EASA
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EUROCONTROL

A Framework for Environmental Performance Enhancement through Technological and Procedural Advancements

Catalogue of Tools and Dashboards & Overview of Best Practices by ANSPs

Pillar 2 – Final Report
Volume II - Catalogue

Acknowledgements

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ABOUT THIS DOCUMENT

This document constitutes Volume II of the final report from the Aviation Environmental Reporting Working Group (hereafter referred to as 'AVENIR WG'), Pillar 2.

It focuses on how individual Air Navigation Service Providers (ANSPs) enhance their environmental performance through the adoption of new technologies, procedures and the utilisation of calculation tools and dashboards.

The "*Catalogue of Tools and Dashboards*" offers ANSPs an overview of available solutions for evaluating fuel consumption, emissions, noise, and their related interdependencies. This catalogue promotes knowledge sharing, minimises duplication of efforts and assists ANSPs in selecting suitable tools that align with their specific operational environments.

> Note: the group has incorporated solutions based on the best available knowledge and presentations received. The catalogue is intended to be a dynamic resource that will continuously be updated with additional tools and dashboards.

In addition to the catalogue, this document includes use cases from ANSPs that illustrate how they have employed the tools described in the catalogue or other methodologies to enhance the environmental efficiency of operations while taking interdependencies into account. This was achieved among others through the participation of ANSPs in two complementary questionnaires, one initiated at the commencement of the sub-group, and the other towards the conclusion of the work. The questionnaires examined how ANSPs manage environmental aspects and calculate related impacts, with an emphasis on technological and procedural changes associated with Air Traffic Management (ATM) considerations. Details can be found in Section 6.

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1 Introduction

One of the purposes of the AVENIR WG was to develop methods and provide insight into how individual ANSPs improve environmental performance through the implementation of new technologies and procedures.

With a focus on exchanging best practices on how the impact of the changes is measured, how environmental performance and all the trade-offs are explained, the goal of Pillar 2 was the creation of a repository containing this information.

Based on presentations made to the group between 2023 and 2025 and various workshops, this document offers ANSPs an overview of available solutions for evaluating fuel consumption, emissions, noise, and their related interdependencies. It promotes knowledge sharing, minimises duplication of efforts and assists ANSPs in selecting suitable tools that align with their specific operational environments.

2 Catalogue of Tools

The various tools described in this document help estimate fuel consumption, emissions and noise to better analyse environmental impacts, address interdependencies and facilitate constructive exchanges with aircraft operators and local communities.

The tools have been designed to objectify pollution (not nuisance[1]) and the emission of gaseous pollutants, and to create a solid basis for further steps. None of the software packages are meant to “judge”, they just provide factual outputs based on the inputs made by the users. Some of the tools focus on the analysis of completed flights, while others are designed for the calculation of planned procedures. Some applications offer both functionalities, while others include the capability for noise impact assessments.

> Note: the information presented in this section has been collected via presentations made to the sub-group by experts from the organisations providing the tools or using them, and/or from information publicly made available on the websites of those organisations. Since the document targets experts, and to avoid making it unreadable, it does not provide the explanation of the acronyms in the description of the tools or dashboards itself. The acronyms can be found in Section 7.

[1] Unwanted sound that, when noise reaches certain levels and intensities, can be annoying and adversely impact people's mental or physical health. (Source: Noise - Law and policy - https://environmentlaw.org.uk/LYE/LYE/Noise/noise-home.aspx).

2.1 AEM

The Advanced Emission Model[2] (AEM) is a software suite which is used for calculation of aircraft engine emissions using 4-dimension trajectories that are cut in segments. It provides the option to calculate 24 pollutants, e.g., CO_2, NO_x, PMs, HC, Cl, SO_x.

One of the different available run modes of AEM allows calculation based on the ICAO CAEP trends method:

- Below 3,000 feet, the fuel burn calculation is based on the LTO cycle defined by the ICAO Engine Certification specifications. The ICAO LTO cycle covers four modes of engine operation: approach, taxi, take-off and climb. They are used in AEM to model the following six phases of operations: taxi-out, taxi-in (idle), take-off, climb-out, approach and landing (approach).
- Above 3,000 feet, during the Climb, Cruise, Descent phases of flight, the fuel burn calculation is based on EUROCONTROL's BADA model, by using pre-calculated aircraft performance tables. It derives aircraft engine emissions from the calculations.

AEM options and setups allow users to adapt the model to their own context and available information: use of input fuel flow (ex. flight data recording, cockpit and real time simulators), atmospheric conditions at the flown segment, adaptation to the study context and reference database evolutions (aircraft and engine definition, default atmospheric model, taxi times, etc.)

The BFFM2 model is used for calculation of non-linear pollutants such as NOx, CO, HC (&VOC TOG) and vPM. The nvPM MEEM is applied for the calculation of nvPM. AEM provides engine emissions indices for jet and piston engines. Particles emission indices are determined with the FOA4 method.

AEM supports service providers in their environmental efforts as follows:

- Emission Estimation: AEM estimates aircraft emissions and fuel burn for various flight profiles and scenarios. It calculates the mass of fuel burned and the corresponding emissions of pollutants such as CO_2, NOx, SOx and particulate matter.
- Detailed Analysis: The tool analyses flight profile data on a flight-by-flight basis, allowing for detailed assessments of emissions for specific air traffic scenarios, from local airport studies to global emissions.
- Regulatory Compliance: AEM helps providers comply with international environmental standards and regulations by providing accurate emissions data that can be used for reporting and regulatory purposes.

[2] https://www.eurocontrol.int/model/advanced-emission-model.

- Scenario Modelling: The tool can model different operational scenarios to assess their environmental impact, helping service providers plan and implement more sustainable air traffic management practices.

AEM Provider

AEM is part of the current environmental tool suite of EUROCONTROL composed of three main models:

- Advanced emission model.
- Open-ALAQS.
- IMPACT.

AEM Versions and OS Requirements

The current version of AEM is AEM 2.6.2b. It has been available since March 2025.

AEM is currently presented as a suite of different tools:

- AEM
    - AEM_CLI: Standalone command line exe.
    - AEM_GUI:Standalone GUI exe.
    - AEM_GEO: Pre-processing trajectory filter.
    - AEM database files.
- AEM API
    - AEM_DLL: AEM Calculations c++ library.

AEM is available for WindowsX:

- AEM_CLI, AEM_GUI, AEM_GEO, AEM database files.
- AEM API (.dll c++ dynamic library).

For Linux – Red hat 7 & 8:

- AEM_CLI, AEM database files.
- AEM API (c++ .so shared object).

AEM is using the following databases/information (AEM 2.6.2b – 2025 version):

- BADA fuel flow and Mach number (BADA3).
- Engine LTO indices (ICAO AEED v30, FOCA).
- Aircraft-engine mapping (ECAC traffic – baseline 2024).
- Airport taxi times (CODA and EUROCONTROL recorded taxi times 2023).

AEM Data Requirements

The following data is required for calculations:

- Aircraft type (ICAO type or user identified).
- Attitude definitions depending on:
    - Phase of flight: climb, level or descent, level off during climb or descent, descent at 3 degrees, hold.
    - Aircraft weight category: nominal, low and high.
- The time and date of each trajectory segment point.
- The number of movements (large traffic aggregation purposes).
- Cruise altitude (the first top of climb altitude during the cruise phase).
- ADEP and ADES.

The following data can be input to improve the precision of the emissions calculations:

- True Air Speed or Mach number.
- Atmospheric conditions at the segment.
- Aircraft fuel flow.

AEM is using reference databases for airports (EUROCONTROL database) and the EUROCONTROL CODA database (baseline 2023) is used for taxi times. For atmospheric model and constants, ICAO ISA standards, ICAO, EU and ECAC databases are used.

AEM Limitations

Limitations of the AEM tool are as follows:

- BADA fuel burn – simplified performance model:
    - Static fuel rate model – AEM is not a total energy model.
    - Input speed and thrust are not used; aircraft weight decrease is not modelled.
- AEM reference database:
    - Default values (to be adapted to the user context).
    - Turboprops database is not included by default (Swedish FOI database – non-disclosure agreement).

AEM Future Developments

- Add single LTO segment type, for example: add only taxi segments.
- nvPM method updates:
    - Implementation of the ICAO CAEP 13 proposed method.
- Helicopter fuel and emissions modelling.

AEM High-Level Assessment

Table 1: AEM assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	EUROCONTROL ensures that the tool remains aligned with evolving env standards. Frequency of updates depends on the calculation methodologies changes, and the reference data updates (e.g., engine emissions indices). Ad-hoc aircraft engine mappings can be provided on a yearly basis.	++
Computational Performance	The tool is designed to handle various air traffic scenarios efficiently and is also the basis for the calculations within the IMPACT and the R-NEST models. The tool is adapted for multi-threading runs. Its computational performance allows for the processing of different scenarios, from airport studies to comprehensive global assessments, in a reasonable time frame.	+++
Usability	AEM is delivered with an automatic installer file, user guide, release note and installation file. AEM API is delivered with dynamic linkage file, interface files and code documentation. AEM tools are dedicated to aviation environmental impact analysts, and their use requires pre-requisite domain expertise. AEM main complexity comes from the adaptation of the input files to the emissions model and the reference to the specificities of the exercise (e.g., fleet definition, etc.) Furthermore, AEM tools are also built up to be included in a more global and automatised workflow. Nevertheless, the user-interface (AEM SUI, Window X) provides easy access to the options selection and processing. The input and output files can be edited with simple spreadsheet tools. Output consists in the enrichment of the input information with the corresponding calculated fuel and emissions amounts. Aggregations are possible (by flight, etc.).	++
Stakeholders' acceptability	AEM is deployed worldwide, with more than 80 multi-users active AEM licenses and with the IMPACT licenses. It is one of the validated emissions calculations models for ICAO/CAEP, the main model for establishing EEA inventories and several EUROCONTROL fuel and emissions reporting (e.g., EUROCONTROL FlyingGreen, PRU).	++
Flexibility and customization	AEM can analyse air traffic scenarios of varying scopes, from local to global, from gate to gate, different operational strategies and policy implementation. AEM options and information setup make the tool adapted for all the LTO and CCD fuel and emissions modes. The AEM DLL is adapted for C++ tool workflows solutions. AEM is adapted for future aircraft types modelling.	+++

CRITERIA	DESCRIPTION	SCORE
Maintenance & Availability	AEM is provided with a user manual and examples. AEM API is provided with the code documentation. Training can be provided on an ad-hoc basis. Support is offered by EUROCONTROL. The tool is under continuous development, as it among others forms the basis for calculating emissions and fuel consumption within tools such as IMPACT and R-NEST.	++

2.2 Open-ALAQS

The Airport Local Air Quality Studies[3] tool (Open-ALAQS) was developed in the context of SESAR to allow its providers to perform local air quality assessments. The tool can be used also for forecasting air quality (e.g., following changes in infrastructure and/or traffic, use of SAF etc.) and for action planning.

The current version is called Open-ALAQS v4, the last major update was provided in January 2025. The source code is, for the first time, publicly available on GitHub under the European Union Public Licence v.1.2.

The key difference with other EUROCONTROL tools is that Open-ALAQS is not limited to aircraft emissions but can calculate emissions from various airport (non-aircraft related) sources including road traffic emissions.

Open-ALAQS can calculate and visualise or export emissions for each of the available source types. The user can just select one emission source or have the whole picture by selecting all sources at the airport at the same time. Sources can be chosen also by name, so the software offers great flexibility in modeling emissions based on their needs.

There are two methods for calculation:

1. By ICAO mode which is covering the whole LTO cycle (all 4 different phases within the LTO cycle).
2. BFFM2 – more advanced method.

For those who are familiar with dispersion modeling it is useful to mention that Open-ALAQS also allows to set receptor points or so-called "points of interest". Defining those points allows the user to flag significant points, such as a school, a hospital, etc.

An important element that is included in the calculation is meteorological data (e.g., METAR, SYNOP). If precise methodological information is not available, standard atmospheric conditions (ISA) are applied.

[3] https://www.eurocontrol.int/online-tool/airport-local-air-quality-studies

IMPACT supports service providers in their environmental efforts as follows:

- Emission Estimation: Open-ALAQS estimates emissions from various airport sources, including aircraft operations and on-airport infrastructure like landside and airside road traffic. This helps the service providers understand the sources and levels of pollutants.
- Comprehensive Modelling: The tool performs a four-dimensional inventory of emissions, calculating and aggregating emissions from both airport and non-airport sources. This comprehensive approach allows for detailed analysis and better management of air quality.
- Dispersion Modelling: Open-ALAQS is coupled with AUSTAL, a dispersion model to calculate pollutant concentrations at and around airports over time. This helps assessing the impact of their operations on local air quality and identify areas for improvement.
- Regulatory Compliance: The tool is compatible with European legislative requirements for pollutant concentrations, helping service providers ensure they meet environmental standards.

Open-ALAQS Provider

EUROCONTROL.

Open-ALAQS Versions and OS Requirements

Open-ALAQS is developed as a plugin for the open-source geographic information system QGIS. It is fully based on an open architecture, making it easily adaptable to other GIS platforms and databases.

The current version of Open-ALAQS is a cross-a- platform tool, which means it can be used on Windows, Linux, or MacOS.

Open-ALAQS Data Requirements

The following databases are used in Open-ALAQS:

- ICAO Engine Emissions Database for jet engines Emission Factors (EFs).
- FOCA Piston engine EFs.
- Possible to use turboprops EFs from the FOI database.
- ANP Database for performance profiles.

To create a new study, it is necessary to provide some general information starting from the name of the project, basic information about the airport (at least ICAO code), the average fleet year and the country, to assign/use the country-specific emission factors.
The next step is to design the emission sources for the chosen airport like taxiways, runways etc. The software supports the use of different base maps which allows the user to create a very precise and detailed picture of the airport. An additional functionality is added to Open-ALAQS to facilitate the creation of emission sources based on the geographic data (roads, buildings, points of interest and more) provided by OpenStreetMap.

The user can also create road traffic emission sources (airside or landside), including parking spaces. Using COPERT V, Open ALAQS can estimate the custom emission factors for those sources based on user defined activity data, like the number of vehicles used or the composition of the fleet. The emission factors are then calculated for the given configuration and for each specific roadway segment in the study, which makes it more accurate and offers higher flexibility.

Open-ALAQS Limitations

Currently, there is no possibility of considering real aircraft trajectories (e.g., ADS-B). Aircraft emissions are based on fixed-point profiles from the Aircraft Noise and Performance (ANP) database which contains a standardised dataset with information related to aircraft flight performance under various conditions.

Open-ALAQS Future Developments

Open-ALAQS remains independent of the dispersion model and other similar modules can be added in the future. A new module is under development that will allow the handing of real aircraft trajectories from ADS-B data, including ground (taxiing) tracks for higher accuracy.

Open-ALAQS High-Level Assessment

Table 2: Open-ALAQS assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	EUROCONTROL periodically updates the tool to incorporate advancements in modeling techniques, data accuracy and regulatory requirements. The tool is regularly updated.	++
Computational Performance	Open-ALAQS handles a range of scenarios with varying complexities, enabling users to conduct detailed air quality assessments efficiently; however complex studies require time to process data.	++
Usability	Open-ALAQS generates comprehensive reports and visualisations related to airport emissions and air quality and this support user in decision making. The tool offers a user-friendly interface that facilitates data input, scenarios configuration and management of studies.	++
Stakeholders' acceptability	There is no official information available.	+
Flexibility and customisation	Users can tailor assessment to specific needs and objectives.	++
Maintenance & Availability	EUROCONTROL has developed comprehensive documentation to assist users in understanding Open-ALAQS functions. This document is available or accessible on GitHub.	++

2.3 IMPACT and INTACT

The Integrated Aircraft Noise and Emission Modelling Platform[4] (IMPACT) is a web application for assessing the impact of aviation on the environment in terms of noise, gaseous and particulate emissions. It implements the BADA 4-based Total Energy Model for modelling flight trajectories.

IMPACT is compliant with the ECAC Doc 29, and an approved model for conducting assessment within the MDG of the ICAO CAEP.

IMPACT is a solution for airspace changes in a TMA for SID, STAR and vertical procedures, as well as for network route changes studies and analysis of en-route flight procedures including flight efficiency.

Another option to use IMPACT is for airport noise exposure assessment according to best practice, which supports the END 2002/49/EC and the ICAO Balanced Approach. It also provides the required flexibility to address more specific requirements linked to national regulatory airport noise mapping.

The outputs are as follows:

- Fuel consumption and emissions – fuel burn/CO_2 masses, 25 pollutant masses (NOx, SOx, HC, CO, PM, etc.), aggregation of results per phase of flight, time, FL range etc.
- Airport noise – noise contours for metrics such as: SEL, Lden, DNL, LAeq, LAmax, NAx; noise contour area and number of people inside the contours.

IMPACT supports ANSPs in their environmental efforts as follows:

- Advanced Assessments: IMPACT provides detailed assessments of fuel consumption, emissions and noise impacts of air traffic operations. This helps ANSPs understand the environmental footprint of their activities.
- Regulatory Compliance: The tool aligns with international standards and regulations, such as those set by ICAO, ensuring that ANSPs meet necessary environmental requirements.
- Scenario Analysis: IMPACT allows ANSPs to model different operational scenarios and their potential environmental impacts. This helps in planning and implementing more sustainable Air Traffic Management practices.
- Data-Driven Decisions: By providing accurate and comprehensive data, IMPACT enables ANSPs to make informed decisions about how to reduce their carbon footprint and improve sustainability.
- Transparency and Reporting: The tool supports environmental transparency by helping ANSPs report their environmental performance and progress towards sustainability goals.

[4] https://www.eurocontrol.int/platform/integrated-aircraft-noise-and-emissions-modelling-platform

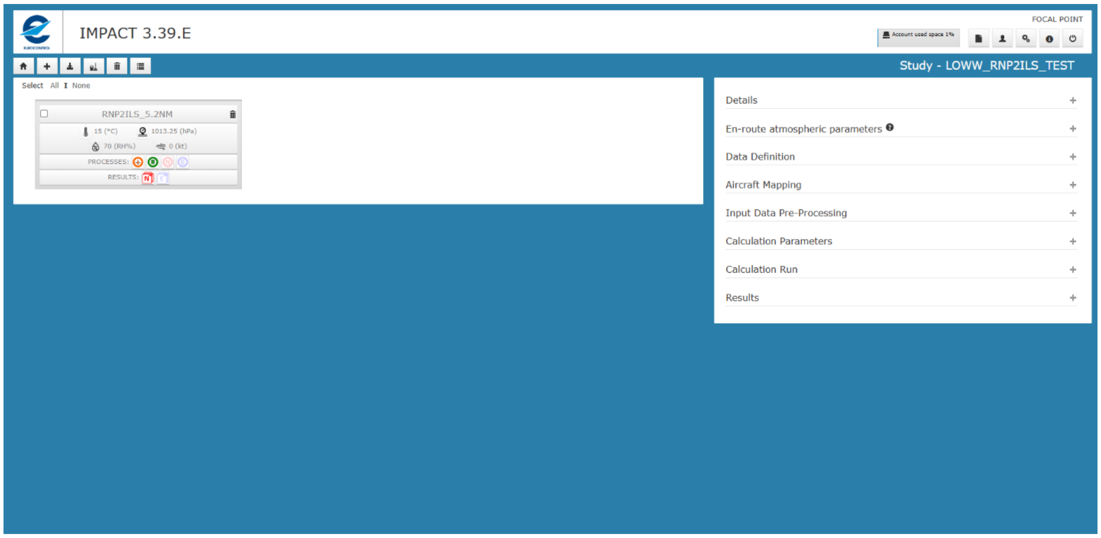


Figure 1 – IMPACT – Work interface

IMPACT Provider

EUROCONTROL.

IMPACT Versions and OS Requirements

Web-based application which does not have specific versions (other than internal updates) and OS requirements.

INTACT is an automated version of IMPACT for assessing local impact of air traffic on the environment. INTACT provides real-time assessment and allows processing of large volume of data. It is connected directly to data sources like airport data and ATM data, can configure static data and control and monitor live exercises. This includes the creation of live noise maps and live emissions graphics.

IMPACT Data Requirements

Supported input data types include the following: airport, RWY, ground tracks (point or vector tracks), vertical flight procedures, pre-calculated “4D” trajectories (engine thrust values are required in this case) and detailed list of operations.

IMPACT Limitations

Areas which are not covered by IMPACT:

- En-route noise – only modelling below 10.000ft possible.
- Rotorcraft noise and emissions modelling.
- Ground APU and taxiing noise and emissions.
- Overflight noise & emissions.
- Airport local air quality.

IMPACT Future Developments

There is currently no information available about future developments.

IMPACT High-Level Assessment

Table 3: IMPACT assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	The tool is updated a couple of times a year, as necessary to remain aligned with current standards and policies.	+++
Computational Performance	IMPACT is a web application, all computations are performed on EUROCONTROL dedicated servers, optimising performance and reducing load on the user side. The platform can process a wide range of scenarios, from simple to complex scenarios.	+++
Usability	The initial training provided by the tool provider is needed, meaning that it can be considered user-friendly. The tool provides outputs such as noise contour shape files, population counts, estimates of fuel burn and emissions for various pollutants. All these outputs are designed to be easily accessible and interpretable.	++
Stakeholders' acceptability	IMPACT successfully passed ICAO stress tests, meaning that the tool is aligned with current standards and policies. IMPACT is recommended for conducting assessments in SESAR and aligning with ICAO guidelines.	+++
Flexibility and customisation	IMPACT enables consistent trade-off analyses between fuel burn, emissions and noise. It also helps users evaluate the impacts of different scenarios and operational changes, but for more complex studies it is not always easy to get all the needed input data - e.g., engine thrust.	++
Maintenance & Availability	The tool has very good technical support, EUROCONTROL provides comprehensive user training, and a user manual is also available. In case of questions, support is available from the IMPACT support team.	+++

2.4 NEST

The Network Strategic Tool[5] (NEST) is a scenario-based modelling tool for network capacity planning and airspace design developed by EUROCONTROL. It is accessible via the DDR Portal[6] (Demand Data Repository), on request.

