.2. Environmental governance and management

1.2.1. Institutional framework for environmental governance

Germany has a sophisticated, well-developed institutional system that ensures vertical and horizontal co-ordination. German governance, which is based on federalism, aims to ensure that social and political issues are addressed by the lowest level of government possible. In practice, there is still room for improvement at various levels. This is especially the case to reduce administrative silos and encourage a more pragmatic and flexible application of shared responsibilities between different governance levels and joint funding mechanisms. Spontaneous, informal co-operation and information exchange could be further encouraged.

As a member of the European Union, Germany has a large number of environmental and climate policies that fall under EU legislation. Drawing on Germany's leadership in Europe, it has contributed to shaping new EU policy (e.g. European Green Deal, Fit-for-55 package, REPowerEU, EU CAP³). At the same time, Germany has benefited from more environmentally rigorous EU directives. Implementation of environmental policies is mainly managed by the 16 Länder within Germany's federal system. The German Environment Agency provides a comprehensive guide to Germany's environmental administration (UBA, 2019^[50]), covering instruments, administration and compliance assurance.

Central government and horizontal co-ordination

Despite recent changes to Germany's climate governance (Section 1.1.3), the BMUV remains the institutional backbone for environmental issues at the federal level. Its work is supported by specialised agencies, namely the German Environment Agency, the Federal Agency for Nature Conservation (*Bundesamt für Naturschutz*), the Federal Office for Radiation Protection (*Bundesamt für Strahlenschutz*) and the Federal Office for the Regulation of Nuclear Waste Management (*Bundesamt für kerntechnische Entsorgungssicherheit*), as well as a growing number of independent expert committees.

Environmental issues are largely mainstreamed across sectoral ministries. Inter-ministerial co-ordination is well developed. When designing a new policy or programme, a lead ministry must consult with other relevant ministries, as well as with local authorities at Länder level if they are involved in the implementation of proposed measures. However, the *Ressort* principle places the lead ministry in a powerful position, as it has the direct right of initiative. Ministries sometimes face conflicting interests between sectoral priorities, and climate and environmental goals. While consultations always take place, they also need to have a meaningful impact on the design of new policies.

Local government and vertical co-ordination

Germany applies a three-tiered system of government: the national level (*Bund – Federation*), the Länder and a two-tiered system of local government comprising counties (*Kreise*), and cities and municipalities (*Städte* and *Gemeinden*). The administration structure of the federal level is generally mirrored at Länder level (Land-specific Ministry of Environment assisted by specialised technical agencies). Länder have the right to create their own subnational laws if the Basic Law does not confer legislative powers to the federal level (Basic Law, Art. 70). In some cases, subnational laws can be more stringent than national law. A biennial Conference of German Environmental Ministers brings together environment ministers of the Länder with the federal level to facilitate co-ordination, also through joint federal-Länder working groups.

In general, the federal level sets the policy framework while the Länder level is tasked with implementation. Many federal policies and programmes are implemented at Länder level. This often leads, however, to varying results in terms of speed and outcomes. The federal government should systematically ensure that federal laws enable over-performance. It could also further develop mechanisms that oblige poor performers at subnational level to move faster. In this respect, it could take inspiration from the onshore wind sector, whose binding area targets must be implemented in all federal states (Wind-on-Land Law).

Local authorities are best placed to advance local policy issues. However, federal laws tend to place a heavy administrative burden on local administrations, which sometimes lack capacity. For example, cities and municipalities should be able to create bicycle lanes and set local speed limits more easily. They also need more flexibility in public procurement and approval processes, as well as sufficient funds for public investments (Dettling, 2022^[51]). Local financial autonomy has been shrinking due to increased social expenditure, despite federal support. The Congress of Local and Regional Authorities of the Council of Europe called on German authorities to “provide local authorities with adequate financial means that allowed them discretion in how to spend the funding” (Council of Europe, 2022^[52]). The taxation power of local authorities could be reformed.

1.2.2. Regulatory framework for environmental management

The regulatory framework for environmental management has been reviewed in previous OECD Environmental Performance Reviews in 1993, 2001 and 2012 (OECD, 2012^[53]). The following section focuses therefore only on current policy challenges.

Overall, Germany has a solid regulatory framework for environmental management. Environmental law is generally strictly enforced. The country transcribed key European laws, such as EU directives on

environmental impact assessment (EIA) or strategic environmental assessment (SEA) into national law (e.g. Environmental Impact Assessment Act – *Umweltverträglichkeitsprüfungsgesetz, UVPG*). As part of the permitting process for major projects, a project developer must conduct an EIA on direct and indirect environmental impacts. In contrast to many other OECD countries, Germany does not have any legal obligation to report and analyse the outcomes of EIAs. Adequate staffing of licensing agencies and more streamlined procedures remain key challenges. Moreover, Germany made progress in implementing the INSPIRE Directive, which aims at developing a European spatial data infrastructure.⁴

Within Germany's federal system, there is no principal environmental regulator, except for nuclear energy (BMUV). Compliance promotion, monitoring and enforcement is decentralised at Länder level. Consequently, information is scattered across various authorities and agencies at all levels. Germany has no centrally managed information on compliance handling or environmental offences. The German Environment Agency compiles some information on environmental crime (UBA, 2016^[54]), but reporting could become more systematic and regular. Public access to information on compliance monitoring and enforcement could be improved through a more centralised information system. This would provide better federal oversight and allow citizens to play a more active role in compliance monitoring.

Permitting

The federal government aims to develop a comprehensive policy package to accelerate planning and approval procedures to enable the massive deployment of renewable energy projects. This also requires better planning capacity in municipalities. In line with a European Council regulation, which provides a temporary framework, renewable energy projects in Germany will benefit from a “simplified assessment for a number of environmental obligations” (EU, 2022^[55]). This shall considerably shorten delays and reduce the administrative burden. For example, the permit-granting process for solar energy equipment should not exceed three months. The installation of heat pumps should be possible within one month, and within three months for larger ground source heat pumps.

While faster and less cumbersome permitting processes are urgently needed, biodiversity considerations should not be overlooked. As elsewhere, it has proven difficult to reconcile bird protection and wind power. The federal government defined a nationwide list of collision-prone breeding bird species with a view to accelerating risk assessments in the permitting process. On the one hand, the government aims to streamline and harmonise processes across 16 Länder and provide legal certainty to wind farm developers. On the other, it intends to secure ecological protection standards required by EU law. Training to ensure consistent application and adequate staffing within local administrations are also needed.

The overriding “public interest” principle should not be used as a pretext to weaken environmental impact assessment, which must remain an essential part of planning. Spatial planning for transport infrastructure and other major facilities requires an integrated analysis of current and potential environmentally harmful impacts. Climate and biodiversity considerations should be addressed coherently. Enhanced dialogue could help reduce the number of lawsuits opposing the partisans of renewable energy and the defenders of biodiversity.

The impact of accelerated permitting processes, including cumulative environmental effects, should also be carefully analysed through *ex post* analysis. Findings could be systematically shared and inform planning to facilitate mutual learning across the 16 Länder. Acknowledging the relationship between species protection and climate protection in the transport sector, the federal government intends to adopt key points for standardisation in species protection in the rail sector. Ultimately, there is no silver bullet for reconciling renewable energy expansion and biodiversity protection. Energy conservation and efficiency are an important part of the equation. Consumption patterns will need to change. Reducing energy consumption will be necessary to achieve an energy transition that is compatible with nature and society (Trommetter, 2018^[56]).

1.2.3. Green digital transition

Germany ranked in position 13 of 27 EU member countries of the 2022 Digital Economy and Society Index (EC, 2022^[57]). The COVID-19 pandemic exposed weak digital capacities as teachers and households lacked basic IT capacity to switch to remote classes. Meanwhile, health authorities relied on fax machines to transmit COVID-19 infection rates. Accelerating Germany's digitalisation consequently became a key priority of the German Recovery and Resilience Plan (Section 1.3.1); more than half of all activities focus on digitalisation. The federal government adopted a comprehensive digital strategy in 2022 involving all ministries. It intends to introduce mandatory common norms and IT standards for public online services to improve synergy and better linkages. Digitalised public administration will also play a key role in accelerating permitting procedures.

Overall, Germany's green and digital transitions have great potential to reinforce each other. Several pilot projects aim to develop digital applications, including geographic information systems related to environmental protection. Germany is working on a Digital Product Passport that could become a key tool to enhance the traceability of products and their components. An artificial intelligence (AI) lighthouse project is dedicated to the digitalisation in agriculture to support sustainable farming. In 2021, it started the use of AI in agriculture, food chain, health nutrition and rural areas (OECD, 2022^[31]).

The Digital Access Act (*Onlinezugangsgesetz*) entails new duties, requirements and digitalised processes. Since the end of 2022, federal state and subnational authorities have had to provide essential information services on line. However, some municipalities will still need to gear up to fulfil this new requirement. Germany has excellent information sources on environmental and climate but they are scattered across ministries, subnational authorities, specialised agencies, research institutes and businesses. The information gateway under development – *Umwelt.info* – offers a great opportunity to bring together the wealth of knowledge and data in a single place while orienting users to relevant information sources.

1.2.4. Environmental democracy

Germany's youth has been a driving force in advancing public climate action. Most prominently, the *Fridays for Future*, a youth-led climate strike movement launched in 2018, has played a prominent role in raising public awareness on the climate crisis. Their claim for more intergenerational justice led to the amendment of the Federal Climate Change Act in 2021 with tightened climate regulations following a ruling of the Federal Constitutional Court. Despite the COVID-19 pandemic, climate and environmental protection remained among the top priorities identified by young Germans in a youth survey (BMUV, 2022^[11]). Most young people are convinced that a joint effort can help combat climate change. More recently, a minority of climate activists became more radicalised, and the term "Climate Terrorists" (*Klimaterroristen*) became more common in public debate. In 2022, a jury chose *Klimaterroristen* as Germany's "non-word of the year", a choice meant to criticise how use of the term tried to discredit the climate action movement.

The importance of climate change is increasingly recognised across different social groups. However, a general perception still prevails that climate change will mainly affect the Global South, and not necessarily Germany, at least not immediately. The flood disaster in 2021 had an eye-opening effect for many Germans and contributed to increasing wider acceptance for stronger climate action. This type of extreme climate event recalls the urgency of preventing future natural disasters (Section 2.1.2).

Nonetheless, the public may hold more progressive and climate-friendly views about climate action than politicians and businesses. For example, 60% of Germans supported a general speed limit of 130 km/h on German motorways (ARD, 2021^[58]). About 66% of Germans believe that "they are more concerned about the climate emergency than their government" and 63% are "in favour of stricter government measures that impose changes on people's behaviour" (EIB, 2021^[59]).

1.3. Towards green growth

1.3.1. Green elements in Germany's COVID-19 recovery package

Germany was among the first countries to present a comprehensive, national recovery package in June 2020 (EUR 130 billion). In April 2021, the domestic plan was transformed into the German Recovery and Resilience Plan (GRRP, 2021-26). It has a budget of EUR 140 billion (4% of GDP), including grants worth EUR 25.6 billion from the EU Recovery and Resilience Facility. With the plan's extension related to adoption of the new REPowerEU chapter, scheduled for 2023, Germany should benefit from an additional EUR 4.7 billion. The EU component is based on a six-year plan, including 40 measures, to be implemented until August 2026; some 135 000 jobs are estimated to be created. About 42% of EU-funded measures support Germany's climate objectives, while about half of all measures will foster the country's digital transition. The green share of Germany's domestic package was estimated to be much lower at 21% (Wuppertal Institut, 2021^[60]). The EU financing focuses on decarbonisation and development of hydrogen (EUR 3.3 billion), eco-friendly mobility (EUR 5.4 billion) and renovation and construction (EUR 2.6 billion). In line with good practices, the plan mainly supports implementation of many existing measures.

An *ex ante* analysis of the German recovery package indicates an overall positive effect of climate-focused components of the recovery plan. The federal government did not weaken any major environmental and social regulations during the COVID-19 crisis. On the contrary, it advanced negotiations with companies on the coal phase-out. Recovery support includes little direct support for fossil fuel industries. A general purchase premium for new cars, which was proposed by the automotive industry, did not go through.

However, the plan also includes some ambiguous measures, notably in the transport sector; for example, public support for plug-in hybrid vehicles and trucks with internal combustion engines (Table 1.3). While the GRRP is clearly future-oriented with a strong emphasis on hydrogen, it pays relatively little attention to existing technologies that could make a difference in the short term, notably energy efficiency measures in the building sector. Key environmental dimensions such as biodiversity and climate adaptation are largely neglected, except in a major sustainable forestry management programme (EUR 700 million).

Table 1.3. Impact of key measures of Germany's recovery

Sector	Key measures	Budget (EUR)
Energy	Lowering renewable energy surcharge	11 billion
	Support for hydrogen projects (electrolyser: EUR 2 billion; infrastructure: EUR 1 billion; international projects: EUR 2 billion; cross-European co-operation: EUR 1.5 billion)	6.5 billion
	Removal of regulatory restrictions on the expansion of wind power and solar PV	-
Mobility	Support for public transport	2.5 billion
	Future fund for automotive industry	1 billion
	Programme for the transformation of car supply chain	2 billion
	Investment in EV infrastructure	2.5 billion
	Increase of equity capital for railway company	5 billion
	Purchase premium for electric and hybrid cars	3.2 billion
	Shipping modernisation measures	1 billion
	Support of best available technology in aviation	1 billion
	Truck fleet renewal programme	1 billion
Industry	Hydrogen use in industry	2.5 billion
Buildings	Investment in building energy efficiency	2.5 billion
Cross-cutting	VAT cut for second term of 2020	20 billion

Note: Colour code: green = positive impact; red = negative impact; grey = mixed impact.

Source: (Wuppertal Institut, 2021^[60]).

Like other countries, Germany needs to ensure that recovery funds are spent efficiently (OECD, 2021^[61]). The recovery package is not part of Germany's regular annual budget cycle and draws on different funding sources at national and European level. This makes a coherent monitoring and impact assessment more complex. In some cases, reporting on existing measures under sectoral policies, which may be financed through recovery grants, may be blurred. The independent Council of Experts on Climate Change could play a role in assessing the impact and effectiveness of recovery measures and their contribution to transformative change. It is important to promote accountability and ensure a transparent impact assessment.

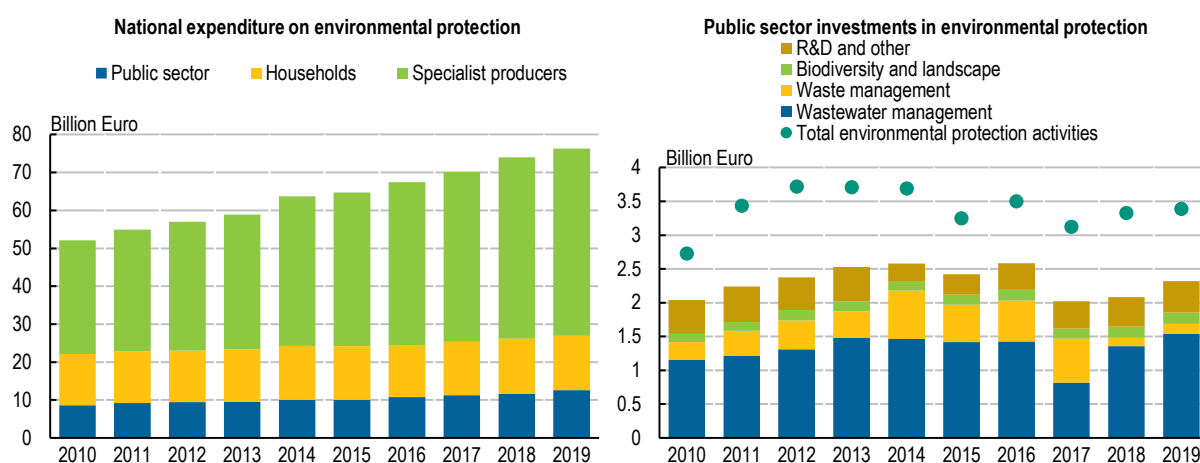
1.3.2. Investing in environmental and low-carbon infrastructure

Environmental protection

Germany spends more on environmental protection than many other European countries. Total national environmental protection expenditure represented about 2.2% of GDP, compared to 1-2% spent by most other European countries. Direct and indirect environmental protection investments amounted in total to EUR 84 billion in the 2014-20 period (EC, 2022^[32]). Most public sector investments in environmental protection goes to wastewater management. About 12% has been spent on research and development in 2019 (Figure 1.24). Moreover, specialist producers make up for the bulk of investments (e.g. waste and water companies) and households also participate through the payment of charges and services.

Spending on biodiversity and landscape protection has been comparatively low but has increased steadily over the past decade. Since end 2021, nature-based solutions receive new policy attention. As of 2023, the spending level will increase significantly with the launch of the Action Programme on Nature-Based Solutions for Climate and Biodiversity (*Aktionsprogramm natürlicher Klimaschutz, ANK*), which represents a major step increase from millions to billions. The federal government plans to invest EUR 4 billion in natural climate protection (Section 2.3.4).

Figure 1.23. Expenditure on environmental protection is increasing



Note: In the right panel, data refer to gross fixed capital formation and acquisition less disposals of non-produced non-financial assets.

Source: OECD (2022), Environmental Protection Expenditure Accounts, *OECD Environmental Indicators* (database).

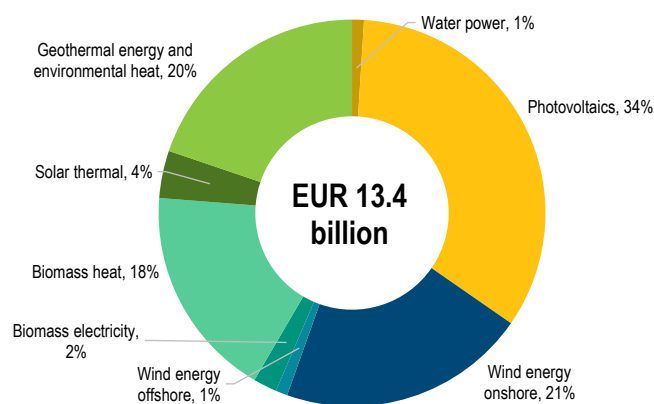
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Clean energy

Large amounts of public support were given to the development of solar, wind and other renewable energy sources. Germany was among the first countries to introduce feed-in tariffs back in 2000 (Section 1.3.3), which guaranteed cash inflows for investors in renewable power for 20 years. Consequently, a large share of the renewable energy systems is owned by non-utility actors, including households and energy co-operatives, leading to a highly decentralised energy system. About one-third of renewable energy is in the hands of households (Berlin Energy Transition Dialogue, 2022^[62]). This bottom-up approach strengthened ownership of the energy transition, which is broadly supported by the German population.

After a decline in the past decade, investments started to grow again as of 2020. The total investments in plants for using renewable energies reached about EUR 13.4 billion in 2021, representing a 20% increase (Figure 1.24). About a third of all investments were made in solar energy. Onshore wind, biomass heat, and geothermal energy and environmental heat represented about 20% each. Strong increases have been recorded in wind energy plants, as well as heat pumps reaching 236 000 units in 2022. In parallel, applications for federal funding to install heat pumps increased strongly. Installations have been mainly impeded by the lack of availability of technicians (Section 1.1.2). The federal government aims to install 6 million heat pumps by 2030, which means that as of 2023, about half a million heat pumps will need to be installed annually, more than double the amount of 2022. This represents an immense challenge in terms of ramping up production and mobilising and training skilled technicians. Nevertheless, nearly 600 000 gas-based systems – more than double the amount of heat pumps – were sold during the same year (EHPA, 2023^[63]).

Figure 1.24. Investment in renewable energy increased by 20% in 2021



Source: Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW), extracted from UBA (2022).

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Green hydrogen

The federal government invests heavily and pledged over EUR 9 billion for hydrogen within its recovery package, including about one-third from EU funding (EUR 3.3 billion) (Wuppertal Institut, 2021^[60]). Several pilot programmes aim to support development of hydrogen production and its use in industry and transport sectors. Among others, four major green hydrogen projects, focusing on the development of electrolyzers and fuel cells, will receive public support under state aid law following a recent EU approval. The European Commission approved a BASF hydrogen project with a view to decarbonising chemical production processes. Moreover, the RWE company aims to build three hydrogen plants with a target of 1 GW

capacity in North Rhine-Westphalia by 2030. Hydrogen development is also advancing in the transport sector: Germany deployed the first fuel cell train fleet (14 trains) in Lower Saxony in August 2022; Siemens has plans to roll out its hydrogen-powered passenger train in 2024. The city of Cologne intends to deploy 60 hydrogen buses (IEA, 2022^[64]).

Germany was among the world's first countries to define a National Hydrogen Strategy in 2020, which provides the framework of the country's hydrogen ambition. In keeping with this strategy, electrolyzers with a total capacity of 5 GW are to be built by 2030. They must be increased to 10 GW ideally by 2035 or by 2040 at the latest (including the offshore and onshore energy production required for providing electricity for the electrolysis). The Renewable Energies Sources Act (EEG 2021) includes specific provisions to support the production and industrial usage of green hydrogen. An action plan sets out 38 measures for the first phase covering 2020-24 in which Germany intends to advance the market ramp-up and lay the foundations of a domestic hydrogen market. In addition, it includes EUR 2 billion in support for building foreign trade partnerships (e.g. Namibia) to promote use of German technologies in the production of hydrogen abroad.

However, green hydrogen represents less than 1% of hydrogen production, which means it produces virtually no benefit for climate change mitigation or energy security. Uncertainties around future demand, regulations and infrastructure impede investment decisions. As a next step, it will be important to clarify the regulatory framework at the European level. Market ramp-up will only be possible if the rules and conditions are clear and reliable over time. This also includes developing a common understanding by providing shared definitions of emission thresholds of different types of hydrogen. Regulatory considerations must be addressed rapidly to facilitate the building of a European hydrogen market. Climate and environmental considerations need to be a priority within Germany's hydrogen strategy.

Buildings

Investments in energy-efficient buildings reached EUR 83.2 billion in 2020. Some 900 000 people were employed in modernising buildings (Berlin Energy Transition Dialogue, 2022^[62]). New energy efficiency and climate policies for the building sector will trigger substantial additional investments. The federal government has earmarked EUR 56.3 billion for 2023-26 to support climate-friendly renovations. The coalition agreement foresees to advance the transition to renewable-based heating systems. As of 2024, every newly installed heating system shall be required to run on 65% renewable energy. This could significantly accelerate emission reduction in the building sector. However, the technical feasibility is under discussion considering major bottlenecks related to the production and installation of heat pumps.

Improving energy efficiency in buildings is essential as the sector represents close to a third of Germany's energy demand (BMWK, 2020^[10]). Overall, progress has been slow despite generous support measures, which did not sufficiently target the worst-performing buildings. Nearly half of all buildings are in urgent need of renovation (OECD, forthcoming^[3]). More than 10 million heating systems are over a decade old and often inefficient (BMWK, 2022^[65]).

