EASA
European Union Aviation Safety Agency

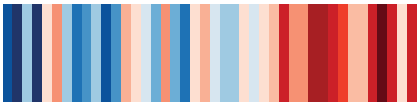
EUROPEAN AVIATION ENVIRONMENTAL REPORT 2025

Executive Summary and Recommendations

European Environment Agency

EUROCONTROL

EXECUTIVE SUMMARY



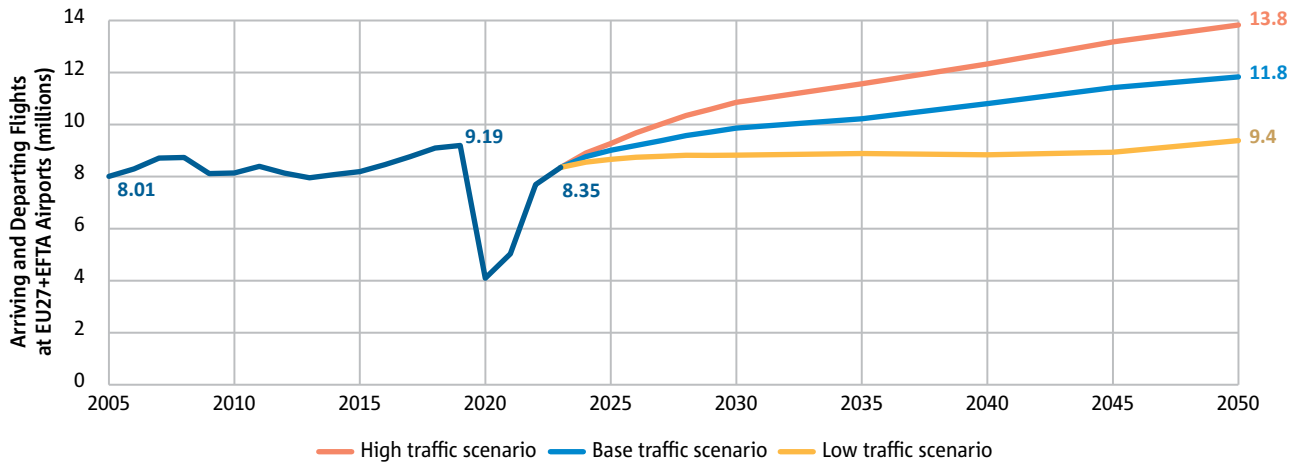
As expected, this decade is proving to be decisive in dealing with climate change. 2023 and 2024 have seen temperature records broken around the world and subsequent climate change trends that are transforming the planet, with Europe warming faster than any other continent.

Along with all other economic sectors, aviation finds itself at a crossroads in its decarbonisation transition, with increasing pressure to deliver against agreed environmental goals and challenges due to supply chain issues delaying fleet renewal as well as the premium price of Sustainable Aviation Fuel and limited production capacity. While aviation is strategically important for Europe and provides significant benefits through connectivity, employment and the wider economy, there is a greater scrutiny of its negative effects (noise, air quality and climate change) on the health and quality of life for European citizens and a desire for intensified action.

These challenges have been acknowledged within Europe and the last few years have seen significant developments under the European Green Deal. The focus must now be on turning sustainability goals into action in order to manage an orderly transition to cleaner aviation while maintaining a high uniform level of safety and connectivity. This 4th European Aviation Environmental Report provides an overview of current progress and the way forward.

EAER DASHBOARD

TRAFFIC



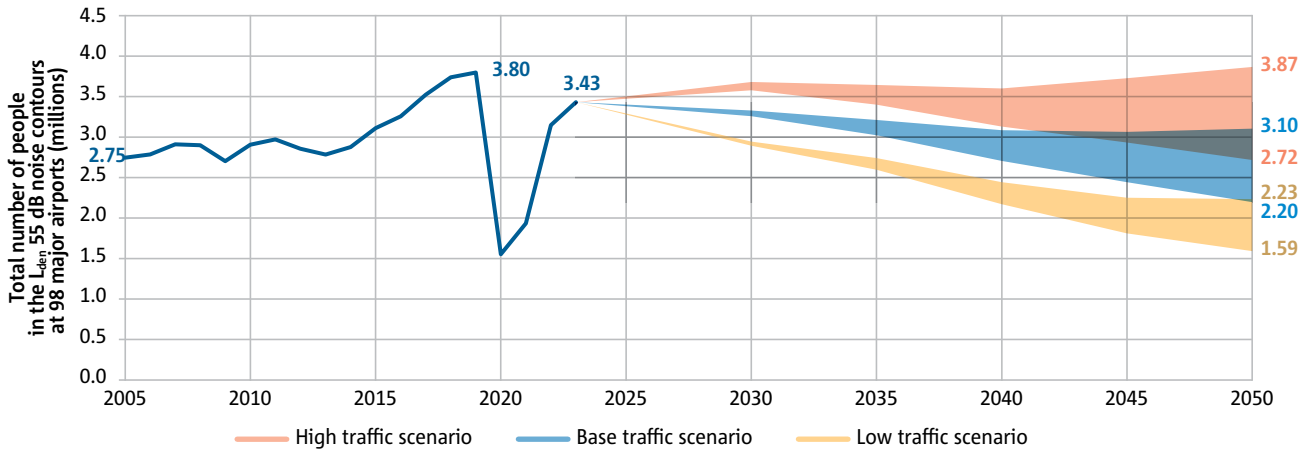
Indicator	Units	2005	2019	2023	2030[1]
Number of flights[2]	million	8.01	9.19	8.35	9.9
Passenger kilometres[3]	billion	777	1 459	1 375	1 683
Number of city pairs served most weeks by scheduled flight		5 368	7 991	7 695	N/A

1 Base traffic scenario

2 All departures and arrivals in EU27+EFTA.

3 All departures from EU27+EFTA.

NOISE



Assumptions:

- *Airport infrastructure is unchanged (no new runway)*
- *Population density around airports is unchanged after 2020*
- *Local landing and take-off noise abatement procedures are not considered*

For each traffic scenario, the upper bound of the range reflects the fleet renewal scenario with frozen technology; the lower bound reflects the scenario with aircraft/engine technology improvements.