> Note: the information provided in this section has been developed by the members of the sub-group without validation by the NEST providers.

[5] https://www.eurocontrol.int/model/network-strategic-modelling-tool
[6] https://www.eurocontrol.int/ddr

The tool can also be used locally by ACCs, airports and globally by other stakeholders involved in strategic planning at the network level.

The main functions discussed within the group and some key features of NEST are:

- Data Processing:
    - NEST uses datasets provided by EUROCONTROL at the end of each AIRAC cycle, describing the consolidated pan-European airspace and route network, the traffic demand and distribution as well as the EUROCONTROL traffic forecasts. Also, daily cumulated traffic with minimal environment is provided, allowing access to traffic data before the end of the AIRAC. Data originates from different sources such as PRISME, STATFOR, DDR2… All data is checked, consistent and interconnected.
    - It can handle large datasets spanning multiple years, providing detailed analysis down to 10-minute intervals. This capability is crucial for accurate and comprehensive planning.
    - Traffic data (post-ops analysis, statistics, delays), airspace data (ACC, sectors, Traffic Volumes, Configurations), RAD or LoA restrictions and data on route charges.
    - Traffic data consists of FTFM, RTFM and CTFM, also referred to as respectively m1, m2 and m3.
    - The function allows the user to visualise the RAD restrictions or LoA constraints applicable to a certain flight / flow.
- Airspace Design:
    - NEST allows to visualise the airspace for which the user wants to analyse traffic or design the airspace to simulate. The user can start from scratch or from an existing airspace adapted vertically or laterally.
    - It can also be used to create a new route structure, whether for a conventional (ATS), conditional (CDR) or free route airspace (FRA) network.
- Simulation tool:
    - NEST can generate future traffic samples using traffic growth forecasts using STATFOR and calculate 4D flight trajectories considering aircraft performance data and various constraints like route restrictions, flight level constraints and military area opening times.
    - Scenario-Based Modeling: NEST allows users to create and modify scenarios to explore various operational planning options. This flexibility helps in designing and developing airspace structures and planning capacity. Users can make changes to the original dataset or reference scenario to model an unlimited number of different operational planning options.

  - This simulation function allows the users to create their own scenarios with – for example – opening a shorter plannable routing and assign the traffic to this newly created network.
  - CAPA simulations: NEST can simulate the impact of capacity changes for a sector or collapsed sectors. It is also able to assess the CAPA impact of a change in sector configuration.
  - ENV simulations: NEST assigns the shorter route to the flight. It is then possible to compare the "baseline" and "new" trajectories graphically and via an Excel sheet that is automatically generated with detailed results, showing the difference in flying distance and time, fuel, CO_2 and NOx.
  - Cost EFF (cost effectiveness, i.e., route charges) simulations: NEST can also simulate and assign traffic on the cheapest route possible. An Excel sheet is produced which indicates financial impact per flight, per country and per flight per country.
- Optimisation: The tool includes features like configuration optimisation, assessment of route charges, regulation building and delay simulation to help manage and mitigate traffic overloads and delays.

NEST provides a suite of data visualisation features including tables, charts and fully integrated capabilities for creating 2D/3D presentations.

The tool supports environmental efforts of ANSPs in several ways:

- Efficient Airspace Design: By optimising airspace structures and traffic flows, NEST helps inform ANSPs about potential fuel savings and unnecessary emissions. Efficient routing and airspace management lead to shorter flight paths and reduced CO_2 emissions.
- Capacity Planning: Proper capacity planning ensures that air traffic is managed efficiently, reducing the need for holding patterns and delays, which in turn lowers fuel burn and emissions.
- Simulation of Environmental Scenarios: NEST can simulate various environmental scenarios, allowing ANSPs to assess the impact of different operational strategies on emissions and fuel consumption. This helps in making informed decisions that balance operational efficiency with environmental sustainability.

NEST Provider

EUROCONTROL.

NEST Versions and OS Requirements

NEST is a Windows based software. There is no need for Admin right and it can be installed easily by the user after access granted via the DDR. AIRAC data can be downloaded for every cycle directly from the tool.

NEST Data Requirements

NEST uses datasets provided by EUROCONTROL at the end of each AIRAC cycle, describing the consolidated pan-European airspace and route network, the traffic demand and distribution as well as the EUROCONTROL traffic forecasts. Also, a daily cumulated traffic with minimal environment is provided every day, allowing to access traffic data before the end of the AIRAC.

NEST Limitations

Nothing to communicate by the group members.

NEST Future Developments

Nothing to communicate by the group members.

NEST High-Level Assessment

Table 4: NEST assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	NEST relies on datasets provided by EUROCONTROL. The tool is updated at the end of each AIRAC cycle, ensuring that the data reflects the most current information available.	+++
Computational Performance	NEST can handle large-scale datasets. It supports detailed scenario modelling, from simple to complex simulations. Tool can provide different scenarios of different complexities in a reasonable time, especially when optimised dataset and suitable hardware is used. However, for highly detailed analyses, processing times can be substantial.	+++
Usability	The data consultation and airspace design functions are simple to use. However, the simulation function requires to have a certain experience and knowledge for the appropriate interpretation of the results.	+
Stakeholders' acceptability	The tool has the buy-in from various key stakeholders working on network capacity planning, airspace design, traffic flow organization, and scenario-based simulations.	++
Flexibility and customisation	The tool is highly flexible in terms of creating different scenarios or case studies, user and evolving policies, including environmental considerations, however it was not primarily created for ENV calculations. Nevertheless, NEST supports fuel burn and CO_2 emissions estimation.	++
Maintenance & Availability	Training as well as technical support is provided by EUROCONTROL; development of the tool is done on a permanent basis.	++

2.5 R-NEST

The Research Network Strategic monitoring Tool[7] (R-NEST) is a strategic tool used for research in network operations, focusing on flow management. R-NEST is primarily used for network performance assessment, evaluating new working methods, tools, or organisational structures. It shares a lot of data and has a common module with NEST, but the workflow and HMI have been adapted for concept validation and research.

R-NEST is a tool dedicated to:

- Assess new concepts.
- Evaluate deployment scenarios.
- Develop new features and metrics for EUROCONTROL and associated research partners.

R-NEST is a dynamic simulation tool which models the behavior of main stakeholders like the Network Manager, ANSPs for flow management, airports and airlines in pre-tactical and tactical phases. Regarding simulation, R-NEST is very close to reality. R-NEST includes a full ATM delay model (i.e., all causes of delays are modelled), integrating the CASA algorithm from the Network Manager and modeling operational noises with non-ATM daily models.

In general, R-NEST is a comprehensive tool for simulating network operations, performance evaluation and future air traffic management concepts. It is designed to support research, simplify simulations and facilitate performance evaluation and analysis of deployment scenarios.

R-NEST Provider

EUROCONTROL.

R-NEST Versions and OS Requirements

R-NEST is Windows based software.

R-NEST Data Requirements

R-NEST, similarly to NEST, uses datasets provided by EUROCONTROL at the end of each AIRAC cycle, describing the consolidated pan-European airspace and route network, the traffic demand and distribution as well as the EUROCONTROL traffic forecasts. R-NEST can process and consolidate large quantities of data spanning over multiple years but makes it possible to drill down into the details by analysing and observing 10-minute periods of data.

R-NEST Limitations

R-NEST tool is used only by EUROCONTROL and the associated research partners under SESAR projects. At present, the tool is not generally available other than as a part of specific projects.

[7] https://www.eurocontrol.int/solution/rnest

R-NEST Future Developments

Because simulations can be very often complex, there was an interest in simplifying the whole process of work with the tool. After the simulations are done, the process of analysis has been started, and the analysis dashboard was integrated to allow the matrix computation and the multiple scenario comparison. Reporting is not yet part of the R-NEST tool, but it is a part of the evolution roadmap.

Future developments are expected as follows:

- Improved airports & TMAs modelling – enriched SID/STAR – more precise definition.
- R-NEST Modernisation – Airspace design & Network routes – Flight route assignment (RAD rules).
- Support to SESAR3:
    - Contrails – visualisation and simulation.
    - Pairing Flights.
    - Virtual Centres.

R-NEST High-Level Assessment

Table 5: R-NEST assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	R-NEST uses the DDR2 data (archive from the operational system).	+++
Computational Performance	R-NEST requires a high-end computer with dedicated 3D graphic card and at least 32 Go of RAM. R-NEST performance is excellent, being able to simulate a standard day of operation (i.e., around 30000 flights) in less than 2 minutes.	+++
Usability	R-NEST provides a clear interface, using the latest up-to-date technology. Workflows have been specifically designed to support validation and research activities.	++
Stakeholders' acceptability	R-NEST is recognised by the industry and the research partners as a unique ATM network-wide simulation tool.	++
Flexibility and customisation	R-NEST is designed to adapt to different use cases, compare scenario actual and future. R-NEST has been used in the SESAR MODUS project to evaluate the impact of future environmental policies on aviation and speed train evolution in Europe.	++
Maintenance & Availability	R-NEST is supporting on-going research activities and projects under the umbrella of the SESAR 3 program. For supported projects, beginner (1 day) and advanced (3 days) training sessions are available, in addition to technical support provided by the R-NEST team.	++

2.6 ACROPOLE

The AiCRaft OPerations nOise and Fuel Efficiency[8] project (ACROPOLE) was developed with the objective of estimating fuel consumption based on radar data. It is based on the ACROPOLE model, that uses artificial intelligence such as supervised learning models built with airlines to provide an accurate prediction of fuel flow and consumption.

The project also aims to present environmental performance indicators on dashboards.

Current ACROPOLE users in DSNA are:

- The Environmental Affairs for fuel burn assessment allowing to perform studies.
- Operations Directorate for performance monitoring, including identification of inefficiencies. This is supported by dashboards.
- ATCOs for awareness and visualisation.

The first objective of the ACROPOLE project targeted the models (fuel and emission).

The fuel model of ACROPOLE makes use of a regression model based on QAR data. A neural network (i.e., AI) has been created that estimates fuel flow based on available parameters in the radar track (speed, altitude) and aircraft and engine parameters.

The model meets the need for ANSPs to estimate consumption from radar data using an AI model that considers real altitude profile (versus pre-defined profile in modelling tools) and is autonomous regarding on-board data (that are held by the airlines).

The fuel model performance was compared against other models by using 1,000 test flights of an A320-214 using real mass and TAS and led to a fuel burn error of 2.73%.

The model also allows calculations to be done quicker than for other models, thanks to the use of neural network.

The emission model is the ICAO engine databank for emissions and the BFFM2 method.

The second objective of the project was to provide targeted indicators for ANSP performance based on fuel, trying to remove effects caused by e.g., weather conditions. This is done by clustering flows and using statistics per aircraft type and using a “wind correlation coefficient” to remove weather impact of the wind in the computation.

One of benefits of the ACROPOLE tool is that it can be trained to deal with missing parameters, meaning that the model could be efficient for aircraft types it has not been trained on (generalisation properties, which is under development).

DSNA is in the process of implementing tools to calculate and present existing CDO/CCO performance indicators, with plans to enhance them using fuel consumption data derived from the ACROPOLE model. In this approach (see Figure 2), radar data, which is stored and centralised in a Big Data environment, will be supplemented with information related to the implementation of CCO/CDO, as defined by the Eurocontrol CCO/CDO Task Force. This includes the position of

[8] https://www.ecologie.gouv.fr/sites/default/files/documents/Plaquette_Acropole_VF.pdf

the Top of Descent/Climb and the distances covered on each segment. The consumption calculated by the model refines this information for each flight phase, enabling the identification of inefficiencies linked to variations in speed, thrust, or aircraft behavior.

Figure 2 – ACROPLE Dashboard – Overview page

Developing a machine learning model for environmental purposes creates future opportunities. Specifically, it enables the direct calculation of fuel consumption from ADS-B/radar data, eliminating the need for pre-processing. Additionally, it lays the groundwork for defining aggregated indicators based on fuel consumption calculations, which can highlight various sources of inefficiency, such as changes in altitude, speed, level-off time, or weather conditions.

ACROPOLE Provider

DSNA uses, for its own needs, ACROPOLE to assess the environmental impact (fuel consumption and CO_2 emissions) and to analyse the 3D inefficiencies of aircraft operations with an ANSP point of view. “Data Office” of DSNA provides software maintenance of the existing model in a Big Data environment.

In parallel, EUROCONTROL is pursuing research into improving the model along various lines of analysis (see below “ACROPOLE Future Developments”).

DSNA is interested in future EUROCONTROL developments of the model. Contacts between EUROCONTROL and DSNA should be initiated shortly to consider the use of new versions of ACROPOLE model for DSNA purposes.

ACROPOLE Versions and OS Requirements

ACROPOLE adds value to radar tracks by enhancing them with fuel flow & fuel burn. If using a Big Data environment instead of a local computer, the volume of data that can be handled and the calculation speed are considerably increased.

ACROPOLE Data Requirements

Input data of the ACROPOLE model include:

- Parameters provided by radar data: aircraft type, altitude, ground speed, vertical speed (and derivatives of ground speed). If available, TAS can be used to predict consumption with greater accuracy.
- Parameters associated with aircraft characteristics: mass normalised by empty weight and maximum take-off weight, aircraft maximum operating speed, wing surface, etc.

Fuel flow coefficients at different characteristic thrust power (take-off, climb-out, approach, idle) are provided for each engine type using the ICAO aircraft engine emissions databank.

ACROPOLE Limitations

The method employed consists in creating a fuel flow prediction model for “proxy aircraft” (A320, A332, B738, CRJX, CRJ7, E170, E190, ATR72), for which on-board data is available. These models offer good predictive accuracy but require long processing time to be trained.

Thanks to the scaling capabilities of the ACROPOLE model, a proxy aircraft (for example A320) is used to predict fuel flow of another aircraft (for example A319) when they have similar flight characteristics. A ratio of fuel flow coefficients between the two aircraft at different thrust power is used to scale the fuel flow of “non-proxy” aircraft in each flight phase. This process slightly affects the accuracy of the “non-proxy” aircraft consumption calculation.

ACROPOLE Future Developments

The improvement targets of ACROPOLE are the subject of studies and research conducted by EUROCONTROL, including:

- Exploring approach of a unified model, usable for a variety of aircraft, by integrating specific parameters and features of aircraft types.
- Finding solutions to compensate for the unavailability of critical parameters such as TAS (True Airspeed) and mass.

ACROPOLE High-Level Assessment

Table 6: ACROPOLE assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	For all phases of flight (departure, cruise and approach), this model is more accurate than the existing models. Building a machine learning model involves training, validation and testing on different datasets (from on-board data), making the model more robust and reliable.	+++
Computational Performance	The ACROPOLE model rapidly predicts consumption, making it ideally suited to real-time processing. It can run on a basic PC.	+++
Usability	The model has no user interface. With the development of a software script (available from DSNA), the model can be easily executed using a text file containing the input data.	+
Stakeholders' acceptability	ACROPOLE is currently only used by DSNA. However, it could meet ANSP expectations in terms of calculating performance indicators based on fuel consumption.	++
Flexibility and customisation	The model can be used for a wide range of use cases requiring consumption to be calculated from radar data: performance indicators, consumption impact assessment as part of environmental studies.	++
Maintenance & Availability	ACROPOLE is not maintained and does not consider the new fleet of aircraft (A320 neo for example). It is open source and is available with basic technical documentation. A machine learning model like ACROPOLE is the object of research at EUROCONTROL, with a view to generalising the model to all aircraft (including untrained ones) or improving the model by predicting aircraft weight.	+

2.7 AEDT

The Aviation Environmental Design Tool[9] (AEDT) is a complex tool that models aircraft performance in a 4D environment to provide the following results:

- Fuel consumption.
- Emissions.
- Noise.

Note: the information provided in this section has been developed by the members of the group without validation by the AEDT providers.

All are highly interdependent and occur simultaneously throughout all phases of flight. AEDT was identified as a tool officially accepted by ICAO.

[9] https://aedt.faa.gov/

AEDT is developed by the U.S DOT Volpe Centre and is considered a next generation aviation environmental design tool that:

- Models aircraft performance in space and time (4D).
- Calculates noise, emissions, emissions dispersion and fuel consumption.
- Supports analyses of interdependencies between environmental consequences.

It allows conducting scalable studies from single airport to regional analysis to global analysis and is used for regulatory compliance, research and development.

Concerning system requirements, AEDT is a stand-alone Windows based application working under Windows 10. The tool requires to have a separate BADA licence. AEDT requires a modern dual core processor with 2 GHz or higher and a hard disk space of at least 100 GB with 16 GB for noise studies and 4 TB when doing emission calculations.

AEDT includes information about airports and air fleet that is permanently updated. Radar data can be used but must be transferred to the tool. It is possible to do modelling for simulations in a similar way to what is done in NEST in case of airspace design or new procedures.

Internal data in AEDT includes a database of 3.000 airframe-engine combinations and over 30.000 airports around the globe. The fleet database contains approximatively 4.600 aircraft (airframe/engine combinations) and 400 non-aircraft emissions sources (ground support equipment, stationary power and fuel equipment, and auxiliary power units).

It utilises the following databases:

- ICAO Aircraft Noise and Performance Database (ANP).
- BADA 3 and 4 (Eurocontrol Base of Aircraft Data).
- ICAO Engine Emission Databank (EDB).

Aircraft performance is the primary input to noise and emissions calculations. AEDT uses the following performance models to approximate the state of an aircraft for each aircraft operation:

- SAE-AIR-1845/ECAC Doc 29 performance model, used for modelling the terminal area (below 10,000 ft AGL).
- BADA 3 performance model, used for modelling the enroute phase (above 10,000 ft AGL).
- BADA 4 performance model, used for all flight regions, including terminal and enroute regions. Since BADA 4 does not contain data and methods to model aircraft operations on the ground, AEDT uses ANP methodology for the ground roll, take-off, initial climb and landing.

Concerning external data, those are mainly U.S. ones. For terrain and population, it is required to insert data relevant to the area that is being studied.

The inputs in AEDT are aircraft types and operations. They can be complemented with topography, weather and population (density). Input files are either csv or ASIF files.

The outputs are as follows:

- Flight performance reports (vertical profile).
- Emission and fuel reports, provided as numbers (no graphical view).
- Noise exposure reports, also provided as numbers.
- Noise contours and emission dispersion reports, which is the most valuable part to support studies.

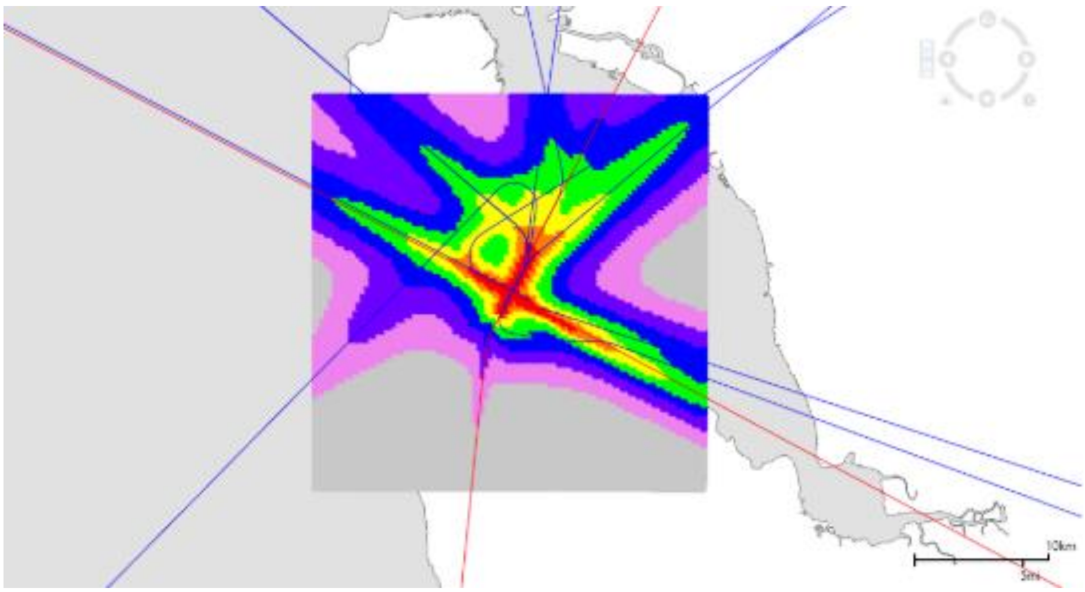


Figure 3 – AEDT – Sample noise exposure contour (U.S. DOT Volpe Center/FAA graphic)

AEDT Provider

AEDT provider is the FAA's Office of Environment and Energy[10].

AEDT Versions and OS Requirements

The latest version is AEDT 3g which was released on August 28, 2024.

AEDT is a stand-alone Windows based application. However, using Microsoft SQL Server connectivity, it is possible to connect multiple computational clients to one central database server.

AEDT uses the following databases/information:

- ICAO ANP Database.
- BADA 3 and 4.
- ICAO EDB.

[10] https://www.faa.gov/about/office_org/headquarters_offices/apl/aee

AEDT Data Requirements

The following data is required for calculation:

- Airport code.
- Operation type – depending on the phase of flight (departure, climb, level, descent, approach).
- Aircraft type.
- Number of movements.

AEDT Limitations

The Population Exposure Report only works with the US Census data. For international users, one possible option is to generate and export noise contours from AEDT as a shapefile, then overlay that against population data in a separate GIS tool. Another option is to use the population point receptors in AEDT.

AEDT Future Developments

There is currently no information available about future developments.