The federal government aims to make Germany's building stock virtually climate neutral by 2045. This requires a massive transformation of existing buildings. The recent switch from a policy mix that was more geared towards new buildings to stronger policy attention to retrofitting existing buildings is welcome. The renovation rate will need to be increased significantly for the country to achieve its efficiency targets.

Box 1.12. Key policy measures to improve energy efficiency in buildings

- **Tighter energy standards for buildings** (review of the 2020 Building Energy Act).
- **Regulation for heating systems:** as of 2024, two years earlier than initially planned, newly installed heating systems should be operated with at least 65% renewable energy.
- **Support for energy-focused refurbishment and installation of energy-efficient heating systems:** The federal government has earmarked EUR 56.3 billion for 2023-26 to support climate-friendly renovations.
- **Climate-friendly social housing:** increased federal financial support to Länder for the construction of new energy-efficient social housing and for energy efficiency retrofits of existing social housing.
- **Updated research strategy on building renovation** (Package for the Future programme providing EUR 2 billion in 2020-21).

Source: (Federal Ministry of Finance, 2022^[66]).

Furthermore, the federal government provided tax incentives, financial support and information services to convince owners to take the necessary renovation measures. Discussions at EU level are underway to enforce mandatory renovation for the worst-performing public and commercial buildings. Socio-economic selection criteria could help provide more targeted support for the most disadvantaged households (DUH, 2022^[67]). The introduction of a new cost-splitting between landlords and tenants depending on a building's energy and climate performance could have a positive impact. The 2022 CO₂ Cost Sharing Act regulates the sharing of costs for CO₂ emissions regarding heating and hot water supply between landlords and tenants. This new measure provides an incentive for property owners to invest in energy-efficient building refurbishments while encouraging tenants to behave in more energy-efficient ways.⁵

Transport

Rail infrastructure has suffered from several decades of chronic underinvestment and the federal government should prioritise and allocate more resources to rail infrastructure, particularly for connecting rural areas to large metropolitan regions. Investment decisions of the Deutsche Bahn AG, Germany's national rail company, also need to become more transparent (OECD, forthcoming^[3]) and set the right incentives to ensure efficient maintenance. The most recent Bahn reform aims at developing faster, better co-ordinated and more reliable connections (*Deutschlandtakt*). Federal support for the overhaul of the most important rail corridors is essential. This would also support implementation of the Rail Transport Master Plan's goal of increasing the share of rail in freight transport to at least 25% by 2030. The share, currently around 19%, has nearly stagnated over the past decade (Allianz pro Schiene, 2023^[68]).

As part of the energy relief package at the end of April 2022, the federal government introduced a new pilot project to enhance public transport use. The 9-euro ticket offered unlimited access to Germany's local and regional rail system for EUR 9 per month. The cost of this measure was EUR 2.5 billion. Over 50 million Germans purchased the ticket between June and August 2022. Capitalising on this success, Germany plans to introduce as of May 2023 the digital *Deutschlandticket* with an introductory price of EUR 49 per month for local public transport throughout Germany. The federal government agreed to cover half of related costs to compensate local transport operators for potential income losses; the other half will be funded at Länder level. The precise cost of this measure is yet unknown. The *Deutschlandticket* is an important step towards making train trips more financially competitive for citizens. This initiative is welcome and should also considerably help simplify the tariff structures of local public transport. In addition, public

transport services need to become more reliable, better developed in low-density areas and more easily accessible for disabled travellers, the elderly and young children. A systematic expansion of park-and-ride facilities could help fill the missing links.

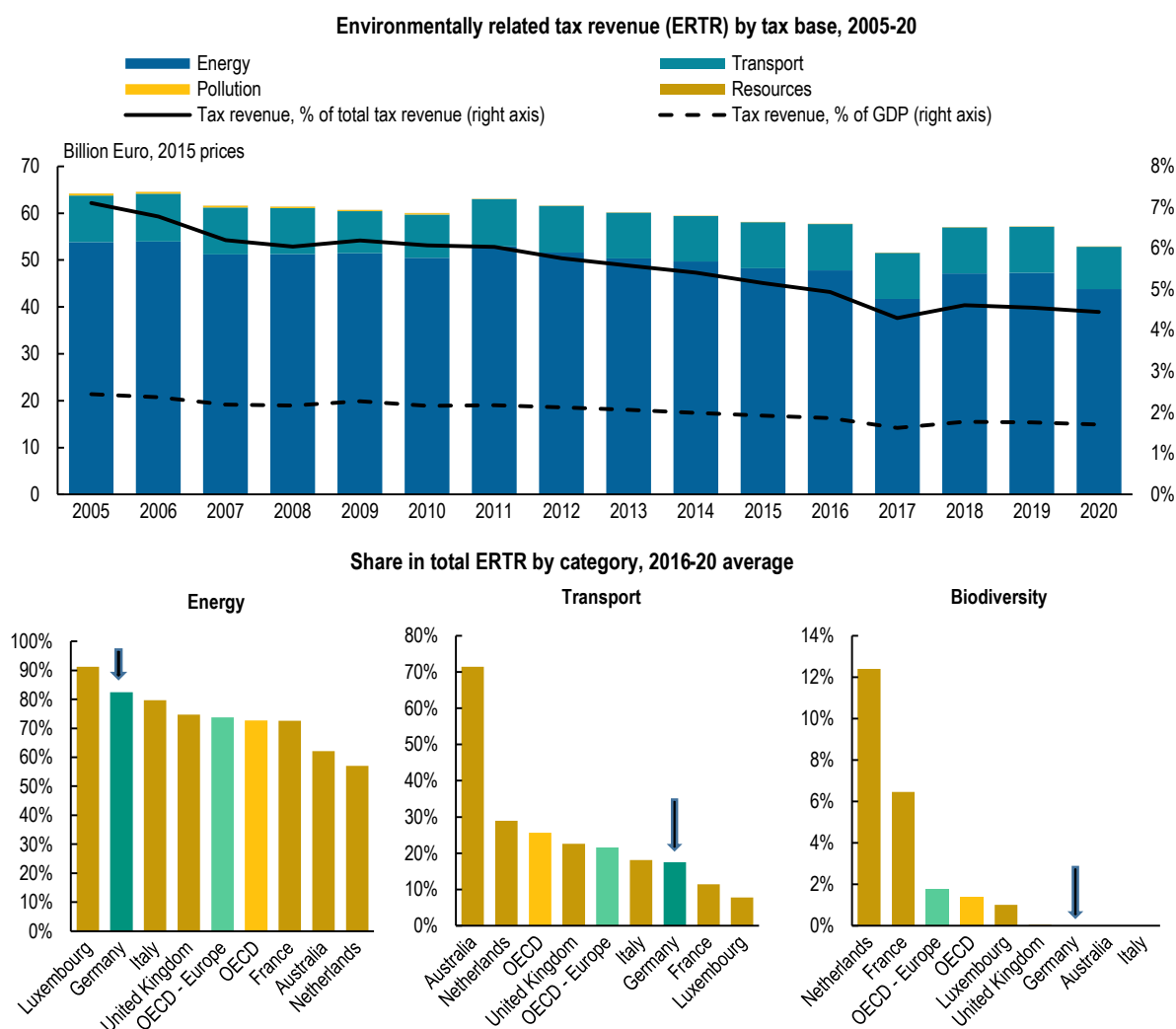
Germany's National Cycling Plan 3.0 includes many good measures, but implementation will require increased funding to build a coherent, high-quality network without weak links in the chain. Some additional funding at federal level has been provided by a special programme for urban and rural areas within the Climate Action Programme 2030. However, within the scope of its constitutional possibilities, the federal government could consider participating to an even greater extent. For example, it could help build cycle tracks and provide targeted support to Länder to encourage development of a spatially coherent, safe and comprehensive bike lane network.⁶ Cycle infrastructure planning must also become faster and easier for Germany to achieve its vision for "more, better and safer cycling" (BMVI, 2021^[69]).

1.3.3. Greening the system of taxes and charges

Germany's environmentally related tax revenue (ERTR) has declined following a peak in 2003 in the context of the eco-tax reform (OECD, 2012^[53]). The tax-to-GDP ratio and the share of ERTR in total tax revenues are both far below the OECD Europe average. While Germany has decoupled GHG emissions from economic growth, the current ERTR downward trend is not driven by a decrease of environmental pressures. Tax rates are poorly aligned with the polluter pays principle. Excise duties on energy products have remained virtually unchanged during the past decade. Moreover, tax rates are typically levied in nominal terms (e.g. per litre of fuel). In line with good practice in many northern European countries, Germany should consider introducing annual inflation adjustments to prevent further devaluation of ERTR. This could be introduced at a timely moment when energy prices are no longer skyrocketing.


As in other OECD countries, energy represents the lion's share of taxes in Germany, followed by transport-related tax revenue. Taxes on pollution and natural resources are virtually absent (Figure 1.25). Waste streams and water resources are mainly managed at the subnational level through a complex system of local fees and charges. While the OECD PINE database accounted for 234 biodiversity-relevant economic instruments across the OECD area in 2021, Germany recorded only a single economic instrument for promoting conservation and sustainable use of biodiversity (OECD, 2021^[70]). As highlighted in the 2012 OECD Environmental Performance Review, Germany has significant scope to expand use of payments for ecosystem services and other market-based instruments (OECD, 2012^[53]). Germany could also make stronger use of environmentally motivated subsidies to foster biodiversity conservation. In this regard, the Federal Action Plan on Nature-Based Solutions could become a game changer by raising Germany's biodiversity ambition to an entirely new level (Section 2.3.4).

Figure 1.25. Environmentally related tax revenue has been shrinking



Note: Data on Germany's pollution revenues not available after 2010.

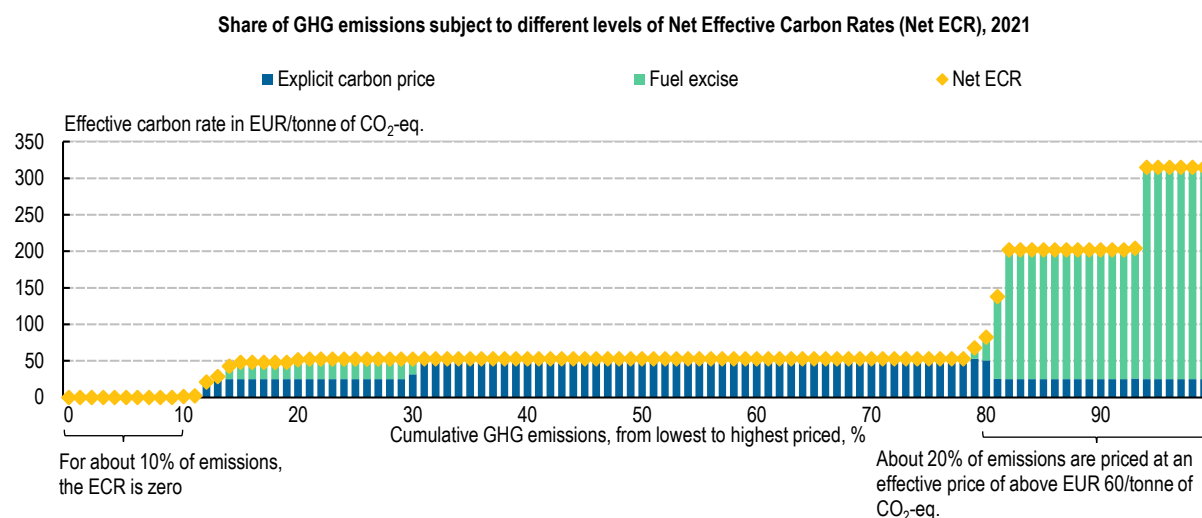
Source: OECD (2022), Environmental policy instruments, OECD Environment Statistics (database).

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Taxes on energy use and carbon pricing


Close to 90% of Germany's GHG emissions are priced, but carbon prices vary and are low in non-road sectors (Figure 1.26). Introducing a common carbon price floor across sectors would improve the effectiveness of abatement decisions (OECD, forthcoming^[3]). Moreover, Germany would need to further reduce the number of exemptions and expand carbon pricing to sectors that are not yet covered. The country joined the European Union Emissions Trading System (EU ETS) in 2005, which covers about half of national GHG emissions. The new agreement on the EU Carbon Border Adjustment Mechanism (EU CBAM) will help reduce carbon leakage and should thus be followed by phasing out free allocation in the industry sector.

Figure 1.26. Emission pricing coverage is significant, but levels are uneven



Note: The explicit carbon price comprises the EU-ETS and the national ETS. The marginal effective carbon rate does not measure the average emission price, as for example free allocations of emission rights in the EU ETS to non-power producers are not included. The measure also includes subsidies or tax exemptions for fuel, which considerably weaken carbon price incentives in Germany. Electricity excise taxes and subsidies generally do not treat fossil fuels in a differential manner compared to clean sources and are therefore excluded from the Net ECR framework.

Source: OECD (2022), Pricing Greenhouse Gas Emissions: Turning Climate Targets into Climate Action, OECD Series on Carbon Pricing and Energy Taxation, OECD Publishing, Paris, <https://doi.org/10.1787/e9778969-en>.

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In 2021, the federal government introduced a national ETS (nETS), mainly targeting the transport and heating sectors (Box 1.13). This is commendable as only a few European countries have started pricing non-ETS sectors. Furthermore, it anticipates the introduction of an EU-wide system under the Fit-for-55 initiative. However, the starting level of the national carbon price was low (EUR 25 per tonne of CO₂). The national carbon price for transportation and buildings will be raised from EUR 30 per tonne of CO₂ in 2022 to EUR 55 in 2025; in 2026, auctions will be introduced alongside a price collar of EUR 55-65 per tonne of CO₂. Higher levels would be needed to decarbonise non-ETS sectors effectively, particularly buildings (OECD, forthcoming^[3]).

Box 1.13. Germany's national emissions trading system for transportation and buildings

To accelerate progress towards Germany's climate targets in the non-ETS sectors, the federal government introduced a national emissions trading system (nETS) in 2021 for emissions from road transport and buildings, which are not covered under the EU ETS. The nETS covers all fuels that fall under the Energy Tax Act, including petrol, diesel, heating oil, natural gas, liquefied gas and non-sustainable biomass. It applies the "cap and trade" principle. Distributors of energy products (e.g. petrol stations) have to pay certificates. The price of these allowances is then transmitted to consumers (motor fuels for motorists, heating fuels for homeowners) when they purchase fuel in line with the polluter pays principle.

A fixed price of EUR 25 per tonne of CO₂ was set for 2021, with a clear trajectory of future stepwise price increases to 2026 when auctions will start (Table 1.4). Unlike excise taxes, which tax diesel at lower rates per tonne of CO₂ than petrol (OECD, 2022^[71]), the scheme applies the same carbon price per tonne of emitted CO₂ irrespective of the fossil fuel source or the sector. This corresponds to a price increase of 7.9 cents per litre for heating oil and diesel, 7 cents per litre for petrol and 6 cents per 10 kilowatt hour for natural gas (EEB, 2022^[72]). Revenues from the nETS flows into the Climate and Transformation Fund (Section 1.1.3).

While the nETS was effective in raising additional revenue (EUR 7.2 billion in 2021), its climate mitigation impact remains to be analysed. *Ex ante* studies anticipated a limited role in reducing emissions due to the weak elasticity of demand (e.g. people still need to heat their homes). To raise social acceptability, the nETS was accompanied by social balancing measures such as an increase of the commuter allowance and social housing benefits.

The level of the carbon price is still much lower than the equivalent carbon pricing through excise tax. The emission cap would need to be aligned with the emissions reduction targets. Moreover, to ease pressure in the context of soaring energy prices, the federal government decided to freeze the step increase in 2023. Providing a long-term perspective on carbon pricing with reliable, predictable increases will secure private investors. The experience of the nETS could provide lessons for a broader EU scheme to cover non-ETS sectors at European level. Germany would benefit significantly from such an expansion.

Source: (EEB, 2022^[72]) and (OECD, forthcoming^[3])

Table 1.4. Scheduled carbon price increase for emission certificates introductory phase, 2021-26

Year	Carbon price per tonne of CO ₂
2021	EUR 25
2022	EUR 30
2023	EUR 30 (freeze of increase)
2024	(EUR 35)
2025	(EUR 45)
2026	EUR 55-65, auction starts

Source: (Federal Ministry of Justice, 2023^[73])

Renewable Energy Sources Act Surcharge

In response to soaring energy prices, the federal government reduced the Renewable Energy Sources Act Surcharge (EEG levy) to zero, six months earlier than planned. This generated a cost of EUR 6.6 billion, which was covered directly by the Climate and Transformation Fund. The EEG levy was completely

abolished as of 1 January 2023. Electricity suppliers were legally required to fully pass on this reduction to end consumers, who gained 3.72 cents per kilowatt hour (kWh) on their respective electricity bills. The abolishment of the EEG levy relieved some pressure from households and energy-intensive industry. However, electricity prices remained high, maintaining incentives for energy savings. On average, households paid 40 cents per kWh in the second half of 2022, compared to 32.16 cent per kWh in 2021 (Wehrmann, 2023^[74]). The feed-in tariff was initially introduced in 2000 to subsidise the expansion of solar, wind, biomass and hydropower plants to cover the difference between the market price and the market premium paid to electricity producers. The scheme was reformed several times and contributed significantly to financing renewable energy development. In turn, it also placed a significant burden on electricity consumers. Germany's average retail price of electricity is among the most expensive worldwide.

Gas and electricity price brakes

In 2022, the federal government announced a EUR 200 billion energy relief plan, including gas and electricity price brakes. The price caps apply to all households and businesses in Germany from January 2023-April 2024. For households and small and medium-sized enterprises, the cap is fixed at 80% of the previous year's energy consumption. For industry, the cap is applied at 70%. In practical terms, this means that 70% or 80% of energy consumption will be subsidised, while the remainder will need to be paid at market price. These measures aim to shield all households and businesses against soaring energy prices while maintaining incentives for energy savings, which is commendable. Still, more precise targeting would not only avoid social hardship but also considerably limit fiscal costs (Kalkuhl et al., 2022^[75]). Therefore, the federal government should develop a targeted and socially just transfer system to mitigate high energy costs through time-bound support that is disconnected from energy consumption levels. A more suitable cash-transfer system is being developed at the federal level. Implementation will require stronger administrative capacities and a better understanding of vulnerabilities (OECD, forthcoming^[3]).

Transport-related taxes and charges

Vehicle taxes

Germany's large preference for car ownership is reflected in its tax system. The level of transport-related taxes is far below the OECD average (Figure 1.25). Germany is one of the rare countries that does not tax vehicle purchase or registration. For the majority of passenger cars, the annual motor vehicle tax is assessed mainly based on CO₂ emissions. As of 2021, newly registered cars with high CO₂ emissions are charged an increased tax while EVs are exempted. This climate component in vehicle taxation should be further amplified. It could be complemented, for example, by a registration tax for heavy vehicles, as practised in other OECD countries (e.g. Denmark, Norway). Higher costs for polluting vehicles would also help accelerate the shift from road to rail. In many cases, federal support sets the wrong incentives at the expense of sustainable transport modes (e.g. company car privilege, commuter allowance).

Germany's transport-related carbon tax base is set to shrink. With the ongoing electrification of vehicles, revenues stemming from taxes on motor vehicles and motor-vehicle fuels will drop sharply in the next decade. In addition, new vehicle emissions standards at the EU level are under discussion. If plans go through, this would ban the widespread sale of petrol and diesel cars and vans in the EU-area by 2035, and thus further decrease transport-related tax revenue. While the gradual erosion of the carbon tax base could be partially mitigated through scheduled increases of carbon tax rates (OECD, 2019^[76]), it makes sense to prepare a more sustainable transport-related tax system. Therefore, the federal government should consider making stronger use of road pricing to make drivers pay more directly according to use and damage. The introduction of a place-based road use tax system, with tax rates depending on where and when the driving takes place, and on the type of vehicle being used, would be welcome. This could help Germany shift towards a self-sustaining, environmentally and sustainable vehicle taxation system.

Company car privilege

Company cars, which represent more than 60% of all new passenger cars, continue to benefit from a low taxation rate for private usage (1%). In practice, company car privileges have been used as a recruitment incentive. This has led to the purchase of heavier, more emissions-intensive cars in the premium segment, mainly benefiting the German car industry. As a result, higher-earning employees were often provided with a bigger car than they would purchase for themselves. In addition, companies often provide fuel cards and usually cover running costs, which are also tax-deductible. This makes company cars cheaper than the use of private cars. Forgone tax revenue was estimated at EUR 3.1 billion in 2018 (UBA, 2021^[77]).

Commuter allowance

Similarly, the commuter allowance encourages users to pursue regular long-distance travel rather than providing targeted, time-bound support for developing viable alternatives. In the context of the nETS, it was further increased in 2021 until 2026, including a mobility premium for low-income employees. As of 2022, anyone travelling more than 20 km to work can deduct 35 cents per km from his/her income tax. The allowance had a fiscal cost of EUR 6 billion in 2018 (UBA, 2021^[77]). For over a decade, the commuter allowance disproportionately benefited medium and higher income groups and people who drive to work; the subsidies remain insufficiently targeted and thus inefficient; from an environmental viewpoint, they are harmful and should be replaced by more targeted support for people in need, privileging public transport.

Road pricing

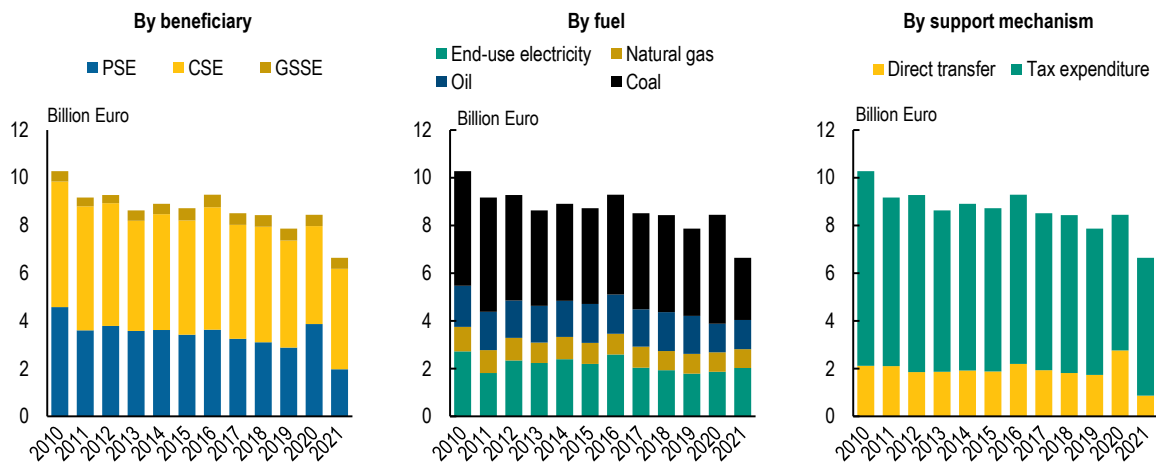
Little progress has been made on developing a fair and efficient road pricing system, with the exception of heavy goods vehicles, which have paid a toll (LKW Maut) since 2005. Following a failed attempt in 2015 to broaden use of road charges,⁷ the LKW Maut may eventually be expanded to all heavy goods vehicles (3.5 tonnes and more) in 2024. To date, Germany does not apply any tolls for passenger cars on German highways. A nationwide toll system for all motorway users, including passenger vehicles, would be a first step towards sharing the financial burden of road maintenance, infrastructure development and other externalities, which represent a significant cost for society. Urban toll rings with environmentally differentiated rates could reduce traffic during peak hours, air pollution and related health risks.

