Department for Transport

United Kingdom State Action Plan on International Aviation CO_2 Emissions Reduction Activities

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1. Introduction

The United Kingdom is a Contracting State of the International Civil Aviation Organization (ICAO) and a member of the European Civil Aviation Conference (ECAC). ECAC is an intergovernmental organisation covering the widest grouping of Member States of any European organisation dealing with civil aviation. It was created in 1955 and is currently composed of 44 Member States.[1]

ECAC States share the view that the environmental impacts of the aviation sector must be mitigated if aviation is to continue to be successful as an important facilitator of economic growth and prosperity, noting the need to achieve the ICAO long-term aspirational goal (LTAG) for international aviation of net-zero carbon emissions by 2050. Together, they fully support ICAO's on-going efforts to address the full range of these impacts, including the key strategic challenge posed by climate change, for the sustainable development of international air transport.

All ECAC States, in application of their commitment in the 2016 Bratislava Declaration, support implementation of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and have notified ICAO of their decision to voluntarily participate in CORSIA from the start of its pilot phase and have effectively engaged in its implementation.

The UK, like all of ECAC's 44 States, is fully committed to and involved in the fight against climate change and works towards a resource-efficient, competitive and sustainable multimodal transport system.

The UK recognises the value of each State preparing and submitting to ICAO an updated State Action Plan for CO_2 emissions reductions as an important step towards the achievement of the global collective goals agreed since the 37th Session of the ICAO Assembly in 2010, including the long-term aspirational goal agreed at the 41st Assembly in 2022.

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[1] Albania, Armenia, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Monaco, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and the United Kingdom.

In this context, it is the intention that all ECAC States submit to ICAO an action plan. This is the action plan of the UK.

The UK strongly supports the ICAO basket of measures as the key means to achieve ICAO's LTAG target and shares the view of all ECAC States that a comprehensive approach to reducing aviation CO_2 emissions is necessary, and that this should include:

a) emission reductions at source, including European support to the work of the ICAO Committee on Aviation Environmental Protection (CAEP) in this matter (standard setting processes);
b) research and development on emissions reduction technologies, including through public-private partnerships;
c) development and deployment of sustainable aviation fuels (SAF), including research and operational initiatives undertaken jointly with stakeholders to meet the ICAO aspirational vision of reducing CO_2 emissions by 5% by 2030 through increased use of SAF worldwide;
d) improvement and optimisation of air traffic management (ATM) and infrastructure use within Europe, in particular through the Single European Sky ATM Research (SESAR), and also beyond European borders through participation in international cooperation initiatives; and
e) market-based measures, which allow the sector to continue to grow in a sustainable and efficient manner, recognizing that the measures at (a) to (d) above cannot, even in aggregate, deliver in time the emissions reductions necessary to meet the ICAO long-term aspirational goal of net-zero carbon emissions by 2050.

In Europe, many of the actions which are undertaken within the framework of this comprehensive approach are in practice taken collectively. They are reported in Section 2 of this Action Plan, where the involvement of the UK is described, as well as that of other stakeholders.

In the UK a number of actions are undertaken at the national level, including those by stakeholders. These national actions are reported in Section 3 of this Plan.

In relation to collective European actions, it is important to note that:

- The extent of participation will vary from one State to another, reflecting the priorities and circumstances of each State (economic situation, size of its aviation market, historical and institutional context, such as EU/non-EU). The ECAC States are thus involved to different degrees and on different timelines in the delivery of these common actions. When an additional State joins a collective action, including at a later stage, this broadens the effect of the measure, thus increasing the European contribution to meeting the global goals.
- Acting together, the ECAC States have undertaken measures to reduce the region's emissions through a comprehensive approach. Some of the measures, although implemented by some, but not all of ECAC's 44 States, nonetheless yield emissions reduction benefits across the whole of the region (for example research, SAF promotion or emissions trading schemes).

Current state of aviation in the UK

Throughout its history, the UK has always valued global connectivity and has relied upon international transportation to facilitate trade and commerce, and to build relationships with people and communities around the globe. As an island nation, the UK has enjoyed vast benefits from the rise of civil aviation since the middle of the last century, with the sector playing an increasingly crucial role in moving both people and goods to and from, and within, the country, and making a significant and growing contribution to the economy. Together the air transport and aerospace sectors directly contribute around £25 billion to UK GDP,[2] and provide around 240,000 jobs,[3] alongside indirectly supporting many more.

While domestic aviation plays a valuable role in ensuring connectivity within the UK, including to areas difficult to reach by other transport modes, the vast majority of UK aviation activity is international. This reflects both the high demand for passenger and freight connections between the UK and nations all around the world and the UK's important position as an international hub, well-established as a connection point on journeys to other destinations. In ICAO's latest rankings from 2019, the UK's share of international aviation activity is the fourth largest in the world, based on nationality of operators, representing over 5% of total international aviation activity.[4]

The UK government is committed to securing the UK aviation industry's long-term future. It recognises that as aviation has grown so have its impacts on the environment, and that addressing these impacts is essential to securing a future where the economic and social benefits of air transport and related industries can continue to be enjoyed. Both government and the aviation industry in the UK have a strong history of working to reduce the sector's environmental impacts, including noise, local air pollution and climate impacts, and as awareness and interest in sustainability continues to grow so does the understanding that tackling this challenge brings exciting opportunities for innovation, alongside new economic and social benefits.

State of UK aviation

Aviation accounts for the vast majority of international passenger trips to and from the UK, as shown in Table 1 below.

Table 1: International Passenger Survey, 2023[5]

Mode of travel	Foreign residents (including EU residents): visits to the UK	UK residents: visits abroad
Air	30,774,000	75,858,000

[2] DfT analysis of Office for National Statistics (ONS) low-level aggregates of UK output GDP, based on data from 2023
[3] DfT analysis of ONS Business Register and Employment Survey data, based on data from 2022
[4] ICAO international rankings of revenue traffic kilometres (2019): https://www.icao.int/sustainability/Documents/RTK ranking/International RTK rankings_2019.pdf
[5] Office for National Statistics, Travel trends estimates: overseas residents in the UK and UK residents abroad (published 2024): https://www.ons.gov.uk/peoplepopulationandcommunity/leisureandtourism/datasets/travelandtourism

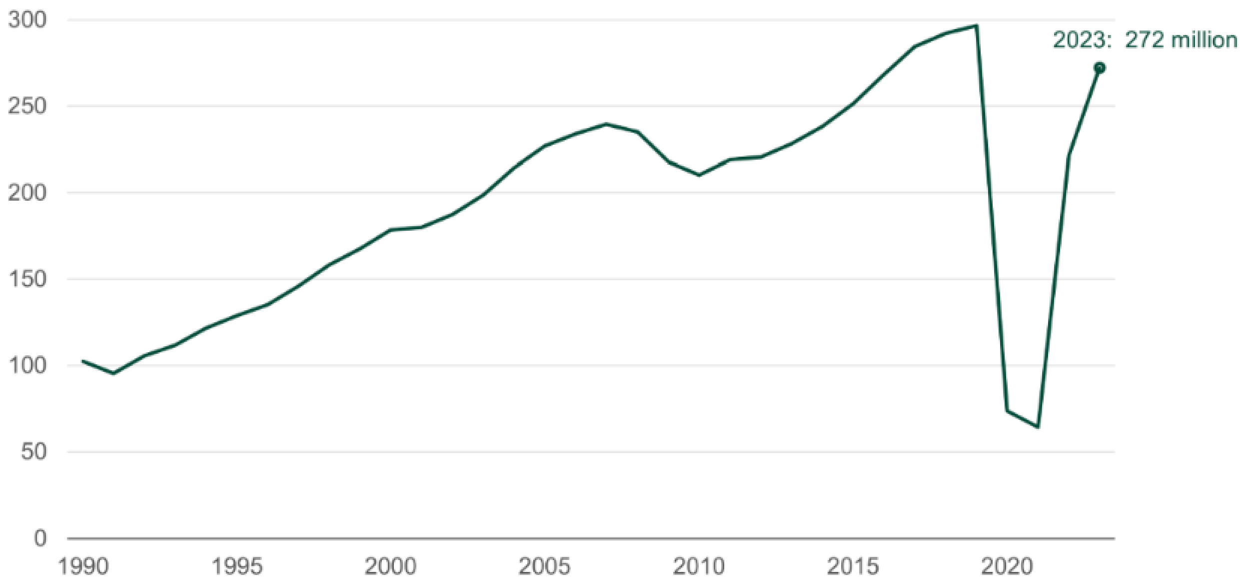
Sea	3,558,000	5,330,000
Channel Tunnel Visits	3,628,000	5,017,000
Total	37,959,000	86,205,000

In 2023, nearly 76 million visits abroad were taken by air by UK residents, equivalent to 89% of 2019 figures. This compares to around 62 million visits by air in 2022 and represents a 22% increase on the year prior, reflecting the progressive recovery of air traffic following the COVID-19 pandemic.

Table 2: Top 10 UK airports by terminal passengers (thousands)[6]

Airport	2019	2022	2023
Heathrow	80,887	61,597	79,149
Gatwick	46,575	32,831	40,894
Manchester	29,367	23,340	28,078
Stansted	28,124	23,290	27,951
Luton	18,214	13,322	16,400
Edinburgh	14,734	11,249	14,395
Birmingham	12,646	9,596	11,479
Bristol	8,960	7,945	9,912
Glasgow	8,843	6,516	7,356
Belfast International	6,278	4,818	5,957

Figure 1: Terminal passengers at UK airports, millions: 1990 to 2023



[6] DfT analysis of CAA airport data

Around 95% of UK cargo imports and exports by weight are moved by sea, with the rest moved by air (<1%) or the Channel Tunnel.[7] However, despite comprising a small proportion of total freight volume, air freight is typically used for high-value and time-sensitive goods (e.g. pharmaceuticals), and accounts for a much larger proportion of the value of UK imports and exports.

There were 2.2 million tonnes of freight handled at UK airports in 2023, with less than 100,000 tonnes of that on domestic routes. UK air freight handling is dominated by three airports: around 60% of air freight is handled by Heathrow, while East Midlands International (~17%) and Stansted (~11%) support significant cargo-only (freighter) operations[8]. In 2023, 66% of international air freight was carried in the hold of passenger flights. This fell from ~72% in 2019 but is expected to return to pre-pandemic levels as the sector continues its recovery.

UK aviation governance

Department for Transport (DfT)

The Department for Transport (DfT) is the UK government department responsible for national aviation policy and for representing the UK internationally on aviation. The Secretary of State for Transport is the senior minister who leads the department, and the Minister for Aviation, Maritime and Security is the minister directly responsible for aviation.

The Aviation Directorate within DfT has overall responsibility for most policy directly related to aviation and airports, but is supported by teams across the department, for example those providing analytical support or leading on international relations. The Aviation Directorate is led by the Aviation Director and consists of several divisions covering specific aspects of aviation policy, including the Aviation Decarbonisation Division which is responsible for national and international decarbonisation policy. The most senior aviation official is the Director General for Aviation, Maritime and Security, who also fulfils the role of Director General of Civil Aviation (DGCA) internationally.

Other central government departments

The Department for Business and Trade (DBT) is the government department with lead responsibility for aerospace policy. The Department for Energy Security and Net Zero (DESNZ) is responsible for energy and overarching decarbonisation strategy, and interacts closely with DfT on aviation decarbonisation matters.[9]

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[7] Port freight annual statistics: 2023 (DfT) published July 2024): https://www.gov.uk/government/statistics/port-freight-annual-statistics-2023 and CAA airport data 2023: https://www.caa.co.uk/data-and-analysis/uk-aviation-market/airports/uk-airport-data/uk-airport-data-2023/

[8] CAA UK airport data, 2023: https://www.caa.co.uk/data-and-analysis/uk-aviation-market/airports/uk-airport-data/uk-airport-data-2023/

[9] Prior to a government restructuring in February 2023, the climate and aviation responsibilities of DBT and DESNZ all sat with the Department for Business, Energy and Industrial Strategy (BEIS).

Civil Aviation Authority (CAA)

The Civil Aviation Authority (CAA) is the UK's independent aviation and airspace regulator. Its key priorities are the continued safety and security of aviation and aerospace, and the protection of consumers. While the CAA does not have a primary duty on the environment, it recognises that managing and mitigating the environmental impacts associated with the sector is the single biggest challenge to aviation, and one of its key strategic focus areas is on supporting industry to improve environmental sustainability. The CAA's 2024 strategic vision is for "safe, secure and sustainable aviation and aerospace working for consumers and the public".

Environment Agency

The responsibilities of the UK Environment Agency (EA) include regulation of emissions trading in England, including under the UK Emissions Trading Scheme (UK ETS) and CORSIA. The EA also regulates aircraft operators registered outside of the UK for the purposes of the UK ETS.

In Wales, Scotland and Northern Ireland, the schemes are regulated by Natural Resources Wales, the Scottish Environment Protection Agency and the Northern Ireland Environment Agency, respectively.