AEDT High-Level Assessment

Table 7: AEDT assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	The FAA periodically updates AEDT to incorporate advancements in modeling techniques, data accuracy and regulatory requirements.	+++
Computational Performance	AEDT is capable processing various scenarios, from individual flights to extensive assessments. The tool's performance is designed to handle complex scenarios efficiently within reasonable timeframes. However, for more complex calculations, it is necessary to have a powerful computer, otherwise this factor has a significant impact on the speed of calculations.	++
Usability	The GUI is designed to facilitate ease of use, enabling users to navigate the tool 's functionalities efficiently and in understandable way. The tool generates outputs related to noise, emissions and fuel consumption. These results are allowing users to review and analyse data relatively promptly.	++
Stakeholders' acceptability	AEDT successfully passed ICAO stress tests, that means that the tool is aligned with current standards and policies. AEDT is recommended for conducting assessments in aligning with ICAO guidelines.	+++

CRITERIA	DESCRIPTION	SCORE
Flexibility and customisation	The tool was created by the FAA for the needs of American users. Due to this fact, some functions of the tool are not functional, or not fully functional, for users outside America - such as population count, terrain data.	+
Maintenance & Availability	The tool is supported by an FAA subsidiary, VOLPE, which provides training, operates the AEDT support team, has created an extensive user and technical manual, and supports something like a user community where users share questions and experiences with using the tool. In the EU, training is offered by the company Airsight.	+++

3 Catalogue of Dashboards

3.1 TMA Flight Efficiency Dashboard

The EUROCONTROL TMA Flight Efficiency Dashboard[11] is an interactive tool that helps analyse and improve the efficiency of flight operations within terminal areas. It also helps identify and prioritise sources for improvement as part of a collaborative process involving all parties (service providers, airspace users, authorities).

The dashboard provides operational insights into both permanent and variable inefficiencies as proxies for airspace versus operations. It provides a detailed view per airport, runway and flow.

Permanent inefficiencies (such as level-off or path extension) are related to airspace design (e.g., because of flow segregation or noise constraints), while variable inefficiencies (such as vectoring) are linked to operational practices caused by sequencing, metering and obviously separation. This distinction helps in targeting specific areas for improvement.

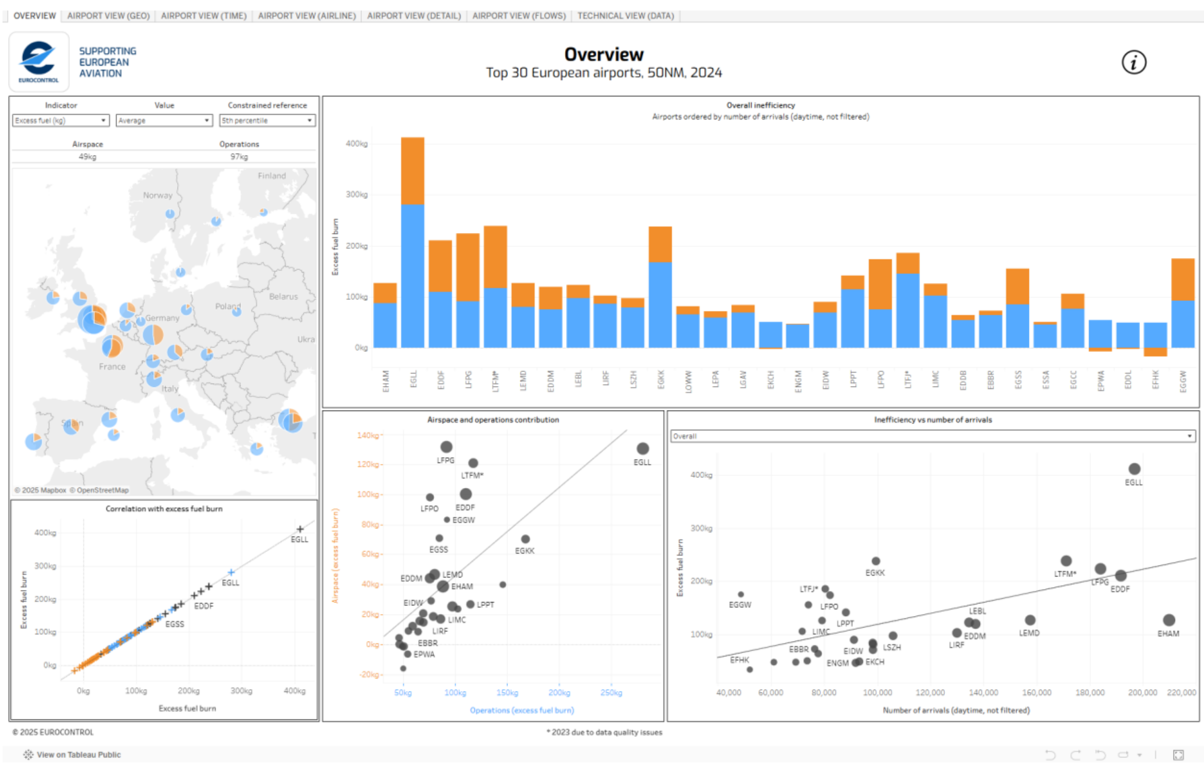


Figure 4 - TMA Flight Efficiency Dashboard – Overview page

The observations are based using the following trajectories:

- Flown trajectory, which is the observed trajectory based on radar track (typically from 50Nm to 5NM to the runway threshold but can be adapted).

[11] https://www.eurocontrol.int/project/improving-terminal-operations

- Constrained reference, a sort of ideal flyable trajectory that incorporates any horizontal, vertical or speed restriction applicable to arrivals to an airport, defined statistically (10th percentile of the flown trajectories).
- Unconstrained reference, a sort of ideal flyable trajectory without any constraint, defined by a common principle for all airports (continuous descent, direct to intercept from entry and intercept at 2000ft AGL).

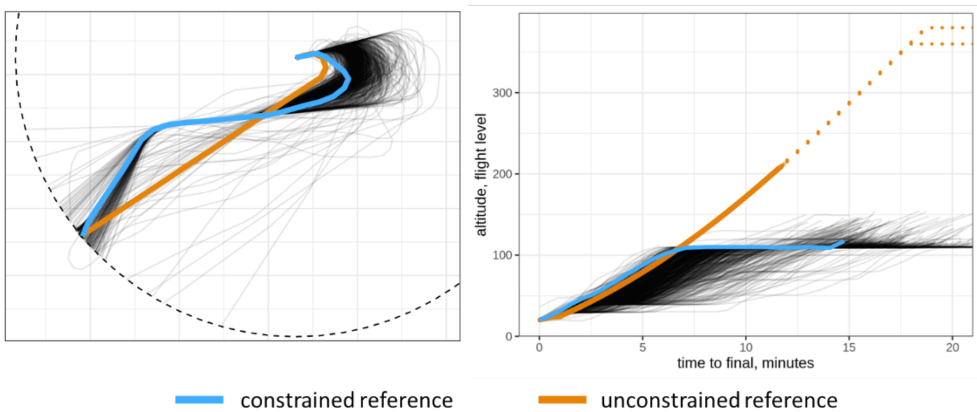


Figure 5 - Method – Constrained and unconstrained references

The inefficiencies are determined using principles of deviations from references: "airspace" related deviation is obtained by the difference between unconstrained and constrained references; "operations" related deviation by the difference between the constrained and flown trajectory.

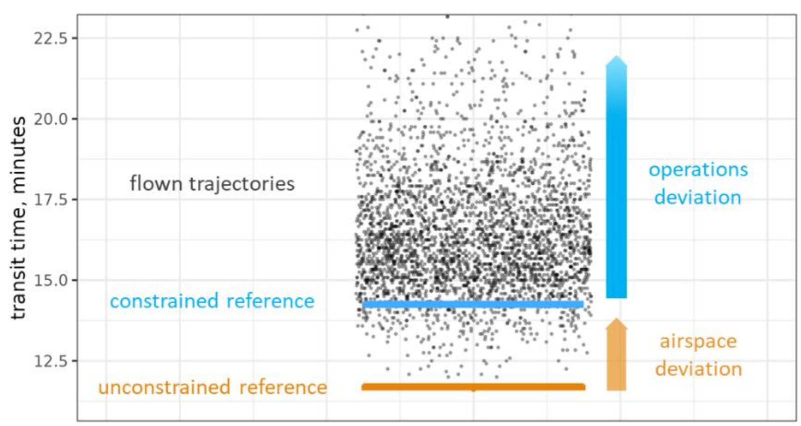


Figure 6 - Method – Airspace and operations deviations

The tool has the following key features and functionalities:

- Data Visualisation: The dashboard provides a visual representation of flight efficiency metrics. This includes graphs and charts that display various aspects of flight performance, and includes representations of flown, constrained and unconstrained profiles, making it easier for stakeholders to understand and analyse data.

- Efficiency Metrics: Several indicators are proposed to support the measurement of flight efficiency along different dimensions: horizontal (time, distance deviations), vertical (altitude, average altitude deviations) and 3D (excess fuel burn in kg, or %). Different aggregations (average, median, sum over the year) and detailed view allow the detailed identification and prioritisation of arrival inefficiencies per flow.
- Interactive Analysis: Users can interact with the dashboard to drill down into specific airport, runway and flow, and analyse trends over a year. This interactivity allows for a more detailed and customised analysis.
- Stakeholder Engagement: It is designed to be used by various stakeholders, including operational staff, airspace users, data analysts and decision-makers. The dashboard facilitates information sharing and collaborative decision-making.
- Environmental Impact: By quantifying the reduction in fuel and excess fuel consumption, the dashboard helps in assessing the environmental benefits of different operational improvements.

TMA Flight Efficiency Dashboard Provider

The dashboard has been developed by the EUROCONTROL Innovation Hub with the support of the Aviation Sustainability Unit, as a contribution to the ATM/ANS Environmental Transparency Working Group.

TMA Flight Efficiency Dashboard Limitations

The dashboard presents data for the top 30 European airports (and with a maximal range of 50NM around the airport).

The accuracy of the dashboard insights depends on the quality and completeness of the data it receives. Incomplete or inaccurate data can lead to misleading conclusions.

The dashboard provides historical information for the last three years (currently 2022, 2023 and 2024). It does not present real-time data.

TMA Flight Efficiency Dashboard Future Developments

Future Developments will include the analysis of departures (in progress).

TMA Flight Efficiency Dashboard High-Level Assessment

Table 8: TMA Flight Efficiency Dashboard assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	The dashboard uses data from EUROCONTROL's internal databases, including operational data repositories. A comprehensive preparation process eliminates any data quality issues. The dashboard is updated on a yearly basis.	+++
Visualisation & User Interface	The dashboard provides clear and consistent representations of data, through interactive graphs, tables, maps and spatial objects (horizontal and vertical profiles). It does not allow to import or export data.	++
Usability	The dashboard is targeting stakeholders (ANSPs, airspace users, national authorities, etc.) having a sufficient understanding of flight efficiency issues in the terminal area. Different views and options, easily accessible, are proposed to provide them with relevant perspectives. Response times have been trimmed to an acceptable rate (around 6 seconds for initial loading of the top 30 European airports, less than a second for the most demanding subsequent requests).	++
Accessibility	Although designed to run on a computer screen, the dashboard can also be used on other devices (smartphones, tablets, etc.). A “quick help” is available on each view to explain its purpose and give instructions on available interactions.	++
Analytical capabilities	The dashboard provides fuel and excess fuel burn estimates within 50NM. It also proposes geometric indicators (based on distance, time, altitude...) to facilitate intuitive assessment of horizontal and vertical flight efficiency. Those metrics can be analysed per airport, runway or flow. For a given airport, evolution trends can be analysed per month, week or day.	++
Stakeholders’ acceptability	Several ANSP/Airport/Airlines are considering the dashboard.	++

3.2 FATHOM

The Network Manager interactive analysis tool[12] (FATHOM) is a data analytics dashboard provided by EUROCONTROL, offering comprehensive insights into European air traffic management. It provides real-time and historical data on air traffic flows, delays, capacity and network performance across Europe. The data is sourced from EUROCONTROL’s extensive aviation databases, including operational flight data, air traffic management systems and network performance reports.

Users can view interactive visualisations, trend analyses and key performance indicators related to air traffic operations. The dashboard is designed for aviation professionals, including ANSPs,

[12] https://www.eurocontrol.int/tool/network-manager-interactive-analysis-tool

airlines, airport operators and policymakers, supporting data-driven decision-making for improving efficiency and planning.

FATHOM can be used for monitoring air traffic trends, assessing network capacity, identifying bottlenecks and enhancing operational strategies. It is accessible through a web-based platform, allowing authorised users to explore critical aviation data in an intuitive and user-friendly interface.

FATHOM Analysis (R35D) and FATHOM Reporting (R14M) are two complementary and separate views of the EUROCONTROL FATHOM dashboard, each serving different purposes[13].

3.2.1 FATHOM Analysis (R35D – Rolling 35 Days):

- Focuses on interactive data exploration and in-depth analytics related to European air traffic management.
- Provides detailed "Day-1" and historical data up to 5 weeks on air traffic flows, delays, network performance and capacity.
- Users can interact with various visualisations, filter data and conduct customised analyses to gain deeper insights into aviation trends and operational challenges.
- Ideal for aviation professionals who need to explore and analyse data dynamically to support strategic and operational decision-making.

3.2.2 FATHOM Reporting (R14M – Rolling 14 Months)

- Focuses on generating comprehensive reports using aggregated dated up to 14 months.
- The purpose is to allow users to create and share detailed reports that summarise operational performance and identify areas for improvement.
- It provides customisable reporting options, enabling users to present data in a clear and structured manner. As such, it can also meet the needs of managers.

[13] FATHOM Reporting User Guide available via the dashboard.

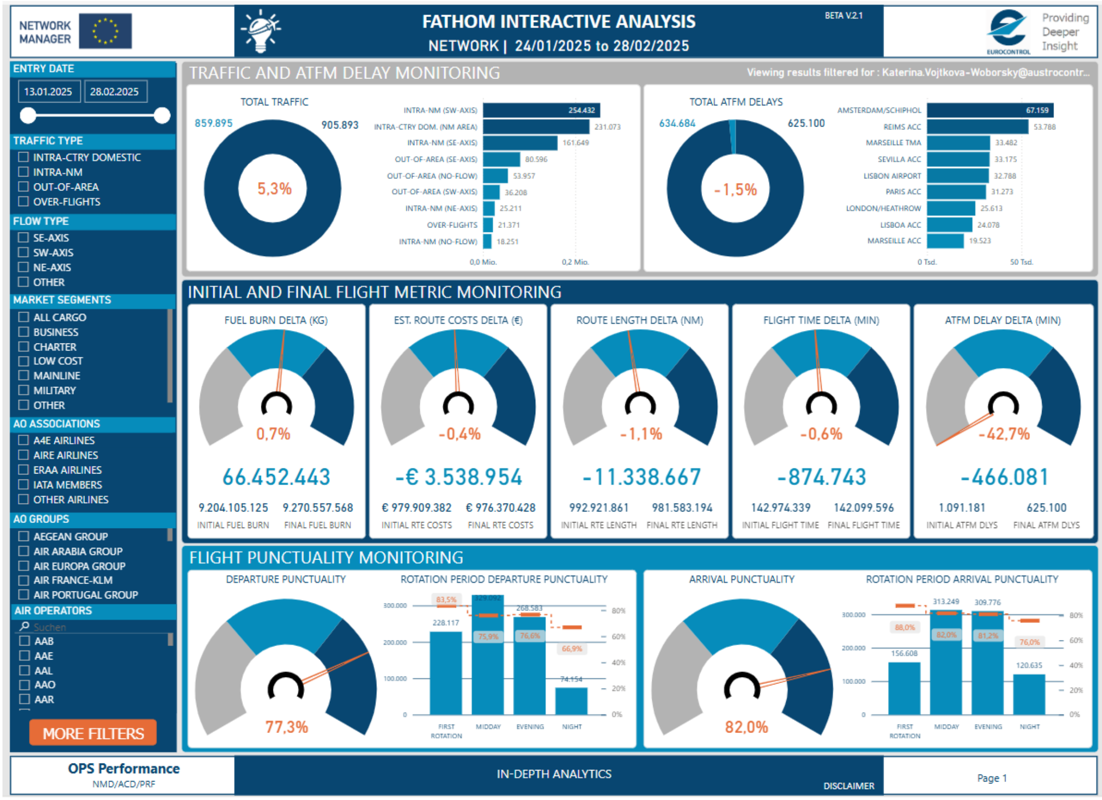


Figure 7 - FATHOM – General view (from webpage)

The assessment is valid for both the R35D and R14M views. Only the criteria "Usability" deserves clarification that the computation time for R14M takes longer than for R35D, considering the large amount of data to process (14 months compared to 5 weeks).

FATHOM Dashboard Provider

The dashboard is developed and provided by the Network Manager Operational Performance Unit.

FATHOM Limitations

The R35D view provides data up to 5 weeks (35 days) in the past, which may be considered not enough, even for analysis purposes.

FATHOM Future Developments

Developments are ongoing to use B2B data to allow real time data visualisation, allowing e.g., airspace users visualising the situation of the morning rotation.

FATHOM High-Level Assessment

Table 9: FATHOM assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	FATHOM displays data from EUROCONTROL's internal databases, encompassing metrics such as traffic statistics, ATFM delays, fuel consumption estimates, route charges etc. The R35D view provides detailed information about flights, while the R14M view provides aggregated data. The dashboard is updated daily, providing users with a five-week rolling period of data.	+++
Visualisation & User Interface	The dashboard has clear tables and graphs, facilitating easy visualisation of complex datasets. However, for proper orientation in their organisation and presentation, a certain basic knowledge is necessary. FATHOM has a user-friendly graphic interface. However, comment was made by a Pillar-2 user that there might be too much information per view. The dashboard allows data downloading in the following format various format, e.g., PDF, PPT, XLS.	++
Usability	FATHOM is designed to handle large amount of data. There may be a feeling that the response time is not always the same across the dashboard. This is because the response time for the R14M view is longer than for R35D because of the amount of data to process for the R14M view.	++
Accessibility	EUROCONTROL offers technical support for all FATHOM users. The support team is prepared to offer their assistance and react to users' inquiries. Comprehensive help, guides and documentation are available. They provide detailed explanations and help users effectively use the dashboard and interpret the data.	++
Analytical capabilities	FATHOM provides insights into fuel burn metrics, allowing users to assess fuel consumption patterns and identify areas for improvements. FATHOM enables users to compare performance across different time frames, identify trends and benchmark against targets set within the air traffic management framework.	++
Stakeholders' acceptability	The data provided is not directly related to legislative requirements and their usability and practical applicability is highly dependent on the approach of individual users (ANSPs in our case). The dashboard has close to 1000 users and good buy-in from the stakeholders. It will increase when the planned developments have been implemented.	++

3.3 CO_2MPASS

CO_2MPASS[14] is an interactive dashboard to support the Network manager Operational Performance Framework. It is designed to support policy makers and operational stakeholders to understand areas of operational improvements.

Updated daily, and storing 14 rolling months of results, CO_2MPASS provides users with access to comprehensive data giving insights into fuel burn through each phase of flight (climb, enroute and descend) and each ACC or TMA. The flight trajectory is "Wheels-up/Wheels-down".

Users can determine how their actual performance compares to their planned performance and can take measures to adapt their planning in the future. The dashboard provides three different views with several filters[15]:

- Network view: it allows users to assess the estimated fuel burn (or CO_2 emissions) for every flight within the NM area, covering the trajectories of all intra-NM and international departures/arrivals to/from the point of entry/exit of the NM Area. This allows visualising the effects that wide-body and very large aircraft have on fuel burn (hence CO_2 emissions), that would not be visualised when restricting the scope to intra-NM Area flights. High level visualisations provide the number of flights and the total fuel burn in tons. User can also see the distribution of fuel burn by each phase of flight. Additional insight can be found from visualisation aggregated in flow, market segment and aircraft category.
- Operator view: designed for air operators to assess the fuel burn for each of their flights covering the full trajectories of all intra-NM and international departures/arrivals. This provides additional insight into their planned (using FTFM) versus actual (using CTFM) fuel burn performance for each phase of flight, listing the ACCs (or TMAs) as well where they experience the highest estimated fuel burn performance in terms of fuel burn per flight.
- ANSP view: designed for ANSPs to assess the fuel burn of every flight that entered their ACCs, covering the part of each flight trajectory within the defined ACC area. This page also provides additional insight into the operators planned (using FTFM) versus actual (using CTFM) fuel burn performance through each phase of flight, listing the operators that experience the highest estimated fuel burn performance in terms of fuel burn per minute.

[14] https://www.eurocontrol.int/dashboard/co2mpass-interactive-dashboard
[15] CO_2MPASS User Guide available via the dashboard.