1.3.4. Removing potentially perverse incentives

While Germany provides substantive financial assistance and tax concessions for environmental and climate protection, it undermines the effectiveness of measures through exemptions and many perverse incentives for environmentally harmful activities. This contradiction between positive and negative measures has been aggravated over time; the amount of environmentally harmful subsidies has been growing during the past decade. Subsidies with negative effects on the environment were estimated at EUR 65 billion in 2018 compared to EUR 48 billion in 2008 (UBA, 2021^[77]). Nearly half of these subsidies are related to the transport sector, followed by close to 40% in the energy sector, 9% in agriculture and 5% in buildings. Germany should improve policy coherence to counterbalance this trend. Phasing out environmentally harmful subsidies would reduce the massive burden on public budgets and thus gain additional budgetary scope for environmental and climate-friendly measures. The Ministry of Finance has already produced 28 issues of its subsidy report with an increasingly climate-focused narrative. This provides a good starting point for advancing the phase-out of already identified harmful subsidies.

In 2021, the bulk of support measures benefited the industrial and agriculture sectors (55% of total support estimates (TSE), the electricity generation sector (23% of TSE) and the production sector (14% of TSE) specifically those related to coal (OECD, 2023^[78]) (Figure 1.27).

Figure 1.27. Fossil fuel support has decreased but remains high, especially coal



Note: PSE = Producer Support Estimate. CSE = Consumer Support Estimate. GSSE: General Services Support Estimate. Fossil fuel subsidy data may be partial. Tax expenditure is an estimate of revenue forgone because the tax system reduces or postpones tax relative to a jurisdiction's benchmark tax system (to the benefit of fossil fuels). Hence, i) tax expenditure estimates could increase due either to greater concessions relative to the benchmark treatment, or to a raise in the benchmark itself; and ii) international comparisons of tax expenditure could be misleading, due to country-specific benchmark tax treatments. Definitions of tax expenditure, and the benchmarks used to estimate the size of expenditure, are nationally determined and may hamper international comparisons. The OECD uses a bottom-up method of estimating government support to fossil fuels by identifying and quantifying individual policy measures. This approach measures fossil fuel support as all direct budgetary transfers and tax expenditures (tax reductions, preferential treatment for cost recovery) that provide a benefit or preference for fossil fuel production or consumption.

Source: OECD (2022), Fossil Fuel Support, OECD Environmental Indicators (database).

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Fossil fuel support

Within its G7 presidency, Germany facilitated the building of a common understanding of “inefficient” fossil fuel subsidies. G7 countries committed to end inefficient subsidies for oil, gas and coal by 2025.

In practice, progress has been slow. While hard coal subsidies in Germany were phased out by 2018, consumer subsidies for fossil fuels are on the rise again with the energy crisis, especially in Europe. Temporary fuel price cuts in Germany (30 cents per L for petrol and 14 cents per L for diesel) were among the highest in the OECD area. They reduced the effectiveness of climate policy (e.g. nETS) and weakened incentives to reduce energy use. Many measures are poorly targeted and should be time-bound and consistent with the transition to carbon neutrality.

Germany also has long-term subsidies, which are no longer justified on economic or social grounds. For example, diesel is still taxed less than petrol despite stronger air pollution impacts. Revenue forgone from the diesel discount was estimated at EUR 7.3 billion in 2019 (Transport & Environment, 2020^[79]). In terms of fuel consumption in the same year, the share of diesel (38.4 billion L) is nearly twice as high as the share of petrol (21.8 billion L). The federal government could capitalise on new political momentum as the German car industry becomes more supportive of phasing out the diesel tax privilege in a bid to unlock the rollout of EVs.⁸ Germany still has “a long way to go before achieving a sustainable fiscal policy that systematically promotes environmental and climate protection and systematically takes environmental concerns into account in all government revenue and expenditure decisions” (UBA, 2021^[77]).

Support for agriculture

Little progress has been made in phasing out potentially environmentally harmful support in agriculture. Recent initiatives failed to phase out diesel subsidies and abolish the exemption of agricultural machinery from the annual road tax due to strong resistance by farmers' organisations. A federal programme for energy efficiency in the agricultural sector aims to reduce and ultimately avoid carbon emissions in stationary and mobile energy use in the agricultural sector.

1.3.5. Towards a budgeting system for sustainable development

Green budgeting has been absent in the German debate for a long time. To date, Germany does not systematically provide information on the environmental and climate impact of individual budget measures. (OECD, 2019^[80]). A stronger focus on impact assessment would improve the efficiency and effectiveness of public finance. The 2022 spending review lays the groundwork to increase the focus on performance-based budgeting for sustainable development, which the federal government intends to develop in the coming years under the leadership of the Ministry of Finance. It aims to link more clearly sustainability aspects with the federal budget using a system of “signalling, tagging and analysing”.

The approach taken by the federal government is ambitious. In future, activities funded under the federal annual budget should be explicitly linked to sustainability targets in budget allocations and budget plans of the line ministries. The “signalling” phase makes sure that targets are clearly defined and explicitly connected to the SDGs and Germany's six transformative areas in the early planning of a given activity. Tagging is used to make the contribution of programmes and policy measures to specific SDGs or transformation areas more transparent and link it to the federal budget database. The analysis aims to improve the measurement of the effectiveness and efficiency in achieving sustainability goals. It also increases accountability of progress towards sustainability goals and other international commitments. Gender impacts must also be considered. A centralised co-ordination ensures coherence across different sectors when classifying projects and reporting on outcomes.

BMUV and BMZ will participate in a pilot to test the proposed signalling and tagging system in the preparatory phase of the 2024 budget exercise. Other ministries could join the pilot phase to familiarise themselves with the new system and collect experience.

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Notes

¹ The effects of organic farming on a global level are less clear-cut as lower average yields also means that more land will need to be drawn into agriculture and thus reduce the potential of carbon sequestration.

² The handbook builds on the leading international, government-backed standards on supply chain due diligence and responsible business conduct: the OECD Guidelines for Multinational Enterprises and the associated due diligence framework set out in the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas and the OECD Due Diligence Guidance for Responsible Business Conduct.

³ The European Green Deal (2020) sets out the main policy initiatives of the European Commission to help Europe become a climate-neutral continent by 2050. The Fit-for-55 package, part of the European Green Deal, was released in two parts in July and December 2021. It includes drafts of EU climate and energy legislation to support its climate objective of reducing greenhouse gas emissions by at least 55% in 2030

compared with 1990 levels. The REPowerEU (2022) is the Commission's response to global energy market disruptions following the Russian war in Ukraine. The EU CAP lays out the priorities of the new Common Agricultural Policy for 2023-27.

⁴ Germany is well advanced in the area of effective co-ordination, data sharing without obstacle and conformity of network services. However, it needs to make further progress in improving the conformity of metadata, spatial data sets and increase the accessibility of these data (EC, 2022^[32]).

⁵ The landlord's cost participation obligation is calculated using a ten-stage model, with values ranging from 0-90%: the higher the CO₂ emission of the building, the higher the share of the CO₂ costs that the landlord has to bear.

⁶ Around 19 000 km of cycle tracks run along federal highways. In 2016, the federal government is providing around EUR 98 million for the structural maintenance and enlargement of this network.

⁷ The proposed measure targeted only users of foreign cars. Cars registered in Germany were set to benefit from a deduction of the road charge from their annual vehicle tax bill. This 1:1 deduction of the vehicle tax from the road charge would lead to a de facto exemption from the charge for cars registered in Germany. The European Commission launched an infringement procedure against the introduction of this discriminatory PKW-Maut.

⁸ "Wenn der Umstieg auf umweltschonende E-Autos gelingen soll, kann der Verbrennungsmotor Diesel nicht auf alle Zeiten weiter wie bisher subventioniert werden" ["If the changeover to environmentally friendly e-cars is to succeed, the diesel combustion engine cannot continue to be subsidised forever as it has been up to now"], declared CEO VW Müller in 2017, www.faz.net/aktuell/wirtschaft/auto-verkehr/vw-chef-matthias-mueller-rueckt-von-diesel-subventionen-ab-15333904.html.

2 Climate change adaptation and nature-based solutions

This chapter provides an overview of Germany's exposure and vulnerability to climate risks and related impacts. It highlights the need to better develop nationwide coverage of localised climate risk assessments. The second section offers a comprehensive review of current and planned climate adaptation engagements. It explores different roles and responsibilities for adaptation policy, as well as related financing architecture and measurement frameworks. The third section briefly reviews key drivers behind the deteriorating trends of ecosystem health and biodiversity to then discuss the potential of investments in nature-based solutions to revert this dynamic. Finally, the chapter focuses on building synergy across sectors and through enhanced co-operation at the EU and international levels.

As part of Germany's broader efforts to strengthen climate action (Chapter 1), the federal government is scaling up its engagement on climate change adaptation across all government levels. More particularly, it is working on a Federal Climate Adaptation Act, which is meant to guide the federal government and federal states in their joint implementation of the national adaptation strategy, including measurable goals. This chapter assesses Germany's ongoing efforts and future plans in this regard.

At the same time, the federal government has initiated an ambitious programme to foster investments in nature-based solutions (NbS) through the Federal Action Plan on Nature-based Solutions for Climate and Biodiversity (*Aktionsprogramm Natürlicher Klimaschutz, ANK*). The EUR 4 billion action plan could become a game changer and contribute massively to enhancing natural climate protection.

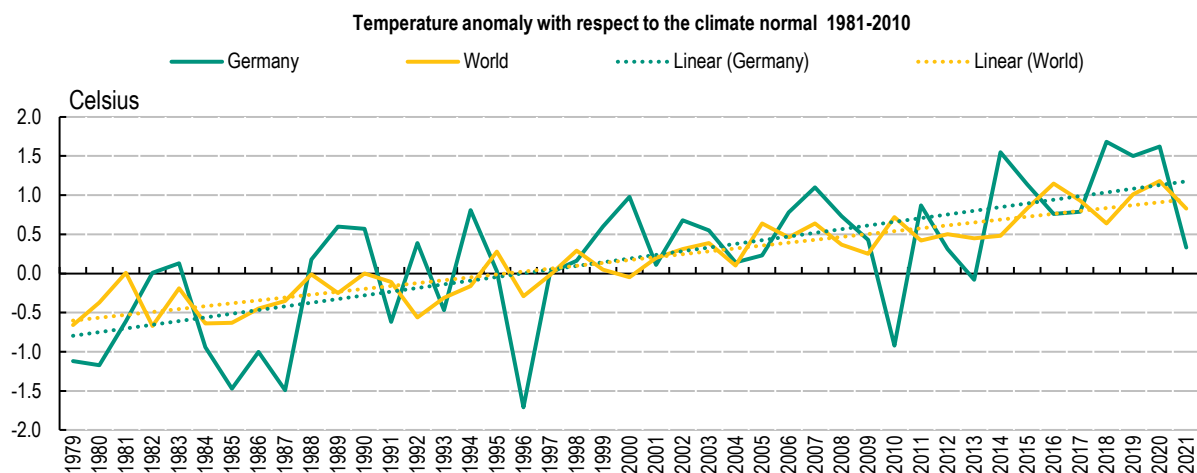
Germany is breaking new ground in both areas. Indeed, the outcomes of this experience could provide many interesting lessons and learning opportunities for other OECD countries and partners. By selecting adaptation and NbS as the focus of its fourth OECD Environmental Performance Review, Germany seeks an initial review of ongoing and planned engagements. At the same time, it hopes to inspire other countries to set out in similar directions.

2.1. Climate risks, impacts and assessments

2.1.1. Key climate risks and impacts

In Germany, average temperature has increased faster than the global average. Annual mean temperatures rose by 1.2°C between 1979 and 2021, as compared to an average global temperature increase of 0.9°C (Figure 2.1). Since 1951, the number of hot days (at least 30°C) has more than doubled in terms of surface area mean from approximately four days to ten days per year (UBA, 2019^[1]). Meanwhile, ice days have become more infrequent during the past 60 years. Climate change will drive temperature increases in the future.

Figure 2.1. Average temperature in Germany is increasing faster than globally



Source: OECD (2023), "Air and climate: Extreme temperature", *OECD Environment Statistics* (database).

StatLink  <https://stat.link/hgra90>

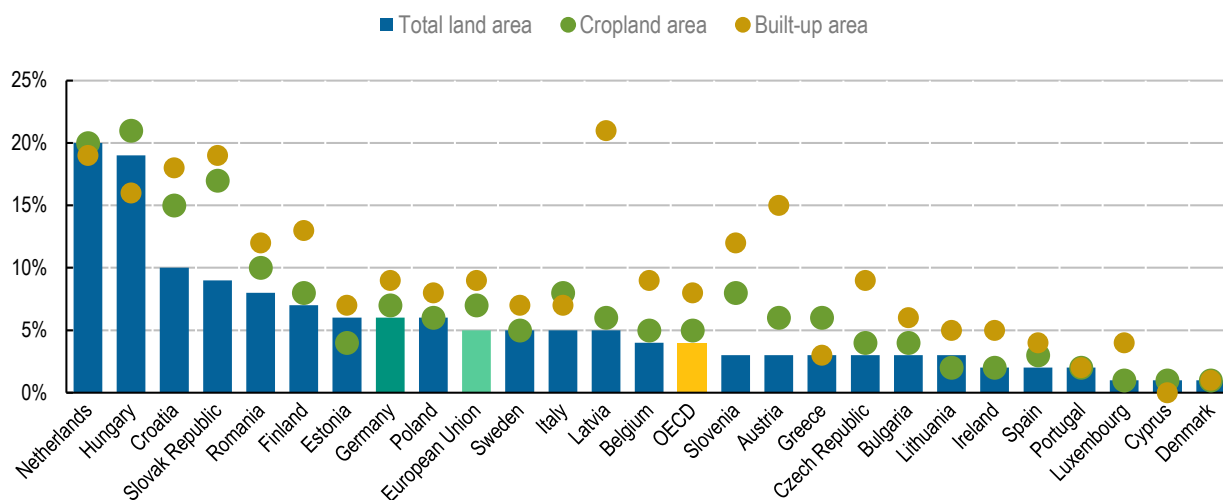
Annual mean precipitation in terms of surface area increased by 8.7% between 1881 and 2020 (DWD, 2022^[2]). Shifts in precipitation patterns vary distinctly by season and geographic location. While mean precipitation has remained predominantly unchanged during the summer months, mean surface area precipitation levels have increased by an average of 25% during the winter since 1881 (DWD, 2022^[2]).

Rising temperatures and changes in average precipitation have contributed to the occurrence and the intensity of a number of extreme weather events. These, in turn, have caused significant loss and damage to the German population, its economy and ecosystems.

Floods are a particularly significant climate-related risk in Germany. Extreme flood events – notably in 2013, 2017 and 2021 – are estimated to have exceeded the once-in-400-years return mark for a very low likelihood, high impact flood (Mohr et al., 2022^[3]). Between 2000 and 2021, flash floods, floods and extreme precipitation caused 230 fatalities and more than EUR 71 billion in total damages (Prognos, 2022^[4]), with the 2021 floods being the most devastating disaster in Germany's post-war period (Box 2.1). About 9% and 7% of Germany's built-up and cropland areas, respectively, are considerably exposed to a 100-year return flood (Figure 2.2). These averages mask stark regional differences. For example, in the harbour city of Bremen, more than 40% of the population are exposed to a 100-year return flood. About 3.2 million people live in coastal areas at risk of flooding (UBA, 2021^[5]).

Figure 2.2. About 9% of built-up area and 7% of cropland area are exposed to flooding

Percentage of surface area exposed to river flooding with a 100-year return period, 2020



Source: OECD (2023), "Air and climate: River flooding", OECD Environment Statistics (database)".

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Box 2.1. The 2021 floods of North Rhine-Westphalia and Rhineland-Palatinate

The 2021 flood catastrophe that hit North Rhine-Westphalia and Rhineland-Palatinate, among other areas, is the costliest disaster since Germany's post-war period. The extreme weather event killed 189 people and caused direct economic damages estimated at EUR 33.1 billion. In addition, EUR 7.1 billion of indirect damages were registered. The direct damages primarily affected private households (EUR 14 billion), transport infrastructure and construction (EUR 7 billion), and industry and commerce (EUR 5 billion). Most affected buildings were not insured against flood damage, which led the federal government and Länder to approve a reconstruction fund of EUR 30 billion to partially compensate for the losses.

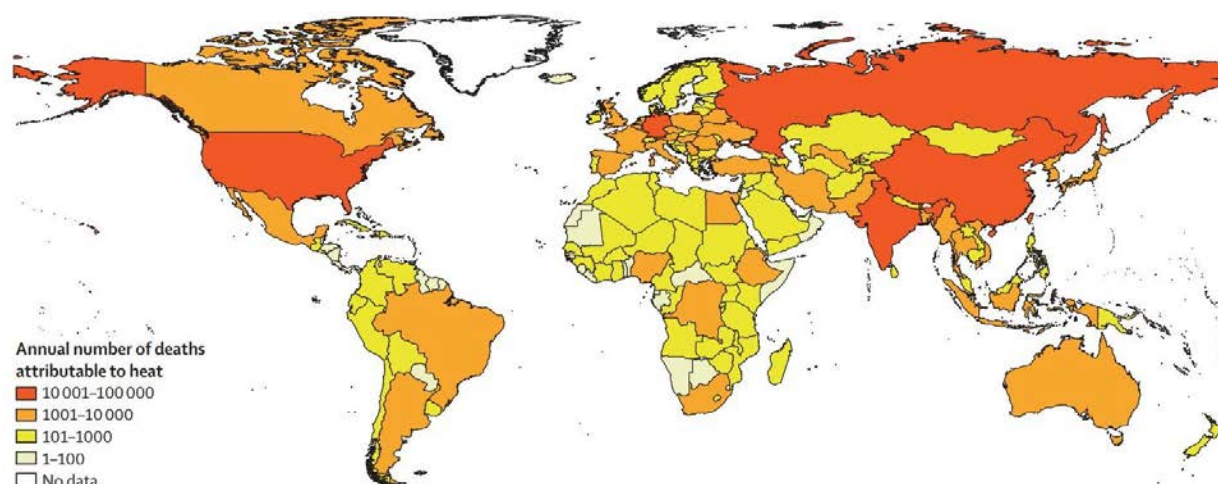
The floods largely surpassed the predictions of previous flood risk assessments. A total of 103 bridges were severely damaged or completely destroyed, which led to higher accumulations of water permitted by the drainage area. Major weaknesses in flood disaster management were related to issuing and understanding warnings. About 30% of affected residents did not receive any warning. Of those who were warned, 85% did not expect very severe floods, while 46% did not know what to do. In response to these shortcomings, Germany has started gearing up to improve flood risk assessments and effective early warning systems. The federal government decided to develop unified standards to assess risk of flooding and heavy rainfall, as well as exposure- and risk-maps to enhance its climate risk monitoring system. It has also set up a nationwide warning app, NINA, which uses push notification to alert the population about dangerous situations. In addition, traditional siren alarms will be used in case of an emergency to make sure that nobody is left behind.

In addition, Germany will need to invest heavily in flood prevention measures. NbS could play a key role in building natural water retention features by increasing the absorption capacity of land close to water bodies. It will also be crucial to review building regulations and planning laws to avoid building more houses and infrastructure in high-risk areas. Moreover, the federal government is assessing the merits of a compulsory climate disaster risk insurance scheme for individual property owners. This could not only contribute to better protect households financially against climate-related damages but also raise awareness about climate risks and exposure.

Source: (Prognos, 2022^[4]); (Thieken et al., 2022^[6]).

In addition to floods, Germany is increasingly exposed to heat stress. The number of heat stress days increased by about 6% between 1981 and 2010¹. Heatwaves regularly cause high numbers of casualties. Between 2018 and 2020, Germany recorded nearly 20 000 heat-related deaths, affecting especially elderly people (Figure 2.3). Heatwaves also lead to disruptions in infrastructure services such as rail routes and affect the capacity to use cool water in power plants (UBA, 2021^[5]).

Figure 2.3. Germany's elderly population is particularly affected by heat

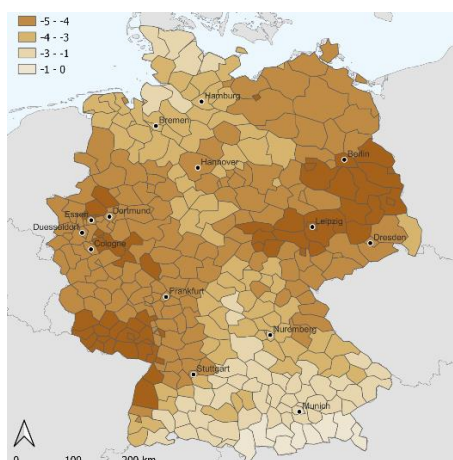


Source: (Watts, N et al., 2020^[7]).

Droughts are closely related to heatwaves. The 2022 drought was the worst on record for 500 years, causing water levels on the Rhine River to decrease up to 40 centimetres (cm). This, in turn, induced ship freight disruptions, which trickled through Germany's broader supply chain structure (Hasselbach, 2022^[8]). The previous droughts of 2018 and 2019 induced agricultural yield losses of EUR 9.9 billion and 11.4 billion,² respectively (Prognos, 2022^[9]). As a result of increasing temperatures and changing precipitation patterns (Figure 2.1), periods of extended and intensive droughts have been on the rise. Soil moisture in croplands, which can have a significant impact on plant growth and agricultural yields, decreased by 4% between 2017 and 2021 compared to the reference period of 1981-2010 (Maes, M. et al., 2022^[10]). While cropland in all of Germany is becoming drier, eastern Germany and the Rhine-Main area are particularly affected (Figure 2.4). More frequent dry summers mean the need for irrigation in agriculture will increase.

Figure 2.4. Germany's cropland is becoming increasingly dry

Cropland soil moisture anomaly (percentage) 2017-21, compared to 1981-2010.