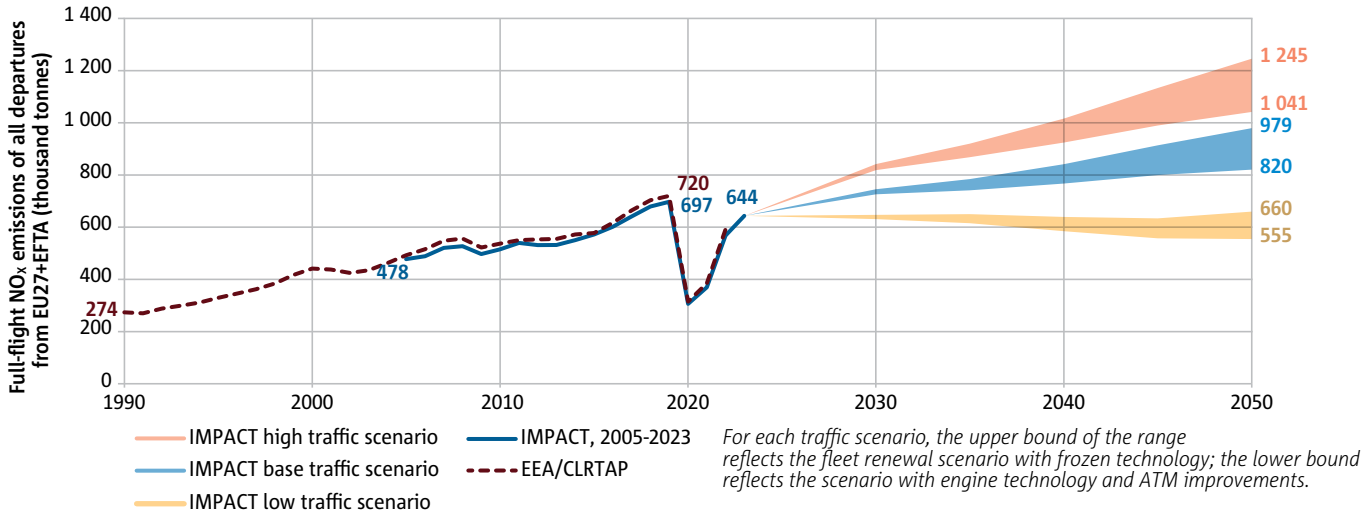
Indicator	Units	2005	2019	2023	2030[4]
Number of people inside L_{den} 55 dB airport noise contours[5]	million	2.75	3.80	3.43	3.26
Average noise energy per operation[6]	10^9 Joules	0.76	0.68	0.63	0.55

[4] Base traffic scenario with aircraft/engine technology improvements.

[5] All departures and arrivals at 98 major European airports.

[6] All departures and arrivals in EU27+EFTA.

EMISSIONS



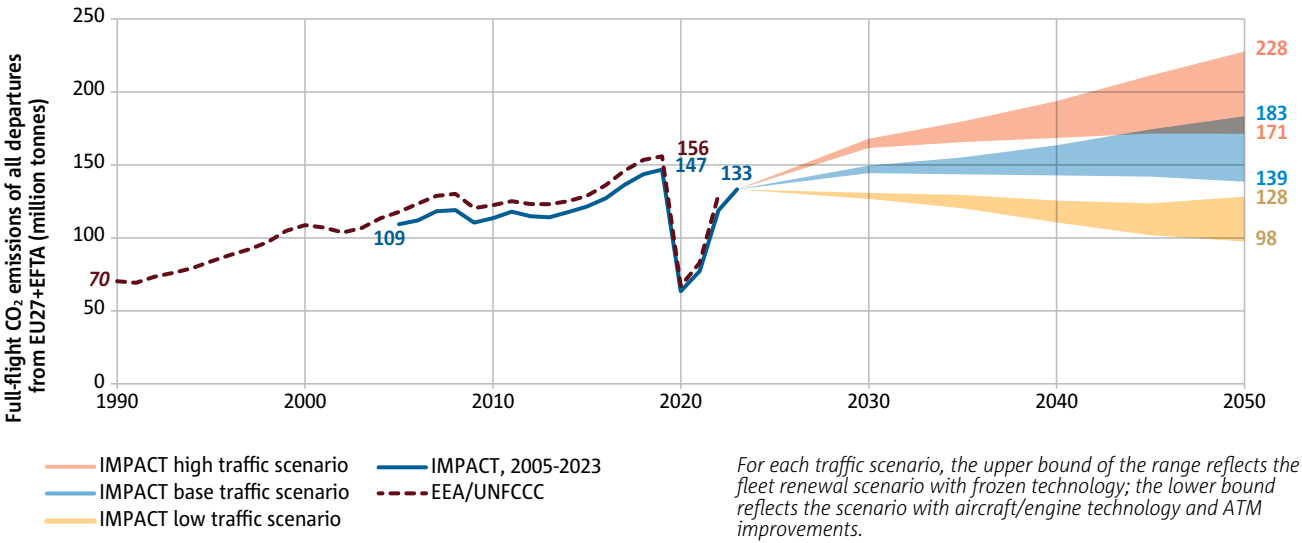
For each traffic scenario, the upper bound of the range reflects the fleet renewal scenario with frozen technology; the lower bound reflects the scenario with engine technology and ATM improvements.