NATS

NATS is the main air navigation service provider in the UK. NATS provides en-route air traffic control services to flights within the UK Flight Information Regions and the Shanwick Oceanic Control Area in the North Atlantic, and provides some air traffic control services to civil and military airports in the UK and Gibraltar.

NATS shares responsibility for the design of low-level airspace (0 to 7,000 ft) with airports and is working closely with airport operators and the Airspace Change Organising Group (ACOG) to develop the Airspace Modernisation Strategy (AMS) masterplan. NATS is solely responsible for the design of airspace above 7,000 ft.

European Civil Aviation Conference (ECAC)

The UK is a founding member state of ECAC and continues to play an active role in all ECAC activities.

Environment is a key priority for ECAC and work in this area is supported by the European Aviation and Environment Group, in which DfT officials are active participants. In 2020, the UK Director General of Civil Aviation was appointed ECAC Focal Point for Environment.

EUROCONTROL

EUROCONTROL is an intergovernmental organisation responsible for overseeing civil and military air traffic management in geographic Europe. It has 41 member States plus two non-European ‘comprehensive agreement’ States. The UK is a founding member of EUROCONTROL, and a vice-president of its governing body, the Provisional Council.

Overseas Territories and Crown Dependencies

The UK is responsible for the aviation affairs of its Crown Dependencies and Overseas Territories. These are included in the UK’s ratification of the Convention on International Civil Aviation (the Chicago Convention). DfT is responsible for ensuring that the UK’s obligations under the Convention, including those relating to decarbonisation, are implemented in the following territories:

1. Anguilla
2. Bermuda
3. British Indian Ocean Territory
4. British Virgin Islands
5. Cayman Islands
6. Falkland Islands
7. Gibraltar
8. Bailiwick of Guernsey
9. Isle of Man
10. Bailiwick of Jersey
11. Montserrat
12. Pitcairn, Henderson, Ducie and Oeno Islands
13. South Georgia and South Sandwich Islands
14. St Helena, Ascension and Tristan da Cunha
15. Turks and Caicos Islands

DfT has been and will continue to closely support the Crown Dependencies and Overseas Territories to implement ICAO environmental standards, including legislating for and regulating CORSIA. The UK encourages these territories to consider climate change impacts when making decisions on aviation policy and, where appropriate, to share best practice.

2. The European Civil Aviation Conference (ECAC) Common Section

Introduction

The ECAC Common Section of this action plan, which is common to all European State Action Plans, presents a summary of the actions taken collectively in the 44 States of ECAC to reduce CO_2 emissions from the aviation system.

Aviation is a fundamental sector of the European economy, and a very important means of connectivity, business development and leisure for European citizens and visitors. For over a century, Europe has led the development of new technologies and innovations to better meet society's needs and concerns, including addressing the sectoral emissions affecting the climate.

Since 2019, the COVID-19 pandemic has generated a world-wide human tragedy, a global economic crisis and an unprecedented disruption of air traffic, significantly changing European aviation's growth and patterns and heavily impacting the aviation industry. The European air transport recovery can nevertheless be an opportunity to accelerate its contribution to the achievement of the global climate ambitions.

In 2023, the number of flights in Europe reached 92% of the 2019 (pre-COVID) levels, owing to the continuous recovery since the outbreak and the strengthening volumes during summer. Ukraine's airspace has remained closed since February 2022, with neighbouring airspace absorbing more traffic (and diverted flights overloading the busy South-East axis). The start of the conflict in the Middle East (October 2023) has affected various flows that were unable to overfly the zone. Geopolitical crises have also had an impact on flows in the South Caucasus, especially overflights. At the moment of drafting this plan, the level of uncertainty of how these crises will impact international air traffic in the long-term is still high, so the assessments made might be revised in the next update, as more accurate data of such impacts are expected to be available. EUROCONTROL is publishing regular comprehensive assessments of the latest traffic situation in Europe, and such best-available data has been used for the preparation of the ECAC Common Section of this action plan.

The Common Section includes an updated description and assessment of the collective European efforts taken to mitigate the climate impacts of aviation, as well as description of future measures driving to additional CO_2 savings.

ECAC scenarios for traffic and CO2 emissions

Despite the current extraordinary global decay on passengers' traffic due to the COVID-19 pandemic, hitting the European economy, tourism and the sector itself, aviation is expected to continue to grow in the long-term, develop and diversify in many ways across the ECAC States. Air cargo traffic has not been as impacted as the rest of the traffic and thus, whilst the focus of available data relates to passenger traffic, similar pre-COVID forecasted outcomes might be anticipated for cargo traffic both as belly hold freight or in dedicated freighters. Analysis by EUROCONTROL and EASA have identified the most likely scenario of influences on future traffic and modelled these assumptions out to future years. Based on this traffic forecast, fuel consumption and CO_2 emissions of aviation have been estimated for both a theoretical baseline scenario (without any mitigation action) and a scenario with implemented mitigation measures that are presented in this action plan.

Under the baseline assumptions of traffic growth and fleet rollover with 2023 technology, CO_2 emissions would significantly grow in the long-term for flights departing ECAC airports without mitigation measures. Modelling the impact of improved aircraft technology for the scenario with implemented measures indicates an overall 21% reduction of fuel consumption and CO_2 emissions in 2050 compared to the baseline. Whilst the data to model the benefits of ATM improvements may be less robust, they are nevertheless valuable contributions to reduce emissions further. Overall CO_2 emissions, including the effects of new aircraft types and ATM-related measures, are projected to lead to a 29% reduction in 2050 compared to the baseline.

The potential of market-based measures and their effects have not been simulated in detail in the Common Section of this action plan, but they will help reach the goal of carbon-neutral growth. As further developments in policy and technology are made, further analysis will improve the modelling of future emissions.

ECAC baseline scenario and estimated benefits of implemented measures

ECAC baseline scenario

The baseline scenario is intended to serve as a reference scenario for CO_2 emissions of European aviation in the absence of any of the mitigation actions described later in this document. The following sets of data (2010, 2019, 2023) and forecasts (for 2030, 2040 and 2050) were provided by EUROCONTROL for this purpose:

- European air traffic (includes all commercial and international flights departing from ECAC airports, in number of flights, revenue passenger kilometres (RPK) and revenue tonne-kilometres (RTK));
- its associated aggregated fuel consumption; and
- its associated CO_2 emissions.

The sets of forecasts correspond to projected traffic volumes in a 'Base' scenario, corresponding to the most-likely scenario, while corresponding fuel consumption and CO_2 emissions assume the technology level of the year 2023 (i.e. without considering reductions of emissions by further aircraft related technology improvements, improved ATM and operations, sustainable aviation fuels or market-based measures).

Traffic Scenario 'Base'

As in all forecasts produced by EUROCONTROL, various scenarios are built with a specific storyline and a mix of characteristics. The aim is to improve the understanding of factors that will influence future traffic growth and the risks that lie ahead. The latest EUROCONTROL Aviation Outlook to 2050[10] has been published in 2024 and inspects traffic development in terms of Instrument Flight Rule (IFR) movements to 2050.

In the latter, the scenario called 'Base' is constructed as the 'most likely' scenario for traffic, most closely following the current trends. It considers a moderate economic growth with regulation reflecting environmental, social and economic concerns to address aviation sustainability. This scenario follows both the current trends, and what are seen as the most likely trends into the future.

Amongst the models applied by EUROCONTROL for the forecast, the passenger traffic sub-model is the most developed and is structured around five main groups of factors that are taken into account:

- Global economy factors represent the key economic developments driving the demand for air transport.
- Factors characterising the passengers and their travel preferences change patterns in travel demand and travel destinations.
- Price of tickets set by the airlines to cover their operating costs influences passengers' travel decisions and their choice of transport.

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[10] EUROCONTROL Long-Term Aviation Outlook to 2050 (December 2024): https://www.eurocontrol.int/publication/eurocontrol-aviation-long-term-outlook

- More hub-and-spoke or point-to-point networks may alter the number of connections and flights needed to travel from origin to destination.
- Market structure considers a detailed analysis of the fleet forecast and innovative projects, hence the future size of aircraft used to satisfy the passenger demand.

Table 1 below presents a summary of the social, economic and air traffic related characteristics of three different scenarios developed by EUROCONTROL. The year 2023 served as the baseline year of the 30-year forecast results[11] (published in 2024 by EUROCONTROL). Historical data for the year 2010 and 2019 are also shown later for reference.

Common Section Table 1: Summary characteristics of EUROCONTROL scenarios

	High	***Base***	*Low*
7-year flight forecast 2024-2030	High ➚	Base ➔	Low ➘
Passenger			
Demographics (Population)	Aging UN Medium-fertility variant	Aging UN Medium-fertility variant	Aging UN Zero-migration variant
Routes and Destinations	Long-haul ➚	No Change ➔	Long-haul ➘
High-Speed&Night trains (new & improved connections)	32 HST/29 NT city-pairs faster implementation	31 HST/29 NT city-pairs	26 HST city-pairs later implementation.
Economic conditions			
GDP growth	Stronger ➚	Moderate ➔	Weaker ➘➘
EU Enlargement	+7 States, Later	+7 States, Earliest	+7 States, Latest
Free Trade	Global, faster	Limited, later	None
Price of travel			
Operating cost	Decreasing ➘➘	Decreasing ➘	No change ➔
Price of CO_2 in Emission Trading Scheme	Moderate, increasing ➚	Moderate, increasing ➚	Moderate, Increasing ➚
Price of oil/barrel	Moderate	Moderate	High
Price of SAF	Relatively High ➚	Relatively High ➚	Highest ➚➚
Structure Network	Hubs: Mid-East ➚➚ Europe ➘ Türkiye ➚ Point-to-point: N-Atlantic. ➘	Hubs: Mid-East ➚➚ Europe & Türkiye ➚ Point-to-point: N-Atlantic ➚, European Secondary Airports.➚	No change ➔
Market Structure	Industry fleet forecast, Clean Aviation and STATFOR assumptions	Industry fleet forecast, Clean Aviation and STATFOR assumptions	Industry fleet forecast, Clean Aviation and STATFOR assumptions
Fuel mix	In line with ReFuelEU Aviation (2%SAF in 2025 to 70% in 2050)	In line with ReFuelEU Aviation (2% SAF in 2025 to 70% in 2050)	5 years behind ReFuelEU Aviation (0.5%SAF in 2025 to 42% in 2050)

[11] EUROCONTROL Long-Term Aviation Outlook to 2050 (December 2024): https://www.eurocontrol.int/publication/eurocontrol-aviation-long-term-outlook

Update of the EUROCONTROL Aviation Outlook to 2050

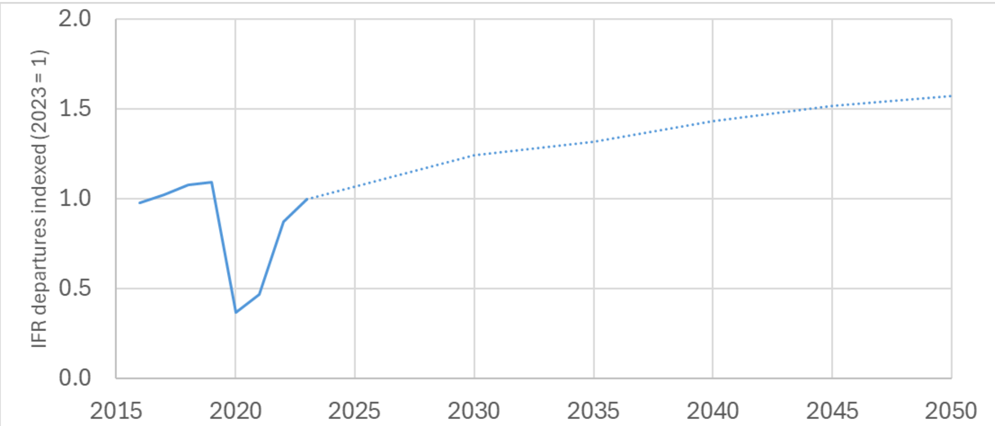
In November 2023, EUROCONTROL started to work on an update of its EUROCONTROL Aviation Outlook to 2050 (EAO). It is an update of the previously published EAO (April 2022), covering the long-term flights and CO_2 emissions forecast to 2050, which was based on 2019 historical flight data. The 2024 edition of the EAO forecast is now based on the latest available actual flight data (2023) and uses the EUROCONTROL seven-year forecast (2024-2030). It includes a complete review of the fleet forecast assumptions as well as a review of other inputs: high-speed rail network development, impact of SAF mandates, jet fuel and CO_2 allowances on ticket prices, as well as future airport capacity constraints.

EUROCONTROL also provides an update of its modelling framework and traffic environmental assessment including:

- An updated technological freeze baseline operations forecast using only growth and replacement in-production aircraft in the baseline year (traffic and fleet baseline scenario) from 2023 to 2050.
- An updated baseline passenger data (Eurostat). Additional data sources may be required to cover the ECAC region.
- Latest versions of the Aircraft Noise and Performance (ANP) database, BADA, ICAO Aircraft Engine Emissions Database (AEEDB), - versions of March 2024.
- Updated assumptions on future technologies, operational efficiency, SAF (e.g. based on the CAEP/13 Environmental Trends complemented with information on emerging technologies).