Note: Soil moisture anomaly refers to monthly average volume of water in the surface soil layer of 0-7 cm deep, expressed as cubic metre of water per cubic metre of soil. Data taken from Copernicus CDS ERA5-Land monthly average data.

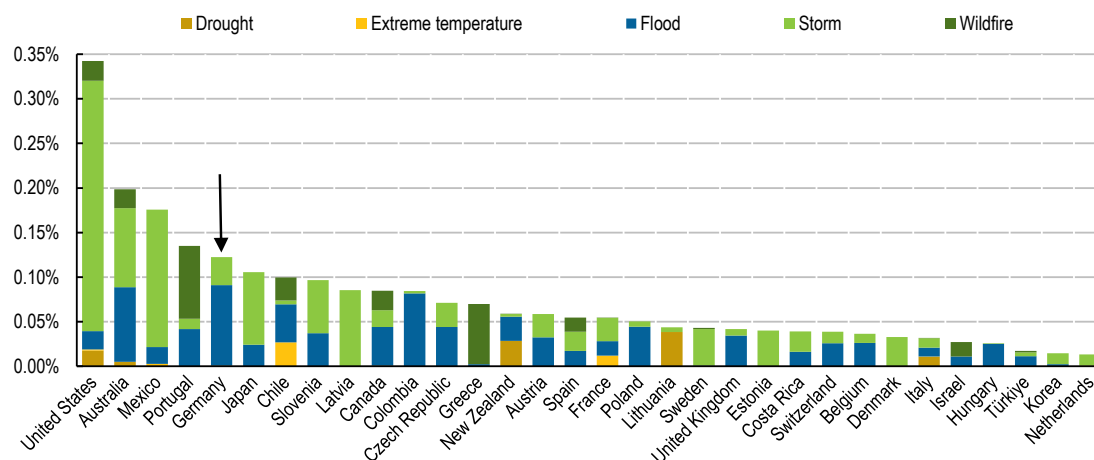
Source: (Maes, M. et al., 2022^[10]).

Sea-level rise and storms also represent an important risk. Mean sea levels rose by about 15-20 cm since 1921, in line with global projections of sea-level rise of 40 cm to 2 m by 2100 (UBA, 2021^[11]). This poses a high risk for the 3.2 million people (about 4% of the population) that live in areas at risk of coastal flooding. It also poses high risk for assets in the flood risk zone, estimated at EUR 46 billion (gross value added is EUR 8.3 billion), and approximately 85 000 jobs (UBA, 2021^[5]). Related to that, Germany is exposed to storms, which affect the coastlines most strongly. At present, 25% of the German population and 26% of built-up area are exposed to storms (wind gust speed > 28.6 meter/second), compared to 5% and 9%, respectively, on average among OECD countries (OECD, 2022^[12]). Whether climate change will cause storms to occur more frequently or more intensively in Germany is not clear (Prognos, 2022^[13]).

Over the last two decades, Germany recorded major economic losses from extreme weather events compared to other European countries (Figure 2.5). The flash floods of 2021, combined with the drought events in 2018 and 2019, caused a total estimated damage of around EUR 80.5 billion alone (Prognos, 2022^[14]). On average and since 2005, such damages have amounted to only 0.12% of Germany's gross domestic product (GDP) annually (Centre for Research on the Epidemiology of Disasters, 2022^[15]). However, this is expected to change significantly. By 2050, EUR 280-900 billion in damages are expected from the impacts of extreme weather events³ (Flaute, Reuschel and Stöver, 2022^[16]). Without adaptation investments, this figure would translate to losses of up to 1.8% of annual GDP.

Figure 2.5. Germany's damages from climate-related disasters are among the highest in the OECD

Damages from climate-related hazards as share of GDP in OECD countries, 2005-21



Note: Ireland, Luxembourg, Norway and Slovakia did not record any or only minimally climate-related hazards. The 2015 constant USD GDP has been converted to 2021 constant USD GDP using a cumulative price increase of 14.33% (average inflation rate of 2.26% per year). The EM-DAT database does not consider indirect damages, which is why total recorded damages differ between sources.

Source: (Centre for Research on the Epidemiology of Disasters, 2022^[15]).

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Climate impacts may also propagate across systems not directly affected. For instance, in 2018, transportation on the Rhine was down 27% year on year due to low water levels (Section 1.1.9). Consequently, industrial production in Germany fell by 1.5%, and the production of chemicals and pharmaceuticals dropped by 10% for three months (McKinsey, 2020^[17]; Globalia Logistics Network, 2022^[18]). This further exacerbated supply chain bottlenecks, impeding the post-pandemic rebound of industrial production (OECD, forthcoming^[19]). Climate impacts also have cascading socio-economic effects. Inequality is expected to increase as a result of increasing prices caused, for instance, by climate-related supply chain disruptions and yield losses in agriculture, as well as higher unemployment rates (Flaute, Reuschel and Stöver, 2022^[16]).

As an export country, Germany relies heavily on imported raw materials, intermediary products, sales markets and international transport infrastructure. Many of Germany's trading partners such as the People's Republic of China are vulnerable to climate change. The 2011 flood in Thailand caused disruption to the automotive industry, resulting in German car manufacturers temporarily closing their plants or reduce production. The costs of these disruptions to the German automotive industry, and to others around the world, were estimated at USD 45 billion (UBA, 2021^[5]). Germany shows growing awareness and built a good understanding of its exposure to climate risks through global supply chains. To that end, it assessed particularly vulnerable products with a high share of imports and exports from and to climate-vulnerable countries (UBA, 2021^[5]). A broader diversification of value chains could improve the resilience of Germany's economy. The EU Corporate Sustainability Reporting Directive, including sustainability reporting standards, could help increase data availability and transparency of companies' climate risks. It could also incentivise companies to adapt their strategic planning and operations to the risks they face (EU Council, 2022^[20]).

2.1.2. Climate risk assessments

Assessing climate risks and their expected change over time and across different jurisdictions is crucial to identify areas where adaptation efforts are most urgently needed. Climate risk is composed of the likelihood of a climate hazards to occur, as well as exposure and vulnerability to those hazards.

Overall, Germany has improved and developed a good understanding of climate risks. The 2021 comprehensive national climate risk assessment (*Klimawirkungs- und Risikoanalyse – KWRA* (UBA, 2021^[5]) provides an integrated assessment of projected regionalised climate risks and how they affect key sectors, including land, water, infrastructure, economy and health and assesses adaptive capacity with regard to about 50 climate impacts as basis for the development of targeted adaptation measures. The KWRA selectively collates, processes and evaluates existing research results with regard to the significance of individual climate risks in a joint, consensus-oriented process. It maps out average temperature, and average and extreme precipitation changes, and identifies hot spots of areas most prone to climate hazards. The hazards covered by the KWRA include sea-level rise, heatwaves, droughts, wildfires, floods and storms. A national flood hazard map has been developed in addition to the KWRA (BfG, 2019^[21]). In response to the 2021 flood disaster, the federal Agency for Cartography and Geodesy is also working on nationwide, modelling-based extreme precipitation hazard maps (BMI & BMF, 2022^[22]). Furthermore, the hazard distribution of storms has been calculated for 110 weather station locations. While different agencies have developed climate risk maps (e.g. German Weather Service, BfG and the Länder), Germany has difficulties synthesising them at the national level as they are not always comprehensive or transparent, and can be misleading.

The KWRA includes some information on hazard exposure.⁴ For flash floods, for example, it identifies that lower settlements, buildings on slopes or swales where water accumulates are particularly at risk. The same is true for coastal sections and roads close to rivers at risk of flooding (UBA, 2021^[5]). For coastal floods, the KWRA identifies the number of people, as well as settlement and transport areas in high flood-risk zones. In its national flood risk map, Germany conducts geographical assessments based on data developed by each Land of the number of people exposed, and type of economic activity or nature conservation area (BfG, 2019^[21]). Despite these considerable improvements over time, the 2021 floods largely exceeded model predictions. It would be useful to model further worst-case scenarios accounting for now known risk factors if possible, such as the entanglement of bridges by flotsam. This could also include a detailed analysis of exposure and vulnerability of critical infrastructure (e.g. hospitals, mobile phone masts, gas, electricity, and water supply and railways).

Densely populated urban areas are especially exposed to heat stress (UBA, 2021^[5]). The KWRA, however, does not assess exposure to heat stress of buildings and critical infrastructure. For droughts, water levels are projected for Germany's major rivers, inferring possible shipping load capacity. Exposure to forest fire

risk (e.g. in wildland-urban interfaces) has not been evaluated to date. To develop targeted adaptation measures, it will be valuable to identify exposed groups and assets for the most important risks from all climate hazards of concern in Germany.

Besides exposure, vulnerability is a key indicator for where adaptation action is most urgently needed. The KRWA identifies particularly vulnerable sectors, ecosystems, species, assets or people for some climate hazards but not for all. It has not identified groups in society that are especially vulnerable to a certain climate impact and where these intersect with climate-hazard hotspots. While the KWRA has identified vulnerability to heat stress, it ignores floods or storms. The impacts of climate change on different social groups are, however, increasingly researched, including with support from government funds (Flaute, Reuschel and Stöver, 2022^[16]). Identifying the location of high climate risks and of those exposed to them is key to protecting vulnerable groups. The federal government is developing more information on climate vulnerability with the preparation of “Regional information for climate action” (RegIKlim).

Awareness is growing of the cascading impacts that climate extreme events can trigger. The KWRA assesses cascading impact chains and how climate risks influence each other. It also identifies cross connections between all climate risks analysed. For instance, nuclear and coal energy depend on the availability of cooling water, which can be limited during droughts (UBA, 2020^[23]).

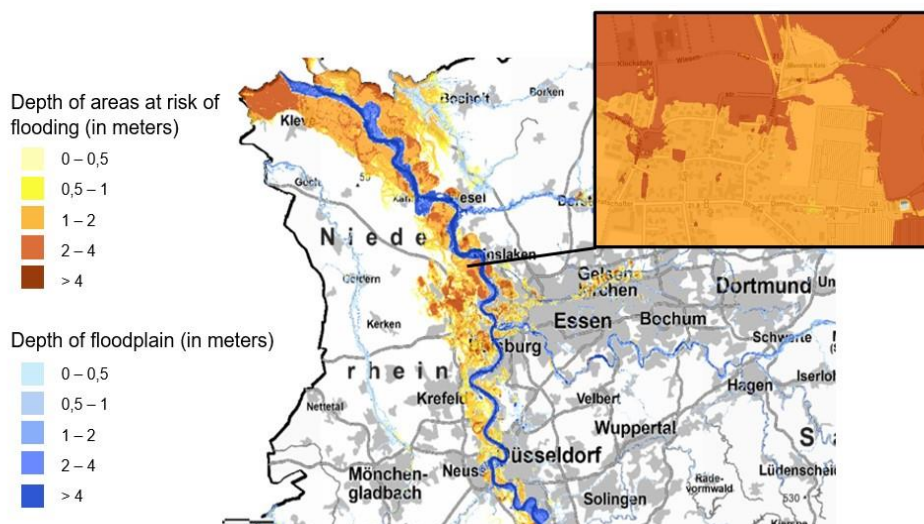
Subnational climate risk assessments

Subnational climate risk assessments that downscale climate change projection models to the regional and municipal levels are essential to inform targeted adaptation measures at the local and regional levels. While 9 out of 16 Länder have developed downscaled climate change projections, comprehensive Land-level climate risk assessments are still scarce. Regional assessments tend to be less detailed than their national counterpart. Germany will need to scale up efforts to ensure country-wide coverage of local risk assessments.

To date, 13 Länder conducted regional projections of average annual temperature and precipitation. Nine Länder have developed state-level climate risk assessments. The state of North Rhine-Westphalia (NRW) is a frontrunner in that regard. In support of implementing the Climate Adaptation Law in NRW, the state developed an online interactive climate atlas that maps different observed hazards (Klimaatlas, 2023^[24]). The state of Hesse developed KLIMPRAX, a map identifying municipalities at risk from heavy rainfall (Hessen, 2016^[25]). For its part, the state of Saxony-Anhalt developed hazard risk maps for heavy rain and hail (Saxon State Chancellery, 2022^[26]). Each Land develops flood risk assessments in line with the EU Floods Directive (Directive 2007/60/EC). However, many Länder often fail to assess the frequency and intensity of other hazards such as heatwaves, droughts or wildfires.

Figure 2.6. Flood risk maps help identify particularly vulnerable areas in North Rhine-Westphalia

Expected flooded area in case of 100-year return-period flood



Note: In an interactive online map, users can zoom in to view individual street names (sample on upper right corner).

Source: (Klimaatlas, 2023^[24]).

The Länder flood risk assessments have established a good understanding of flood exposure. For example, they include exposure variables (i.e. those collated at the national level) (Figure 2.6). However, exposure assessments of other hazards such as droughts or wildfires are not always conducted. The climate atlas of NRW serves as a positive example. It maps hazard risk in relation to cropland (vulnerable to drought) and population density (Klimaatlas, 2023^[24]). Overall, exposure assessments to other hazards are inconsistent across the Länder that do have climate hazard information.

Some Länder evaluate the vulnerability of individual sectors. For comprehensive vulnerability assessments, the city of Berlin – which also has the status of a federal state – is exemplary. The city assesses the vulnerability of nine sectors to the impacts of climate change by analysing how they have been affected in the past and which groups or assets are most at risk (UBA, 2016^[27]). One example is Berlin's sewage system, which due to its age, is at risk of flooding from heavy rain. In addition, Berlin's climate change management strategy is based on an in-depth analysis of the ecological, economic and social aspects of climate vulnerability. This includes indirect impact such as climate refugees, negative effects on international trade and tourism, and damage to European energy grids (King, 2022^[28]).

At the local level, some frontrunner cities have conducted comprehensive city-wide assessments. For example, the metropolitan region of Stuttgart assesses the vulnerability of its citizens to climate risks based on age, health status, access to green areas and so on. By analysing the vulnerability of ecosystems, such as the capacity of forest types to survive projected heat stress, it identifies hotspots for urgent adaptation action (Verband Region Stuttgart, 2015^[29]). This type of local analysis could be scaled up to inform more comprehensive climate risk assessments at Länder level. However, local risk assessments are scarce due to limited resources of cities and municipalities.

With the expansion of an information system on regional climate risks (Regionale Informationen zum Klimahandeln – RegIKlim), which is set to include local-scale vulnerability data, the federal government is increasing its understanding of climate vulnerability. Other OECD countries, such as Chile and Greece, could serve as examples in the development of climate risk maps. Such maps identify the socio-economic vulnerability of population groups at municipal or household levels across some or all of countries' most exposed territories. Chile, for instance, has developed a climate risk atlas in which it assesses

socio-economic vulnerability indicators to 52 climate risks for each municipality (Ministerio del Medio Ambiente, 2020^[30]). Indicators include proportion of children and elderly, income poverty, housing conditions and number of health facilities.

Germany needs to ensure nationwide coverage of localised climate risk assessments, a process in which the Länder play a key role. Cities and municipalities are well placed to develop comprehensive assessments but need technical and financial support. It is especially important to have coverage in climate risk exposed municipalities. In France, for instance, the Territorial Organisation of the Republic (NOTRe) law imposes several requirements on municipalities with more than 20 000 inhabitants. They must assess the climate vulnerability of their territory and develop a strategy and action programme with quantified objectives, including on adaptation, including a monitoring and evaluation system to assess progress (Climate-ADAPT, 2021^[31]). In Germany, according to the Basic Law, the federal government cannot oblige cities and municipalities to assess local climate risks. However, it could mandate the Länder to do so. Existing federal support programmes could be extended; however, Länder would also need to play a more active role in supporting local authorities in need. Regular stock-takes by the federal government and the Länder of local climate risk assessments would help target efforts more effectively.

To date, Germany has a broad range of different indicators, criteria and thresholds to analyse climate-related hazards and related risks. Federal agencies should pursue efforts to encourage use of common methods and data standard to enhance comparability and possibilities for aggregation. This could be similar to what the coalition agreement sets out in terms of unifying standards for land-level flood and extreme precipitation risk maps.

Climate risk awareness and information sharing

Communicating results of climate risk assessments is critical to trigger action. It allows relevant stakeholders to determine whether and to what extent their assets and activities are affected by climate change and to inform targeted measures to address them.

To date, climate risk information sits within different reports and websites across different government agencies at national and subnational level. Germany communicates results from climate risk assessments primarily through the KWRA, as well as its monitoring reports, which are publicly accessible on line. Land-level climate impact and risk assessments are published on Land-specific websites and collated on the UBA webpage. More detailed information and maps on some climate risk information is available on specific websites such as the German Weather Service. Information and maps on exposure and vulnerability in relation to the affected system examined are available at the Federal Institute for Building, Urban and Spatial Research (BBSR), the Federal Statistical Office or in different sectors and Länder.

The DAS Basic Service for Climate and Water (*Basisdienst Klima und Wasser*) and the KliVO portal provide general access to information on climate risk. Through the KliVO portal, for example, the Ministry for Environment, Nature Conservation and Nuclear Safety (BMUV) provides broad information and services related to climate change to local governments, and federal and state administrations (BMUV, 2022^[32]). Regional climate portals have also been established for individual or groups of Länder. The states of Saxony, Saxony-Anhalt and Thuringia, for example, have created their own regional climate information system (ReKis). These collate information on regional climate impacts, geared towards the requirements of municipal actors and administration (ReKIS, 2022^[33]). The Centre for Climate Adaptation (*Zentrum KlimaAnpassung*, ZKA) provides a one-stop shop for information on climate adaptation. While these platforms provide a lot of useful information, they do not allow for user-friendly and easy-access maps of observed and projected climate hazards, or vulnerabilities and exposure. With easier and more user-friendly access to such information, targeted action could be easier to identify. Municipalities and businesses, and especially groups vulnerable to climate impacts, must be better informed and supported. An information gateway such as the research project RegKlim, which will act as a component for risk monitoring, could help address this issue (RegIKlim, 2021^[34]).

Moreover, to date, it is impossible to assess to what extent climate risk information triggers relevant players to act. For example, evaluations of the 2021 flood catastrophe point to actors not being sufficiently informed about risk exposure. Early warnings about an imminent flood were also largely ignored and insufficiently communicated. Likewise, awareness and use of early warning systems for health-related risks is still low (WIdO, 2021^[35]), highlighting major weaknesses in disaster management. With regards to health impacts, about a third of German citizens report they are insufficiently informed about their risk (WIdO, 2021^[35]). To strengthen awareness, citizens must be better informed about the individual climate risks to which they are exposed and vulnerable. Interactive online platforms could allow users to view their exposure to hazards and offer guidelines on how to prepare and react to them.

2.2. Towards a new strategic framework for climate change adaptation

2.2.1. Germany's adaptation policy framework at the federal level

Germany has progressively developed its adaptation policy framework over the past decade. The foundations were laid in the 2008 German Strategy for Adaptation to Climate Change (*Deutsche Anpassungsstrategie – DAS*), which continues to serve as the overarching policy framework.

The DAS lays out a strategy for the federal government's engagement on adaptation and provides guidance for action to all relevant stakeholders (Bundesregierung, 2008^[36]). The DAS intends to i) improve the available knowledge base to better define and communicate opportunities and risks; ii) create transparency and participation by communication and dialogue, as well as support stakeholders in decision making by providing information; iii) raise the awareness of stakeholders and that of the public regarding climate change adaptation; iv) develop strategies to tackle uncertainty factors; and v) identify ways to co-ordinate and define responsibilities and implement actions (Bundesregierung, 2008^[36]).

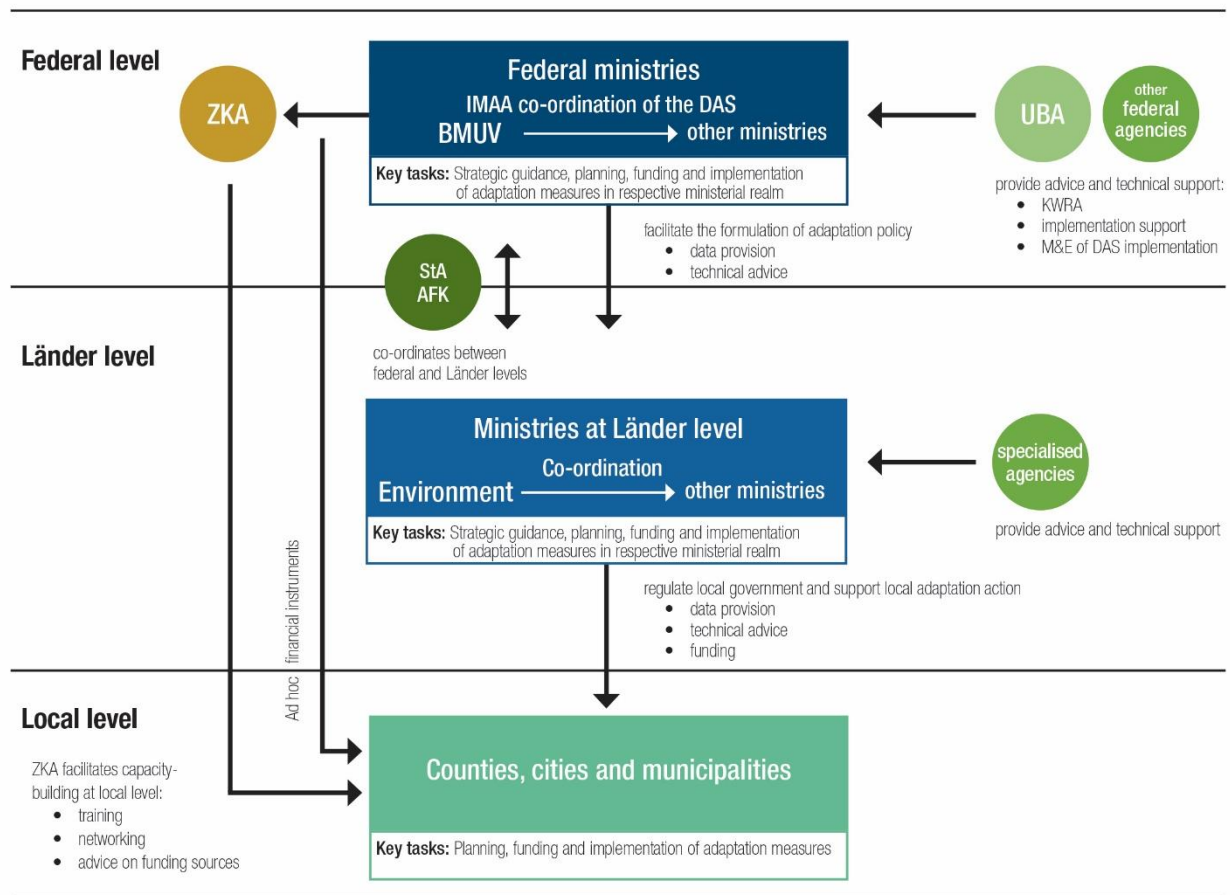
The coalition government seeks to mark a step change in Germany's adaptation engagement. In its Immediate Action Programme for Climate Change Adaptation (Sofortprogramm Klimaanpassung), it will develop a new climate adaptation strategy to steer action in all sectors at all governance levels. The strategy will be supported by a federal law on climate change adaptation (*Klimaanpassungsgesetz*) and include concrete, measurable targets in all action areas. In addition, the coalition agreement aims to create a coherent, nationwide funding mechanism for adaptation, jointly managed by federal and Länder levels in support of municipal adaptation investments (BMUV, 2022^[37]). The law aims to give adaptation a legal basis as was done for climate mitigation through the Federal Climate Action Act 2021 (*Klimaschutzgesetz*) (Section 1.1.3).