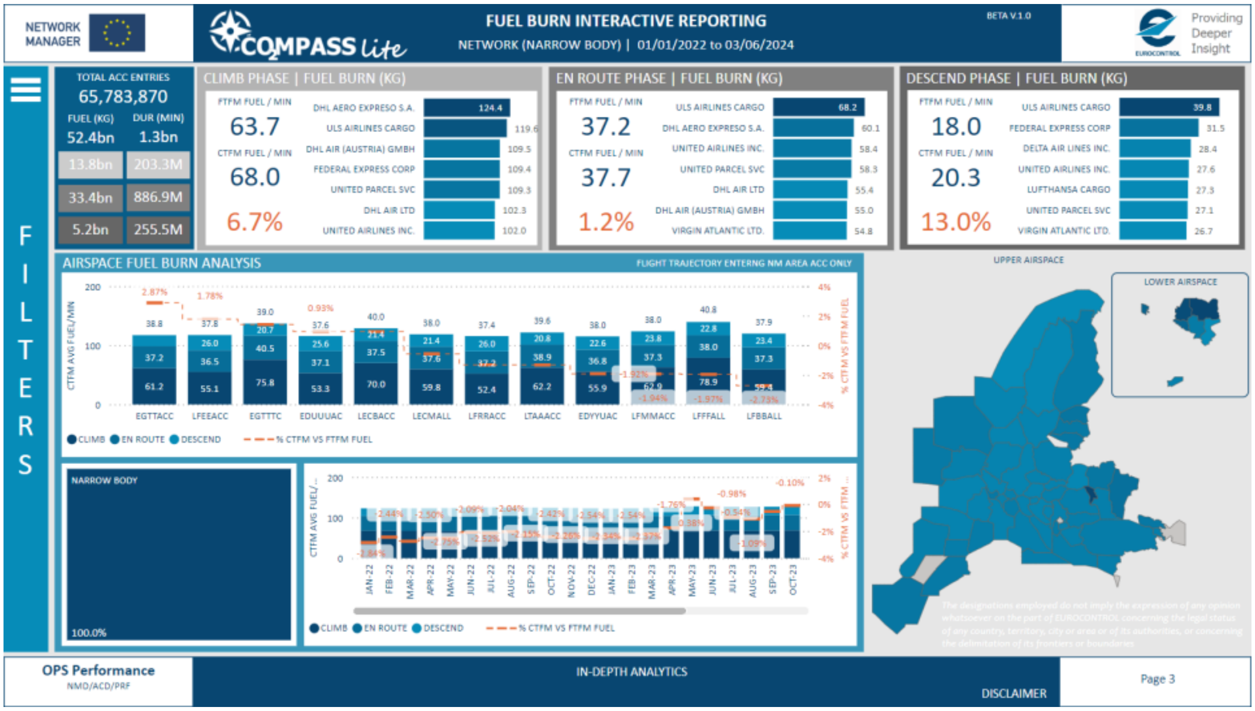


Figure 8 - CO_2MPASS – ANSP view (from webpage)

Three roles exist for users outside of the EUROCONTROL Agency:

- ANSP role: users can see all available details for flights that passed through their ACC/FAB. Filters are set for ACC entry flight. Different ANSPs crossed by a flight can see the same data.
- Air Operator role: users can see all available details for flights based on ICAO_AO_ID. AO Group roles also exist allowing access to all the flights of a specific airline group.
- Airport role: users can see all available details for flights that departed or arrived at their airport. Airport group roles also exist.

Access to CO_2MPASS can be granted to operational stakeholders via the webpage of the tool. Users see data that is relevant to them.

CO_2MPASS Provider

The dashboard is developed and provided by the Network Manager (NM) Operational Performance Unit.

CO_2MPASS Limitations

The dashboard provides CO_2 estimations for the portion “Wheels-up/Wheels-down”, not considering emissions produced during the taxi phase.

CO_2MPASS Future Developments

Developments are ongoing to use B2B data to allow real time data visualisation, allowing e.g., airspace users visualising the situation of the morning rotation.

CO_2MPASS High-Level Assessment

Table 10: CO_2MPASS assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	CO_2MPASS utilises data from various ATC surveillance systems provided by the Network Manager. The dashboard is updated daily, ensuring users have access to the most recent data for analysis. CO_2MPASS results will be different than other data from EUROCONTROL (not from the Network Manager) because CO_2MPASS considers the "Wheels-up/Wheels-down" part of the flight, is limited to the NM Area and relies to CTFM trajectories from ETFMS rather than using the AEM model.	+++
Visualisation & User Interface	CO_2MPASS offers intuitive user interface with interactive tables and graphs. The dashboard provides detailed insights into fuel burn across each phase of flight – climb, enroute and descent. Dashboard allows easy way of data downloading in various format (e.g., CSV, PPT, PDF...).	++
Usability	The dashboard offers timely responses to users queries and is designed to handle large datasets efficiently. Nevertheless, there are no specific performance metrics publicly disclosed (the above-mentioned is based on user experience).	++
Accessibility	EUROCONTROL provides contact details for user support and welcomes comments or suggestions regarding dashboards. Users can access information about the dashboard's functionalities and updates through Eurocontrol website.	+++
Analytical capabilities	CO_2MPASS provides detailed insight into fuel burn and emissions data only. The dashboard is designed to support users in understanding areas of operational improvement, which includes also analyses of historical trends and benchmarking performance.	+++
Stakeholders' acceptability	The data provided is not directly related to legislative requirements, and their usability and practical applicability is highly dependent on the approach of individual users (ANSPs in our case). The dashboard has good buy-in from the stakeholders. It will increase when the planned developments have been implemented. The dashboard currently has over 210 users.	++

3.4 FLair

The Flight Level Adherence Interactive Reporting dashboard[16] (FLair) provides users with flight level details to those flights that did not adhere to the filed (requested) flight level at some point during their route.

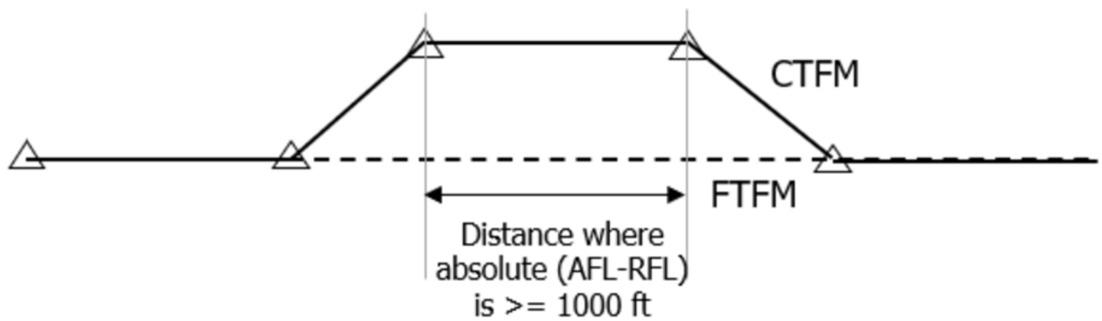
Non-adherence to the RFL is referred to as “Off RFL” in the dashboard and is considered anytime a flight is above/below 1000 feet from its RFL (see below). The dashboard can provide details for non-adherence to RFL in terms of distance (in nautical miles) and illustrates the performance (adherence) using two performance indicators:

- Nr of flights “Off RFL”.
- Distance “Off RFL”.

The RFL adherence is based on the following elements:

- The FTFM and CTFM point profiles are compared:
  - First NAV point where Actual FL=RFL is considered as “Top of Climb” (ToC).
  - Last NAV point where Actual FL=RFL is considered “Top of Descent” (ToD).
  - The Adherence to RFL is measured only between ToC and ToD.
- The RFL adherence metrics are then calculated as follows:

  At least two common points at >= 1000 ft generates a “distance” where a non-adherence to RFL is calculated.



- The RFL (non-)adherence indicator is then:

$$RFL\ indicator = \frac{Distance\ where\ absolute(AFL - RFL) \geq 1000\ ft}{Distance\ between\ ToC\ and\ ToD}$$

Figure 9 – RFL (non-)adherence indicator (from FLair Info Doc)

[16] https://www.eurocontrol.int/dashboard/flight-level-adherence-interactive-reporting

The dashboard provides three different pages with several filters[17]:

- Overview: this page is the landing page for all users. The page provides a "global" view of their performance based on the user's role. There are some high-level visualisations that provide the number of flights and the total distances that the flights were "Off RFL". There is also aggregated views that provide additional insight, illustrating specific air operators, airspaces (TMAs & ACCs) or specific city-pairs that demonstrate the worst performance in terms of flights being "Off RFL".

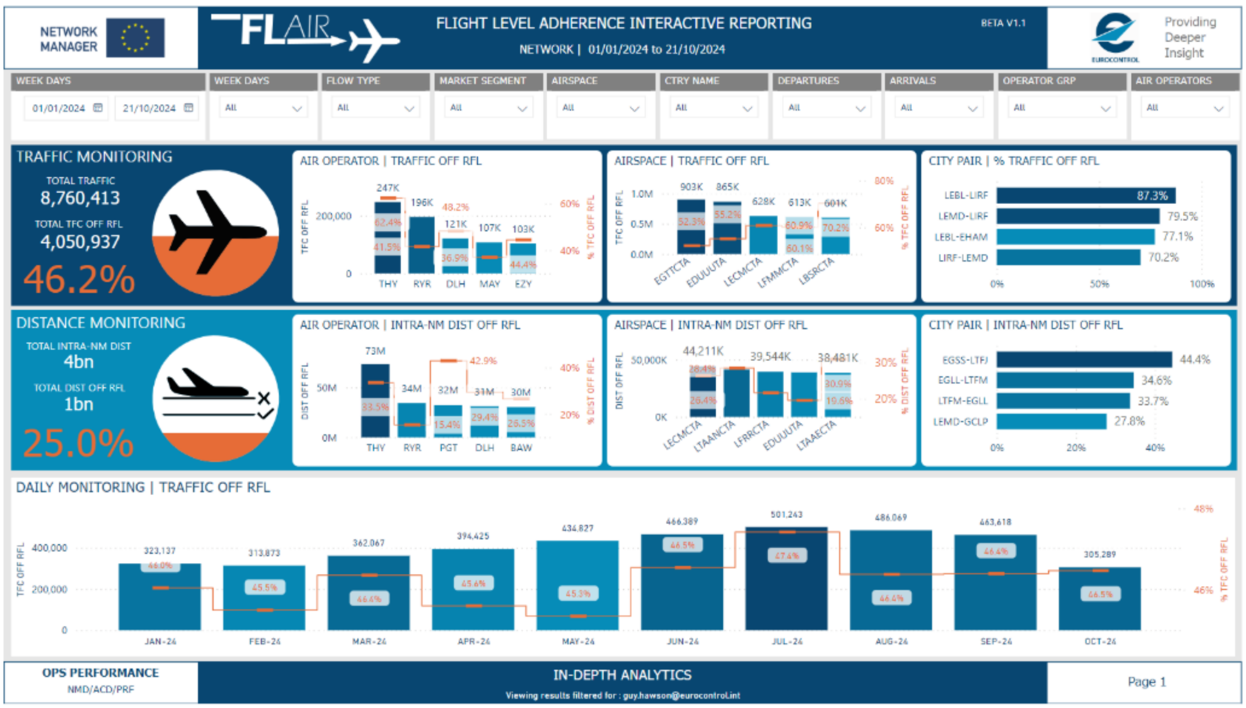


Figure 10 - Flair Overview (from FLair Info Doc)

- Operator: it provides an air operator perspective on the number of their flights and total distance that flights were "Off RFL". Users will find the same filters and several other visuals that will provide insight into the non-compliance of requested flight levels. Each visual is interactive, and clicking on any visual will update the other visual to reflect the results of the selected subset of data.
- Airspace: this page provides an airspace perspective for non-adherence to the requested flight levels. With the same filters as the previous pages, users can quickly drill down to see specific operational results. Some high-level numbers provide the number of flights, total distance and proportion of flights that did not adhere to the requested flight levels. A treemap visual allows users to quickly identify the airspace with the lowest compliance

[17] From FLair Info Doc available via the dashboard.

to RFL adherence. Clicking on this visual will update the map and tables to reflect the results of the new data subset.

FLair Provider

Like CO_2MPASS and FATHOM, the FLair dashboard is developed and provided by the Network Manager (NM) Operational Performance Unit.

FLair Limitations

Currently, non-adherence is looking at any deviation with an absolute value of 1000ft or above without distinction between below or above the RFL.

FLair Future Developments

To lift the limitation mentioned above, it will be possible to make a distinction between “above RFL” and “below RFL” on top of “Off RFL”.

Developments are ongoing to use B2B data to allow real time data visualisation, allowing e.g., airspace users visualising the situation of the morning rotation.

FLair High-Level Assessment

Table 11: FLair assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	FLair makes use of data of uses archived data from NM operational systems. The dashboard is updated daily, ensuring users have access to the most recent data for analysis.	+++
Visualisation & User Interface	FLair offers intuitive user interface with interactive tables and graphs. The dashboard provides detailed insights into the number of flights being “Off RFL” together with the distance flown “Off RFL”. Definition of “Off RFL” and scope are clearly defined. The dashboard allows easy way of data downloading in PPT and PDF formats.	++
Usability	The dashboard is offering timely responses to users queries and is designed to handle large datasets efficiently. There is no specific performance metric publicly disclosed. The above-mentioned elements are based on user experiences.	++
Accessibility	EUROCONTROL provides contact details for user support and welcomes comments or suggestions regarding dashboards. Users can access information about the dashboard’s functionalities and updates through the EUROCONTROL website and via an INFO DOC available via the dashboard.	+++
Analytical capabilities	FLair provides detailed insight into the number of flights being “Off RFL” together with the distance flown “Off RFL”. It would be interesting to differentiate between “below RFL” and “above RFL”.	++

CRITERIA	DESCRIPTION	SCORE
	The dashboard is designed to support users in understanding areas of operational improvement, which includes also analyses of historical trends and benchmarking performance.	
Stakeholders' acceptability	The dashboard has good buy-in from the stakeholders. It will increase when the planned developments have been implemented.	++

3.5 FlyingGreen Platform - NetZero Pillar

FlyingGreen[18] is a comprehensive sustainability initiative launched by EUROCONTROL and managed by the Aviation Sustainability Unit. It provides a one-stop shop platform to support States, ANSPs, airports and other aviation stakeholders in reducing their environmental impact. FlyingGreen is structured around four strategic pillars, with the NetZero pillar focusing on reducing emissions and tracking fuel burn at various operational levels — from the Network down to individual states, ANSPs or airports.

The NetZero pillar[19] offers a user-friendly dashboard that enables monitoring and forecasting of emissions based on operational improvements, fleet renewal and traffic growth scenarios. This centralised platform integrates operational radar data (Correlated Position reports for a Flight – CPF) and forecast data (STATFOR) to provide accurate estimations of fuel burn and CO_2 emissions. The use of EUROCONTROL's AEM tool further strengthens the reliability of these calculations.

The FlyingGreen platform provides a dashboard to monitor fuel burn and emissions, and to forecast future emissions based on different growth scenarios with the following features:

- Comprehensive Information: Centralised platform where stakeholders can access detailed information on fuel burn and emissions, impact of operational improvements, and in the other FlyingGreen pillars detailed information on fuel requirements and pathways, climate impact, adaptation and mitigation measures and financing options for sustainable developments.
- User-Friendly Interface: An intuitive interface that allows users to easily navigate and find relevant data and tools.
- Customisable Views: Options to view data at different levels (network, state, FAB, ANSP, airport) and customise the analysis based on specific needs.

FlyingGreen/NetZero addresses several critical challenges in the aviation sector, including:

- Emission Reduction: The need to reduce CO_2 emissions to meet net-zero targets.
- Fuel Transition: Transitioning to sustainable aviation fuels (SAF) and other alternative energy sources.

[18] https://flying-green.eurocontrol.int/
[19] https://flying-green.eurocontrol.int/#/net-zero

- Operational Efficiency: Improving operational efficiency to reduce fuel burn and emissions.
- Data Utilisation: Leveraging comprehensive data for accurate emission tracking and forecasting.

Concerning Data Processing, NetZero includes:

- Trajectories: Using actual radar tracks (CPF) to create detailed trajectory segments. CPF is an airspace profile following as much as possible the actual flown trajectory derived from ATC surveillance systems (CPR).
- Forecasting: Incorporating medium and long-term forecasts to predict future emissions and fuel burn.
- Aircraft Allocation Tool: Replacing older aircraft with newer, and options to introduce more efficient models such as hydrogen and electric aircraft in the forecasts via What-If functionality.
- Advanced Emission Modelling: Utilising the EUROCONTROL AEM tool to calculate fuel burn and emissions accurately.

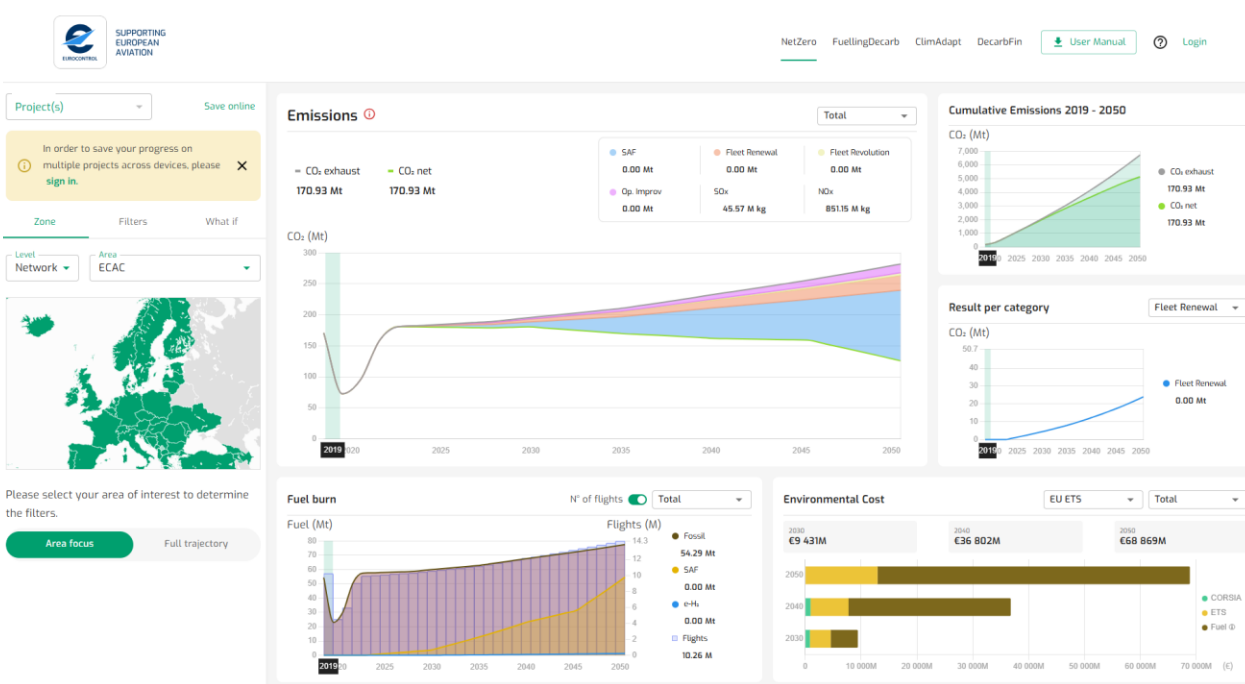


Figure 11 - FlyingGreen - NetZero page (from webpage)

NetZero can be seen as a comprehensive toolkit for decarbonisation efforts that includes:

- Fuel Burn and Emission: Detailed graphs and charts showing current and forecasted emissions and fuel consumption.
- What-If Scenarios: Tools to model the impact of different operational improvements per flight phase together with fleet renewals and evolutions on emissions.
- Cost Analysis: Simplified cost analysis for additional environmental costs related to fuel, ETS and CORSIA.

FlyingGreen Provider

FlyingGreen is provided by EUROCONTROL Aviation Sustainability Unit.

FlyingGreen Limitations

There are no assumptions made about missing traffic or trajectory information (e.g., taxi phase missing, therefore emission values in certain phases (especially on the ground) can be slightly lower than official reported traffic numbers.

Economic related indicators are at the moment calculated based on very basic business models, e.g., operational margins fixed, elasticity values fixed across market segments and routes, etc.

FlyingGreen Future Developments

Further releases (next releases planned for April and July 2025) of NetZero will contain the following changes:

- Detailed emission and fuel burn presentations for ANSPs (based on major CTAs, TMAs).
- More detailed options for operational improvements, allowing users to tailor these improvements based on flight phases or operational concepts.
- Management dashboard: Development of a management dashboard with key indicators is underway. This dashboard will provide a high-level overview of important metrics and performance indicators.
- The environmental cost analysis feature will be enhanced to provide more specific information on additional environmental costs and the impact on ticket prices and demand. This will include a more detailed breakdown of costs per market segment and other relevant categories.

The team is actively working on incorporating user feedback to optimise the platform. This includes improving the performance and usability of the tool based on user experiences and suggestions.

FlyingGreen High-Level Assessment

Table 12: FlyingGreen assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	The FlyingGreen NetZero dashboard utilises operational (e.g., radar data) and forecast data (e.g., STATFOR) available to EUROCONTROL. The dashboard's data is updated several times per year (depending on development cycle) and includes historical data back to 2019, allowing users to analyse trends within the required scope and assess the impact of flights in terms of fuel burn, (cumulative) emissions and environmental costs.	+++
Visualisation & User Interface	The FlyingGreen NetZero dashboard offers an intuitive user interface. Users can access State, FAB, ANSP or airport data together with a full network view. Filters allow showing data based on different elements such as flight type or phase. It provides clear tables and graphs, facilitating comprehensive analysis. A what-if function allows probing different decarbonisation scenarios until 2050. Some data can be downloaded or obtained upon request.	+++
Usability	Different types of performance metrics are available depending on the view (e.g., Network, State, ANSP, airport). The tool can handle large amounts of data.	+++
Accessibility	A comprehensive user guide is available to facilitate effective use of the dashboard. EUROCONTROL offers also technical support and assists users in resolving any issues or inquiries they may have. The dashboard is designed to function across various devices and browsers. FlyingGreen platform is open source and available to anyone.	++
Analytical capabilities	The dashboard provides detailed estimation of fuel burn, (cumulative) emissions and environmental costs for various flight types, phases and segments together with what-if scenarios, supporting users in their environmental assessments. With historical data since 2019, users can analyse trends and perform performance benchmarking to identify areas for improvement in emissions reduction strategies.	+++
Stakeholders' acceptability	The fact that the dashboard is operated by EUROCONTROL gives it a certain amount of weight, however, no other specific information and its practical use by stakeholders are known at this stage. The platform of services and tools is still under development.	(*)

(*) No scoring has been given at this stage since the platform is still under development.