Figure 1 below shows the ECAC scenario of the passenger flight forecasted international departures for both historical (solid line) and future (dashed line) years.

Common Section Figure 1: Updated EUROCONTROL 'Base' scenario of the passenger flight forecast for ECAC international departures from 2024 to 2050.



Further assumptions and results for the baseline scenario

The ECAC baseline scenario was generated by EUROCONTROL for all ECAC States. It covers all commercial international passenger flights departing[12] from ECAC airports, as forecasted in the aforementioned traffic 'Base' scenario. The number of passengers per flight is derived from Eurostat data.

EUROCONTROL also generates a forecast for all-cargo flights in its baseline scenario. However, no information about the freight tonnes carried is available. Hence, historical and forecasted cargo traffic have been extracted from another source (ICAO[13]). This data, which is presented below, includes both belly cargo transported on passenger flights and freight transported on dedicated all-cargo flights.

Historical fuel burn and emission calculations are based on the actual flight plans from the PRISME[14] data warehouse used by EUROCONTROL, including the actual flight distance and the cruise altitude by airport pair. These calculations were made with a subset of total passenger traffic (with available and usable information in the flight plans) covering 98% in 2010, and 99% in 2019 and 2030. Determination of the fuel burn and CO_2 emissions for historical years is built up as the aggregation of fuel burn and emissions for each aircraft of the associated traffic sample characteristics. Fuel burn and CO_2 emission results consider each aircraft's fuel burn in its ground and airborne phases of flight and are obtained by use of the EUROCONTROL IMPACT environmental model[15], with the aircraft technology level of each year.

Forecast years (until 2050) fuel burn and modelling calculations use the 2023 flight plan characteristics as much as possible, to replicate actual flown distances and cruise levels, by airport pairs and aircraft types. When not possible, this modelling approach uses past years' traffics too, and, if needed, the ICAO CAEP forecast modelling. The forecast fuel burn and CO_2 emissions of the baseline scenario for forecast years use the technology level of 2023. The usable forecast passenger traffic for calculation represents 99.7% of the total available passenger traffic.

For each reported year, the RPK calculations use the number of passengers carried for each airport pair multiplied by the great circle distance between the associated airports and expressed in kilometres. Because of the coverage of the available passenger estimation datasets (Scheduled, Low-cost, Non-Scheduled flights, available passenger information, etc.) these results are determined for 96% of the historical passenger traffic in 2010, 97% in 2019, 99% in 2023, and around 99% of the passenger flight forecasts.

From the RPK values, the passenger flights RTK can be calculated as the number of tonnes carried by kilometres, assuming that one passenger corresponds to 0.1 tonne.

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[12] International departures only. Domestic flights are excluded. A domestic is any flight between two airports in the State, regardless of the operator or which airspaces they enter en-route. Airports located overseas are attached to the State having the sovereignty of the territory. For example, France domestic include flights to Guadeloupe, Martinique, etc.
[13] ICAO Long-Term Traffic Forecasts, Cargo, Europe, International (excluding Russian Federation, Belarus and Greenland), 2021.
[14] PRISME is the name of the EUROCONTROL data warehouse hosting the flight plans, fleet and airframe data.
[15] EUROCONTROL Impact Model: https://www.eurocontrol.int/platform/integrated-aircraft-noise-and-emissions-modelling-platform

The fuel efficiency represents the amount of fuel burn divided by the RPK for each available airport pair with passenger data, for the passenger traffic only. Therefore, the fuel efficiency can only be calculated for city pairs for which the fuel burn and the RPK values exists[16].

The following tables and figures show the results for this baseline scenario, which is intended to serve as a reference case by approximating fuel consumption and CO_2 emissions of European aviation in the absence of mitigation actions.

Common Section Table 2: Baseline forecast for international traffic departing ECAC airports

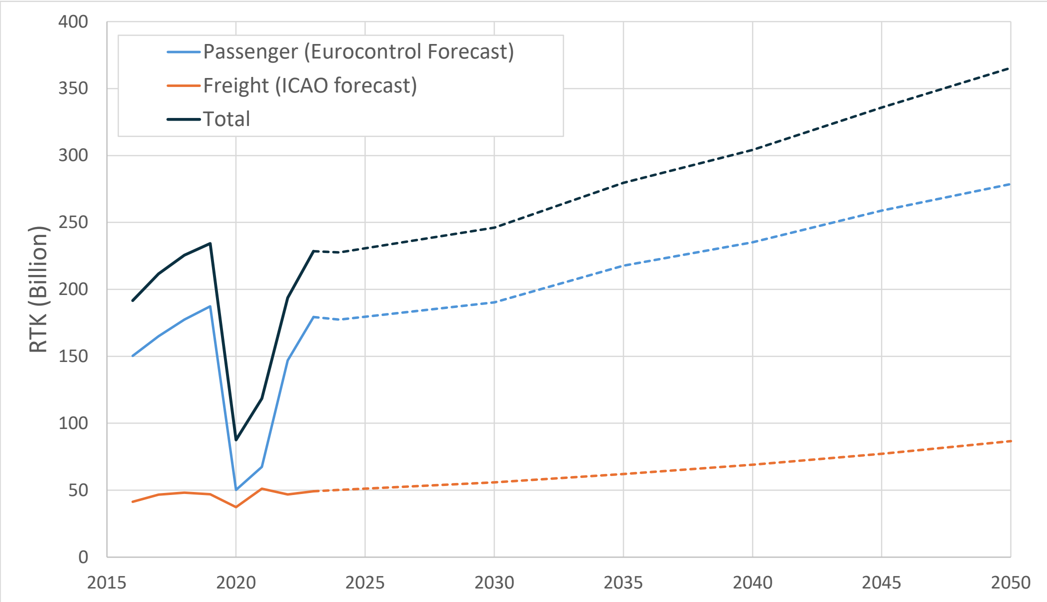
Year	Passenger Traffic (IFR movement) (million)	Revenue Passenger Kilometres[17] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[18] FTKT (billion)	Total Revenue Tonne Kilometres[19] RTK (billion)
2010	4.71	1,140	0.198	41.6	155.6
2019	5.88	1,874	0.223	46.9	234.3
2023	5.38	1,793	0.234	49.2	228.5
2030	6.69	2,176	0.262	55.9	273.5
2040	7.69	2,588	0.306	69.0	327.8
2050	8.46	2,928	0.367	86.7	379.5

Common Section Table 3: Fuel burn and CO_2 emissions forecast for the baseline scenario

Year	Fuel Consumption (10^9kg)	CO_2 emissions (10^9kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	38.08	120.34	0.0327	0.327
2019	53.30	168.42	0.0280	0.280
2023	48.41	152.96	0.0268	0.268
2030	54.46	172.10	0.0250	0.250
2040	62.19	196.52	0.0240	0.240
2050	69.79	220.54	0.0238	0.238
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

[16] Dividing the fuel by the RPK results of the tables presented in this document is not suitable to estimate the fuel efficiency (traffic coverage differences). The presented result has been calculated on an airport pair basis.
[17] Calculated on the basis of great circle distance between the airports of the available passenger reports (subset of the global traffic; from 97% in 2010 up to 99% for the forecast years).
[18] Includes passenger and freight transport (on all-cargo and passenger flights).
[19] A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).

Common Section Figure 2: Forecasted traffic until 2050 (assumed both for the baseline and implemented measures scenarios)



Although data are not shown in **Table 2**, the number of flights between 2019 and 2023 in **Figure 2** is reflecting the impact of COVID-19 starting in 2020. If the passenger segment has been drastically affected by the outbreak, the freight segment seemed more immune.

As detailed in **Table 3**, from 2010 to 2019, the CO_2 emissions increased from 120 to 168 million tonnes, corresponding to an annual growth rate of 3.8%. In 2023, due to the impact of the COVID-19 crisis on the traffic, the CO_2 emissions were lower than the 2019 level, with 153 million tonnes. For the forecast years, the estimated CO_2 emissions of the ECAC Baseline scenario would increase from 172 million tonnes in 2030 to 220 million tonnes in 2050 (corresponding to annual growth rate of 1.25%).

The fuel efficiency improvement is expected to be less important in the forecast years (annual growth rate of 0.4% between 2023 and 2050) than between 2010 and 2023 (1.5% per year), mainly due to the entry into service of the new generation aircraft families (e.g. MAXs, NEOs).

ECAC scenario with implemented measures: estimated benefits

To improve fuel efficiency and to reduce future air traffic emissions beyond the projections in the baseline scenario, ECAC States have taken further action. Assumptions for a top-down assessment of the effects of mitigation actions are presented here, based on modelling results by EUROCONTROL and the European Union Aviation Safety Agency (EASA). Measures to reduce aviation’s fuel consumption and emissions will be described in the following chapters.

For reasons of simplicity, the scenario with implemented measures is based on the same traffic volumes as the baseline case, i.e. updated EUROCONTROL’s ‘Base’ scenario described earlier. Unlike in the baseline scenario, the effects of aircraft-related technology development and improvements in ATM/operations are considered here for a projection of fuel consumption and CO_2 emissions up to the year 2050.

Effects of **improved aircraft technology** are captured by simulating fleet roll-over and considering the fuel efficiency improvements of the expected future aircraft types with conventional engines (e.g. Boeing 777X, reengineered Airbus A321Neo, etc.) and powered by hybrid electric and hydrogen engines. The simulated future fleet of aircraft has been generated using the Aircraft Assignment Tool (AAT)[20] developed collaboratively by EUROCONTROL, EASA and the European Commission. The retirement process of AAT is performed year by year, allowing the determination of the number of new aircraft required each year.

This technical improvement is modelled by a constant annual improvement of fuel efficiency of 1.16% per annum assumed for each aircraft type, with entry into service from 2024 onwards. This rate of improvement corresponds to the ‘Advanced’ fuel technology scenario used by CAEP to generate the fuel trends for the ICAO Assembly. This modelling methodology is applied to the years 2030 to 2050. In addition, the entry into service of hybrid electric and hydrogen aircraft types in the traffic induce a percentage of baseline fuel consumption reduction ramping up from 0% in 2035 to 5% in 2050.

The effects of improved **ATM efficiency** are captured in the Implemented Measures Scenario based on the European ATM Master Plan, managed by SESAR 3. This document defines a common vision and roadmap for ATM stakeholders to modernise and harmonise European ATM systems, including an aspirational goal to reduce average CO_2 emission per flight by 5-10% (0.8-1.6 tonnes) by 2035 through enhanced cooperation. Improvements in ATM system efficiency beyond 2023 were assumed to bring reductions in full-flight CO_2 emissions gradually ramping up to 5% in 2035 and 10% in 2050. These reductions are applied on top of those coming from aircraft/engine technology improvements.

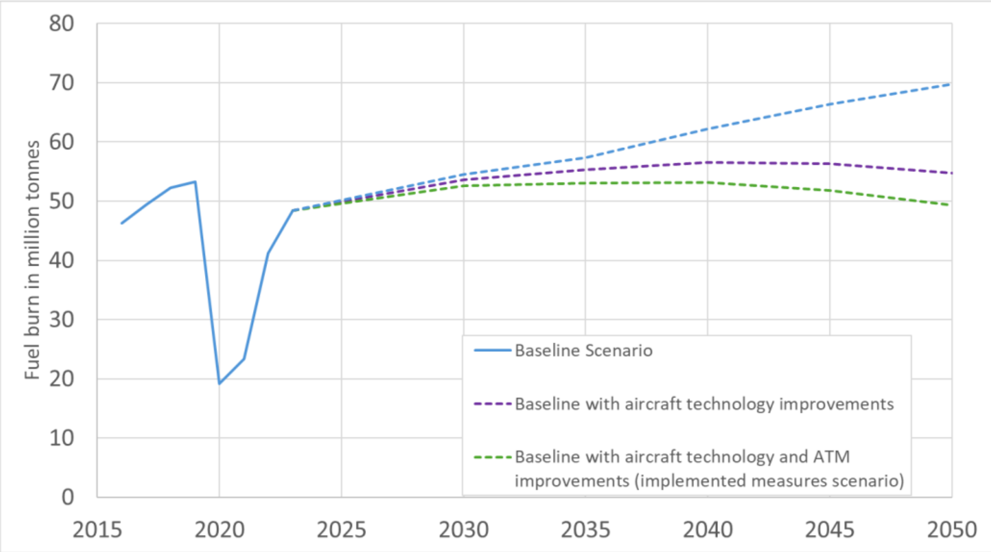
The yet un-estimated benefits of Exploratory Research projects[21] are expected to increase the overall future fuel savings.