2.2.2. Roles and responsibilities for adaptation policy

Vertical co-ordination

Responsibility for climate change adaptation is shared between the federal, Länder and local levels; provisions are defined in the Basic Law of Germany (*Grundgesetz*). This shared responsibility led to the creation of a complex landscape of roles related to planning, implementing and financing adaptation measures (Figure 2.7).

Figure 2.7. Cross-government adaptation roles and responsibilities in Germany



Note: DAS = German Strategy for Adaptation to Climate Change. IMAA = Interministerial Working Group on Adaptation to Climate Change. KWRA = Climate Impact and Risk Assessment for Germany. M&E = Monitoring and Evaluation. StA AFK = Standing Committee on Adaptation to Climate Change Impacts. UBA = German Environment Agency. ZKA = Climate Adaptation Centre.

While the federal agencies co-ordinate and steer national policies on adaptation, the Länder and municipalities build climate resilience. The Länder can legislate and regulate, requiring local governments to implement adaptation action (adelphi and Climate Chance, 2021^[38]). The BMUV can only implement adaptation actions in areas that fall under federal control (e.g. federal properties and transport networks).

The federal government has developed many effective mechanisms to steer subnational government action in adaptation. The BMUV, in collaboration with the UBA, has provided technical support and policy recommendations (GIZ, 2014^[39]). The federal Agency for Nature Conservation (BfN) provides scientific and administrative support for conservation and landscape management. The Zukunft-Umwelt-Gesellschaft (ZUG), a federally owned company, supports implementation and management of BMUV national funding programmes and projects. To assist Länder in formulating their adaptation policy and action, the federal state provides data, technical support and ad hoc financial instruments. Services include the KliVO portal (Section 2.1.2); the KomPass Competence Centre of the UBA; and the Expert Dialogue on Climate Impacts (*Fachgespräch Klimafolgen*) facilitated by the UBA; and the Guidelines for Climate Impact and Vulnerability Assessments.

Germany has created several vertical co-ordination platforms to enhance communication and co-operation. The Standing Committee for Adaptation to Climate Change Impacts (*Ständiger Ausschuss zur Anpassung an die Folgen des Klimawandels, StA AFK*) has been in place since 2009. It encourages collaboration and exchange between the federal and Länder levels (Bundesregierung, 2020^[40]). In 2017,

an Ad Hoc Working Group on Adaptation to the Impacts of Climate Change in the Health Sector was created, bringing together representatives from the federal government and Länder. The working group developed recommendations on how to design regional heat action plans (Bundesregierung, 2020^[40]). The working group has been transformed into a permanent body, facilitating inter-institutional dialogue on health and climate change. In addition, the federal government and the Länder developed the National Flood Protection Programme (NHWSP). This sets out urgent flood protection measures supra-regionally, contributing to adaptation measures (BMUV, n.d.^[41]).

Horizontal co-ordination

To complement the BMUV's co-ordination role, different federal ministries contribute to adaptation action plans in six cluster areas (water, infrastructure, land, human health, economy, spatial planning and civil protection), as well as a cross-cutting cluster (Table 2.1). In addition, the Interministerial Working Group for the Implementation of the Sendai Framework co-ordinates Germany's national disaster risk management framework (Bundesregierung, 2020^[40]). The country's international collaboration efforts on adaptation at the ministerial level are mainly led by the Federal Ministry for Economic Co-operation and Development (BMZ) and its implementation agencies (Section 2.4.3).

Table 2.1. Core ministries in charge of adaptation policy at the sectoral level

Responsible federal ministries for each cluster in the Adaptation Action Plan III

Cluster	Core responsible ministries	Associated ministries
Water	BMUV	BMG, BMEL, BMDV, BMI
Infrastructure	BMDV	BMI and BMWK
Land	BMUV and BMEL	BMBF
Human health	BMG, BMAS, BMUV	BMBF
Economy	BMWK, BMUV, BMDV, BMI	
Spatial planning and civil protection	BMWSB (since 2021)	
Cross-cutting	BMUV, BMDV, BMWK, BMBF	

Note: BMAS = Ministry of Labour and Social Affairs. BMBF = Ministry of Education and Research. BMDV = Ministry of Transport and Digital Infrastructure; BMUV = Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection. BMG = Ministry of Health. BMI = Ministry of the Interior and Community. BMEL = Ministry of Food and Agriculture; BMWK: Ministry of Economic Affairs and Climate Action; BMWSB = Ministry for Housing, Urban Development and Building.

The Interministerial Working Group on Climate Change Adaptation (IMAA) has helped raise awareness, co-ordinate action and increase support for federal adaptation initiatives. The IMAA was established in 2009 under the leadership of the BMUV to facilitate dialogue on adaptation policy and to drive further sectoral action. It is composed of representatives of almost all federal ministries and meets at least twice a year to develop synergy in federal adaptation policies and actions. Evaluations found that participating ministries often defend their sectoral priorities in the IMAA and relegate adaptation priorities where they go against departmental interests (Radtke, Hustedt and Klinnert, 2016^[42]). Furthermore, the evaluation of the DAS (Section 2.2.5.) indicated that IMAA work is regarded as overly formal. Deeper collaboration is necessary to ensure practical co-operation among ministries (Bundesregierung, 2020^[40]).

Despite the well-structured sectoral responsibilities, the actual integration of adaptation into the work of sectoral ministries has been piecemeal (Section 2.2.4). Many ministries assign adaptation responsibilities to at least one department or have a specific thematic unit working on adaptation. However, in other ministries, such units are missing (UBA, 2019^[43]). Overall, there is room for moving beyond dialogue to collaborate jointly and accelerate adaptation action in sectoral policies. The new adaptation strategy provides an opportunity to deepen sectoral adaptation engagement, especially by developing targets.

2.2.3. Implementation of adaptation actions at the subnational level

Adaptation at the Länder level

Given that subnational adaptation is voluntary rather than mandatory, adaptation engagement varies significantly across the Länder. Climate risk assessment, as well as adaptation policy and implementation, all take heterogeneous approaches.

The DAS encourages Länder to develop their own adaptation strategies. These should consider regional specificities and ensure the federal and Länder levels share implementation of adaptation measures (King, 2022^[28]). All Länder have developed strategies or recommendations on adaptation to climate change. The breadth of these strategies, however, varies greatly. Similar to the federal level, most Länder follow the sector-specific structure of the DAS, adjusting the sectors where adaptation measures are necessary based on regional needs. Overall, most strategies are loosely connected to sectoral actions (King, 2022^[28]). Different adaptation strategies are coupled with varying levels of institutional co-ordination at the Land level. While working groups, councils or technical units can facilitate adaptation action, many Länder do not have such mechanisms (King, 2022^[28]).

The Land level is progressively establishing legal mandates for adaptation, an encouraging sign for strengthening adaptation at subnational level. The state of NRW adopted the first Land-level Climate Change Adaptation Act in Germany in July 2021 (NRW, 2021^[44]). The law mandates public authorities to consider climate impacts and adaptation in all planning and decision-making processes (NRW, 2021^[44]). In addition, the law sets out the need to update the adaptation strategy, incorporating the ongoing scientific climate impact and risk assessment framework (NRW, 2021^[44]). The state of Baden-Württemberg adopted a new Climate Change Action Act in 2023, covering mitigation and adaptation.

Adaptation at the local level

In the absence of legal requirements for adaptation action or reporting, a definitive understanding of local-level engagement is not possible, but it appears to be heterogeneous across the country. Only about one-third of German municipalities have an adaptation plan (King, 2022^[28]). Based on an UBA survey, municipalities were most likely to take adaptation action if they have directly experienced extreme weather events and when political leaders supported adaptation action. However, a third of surveyed municipalities have not engaged in adaptation at all (UBA, 2019^[45]). Other studies estimate that only about a third of German cities have adaptation policies in place, with medium and small cities less likely to have developed one (Otto et al., 2021^[46]; King, 2022^[28]). Certain German cities started taking adaptation measures several decades ago, whereas others are only now considering them. This leads to an uneven level of climate preparedness and may reinforce vulnerabilities to climate risks. Highly vulnerable communities may not necessarily be best placed or supported by their respective Land to build climate resilience.

Under the adaptation policy framework, the Länder are expected to provide funding, technical support, data and guidance for adaptation action at the local level. Several, but not all, Länder support municipalities with capacity building and/or information centres on climate change and adaptation. For example, the state of Bavaria supports municipalities via several instruments, including best practice guides on municipal adaptation (StMUV, 2021^[47]); capacity building instruments, such as the Centre for Sustainable Community Development (*Zentrum für Nachhaltige Kommunalentwicklung*); and a complex array of funding opportunities. In the state of Hesse, municipalities can apply for funding implementation of adaptation measures via the Climate Funding Programme (*Förderung Klimarichtlinie*) for up to EUR 250 000 per municipality (Hessen, n.a.^[48]). In addition, Hesse supports municipalities via the capacity building and information services of the Special Centre on Climate Change and Adaptation (Fachzentrum Klimawandel und Anpassung) (HLNUG, n.d.^[49]).

The Federal Ministry for Housing, Urban Development and Building (*Bundesministerium für Wohnen, Stadtentwicklung und Bauwesen, BMWSB*) supports municipalities in adapting to climate change and climate protection with various funding programmes. For example, within its urban development programmes, municipalities are required to implement climate protection and adaptation measures in order to receive financial support. The Federal Programme on Adaptation of Urban Areas to Climate Change promotes, among others, climate-adapted development of parks and green spaces, unsealing of areas, measures for rainwater management, greening of open and traffic areas, and strengthening of biodiversity. The funded projects must demonstrate high quality in terms of their energy effects and adaptation to climate change. The Urban Energy Redevelopment – Climate Protection and Climate Adaptation in Neighbourhoods programme provides loans and reduced interest rates for green infrastructure, heating and cooling supply, energy-efficient wastewater disposal, and climate-friendly mobility.

Box 2.2. The Climate Adaptation Centre and other federal support to local climate action

To further increase adaptation support at the subnational level, the BMUV set up the Climate Adaptation Centre (*Zentrum Klimaanpassung – ZKA*) in 2021. The ZKA provides a central platform to inform, advise and support Länder, municipalities and a wide variety of community actors and social institutions in climate change adaptation. Specifically, it helps with i) knowledge development in the selection and use of funding; ii) the education and training of subnational adaptation managers; and iii) exchange and networking for project implementation between actors and experts from all areas of society across regional, Land and federal levels, fostering co-operation. Within its first year of operation, the ZKA organised networking conferences, provided tailor-made municipal advice and organised a number of knowledge-sharing sessions. This helped scale up engagement in adaptation action in several regions, targeting structurally weak areas. However, as the take-up of ZKA offers is voluntary, engagement with its services depends on municipal priorities and capacity to do so.

In addition, the federal government has provided several other tools to increase municipalities' adaptation engagement. As part of its Immediate Action Programme for Climate Change Adaptation, its initiative to fund 100 additional adaptation managers in municipalities across Germany has been useful to help build capacity. The federal database (*Tatenbank*) provides a repository of successful local and regional adaptation projects and measures to inspire municipalities. The Climate Navigator (*Klimalotse*) is an online guide to help municipalities assess climate risks. This includes planning the adaptation process, understanding and assessing climate risks, formulating goals and adaptation measures, and implementing and assessing progress (Bundesregierung, 2020^[40]; UBA, n.d.^[50]).

Source: ZKA, 2022.

While many local authorities engage in climate adaptation actions, several barriers make it challenging to scale them up. The UBA survey reveals that a lack of resources for preparation (55%) and implementation (49%) are the most important barriers to adaptation (UBA, 2019^[45]). Around a third of surveyed municipalities had no dedicated staff focusing on adaptation issues. In addition, lack of experience, lack of good quality data and the unwillingness of municipal leaders to take adaptation action have equally inhibited progress. Several federal initiatives have sought to help bridge the local capacity gap to increase adaptation engagement (Box 2.2). While these initiatives contribute to raising awareness and encourage local capacity building, they may only reach local actors already committed to adaptation action. With a view to leaving no one behind, the Immediate Action Programme for Climate Adaptation (*Sofortprogramm Klimaanpassung*) could therefore provide more targeted support for lagging municipalities. The Federal Climate Change Act is an opportunity to manifest support for municipalities, where it is most needed. Furthermore, through innovative finance instruments, municipalities could be encouraged to jointly invest in adaptation measures that cross municipal borders. For highly climate-vulnerable municipalities, with

limited adaptation capacities, the federal government could encourage Länder to play a stronger role through co-financing and implementation support. Co-funding instruments could lead subnational governments to accelerate action, and perhaps also result in sectoral investments in adaptation.

2.2.4. Mainstreaming adaptation in sectoral policies

The need for integrating adaptation into sectoral strategies has been recognised in many areas. The agriculture, water and forestry sectors have been among the areas where adaptation has been streamlined in sectoral policies. Adaptation is considered in the Arable Farming Strategy 2035, the Future of Agriculture policy paper (*Zukunft Landwirtschaft*) and the BMEL's agenda for adaptation in the agriculture, forest, fishery and aquaculture sectors (BMEL, 2021^[51]). The Arable Farming Strategy 2035 acknowledges the need for region-specific strategies throughout Germany, but they have yet to be developed. (BMEL, 2021^[52]). The Forest Strategy 2050 makes climate change adaptation a central component. It sets forest conversion plans for the 2.85 million hectares (ha) of forest that are threatened by climate-induced droughts (BMEL, 2021^[53]).

Germany's disaster risk reduction frameworks also increasingly consider climate change adaptation at the strategic level (Bundesregierung, 2022^[54]) as does the tourism sector. The new work programme "Making Sustainable Tourism Competitive", for example, recognises the need for tailor-made adaptation measures (BMWK, 2022^[55]). It also foresees the development of a climate information system with indicators and an interactive mapping tool of past and future changes in climate (BMWK, 2022^[55]).

While integration of adaptation at the strategic level is encouraging, the implementation of actual actions has remained more piecemeal. The DAS Adaptation Action Plans (APAs) clearly define responsibilities for implementation of each measure. However, although the third APA (APA III) was published in 2020, APAs have only been partially implemented. Of 147 measures identified in the previous APA, about three-quarters have been implemented (Bundesregierung, 2020^[40]). While the APA specifies funding for certain measures in the action plan, this is not always the case. Funding remains undetermined for about 80% of the measures within APA III. A systematic review of adaptation integration into different sectors, respective funding levels and impacts could help Germany identify gaps. Germany's Council of Experts on Climate Change (Expertenrat für Klimafragen), for example, has a mandate to assess annual GHG emissions trends and the effectiveness of measures taken under the Federal Climate Change Act. It could be expanded to monitor sectoral mainstreaming of adaptation.

The federal government has worked to reinforce adaptation considerations in spatial and urban development, infrastructure investments as well as regulatory measures to promote the integration of adaptation into all key investments and economic activities. Climate adaptation has been integrated into federal and state urban development funding requirements. Each urban development investment must have a climate mitigation or adaptation element to be eligible for funding. Furthermore, the Federal Programme on Adaptation of Urban Areas to Climate Change supports cities in climate-resilient development. The programme supports around 300 projects, including the climate-adapted development of parks and green spaces, the unsealing of surfaces, storm water management measures, the greening of open spaces and traffic areas, and the strengthening of biodiversity.

In addition, Germany's Environmental Impact Assessment Act requires consideration of the vulnerability of federal infrastructure investments (such as federal railways, roads, buildings) to climate change. Guidelines are available to help project evaluators in their work. The Federal Spatial Planning Instrument for Flood Protection (BRPH) established nationwide regulations on water and flood risk management, as well as development of settlements, transport and energy infrastructure. Current and future flood plains and retention areas have to be kept free or reclaimed, banning any new development in these areas (BMWSB, 2021^[56]). The BRPH ensured the nationwide harmonisation of spatial planning standards. Proposed settlements must consider impacts of climate change on flood events. Such instruments can greatly foster climate resilience in new developments. However, appropriate monitoring and enforcement

– such as linking compensation for loss and damage of assets to the integration of climate risk-proofing measures – are important to ensure their effectiveness.

While efforts are underway to understand climate risks and impacts at sectoral level, there is further room to plan and implement adaptation measures strategically. The expert network of the federal Ministry of Transport conducted several research projects to assess climate risks for transport infrastructure. However, adaptation measures addressing these risks are yet to follow. The experience of the Action Plan Low Water Rhine (*Aktionsplan Niedrigwasser Rhein*) could be instructive. The plan was released after the 2018 drought caused low water on the River Rhine and blocked transport on a major shipping route (Section 1.1.9). Despite the action plan, the drought in August 2022 caused continued difficulties on the Rhine, forcing ships to lighten their cargo, delaying deliveries and increasing freight cost (Muller, 2022^[57]). The experience in the River Rhine shows that strategies and response measures to address climate risks and impacts often follow already observed climate impacts, instead of originating from forward planning.

2.2.5. Understanding and measuring progress in implementing adaptation policies

Measuring progress on adaptation policies is vital to understand whether they contribute effectively to enhancing climate resilience. Findings can inform and improve policy development, as well as strengthen accountability. The federal government recognises the need to measure progress in implementing adaptation policies and regularly releases monitoring and evaluation reports to this end. The UBA publishes monitoring reports every four years with the latest report released in 2019 (UBA, 2019^[1]).

Through the iterative process of publishing regular monitoring reports, Germany has improved the array and coverage of monitoring indicators. The monitoring reports summarise observed climate variability and extreme events and impacts (e.g. number of hot days and heat-related deaths) and discuss implementation of selected adaptation measures. Compared to the 2015 Monitoring Report, the 2019 edition made progress in the variety of indicators and ensuring that they provide information covering the entire country. However, the report does not analyse how these measures influence trends observed in climate impacts. In some cases, longer time series are required to draw statistically significant concluding statements, such as in the case of heavy precipitation events.

The federal government recognises the need to evaluate progress in implementing adaptation policies as to assess whether implemented actions have been effective in reducing climate risk. For the most recent DAS evaluation, Germany developed the “impact model” (*Wirkungsmodell*). This examined whether measures and instruments in the DAS are suitable for achieving its overall goal to reduce climate risks and increase resilience of natural, societal and economic systems (UBA, 2019^[43]). Germany’s DAS evaluation has, however, predominantly been descriptive, providing limited understanding of which actions work – or not – in building resilience. Further development and use of the impact model could enhance the usefulness of adaptation measurement, going beyond tracking implementation and building a comprehensive understanding of the effectiveness of implemented actions. For example, it could help users better understand links between implemented adaptation measures and climate impacts; and apply the impact evaluation to an increasing number of measures.

To reinforce its ability to understand progress in climate resilience building, Germany is becoming one of a few leading countries in the OECD engaged in identifying measurable, sector-specific targets on adaptation, on the basis of indicators. The new adaptation law through its dedicated adaptation strategy, should integrate sector-specific measurable targets, verifiable actions and cyclical interventions that enable transparent adaptation monitoring, similar to the Federal Climate Change Act (BMUV, 2022^[37]). Ministries are currently developing adaptation indicators and targets. With the guidance of the IMAA, goals are developed in the water, infrastructure, land, human health, economy, spatial planning and civil protection, as well as a cross-cutting cluster. While this is a complex task, indicators and measurable targets will allow Germany to better gauge progress in the implementation of adaptation policy, and enhance transparency and accountability. It is encouraging to see that Germany has started taking up this

challenge through a broad-based consultation process, involving all sectors. Germany is breaking new ground in this area, an exercise that will be relevant for other OECD countries. Currently, seven OECD countries – Finland, Greece, Japan, Ireland, Mexico, Norway and the United Kingdom – have a legislated mandate to report progress on implementation of adaptation set out in their national adaptation strategies and/or plans (OECD, forthcoming^[58]). Legal frameworks can also enhance the goal setting, implementation and monitoring processes (Box 2.3).

Box 2.3. Policies in practice: Assessing adaptation progress in the United Kingdom

The United Kingdom's Climate Change Committee (CCC) is an independent statutory body that evaluates progress on adaptation through progress reports of the UK government and its devolved administrations' national adaptation programmes. The CCC evaluation method considers both the content of the National Adaptation Plan (NAP) and other activities underway through a two-part framework where:

- ***Decision-making analysis is employed to assess the quality of adaptation plans***

The CCC assesses the extent to which planning for climate change is taking place, including whether climate-sensitive plans and policies are adequately considering the risks and opportunities arising from climate change. A plan is qualified as good if it i) considers a range of climate change scenarios and sets out specific actions (rather than simple guidance) with SMART goals (specific, measurable, attainable, relevant and time-bound); ii) has clearly stated outcomes and can demonstrate links between those outcomes and corresponding actions; iii) is up to date and iv) has an effective monitoring and evaluation framework.

- ***An indicator framework is employed to assess progress in managing the risk***

The CCC collects indicators, which assess trends in factors contributing to climate risks (hazard, vulnerability and exposure), along with indicators to assess trends in adaptation action and climate impacts; an assessment of how the risk is changing is then provided. Where there are climate impact indicators available, the CCC uses them to review how actions in the NAP are addressing climate risks. The CCC aims to provide an up-to-date picture of how vulnerability and exposure to risk are changing, whether opportunities are being seized, and whether government goals are being achieved. A high score is given if there is evidence that risk is decreasing and/or is on track to meet the respective goals and if there is sufficient evidence on the actions' impact on risks. The CCC then assigns a score to the progress made as regards each adaptation priority, based on the quality of plans and progress in managing risk.

Source: Government of the United Kingdom (2022), Department for Environment, Food & Rural Affairs.

2.2.6. The funding architecture for climate change adaptation

Public investment

In light of past observed and projected impacts of climate extreme events, Germany's needs for adaptation funding are important and will grow significantly in the future. Given the mosaic of adaptation funding sources available among different entities across the government, it is difficult to assess the funding gap. Germany has mobilised significant federal resources for compensating for loss and damage in response to extreme events. It should consider leveraging these resources for greater *ex ante* protection from the impacts of extreme climate events.