Indicator[7]	Units	2005	2019	2023	2030
Full-flight CO_2 emissions[8]	million tonnes	109	147	133	144
Full-flight 'net' CO_2 emissions[9]	million tonnes	109	114	108	139
Full flight NO_X emissions[8]	thousand tonnes	478	697	644	726
Average fuel consumption[8]	litres fuel per 100 passenger kilometre	4.8	3.5	3.3	2.9

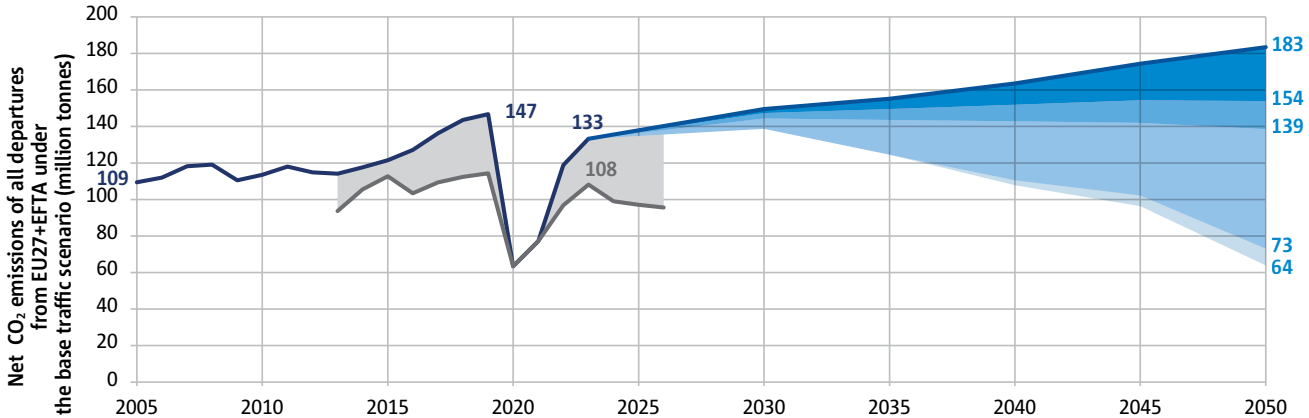
7 All departures from EU27+EFTA

8 2030 value is for the base traffic scenario with technology and operational improvements.

9 2030 value is for the base traffic scenario with technology and operational improvements and sustainable aviation fuels. 2019 and 2023 values include emissions reductions from market-based measures.



For each traffic scenario, the upper bound of the range reflects the fleet renewal scenario with frozen technology; the lower bound reflects the scenario with aircraft/engine technology and ATM improvements.



The blue wedges include the effect of in-sector measures under the base traffic forecast: CO_2 emissions reductions from conventional aircraft technology and ATM-Operations, as well as CO_2eq reductions from SAF (in line with ReFuelEU Aviation supply mandate and minimum emissions reduction thresholds) and electric/hydrogen propulsion. The grey wedge shows the effect of market-based measures: EU ETS (2013-2026), CH ETS (2020-2026) and ICAO CORSIA (2021-2026).

KEY MESSAGES

Overview of Aviation Sector

- The number of flights arriving at and departing from EU27+EFTA airports reached 8.35 million in 2023, which is still 10% below the pre-COVID 2019 level.
- Low-cost operators have recovered faster from the COVID crisis than mainline operators.
- Since February 2022, flight operations have been affected by the war in Ukraine and the subsequent airspace and operator restrictions. From October 2023, some re-routings have also been caused by the conflict in the Middle East.
- The average number of passengers (135) and distance (1 730 km) per flight continues to grow, as does the average fleet age (11.8 years).
- Future traffic growth was revised downwards compared to previous outlook, with 9.4, 11.8 and 13.8 million flights now foreseen in 2050 under the low, base and high traffic scenario respectively.
- At 98 major European airports during 2023, 3.4 million people were exposed to L_{den} 55 dB aircraft noise levels and 1.6 million people were exposed to more than 50 daily aircraft noise events above 70 dB.
- While the total European airport noise exposure is still slightly below 2019 levels, there are different trends at the individual airport level with an increase in noise exposure at about one third of these major airports between 2019 and 2023.

- Single-aisle jets generated 71% of the total landing and take-off noise energy in EU27+EFTA during 2023.
- Fleet renewal could lead to a reduction in total noise exposure at European airports as measured by the L_{den} and L_{night} indicators over the next twenty years. However, the evolution of these indicators may differ significantly between airports.
- In 2023, flights departing from EU27+EFTA airports emitted 133 million tonnes CO_2, which is 10% less than in 2019. Single and twin-aisle jets accounted for 77% of these flights and 96% of the CO_2 emissions. 6% of the flights were long-haul (>4 000 km) and accounted for 46% of the CO_2.
- The average mass of CO_2 emitted per passenger kilometre further reduced to 83 grams in 2023, equivalent to 3.3 litres of fuel per 100 passenger kilometres.
- Market-based measures should help stabilise European aviation's net CO_2 emissions in the short term.
- Meeting the ReFuelEU Aviation supply mandate for sustainable aviation fuels could cut the net CO_2 emissions by at least 65 million tonnes (47%) in 2050.
- NO_X emissions have grown faster than CO_2 emissions since 2005 and are expected to continue to do so without further improvement in engine technology.
- In 2021, the sector accounted for 10% of the population exposed to transport noise above L_{den} 45 dB in EU27+EFTA.
- In 2022, flights departing from EU27+EFTA represented 12% of total transport greenhouse gas (GHG) emissions and 4% of total GHG emissions in EU27+EFTA.