Effects on aviation’s CO_2 emissions of **market-based measures** including the EU Emissions Trading System (EU ETS) with the linked Swiss ETS, the UK Emissions Trading Scheme and CORSIA have not been modelled explicitly in the top-down assessment of the implemented measures scenario presented here. CORSIA aims for carbon-neutral growth (CNG) of aviation, and this target is therefore shown in **Figure 4**[22].

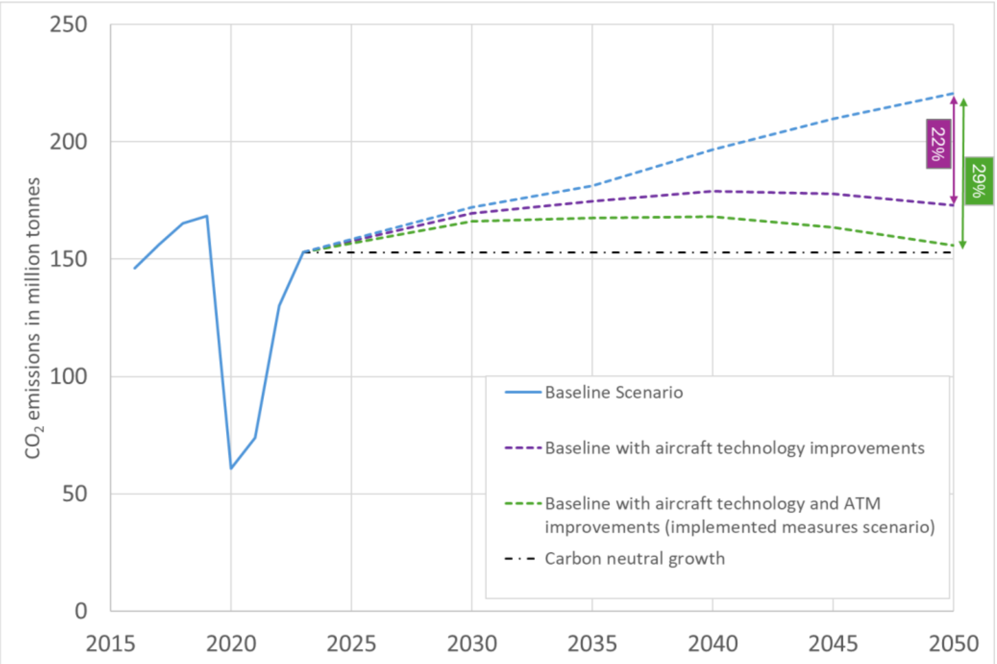
Tables 4-6, **Figure 3** and **Figure 4** summarise the results for the scenario with implemented measures. It should be noted that **Table 4** and **Table 6** show direct combustion emissions of CO_2 (assuming 3.16 kg CO_2 per kg fuel). More detailed tabulated results are found in the **Appendix**.

[20] Aircraft Assignment Tool: https://www.easa.europa.eu/domains/environment/impact-assessment-tools
[21] See SESAR Exploratory Research projects: https://www.sesarju.eu/exploratoryresearch.
[22] Note that in a strict sense the CORSIA target of CNG is aimed to be achieved globally (and hence not necessarily in each world region).

Common Section Figure 3: Fuel consumption forecast for the baseline and implemented measures scenarios (international passenger flights departing from ECAC airports)



Common Section Figure 4: CO_2 emissions forecast for the baseline and implemented measures scenarios



As shown in **Figure 3** and **Figure 4**, the impact of improved aircraft technology indicates an overall 22% reduction of fuel consumption and CO_2 emissions in 2050 compared to the baseline scenario. Overall CO_2 emissions, including the effects of new aircraft types (conventional, hybrid electric and Hydrogen) and ATM-related measures, are projected to lead to a 29% reduction in 2050 compared to the baseline.

Common Section Table 4: Fuel burn and CO_2 emissions forecast for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)

Year	Fuel Consumption (10^9kg)	CO_2 emissions (10^9kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	38.08	120.34	0.0327	0.327
2019	53.30	168.42	0.0280	0.280
2023	48.41	152.96	0.0268	0.268
2030	52.57	166.11	0.0241	0.241
2040	53.20	168.11	0.0205	0.205
2050	49.29	155.75	0.0168	0.168
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

As detailed in **Table 5**, under the currently assumed aircraft and ATM improvement scenarios, the fuel efficiency is projected to lead to a 37% reduction from 2023 to 2050. The annual rate of fuel efficiency improvement is expected to be at 1.5% between 2023 and 2030 and reach 2% between 2040 and 2050. However, aircraft technology and ATM improvements alone will not be sufficient to meet the post-2020 carbon neutral growth objective of ICAO, nor will the use of alternative fuels, even if Europe's ambitious targets for SAF are met. This confirms that additional action, particularly market-based measures, are required to fill the gap.

Common Section Table 5: Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)

Period	Average annual fuel efficiency improvement (%)
2010-2023	-1.50%
2023-2030	-1.51%
2030-2040	-1.60%
2040-2050	-1.98%

Table 6 below summarises the cumulated effects of each implemented measure. It identifies the weight of the technical improvement on the reduction of CO_2 emissions (from 2% in 2030 to 22% in 2050 compared to the Baseline scenario). The overall impact of the implemented measures (aircraft technology improvements and ATM) shows a reduction of CO_2 emissions by 29% in 2050 compared to the Baseline scenario.

Common Section Table 6: Summary of CO_2 emissions forecast for the scenarios described in this chapter

Year	CO_2 emissions (10^9 kg)			% improvement by Implemented Measures (full scope)
	Baseline Scenario	Implemented Measures Scenario		
		Aircraft technology improvements only	Aircraft technology and ATM improvements	
2010	120.34			
2019	168.42			
2023	152.96			
2030	172.10	169.50	166.11	-3%
2040	196.52	178.84	168.11	-14%
2050	220.54	173.06	155.75	-29%
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

Appendix A of this document provides the detailed results for each scenario.

Actions taken collectively in Europe

Note:

For the purposes of this UK State Action Plan, only the descriptions of collective measures and policies that the UK is involved in, or has past or current links to, have been extracted from the ECAC Common Section. Further detail on the UK's contribution to these actions is described in the UK National Section.

Excluded elements from the full ECAC Common Section include, among other things, the chapter on sustainable aviation fuels (SAF). This is because, while high ambition in this area is shared with other ECAC States, the UK has its own specific policies and measures to support SAF.

Technology and design

The recent certification of new types of large transport aircraft and engines has continued to be focused on performance improvement packages for aircraft certified in the 2010s (e.g. Airbus A350, A330neo and A320neo; Boeing 737MAX and 787). The penetration of these aircraft types into the European fleet has slowed due to reduced annual deliveries following the COVID crisis. In contrast, there has been increased research and certification activity in emerging markets such as zero carbon emission aircraft (e.g. electric and hydrogen powered aircraft).

Aircraft environmental standards

Since 1 January 2020, new aircraft types have to comply with a new-type CO_2 standard[23], although no aircraft has been certified against this standard as of the start of 2025. The focus thus far has been on certifying in-production aircraft types against a less stringent in-production CO_2 standard as all aircraft have to be certified against this new requirement if they wish to continue to be produced beyond 1 January 2028.

As of the end of 2024, Airbus continues to be the only manufacturer to have certified in-production aircraft types, such as the A330-800neo and -900neo variants, and so the availability of certified CO_2 data remains limited.[24] In light of the approaching production cut-off deadline in 2028, certification of other aircraft types is ongoing and other regions of the world have also implemented the CO_2 standard into their legislation. The 2019 ICAO Independent Experts Panel goals for leading edge CO_2 emissions performance in 2027 and 2037 would need to be reviewed soon for them to remain relevant.

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[23] ICAO Annex 16, Volume III to the Chicago Convention contains international aircraft CO_2 standards. The CO_2 metric is a specific air range-based metric (kg fuel per km flown in cruise) adjusted to take into account fuselage size.

[24] EASA (2025): https://www.easa.europa.eu/en/domains/environment/easa-aeroplane-co2-emissions-database-0

Hydrogen-powered aircraft

The potential of hydrogen to power carbon-free flight has rekindled interest in this alternative fuel, with green hydrogen being relatively easy to produce, provided sufficient renewable energy is available. In particular, there has been a strong interest in the potential of hydrogen used in conjunction with fuel cells and electric motors for regional and short-haul aviation, where the weight of batteries needed for energy storage is currently seen by many as restrictive.

Pioneers in the field have advanced their flight test activity, with H2FLY conducting the world's first piloted flight of a liquid hydrogen powered electric aircraft in September 2023, using their HY4 demonstrator aircraft, operating from Maribor in Slovenia. Other notable flights include ZeroAvia's flight test campaign using a Dornier 228 with the left side propeller powered by their ZA600 prototype engine and, most recently, Beyond Aero achieved France's first manned fully hydrogen-electric flight, using a retrofit model G1 SPYL-XL to demonstrate their technology.

Although the headlines have primarily been related to these aforementioned flight tests using fuel cells, there has also been demonstrable progress on hydrogen combustion technology with Rolls Royce, Safran and GE all successfully running ground tests in this field.

Research and Innovation Programmes

Aviation environmental research is embedded in European, national and industry research programmes. At EU level, most research is currently funded through 'Horizon Europe' (2021-2027) with an initial budget of €95.5 billion.[25] [26] Aviation specific research contributes primarily to the European Green Deal and the EU's digital and competitiveness strategies across all three Horizon Europe pillars:

- Pillar I: European Research Council science, which often advances the limits of science and technology (e.g. new materials, breakthrough physical processes, artificial intelligence and quantum computing, sensor technologies);
- Pillar II: Cluster 5 aviation programme has been the foundation of aeronautics research for over 35 years, including relevant partnerships (e.g. Clean Aviation, Clean Hydrogen and SESAR), industry-led technology demonstrators and Cluster 4 synergies (Digital, Industry and Space); and
- Pillar III: European Innovation Council research actions, with emphasis on supporting and connecting SMEs and the aviation supply chain.

The collaborative and fundamental Pillar II Cluster 5 aviation environmental research develops and derisks technologies up to a Technology Readiness Level (TRL) 4, to be

[25] EU (2025) Horizon Europe: https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

[26] The UK was a member of the EU until the 31 January 2020 and contributed to its Horizon Europe programme and Clean Sky 2 research. Since January 2024 the UK has been an associate country to Horizon Europe and UK entities are eligible to apply for funding under the programme. See the UK National Section, pages 62 and 64, for details.

taken further by Horizon Europe partnerships, national or industry programmes. The current research is focused on:

- lightweight, multifunctional and intelligent airframe and engine parts
- holistic digital framework for optimized design, manufacturing and maintenance
- uncertainties quantification for design, manufacturing and operation
- ultra-efficient aircraft propulsion
- electrified and hydrogen-enabled propulsion
- fuel-flexible combustion systems and cryogenic liquid hydrogen storage
- better understanding and mitigating non-CO_2 emissions, with emphasis on contrails
- reduction of NO_x, and particulate matter emissions
- noise reduction technologies and abatement procedures

One such Horizon Europe project is HESTIA that focuses on increasing the scientific knowledge of the hydrogen-air combustion of future hydrogen-fuelled aero-engines.[27] Further information on the extensive projects funded under Horizon Europe research programme can be found on the European Commission website.[28]

Clean Sky 2 (part of 'Horizon 2020' – 2014 to 2020)

The Clean Sky 2 projects (2014-2024) had a combined public and private budget of around €4 billion, with EU funding up to €1.75 billion.[29] Its objectives were to develop, demonstrate, and accelerate the integration of technologies capable of reducing CO_2, NO_x and noise emissions by 20 to 30% compared to 'state-of-the-art' aircraft in 2014.

The benefits and potential impact from Clean Sky 2 research at the aircraft, airport and fleet level are evaluated through a dedicated Technology Evaluator function with key assessment and reporting duties. The final assessment by the Technology Evaluator was performed in 2024[30] and the results are summarised in Table 7.

Common Section Table 7: Final Clean Sky 2 Technology Evaluator Assessment Results

Mission Level Assessment				
Concept Model	**Assessment**	**CO_2[1]**	**NOx[1]**	**Noise[2]**
Long Range (LR+)	1st	-13%	-38%	<-20%
	2nd	**-18.2%**	**-44.9%**	**-20.1%**
Short-Medium Range (SMR+ & SMR++)	1st	-17% to -26%	-8% to -39%	-20% to-30%
	2nd	**-25.8% to -30.4%**	**-2.3% to -5.1%**	**-11.5% to -16.3%**
Regional (TP90 -TP130 - MM TP70)	1st	-20% to -34%	-56% to -67%	-20% to -68%
	2nd	**-25% to -32.5%**	**-44% to -60%**	**+14% to -44%**
Commuter[3] & BJ	1st	-21% to -31%	-27% to -28%	-20% to-50%
	2nd	**-17.3% to -19.6%**	**-16.5% to -51.5%**	**-19% to -31%**

[27] Hestia: https://www.hestia-project.eu/
[28] EU (2025): https://cordis.europa.eu/projects
[29] Council Regulation (EU) No 558/2014 of 6 May 2014 establishing the Clean Sky 2 Joint Undertaking: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32014R0558
[30] Clean Sky 2 Technology Evaluator (2024): https://www.clean-aviation.eu/clean-sky-2/technology-evaluator

(1) CO_2 and NO_x values per passenger-kilometre.
(2) Averaged Perceived Sound Volume Reduction (EPNLdB) according to ICAO Annex 16 conditions for fixed-wing aircraft (Chapter 10 for CS-23 aircraft and Chapter 14 for CS-25 aircraft). 20% noise reduction is equivalent to 3dB reduction. 30% of noise reduction is equivalent to 5dB reduction.
(3) Only fossil fuel concepts, excluding the innovative E-Short Take-Off and Landing (STOL) hybrid-electric commuter concept.