3.6 Landing and Take-Off (LTO) Cycle Emissions Estimator

The Landing and Take-Off (LTO) Cycle Emissions Estimator[20] is designed to quickly and easily access emission information (CO_2 and NO_x emissions) during the landing and take-off phases of aircraft operations based on operational data instead of standardised ICAO LTO flight phase durations.

The information available in the LTO Dashboard is also available in FlyingGreen (see Section 3.5), however the LTO Dashboard provides more detailed historical emission overviews and functionalities in the LTO flight phases, close to operations at D+2.

The estimator includes the following key aspects:

- Phases covered: The LTO cycle encompasses the approach phase from 3000 feet to landing, taxi-in, taxi-out and take-off phase up to 3000 feet in the climb-out.
- The tool uses operational data of the taxi-in and taxi-out phases from EUROCONTROL's Network Manager, including actual off-block times, take-off times and in-block times. This data replaces the standard taxi-in and taxi-out times defined by ICAO with more accurate, real-world values and improves the FEIS procedure.
- The tool provides a backward-looking analysis with data from the past five years, allowing airports to analyse historical emissions and identify areas for operational improvements.
- Users can customise the tool by selecting specific runways, flight phases, time slices, operators and wake categories. They can also adjust taxi times, introduce single-engine taxi operations and change the types of sustainable aviation fuels used.
- The tool includes a benchmarking feature that compares emissions and fuel burn across different airports in the same category, helping airports identify best practices and areas for improvement.
- The results and tables generated by the tool are exportable, allowing users to use the data for further analysis and reporting.

The estimator covers all the airports in the EUROCONTROL Area. The users can access their own data for their respective airport(s).

Network Manager's flight data is used together with the Advanced Emission Model that considers specific aircraft/engine configurations, using the latest ICAO Aircraft Engine Emissions Databank. Airports integrated with the Network Manager (i.e., AOP/ NOP, A-CDM and Advanced ATC Tower airports) benefit from early availability of precise taxi time data per individual flight, thereby improving the accuracy of the estimates. If available, usually after several weeks, accurate taxi-time data input from airports or airlines will be used to update the initial operational data.

[20] https://www.eurocontrol.int/tool/landing-and-take-cycle-emissions-estimator

Figure 12 - LTO Cycle Emissions Estimator overview (from webpage)

LTO Dashboard Provider

The dashboard was developed by EUROCONTROL to assist stakeholders in assessing the impact of flight operations on emissions and to support their reporting for both voluntary and legislative emissions reduction programmes.

This application was developed as part of the SESAR in-kind contributions to additional activities project RACINE[21] within the SESAR 3 Research and Innovation Programme.

LTO Dashboard Limitations

The tool covers all the airports in the EUROCONTROL Area. The users can access their own data for their respective airport(s), which is updated daily and contains five years of historical data, but not older.

LTO Dashboard Future Developments

As part of the PEACOCK[22] project the LTO Emission Estimator will include operational data for the airborne phases. In addition, some additional indicators may be added, such as holding time or level-off times.

[21] Regional Airport and Collaborative environmental Integration in the Network – SESAR 3.
[22] https://www.sesarju.eu/projects/PEACOCK.

LTO Dashboard High-Level Assessment

Table 13: LTO Dashboard assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	The LTO Dashboard utilises operational data from existing Network Manager's systems provided by EUROCONTROL for the taxi-in and taxi-out phases. Other LTO phases are based on standard ICAO LTO timestamps. The dashboard's data is updated daily and includes five years of historical data, allowing users to analyse trends within limited scope and assess the impact of flight operations over time.	+++
Visualisation & User Interface	The LTO Dashboard offers an intuitive user interface. Users can access their respective airport data, which includes clear tables and graphs, facilitating comprehensive analysis of emissions during the landing and take-off cycles.	++
Usability	There are no specific performance metrics publicly available, nevertheless the tool is designed to handle large datasets, resulting in lower timely responses to users.	+
Accessibility	Comprehensive user guides and help documents are available to facilitate effective use of the dashboard. EUROCONTROL offers also technical support and assists users in resolving any issues or inquiries they may have. The dashboard is designed to function across various devices and browsers, nevertheless response time is very slow.	+
Analytical capabilities	The dashboard provides detailed taxi-in and taxi-out estimations of emissions during the LTO cycles (and other phases based on ICAO standard times), supporting users in their environmental assessments. With five years of historical data, users can analyse trends and perform performance benchmarking to identify areas for improvement in emissions reduction strategies.	++
Stakeholders' acceptability	The fact that the dashboard is operated by EUROCONTROL gives it a certain amount of weight, however, no other specific information and its practical use by stakeholders are known at this stage.	+

3.7 Aviation Intelligence Portal – Flight Efficiency

The Efficiency and Environment[23] section of the Aviation Intelligence (AIU) Portal is a EUROCONTROL dashboard that provides data-driven insights into the efficiency and environmental impact of European aviation.

It provides historical data on flight efficiency, fuel consumption, CO_2 emissions and air traffic management efficiency.

The portal sources its data from EUROCONTROL's aviation databases including flight tracking systems and environmental performance assessments.

The portal provides information on the following performance indicators:

- Horizontal en-route flight efficiency.
- Vertical flight efficiency.
- Terminal holdings (ASMA).
- Taxi-out efficiency.
- Taxi-in efficiency.

The main goal of the portal is to support sustainability efforts and enhance operational efficiency in European aviation.

Users can explore interactive visualisations, key performance indicators and trend analyses to assess aviation efficiency and sustainability. The portal is designed for a wide range of stakeholders, including ANSPs, airlines, airport operators, EU policymakers and researchers, supporting efforts to improve operational efficiency and reduce aviation's environmental footprint.

It is accessible via a web-based platform (best viewed in Chrome or Firefox), offering access for informed decision-making and strategic planning.

All the data used for the various dashboards is available for download in the corresponding download section of the AIU Portal.

[23] https://ansperformance.eu/efficiency/

Figure 13 - AIU Portal – Efficiency and environment overview (from webpage)

Aviation Intelligence Portal (Flight Efficiency) Limitations

There are no significant limitations. The AIU Team strives to provide the underlying data with a high level of granularity, encouraging users to conduct their own complementary analyses.

Aviation Intelligence Portal (Flight Efficiency) Future Developments

After summer 2025 and guided by user feedback, the dashboards, indicators and datasets will continue to be developed and enhanced to support performance improvements in the European aviation system.

Aviation Intelligence Portal (Flight Efficiency) High-Level Assessment

Table 14: AIU Portal (Flight Efficiency) assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	The portal aggregates data from multiple internal databases within EUROCONTROL, including surveillance systems and operational data repositories. These sources provide detailed information on different metrics such as additional taxi-out time, additional ASMA etc. Internal databases are updated daily, with statistical processing performed monthly.	++
Visualisation & User Interface	The portal presents data in clear way, mainly for expert audience. Graphical representation alone helps to understand complex datasets, making it easier for users to make informed decisions. The portal allows easy way of data downloading in various format (e.g., CSV, xlsx, pdf, ODS, TSV)	++

CRITERIA	DESCRIPTION	SCORE
Usability	The portal has intuitive interface mainly for the professional audience. The portal is designed to handle large dataset in efficient way and can deliver timely responses to user requirements.	++
Accessibility	There is comprehensive user guide and metadata documentation available, which offers detailed explanations of performance indicators, data sources and processing methodologies. Technical support for users is provided by Performance Review Unit via email pru-support@eurocontrol.int .	+++
Analytical capabilities	The portal facilitates the analysis of historical trends and performance benchmarking by providing access to data from multiple reporting periods.	++
Stakeholders' acceptability	The AIU Portal is a source of comprehensive data for a large variety of stakeholders. It supports them in making informed decisions aimed at improving the efficiency and environmental sustainability.	+++

3.8 Single European Sky (SES) Data Portal

The Single European Sky (SES) Data Portal[24] offers comprehensive reporting on performance indicators that are subject to targets or are monitored within the framework of the Single European Sky (SES) performance scheme.

Maintained and updated monthly by the EUROCONTROL Performance Review Unit (PRU) on behalf of the European Commission, the portal provides data aligned with the legal and regulatory framework governing Air Traffic Management performance since 2012. This includes key legislation such as:

- Commission Regulation (EU) No 691/2010 – the original Performance Regulation.
- Commission Implementing Regulation (EU) No 390/2013.
- Commission Implementing Regulation (EU) 2019/317.
- Commission Implementing Regulation (EU) 2024/3128.

The portal delivers data on the relevant performance indicators defined for each reference period, enabling informed analysis and oversight.

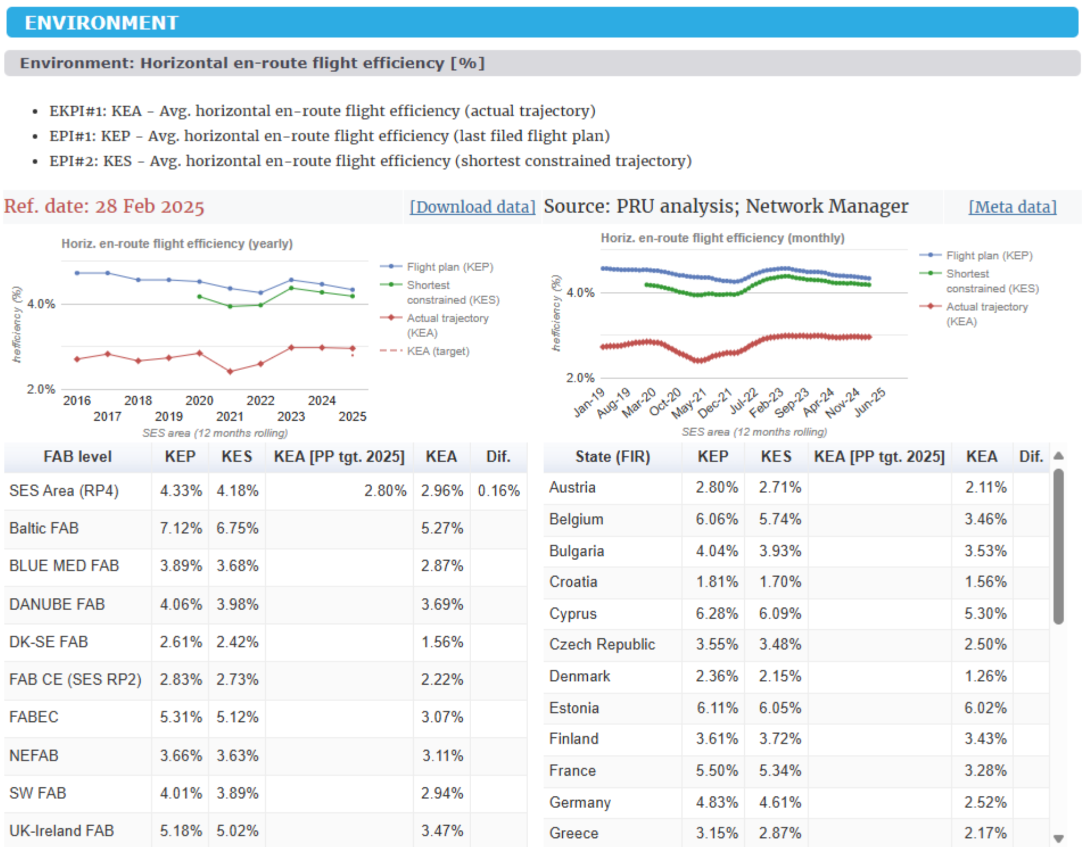
Regarding environmental performance, the portal provides information on the following performance indicators:

- Horizontal en-route flight efficiency.
- Vertical en-route flight efficiency.

[24] https://www.eurocontrol.int/prudata/dashboard/

- Additional taxi-out and taxi-in times.
- Average duration in climb/ descent.
- Terminal holdings (ASMA).

Its primary users include policymakers, regulatory authorities, ANSPs and industry stakeholders, who rely on the portal to monitor compliance with SES objectives and support evidence-based decision-making.



FAB level	KEP	KES	KEA [PP tgt. 2025]	KEA	Dif.
SES Area (RP4)	4.33%	4.18%	2.80%	2.96%	0.16%
Baltic FAB	7.12%	6.75%		5.27%	
BLUE MED FAB	3.89%	3.68%		2.87%	
DANUBE FAB	4.06%	3.98%		3.69%	
DK-SE FAB	2.61%	2.42%		1.56%	
FAB CE (SES RP2)	2.83%	2.73%		2.22%	
FABEC	5.31%	5.12%		3.07%	
NEFAB	3.66%	3.63%		3.11%	
SW FAB	4.01%	3.89%		2.94%	
UK-Ireland FAB	5.18%	5.02%		3.47%	

State (FIR)	KEP	KES	KEA [PP tgt. 2025]	KEA	Dif.
Austria	2.80%	2.71%		2.11%	
Belgium	6.06%	5.74%		3.46%	
Bulgaria	4.04%	3.93%		3.53%	
Croatia	1.81%	1.70%		1.56%	
Cyprus	6.28%	6.09%		5.30%	
Czech Republic	3.55%	3.48%		2.50%	
Denmark	2.36%	2.15%		1.26%	
Estonia	6.11%	6.05%		6.02%	
Finland	3.61%	3.72%		3.43%	
France	5.50%	5.34%		3.28%	
Germany	4.83%	4.61%		2.52%	
Greece	3.15%	2.87%		2.17%	

Figure 14 - SES Portal – Reporting Period 4 – Extract of Environment data (from webpage)

Single European Sky (SES) Data Portal Limitations

The portal is limited to the set of indicators defined in EU legislation. As the SES performance scheme operates on annual review cycles, data is typically provided at the monthly or annual level.

Single European Sky (SES) Data Portal Future Developments

Since the performance indicators have already been defined for the entire reference period (2025–2029), only limited new developments are expected. However, the portal is periodically updated to enhance user-friendliness and improve data visualisations where appropriate.

Single European Sky (SES) Data Portal High-Level Assessment

Table 15: SES Data Portal assessment

CRITERIA	DESCRIPTION	SCORE
Accuracy & Reliability	The portal aggregates data from multiple internal databases within EUROCONTROL, including surveillance systems and operational data repositories. These sources provide detailed information on different metrics such as additional taxi-out time, additional ASMA etc. Internal databases are updated daily, with statistical processing performed monthly.	++
Visualisation & User Interface	The portal presents data in clear way, mainly for expert audience. Graphical representation alone helps to understand complex data sets, making it easier for users to make informed decisions. The portal allows easy way of data downloading in various format	++
Usability	The portal has intuitive interface mainly for the professional audience.	++
Accessibility	There is comprehensive help guide and metadata documentation available, which offers detailed explanations of performance indicators, data sources and processing methodologies. Technical support for users is provided by Performance Review Unit via email pru-support@eurocontrol.int.	+++
Analytical capabilities	The portal facilitates the analysis of historical trends and performance benchmarking by providing access to data from multiple reporting periods. Compared to the Aviation Intelligence Portal, it provides only data related to the SES Performance Scheme.	++
Stakeholders' acceptability	The SES Performance Portal is a source of comprehensive data for a large variety of stakeholders. It supports them in making informed decisions aimed at improving the efficiency and environmental sustainability.	+++

4 Overview of Use Cases

This section provides an overview of use cases by ANSPs illustrating the usage of tools detailed in the catalogue to support implementations improving the environmental efficiency of ATM operations. They are organised per date of presentation to the group members. They are listed in the chronological order of the presentations to the sub-group members.

4.1 MUAC - Pre-flight efficiency optimisation

The Pre-Flight Check (PFC) initiative, launched by the Maastricht Upper Area Control Centre (MUAC) in 2020, aims to enhance flight efficiency during the pre-flight phase. The PFC's goal is to optimise flight plan routes before departure, by filing a flight plan trajectory closer to the expected actual flight path, improving operational efficiency and environmental sustainability.

The PFC compares the flight plan submitted by an aircraft operator for a specific flight with a database of available routes for that city-pair. If a more efficient (often shorter) route proposal is available, a MUAC operator will perform additional checks and, if deemed operationally suitable, approve the proposal from the PFC for further processing.

For communication to the aircraft operator, the Pre-Flight Check utilises the MUAC ATM Portal (ATM-P), a specialised B2B web-based platform in place in MUAC since 2017 that connects MUAC with aircraft operators and other ATM actors. ATM-P enables MUAC to collaborate, share data and information, and act on flight improvements and various cost-saving and environmental opportunities. More than 200 aircraft operators can receive re-routing proposals from MUAC. The re-routing proposals are made available to the aircraft operators via emails generated by the ATM-P upon approval by the MUAC operator, as explained above.

Figure 15 - MUAC ATM Portal – Illustration from EUROCONTROL publication

Building on the PFC, a more advanced concept of "ECO trajectories" has been assessed in 2023. This concept addresses all greenhouse gas emissions (not only CO_2) using additional environmental data estimated by the Advanced Emissions Model (AEM), developed and maintained by members of the EUROCONTROL's Aviation Sustainability Unit working at the EUROCONTROL Innovation Hub (EIH).

Using advanced algorithms, AEM processes flight trajectories on a flight-by-flight basis to estimate fuel burn and related exhaust emissions. This process identifies routes with a smaller environmental impact, for potential re-routing proposals to the aircraft operators. The use of AEM for this purpose is the result of a collaborative effort.

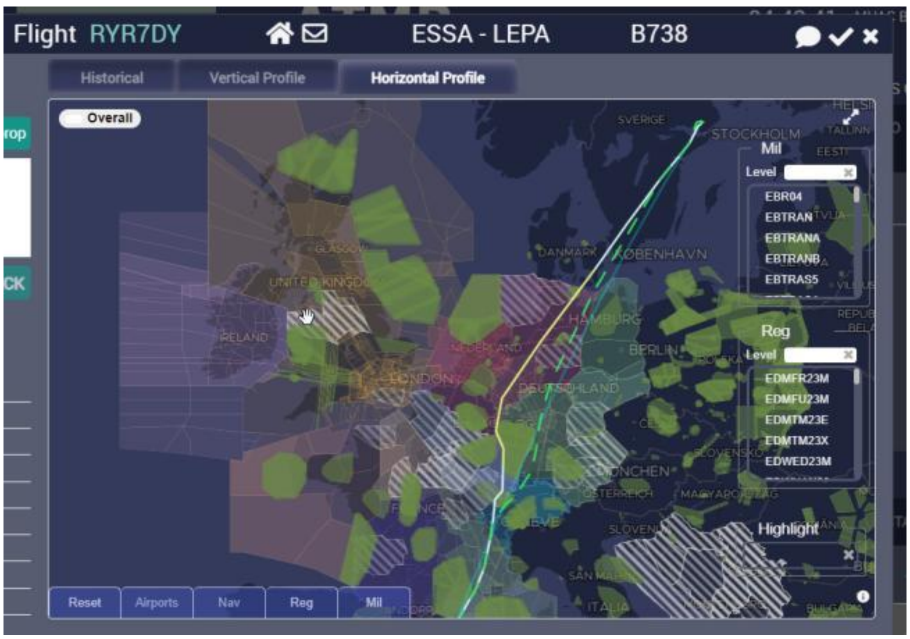


Figure 16 - MUAC ATM Portal – Graphical re-routing support (simulated case)

Over a few years, the PFC and the concept of "ECO trajectories" have led to the generation of more than 10.000 pre-flight re-routing proposals, assessed as providing optimised profiles. At the time of finalising this report, the acceptance rate by the airlines was between 25% and 30%.

4.2 Austro Control (ACG) - Noise calculation

Salzburg airport RWY 15 can be easily approached from the north due to flat terrain, nevertheless in this case air traffic for an Austrian airport is influencing populated areas in Germany and in addition, when doing a circling, flying over the whole city Salzburg. Approach from the South to Salzburg Airport (LOWS) is generally possible as well but with some limitations – no ILS and high mountains in close vicinity of the airport. There is a valley which is generally allowing an approach, but it doesn't stretch along the extended runway centre line, and it is not straight either.

During suitable weather conditions a visual approach can be flown along the valley, but this depends of course on visibility and cloud base. Some alternatives are as follows:

- An RNP approach which is better than the visual approach but still has a relatively high minimum.
- An RNP AR approach which better avoids villages in the south; unfortunately, it requires RF legs (Radius Fixed Turns) in the final segment and is based on RNP AR design criteria, which makes the special authorisation necessary.
- A circling approach from the north using the ILS to RWY 15 followed by a visual circuit east of the airport with a final turn to RWY 33.

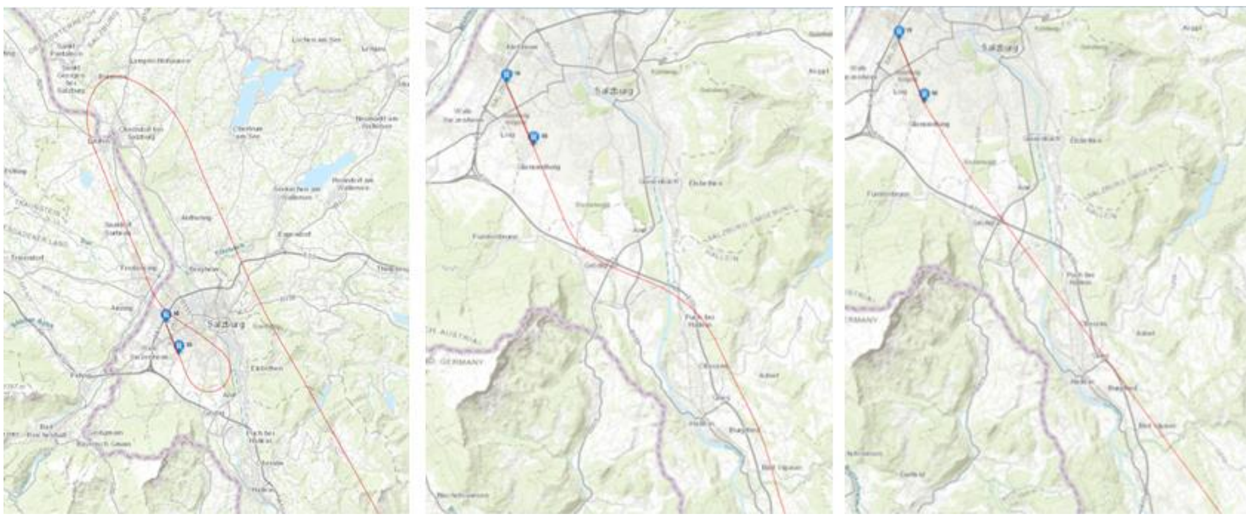


Figure 17 - Visual display of possible alternatives

The RNP T from south was seen as a possible solution and was also the reason for conducting a feasibility study and all additional calculation, mainly noise and population count.