Aviation Environmental Impacts

- Latest IPCC, WMO and Copernicus Climate Change Service all highlight widespread, rapid and record-breaking changes in the climate and extreme weather events, with Europe warming twice as fast as the global average making it the fastest warming continent in the world.

- The overall climate impact from aviation is a combination of both its CO_2 and non-CO_2 emissions (e.g. NO_x, PM, SO_x, water vapour and subsequent formation of contrail-cirrus clouds).

- The estimated Effective Radiative Forcing (ERF) from historic non-CO_2 emissions between 1940 and 2018 accounted for more than half of the aviation net warming effect, but the level of uncertainty from the non-CO_2 effects is 8 times higher than that of CO_2.

- Further research on the climate impact of non-CO_2 emissions from aviation, especially on induced changes in cloudiness and methodologies to estimate aircraft GHG inventories, is required to reduce uncertainties and support robust decision-making.

- Emissions with a short-term climate impact (e.g. NO_x) can be expressed as equivalent to emissions with long-term climate impacts (e.g. CO_2) in order to assess trade-offs of mitigation measures, but this is influenced by the metric and time horizon used.

- A non-CO_2 MRV framework began on 1 January 2025 aiming at monitoring, reporting and verifying the non-CO_2 emissions produced by aircraft operators. This framework is designed to provide valuable data for scientific research that will enhance our understanding of non-CO_2 effects and help address aviation climate impacts more effectively.

- A European Parliament pilot project was launched in 2024 to explore the feasibility of optimizing fuel composition in order to reduce the environmental and climate impacts from non-CO_2 emissions without negatively impacting safety (e.g. lower aromatics, sulphur).

- The Aviation Non-CO_2 Expert Network (ANCEN) has been established to facilitate coordination across stakeholders and to provide objective and credible technical support that can inform discussions on potential measures to reduce the climate impact from non-CO_2 emissions.

- Aviation adaptation and resilience to climate change will be critical to address projected future trends in hazardous weather events (e.g. severe convective storms and clear air turbulence) and changes to climatic and environmental conditions (e.g. sea level rise, changes to prevailing surface winds, upper atmosphere turbulence).

- Aircraft engine emissions (mainly NO_X and particulate matter) impact air quality around airports. Exposure to NO_2 and ultrafine particles levels from aviation could be significant in residential areas in the vicinity of airports.

- The Environmental Noise Directive 2022 data estimates 649 000 people experience high levels of annoyance due to aircraft noise, while 127 000 suffer from significant sleep disturbances.

- The REACH[10] Regulation restrictions on Substances of Very High Concern (e.g. chromium trioxide, PFAS) are impacting the aviation sector due to the absence of immediate alternatives.

[10] Registration, Evaluation, Authorisation and restriction of CHemicals (REACH)

Technology and Design

- There have been a limited number of new certified large transport aircraft and engine types over the last few years with marginal environmental improvements, while deliveries of the latest generation of aircraft continue to penetrate the European fleet.
- The average margin to the latest noise standard of new regional, single-aisle and twin-aisle jet deliveries is levelling off, and the rate of deliveries is still recovering from the COVID crisis.
- Certification of all in-production aircraft types against the ICAO CO_2 standard is required by 1 January 2028, which is leading to an increase in activities within this area.
- All new aircraft joining the European fleet since 2020 have engines that meet the latest CAEP/8 NO_X standard, thereby suggesting a need to review this standard during the CAEP/14 work programme (2025-2028).
- Environmental technology standards will be important in influencing new aircraft and engine designs and contributing to future sustainability goals.
- In February 2025 the ICAO CAEP is aiming to agree on new aircraft noise and CO_2 limits that would become applicable in the next five years.
- Discussions have been initiated within ICAO CAEP to review the noise limits for light propeller-driven aircraft and helicopters, which have been unchanged since 1999 and 2002 respectively.

- ICAO independent experts medium-term (2027) and long-term (2037) technology goals were agreed in 2019 and are becoming outdated.

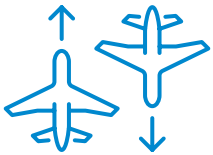
- Emissions data measured during the engine certification process acts as an important source of information to support modelling of operational emissions in cruise.

- There have been further developments within the low carbon emissions aircraft market (e.g. electric, hydrogen), with support from the Alliance for Zero-Emissions Aircraft to address barriers to entry into service and facilitate a potential reduction in short / medium-haul CO_2 emissions of 12% by 2050.

- EASA has published noise measurement Guidelines and Environmental Protection Technical Specifications in order to respond to the emerging markets of Drones and Urban Air Mobility.

- EASA has launched a General Aviation Flightpath 2030+ program to accelerate the transition of propulsion technology, infrastructure and fuels to support sustainable operations.