Airport Level Assessment			
Assessment	CO_2	NO_x	Noise Area
1st	-8% to-13.5%	-6.5% to -10.5%	-10% to-15%
2nd	**-11.5 to -15%**	**-10.5 to -14.5%**	**-8% to -17% (Lden[1])**

(1) Surface area Reduction of Lden contours for 60-65 dB(A) noise levels at the European airports considered.

Fleet Level Assessment			
Assessment	CO_2	NO_x	Fleet Renewal
1st	-14% to-15%	-29% to -31%	70% to 75% (ASK)
2nd	**-14.5%**	**-29%**	**71.4% (ASK) 61.6% (a/c)**

UltraFan® Technology Demonstrator

Rolls-Royce has successfully run its UltraFan® technology demonstrator to maximum power during 2023. The initial stage of the test was conducted using SAF. UltraFan® delivers a 10% efficiency improvement over the Trent XWB engine and a 25% efficiency gain since the launch of the first Trent engine. Testing has been supported by various partners, including the EU Clean Sky programmes.

Hydrogen fuel cells

Airbus has performed ground testing to achieve the milestone of running a fuel cell engine concept at full power (1.2 MegaWatts). This is the most powerful fuel cell test ever in the aviation sector, coupling 12 fuel cells to reach the output needed for commercial use. In addition, the Non-Propulsive Energy demonstrator, HyPower, will use a fuel cell containing ten kilograms of gaseous hydrogen generated from renewable sources to produce electricity when tested on board an Airbus A330 in standard operating conditions. It aims to reduce the CO_2, NO_x and noise levels associated with a traditional auxiliary power unit (APU).

RISE Open Fan

Safran is developing the CFM RISE Open Fan engine demonstrator combining lightweight equipment and advanced technologies such as hybrid electric systems. An open fan architecture has the potential to reduce fuel consumption and CO_2 emissions by more than

20% compared to today's most efficient engines. This advanced, new generation open fan architecture is expected to be able to fly at the same speed as current single-aisle aircraft (up to Mach 0.8) with a noise signature that will meet anticipated future regulations.

Flight testing of the RISE Open Fan is being done in collaboration with Airbus using their A380 Flight Test Demonstrator that aims to mature and accelerate the development of advanced propulsion technologies. The programme objectives include enhanced understanding of engine/wing integration and aerodynamic performance as well as propulsive system efficiency gains, evaluating acoustic models, and ensuring compatibility with 100% SAF.

Air traffic management and operational improvements

Single European Sky ATM Research and Development

The SESAR (Single European Sky ATM Research and Development) project is the technological innovation pillar of the Single European Sky (SES) initiative of the European Commission, aiming to modernise ATM through the innovation cycle of defining, developing and deploying innovative technological systems and operational procedures.[31] The goal is to achieve the 'digital European sky' defined in the European ATM Master Plan, which is a common roadmap to establish Europe as the most efficient and environmentally friendly sky in the world.[32] It includes the goal to reduce the average CO_2 emission per flight by 9.3% (600 kg) by 2050. A key element in achieving that goal is the deployment of Common Project One (CP1), which facilitates service provision along optimised routes from gate-to-gate and thereby reduces both CO_2 and non-CO_2 emissions.[33]

Total gate-to-gate CO_2 emissions

The total gate-to-gate CO_2 emissions within the EUROCONTROL area,[34] or the part of the trajectory within the airspace for flights to and from the area, were 180.2 million tonnes in 2023, which represents an increase of 14% over 2022. Figure 5 illustrates the breakdown of these CO_2 emissions by flight phase and, as expected, the cruise and climb phases have the highest share of emissions with 63% and 23% respectively. While much less inefficiencies are detected in the climb phase than in the descent phase, and consequently more attention was given to the descent phase, it is important to note that even a small percentage of inefficiency during the climb can result in a significant amount of additional CO_2.

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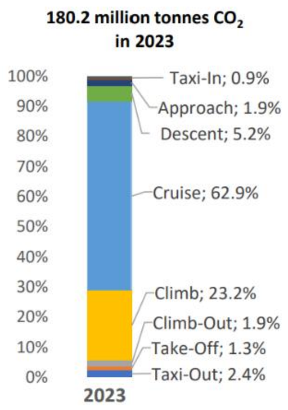
[31] As an associate country to Horizon Europe, the UK continues to be a part of the SESAR programme. See UK National Section, pages 61 and 68, for details.
[32] SESAR, European ATM Master Plan (2020): https://www.sesarju.eu/masterplan
[33] Common Project 1 Regulation (EU, 2021): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R0116
[34] EUROCONTROL area: https://ansperformance.eu/definition/eurocontrol-area/

Common Section Figure 5: Total CO_2 emissions by flight phase within the EUROCONTROL area during 2023



Free Route Airspace

Free Route Airspace (FRA) is a SESAR solution that is defined as a volume of airspace within which users may freely plan a route between any defined entry and exit points, subject to airspace availability.[35] The continuous implementation of FRA in Europe over the past years has been an enabler for improved flight efficiency, as it provides airlines with greater flexibility to file more efficient flight plans. However, FRA must not only be implemented but also applied by airlines to reap the benefits.

In line with the European ATM Master Plan and European Commission Regulation No. 2021/116, FRA implementation with cross-border dimension and connectivity to Terminal Manoeuvring Areas (TMA) should be completed by 31 December 2025. Cross-border FRA areas have been implemented between the following States:

- BALTIC FRA: Poland and Lithuania.
- BOREALIS FRA: Denmark, Estonia, Ireland, Iceland, Finland, Latvia, Norway, Sweden and United Kingdom.
- SECSI FRA: Albania, Austria, Bosnia and Herzegovina, Croatia, Montenegro, North Macedonia, Serbia and Slovenia.
- SEE FRA: Bulgaria, Czech Republic, Hungary, Republic of Moldova, Romania and Slovakia.
- BALTIC FRA and SEE FRA.
- SECSI FRA and FRA IT

The Borealis Alliance (a collaboration of ANSPs from Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Norway, Sweden and the United Kingdom) is a pioneer in the implementation of a cross-border FRA among its nine national airspaces. Whilst implementation has been slowed down by the COVID crisis, full implementation is still planned by the end of 2026. The below figure illustrates the actual benefits of FRA achieved in 2018 and the estimated annual gains in 2026 with full FRA implementation.

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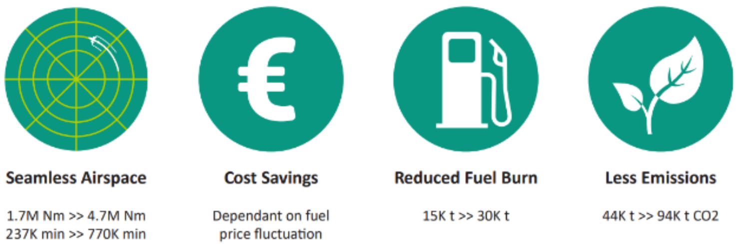
[35] Free Route Airspace (EURCONTROL, 2015): https://www.eurocontrol.int/concept/free-route-airspace

Common Section Figure 6: Benefits of free route airspace



SESAR Research and Development

The first SESAR Joint Undertaking was established in 2007 as the EU body responsible for the research and development phase of the SESAR innovation cycle. It has produced over 100 solutions with an estimated combined benefit that could enable a 4% reduction in CO_2 emissions per flight. The online SESAR solutions catalogue contains technical information on these solutions and their level of deployment as reported by European states.[36]

The current SESAR 3 Joint Undertaking has a 10-year mandate (2021-2031) to continue this work. During 2024, the European ATM Master Plan was updated to define the critical path for establishing Europe as the most efficient and environmentally friendly sky to fly in the world. It defines the Strategic Deployment Objectives and Development Priorities, providing a framework to facilitate the roll out of SESAR solutions and shaping the European position to drive the global agenda for ATM modernisation at ICAO level.

The implementation of a first critical sub-set of SESAR solutions is mandated by the Common Project 1, ensuring a coordinated and timely deployment of key enablers for Trajectory-Based Operations (TBO) and for establishing a digital backbone for the Single European Sky.

SESAR addresses the full scope of aviation's environmental impacts, from CO_2 and non-CO_2 emissions to noise and air quality at every phase of flight.

- **TAXI phase:** During the ground part of the trajectory, a key objective is to reduce the engine-on time. Increasing the predictability of the take-off clearance time avoids waiting time at the runway holding point. In addition, single-engine taxi and engine-off taxi, where aircraft are towed by a sustainable taxi vehicle, can reduce overall engine emissions. The expected reduction of emissions from an engine-off taxi initiative can be over 50%, that also was showcased in the ALBATROSS project.[37]

- **CLIMB and DESCENT phases:** The focus in this phase is to leverage the availability of the optimum profile for each individual flight through the Extended Projected Profile (EPP), where aircraft tend to start their descent on average 35-70 nautical miles (nmi) before what would be their optimum Top-of-Descent (ToD)

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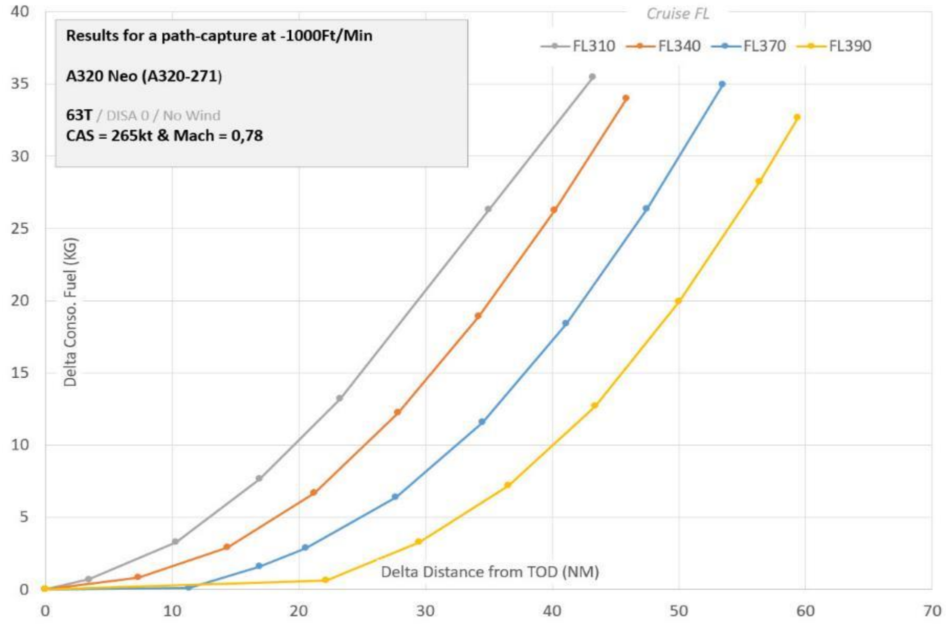
[36] SESAR Solutions Catalogue (2021): https://www.sesarju.eu/catalogue
[37] ALBATROS Project (SESAR, 2022): https://www.dlr.de/en/site/albatross

point. This leads to long thrust descent, which is inefficient even if it does not include intermediate level-offs (Figure 7). The EPP provides visibility of the optimum top-of-climb and top-of-descent points on the ground, making it possible for air traffic controllers to facilitate a better trajectory. In addition, SESAR advocates a transition from conventional fixed arrival routes commonly used today, towards a more dynamic deployment of RNP (Required Navigation Performance) route structures within the Terminal Manoeuvring Area. Utilising these dynamic routes increases capacity during peak periods, optimises fuel consumption during off-peak hours, and decreases the noise footprint particularly during nighttime operations. Moreover, the adoption of these dynamic routes enables agile responses to fluctuations in operational conditions.

Common Section Figure 7: Increased fuel consumption as a function of the distance before the optimum Top of Descent that the descent phase is started, without intermediate level-offs (e.g. when a descent from cruise at FL370 is started 50nmi early, the additional fuel burn is 30 kg).