In line with Germany's federal system, those in charge of implementing adaptation actions – subnational governments and sectoral agencies at different government levels – are expected to fund investments. In addition to *ex post* disaster assistance, the federal government can only provide regular adaptation funding to subnational levels via “joint tasks” (*Gemeinschaftsaufgaben*) set out in the German Basic Law. There are two such joint tasks, namely the Joint Task for the “Improvement of Agricultural Structures and Coastal Protection” (*Gemeinschaftsaufgabe “Verbesserung der Agrarstruktur und des Küstenschutzes”, GAK*) and the Joint Task for “Improving Regional Economic Structures” (*Gemeinschaftsaufgabe “Verbesserung der regionalen Wirtschaftsstruktur”, GRW*). Commensurate with its role, the federal level finances adaptation lighthouse projects and measures linked to its facilitation role, such as the climate risk assessment, and the knowledge provision and capacity support programmes (e.g. ZKA, KliVO portal) (Section 2.2.3).

Länder do not have dedicated adaptation funds. To fund adaptation actions, some regions, cities and municipalities have made use of federal aid such as the Urban Development Support Programme or the BMUV Support Programme for Adaptation to Climate Change (Bundesregierung, 2020^[40]). Federal assistance is also provided through the Forest Climate Fund (under the GAK), part of which is dedicated to financing adaptation measures. The federal budget for water management of EUR 420 million (co-) finances flood protection investments, such as restoration of watercourses and floodplains. Länder can complement these federal sources with EU-level funding, such as at the European Social Fund (Bundesregierung, 2020^[40]).

For municipalities, the funding landscape becomes complex to navigate. In addition to the multiple federal and Land-level support programmes that might fund their adaptation actions, municipalities also receive support from sectoral support programmes (UBA, 2019^[45]). Three-quarters of surveyed municipalities also use their own budget to support adaptation action. Overall, demand for adaptation funding at the municipal level is increasing and likely outpacing available funding. This is demonstrated by the increases in the applications of municipalities to federal funding programmes (UBA, 2021^[59]). Access to adaptation funding for municipalities needs to be easier. The ZKA focuses much of its efforts to help municipalities identify appropriate funding sources and support for applications to receive additional funding (Box 2.2). The federal government should streamline procedures and reporting mechanisms to make it easier for eligible actors to access funding. An effective funding system needs to provide targeted support to ensure that no one is left behind.

To understand adaptation funding gaps and to improve oversight, the BMUV has started to work with the Länder to identify and document regional adaptation funding needs. This is an important first step to inform building an effective funding architecture. The BMUV and the BMWK have also commissioned studies that assess the cost of climate change impact. The BMUV aims at introducing budget tagging mechanisms to better identify adaptation-relevant spending. The latter remains a difficult task as adaptation spending is often embedded in broader investments. A new initiative to develop a budgeting system for sustainable development is underway (Section 1.3.5).

In light of an observed and projected upward trend in extreme weather events, Germany's adaptation funding needs are considerable and set to grow. Increasing adaptation spending is crucial to avoid more costly recovery and rehabilitation spending for public authorities. By 2050, the implementation of adaptation measures⁵ could reduce economic costs that arise from the impacts of climate change by 62 to 100% compared to a scenario without adaptation, considering a strong to weak climate change scenario (Flaute, Reuschel and Stöver, 2022^[16]). Revenue-raising instruments could be introduced to cover increased budget needs. This could include local tax instruments or beneficiary contributions.

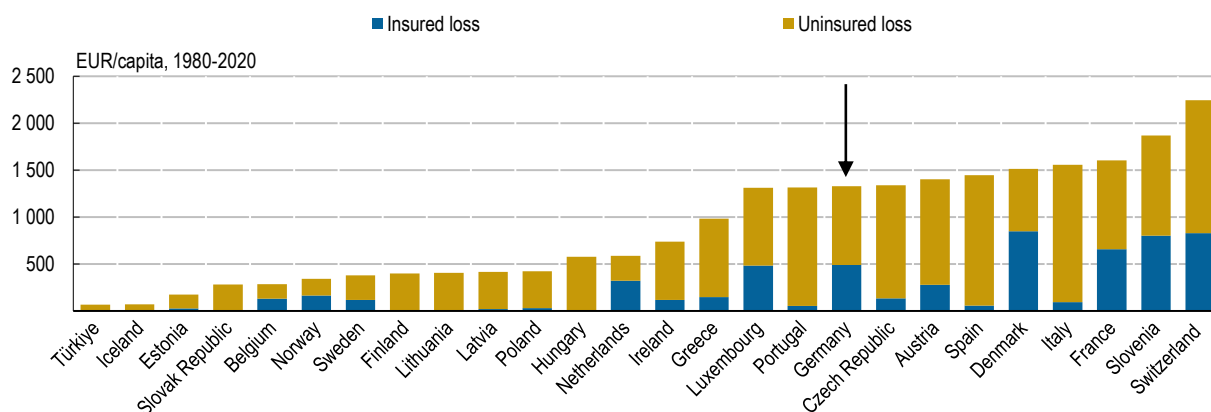
Overall, the federal post-disaster assistance (e.g. more than EUR 30 billion for reconstruction measures in relation to the 2021 flood disaster) is significantly higher than the total adaptation funding available by subnational governments and sectors combined. Knowing the federal government steps in to assume contingent liabilities after extreme events can significantly influence the readiness of public and private

actors to invest in adaptation. The future adaptation policy framework should strongly consider increasing federal funding for adaptation and do so in a way that crowds in all other actors' contributions.

Private investment

In light of rapidly growing climate risks, private investment (e.g. businesses, households) in adaptation is indispensable to ensure effectiveness of public efforts and reduce reliance on state aid in response to a disaster. Insurance against loss and damage from natural hazards is an important element. In Germany, on average, about half of private households are insured against natural hazards (ifo Institut, 2021^[60]), and insurance covers about a third of loss and damages from extreme events. Nevertheless, insurance coverage varies greatly. Concerning residential buildings, 94% are insured against storms and hail, whereas only 45% are insured against floods and extreme precipitation. Regional differences are large. For example, in the state of Baden-Württemberg, 94% of buildings are insured against floods and extreme precipitation, whereas in Bremen only 28% are covered (Prognos, 2022^[4]). Overall, the average insurance density for natural hazard insurance for residential buildings increased from 19% in 2002 to 34% in 2013 (GDV, 2021^[61]). The federal government should consider mandating insurance against natural hazards. In so doing, it would help protect assets to the expected increase in the exposure of buildings against extreme weather events.

Figure 2.8. Insurance covers more than a third of economic losses related to extreme weather and climate events in Germany, 1980-2020



Source: EEA (2022), Economic losses and fatalities from weather- and climate-related events in Europe.

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For insurance to reduce the cost of the state, France has developed a solidarity mechanism called the CatNat. Every household and vehicle insurance policy holder contributes an annual flat rate to the CatNat. As a result, 98% of French households are covered against all types of natural hazard damage. The proceeds from CatNat are reinvested in adaptation measures. A state guarantee ensures that damages from extreme events can be covered (OECD, 2019^[62]).

The federal government could reward, ex ante, adaptation investments and provide financial assistance for covering loss and damage from extreme weather events; for example, by considering them in the ex post allocation of recovery funding. In doing so, the funding architecture should also consider the role of private households and business in investing in adaptation. This should include how climate risk insurance could encourage private adaptation investments.

2.3. Valuing nature to address the biodiversity and climate crises

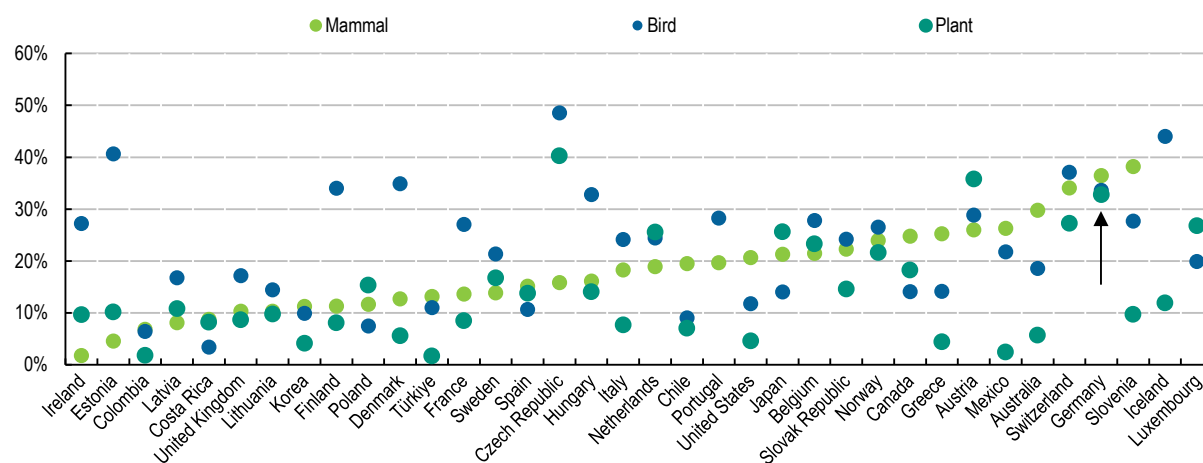
2.3.1. Biodiversity loss

Threatened species and ecosystems

Germany experienced a marked acceleration in biodiversity degradation in the past decades, affecting different ecosystems, as well as species loss. The conservation status of species and habitats shows deteriorating trends. More than one-third of species are endangered (Figure 2.9), making Germany one of the lowest performing countries across the OECD. Species of agricultural landscapes, in particular, have declined significantly. For example, bird species typical of agricultural ecosystems (which cover nearly half of Germany) have declined by about 30% on average since 1990. Almost 13% of agricultural land with high nature value was lost in the six years between 2009 and 2015 (Heinrich Böll Stiftung, 2019^[63]). Reptiles are particularly at risk, with almost 70% endangered (OECD, 2023^[64]). About 41% of wild bee species, one of the most important pollinator groups in Germany, are endangered in their population (Heinrich Böll Stiftung, 2019^[63]). Since 1990, 75% of insects have been lost.

Figure 2.9. The share of threatened species in Germany is high compared to the OECD average

Threatened species as percentage of known species, 2015 or latest available data.



Note: The threatened category refers to critically endangered, endangered and vulnerable species, that is those plants and animals that are in danger of extinction or likely soon to be (for further information, see the IUCN Red List Categories and Criteria: Version 3.1, Second edition). Iceland, Luxembourg and Portugal: partial data; Norway: 2021 data.

Source: OECD (2023), "Biodiversity: Threatened species", OECD Environmental Indicators (database).

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Nevertheless, Germany has kept all species from risk of extinction. The Red List Index, a measure of change in aggregate extinction risk across groups of species, has remained high (low extinction risk) at 0.98 since 1991 compared to the global average, which has decreased from 0.81 to 0.73 since then (IUCN, 2022^[65]). As regeneration of threatened species is not yet evident, Aichi target 5 of the Convention on Biological Diversity (CBD) is yet to be fulfilled, and almost 70% of species habitats are in an inadequate or poor condition (BMUV, 2021^[66]).

Forest area has grown by 1 million ha (about 10%) in the past 40 years to 11.4 million ha in 2021. However, in a third of this area, the proportion of damage, tree death rates and tree crown defoliation of deciduous trees – a key indicator for tree vitality – has risen sharply since 1984 (BMEL, 2022^[67]). This is mainly due

to climate change, especially drought, which causes premature leaf fall and mass reproduction of bark beetles. Storms and wildfires brought on by climate change are another factor in tree loss and damage (BMEL, 2022^[67]) only about one-third of Germany's forests have near-natural conditions (BMUV, 2022^[68]). The loss of around 0.5 million ha of mainly spruce-dominated forests opens unexplored possibilities to restock biodiverse forests.

Germany has 1.8 million ha of peatland soils, of which about 92% of peatland soils have been drained of water for agricultural use and due to increasing temperatures. Meanwhile, intact, hence near-natural, peatlands are damaged by extensive nutrient input from adjacent uses. Large parts of even protected peatlands are degraded (BfN, 2017^[69]). Almost a third of floodplains are used as farmland, settlement, transport or commercial areas, leaving only 9% ecologically intact (BMUV, 2022^[68]). Four of five grassland biotope types are endangered (Heinrich Böll Stiftung, 2019^[63]).

Despite progress in implementing the National Strategy on Coastal and Marine Biodiversity, key goals have not yet been achieved. Species decline and habitat degradation continue (BMUV, 2021^[66]). The conservation status of many habitats, such as overwashed sandbanks, or estuaries and reefs, remain in an unfavourable condition (BMUV, 2021^[66]). The main pressures are commercial fishing, extractive uses and increasing noise pollution (Greenpeace, 2021^[70]). Germany failed to achieve the objectives of the EU Natura 2000 directives and the European Marine Strategy Framework Directive, which aim to achieve a good or favourable conservation status of the marine environment and its protected goods.

About 44% of settlement and transport areas are sealed. Germany is not on track to achieve its objective to reduce land-take to less than 30 hectares (ha) by 2030. This has led to increased soil sealing, causing loss of soil functions, especially water permeability and fertility. This, in turn, increases the risk of flooding, higher vulnerability to heat stress and significant biodiversity loss in urban areas.

Another key driver of biodiversity loss is intensive agriculture and associated frequent and widespread use of plant protection products and fertilisers. Nitrate water pollution from agriculture remains a serious concern (Section 1.1.5). Additional causes are urban sprawl, landscape dissection, hydraulic engineering and watercourse maintenance, construction measures, gradual changes in temperature and precipitation, and extreme climatic events such as heavy rainfalls and long periods of drought (UBA, 2021^[5]). Moreover, the loss of meadows and fallow land have contributed to biodiversity loss. The increased use of wind farms can also negatively affect bird populations (Section 1.2.2).

Germany has undertaken multiple efforts to increase and protect biodiversity. In 2007, the BMUV developed its National Biodiversity Strategy setting out 330 targets, which are the current reference. With the Federal Nature Conservation Act 2010, the government set the legislative competence for nature conservation (CBD, 2022^[71]). The Länder are key actors in preserving biodiversity through their responsibility for nature conservation and landscape management. An increasing number of Länder have developed biodiversity-related plans and programmes. At the municipal level, an alliance for biodiversity was founded in 2012.

Despite all efforts to date, it has not yet been possible to reverse loss of biodiversity. Many national targets adopted under the CBD have not achieved sufficient progress. Less than 2% of German territory, for example, is developing undisturbed (Target 8). In addition, reduction of additional land-take due to settlement and transport is not sufficient to achieve target of 30 ha per day (Target 10). Moreover, only 25% of the German population have at least adequate awareness of biodiversity compared to the goal of 75% (part of national Target 1) (CBD, 2019^[72]). Concomitantly, Germany has also failed to achieve several goals of the 2007 National Biodiversity Strategy. In line with calls under the CBD for the reform of incentives, Germany has identified and assessed the types and magnitudes of environmentally harmful incentives (UBA, 2021^[73]; FOES, 2021^[74]). It will be important to adjust key subsidies to prevent further harm to biodiversity.

Against the background of new target systems for the protection of biodiversity in the European Union and within the Kunming-Montreal Global Biodiversity Framework, the National Biodiversity Strategy will be further developed to contain concise objectives for 2030. Each objective will contain at least one suitable quantitative indicator. With the new strategy, Germany intends to incorporate relevant fields of action that are not sufficiently addressed in the 2007 strategy. These include insect protection, energy transition, marine nature conservation, urban nature and plant protection (BfN, 2021^[75]).

To give implementation of biodiversity goals stronger leverage, interdisciplinary co-operation will be crucial. This can be ensured through a new federal strategy that mainstreams biodiversity goals in relevant sectors (e.g. accounting for biodiversity in welfare indicators). Given strong agricultural pressures on biodiversity, agricultural and environmental policies should be more closely interwoven to avert biodiversity loss. In addition, the legal framework for nature conservation could be strengthened by including a habitat improvement imperative (German Council for Sustainable Development, 2022^[76]).

Overall, more profound behavioural changes need to be incentivised. Notably, subsidy payments should be linked to the preservation and improvement of ecosystem services to make nature-friendly agriculture economically attractive. For example, to date, land users have few incentives to conserve areas and use them in a biodiversity-friendly way. The EU CAP will support German farmers to transform their businesses and apply more sustainable farming practices (Section 1.1.5).

An appropriate balance between sticks (making polluters pay such as through taxes on pollution or natural resource fees) and carrots (incentivising good behaviour such as through “good subsidies”) is required. However, an effective strategy incentivises behavioural change by reflecting the true values of biodiversity and hence the costs of its damage (e.g. pesticide use) across the entire economy through for instance, payments for ecosystem services (OECD, 2022^[77]). The example of the Forest Strategy 2050, which envisions rewards for protecting ecosystem services, could also be applied to other ecosystems.

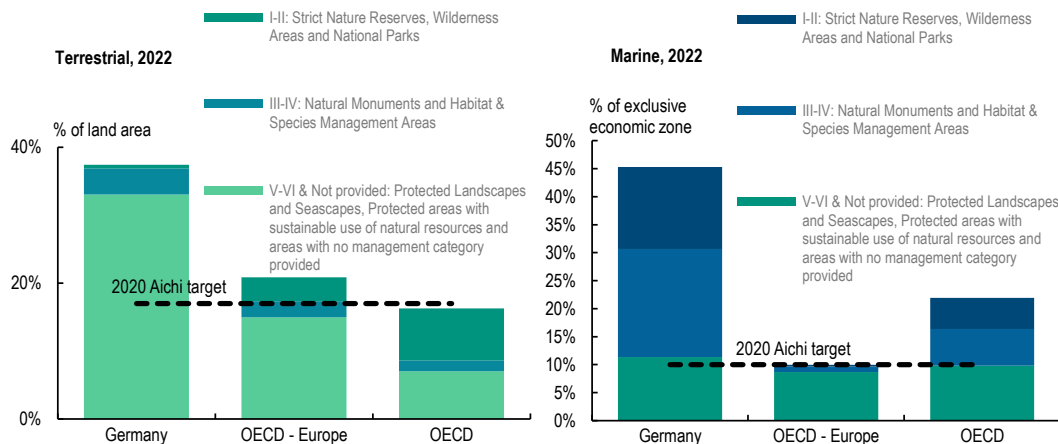
Germany fills important gaps in monitoring biodiversity trends by developing indicators for species biodiversity and landscape as part of the new strategy. Annual reporting on progress towards Germany’s biodiversity goals could be established to strengthen accountability and action to achieve national biodiversity targets and the goals agreed upon at COP15. Further, developing indicators to measure policy impacts can help ensure effective implementation through corrective action.

Protected areas

Germany protects 38% and 45% of its terrestrial and marine surface area, respectively,⁶ compared to OECD country averages of 15% and 21% (Figure 2.10). However, strict terrestrial nature reserves, wilderness areas and national parks, as defined by the European Union, comprise only 1% of the total surface area. They should be expanded to contribute to achieving the EU member states’ collective goal of achieving 10% of terrestrial surface area by 2030 in line with the EU Biodiversity Strategy (EC, 2022^[78]). Between 2000 and 2016, Germany increased areas designated as nature reserves from about 3% to 4.4% of total surface area (UBA, 2019^[79]). In these reserves, strict regulations ensure conservation and development of rare and endangered species and biotopes. About 60% of nature reserves are smaller than 50 ha (BfN, 2020^[89]), which impacts their effectiveness in protecting biodiversity.

Figure 2.10. Germany's share of protected areas lies significantly above OECD average

Terrestrial and marine protected area (percentage of total national surface area), 2021



Note: The OECD aggregate includes all members as of January 2023. The OECD aggregate includes “metropolitan” member country areas only, e.g. it does not include overseas territories or affiliates.

Source: OECD (2023), “Protected areas”, Environment Statistics (database).

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Protection alone does not guarantee nature conservation. It needs to go hand-in-hand with sustainable management of these areas and incentives to facilitate nature-friendly behaviour and ensure the effectiveness of protected areas (OECD, 2023^[80]). Moreover, protected areas do not yet exist in coastal area management plans for Natura 2000 in the Baltic Sea; they have only existed since May 2020 in the North Sea (Greenpeace, 2021^[70]). Furthermore, it is important to establish management plans that include clear objectives for their sustainable management. To date, the quality of protected areas and their management cannot be easily assessed because regulations governing many individual protected areas vary widely (UBA, 2021^[81]). Common standards and requirements for sustainable management of protected areas can help assess the quality of these areas.

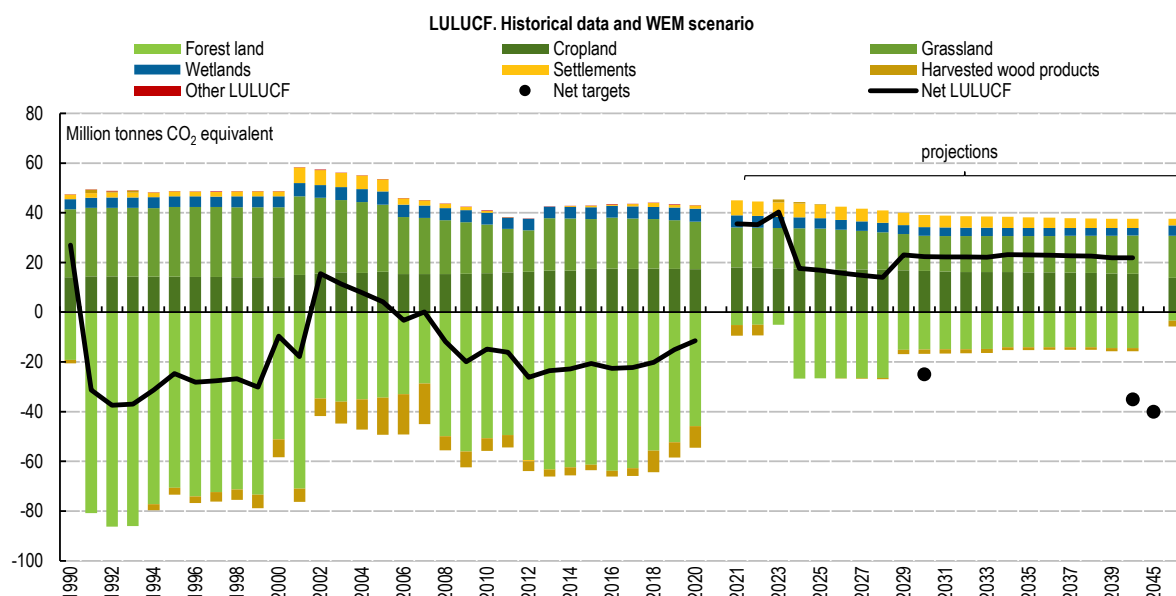
Land-use and landscape planning plays an essential role in nature and landscape conservation because it designates priority areas and sets requirements and measures to conserve nature. Nature and landscape conservation and requirements for biotope and species protection have been increasingly incorporated into landscape programmes at the regional and Land level (UBA, 2019^[1]). Climate impacts, such as droughts, wildfires and extreme precipitation, pose a key risk for ecosystems (Section 2.1.1). Adapting ecosystems to the impacts of climate change is therefore key to conserve them sustainably. In land-use and landscape planning, most plans still show a lack of tangible objectives and measures for nature conservation to adapt to climate impacts. As of 2017, only 17% of landscape framework plans provided a rationale for nature conservation objectives and measures that address climate impacts (UBA, 2019^[1]).