- Horizon Europe, with a budget of €95 billion, is funding collaborative and fundamental aviation research, as well as partnerships (e.g. Clean Aviation, Clean Hydrogen) who are developing and demonstrating new technologies to support the European Green Deal.



Air Traffic Management and Operations

- The Single European Sky (SES2+) proposal of the Commission was formally adopted by the Council and the European Parliament in 2024, although only modest progress was made and various issues were left unresolved.
- Implementation of SES2+, and a focus on continuous improvement to address unresolved issues, is critical to enhance capacity, efficiency and sustainability.
- RP4 (2025-2029) SES performance targets reflect the ambition to enhance environmental performance, as does the desire to develop improved environmental monitoring indicators while building up resilience and strengthening capacity.
- It is recognized that the SES performance scheme needs to be improved in terms of the ATM-related performance indicators for environment. Work is ongoing to identify a more robust KPI which, after a period of monitoring and analysis during RP4, will be ready for performance target setting in RP5 (2030-2034).
- Updated SES ATM Master Plan has been aligned with the RP4 ambitions such that ANSPs invest in technologies to provide greener, smarter and more effective air traffic.
- Ambitious environmental performance targets cannot be achieved unless the ATM system supports and incentivises all stakeholders to optimize the efficiency of their operations.
- 400 million tonnes of CO_2 emissions (9.3% less CO_2 per flight) could be saved with the completion of the SES ATM Master Plan vision by 2050.
- The war in Ukraine and the Middle East conflict, and the subsequent impact on EU airspace, has made it more difficult to assess whether ATM actions towards improving

environmental performance indicators have resulted in tangible benefits.

- During busy periods, Air Traffic Controllers may need to use alternative procedures to maintain required aircraft separation, thereby limiting the capacity to accommodate fuel efficient Continuous Descent Operations.

- Total gate to gate CO_2 emissions broken down by flight phase indicates that most emissions originate from the cruise phase (62.9%) and climb phase (23.2%).

- The implementation of cross-border, free route airspace (FRA) significantly improves en-route environmental performance. Up to 94 000 tonnes of annual CO_2 emissions are estimated to be saved by 2026 through the Borealis Alliance FRA implementation among 9 States.

- Air traffic control strikes in 2023 had a significant environmental impact with an additional 96 000 km flown and 1 200 tonnes of CO_2 emissions due to knock-on effects across neighbouring States and the wider SES Network.

- A SESAR study estimated that €1 invested in Common Project 1 (CP1) ATM functionalities during 2023 resulted in €1.5 in monetizable benefits and 0.6 kg of CO_2 savings, and these benefits are expected to increase overtime as CP1 is fully implemented.

Airports

- During 2023, EASA took over the management and hosting of the Aircraft Noise and Performance (ANP) legacy data, approved prior to EASA's legal mandate under the 'Balanced Approach' Noise Regulation, in order to establish a single source of ANP data within Europe.
- An assessment of the Environmental Noise Directive implementation in 2023 concluded that the Commission should assess possible improvements, including noise reduction targets at the EU level as per the Zero Pollution Action Plan.
- This same assessment noted that Member States needed to accelerate compliance efforts and ensure that mitigation measures are in line with the Balanced Approach.
- There is growing pressure to address environmental impacts at the 'airport system' level or else face more stringent operational restrictions.
- Revisions to the EU Ambient Air Quality Directives agreed in 2024 included development of air quality action plans where limits are exceeded, enhanced monitoring of compliance, greater transparency for citizens as well as penalties and compensation for infringements.
- In 2022, the 1st Zero Pollution Action Plan Monitoring Assessment concluded that the 2030 noise target is unlikely to be met, while good progress had been made on air pollution targets.
- 51% of operations in Europe were made by aircraft compliant with the latest Chapter 14 noise standard in 2023.

- Significant airport initiatives are being taken forward to invest in onsite production of renewable energy to electrify ground support equipment, thereby mitigating noise and emissions.

- Airport infrastructure will need to be adapted to accommodate Sustainable Aviation Fuel (SAF) and zero emissions aircraft (electric, hydrogen) to meet ReFuelEU Aviation requirements. Various research projects and funding mechanisms are leading the way.

- Some airports are supporting the uptake of SAF through investment in production, supply chain involvement, raising awareness, financial incentives and policy engagement.

- 118 airports in Europe have announced a net zero CO_2 emissions target by 2030 or earlier, of which 16 airports have already achieved it.

- In 2023, a new Level 5 was added to the Airport Carbon Accreditation programme requiring 90% CO_2 emissions reductions in Scopes 1 and 2, a verified carbon footprint and a Stakeholder Partnership Plan underpinning the commitment of net zero CO_2 emissions in Scope 3.[11]

[11] Scope 1: direct airport emissions. Scope 2: indirect emissions under airport control from consumption of purchased electricity, heat or steam. Scope 3: emissions by others operating at the airport such as aircraft, surface access, staff travel.