- **CRUISE phase:** Free route in the horizontal domain is already widely available in Europe. As such, the enhancement of vertical flight efficiency is a priority through the provision of sufficient airspace capacity for aircraft to fly at their optimum altitude. While the exact increase in emissions varies based on aircraft type and specific flight conditions, studies suggest that flying at lower altitudes can increase fuel consumption by approximately 6-12% compared to optimal cruising altitudes.[38] An increase in capacity can be achieved via digital and automation support for all ATM processes, including air traffic controllers, such as Dynamic Route Availability Document (RAD) that results in fewer vertical restrictions both at flight-planning and during the flight.[39] ATM may also evolve to support the deviation of flights to avoid

[38] ALBATROSS Project (SESAR, 2022): https://www.dlr.de/en/site/albatross
[39] Dynamic Route Availability Document (SESAR, 2024): https://www.sesarju.eu/sesar-solutions/dynamic-route-availability-document-rad

cruising within airspace where non-CO_2 impacts are disproportionately high (referred to as eco-sensitive volumes).

The SESAR 3 Joint Undertaking has also provided support to operational stakeholders in the monitoring and management of their environmental performance in the planning, execution, and post-operation phases. At the airport level, this includes the full integration of environmental performance monitoring with the Airport Operations Plan (AOP).[40]

Trajectory optimisation in a digital environment

The deviation from the flight plan during the execution of the flight, for example by allowing an unplanned shortening of the flight path, allows fuel savings and reduced emissions for the flight concerned and its specific flight phase. However, this can have a negative impact on the predictability of the air traffic network, which in turn could have a negative impact on the environment. Trajectory-Based Operational (TBO) concepts ensure the free flow of information between air traffic management units and the Network Manager, allowing rapid sharing of trajectory information across the network and increased flexibility in the execution of the flight for airspace users.

The updated ATM Master Plan has defined the European TBO roadmap for the 2025–2045 period with the ambition of guaranteeing continuous and precise optimisation of all aircraft trajectories throughout their life cycle, from planning to execution, from gate to gate, even in congested airspace. With the potential introduction of zero-emission aircraft beyond 2035, their specific performance characteristics will also need to be considered in terms of any impact on the network.

SESAR Deployment

The SESAR Deployment Manager[41] plans, synchronises, coordinates and monitors the implementation of the ‘Common Projects’ that mandate the synchronised deployment of selected ATM functionalities (AF) based on SESAR solutions. The current Common Project (CP1) [EU 2021/116] has 6 AF (Figure 8) aiming to reduce inefficiencies and thus generate fuel and CO_2 savings in different phases of the flight, especially cruise. The SESAR Deployment Programme[42] defines how the operational stakeholders will implement CP1 AF, which is due to be completed by 31 December 2027. The expected performance benefits from CP1 AF represent approximately 20% of the European ATM Master Plan performance ambitions for 2035[43] and will be a critical step towards sustainable ATM-related aviation in Europe. 65% of CP1 CO_2 savings are expected to be found in the cruise phase, 25% in the descent phase and 10% in the taxi-out phase. By the end of 2023, CP1 already delivered €4.6bn worth of cumulative benefits. This value is set to reach €19.4bn by 2030, once the CP1 is fully deployed, whilst in a longer timespan CP1 is expected to bring €34.2bn worth of cumulative benefits by 2035 and €52.3bn by 2040.

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[40] Airport Operations Plan (SESAR, 2024): https://www.sesarju.eu/sesar-solutions/airport-operations-plan-aop-and-its-seamless-integration-network-operations-plan
[41] SESAR Single Basic Act (EU, 2021): https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52021PC0087
[42] SESAR Deployment Framework (EU, 2013): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R0409
[43] SESAR Deployment Manager (2025): https://www.sesardeploymentmanager.eu/

Common Section Figure 8: Overview of Common Projects 1 (CP1) ATM Functionalities

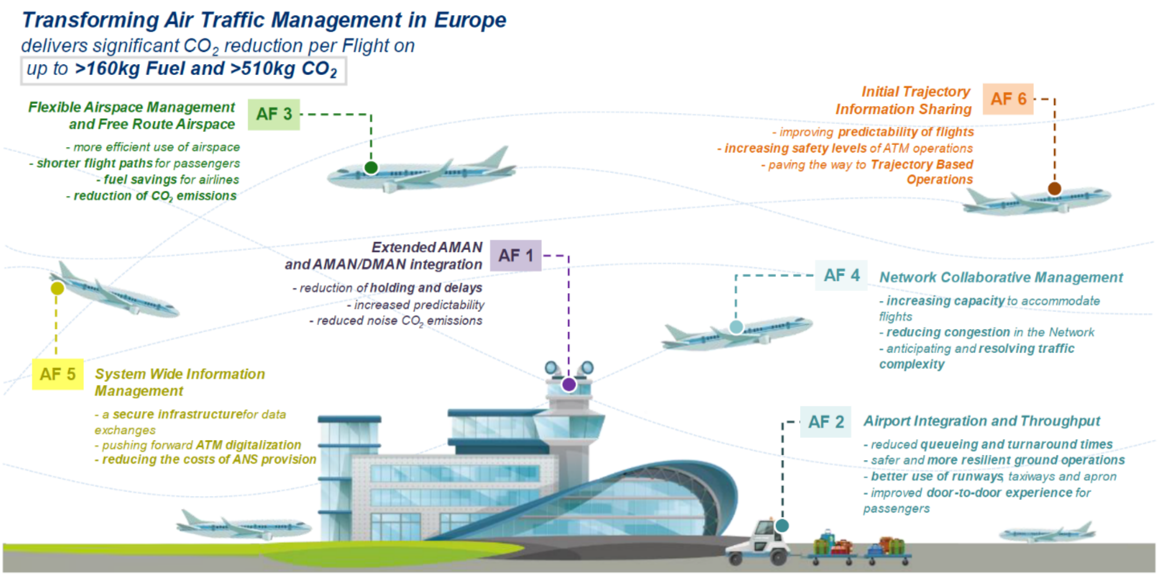

Table 8 below details the total CO_2 savings potential of concerned flights, that could be expected should all CP1 sub-AF concepts be deployed in the future ATM system with all technologies mature and realising their full benefits. The values in the table below represent an order of magnitude of CO_2 savings that can be expected from different sub-functionalities, and which highly depend on the specific conditions of the flight and the local situation.

Common Section Table 8: CO_2 savings per Common Project 1 ATM Functionality

CP1 Functionality		Fuel saving per flight concerned	CO2 savings per flight concerned	Time saving per flight concerned	% of ECAC flights concerned	Flight phase concerned
AF1	Departure Management Synchronised with Pre-departure sequencing	[2.9 – 10 kg]	[9.2 - 31.5 kg]	[0.5 – 1 min]	30%	Taxiing phase
	Initial/ extended AOP	[0.4 – 0.8 kg]	[1.2 - 2.5 kg]	[0.1 – 0.1 min]	70%	Taxiing phase
AF2	Airport Safety Nets	[0.1 – 3.1 kg]	[0.3 - 9.7 kg]	[0.01 – 0.01 min]	30%	Taxiing phase
AF3	ASM and A-FUA	[8 – 41.7 kg]	[25.2 - 131.3 kg]	[0.15 – 0.55 min]	10%	Cruising phase
	Enhanced Free Route Airspace Operations	[35 – 58 kg]	[110.2 - 182.7 kg]	[1 – 2 min]	75%	Cruising phase
AF4	Enhanced Short Term ATFCM Measures	n/a		[0.3 – 0.4 min]	5%	Pre departure phase
	Interactive rolling NOP	n/a		[0.2 – 0.3 min]	50%	Pre departure phase
AF5	Automated Support for Traffic Complexity Assessment and Flight Planning interfaces	n/a		[0.1 – 0.2 min]	70%	Pre departure phase
AF6	Initial AirGround Trajectory Information Sharing	[8 – 12 kg]	[25.2 - 37.8 kg]	[0.05 – 0.1 min]	90%	Cruising phase

The benefit-cost ratio (BCR) of the investment in CP1 AF shows the value of the investment by comparing the costs of a project with the benefit that it generates. In this case, it has been estimated that every euro invested into CP1 deployment brought 1.5 euros in return during 2023 to the stakeholders in terms of monetisable benefits, as well as 0.6 kg of CO_2 savings (Table 9). Furthermore, the BCR and CO_2 savings are expected to increase over time as CP1 AF are fully implemented (Table 10).

Common Section Table 9: Benefit-Cost Ratio and CO_2 savings from CP1 AF implementation

	Already achieved			
Metric	**2023**	**2030**	**2035**	**2040**
Benefit-cost ratio[13]	**1.5**	3.8	5.9	8.0
CO_2 kg saved per € invested[14]	**0.6**	2.2	4.0	6.0

Common Section Table 10: Savings in fuel and CO_2 emissions per flight in 2023 and the forecast out to 2040

	Already achieved			
Metric	**2023**	**2030**	**2035**	**2040**
Fuel kg saved	**7.0 kg**	42.3 kg	47.0 kg	47.8 kg
CO_2 kg saved	**22.1 kg**	133.2 kg	147.9 kg	150.5 kg

Market-based measures

EU Emissions Trading System

The EU decided to include aviation activities within the EU ETS in 2008[44], and the system has been applied to aviation activities since 2012.[45] As such, they are subject to the EU's greenhouse gas emissions reduction target of at least minus 55% by 2030 compared to 1990. The initial scope of the EU ETS covered all flights arriving at, or departing from, airports in the European Economic Area (EEA).[46] However, flights to and from airports in non-EEA countries or in the outermost regions were subsequently excluded until the end of 2023 through a temporary derogation. This exclusion facilitated the negotiation of a global market-based measure for international aviation emissions at ICAO.

The EU's 'Fit for 55' Legislative Package to make its climate, energy, transport and taxation policies fit for achieving the 2030 greenhouse gas emissions reduction target included proposed amendments to the EU ETS Directive for aviation activities, which entered into force on 5 June 2023.[47] The main changes to the aviation ETS are applicable from 2024 onwards, and include applying EU ETS for flights within and between countries in the European Economic Area, as well as departing flights to Switzerland and to the United Kingdom, while applying CORSIA for flights to and from third countries.

CORSIA

In 2016, the 39th ICAO Assembly reconfirmed the 2010 aspirational objective of stabilising CO_2 emissions from international aviation at 2020 levels. In light of this, ICAO States adopted Resolution A39-3 which introduced a global market-based measure called the 'Carbon Offsetting and Reduction Scheme for International Aviation' (CORSIA). ICAO Assembly Resolutions are reassessed every three years, and the current Resolution A41-

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44 Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0101
45 The UK participated in the EU ETS until 31 December 2020, after which point the UK Emissions Trading Scheme became operational. See UK National Section pages 49-51 for more details on the UK ETS.
46 The European Economic Area includes the EU, plus Norway, Iceland and Liechtenstein.
47 Directive (EU) 2023/958 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC as regards aviation's contribution to the Union's economy-wide emission reduction target and the appropriate implementation of a global market-based measure: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023L0958

22 for CORSIA implementation was adopted by the 41st ICAO Assembly in 2022, following the outcome of the first CORSIA Periodic Review by the ICAO Council.[48]

CORSIA is being implemented through the associated ICAO Standards and Recommended Practices (SARPs) contained Volume IV of Annex 16 to the Chicago Convention, the 1st Edition of which became applicable on 1 January 2019. In March 2023, the 2nd Edition of Volume IV was approved by the Council and became applicable 1 January 2024.

In line with the 'Bratislava Declaration' signed on 3 September 2016, and following the adoption of the CORSIA SARPs by the ICAO Council, EU Member States and the other Member States of ECAC notified ICAO of their intention to voluntarily participate in CORSIA offsetting from the start of the pilot phase in 2021, provided that certain conditions were met, notably on the environmental integrity of the scheme and global participation.

Voluntary Offsetting

In recent years, some airlines have introduced voluntary offsetting initiatives aimed at compensating, partly or in full, those CO_2 emissions caused by their operations that are not mitigated by other measures. Such voluntary initiatives have the potential to contribute to a more sustainable aviation sector, assuming that investments are channelled to high quality offset credits that meet certain quality criteria, e.g. are additional[49]. However, there has been some criticism of the quality of offset credits in this unregulated voluntary market, as well as scepticism of such voluntary activity enhancing aviation sustainability.

Airbus Carbon Capture Offer (ACCO)

Airbus developed ACCO with the aim to bring to the aviation industry high-environmental integrity, scalable and affordable carbon dioxide removal credits.[50] ACCO looks to support the management of the remaining and residual CO_2 emissions of aircraft with the latest carbon removal technologies.

As a first step, Airbus partnered with 1PointFive for exploring direct air carbon capture and storage solutions for the aviation industry. In particular, 1PointFive is developing a large-scale facility expected to capture 0.5 million tonnes of CO_2 per year starting in 2025. Airbus has committed to purchase 400,000 tonnes of CO_2 removals. This initiative aims to support efforts for decarbonising and mitigating Airbus's Scope 3 emissions from the use

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[48] ICAO Resolution A41-22, Consolidated statement of continuing ICAO policies and practices related to environmental protection — CORSIA: https://www.icao.int/environmental-protection/CORSIA/Documents/Resolution_A41-22_CORSIA.pdf

[49] "Additionality" means that the carbon offset credits represent greenhouse gas emissions reductions or carbon sequestration or removals that exceed any greenhouse gas reduction or removals required by law, regulation, or legally binding mandate, and that exceed any greenhouse gas reductions or removals that would otherwise occur in a conservative, business-as-usual scenario (definition from ICAO CORSIA Emissions Unit Eligibility Criteria (2019): https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO_Document_09.pdf)

[50] Airbus Carbon Capture Offer (2024): https://aircraft.airbus.com/en/services/operate/airbus-carbon-capture-offer

of its sold product, and also contributes to the larger efforts already underway across the aviation industry.