2.3.2. Land use, land-use change and forestry

With the amendment of the Federal Climate Change Act in 2021, Germany increased its ambition for the land use, land-use change and forestry (LULUCF) sector to reduce carbon emissions and enhance its carbon sink capacity by absorbing at the very least -25 MtCO₂-eq by 2030, -35 MtCO₂-eq by 2040 and -40 MtCO₂-eq by 2045. However, emission balance projections expect Germany to fall short of these targets by about 7 MtCO₂-eq in 2030 and 22 MtCO₂-eq in 2040 (Figure 2.11).

Figure 2.11. The land use, land-use change and forestry sector holds considerable untapped potential

LULUCF emissions, million tonnes CO₂-eq and carbon removal net targets



Note: Projections are based on data submitted by Germany to the EEA and United Nations Framework Convention on Climate Change. Calculations are based on “with existing measures”, which includes existing measures undertaken in the land use, land-use change and forestry sector.

Source: EEA (2022), National emissions reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism (database), European Environment Agency.

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These projections are based on already adopted LULUCF policies and expected land and land-use changes in the sector until 2040. It would be useful to update projections to include the expected impact of new climate and biodiversity measures. To reach its LULUCF emissions targets, Germany needs to significantly accelerate action. It has vast potential to sequester carbon by expanding and maintaining near-natural forests, which store 1.3 billion tonnes (Bt) of CO₂-eq and sequester an additional 62 Mt annually (Thünen-Institut, 2017^[82]). Rewetting drained peatlands could significantly reduce CO₂ emissions, estimated at 53 MtCO₂-eq in 2020, and enhance its carbon sink capacity (BMUV, 2022^[83]). There is considerable potential to address climate change through nature-based solutions (NbS) in the LULUCF, as well as through spatial planning and coastal management.

2.3.3. Policies in support of implementing nature-based solutions

The federal government has adopted various policies in support of NbS in response to Germany's challenges in mitigating climate change, averting biodiversity loss and adapting to climate impacts. They include climate protection in the LULUCF sector; preserving forests and intact peatlands; increasing and restoring natural floodplains in water courses; protecting ecosystems to reduce climate-induced stressors for species and habitats; and increasing green spaces and fresh air corridors in urban areas (BfN, 2021^[84]). Since 2022, the BMUV has been developing an ambitious NbS programme, which brings together existing and new instruments to facilitate implementation of NbS across all sectors (Section 2.3.4).

Forests

The protection and adaptation of forests is an effective nature-based approach to mitigate CO₂ emissions and adapt to the impacts of climate change. It also provides a habitat for many animals and plants. Given that forests are increasingly under pressure from climate change, Germany has adopted several measures for forest protection and reforestation.

The Federal Forest Act, together with regional forest acts at Länder level, are key legal instruments to conserve forests. They protect the forest from improper treatment, clearance and conversion to other forms (BMJ, 2021^[85]). Forest owners are legally obliged to reforest bare forest areas. So far, this has been effective, leaving forest surface area largely unaffected by land-take resulting from settlement and transport measures. However, the Act only provides framework regulations to preserve forests, which are not further defined. The Federal Nature Conservation Act also aims to protect and sustainably manage forests (BMUV, 2009^[86]). Given the increasing degradation of forest habitats, the federal government should consider strengthening regulations to preserve and reinstate good forest condition. To that end, it could define sustainable forest management and commonly recognised conservation practices.

The German Forest Strategy 2020 comprises a number of NbS measures to support climate protection. The strategy notably aims to maintain forest as a CO₂ sink by adapting forests to climate impacts and tapping into the CO₂ abatement potential (BMEL, 2020^[87]). German forests store an estimated 1.26 BtCO₂-eq and sequester an additional 62 MtCO₂-eq annually (Thünen-Institut, 2017^[82]). Between 2017 and 2020, the amount of carbon sequestered by forests decreased by about 27% (from about 63 MtCO₂-eq to 46 Mt CO₂-eq) (EEA, 2021^[88]). Germany could take additional measures to preserve forests by increasing forest resilience against climate impacts. This could include planting drought-tolerant tree species, improving water storage capacity of forest soils and establishing mixed tree species in forests. In so doing, these measures can also secure forests as a carbon sink.

Peatlands

Peatlands act as a carbon sink, regulate water and nutrient balance, reduce local air temperature and host a multitude of often endangered animal and plant species, such as bittern, cotton grass or sundew. About 92% of peatlands are drained and related net emissions have increased from 4.2% to 6.7% (Thünen Institut, 2012^[89]). To date, emissions from peatland are estimated at 53 MtCO₂-eq annually, representing about 6.7% of total national GHG emissions (BMUV, 2022^[68]). Rewetting drained peatlands could significantly reduce these CO₂ emissions.

With the 2022 National Peatland Protection Strategy, the government seeks to harness peatlands' potential for climate protection. The carbon sequestration potential of restored peatlands is estimated at 3-8.5 MtCO₂-eq annually (BMWK, 2022^[90]). By focusing on the rewetting and renaturation of peatlands, the National Peatland Protection Strategy complements the strategic objectives of the national water dialogue (Box 1.11). Considering that all peatland biotopes are severely endangered due to drainage, the strategy also has a large potential to contribute to Germany's biodiversity targets.

The National Peatland Protection Strategy is supplemented by the 2021 Federal-Länder target agreement on climate protection through peatland soil conservation. This envisages financial incentives for the rewetting of peat soils to reduce use of peat in growing media. Ultimately, this seeks to largely eliminate the use of peat in horticulture within this decade (BMWK, 2022^[90]). On this basis, the BMEL also published the Peat Reduction Strategy 2022, which aims to reduce use of peat as a cultivation substrate and soil as a growing medium and soil conditioner. It aims to completely abandon use of peat when climate-friendly alternatives can be used. The federal government will provide around EUR 50 million over the next ten years for pilot projects on peatland soil protection (UBA, 2019^[79]).

Water

NbS offer vital means to address water-related challenges as they can enhance water availability (e.g. soil moisture retention, groundwater recharge), improve water quality (e.g. natural and constructed wetlands) and reduce risks associated with water-related climate impacts (e.g. floodplain restoration, green roofs). In 2017, the federal government adopted Germany's Blue Belt Programme (Blaues Band Deutschland) that aims to restore more than 2 800 km of federal waterways over the next 30 years (BMUV, 2020^[91]). As part of Germany's third River Basin Management Plan in support of WFD, Germany focuses on restoration measures to help create habitats in water bodies (27% of water bodies) and establish river continuity (26% of water bodies) and near-natural water supply (19% of surface waters) (UBA, 2021^[92]). While water bodies are managed at local level, the government foresees investing EUR 1 billion of federal support over the next ten years. This aims to improve the ecological status of water bodies and help Länder and municipalities become more climate resilient.

Moreover, the federal government has developed a new National Water Strategy to improve the quality of surface waters and address current and future climate risks of Germany's water sector (Box 1.11). Among other key measures, the strategy aims to make water infrastructure more climate resilient. In this way, it could address extreme weather events such as heavy rainfall, drought and sea-level rise, and maintain ecosystem services (e.g. self-purification of water bodies, retention, groundwater recharge and sink function). The strategy is a good example of mainstreaming adaptation and biodiversity in relevant sectoral policies (Section 2.4.1). However, clear operational and regulatory requirements to achieve the strategy's objectives should correspondingly be set in the Federal Water Act. To date, the Act only sets general clauses for adapting the water sector to climate impacts to strengthen their implementation (UBA, 2019^[79]).

Adaptation

The National Adaptation Strategy, as well as its subsequent action plans (Section 2.2.1), include the renaturation of wetlands and river courses to limit climate impacts through improved flow regulation during floods. They also aim to reduce heat stress on humans and urban ecosystems, and improve air quality and flood management (Bundesregierung, 2008^[36]). They also set out to engage in forest conversion to climate-adapted mixed forests to increase forests' ability to provide their ecosystem functions in the long-term, soil-conserving and conservation methods in agriculture. This, in turn, would help preserve natural soil functions and reduce erosion and compaction. A key result of these efforts can be seen in Germany's floodplains. These have increased by about 4 000 ha since 1983, amounting to 480 000 ha in total floodplains available as retention area in the event of flooding (UBA, 2019^[11]).

The implementation of NbS has also been increasingly promoted in urban areas. The Federal Concept on Green Infrastructure 2017, the city-nature master plan (*Masterplan Stadtnatur*) 2019 and the Federal Programme on Adaptation of Urban Areas to Climate Change (*Bundesprogramm „Anpassung urbaner Räume an den Klimawandel“*) 2020 as well as the urban development funding programmes (BMUV, 2020^[93]; BMUV, 2019^[94]; BBSR, 2022^[95]) (BMWBS, 2022^[96]); all aim at promoting urban NbS. With these programmes, Germany supports integrated urban development through the conservation and improvement of ecosystems and their services, unsealing soils and increasing green spaces in cities to reduce urban temperatures; manage excess rainwater; enhance the diversity of species and biotopes in cities; and support climate protection (BfN, 2017^[97]). Municipalities have especially encouraged installation of green roofs and façades through provisions in local development plans (Box 2.4).

NbS have been increasingly incorporated in urban development plans, emphasising “no-regret” solutions that are cost effective and also address other socio-economic challenges (ecologic, 2020^[98]). However, challenges remain in addressing space and planning issues in cities, as well as in building technical capacity in the planning, implementation and maintenance of NbS. Building codes are a key regulatory lever that can foster use of NbS by integrating minimum requirements for green space areas on and around

new buildings and permeable material in driveways to increase water absorption and retention capacities (OECD, 2021^[99]). Urban development contracts pursuant to the Federal Building Code (BauGB) can be used to introduce rules for the safeguarding and development of NbS.

Box 2.4. Policies in practice: Germany's sponge cities to tackle heat and flooding

Germany promotes nature-based solutions to advance climate adaptation in cities. By imitating the natural water cycle, green roofs, façades and other green spaces absorb the rainwater where it lands. They soak up the water like a sponge until it can infiltrate into the ground or evaporate. This serves as a natural flood prevention and also helps keep buildings cool, encouraging biodiversity and improving air quality and citizens' well-being. Many German cities have embarked on greening their buildings. This is also an important climate measure of Germany's Climate Action Plan 2050.

Germany's green roof areas have more than doubled over the past decade, representing about 9% of newly constructed flat roofs. The green building sector also provides new jobs in related professions, including roof garden maintenance. However, the situation varies greatly across the country, depending on a large number of different building regulations, urban development plans, municipal bylaws, nature-based-specific regulations, municipal funding and other incentives. According to a nationwide Green Roof Index, the cities of Munich, Stuttgart and Berlin have the largest green roof areas with over 4 million m².

To amplify the expansion of green roofs and façades, it would make sense to establish common standards and a nationwide inventory to measure progress and assess the effectiveness of support measures. To date, German cities use different approaches to estimate the size of green roofs and façades (aerial or satellite images, building cadastral data or digital building models). Only a few cities maintain a green roof inventory with annual updates, although this information could help monitor the effectiveness of direct and indirect support measures. Developing climate-resilient, smart cities should become a priority. Public investment decisions need to be made accordingly.

Source: (OECD, 2022^[100]).

2.3.4. Federal Action Plan on Nature-based Solutions for Climate and Biodiversity

To address the interdependent crises of biodiversity loss and climate change, a new and ambitious programme, the Cabinet approved the Federal Action Plan on Nature-based Solutions for Climate and Biodiversity (*Aktionsprogramm Natürlicher Klimaschutz, ANK*), in March 2023⁷ (Box 2.5). With the ANK, the government aims to build synergy between climate protection and nature conservation measures (BMUV, 2022^[68]). NbS directly protect, strengthen and restore natural ecosystems and reduce GHG emissions. The ANK views the strengthening of the resilience of ecosystems to the climate change impacts also as an important goal of NbS (BMUV, 2022^[68]).

Box 2.5. Federal Action Plan on Nature-based Solutions for Climate and Biodiversity

The Federal Action Plan on Nature-based Solutions for Climate and Biodiversity (*Aktionsprogramm Natürlicher Klimaschutz, ANK*) has an unprecedented, planned funding envelope of EUR 4 billion for 2023-26. With this budget, it aims to accelerate implementation of NbS towards achieving national climate targets. In doing so, it will pay special attention to the land use, land-use change and forestry sector. Parallel activities will help reverse biodiversity loss and build climate resilience. The action plan is linked closely to many sectoral programmes and strategies to build synergy and bundle all NbS activities within a coherent approach.

The ANK defines 64 individual measures in ten fields of action, including among others:

- implementing the National Peatland Protection Strategy
- restoring a near-natural water balance
- promoting healthy forests
- making cities and municipalities climate resilient.

Activities related to data gathering, monitoring, modelling and reporting, as well as research and capacity building, will complement the thematic work areas. In addition, synergy is also being sought at the European and international levels. A series of pilot projects started in 2022. The plan has been further fine-tuned following a nationwide consultation process launched in September 2022.

Source: (BMUV, 2022^[68]).

The ANK emphasises the LULUCF sector, which is important to reach Germany's LULUCF emission targets (Section 2.3.2). It aims at significantly preventing emissions from dry and degraded peatlands to escape through rewetting, and enhancing carbon sink functions from all ecosystems, including through forest conservation and restoration.

Beyond the restoration and protection of natural ecosystems, Germany, through the ANK, also promotes implementation of NbS in urban areas. The ANK sets out to improve water retention, including in urban areas, and to strengthen the infiltration of rainwater by funding and financing unsealing projects (BMUV, 2022^[68]). Additional measures are funded through the Programme on Adaptation of Urban Areas to Climate Change (BMWSB). In addition, the federal government plans to financially support 20 municipalities annually in near-natural green space management. Location-specific concepts will make inner-city federal properties more usable for urban green infrastructure and reduce new daily land use from around 54 ha to 30 ha to achieve net-zero land consumption by 2050 (BMUV, 2022^[68]).

The ANK intends to increase climate resilience. Measures primarily seek to increase capacity of natural ecosystems to store more water. This can limit the impacts of extreme weather events, particularly extreme precipitation, as well as drought periods. NbS have a large potential to help adapt to climate impacts. Germany could more strongly consider building climate resilience as a key objective, rather than a valuable co-benefit of the measures. Framing NbS as such can help mobilise relevant stakeholders, increase funding and raise awareness of the need for adapting to the impacts of climate change.

Implementation and delivery mechanisms

The BMUV holds the main responsibility for developing measures set out in the ANK. In addition, the BMEL manages individual measures for peat-use reduction and forest monitoring. However, concrete delivery mechanisms and responsibilities have not been determined yet. To that end, Germany aims to co-operate closely with the Länder, which have key responsibilities in nature conservation. The Länder may already have a comprehensive understanding of the NbS potential in their regions and relevant networks of

government and non-government agencies. As the Länder are closer to those who will be directly affected by the measures, such as municipalities, landowners and farmers, they are well positioned to identify and address potential implementation barriers. An innovative element of the ANK is the intended target audience for project leaders. Beyond government agencies, the ANK seeks to encourage citizens, companies and organisations to develop projects and apply for funding.

Given the short timeframe and large scope of the ANK, key priorities, concrete mechanisms of NbS implementation, timelines and responsible actors, especially related to the Länder, should be clear to ensure accountability. Germany will need to define rapidly delivery mechanisms for the ANK measures to deliver results within a short timeframe (2023-26). Besides identifying new measures, the programme builds on many policies such as the reconnection and renaturation of floodplains, increasing protected areas or afforestation. The ANK aims to secure enough funding to accelerate implementation of NbS for climate protection and biodiversity. At the same time, it seeks to remove policy and institutional barriers to advance those measures that have thus far not achieved their targets (e.g. biodiversity protection, forest health).

Overcoming implementation barriers and ensuring long-term effectiveness

The BMUV co-ordinated broad public consultations, engaging citizens, community-based and non-profit organisations, and agencies across government to inform the design of the programme. The consultation helped raise awareness of ANK objectives among key stakeholders, and thus lays the ground for its implementation. In addition, the BMUV has started several pilot projects in 2022, which are valuable to demonstrate the effectiveness of NbS on the ground. These can raise awareness and improve understanding of NbS among policy makers, administrators, planners, engineers, private actors and citizens. Initial projects, such as peatland rewetting, have revealed barriers to implementation. These include approvals needed from neighbouring property owners, specialised non-market machinery to harvest crops from peatland, uncertain prospects of profit from paludiculture products or viability of solar panel installation. For implementation of the ANK, especially the rewetting of peatlands, it will be important for landowners and farmers to generate sustainable revenue from NbS.

While NbS are no-regret options, Germany should account for their long-term effectiveness and potential conflicting goals in implementation. The ability of ecosystems to act as a sink for CO₂ emissions, reduce impacts of climate change and provide space for a range of species is directly affected by the exposure and vulnerability of the ecosystems themselves to climate change and resulting impacts. Continued warming and expected increases in climate impacts, combined with other stressors such as land-use change and pollution, can lead to a decline in the adaptive capacity and therewith the potential to store emissions of ecosystems. This can hamper the effectiveness of NbS in the long term and may discourage landowners, municipalities and other relevant actors from pursuing this approach. For example, rewetting of peatlands may become increasingly difficult under more frequent and intense heatwaves and droughts, reducing their effectiveness in storing carbon emissions. Depending on the ecosystem concerned, it is crucial to incentivise practices to reduce pressures on ecosystems such as pollution, invasive species, habitat loss and fragmentation and over-exploitation. It is equally vital to enhance genetic species and functional richness, which buffers the impacts of extreme weather and pests. In the context of a changing climate, it will also be important to model how the performance of NbS varies under climate change.

Subsidies, such as those provided by the EU and German agricultural and climate policies, used to hamper implementation of NbS. This is now slowly changing. (Wüstemann et al., 2017^[101]). In this regard, Germany's CAP Strategic Plan is a critical achievement in supporting NbS application on peatlands (Box 1.8). Compared to the former CAP funding criteria, which incentivised farmers to drain and fertilise peatland soils for biomass and energy maize production, the reformed CAP aims to protect peatlands. Moreover, three Länder have Agri-environment Climate Measures funded by the EU CAP for peatland rewetting, and two for paludiculture. To ensure an effective approach to facilitate NbS implementation, it

will be important to set and regulate agricultural subsidies so that they incentivise peatland rewetting and improve management of drained peatlands.

Overall, the ANK needs to consider the complex landscape of regulations at the subnational, federal and EU levels and find ways to overcome potential barriers in delivery. Delivering parts of the programme directly through citizens, companies and organisations under public or private law is itself progressive and may lead to innovative suggestions in NbS. However, the size of the programme would not allow it to be fully deliverable through private stakeholders alone.

Monitoring progress in implementing nature-based solutions

As NbS were often only indirectly integrated into a broad range of policy instruments, they have not been monitored as a coherent concept on their own. Nevertheless, the state of different ecosystems, and in some cases the implementation of individual policies that make use of NbS have been monitored.

Germany monitors ecosystems in part through the National Forest Inventory, in which the BMEL assesses the condition of trees and changes thereof between inventories. Since 2007, Germany has inventoried its forests every five years and is conducting its fourth one (BMEL, 2022^[102]). For the LULUCF sector, the Thünen Institute monitors and analyses LULUCF emissions on behalf of the federal government. The UBA has monitored and reported annual changes in the national carbon budget resulting from changes in land use between 1990 and 2018 (UBA, 2020^[103]). As concerns biodiversity, Germany monitors nature conservation, ecosystems, farmland, birds, insects and genetically modified organisms (BfN, 2022^[104]). The country is bringing individual programmes together and gathering data for a more comprehensive, nationwide approach to biodiversity monitoring.

To improve monitoring the state of ecosystems, the ANK sets out several actions to connect data gathering more effectively and expand databases. This aims to measure progress towards the goals of the Climate Change Act. Within the BfN a co ordinating body for the ANK's implementation and further development will be established. In addition to improving accuracy and informational value of emission data, the UBA will set up a soil monitoring centre to create the legal foundation for reporting GHG emissions in the land sector.

While these measures aim to fill data gaps and expand monitoring, modelling and projections of ecosystem developments, the effectiveness of NbS measures is rarely assessed. To some extent, the Monitoring Report and Evaluation of the DAS does assess NbS in the DAS and its subsequent action plans (Section 2.2.5). However, projects funded to implement the National Strategy on Biological Diversity 2007 have not yet been evaluated. The BfN commissioned adelphi, an EU think tank, to evaluate implemented projects, measuring their degree of target achievement and ultimately the success of the funded projects and the federal programme (adelphi, 2022^[105]). For the ANK to deliver on its high ambitions, it will be crucial to gather information of NbS performance over time and their maintenance needs (OECD, 2021^[99]). Ultimately, based on proposed improvements to databases, measuring progress in the ANK's implementation will help evaluate whether NbS effectively contribute to achieving Germany's goals. Germany can then take corrective action based on evolving socio-economic and climatic conditions (IPCC, 2022^[106]). Specifically, it can ensure that resources earmarked for NbS are efficiently used and allocated where they can have the most impact, secure long-term government funding and potentially attract private sector finance, as well as incentivise landowners, cities and municipalities to take up NbS (IPCC, 2018^[107]).

To evaluate NbS effectiveness, Germany should set clear objectives and targets and a measurement framework to assess progress against them before implementation. Further, compiling and communicating good practices, such as the pilot projects already initiated under the ANK, can significantly support the scale at which NbS are considered as part of the decision-making process. This could be accomplished through a repository, guidelines or other design tools.

Funding architecture

The ANK marks a step-increase in funding made available for NbS. Germany is among the frontrunners by making NbS eligible for funding, which globally is not common practice. The unprecedented amount of EUR 4 billion provides an opportunity to greatly upscale NbS and change long-standing, harmful practices that have degraded Germany's biodiversity. Total funding for NbS before the ANK is difficult to establish given their integration into a number of sectoral and subnational government budgets.

The budget for 2023 is EUR 590 million, compared to only 10 million in 2022. The currently planned budget envelope will further increase to EUR 1 billion in 2024 and EUR 1.2 billion in 2025 and 2026 respectively. In comparison, Scotland has committed to spend the equivalent of EUR 285 million on peatland restoration (25% of surface area is peatland) over the next ten years. Meanwhile, Canada is establishing the Natural Climate Solutions Fund, investing EUR 2.8 billion (CAD 4 billion) over the next ten years in nature conservation and restoration (Government of Canada, 2022^[108]). Globally, although difficult to compare and estimate, investments in NbS are estimated at EUR 125 billion (UNEP, 2022^[109]).