Sustainable Aviation Fuels

- The ReFuelEU Aviation Regulation has set a minimum supply mandate for Sustainable Aviation Fuels (SAF) in Europe, starting with 2% in 2025 and increasing to 70% in 2050.
- A sub-mandate for synthetic e-fuels, starting at 0.7% in 2030 and increasing to 35% in 2050, underlines their significant potential for emissions reductions.
- All SAF supplied under the ReFuelEU Aviation mandate must comply with the sustainability and greenhouse gas emissions saving criteria as set out in the Renewable Energy Directive (RED).
- In 2023, the ICAO CAAF/3 conference agreed on a global aspirational vision to reduce CO_2 emissions from international aviation by 5% in 2030 through the use of SAF, low-carbon aviation fuels and other aviation cleaner energies.
- As of 2024, SAF production represented only 0.53% of global jet fuel use. Significant expansion of production capacity is required to meet future mandates and goals.
- SAF must meet international standards to ensure the safety and performance of aviation fuel. Various types of SAF have been approved, with ongoing efforts to increase blending limits and support the use of 100% drop-in SAF by 2030.
- SAF have the potential to offer significant CO_2 and non-CO_2 emissions reductions on a lifecycle basis compared to conventional jet fuels, primarily achieved during the production process using sustainable feedstock. However, various factors such as land use changes can negatively impact the overall lifecycle emissions.

- The upscaling of SAF has generated concerns about potential fraudulent behaviour whereby products labeled as meeting sustainability requirements are not compliant.
- Various measures have been put it place to support the achievement of European and ICAO goals on SAF, including a European Clearing House, financial incentives, research programmes and international cooperation.
- SAF production capacity currently under construction could supply the 3.2 Mt of SAF required under ReFuelEU Aviation in 2030 but would be required to ramp up quickly thereafter.
- SAF prices are currently 3 to 10 times more expensive than conventional fuel, although they are expected to reduce substantially as production technologies scale up.

Market-Based Measures

- Market-based measures incentivise 'in-sector' emissions reductions from technology, operational measures and sustainable aviation fuels, while also addressing residual emissions through 'out-of-sector' measures.
- Emissions trading systems (e.g. ETS) have a greenhouse gas emissions cap covering various economic sectors, while offsetting schemes (e.g. CORSIA) compensate for emissions via reductions in other sectors but without an associated cap.
- During 2013 to 2023, the EU ETS led to a net CO_2 emissions reduction in aviation of 206 Mt through funding of emissions reductions in other sectors, of which 47 Mt was in 2021-2023.
- EU ETS allowance prices have increased in the recent years, reaching an average annual price of more than €80 per tonne of CO_2 in 2022 and 2023.
- Revisions were agreed to the EU ETS in 2023, including a gradual phase-out of free allowances to airlines and a reduction to the aviation emissions cap from 2024 onwards.
- Monitoring, reporting and verification of CO_2 emissions under CORSIA began in 2019. As of 2025, 129 out of 193 ICAO States have volunteered to participate in the CORSIA offsetting scheme.
- Offsetting under the CORSIA scheme is expected to start for the year 2024 based on data to be reported in 2025. A total of 19 Mt of CO_2 emissions are forecast to be offset for flights departing from Europe during CORSIA's first phase in 2024-2026.

- The first emissions units have now been authorized for use in CORSIA, complying with the UNFCCC rules on avoidance of double-counting of emissions reductions.
- Technology to capture carbon from the air and store it underground is being developed to support the broader decarbonisation efforts of the aviation sector.
- The EU Taxonomy System sustainable finance initiative has been amended to include aviation activities.
- No agreement has been reached on proposals to revise the Energy Taxation Directive to introduce minimum rates of taxation on fuel for intra-EU passenger flights.

International Cooperation

- Global environmental challenges require global cooperation to achieve agreed future goals.
- International Cooperation is a key element to reach the global aspirational goal for international aviation of net-zero carbon emissions by 2050, including the aim to achieve a 5% reduction of CO_2 emissions from the use of Sustainable Aviation Fuels (SAF), Low Carbon Aviation Fuels and other aviation cleaner energies by 2030.
- Since 2022, European entities (e.g. States, Institutions and Stakeholders) have committed more than €20M to support environmental protection initiatives in civil aviation across Africa, Asia, Latin America and the Caribbean.
- Collaboration with Partner States has contributed to the sound implementation of CORSIA-Monitoring Reporting and Verification in more than 100 States and facilitated new States joining its voluntary pilot and first phases.
- Technical support contributed to the development of a first or updated State Action Plan for CO_2 emissions reduction within 18 States, and to an enhanced understanding of SAF and the associated opportunities worldwide.
- Future efforts with Partner States in Africa, Asia, Latin America and the Caribbean are expected to focus on the implementation of CORSIA offsetting and building capacity to increase SAF production.
- SAF, which has the biggest potential to significantly reduce the carbon footprint of air transport in the short- and long-term, are also an opportunity for States to develop their green economy and to boost job creation. Hence, initiatives like the EU Global Gateway are providing financial support (initially on feasibility studies) to help realise viable SAF production projects in Partner States.

- Awareness, coordination, and collaboration in International Cooperation initiatives among supporting partners are essential factors to maximise the value of the resources provided to Partner States.

- The Aviation Environmental Protection Coordination Group (AEPCG) provides a forum to facilitate this coordination of European action with Partner States.

> Much has been done in recent years to set us on the right path to achieve the European Green Deal objectives. However, we need to move faster at turning sustainability goals into action. A concerted effort is required now to manage an orderly transition to cleaner aviation while maintaining a high uniform level of safety and connectivity. Honest, transparent and effective communication is critical to securing the trust of European citizens that aviation is indeed acting to become more sustainable and will meet the future goals.