Additional measures

Green Operational Procedures

Building on the previous ALBATROSS research project,[51] the goal of the SESAR project HERON launched in 2023 is to reduce the environmental impact from aviation through the deployment of already-mature solutions that range from more efficient aircraft operations to optimised management of air traffic during flights.[52] This includes the Green Apron Management demonstration, which uses sensors and artificial intelligence for more predictable and efficient aircraft handling during airport stopovers.

Noise Abatement Departure Procedures (NADPs)

NADPs aim to reduce the noise impact of departing aircraft by selecting the appropriate moment to clean the aircraft (i.e. retract flaps), which has an impact on the flown vertical profile. NADP1 results in noise reductions close to the airport, while NADP2 reduces noise further away and has lower fuel consumption. Depending on the operational context (aircraft type, take-off weight, weather, etc) and on the location of the noise sensitive areas, the best balance between noise and emission reductions needs to be determined.

A study performed by EUROCONTROL highlighted that in many cases a fixed NADP procedure for all aircraft types and runways is advised or mandated by the airport authorities, but that this is not always the optimal solution to balance noise and emission reductions. Noise sensitive areas vary from airport to airport, and from departure runway to runway. As such, airports should identify key noise sensitive areas in each Standard Instrument Departure procedure. By taking the local operational context into consideration and allowing the flight crew to determine the best NADP, additional noise or emission reductions could be achieved.

The study concluded that in some cases where NADP1 procedures are applied, using NADP2 procedures could reduce fuel burn by 50kg to 200kg while only marginally increasing noise by 1dB close to the airport.

Sustainable Taxiing

Trials linked to sustainable taxiing are ongoing at various airports (e.g. Amsterdam Schiphol, Eindhoven, Paris Charles-de-Gaulle and Brussels) through various SESAR research projects as well as national projects. To incentivise implementation and to

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[51] ALBATROSS Project (SESAR, 2022): https://www.dlr.de/en/site/albatross
[52] HERON Project (SESAR, 2023): https://www.airbus.com/en/newsroom/stories/2023-03-heron-project-to-increase-fuel-efficiency-in-aviation-takes-flight

synchronize developments, a EUROCONTROL / ACI (Airports Council International) EUROPE Sustainable Taxiing Taskforce developed a Concept of Operations in 2024.[53]

The Concept of Operations (CONOPS) addresses the potential fuel burn reductions of several sustainable taxiing solutions, which could be up to 400kg CO_2 from a single aisle aircraft taxi-out phase. In addition, there are noise and air quality benefits as the aircraft engine start-up and shut-down procedures occur away from the gate area.

These benefits are mainly the result of operational improvements, such as single engine taxing, combining engine start-up while taxiing, or combining pushback and taxi clearances by air traffic control, thereby reducing total taxi and engine running times that still take into consideration engine thermal stabilisation and some additional complexity in ground operations. Research is also looking into limiting Auxiliary Power Units use to outside certain temperature above a certain threshold. On-going trials are expected to further clarify how to integrate the different taxi operational solutions and quantify their benefits by end of 2025.

Airports Council International Europe Sustainability Strategy

ACI EUROPE represents over 500 airports in 55 countries, which accounts for over 90% of commercial air traffic in Europe. It works to promote professional excellence and best practice amongst its members, including in the area of environmental sustainability.

The ACI EUROPE Sustainability Strategy was launched in 2019,[54] which included the Net Zero Resolution that has been updated in 2024.[55] 303 European airports have since committed to net zero carbon emissions from airport operations within their control by 2050 and provided a roadmap detailing how this will be achieved.[56]

This net zero commitment covers Scope 1 direct airport emissions and Scope 2 indirect emissions (e.g. consumption of purchased electricity, heat or steam). 132 airports have announced a net zero target by 2030 or earlier, and 13 airports have already achieved net zero. In 2022, guidance on reducing Scope 3 emissions from others operating at the airport which are the largest share of emissions (e.g. aircraft, surface access, staff travel) was published[57] and this was followed in 2023 with guidance on developing Net Zero carbon roadmaps.[58]

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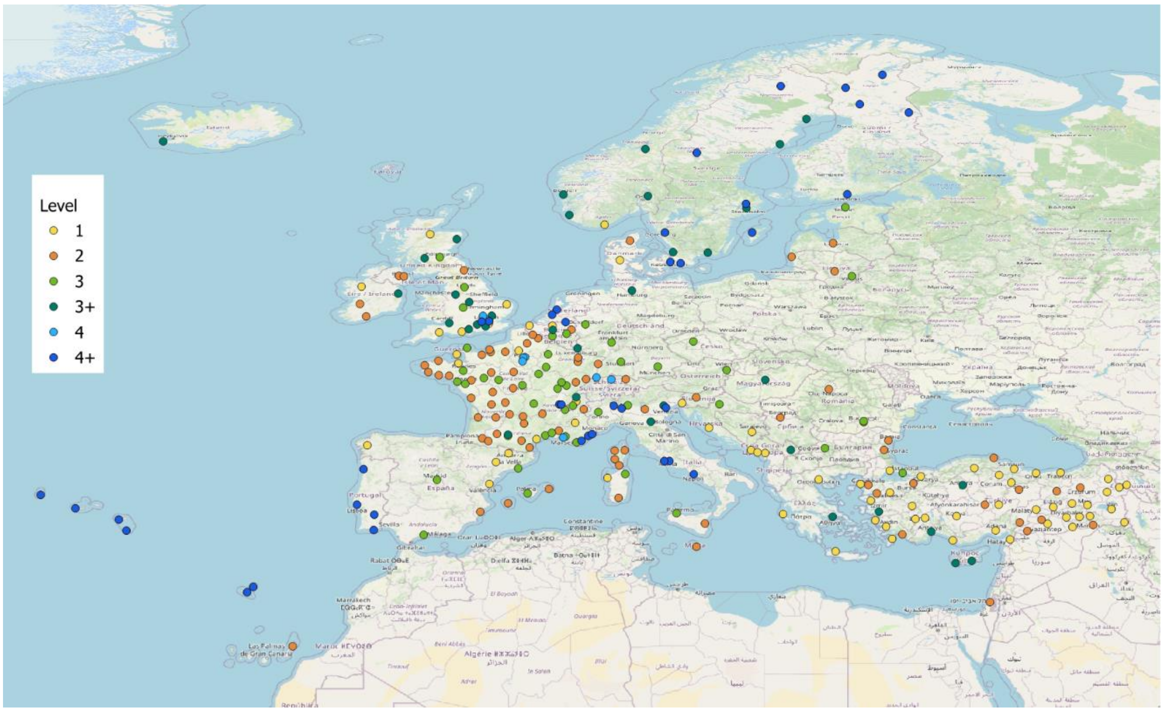
[53] Sustainable Taxiing Operations – Concept of operations and Industry Guidance (EUROCONTROL, 2024): https://www.eurocontrol.int/publication/sustainable-taxi-operations
[54] ACI EUROPE Sustainability Strategy (2020): https://www.aci-europe.org/downloads/resources/ACI%20EUROPE%20SUSTAINABILITY%20STRATEGY%20-%20SECOND%20EDITION.pdf
[55] What is Net Zero? (ACI EUROPE, 2024): https://www.aci-europe.org/netzero/what-is-net-zero.html
[56] Repository for airport net zero CO_2 roadmaps (ACI EUROPE, 2022) https://www.aci-europe.org/netzero/repository-of-roadmaps.html
[57] Guidance on Airports' Contribution to Net Zero Aviation (ACI EUROPE, 2022): https://www.aci-europe.org/downloads/content/Guidance%20on%20Airports%20Contribution%20to%20Net%20Zero%20Aviation.pdf
[58] Developing an Airport Net Zero Cabron Roadmap (ACI EUROPE, 2023): https://www.aci-europe.org/downloads/roadmap/Developing%20an%20Airport%20Net%20Zero%20Carbon%20Roadmap%20-%20ACI%20EUROPE%20Guidance%20Document%20-%202nd%20Edition.pdf

Airport Carbon Accreditation Programme

The Airport Carbon Accreditation (ACA) programme[59] was launched in 2009 by ACI EUROPE and, as of June 2024, now includes 564 airports on a global basis. The ACA is a voluntary industry led initiative, overseen by an independent Administrator and Advisory Board, that provides a common framework for carbon management with the primary objective to encourage and enable airports to reduce their CO_2 emissions. All data submitted by airports is externally and independently verified. As of the latest 2022-2023 reporting period, there were **290 European airports** participating in the programme corresponding to 77.8% of European passenger traffic (Figure 9).

Common Section Figure 9 – European airports participating in the ACA programme



The ACA programme was initially structured around four levels of certification (Level 1: Mapping, Level 2: Reduction, Level 3: Optimisation; Level 3+: Neutrality) with increasing scope and obligations for carbon emissions management (Scope 1: direct airport emissions, Scope 2: indirect emissions under airport control from consumption of purchased electricity, heat or steam and Scope 3: emissions by others operating at the airport such as aircraft, surface access, staff travel).

In 2020, Levels 4 (Transformation[60]) and 4+ (Transition[61]) have been added as interim steps towards the long-term goal of achieving net zero CO_2 emissions and to align it with the objectives of the Paris Agreement. Guidelines were also published to inform airports about offsetting options, requirements and recommendations, as well as dedicated

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[59] Airport Carbon Accreditation Programme (ACI EUROPE, 2022): https://www.airportcarbonaccreditation.org/

[60] Definition of a long-term carbon management strategy oriented towards absolute emissions reductions and aligned with the objectives of the Paris Agreement. Demonstration of actively driving third parties towards delivering emissions reductions.

[61] All Levels 1 to 4 plus offsetting of the residual carbon emissions over which the airport has control.

guidance on the procurement of offsets.

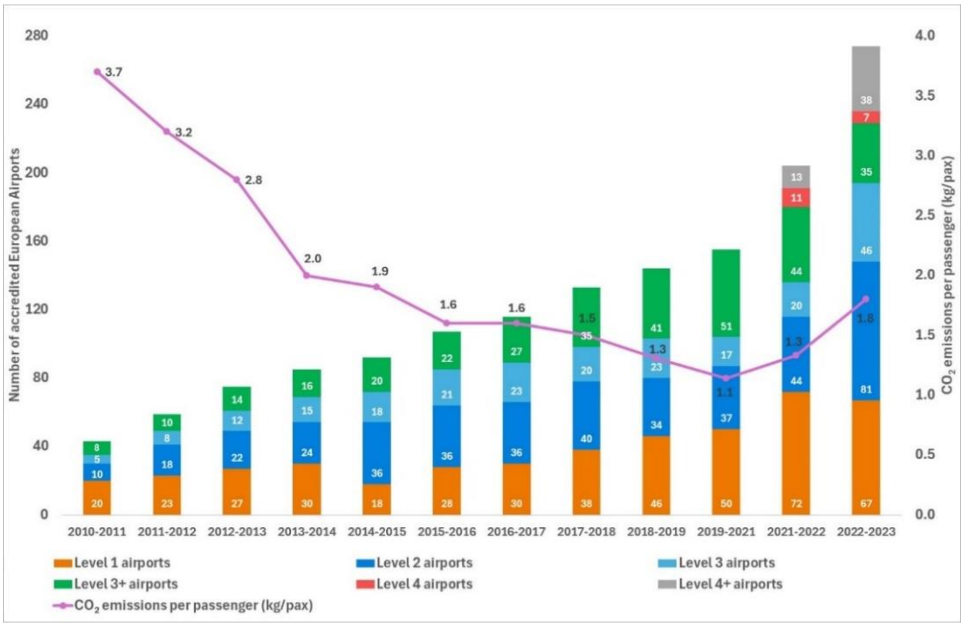
In 2023, a new Level 5 was added to the ACA programme. When applying for Level 5 airports are required to reach and maintain ≥ 90% absolute CO_2 emissions reductions in Scopes 1 and 2 in alignment with the ISO Net Zero Guidelines, as well as commit to achieving net zero CO_2 emissions in Scope 3 by 2050 or sooner. Any residual emissions need to be removed from the atmosphere through investment in credible carbon removal projects. To support airports in this endeavour, an update to the Airport Carbon Accreditation Offset Guidance Document was published on carbon removal options and most effective removal strategies.[62] Level 5 accredited airports need to outline detailed steps to achieve their emissions reduction targets, as part of their Carbon Management Plan.