Another option for approach from the south is getting vectored to the north followed by an ILS intercept to RWY15, followed by a circling or visual approach to RWY33.

The main reason for the RNP AR Z to RWY33 was to provide a direct approach from the south, without the need to fly a lot of additional miles followed by an approach from the north. This is beneficial for airlines but also helps to distribute noise by reducing landings from the north. The RNP AR Z option remove at least partially arrival operations from communities.

Unfortunately, RNP AR requires special crew training, special aircraft capabilities/equipment, and an approval by Austro Control as well as from the operators' competent authorities to use the procedure. So, if landing RWY 33 is required, many operators approach from the north and use the circling (overflying the city).

The RNP T from the South was just a feasibility study, after a design and the analysis, the project was stopped and will most likely not resume for various reasons.

ACG currently investigates another option that seems more promising and easier to implement.

The use case presented was part of the mentioned feasibility study which was discussed with public stakeholders where noise and population count are a significant part of the project.

As all three procedures have a common final the number of affected people in the highest noise exposure is almost identical.

IMPACT calculation provided an option to make a comparison among proposed options.

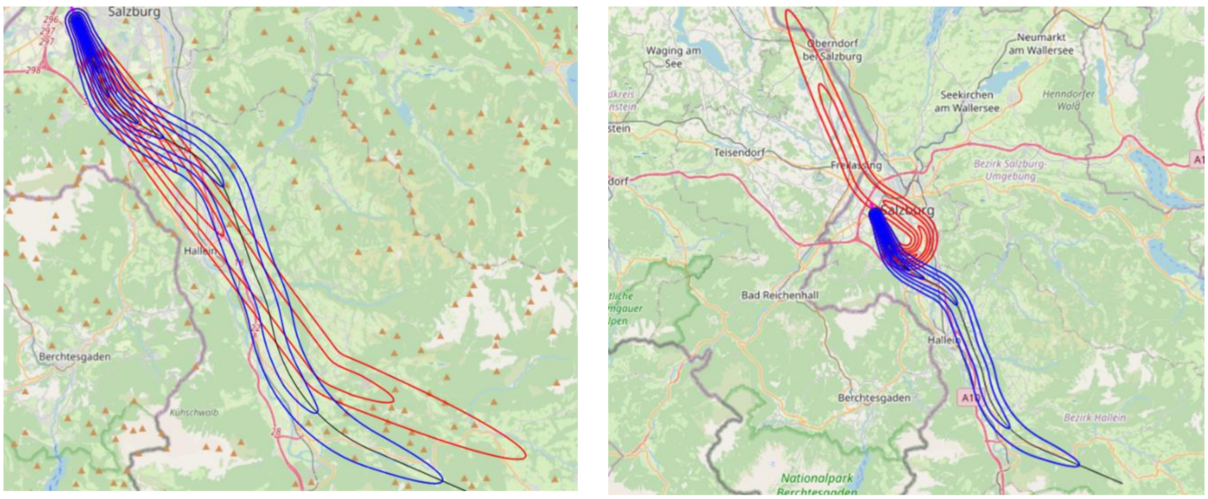


Figure 18 - Comparison of different scenarios in terms of noise in IMPACT

4.3 skeyes – RNP trials

The objective of the RNP trials at Brussels airport was twofold:

- Familiarise ATC/flight crews with RNP approaches (on-going PBN transition).
- improve environmental performance for arriving flights, by enhancing predictability for the flight crews.

The standard mode of operations in Brussels is radar vectoring because of the density and complexity of the airspace and traffic, with a lot of military areas around Brussels Airport (EBBR), and traffic that needs to be merged and sequenced from various directions. This means that crews get radar vectors as from 30 to 40 NM from the airport and have no view of the actual Distance To Go (DTG) before landing, implying that crews cannot fully optimise their descent.

The trial was conducted in two phases (in summer 2022 and in winter 2023-2024). For both phases, it was taking place with all airlines, during night (low traffic), for RWY 25R-25L, workload & weather permitting and using ATC and airline input as part of the Collaborative Environmental Management (CEM) framework in place at EBBR. The main airlines contributing to the project were Brussels Airlines, Lufthansa and TUI.

The evaluation of both phases of the trial was done based on the following monitoring areas, supported by insightful tables using boxplots providing comparisons between RNP and non-RNP approaches:

- General statistics using cumulative numbers between RNP flown/not flown.
- RNP eligibility: How often could the RNP approach be flown? (Put as primary approach in ATIS.)
- RNP acceptance: How often is the RNP approach effectively flown?
- Horizontal flight efficiency in terms of track DTG. One of the assumptions to check is if radar vectoring is sometimes not more efficient than published approaches since vectoring also allows for shorter routings.
- Vertical flight efficiency looking at average level-off time =< FL100, FL75 and 3000 ft.
- Noise assessment by means of mobile noise monitoring stations installed in the approach path.
- Fuel assessment using data from AOs. For specific airlines, fuel data has also been correlated with skeyes' data (correlation study level-off times and fuel usage).
- ATC/Flight Crew feedback.

Observations were conducted by allocating arrivals to a flow (N, E, SE, SW, W) and setting up an intersection gate for each of those flows. Those gates were established within a circle with a radius of 35NM centered around a point situated 6NM E of RWY 25L/R between the axes.

For each arrival, the track DTG and altitude/FL intersection was recorded.

In the second phase of the trial, adjustments from the first phase were applied and validation of the expected improvements was conducted. The set-up was similar to the first phase. The adjustments consisted among others in:

- The addition of speed constraints in the RNP procedures aiming at improving sequencing and environmental performance (notably noise) by reducing level-offs at low altitude, the addition of a waypoint in the procedure to improve turn anticipation in case of a shortcut would be given by the ATCO.
- The refinement of the meteorological scope:
    - Minimum temperature of -5°C (since performed in the winter). With temperatures below -10°C, approaches could not have been flown in LNAV/VNAV (only LNAV), meaning that aircraft would have had to fly them as a 2D approach.
    - Visibility and ceiling criteria were relaxed since considered too restrictive in trial period 1.

After the completion of the second trial, a comparison was made between the two trial periods. Some findings were discovered that are further investigated in cooperation with participating airlines. The results of the trials are issued by the Stargate project consortium but are not publicly available at the time of completing the work of Pillar 2.

4.4 LVNL and FABEC - Curved night arrival routes

This use case addresses one of the measures of the programme "Minder Hinder Schiphol[25]" ("Less Nuisance for Schiphol") that resulted from the requirement from 2019 of the Dutch government requesting stakeholders at Amsterdam Schiphol (EHAM) to make a plan to reduce noise nuisance for people living around the airport.

For context, it is important to note that EHAM already had night approach procedures with continuous descents for RWY 06 and for RWY 18R.

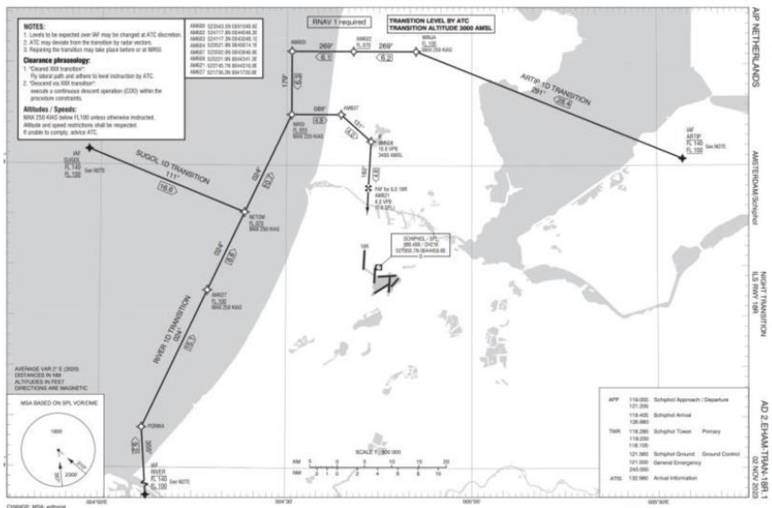


Figure 19 - Extract from AIP Netherlands – Night Transition ILS RWY 18R

Runway 18C is the main replacement in case runway 18R is not available. However, inbounds to 18C are vectored to the ILS instead of following a night transition.

The operational change consisted in creating a curved approach to runway 18C with continuous descents to avoid overflying communities, hence reducing noise nuisance. The design of the curved approach was done in a collaborative way with the communities.

Figure 20 - Route design – Illustration of advanced RNP route

Two approaches were designed, but one of them had a design that only aircraft with advanced RNP capabilities could fly, so that it was complemented by a straight-in approach also with continuous descent for aircraft not able to fly the curved RNP approach.

[25] https://minderhinderschiphol.nl/

Since the focus was on noise reduction, there (most probably) had to be a trade-off with flight efficiency, especially for the flights coming from the East since they must fly towards the sea before proceeding for the approach, meaning that they must fly a longer route.

The approach followed for the assessment of the environmental impact was as follows: the change considered the trade-off between noise load/nuisance and fuel/CO_2 emissions. As a result, both aspects have been assessed (as part of a FABEC initiative, an impact assessment on flight efficiency (emissions) was made):

- Noise: measurement of peak levels in six points north of Schiphol.
- Emissions: NEST used to model old and new trajectories, and calculate route length, fuel consumption and emissions; low and high estimation was made based on annual number of night landings on 18C (1.7% to 4.6% of total, see *Figure 21* on the right)

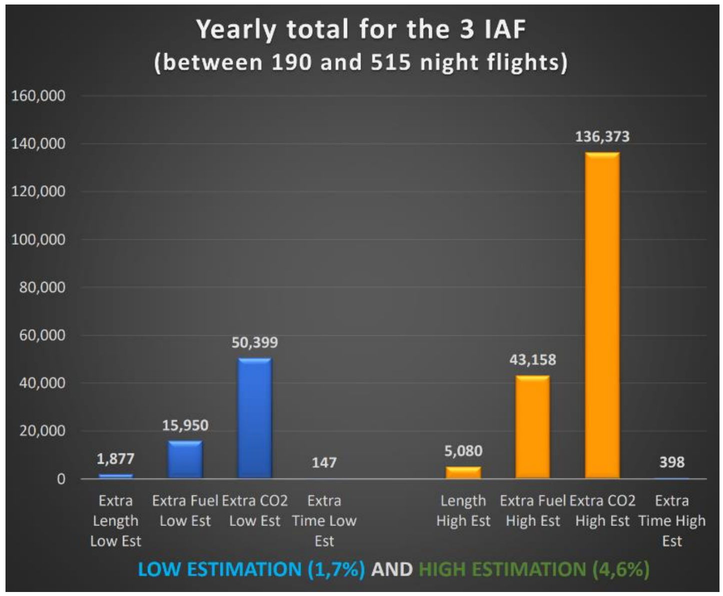


Figure 21 – Impact on time/fuel/CO2 emissions

Concerning noise results, the measure was evaluated, with results being published in May 2023:

- Maximum noise levels were measured in six points, of which three usable. For the other points the number of measurements was too low.
- Maximum noise levels were up to 4.1 dB lower than in 2019, before the introduction of the new procedure. The communities situated below the straight-in approach procedure benefit a lot of the new curved approach procedure.
- About 75% of the night approaches to 18C uses the curved procedure, another 14% a continuous descent with straight approach and the remaining 11% is vectored.

For emissions, the following results were obtained:

- The fuel consumption and thus CO_2 emissions are higher with the curved approach (many flights at night come from the East and the Mediterranean area).
- The longer route length is not compensated by the benefits of continuous descents.
- The annual cost (fuel/CO_2) of the curved night approach procedure is approximately 16 to 43 tons of fuel (50 to 136 tons of CO_2).

In short, the conclusions of the assessment are as follows:

- The night arrival procedures for runway 18C have been designed to minimise as much as possible the noise impact on residential areas.
- The maximum noise levels have indeed been significantly reduced, but at the cost of increased fuel burn and emissions.
- In the end, the increased emissions played no (significant) role in decision-making, as noise prevailed over emissions (below FL60).

Concerning the application of the use case to other airports, it is believed that the same assessment could easily performed for other airports since noise level measurements are easy, and probably all ANSPs can use the NEST tool to model trajectories before and after the (proposed) change.

What was not included in the assessment is the following:

- The effects on the experienced noise nuisance since it could be very subjective and including the perception of the people living in areas being overflown because of the change in procedure.
- The effects on legislation about noise since it depends on local circumstances:
    - The current framework is based on "noise load distribution" expressed by L_{den} & L_{night} that take into consideration the number of people and number of dwellings inside noise contours together with noise load in enforcement points.
    - The operations are not based on that framework but rather on the use of preferential runways and routes.

4.5 ENAIRE - Measuring procedures efficiency: Malaga Airport

ENAIRE implemented the Malaga Improved Design of AirSpace[26] project (MIDAS) that aims at measuring the efficiency of implemented procedures at Malaga airport (LEMG). This was done as part of a project for the transition from conventional to PBN approach according to the EU regulation.

It was based on common path having in mind the need to change runway configuration, increasing resilience to adverse weather events and improving the mode of ATC operations.

New ATC operational modes were implemented for arrival sequence, increasing predictability and reducing communication and frequency congestion (radio calls go from 3 to 1). It would also allow shorter departure procedures segregated from take-offs, increasing efficiency.

The procedure was implemented in November 2023 with an operational transition period of one month. After one year of assessing the results, the official Environmental monitoring started in December 2024 having in mind that the reporting is mandatory by law at Malaga and must be reported three years in the row.

[26] https://www.enaire.es/en_GB/2023_11_08/np_enaire_completa_nuevos_procedimientos_malaga_gb

The figure below presents the tracks for the North configuration arrivals with the difference between the "old" way of vectoring up to 2023 and the "new" one via PBN in 2024, aiming at reducing the miles flown and the amount of holding. It is to note that 2024 traffic considered for the monitoring of the implementation was 35% higher than 2023 traffic (21.518 versus 15.903).

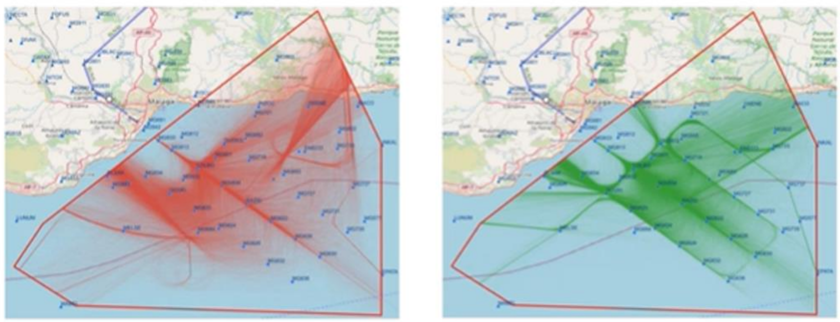


Figure 22 - North configuration arrivals: 2023 (left) versus 2024 (right)

Before MIDAS, the average length of the approach path was around 35NM with 50% of the aircraft flying less than 32NM. After MIDAS, it was respectively 32NM and 30NM, meaning that it successfully met the objective.

The project also allowed to assess the "Probability of Flying "[x]" NM" in the approach before landing. As visible in the graph below, the probability to fly less than 20NM is much higher than before MIDAS, while the probability to fly more than 30 NM decreases. This demonstrates the efficiency of the new procedure.

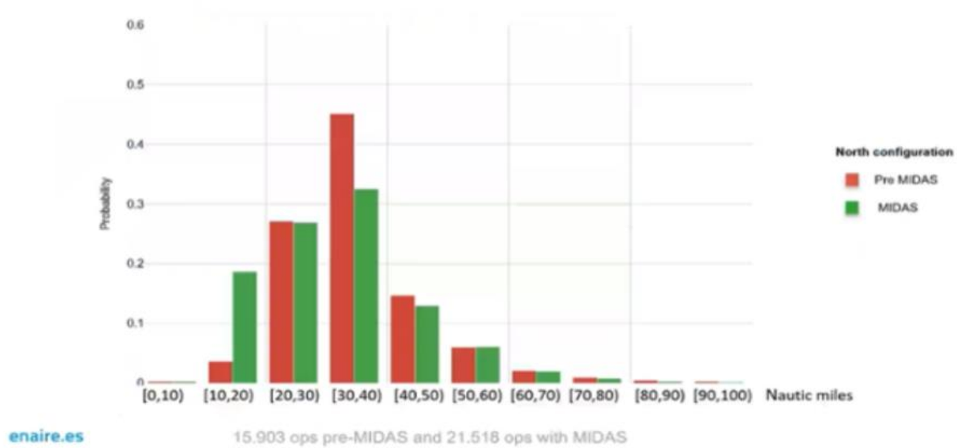


Figure 23 - North configuration arrivals probability of flying [x]NM-2023 versus 2024
(2023 in red and 2024 in green)

As part of the next step for the North configuration, the idea is to publish the probability to fly a certain distance before landing depending on the time of the year and the day.

The figure below presents graphical results for the South configuration showing that traffic can merge at the same point when traffic is not too high.

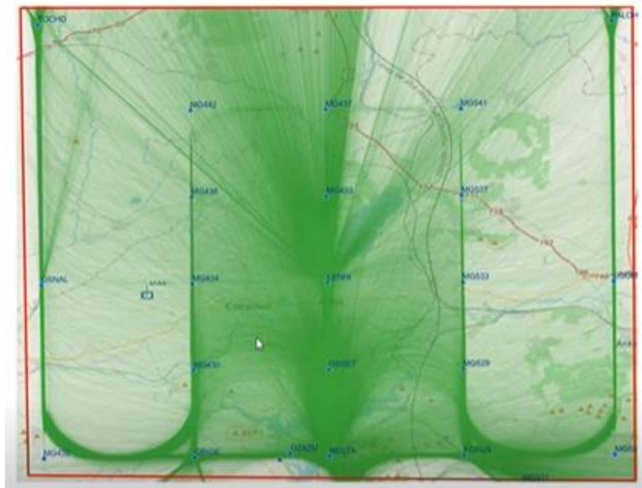


Figure 24 - South configuration – Merging of traffic

The table below shows the differences in fuel consumption (in tons) and CO_2 emissions (in tons as well) based on the requirements set by the Spanish authorities. It presents the different procedural elements addressed by the change (SID, STAR + approach and Total), both pre- and post-MIDAS implementation. The table considers the number of holdings (to estimate the fuel consumption) and the number of nautical miles flown, then compares the actual values with the estimated ones. Based on the estimation, a reduction of 0,16% in fuel consumption and CO_2 emissions was reported.

Theorical study	Pre MIDAS		MIDAS		DIFFERENCE		
	Fuel consumption (t)	Emissions CO_2 (Kt)	Fuel consumption (t)	Emissions CO2 (Kt)	Fuel consumption (t)	Emissions CO_2 (t)	%
SID	74.186,87	234,43	73.445,82	232,09	-741,06	-234	**- 0,16%**
STAR + approach	75.799,42	239,53	76.302,01	241,11	502,6	159	
Total	149.986,29	473,96	149.747,83	473,20	-238,46	-750	

Figure 25 - Table of assessment before and after the implementation of MIDAS

As a final step, the monitoring includes an analysis of the data together with ATC staff to identify best practices (not detailed here).

4.6 NATS – Pairwise

Pairwise[27] separation is a solution that has been developed within the framework of the SESAR JU by NATS and other partners. It has been deployed at Heathrow Airport (EGLL) and at NATS' Swanwick ATC Centre in December 2024, marking a world-first in Air Traffic Control.

This innovation is designed to boost on-time performance and reduce carbon emissions.

During approach and landing, aircraft need to be separated for wake turbulence reasons; this time is needed for the wake vortices to dissipate sufficiently. In most cases, ATC use (fixed) distances between consecutive arrivals to achieve this separation; the distance depends on the aircraft type of both the leading and following aircraft. Especially in (strong) headwind operations, using the same (fixed) distance substantially increases the time between two consecutive arrivals. As a result, the arrival rate drops and potentially impacts capacity.

To overcome this issue, Time-Based Separation[28] (TBS) can be introduced. Instead of using (fixed) distances, it directly applies a time separation for wake turbulence purposes. The goal is to maintain a consistent time interval between arriving aircraft, even if the distance between them changes due to wind.

TBS is an enabler of Pairwise. It is beneficial at Heathrow due to the airports' two runways being 99% capacity constrained. High winds (typically 65 days a year) at Heathrow cause significant ATFM delays, reducing landing rates from 40-45 to as low as 32 per hour in the case of strong headwinds. This situation increases holding delays hence increased fuel burn and emissions and may cause flight cancellation. TBS allows the management of separation between aircraft during landing, especially in varying wind conditions.

TBS is used to nominal separation: aircraft are typically separated by a set distance (e.g., 6 miles, 4 miles, 5 miles) based on their type. In strong headwinds, the time to cover these distances increases, leading to longer intervals between landings. TBS adjusts the separation distance based on wind conditions to maintain the same time interval. Stronger winds result in shorter distances between aircraft to keep the landing rate consistent. In the case of strong headwinds, with TBS, the distance between aircraft is reduced to maintain the same time interval, improving landing rates up to 40 aircraft per hour in strong headwinds (instead of about 35).