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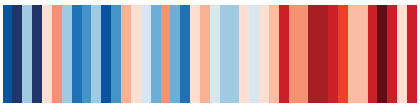
Executive Director
European Union Aviation Safety Agency (EASA)

RECOMMENDATIONS



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PROGRESS ON EAER 2022 RECOMMENDATIONS

The following highlights key areas of progress on the previous Recommendations from EASA and EEA since the European Aviation Environmental Report (EAER) 2022 was published:

- Establishment of collective aspirational goals at ICAO level:
  - Net zero carbon emissions from international aviation by 2050.
  - Reduction in CO_2 emissions from international aviation by 5% in 2030 with the increased production of Sustainable Aviation Fuel and other clean energy initiatives.

- Adoption of ReFuelEU Aviation Regulation with a long-term Sustainable Aviation Fuel (SAF) supply mandate increasing to 70% in 2050 and the creation of a Flight Emissions Label.
- Establishment of supporting measures to deliver ReFuelEU Aviation mandate (e.g. Renewable and Low-Carbon Fuels alliance, EU Clearing House, Taxonomy, Green Deal Industrial Plan).
- Initiation of European Fuel Standard project to consider optimization of fuel composition to mitigate non-CO_2 emissions.

- Completion of an assessment on new dual ICAO aircraft noise and CO_2 standards that are technically feasible, economically reasonable and environmentally beneficial to inform a decision in 2025.
- Development of environmental requirements to support the design and operational integration of new markets into the aviation sector (e.g. drones, urban air mobility, supersonic transport) at EU and ICAO level.

- Launch of significant research initiatives to increase knowledge and insight on how to address the overall climate change effect from aviation emissions (CO_2 and non-CO_2).

- Adoption of modest Single European Sky reforms and update to European Air Traffic Management Master Plan with a target of 9.3% reduction in CO_2 emissions per flight by 2050 compared to 2023.
- Increase from 90 to 118 European airports that have a net zero CO_2 emissions target by 2030.

- Revision of EU Emissions Trading System to include a gradual phase-out of free allowances to airlines, a reduction to the aviation emissions cap from 2024 onwards, establishment of a non-CO_2 MRV framework and a price-bridging mechanism of 20 million ETS allowances to support SAF uptake.
- Amendment of EU Taxonomy System to define aviation products and services that are considered environmentally sustainable.

- European entities (e.g. States, Institutions and Stakeholders) committed more than €20M to support civil aviation environmental protection initiatives across Africa, Asia, Latin America and the Caribbean.
- Coordination between EAER and the European Common Section of the ECAC State Action Plan processes to harmonise information at an EU and ICAO level.
- Creation of European Networks to facilitate coordination across stakeholder groups on the impacts of climate change on the aviation sector, sharing of climate adaptation best practices and technical support on measures to reduce the climate impact from aviation non-CO_2 emissions.

EAER 2025 RECOMMENDATIONS

This section identifies further recommendations from EASA and EEA building on the information and analysis within EAER 2025. They aim to improve the level of environmental protection in the area of civil aviation, without compromising safety, and assist the European Union in ensuring that the aviation sector contributes to the objectives of the European Green Deal[12] through effective collaboration, commitment and verification.

1. Ensure effective oversight and progress towards policy objectives

- Continue to enhance the EAER such that it delivers a comprehensive monitoring system on the environmental performance of the European aviation sector and allows prioritising actions[13] and use of resources to achieve agreed objectives.
  - ◊ Provision of aviation sector data and analysis to demonstrate the effectiveness of European Green Deal policies.
  - ◊ Supply information for robust decision-making and harmonise reporting at the European and ICAO level.
  - ◊ Closer cooperation between European organisations (e.g. EU, EUROCONTROL, ECAC), and their Member States, is critical in achieving this objective.

[12] The European Green Deal encompasses in particular the European Climate Law, the Sustainable and Smart Mobility Strategy and the Zero Pollution Action Plan.

[13] In 2023, single-aisle jets generated 71% of the total landing and take-off noise energy at all EU27+EFTA airports. Single and twin-aisle jets accounted for 77% of flights departing from EU27+EFTA airports and 96% of CO_2 emissions, while 6% of the flights were long-haul (>4 000 km) accounting for 46% of CO_2. In 2050, the aviation sector in the EU27+EFTA should reduce its CO_2 emissions from departing flights by at least 65% through in-sector measures (technology, operations, fuels). This would leave almost 60 million tonnes of CO_2 that would need to be addressed through out-of-sector measures (e.g. market-based measures).

- Respond to concerns of European citizens by promoting accurate, transparent and effective communication[14] on the environmental performance of aviation.

2. Technology standards to incentivise innovation

- Agree on ambitious CO_2 and noise standards for new aircraft types at CAEP/13 in 2025 in order to influence future designs and contribute to achieving agreed sustainability goals (e.g. EU Climate Law and Zero Pollution Action Plan; ICAO goal of net zero carbon emissions by 2050).

- Review the current NO_X emissions standard for aircraft engines, and enhance non-volatile Particulate Matter emissions measurement procedures, during the CAEP/14 work programme (2025-2028).

- Update the current ICAO independent experts 10-year medium (2027) and 20-year long-term (2037) technology goals so they remain relevant and fit for purpose.

- Enhance the understanding of aircraft engine emissions characteristics, including during the certification process, so as to improve the modelling accuracy of non-CO_2 emissions in cruise.

- Ensure technological, industrial and certification readiness of new concept aircraft and engines to meet the planned in-service schedule and use of 100% SAF.

[14] e.g. EAER, Certified aircraft-engine environmental data, SES Performance Scheme KPIs, Flight Emissions Label, annual ReFuelEU SAF Reports, ETS / CORSIA emissions data, Zero Pollution Monitoring Reports.