The ANK also includes existing measures funded through various programmes and other funding sources (Table 2.2). The former Energy and Climate Fund (now Climate and Transformation Fund), for example, finances climate protection policy programmes and includes individual components such as the Forest Climate Fund. Other financing mechanisms of NbS include carbon certificates offered to companies or individuals by the Länder Brandenburg, Mecklenburg-Western Pomerania and Schleswig-Holstein on the voluntary carbon market to finance the rewetting of peatlands (MoorFutures, 2019^[110]).

Table 2.2. Examples of funding programmes in support of nature-based solutions

Funding source	Measures funded	Amount of funding	Disbursement period
Immediate Climate Action Programme	Protection of peatlands, sustainable forest management and humus conservation and development	EUR 200 million EUR 100 million EUR 176 million EUR 200 million	From 2020 onwards From 2021 onwards From 2022 onwards From 2023 onwards
Federal Programme on Adaptation of Urban Areas to Climate Change	Green and blue infrastructure projects of cities and municipalities for climate protection and adaptation	EUR 290 million EUR 176 million	2020 2021
Forest Fund	Measures to reduce CO ₂ emissions, energy and substitution potential of forests and wood and to adapt German forests to climate change	EUR 157 million	Since 2013
Economic stimulus package 2020 (earmarked for forests and wood)	Addressing forest damage, reforestation and adapting forests to climate change	EUR 700 million	From 2020 onwards
Germany's Blue Belt Programme: Funding programme floodplains	Renaturation and reconnection of federal waterways and their floodplains	No fixed budget associated (up to a maximum of 75% of projects costs are financed)	BMUV: In 2023, earmarked budget of EUR 7 million
GAK	Improvement of agricultural structure and coastal protection (includes funding for private and communal forest owners to cope with forest damage and adapt forests to climate change)	EUR 800 million	2020-23
Funding Programme on Biological Diversity	Protection, sustainable use and development of biodiversity	EUR 45 million	From 2021 onwards

Note: Only selected funds and programmes are displayed. Funding of these can also be allocated to non-NbS measures.

Source: (German Government, 2021^[111]) (BMEL, 2022^[112]) (BBSR, 2022^[95]) (BfN, 2019^[113]) (BMUV, 2020^[91]).

Allocation of disbursement for ANK measures and corresponding recipients has not been determined. It will be important to set up appropriate funding mechanisms that make use of and co-ordinate with existing funding channels to Länder and sectors (e.g. GAK), within the constraints of the provisions of the Basic

Law and related budgetary requirements. The short timeframe and the large scope of the ANK represent a major challenge for the BMUV. Furthermore, it will be key to agree upon eligibility criteria for funding, as well as accountability mechanisms. Germany plans to use specialised agencies for natural climate protection to inform interested parties about funding opportunities. Appropriate funding mechanisms for the maintenance of NbS and beyond the initial phase will have to be set up to sustain the ANK's outcomes beyond 2026.

2.4. Building synergies for effective long-term climate action

2.4.1. *Fostering synergies between climate, biodiversity and water-related action*

The BMUV actively considers synergies in strategies concerning climate mitigation, adaptation, biodiversity and water. For example, forest and water strategies increasingly identify synergies with climate mitigation, adaptation and biodiversity, but these need to be translated into practice. The Forest Strategy 2050 sets measures to enhance biodiversity and nature protection. It provides financial incentives for forest owners to foster biodiversity and nature protection and establishes a monitoring system for forest ecosystems. The impact of these synergies in practice should be monitored and evaluated.

Similarly, the National Water Strategy considers synergies between climate mitigation, adaptation and NbS measures. It sets out how development of water bodies through NbS and other measures can enhance flood protection, as well as foster biodiversity and preserve ecosystems. It also encourages urban land-use practices compatible with water and climate policy objectives (BMU, 2021^[114]). In doing so, it acknowledges the strategy's goals are not always free of conflict with other policy areas. For example, it is challenging to reach a semi-natural water balance in areas where water is withdrawn by different sectors (e.g. mining, energy) (BMU, 2021^[114]).

The ANK is a unique opportunity to both foster synergies and demonstrate how this is done in practice. As it sets out to address climate change and biodiversity loss through NbS, the ANK can identify projects and demonstrate how they harness such synergies effectively. In doing so, the ANK's monitoring system should identify indicators that evaluate each NbS impact on different objectives.

The envisaged measures under ANK could benefit from more explicit emphasis on adaptation synergies. NbS projects financed by the ANK need to demonstrate their contribution to climate mitigation. However, they must also show their own exposure and vulnerability – and contribution to building the resilience – to the impacts of climate change. For example, new trees planted through the ANK to increase carbon storage must be adapted to expected changes in temperature or precipitation. Failure to do so risks undermining their impact over time. Similarly, while the National Peatland Strategy emphasises mitigation, water and biodiversity objectives, it pays less attention to adaptive capacity. Adaptation objectives are, however, important to consider as climate change is likely to impact rewetted peatlands. It can take decades for biodiversity and soil processes to restore in rewetted peatlands, which may leave their climate resilience levels lower than those of intact peatlands.

2.4.2. *Opportunities for increased EU and international co-operation*

Germany has contributed to – and benefited from – strong EU and international co-operation on adaptation. Its domestic efforts on adaptation and their importance are embedded within EU and international frameworks (e.g. Paris Agreement). At the EU level, the Green Deal, new Climate Law and Adaptation Strategy provide anchors for adaptation policy. In line with reporting requirements, Germany has increased efforts to measure adaptation as demonstrated by ongoing initiatives to quantify adaptation spending. Targeted EU funding has helped scale up implementation of adaptation initiatives, especially at subnational level. For example, the Horizon Europe Mission on Adaptation has the potential to scale up adaptation at local and regional levels via innovative solutions, a challenge many subnational actors face in Germany.

Furthermore, Germany has been an active participant in, and initiator of, information and knowledge exchanges with other EU member states and the European Commission, including the development of measurable adaptation goals.

EU platforms have also facilitated collaboration with countries where cross-border adaptation planning and investments are required. While Germany participated actively in EU and international collaboration, the 2021 floods affecting the Netherlands, Belgium and Germany demonstrated the need for further steps to assess and address cross-border climate risks. The forthcoming EU Climate Risk Assessment in 2024 can serve as an important catalyst for Germany to enhance its understanding of such risks and increase co-operation to tackle them. Acknowledging existing gaps, Germany, alongside Switzerland (Nathani et al., 2019^[115]) and the United Kingdom (Sturminski, 2022^[116]), increased efforts to assess cross-border climate risks. To that end, they identified climate-related supply chain risks, being a forerunner in this area and thereby responding to a key priority of the EU Adaptation Strategy. For other cross-border climate risks, such as migration from climate-vulnerable countries, EU and international co-operation will also be a vital tool to take appropriate measures and help developing countries to become more climate resilient (JRC, 2021^[117]).

Germany has promoted use and scaling up of NbS at international level, making it a key commitment under its G7 presidency in 2022 (G7, 2022^[118]). As a result, the G7 committed to protecting at least 30% of land and 30% of the ocean nationally and globally by 2030. Mirroring Germany's domestic policy objectives, the G7 also recognised the need to transform agriculture by creating synergies between biodiversity, climate change and food security (G7, 2022^[119]). Conversely, as recognised by the ANK and the National Peatland Strategy, Germany's own success in implementing the ANK programme will depend on certain pieces of international legislation. These include phasing out peat products' horticulture in support of measures which, without an EU-wide ban, would lead to shifting peat extraction abroad.

2.4.3. Germany's support to developing countries

Political commitment and international climate and biodiversity finance

Germany is strongly committed to supporting the implementation of Agenda 2030 for Sustainable Development in developing countries and emerging economies. German development co-operation has traditionally focused on environmental issues. Within the BMZ 2030 reform process launched in 2020, Germany further sharpened its commitment to tackle climate change and promote environmental protection. "Forging ahead with the Just Transition" is one of four priority areas of Germany's development policy (BMZ, 2023^[120]). In terms of geographic focus, the BMZ recently reduced the number of partner countries from 85 to 65, while maintaining a strong focus on Africa and Asia (OECD, 2022^[121]).

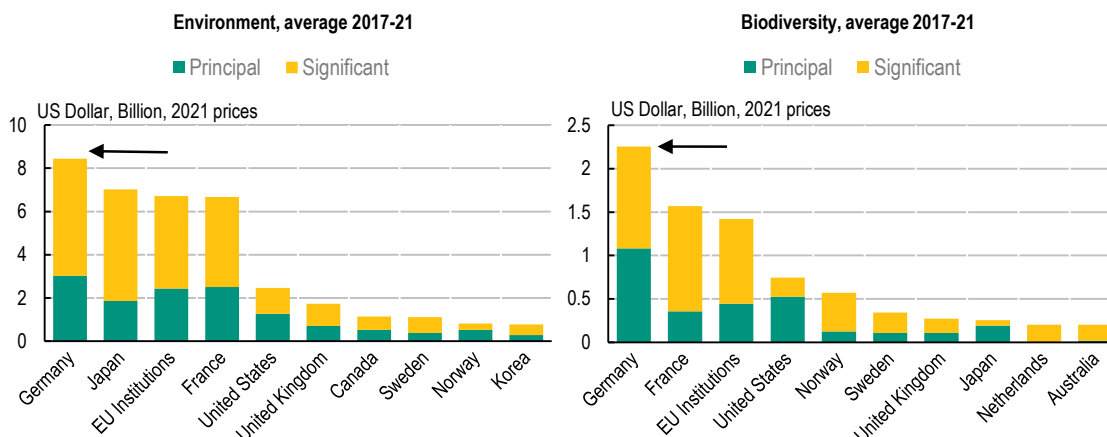
Germany recognises that Agenda 2030 and the Paris Agreement are intrinsically linked. In response, with other members of the OECD Development Assistance Committee (DAC), it committed to co-ordinate development approaches with international climate and environment objectives through a member-driven process. In line with the OECD-DAC Declaration of 2021, Germany aims to align its official development assistance (ODA) with the goals of the Paris Agreement (OECD, 2021^[122]). It supports developing countries' efforts to fight climate change, biodiversity loss and environmental degradation by channelling a substantial part of its ODA to these purposes.

With total ODA (USD 32.2 billion, preliminary data) representing 0.74% of gross national income, Germany is the second largest bilateral provider of ODA (OECD, 2022^[121]). This reflects a large increase in ODA, more than double the amount spent a decade ago (USD 12.7 billion in 2010) (OECD, 2012^[123]). It also makes Germany the largest provider of environment- and biodiversity-focused ODA globally (Figure 2.12). According to the Rio Markers, about 37% of Germany's bilateral ODA had an environmental focus in 2019-20, with about 16.8% spent on climate mitigation; 13.1% on climate change adaptation; and 10.8% on biodiversity (OECD, 2022^[121]). Germany has also been the largest donor of the Adaptation Fund, a key

multilateral instrument for climate adaptation financing. The OECD provides a comprehensive development co-operation profile of Germany, which is updated annually (OECD, 2022^[121]).

Figure 2.12. Germany is a major provider of ODA in support of environmental protection

Top ten providers of ODA on environment and biodiversity, in USD, in 2020.



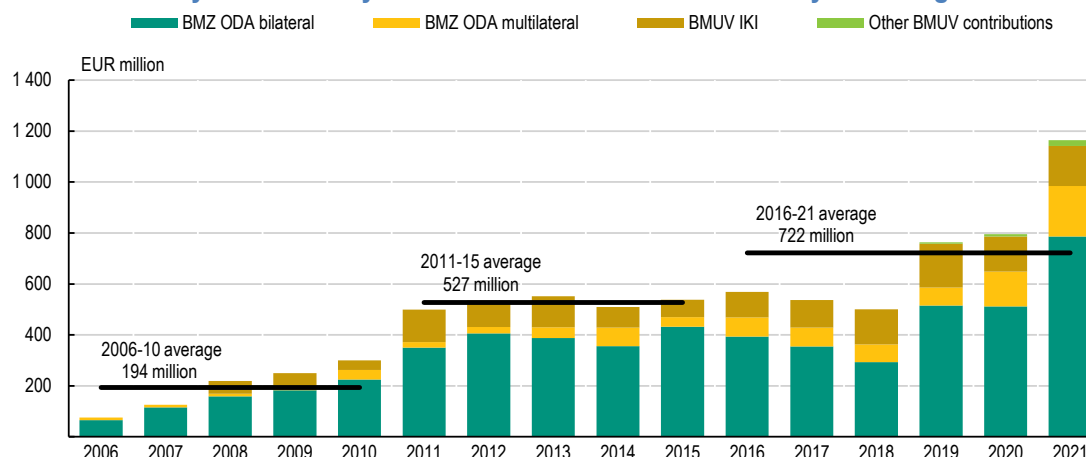
Note: Top 10 donors by Rio Marker. Bilateral allocable Overseas Development Aid (ODA), to developing countries, all sectors. In their reporting, donors are requested to indicate for each activity whether or not it targets environment and the Rio Conventions (biodiversity, climate change mitigation, climate change adaptation and desertification). A scoring system of three values is used, in which aid activities are "marked" as targeting environment as the "principal objective" or a "significant objective", or as not targeting the objective.

Source: OECD (2023), "Creditor Reporting System: Aid activities targeting Global Environmental Objectives", OECD International Development Statistics (database).

StatLink  <https://stat.link/vgskl9>

The federal government aims to scale up its international climate finance to reach EUR 6 billion annually by 2025, contributing to fulfilling the collective USD 100 billion goal. The country also works towards increasing the amount of finance committed to nature. As part of its EUR 6 billion package, Germany has pledged to reach EUR 1.5 billion annually for international biodiversity conservation beginning in 2025. This commitment, made on the sidelines of the 77th General Assembly of the United Nations in September 2022, would amplify the upward trend for biodiversity funding. It would more than double the average amount provided between 2016 and 2021 (Figure 2.13). Apart from budgetary sources, Germany also mobilises capital market funds and private climate finance. Germany total contribution of climate finance is estimated at about EUR 8.1 billion in 2021 (Federal Foreign Office, 2022^[124]).

Figure 2.13. Germany continuously increased international biodiversity financing



Note: BMUV= Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection; BMZ = Federal Ministry for Economic Co-operation and Development; IKI=International Climate Initiative; ODA = Official Development Assistance.

Source: (BMZ and BMUV, 2022^[125])

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Key stakeholders and initiatives

While the BMZ develops strategic orientations of Germany's development co-operation policy and oversees ODA reporting, two specialised agencies manage implementation of bilateral ODA. GIZ oversees technical co-operation and KfW (comprising KfW Development Bank and the DEG, the development finance institution) manage financial co-operation (OECD, 2022^[121]). Together, the two institutions deliver most of the bilateral co-operation projects in collaboration with partner countries' governments and other key stakeholders. In addition, Germany's International Climate Initiative (IKI) (Box 2.6) plays a key role in funding international climate action and biodiversity conservation. To a lesser extent, other ministries, including BMUV or BMEL, also contribute to adaptation action in other countries through a mainstreaming approach (Bundesregierung, 2020^[40]). Engaging with local partners and beneficiaries is also a key factor in many GIZ projects to ensure alignment and sustainability. Moreover, Germany supports a large number of multilateral organisations and initiatives, including the work of various OECD bodies (e.g. DAC, OECD Development Centre).

Box 2.6. Germany's International Climate Initiative

Germany's International Climate Initiative (*Internationale Klimaschutzinitiative, IKI*) is a key instrument of the federal government for funding international climate action and biodiversity conservation. Since 2008, it has supported developing countries in formulating and implementing their respective Nationally Determined Contributions under the Paris Agreement. The IKI has four major funding areas:

- Mitigation of greenhouse gas emissions
- Adaptation to the impacts of climate change
- Conservation of natural carbon sinks with a focus on reducing emissions from deforestation and forest degradation (REDD+)
- Conservation of biodiversity.

IKI uses idea competitions to select innovative projects. The process is open to non-governmental implementing organisations, which can apply for funds. IKI approved EUR 5 billion for more than 950 climate and biodiversity projects in over 150 countries between 2008 and 2021. Overall, Germany's assistance through IKI has been well targeted to countries most vulnerable to climate risks. As of 2022, three different ministries (BMUV, BMWK and the Federal Foreign Office) co-manage IKI. It will therefore be important to align priorities, ensure policy coherence and avoid increased administrative costs.

Source: IKI: www.international-climate-initiative.com.

For many years until now, Germany has contributed to the implementation of the Paris Agreement by supporting partner countries in formulating and implementing Nationally Determined Contributions (NDCs), long-term strategies, resilience plans and National Adaptation Plans (NAPs) under the umbrella of the NDC Partnership. It has supported the NAP Global Network for nearly one decade, and continues to do so. Germany also collaborates with the Vulnerable Twenty Group of countries (V20) and the Africa Adaptation Initiative. In addition, it is a member of the Coalition for Disaster Resilient Infrastructure and the Adaptation Action Coalition. Many other projects and policy dialogue platforms contribute to advancing Germany's global climate agenda, including the International Climate Club, which was initiated by Germany within its G7 presidency. Germany is committed to promoting a just energy transition and supports several long-term Just Energy Transition Partnerships to support the decarbonisation efforts of emerging economies (e.g. Indonesia, South Africa).

Within Germany's G7 Presidency in 2022, G7 countries committed to establish the Global Shield against Climate Risks, in partnership with the V20. The initiative, launched at COP27, aims to scale up insurance availability to support developing countries in addressing climate-related loss and damage. It follows up on recommendations in "Managing climate risks, facing up to losses and damages", an OECD study. The study, initiated by the BMZ, calls for enhancing global climate and disaster risk finance and insurance (OECD, 2021^[126]). Moreover, Germany is the largest supporter of the precursor to the Global Shield, the InsuResilience Global Partnership (EUR 800 million), which aims to give 500 million poor people access to insurance against extreme weather impacts by 2025. InsuResilience also supports the African Risk Capacity, an insurance pool which offers financial risk protection against the financial effects of droughts for African countries.

In the area of NbS, the BMZ allocates funding through bilateral projects and supports international initiatives such as the Legacy Landscapes Fund, the Blue Action Fund, the Global Fund for Coral Reefs, the African Forest Landscape Restoration Initiative (AFR100) and the Alliance for Development and Climate. In addition, it launched a new initiative on "Restoration of Ecosystems and Nature-based Solutions" in 2022.

In line with the “leaving no one behind” principle, Germany supports several initiatives for marginalised population groups (e.g. Indigenous peoples and local communities, Alliance of Small Island States, Sahel Alliance, early warning systems in least developed countries). Germany has been the biggest contributor of the Least Developed Countries Fund (World Bank, 2023^[127]). Between 2001 and 2021, Germany pledged EUR 415 million to the Least Developed Countries Fund and is in absolute terms, the largest contributor to that fund. (Deutsche Klimafinanzierung, 2022^[128]; World Bank, 2023^[127]). The 2021 OECD Development Co-operation Peer Review recommended that Germany develop further guidance and monitor more closely the extent to which its investments contribute to reducing poverty and inequality (OECD, 2021^[129]).

Monitoring, evaluation and learning framework

Within Germany's Sustainable Development Strategy, national voluntary assessments measure progress towards achieving the SDGs abroad. They provide a detailed target-by-target analysis of the impact of Germany's development co-operation. The 2021 OECD-DAC peer review suggests that Germany could be more systematic in addressing the spillover effects of its policies on developing countries (OECD, 2021^[129]). This is particularly true for environmental impacts along the supply chain (Box 1.10).

Within the BMZ 2030 reform, Germany developed standardised indicators to measure the impact of its co-operation activities across various countries and sectors. They also cover climate and environment-related core areas, providing an overview on the achievement of different metrics towards climate change mitigation, adaptation and biodiversity conservation. For example, they measure the number of people trained to adapt to climate change impacts or the additional square kilometres of natural protection (OECD, 2021^[130]). As of 2022, use of these indicators has become mandatory. It would be interesting to capitalise on this process and compare the indicators with ongoing work within the BMUV aimed at developing adaptation indicators for domestic policy implementation (Section 2.2.5). Several other initiatives are underway. For example, Germany's Institute for Development Evaluation (DEval) integrates climate-related aspects into its assessment of the German REDD+ and climate adaptation engagements. Results and recommendations are fed into new implementation processes, a formalised system for planning steps to implement evaluation findings (OECD, 2021^[130]).

Despite progress, there is room for greater exchange of experience in the implementation of climate, biodiversity and NbS policies. This includes reciprocal knowledge exchanges between Germany's sectoral agencies and its development co-operation agencies. So far, there has been no institutionalised process for learning from Germany's international actions to facilitate domestic policy development due to capacity constraints and the separation of financing responsibilities. However, Germany is exploring the creation of dialogue platforms to encourage exchange of experience between Germany's development practitioners and key stakeholders involved in national adaptation and NbS initiatives. This could be a positive development, facilitating incorporation of international lessons to enhance the impact and effectiveness of domestic policy. Other learning frameworks for South-South knowledge exchange (e.g. NAP Global Network) should also be further developed. There is a huge opportunity to improve the sharing of good practices and lessons learnt more systematically across different countries and regions.

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Notes

¹ Heat stress exposure (UTCI > 32°C) over the period 2017-21 compared to the reference period 1981-2010.

² Accounts for direct and indirect economic losses due to reduced yields of winter wheat, silage maize and field crops.

³ The exact amount is dependent on the climate scenario assumed (weak, medium, strong); numbers are measured in terms of cumulative changes in real GDP.

⁴ Exposure determines the degree to which a population, physical assets or ecosystems are exposed to climate hazards, while vulnerability refers to the propensity or predisposition to be adversely affected by a climate hazard (IPCC, 2022^[106]).

⁵ Measures included in the calculation are those set out in the latest Adaptation Action Plan (III) (assuming a “realistic” implementation) as well as potential adaptation opportunities identified for 29 key climate impacts assessed in the KWRA 2021.

⁶ Data is based on definition of protected area from the IUCN: “Data is based on World Database on Protected Areas” (WDPA).

⁷ Findings in this report were developed on the basis of a draft version of the ANK that was published in September 2022.

OECD Environmental Performance Reviews

GERMANY

Germany has continued to improve its environmental performance over the past decade. It has ambitious climate targets with the aim to reach climate neutrality by 2045 and achieve negative emissions after 2050. Nevertheless, Germany will need to further accelerate climate action, particularly in the buildings and transport sectors, and address the triple crisis of energy, climate and biodiversity in an integrated and holistic manner. As part of its energy crisis response, Germany has taken a series of measures, which are historic in size and scope. They are set to massively accelerate its green energy transition in the coming years. It is also scaling up its engagement on climate change adaptation across all government levels and has initiated an ambitious programme to foster investments in nature-based solutions. This is the fourth *OECD Environmental Performance Review of Germany*. It provides 28 recommendations to help Germany further improve its environmental performance.