Another enabler has been the use of RECAT (Re-categorisation of Wake Turbulence Separation Minima) concept, that updates aircraft categories based on weight and wingspan, allowing for more efficient separations. RECAT EU[29] divides aircraft into six categories (from A to F) based on wake turbulence. Enhanced TBS was implemented in 2018 when NATS moved to RECAT-EU.

[27] https://www.sesarju.eu/news/sesar-pairwise-separation-solution-goes-operation-heathrow-cutting-delays-and-emissions
[28] https://www.sesarju.eu/sesar-solutions/time-based-separation
[29] https://www.eurocontrol.int/publication/european-wake-turbulence-categorisation-and-separation-minima-approach-and-departure

Along with this change, they introduced optimised runway delivery that provided ATCOs with indicator support until the leader gets the threshold. When the leader crosses 4 DME and starts to decelerate, compression starts with the aircraft behind because that one is still flying at 160 knots. Compression is entirely aircraft type or type variant dependent (because of standard speed on final).

The wake vortex categories have been further refined with RECAT EU Pairwise which provides specific separation distances for each aircraft pair, optimising safety and efficiency. This was implemented in the latest version of Intelligent Approach at Heathrow in December 2024 and is known as Pairwise. This allows individual wake separations for 40 most common aircraft types at Heathrow, meaning 1600 possible combinations, hence a need for support tools since an ATCO cannot cope with so many possibilities. It has been an incremental change over the years, evolving from indicator support (the deceleration point between wake aircraft) to indicated support between all aircraft pairs, including the compression support to thresholds.

Pairwise separation also factors in runway occupancy time, ensuring aircraft have enough time to land, decelerate and vacate the runway before the next aircraft lands. This helps maintain a smooth flow of arrivals and departures, reducing delays and improving efficiency.

Metrics	Result (based on 2019 full year)
Maximum increase in hourly Arrival Throughput	2.8 movements
Average Airborne Delay per Holding Flight reduction	2.7 minutes
Total Holding Minutes Saved	285,685 (1.2min per arrival flight)
Average Fuel Saving (kg/min)	63.8
Total Fuel Saved (tonnes)	**18,227**
Total CO_2 Saved (tonnes)	**57,961**
Avg Holding per Holding Flight (during 2019)	7.22 minutes
Saving on UK 3Di Score	**1.01**

Figure 26 - Table of predicted benefits of Pairwise (UK)

TBS has also been implemented at Amsterdam Schiphol (EHAM), where environmental benefits have been confirmed in terms of noise because of its operational set-up with six runways, with two noise preferential landing runways and where they open the other runways when they have increased demand. Amsterdam can land on average between three and six additional aircraft per hour per noise preferential landing runway. This means they are opening their non-noise preferential runways less often, providing also a benefit in terms of noise reduction thanks to TBS.

The tool has also been implemented in Toronto Pearson (CYYZ).

4.7 DFS – Improved STAR distances

This work is the result of a close collaboration of Lufthansa and DFS. First steps were implemented at Frankfurt Airport (EDDF), Munich Airport (EDDM) and Düsseldorf Airport (EDDL) in 2020. Further steps (between NOV 2022 and OCT 2025) within the Digital Sky Demonstrator project HERON address Berlin Brandeburg Airport (EDDB), Nuremberg Airport (EDDN), Hamburg Airport (EDDH) and Stuttgart Airport (EDDS).

The start point of the project is the observation that PBN standard arrival routes are often designed with a long downwind leg to allow for safe and fluent traffic flows in case of peak traffic resulting in delays as shown below with the STAR (in blue below).

However, the actual traffic is usually not peak traffic, allowing air traffic controllers to provide shorter tracks and reduce the actual flown distance as shown with the visualisation of the radar tracks in yellow.

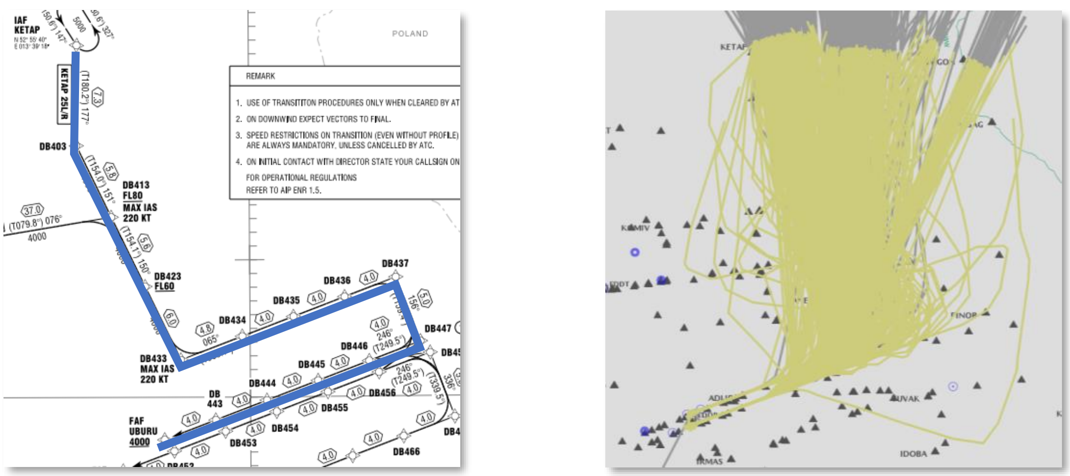


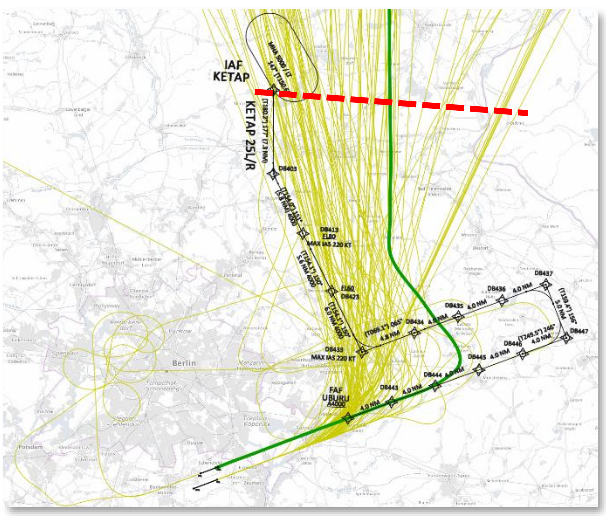
Figure 27 - Published STAR for EDDB (left) versus flown tracks (right)

The idea of the project is to publish a shorter and more realistic distance estimate in the AIP which can be used in flight planning (hence having an impact on the planned fuel). Once published in the AIP, the reduced planning distances can be used by all airspace users as part of their planning process. The routing in the AIP does not change.

The solution was to derive the new planning distance from a post flight analysis using the following methodology (colours refer to Figure 28 below):

- Collect the distribution of actual flown arrival distances for the respective airports (yellow tracks).
- Define a line as the balance boundary line that cuts off as many flight tracks as possible in a meaningful way, in accordance with the STAR (red line).
- Measure ground distance from this line to landing.

- Select the 90th percentile of these distances for safety reasons (green line).
- Compare the distance with the nominal transitions published in the AIP (black line) for the benefit assessment.
- Ensure that the alignment of intersection line of the STAR (red line) does not exceed the flight plan segment before the STAR (starting at the IAF).
- Publish the 90th percentile as an expected flight distance with an AIP amendment.
- Monitor the actual arrival distances once or twice a year after the implementation / publication.
- Update the amendment of AIP for any deviations above 5 NM from published one before.



- Yellow: Radar tracks for KETAP arrivals EDDB RWY 24 L/R.
- Black: KETAP STAR in accordance with AIP-Germany.
- Red: STAR entry line.
- Green: 90th percentile of KETAP arrivals.

Figure 28 - Methodology example for KETAP STAR (EDDB)

Potential fuel savings are not attributed to fewer track miles being flown before or after the information was published in AIP. In actual operations, there were no changes. The savings are due to a reduction in the planned distance. This decrease in planned distance leads to a reduced fuel uptake, which in turn results in a lower aircraft weight throughout the entire flight. The lower aircraft weight consequently causes a lower fuel consumption during the whole flight.

Potential Fuel Saving per flight were calculated for all flights in 2023 on all STARs to EDDB using the 90th percentile. This was done by multiplying the Distance Saved by the Fuel Flow (for short- and long-range flights) and Cost of Weight. The Cost of Weight is calculated using the rule of thumb of 5kg fuel/NM for short range flights and 15 kg fuel/NM for long range flights.

The potential savings amount to 845,063 kg of fuel (i.e., 2,662 tonnes of CO_2) if all aircraft adopt the new distance as shown in the table below.

EDDB	Nominal	AIP (new)	Diff [NM]	Flights SR (2023)	Flights LR (2023)	Saving SR	Saving LR	Total Savings [kg Fuel]
ATGUP_07	88,9	60	28,9	3950	3	5,8	151,7	23.286
ATGUP_25	87,6	52	35,6	7151	13	7,1	186,9	53.345
KETAP_07	111,8	69	42,8	1926	11	8,6	224,7	18.958
KETAP_25	79,6	49	30,6	3782	17	6,1	160,7	25.877
KLF_07	76,3	37	39,3	4150	3	7,9	206,3	33.238
KLF_25	85,1	53	32,1	8850	19	6,4	168,5	60.019
NUKRO_07	106	71	35	5304	445	7,0	183,8	118.897
NUKRO_25	92,5	54	38,5	11.062	1015	7,7	202,1	290.334
OGBER_07	73,1	40	33,1	5292	226	6,6	173,8	74.306
OGBER_25	103,4	67	36,4	9849	393	7,3	191,1	146.803
			Sum of flights:	61.316	2145			Total: 845.063

Figure 29 - Table of potential savings for EDDB

Dissemination and implementation aspects to ensure that AOCCs and CFSPs are aware were addressed as follows:

- Preparation of the values:
  - The 90th percentile values are transferred in a tabular description for the AIM department.
- Notification of the publication:
  - The AIM department is informed on an update or new data set for respective aerodrome in chapter EDXX AD 2.22 of AD 2 section. Publication is done with the next AIRAC.
- Dissemination:
  - Information campaign was launched towards the airlines.
  - Flight planning departments need to use the information:
    - Either manually coding as “modified” STAR length for fuel calculation,
    - Or via NM B2B services (ENV coordinator will provide NM with the update procedure length for coding in CACD).
- Monitoring:
  - All flights of selected airports must be re-analysed once or twice a year. STAR distances with changes of more than 5 NM have to be updated in the AIP.

An example of the results for EDDB can be found below:

LUFTFAHRTHANDBUCH DEUTSCHLAND
AIP GERMANY

AD 2 EDDB 1-25
31 OCT 2024

STAR Bezeichnung/ STAR ID	Betriebspiste/ RWY in use	Durchschnittliche Flugentfernung/ Average flight distance (NM)
ATGUP 06L/R	06	60
ATGUP 24L/R	24	52
KETAP 06L/R	06	69
KETAP 24L/R	24	49
KLF 06L/R	06	37
KLF 24L/R	24	53
NUKRO 06L/R	06	71
NUKRO 24L/R	24	54
OGBER 06L/R	06	40
OGBER 24L/R	24	67

Flugplanung

Im Gegensatz zum Flugplan können nachfolgende Entfernungen vom Anfangspunkt der STAR bis zur Landung als zu erwartende Flugentfernung für die Flug- und Treibstoffplanung angenommen werden. Abweichungen davon können als Verzögerung betrachtet werden.

Flight planning

In contrast to the flight plan, the following distances from the starting point of the STAR to the landing may be regarded as the expected flight distance for flight and fuel planning purposes. Any deviations from this may be regarded as a delay situation.

AMDT 11/24

© DFS Deutsche Flugsicherung GmbH

Figure 30 - Extract from AIP-Germany

A proposed way forward to allow for a harmonised expansion of the procedure at European level was addressed. The prerequisites for this would be:

- Standardised evaluation method to apply same distance principles at every airport (if meaningful).
- Data source with all relevant flight tracks (all airlines).
- Assessment of applicability – would there be regional showstoppers? What would be the exit criteria?

To make this possible, some open items must be addressed:

- Responsibility for analysis of distances and monitoring – Who?
- Consultation of ANSPs – What is required to publish?
- Consultation of flight planning providers – What is required to use it?
- Consultation of airlines – What is required to use it?

5 Environmental Strategies of ANSPs

Many ANSPs have an environmental strategy in place, often made publicly available. Mostly the strategies consist of different aspects addressing both the corporate footprint and the operational side of the activities. Concerning operations, noise as well as emissions are addressed.

As explained in the report of Pillar 3 of the ATM/ANS Environmental Transparency Working Group[30], CANSO Green ATM can assist ANSPs by providing validation of their efforts to increase sustainability and environmental management[31].

A few examples of environmental strategy elements are provided below based on feedback from the members.

The environmental strategy of DFS[32] is part of its overall long-term strategy**.** The objective of the environmental strategy is to support green flying and to engage in projects that make flying more climate friendly. To this end, DFS considers and develops the conditions for climate-friendly flight procedures that complement our noise-mitigation obligations.
To also reduce in-house energy consumption, DFS will make increased use of renewable energy. DFS is EMAS certified.

The DSNA 2030 strategy[33] comprises one pillar dedicated to meeting the challenge of ecological transition.
By 2030, the corresponding priorities are as follows:

- Improve the environmental performance of flights (Free route, optimised trajectories, green operations in collaboration with airlines) to maximise carbon savings, while meeting capacity challenges.
- Reduce noise pollution for residents by, for example, introducing CDO.
- Obtain the CANSO Green ATM accreditation.
- Reduce the DSNA's ecological footprint and initiate an eco-responsible dynamic.

Progress in implementing the strategy is monitored by means of thematic transformation plans, which include target indicators. For example: increasing the CDO75 rate by 20% or reducing energy consumption by 15% for operational buildings.
DSNA is currently updating its environmental policy and strategy document in line with the DSNA 2030 strategy.

[30] https://www.eurocontrol.int/sites/default/files/2023-01/eurocontrol-step-by-step-guide-measure-ansps-carbon-footprint.pdf
[31] https://canso.org/our-focus/canso-green-atm/
[32] https://www.dfs.de/homepage/en/environment/
[33] https://www.ecologie.gouv.fr/sites/default/files/publications/strategie_environnementale_dsna_eng.pdf

The environmental sustainability strategy of ENAIRE is called GREEN SKY[34]. The current program consists of five initiatives to improve the environmental sustainability of our business derived from our environmental policy:

- Fly Clean (Reduction of aircraft emissions through operational improvements and fuel savings).
- Fly Quiet (Reduction of the acoustic impact on population and biodiversity).
- Eco-ENAIRE: Energy Efficiency & Waste Improvement Management (ecofriendly initiatives).
- Green Commitment (Excellence in ENAIRE's environmental strategy).
- Environmental Responsibility (Reduction and monitoring of the environmental impact of our projects).

They are currently developing a new one for 2026-2030.

MUAC’s environmental strategy is articulated around the following building blocks:

- ATM Operations & Developments, with a direct link to innovation activities.
- Staff Awareness & Training.
- Corporate Footprint.
- Partnerships.
- Indicators.

The environmental strategy is aligned with the overall strategy of the ANSP and serves as a vehicle for aligning internal and external activities and to effectively support their activity portfolio management process. Associated environmental strategic objectives have been defined. MUAC aims to become a climate-neutral entity by 2050 at the latest. Besides supporting the industry in its efforts to reduce CO_2 emissions, they are active in the field of contrail mitigation, conducting in 2021 already the first ever live operational trial on the topic.

In Austro Control (ACG), a comprehensive environmental strategy[35] has been implemented to enhance sustainability in ATM. Key elements of the strategy include:

- Implementation of FRA.
- Optimisation of Approach and Departure Procedures.
- Deployment of Arrival Manager Software and Departure Manager Software.
- Enhancement of Ground Operations (transitioning to energy efficient technologies – installation of photovoltaic systems across multiple sites, ATO is platinum certified building etc).
- Promotion of Sustainable Mobility – partnered with a company to establish 31 charging points at various locations).

[34] https://www.enaire.es/en_GB/2024_03_01/ndp_enaire_greensky_sustainabilityplan_eng

[35] https://www.austrocontrol.at/en/company/profile/environment#:~:text=To%20this%20end%2C%20Austro%20Control,is%20made%20from%20recycled%20wastepaper

Skyguide's vision is to contribute to a sustainable future by actively supporting efforts to reduce CO_2 emissions in aviation. They aim is to improve environmental performance through optimised airspace management, efficient flight trajectories and modernised infrastructure. Their strategy focuses on two main areas: enhancing ATM services to reduce aircraft emissions, and minimising their own environmental footprint through energy-efficient buildings, IT systems and sustainable mobility practices.
Skyguide participates in environmental initiatives at national, European and global levels, including Swiss government programs, SESAR research projects and international aviation forums.

skeyes has developed an Environmental Action Plan. The document describes the actions ongoing and planned at skeyes which are addressing flight efficiency and gas emissions. It contains a concrete set of action items, split in four main pillars:

- Pillar 1 - Flight efficiency improvements: the main objective is the establishment of a Flight Efficiency Improvement Plan through the involvement of all stakeholders concerned.
- Pillar 2 - Improved monitoring of environmental performance.
- Pillar 3 - Enhanced information towards the public. skeyes continues investing in (new) initiatives, to provide the public with insights in the actual operations at/near the airport.
- Pillar 4 - Financial incentives such as modulation of air navigation charges can be used to support improvements in environmental performance.

NATS' promise is to be a net zero emissions company by 2035 and to play their part in helping the aviation industry reach net zero by 2050[36]. They have already reduced their emissions by 37% since 2018 and their environmental strategy commits to further robust targets, improving their emissions performance both in how they run their business and in how they manage UK airspace. While aviation delivers strong economic and social benefits to the UK and beyond, it also has a clear impact on the environment; NATS sees it as their responsibility to help drive, deliver and maintain a sustainable future for the industry. Reducing aviation's environmental impact and saving fuel is important to them and to their customers. As part of their environmental strategy, NATS are implementing smarter and more responsive ways to do this, focusing on key areas:

- Implementation of FRA.
- Increased systemisation of lower airspace.
- Implementation of new technologies such as queue management and intelligent approach.
- Post operational analysis and pre-operational planning.
- ATCO awareness and engagement.

[36]https://www.nats.aero/environment/

6 Questionnaires to ANSPs

As explained in Section 2 of Volume I, one of the first steps undertaken in Pillar 2 sub-group in Summer 2023 was to jointly develop a questionnaire focusing on how different ANSPs handle environmental aspects and the calculation thereof with a focus on technological and/or procedural changes connected with ATM aspects. The purpose was to gain a comprehensive understanding of how different ANSPs handle and calculate environmental aspects. The aim was to gather feedback on the tools and methodologies used, as well as address the challenges faced by the need to balance various environmental requirements.

Following the exchange of information during the finalisation of the 2nd intermediate report in December 2024, the sub-group deemed it beneficial to distribute a new questionnaire in January 2025. This questionnaire requested updates from Pillar-2 members on aspects previously addressed in the 2023 questionnaire, as well as soliciting their input on the content of the final report, with particular emphasis on the design of dashboards.

More information and anonymised results are provided below.

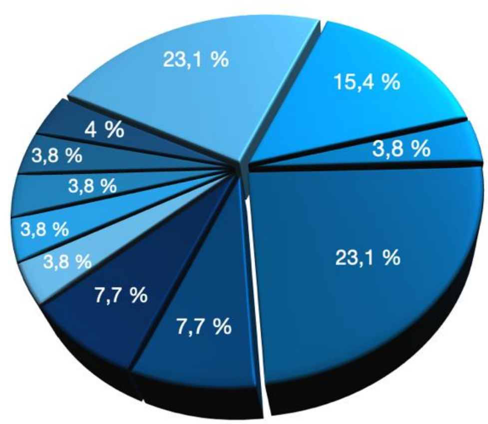
6.1.1 Questionnaire#1 – Summer 2023

The questionnaire was sent to the members of the WG on August 10th, 2023. Responses were received from 10 WG members out of 23 addressed, of which 13 ANSPs. Hence it can be stated that the results represent view of the majority of the WG representing ANSPs.

Q1: Which ENV aspects do you calculate / monitor (it can be indicators, performance areas or other aspects), other than the SES (key) performance indicators. How often do you calculate / monitor them (weekly, monthly, yearly)?

The PRU standards such as HFE / VFE / KEA[37] were listed quite frequently. Also, metrics and basis coming with CCO/CDO are used repeatedly. The ways of counting are highly site specific – either percentage of flights or total.

The response about the frequency of calculation/monitoring shows a homogenous result. It is quite common to apply an annual or monthly rhythm of calculation/monitoring. Still, there are exceptions, where calculation or monitoring is done on a weekly or even daily basis.

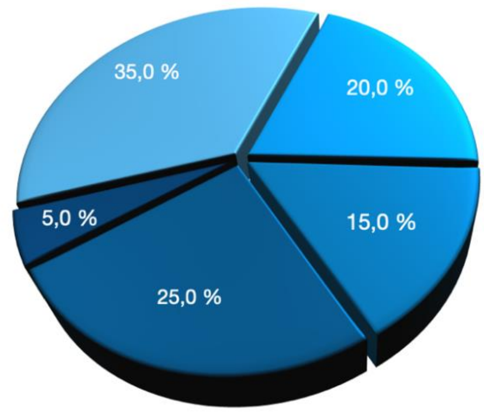


	HFE	VFE	XMAN	CCO/CDO	ASMA	Taxi time	Mnm LineUp	SID Dev	Nnm Altitude	KEA/KEP	ABN Holding
Count	6	4	1	6	2	2	1	1	1	1	1

[37] Horizontal Flight Efficiency / Vertical Flight Efficiency / Key performance Environment indicator based on Actual trajectory

Q2: What is the reason for calculating / monitoring those ENV aspects?