3. Step-up efforts to implement Single European Sky sustainability objectives

- Build on the recent Single European Sky (SES2+) reform to modernise Air Traffic Management (ATM) and to incentivise environmental performance.
- Accelerate development of new SESAR solutions, and their deployment, with environmental benefits (e.g. 'Common Project 1' ATM functionalities and Master Plan Strategic Deployment Objectives).
- Drive forward improvements in ATM infrastructure and aircraft operations through closer cooperation, and the development of suitable key performance indicators to achieve better climate and environmental performance in the European aviation network.

4. Implement effective airport action plans

- Foster onsite production of renewable energy at airports, with the support of the Connecting Europe Facility, to electrify ground operations and mitigate noise, air quality and climate impacts.
- In line with ReFuelEU Aviation, take all necessary measures to facilitate the access to and uptake of SAF through infrastructure investment, cooperation with supply chain stakeholders, financial incentives and supportive policy / governance frameworks.
- Consider improvements to the 'Balanced Approach' Noise Regulation for managing noise impacts around airports that facilitate consistent implementation by Member States, accelerated compliance and ensures operational restrictions are used only after consideration of all other elements.

5. Scale up Sustainable Aviation Fuels to achieve emission reduction targets

- Reduce the price gap between SAF and fossil-based fuels by building on the Green Deal Industrial Plan, the allocated ETS allowances and ReFuelEU Aviation supporting measures to deliver the supply mandate.
- Promote SAF with the greatest emissions reductions to maximise their contribution to the European Green Deal as well as the ICAO LTAG and CAAF/3 objectives.
- Explore the potential of accounting mechanisms for SAF to facilitate the traceability and claiming of SAF benefits, while preserving the environmental integrity of decarbonisation schemes.
- Progress towards alignment of SAF sustainability certification across regulatory compliance regimes.
- Identify how aviation fuel composition, both fossil and SAF fractions, can be optimised to mitigate overall climate and air quality impacts (e.g. fuel standards).

6. Market-based incentives to promote innovation in sustainability

- Incentivise sustainable finance within the sector, including via the implementation of the EU Taxonomy System for aviation activities.
- Support the 2025 CORSIA Periodic Review to ensure the effectiveness of the scheme in contributing to the sustainable development of the global aviation sector and encourage participation of ICAO States during the voluntary Phase 1 period (2024-2026).
- Progress proposed revisions to the Energy Taxation Directive to encourage the use of low or zero carbon energy sources.

- Ensure the quality and credibility of voluntary and compliance-based carbon credits, including carbon removals, used to offset or reduce emissions within the aviation sector.

7. Facilitate research and implementation of solutions

- Increase research resources and coordination at the EU (e.g. Horizon Europe, EU Innovation Fund) and National level on strategic priorities across all areas (technology, operations, fuels) to meet the 2030 climate target and ensure the aviation sector is on the right path for the 2040 target.

- Bring greater cohesion to the research on the climate effect of aviation non-CO_2 emissions. This would aim to advance scientific understanding and to develop robust decision-making capabilities that take into account uncertainties as part of a risk-based assessment to ensure mitigation measures lead to an overall reduction in climate impact (CO_2 and non-CO_2).

- As Europe's climate is warming twice as fast as the global average, place a greater priority on ensuring the aviation sector's resilience and preparedness for these future changes.

8. Global cooperation to address global challenges

- Step up green diplomacy and technical collaboration with Partner States to address global aviation sustainability challenges.

- Facilitate the transition to sustainable economic models, including through the realisation of viable SAF businesses.

- Maximise the use of international cooperation resources through the effective coordination of European actions with Partner States.


100%
Sustainable
Aviation
Fuel
ATR 72-600

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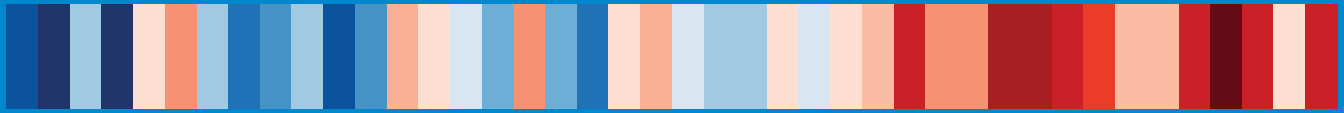
Appendices: A list of resources and detailed assumptions on modeling can be found in the Appendices of the Main Report

Aviation Warming Stripes

The aviation warming stripes on the pages that separate the Chapters in this report were developed in collaboration with the University of Oxford, Manchester Metropolitan University, and the NERC National Centre for Earth Observation.

Based on a recent study that quantified aviation's contribution to global warming,[15] the below aviation 'warming stripes' have been developed with the aim of communicating a complex message in a visually simple and memorable way that people can relate to. Warming stripes typically communicate on the impact of global warming in terms of changes in average surface temperature over time at the global or national level.[16] In comparison, the colours of the aviation warming stripes below represent the modelled % contribution of aviation emissions to overall global warming (temp. increase against a pre-industrial baseline) for a given year between 1980 (1.9% on left) and 2021 (3.7% on right). Note that there remain uncertainties with regard to the climate effects of aviation non-CO_2 emissions (see Chapter 2 on Environmental Impacts).



[15] Klöwer, M., Allen, M. R., Lee, D.S., Proud, S.R., Gallagher, L. and Skowron A. (2021) Quantifying aviation's contribution to global warming. Environmental Research Letters, Volume 16, Number 10.

[16] University of Reading (2018), Warming Stripes.

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