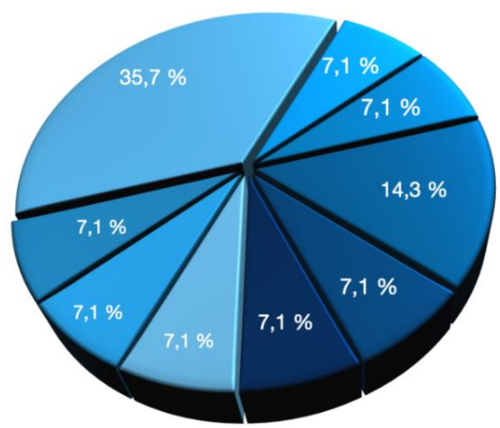
The main thing mentioned is the intention to prepare information both for internal and external use. Followed by agreements with stakeholders and/or communities and to validate changes applied. Finally legal requirements and to reduce the impact of aviation in general.
Percentage calculated based on response received.



	Information	Validate Changes	Legal Requirements	Local Agreements	Reduce Impact
Count	7	4	3	5	1

Q3: What methodologies and tools do you use to calculate the different ENV aspects? Please indicate if a methodology or a tool can be used to cover more than one aspect.

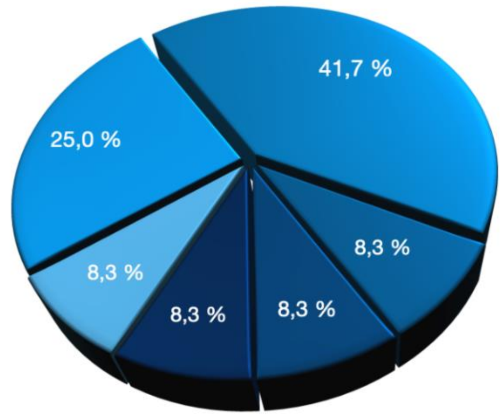
The feedback to this question must be used with care as the question itself most probably created a misunderstanding. Most respondents explained what is calculated and not so much the methodology.
Another clear result – if the low number of data samples allow such a conclusion – is the very heterogeneity in the tools and methods used.



	In-house	GHG protocoll	AEDT	IMPACT	AEM	NEST	ACROPOLE	VARIOUS	3Di
Count	5	1	1	2	1	1	1	1	1

Q4: Are there local ENV aspects calculated on your behalf by another body (e.g., EUROCONTROL, a research institute, an airport…)?

Support from EUROCONTROL was mentioned frequently followed by 'in-house' calculations.

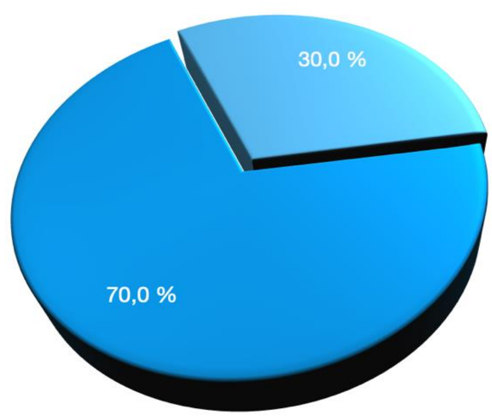


	Partner ANSP	NO	Eurocontrol	Airports	FABEC	SESAR
Count	1	3	5	1	1	1

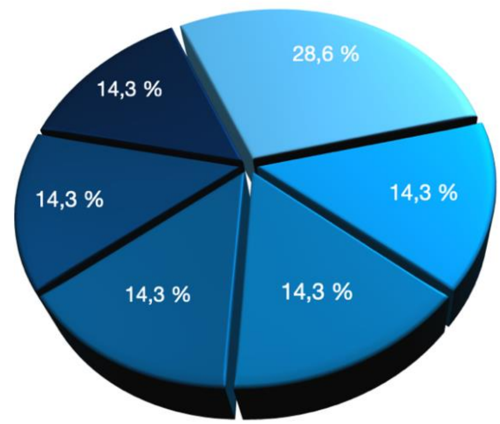
Q5: Do you convert (some of) your calculations into emissions (CO_2 or other)? If yes, what methodology and tools do you use to do so?

It is clearly visible that two thirds of the feedback were positive here – means that calculation is done although not necessarily always as part of routine procedure. CO_2 is calculated.

	NO	YES CO2
Calculation	3	7



The tools used are site specific, no trend or kind of main tool can be identified from the response received.



	Eurocontrol	AEDT	IMPACT	ACROPOLE	BADA	3Di
Count	2	1	1	1	1	1

Q6: When implementing a change, do you assess the impact on ENV? If yes, when do you perform such an assessment (before / after / both)? How do you assess it?

In most cases, the comparison of the change is performed as a part of change management, which is regulated internally. In two cases, there is even a regulatory requirement, which mandates an evaluation of the comparison of the situation before and after the change. In one case a post implementation review is done in addition a year after the change is put into operation.

	NO	YES
Count	0	10

Q7: When implementing a change, do you consider the interdependencies between the different ENV aspects (e.g., CO_2 versus noise) or with the performance areas that are calculated as part of the SES (or outside the scope of SES in case of local performance area)?

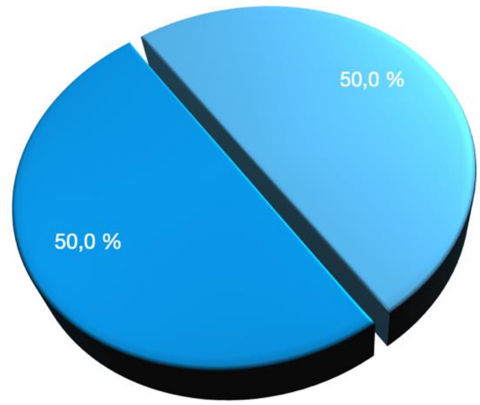
Half of the respondents try to balance the relationship between many factors, but especially between noise and emissions. It is interesting to see which altitudes are taken for what.

One method focuses on noise below 4.000ft, on noise again but already considering emissions as well between 4.000ft and 7.000ft and finally putting the focus on emissions above 7.000ft.

In another case priority is put on noise reduction below 6.500 feet and focus on emissions is put above 9.000 feet. In the area in between, the best compromise is to be sought.

In many cases interdependencies with CO_2, safety and capacity are considered.

Half of the responses indicate that this difficult topic is addressed already but not by the majority.



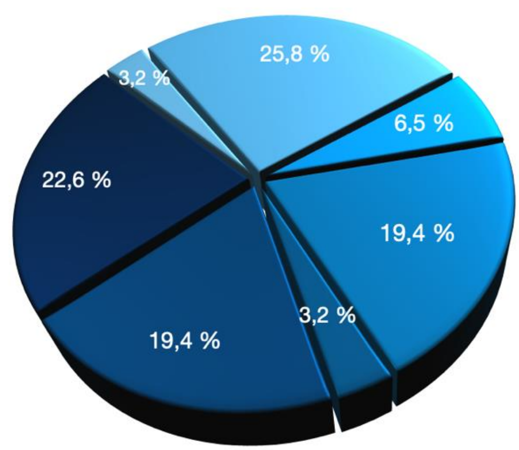
	NO	YES
Count	5	5

Q8: How do you communicate about ENV aspects (externally and internally)? Do you use this information internally for guidance towards further improvements?

There are lots of options to do this and most are used frequently. Internal information and external reports seem to be a standard already.

Externally, this data can be shared via publishing on a yearly basis, dialog with external stakeholders, reports to the regulator, or the engagement of airlines is also seen as good practice.

Interesting is the ATCO training, where future ATCOs are informed and involved in the entire ENV right from the beginning has been mentioned only once.



	External Reports	Eurocontrol	Media	Magazines	Meetings	Internal	ATCO TNG
Count	8	2	6	1	6	7	1

Q9: Please provide an example of how the different ENV aspects have been addressed within your unit when implementing a change (technology and/or procedure).

Very interesting use cases have been provided. They are included in Section 4.

6.1.2 Questionnaire#2 – Winter 2024

The second questionnaire was sent to the members of the sub-group on February 7^{th}, 2025.

Responses were received from 7 ANSPs. The questions and anonymised results are provided below.

Q1: In your country, are there local / national requirements (such as noise) for ANSPs that have priority on "emission reduction"?

Are those requirements hard ones (such as law) or soft ones (such as "agreements")?

How difficult is it to deviate (if possible) from those requirements to prioritise "emission reduction"?

As a general principle, safety is prioritised above all.

In several countries, there are local and national requirements for ANSPs that prioritise noise abatement procedures about emissions. These requirements can be either soft, such as agreements with adjacent communities, or hard, such as Aeronautical Information Publication (AIP) restrictions or laws. AIP restrictions include limitations on ground engine run-ups, visual approaches to avoid populated areas, recommendations for Continuous Descent Operations (CDOs), specific power settings for departure procedures and Standard Instrument Departures (SIDs) designed to avoid populated areas.

Additionally, there are noise action plans that are regularly reviewed and involve multiple stakeholders, including ministries, airports, airlines and citizen associations. Air Traffic Control has the option to deviate from SIDs once departing aircraft pass a certain altitude (e.g., 4000 feet), issuing vectors or direct clearances to shorten flight tracks.

Another respondent specifies that – at low altitudes – the regulatory framework requires environmental impact studies for changes in air navigation procedures, assessing the impact of noise, overflights and CO_2 emissions. There is no regulatory priority given to reducing emissions or noise. Public acceptance is crucial, as noise pollution remains a major concern for residents. New airspace projects often require public consultation and acceptance. For the enroute part, the regulatory framework requires an impact study focusing on fuel consumption and gaseous emissions. In this context, the environmental priority is clearly the reduction of emissions.

It was also mentioned that public health is a priority, especially in urban and residential areas, and noise and emission requirements apply to all emitters, not just ANSPs. Legal requirements make it difficult to prioritise emission reduction over noise abatement. Specific national and EU legislation must be respected for both noise and emissions. That legislation is not specific to air navigation services, but to all emitters in general.

One case mentions that there is no strict guideline about prioritising noise over emissions, but a general principle of protection against noise. As a result, in practice, the design of new procedures involves mainly noise but both should be considered to comply with legal requirements.

In terms of emission reduction, one ANSP has a national plan aimed at reducing CO_2 emissions, coordinated with various ministries and the National Supervisory Authority (NSA). However, there are no specific priorities for noise over CO_2 emissions, and indications aim at supporting a policy that reduces emissions, in line with the European Green Deal.

Punctuality is still mentioned somehow taking precedence over sustainability due to pressure on ANSPs to avoid delays.

Q2: About planning and/or after implementation of a change, please provide an update – if any – on how you consider/monitor the interdependencies between the different environment aspects (e.g., CO_2 versus noise or versus capacity) or with the performance areas that are calculated as part of the SES (or outside the scope of SES in case of local performance area)?

Responses show that interdependencies between various environmental aspects (noise / CO_2) or performance areas (capacity) are monitored when an airspace change is planned.

Of course, safety remains as “above all”.

The assessments prior to a change can be made using tools (or even real time simulations) or based on expert judgement only.

The changes are also monitored after implementation, using indicators such as CCO/CDO and time flown at level-off, or the SES indicators (KEA, KEP)[38]. This monitoring can be done using either EUROCONTROL or internally developed dashboards. About noise, best practice shows that consultation takes place with the local communities as part of the change process.

However, around airports, changes such as a change to a SID will mainly be driven by noise considerations only.

[38] Key performance Environment indicator based on Actual trajectory and Key performance Environment indicator based on last filed flight Plan

Q3: One of the objectives of Pillar 2 is to develop the format and content of a catalogue of tools, including a proposal for its hosting and maintenance as part of the recommendations.

1. **What would be your requirements for such a catalogue?**

The catalogue should contain enough tools to be consistent, together with the possible use, environmental areas concerned and information about the calculation methods. It should be updated regularly to remain reliable over time.

The catalogue must be well-structured and easily searchable, possibly listing tools by theme. Initially, a paper version and its corresponding digital version might be appropriate before considering a web application. Users need an overview of available tools, input data and output for specific use cases, and the ability to compare their own tools with industry standards. The tool(s) should also provide support when building a cost-benefit analysis.

Legal/formal requirements include storage of data (privacy, IT security), legal ownership of data and results, intellectual property rights, access to stored analyses and costs.

Technical requirements involve input data format and time for implementation.

Operational requirements include complexity/handling of user interface and time for running the tool.

2. **When using a catalogue of tools, what information would you be interested in / looking for?**

Information on the tool's type or area of use (e.g., simulator, dashboard, noise/emissions calculation) is considered important, as is the name of the tool supplier (e.g., EUROCONTROL, ANSP, or company) and the website for more information (including a contact reference if possible).

Furthermore, a summary of the tool’s purpose with users need details should comprise the advantages and limitations of the tool. Information on the input and output data is crucial. Especially methodologies, best practices and figures from other ANSPs, as well as interdependencies and legal restrictions from other countries could be part of the catalogue.

One respondent insisted on the sharing of best practices as part of the catalogue and on assisting the ANSPs by providing the links to the regulatory framework aspects.

> Note: for both questions, respondents were also asked to consider the information already provided in the 2nd Intermediate report (i.e., general and calculation method, provider, versions and OS requirements, data requirements,… for each tool), and assess what else they would add to make the catalogue of tools meet their requirements/assumptions, in addition to the questions listed above. Responses are included in the summary of the two sub-questions above.

Q4: Please provide information about dashboards used (or being developed) by your organisation to monitor / examine / report on ENV performance. The scope of topics that could be provided in your responses is:

- **What are the purposes of those dashboards?**
- **What are the indicators/metrics considered?**
- **Are they tailor-made for your internal use?**
- **What is the audience? Is it only internal audience or also external (e.g., local airport communities, or NSA or…)?**
- **Do you use external dashboards such as AIU, NM etc? Do you integrate information from external dashboards into your own dashboards?**
- **Do you use actual data from your airspace users? (e.g., intended vs. actual Top of Descent.)**
- **Do you ensure user feedback about the dashboards?**

Dashboards are used for monitoring, examining and reporting on environmental performance. The purposes of these dashboards include monitoring environmental performance, examining the impact of various procedures and reporting on CO_2 and noise effects.

The indicators and metrics considered in these dashboards vary but generally include fuel consumption, CO_2 emissions, noise levels and other environmental impacts, but also additional elements such as operational benefits related to the implementation of AMAN (Arrival Manager), ATCO productivity, workload optimisation, capacity improvement, landing rate optimisation, effective use of reserved or segregated airspace etc.

These dashboards are often tailor-made for internal use, designed to meet the specific needs and requirements of the organisation. The audience for these dashboards can be both internal and external, including internal stakeholders, local airport communities, national supervisory authorities (NSAs) and other relevant parties.

Some organisations use external dashboards such as AIU, CHMI, PRU, NM and integrate information from these external sources into their own dashboards to enhance the comprehensiveness and accuracy of their data.

Actual data from airspace users is also utilised to ensure the dashboards reflect real-world performance and conditions. Top of Descent was mentioned several times.

User feedback is an important aspect of these dashboards, with organisations ensuring that feedback is collected and used to improve the dashboards' functionality and relevance.

Other considerations mentioned the need for the dashboards to be well-structured, easily searchable, and regularly updated to remain reliable and useful over time.

The integration of methodologies, best practices and figures from other organisations is also highlighted as a valuable feature.

One respondent mentioned the future purchase of a tool will enable them analysing the environmental performance of all their arrival and departure routes and procedures. This is significant as the routes were designed from an operational and safety point of view but have not yet been analysed from an environmental perspective. The first phase of the tool will enable them to gather information about emissions and noise generated by the current areas, and which communities have been most affected. In a second phase, the tool will enable the optimisation of the current routes and simulate the impact of future route updates to decrease their environmental impact in terms of emissions and noise.

Q5: Does your organisation have an environmental strategy in place, or being developed? If yes, can you share some of the elements addressed in the strategy? Is the information publicly available?

Most of the respondents confirmed that they have an environmental strategy in place, often made publicly available.

See Section 5 for more information.

7 Acronyms

Table 16: Acronyms

Acronym	Definition
2/3/4D	Two/Three/Four-dimensional space
3Di	Three-Dimensional Insight
A-CDM	Airport Collaborative Decision Making
ACC	Area Control Centre
ACG	Austro Control
ADEP	Aerodrome of Departure
ADES	Aerodrome of Destination
ADS-B	Automatic Dependent Surveillance-Broadcast
AEM	Advanced Emissions Model (tool)
AGL	Above Ground Level
AIM	Aeronautical Information Management
AIU	Aviation Intelligence Unit
AIRAC	Aeronautical Information Regulation And Control
AMAN	Arrival Manager
ANP	Aircraft and Noise Performance
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
AOCC	Airline Operations Control Center
AOP	Airport Operations Plan
API	Application Programming Interface
APU	Auxiliary Power Unit
ASMA	Arrival Sequencing and Metering Area
ASU	Aviation Sustainability Unit
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATM-P	Air Traffic Management Portal
ATS	Air Traffic Services
B2B	Business To Business

Acronym	Definition
BADA	Base of Aircraft Data
BFFM2	Boeing Fuel Flow Method 2
CAA	Civil Aviation Authority
CACD	Central Airspace and Capacity Database
CAEP	Committee on Aviation Environmental Protection
CANSO	Civil Air Navigation Services Organisation
CAPA	Capacity
CASA	Computer-Assisted Slot Allocation
CCD	Climb Cruise Descent
CDO	Continuous Descent Operations
CEM	Collaborative Environmental Management
CFSP	Computerised Flight Planning Service Provider
Cl	Chlorine
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CODA	Central Office for Delay Analysis
CPF	Correlated Position reports for a Flight
CPR	Correlated Position Report
CSV	Comma-Separated Value
CTFM	Current Tactical Flight Model
dB	Decibel
DDR	Demand Data Repository
DFS	Deutsche Flugsicherung
DLL	Dynamic Link Library
DNL	The Day Night Average Sound Level[39]
DSNA	Direction des Services de la Navigation Aérienne
DTG	Distance To Go
EASA	European Union Aviation Safety Agency
ECAC	European Civil Aviation Conference
EDB	Engine Emission Databank
EEA	European Environment Agency

[39] Noise metric used to reflect a person's cumulative exposure to sound over a 24-hour period.

Acronym	Definition
EF	Emission Factor
END	Environmental Noise Directive
ENV	Environment
ETS	Emissions Trading Scheme
EU	European Union
FAA	Federal Aviation Authority
FABEC	Functional Airspace Block Europe Central
FEIS	Fuel Burn and Emissions Inventory System
FL	Flight Level
FLair	Flight Level Adherence Interactive Reporting
FOA4	First Order Approximation 4
FOCA	Federal Office of Civil Aviation
FOI	FOrskningsInstitut
FRA	Free Route Airspace
FTFM	Filed Tactical Flight Model
GUI	Graphical User Interface
HC	Hydrocarbons
HFE	Horizontal Flight Efficiency
HLP	High Level Principles
HMI	Human Machine Interface
IAF	Initial Approach Fix
ICAO	International Civil Aviation Organisation
IT	Information Technology
ILS	Instrument Landing System
IMPACT	Integrated Aircraft Noise and Emission Modelling Platform
ISA	International Standard Atmosphere
KEA	Key performance Environment indicator based on Actual trajectory
KEP	Key performance Environment indicator based on last filed flight Plan
KPA	Key Performance Area
KPI	Key Performance Indicator
LAeq	Equivalent Continuous Sound Level with A-weighting
LAmax	Maximum noise level (peak of noise)
LNAV	Lateral Navigation

Acronym	Definition
L_{den}	Day-evening-night sound level
LoA	Letters of Agreement
L_{night}	Night-time average sound level
LTO	Landing and Take off Cycle
MDG	Modelling and Databases Group
MEEM	Mission Emissions Estimation Methodology
METAR	Meteorological Aerodrome Report
MUAC	Maastricht Upper Area Control Centre
NATS	National Air Traffic Services
NAx	Number Above[40]
NEST	Network Strategic Tool
NM	Network Manager
NOP	Network Operations Portal
NO_x	Nitrogen Oxides
nvPM	non-volatile Particulate Matter
Open-ALAQS	Airport Local Air Quality Studies tool
OS	Operating Systems
PBN	Performance Based Navigation
PFC	Pre-Flight Check
PM	Particulate Matter
PRISME	Pan European Repository of Information Supporting the Management of EATM
QAR	Quick Access Recorder
RAD	Route Availability Document
RECAT	Re-categorisation of Wake Turbulence Separation Minima
RFL	Requested Flight Level
RF leg	Radius Fixed turn
R-NEST	Research network strategic monitoring tool
RNP	Required Navigation Performance
RNP AR	Required Navigation Performance Authorisation Required
RNP T	Required Navigation Performance Terminal
RTFM	Regulated Tactical Flight Model

[40] Number of operations which exceed a given noise level threshold.

Acronym	Definition
SAF	Sustainable Aviation Fuel
SEL	Sound Exposure Level
SESAR	Single European Sky ATM Research
SID	Standard Instrument Departure
SOx	Sulphur Oxides
STAR	Standard Terminal Arrival
STATFOR	Statistics and Forecast Service
SUI	System User Interface
SYNOP	Surface Synoptic Observations
TAS	True Airspeed
TBS	Time Based Separation
TMA	Terminal Control Area
TOG	Total Organic Gas
VFE	Vertical Flight Efficiency
VNAV	Vertical Navigation
VOC	Volatile Organic Compounds
vPM	volatile Particulate Matter
WG	Working Group

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