Level 5 also requires airports to submit a verified carbon footprint for Scopes 1 and 2, and all relevant categories of Scope 3 as per the requirements of the GHG Protocol Guidance,[63] notably covering all significant upstream and downstream activities from third parties, including airlines. Finally, airports must establish a Stakeholder Partnership Plan underpinning their commitment to net zero CO_2 emissions in Scope 3, by engaging with the entire airport ecosystem and actively driving third parties towards delivering emissions reductions with regular milestone to gauge progress.

Ten airports were certified against Level 5 at launch, including 9 European airports (Amsterdam Schiphol, Eindhoven, Rotterdam-The Hague, Beja, Madeira, Ponta Delgada, Göteborg Landvetter, Malmö and Toulon-Hyères). Ivalo, Kittilä, Kuusamo and Rovaniemi airports were also subsequently accredited to Level 5 in 2024.

[62] Offset Guidance Document (Airport Carbon Accreditation, 2023): https://www.airportcarbonaccreditation.org/technical-documents/
[63] GHG Protocol Scope 2 and 3 Calculation Guidance (2025): https://ghgprotocol.org/guidance-0

Common Section Figure 10 – Increasing number of accredited European airports and decreasing CO_2 emissions per passenger



The carbon emission per passenger travelling through European airports at all levels of Airport Carbon Accreditation has increased to **1.8 kg CO_2/passenger** (Figure 10). A total reduction in Scope 1 and 2 emissions compared to a three-year rolling average[64] of **452,893 tonnes of CO_2** for all accredited airports in Europe was also reported (Figure 11). This represents about 20% reduction compared to the three-year rolling average.

Common Section Figure 11: Airport Scope 1 and 2 emissions reductions

64 Emissions reductions have to be demonstrated against the average historical emissions of the three years before year 0. As year 0 changes every year upon an airport's renewal/upgrade, the three years selected for the average calculation do so as well. Consequently, airports have to show emissions reductions against a three-year rolling average.

Tracking progress of business travel emissions savings

Travel Smart is a global campaign aiming at reducing corporate air travel emissions by 50% or more from 2019 levels by 2025, led by a coalition of NGOs in Europe, North America and Asia. The campaign ranks over 327 companies based on the sustainability of their business travel practices and holds them accountable through an Emissions Tracker.[65] This tool uses Carbon Disclosure Project corporate emissions database[66] and allows users to track the progress of a company's business air travel emissions reduction target.

The tracker shows through coloured bars whether companies have returned to levels of emissions above their targets or whether they have maintained reductions of -50% or more, thereby highlighting leaders and incentivising competition between companies. Through this Travel Smart campaign, various company best practices have highlighted that reducing flying is compatible with continued development of profitable business.[67]

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[65] Travel Smart Emissions Tracker (2024): https://travelsmartcampaign.org/emissions-tracker/
[66] Carbon Disclosure Project (2025): https://www.cdp.net/en/companies
[67] Travel Smart Case Studies of company best practices (2025): https://travelsmartcampaign.org/case-studies/

3. United Kingdom National Section

Introduction

This section describes planned actions to address UK emissions from international aviation and quantifies the expected impact of these. It compares a 'baseline scenario' in which the UK government and stakeholders take no specific action to reduce aviation emissions with a 'mitigation scenario' in which the current policies, plans and ambitions of government and stakeholders for reducing aviation emissions are realised. Mitigation actions are set out, including those by non-government parties, and the results of the analysis described.

UK modelled scenarios: methodology

To quantify the impact of UK measures to address emissions from international aviation two modelled scenarios are presented:

- The 'baseline scenario' has been constructed to represent a world in which the UK government and industry take no specific action to mitigate international aviation emissions.
- The 'mitigation scenario' includes assumptions relating to UK actions on aviation decarbonisation, including policy measures already in place and actions already being taken by industry as well as broader ambitions, plans and commitments. The baseline scenario acts as a comparator to determine the overall level of emissions reductions achieved through the 'mitigation' scenario.

Baseline and mitigation scenarios have used the methodology of the Intergovernmental Panel on Climate Change (IPCC), attributing international emissions to the UK on the basis of all international flights departing UK airports.[68] This is consistent with the approach taken in other published UK government analysis and is considered to be an

[68] ICAO recommends States should use one of two methodologies for accounting for CO_2 emissions from international flights in their State Action Plans: in the IPCC methodology each State reports emissions from all international flights departing from aerodromes located within the State, while in the ICAO methodology each State reports emissions from all international flights operated by aeroplanes operators attributed to the State.

accurate and appropriate way to represent the impact of policies and measures implemented by the UK.

For both scenarios, data from 2016 to 2021 represents actual outturn emissions taken from “Final UK greenhouse gas emissions national statistics: 1990 to 2021”.[69] Forecast emissions data from 2022 to 2050 is taken from DfT aviation modelling suite forecasts[70] and represents UK departing freight and passenger flights only. The aviation model has been updated since the 2021 update of the UK State Action Plan, to account for revised economic indicators.

A number of assumptions have been made to facilitate the modelling of both scenarios presented in this plan, relating to key economic drivers and policy ambition. The main differences between the baseline and mitigation scenarios relate to varying assumptions about the adoption of aviation decarbonisation measures and not to different assumptions about the wider economy. These assumptions and differences are presented below in Table 3.

Table 3: Key assumptions used in UK modelling for the State Action Plan

	Baseline	**Mitigation**
Accounting for COVID-19	Forecasts account for the effect of COVID-19 by reflecting the level of demand where data is available for 2020-2022. For years beyond this, a trajectory is set for recovery to return to 2019 levels.	
UK ETS carbon pricing	No UK ETS carbon pricing assumptions are applied.	The ‘Market Carbon Values’ trajectory from the traded carbon value for modelling purposes published by DESNZ are applied from 2021 to 2050. [71]
CORSIA carbon pricing	No CORSIA carbon pricing assumptions are applied.	The central illustrative CORSIA price series published by DfT previously is applied out to 2035. [72] No CORSIA carbon price assumptions are applied after 2035. Estimates of emissions savings from CORSIA offsets are presented separately.
Sustainable aviation fuel (SAF) uptake	There is assumed to be no uptake of SAF.	The forecast assumes SAF uptake increases to 22% by 2040, in line with the

[69] Final UK greenhouse gas emissions national statistics: 1990 to 2021 (UK Government, published February 2023): https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2021

[70] Details about the model used, and the updates made since 2021 can be found in DfT’s aviation modelling suite (April 2024): https://assets.publishing.service.gov.uk/media/668546fa541aeb9e928f43eb/dft-aviation-modelling-framework.pdf

[71] Traded carbon values used for modelling purposes, 2023 (UK Government, published November 2023): https://www.gov.uk/government/publications/traded-carbon-values-used-for-modelling-purposes-2023/traded-carbon-values-used-for-modelling-purposes-2023

[72] Jet Zero: further technical consultation (DfT, March 2022): https://assets.publishing.service.gov.uk/media/6238736fd3bf7f6abc6582f6/jet-zero-further-technical-consultation.pdf

		UK SAF mandate[73], and then increases to 50% of total jet fuel demand by 2050. For the purpose of data submission to ICAO, SAF uptake has been split to show expected industry SAF uptake in the absence of further policy action, and the additional uptake assumed to be incentivised under the mitigation scenario. Industry-driven SAF uptake is assumed to represent 10% of total jet fuel demand by 2050, compared with 50% of jet fuel demand by 2050 in total under the 'mitigation scenario'.[74] The forecast presented in this plan assumes all SAF achieves 70% lifecycle emissions savings compared to conventional kerosene. Alongside emissions reductions from the use of SAF, the aviation model accounts for the reduction in demand associated with SAF uptake resulting in higher ticket prices.
Economic drivers, including GDP assumptions and oil prices	Central GDP and oil price assumptions are used for both scenarios, further details on source data can be found in the DfT aviation modelling suite.[75]	
Operational and technological efficiency improvements	An annual efficiency improvement of 0.5% per annum from 2016-2050 is assumed. This represents: aircraft efficiency improvements from the purchase of newer and more efficient aircraft that are not primarily attributable to environmental goals, given the fleet plans of operators will naturally include the replacement of older and less efficient aircraft; and	A 0.5% per annum efficiency improvement from 2016-2050 is assumed for the core analysis to avoid double counting with the ECAC Common Section. However, the impact of the environmental incentive for the development, manufacture and purchase of more efficient aircraft, improvement in airspaces and for additional operational changes has also been assessed. This supplementary scenario uses a 2% per annum efficiency

[73] Sustainable aviation fuel initiatives (DfT, July 2024): https://www.gov.uk/government/speeches/sustainable-aviation-fuel-initiatives

[74] The levels of SAF uptake assumed in the absence of further policy action and in the 'mitigation scenario' are in line with those assumed in the 'Continuation of Current Trends' and 'High Ambition' scenarios used in previous DfT analysis presented in Jet Zero illustrative scenarios and sensitivities respectively. https://assets.publishing.service.gov.uk/media/668546fa541aeb9e928f43eb/dft-aviation-modelling-framework.pdf#:~:text=1.1%20The%20Department%20for%20Transport%20(DfT)

[75] DfT Aviation Modelling Suite, page 17: https://assets.publishing.service.gov.uk/media/668546fa541aeb9e928f43eb/dft-aviation-modelling-framework.pdf#:~:text=1.1%20The%20Department%20for%20Transport%20(DfT)

	emissions savings being realised from more efficient operational measures implemented for reasons other than environmental goals.	improvement from 2016-2050 and is presented separately for completeness.[76]
Zero-emission aircraft	No uptake of zero-emission aircraft.	No uptake of zero-emission aircraft is assumed for the core analysis to avoid double counting with the ECAC common section. However, for completeness, we have presented a supplementary scenario including zero-emission aircraft uptake on UK international flights. This scenario assumes 100% of retiring Class 1 & 2 (<150 seats) aircraft entering the fleet are zero emission in 2035; and 50% of retiring Class 3 aircraft (150-250 seats) replaced with zero emission aircraft from 2040, at current replacement rates. This results in 27% of air traffic movements having zero CO_2 emissions by 2050.[17]

The order in which the various policy levers are applied during the DfT aviation modelling process influences the overall level of emissions savings reported for each measure. For this analysis, the order in which the levers are applied is consistent with similar UK government analysis and corresponds to the order in which they are presented throughout the plan: UK ETS pricing, followed by CORSIA pricing, and finally the uptake of SAF. Where further action to improve efficiency or increase zero emission aircraft uptake is modelled, these levers have been applied assuming carbon pricing under the UK ETS and CORSIA, and action to drive SAF uptake, is already in place.

In the absence of published future carbon price assumptions for the UK ETS and CORSIA, the modelling for the previous update to the UK State Action Plan in 2021 applied Green Book carbon values for appraisal[77] to all flights to estimate the impact of carbon pricing, in the knowledge that the market price of carbon under each scheme was likely to be lower in practice. As set out in Table 3 above, the latest modelling makes use of published carbon price assumptions for modelling for both the UK ETS and CORSIA. The updated aviation model applies carbon pricing based on regions, with the UK ETS price applied for flights departing the UK to Europe, and CORSIA prices applied for flights departing the UK to other world regions out to 2035. These updated values are significantly lower than the values used previously, particularly for those flights leaving the UK to areas outside of Europe. However, this should not be interpreted as a reduction in ambition since 2021. In

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[76] This is in line with the High Ambition scenario used in previous DfT analysis presented in the Jet zero: further technical consultation (March 2022): https://assets.publishing.service.gov.uk/media/668546fa541aeb9e928f43eb/dft-aviation-modelling-framework.pdf#:~:text=1.1%20The%20Department%20for%20Transport%20(DfT)

[77] Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal (DESNZ, October 2012): https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

reality, there have been changes to the UK ETS since 2021 to bring the cap in line with the UK's net zero by 2050 goal, which is expected to significantly increase emissions reduction.

Historical emissions and the UK baseline

This chapter presents the latest available data on historical emissions from UK international aviation, and the results of a modelled baseline scenario which aims to represent the future trajectory of UK aviation emissions were there to be no mitigation actions.

The purpose of the baseline scenario is to allow for the quantification of UK specific abatement measures. The data presented in the UK baseline is not intended to replace data submitted through the Common Section, rather it aims to isolate the international aviation emissions attributable to the UK.

Table 4 shows historical emissions from UK international aviation from 2016 to 2021. [78]

[78] Final UK greenhouse gas emissions national statistics: 1990 to 2021 (UK Government, published February 2023): https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2021

Table 4: Historical UK emissions from international aviation (2016-2021)

Year	Fuel consumption (Mt kerosene)	Historical UK international aviation emissions (Mt CO_2)
2016	10.6	33.6
2017	11.5	36.2
2018	11.8	36.6
2019	11.6	36.7
2020	4.7	14.8
2021	4.2	13.3

Table 5 and Figure 2 show a baseline scenario without mitigation action, where the UK government and industry take no specific action to reduce international aviation emissions. Table 3 gives a detailed explanation of assumptions used to forecast this scenario.

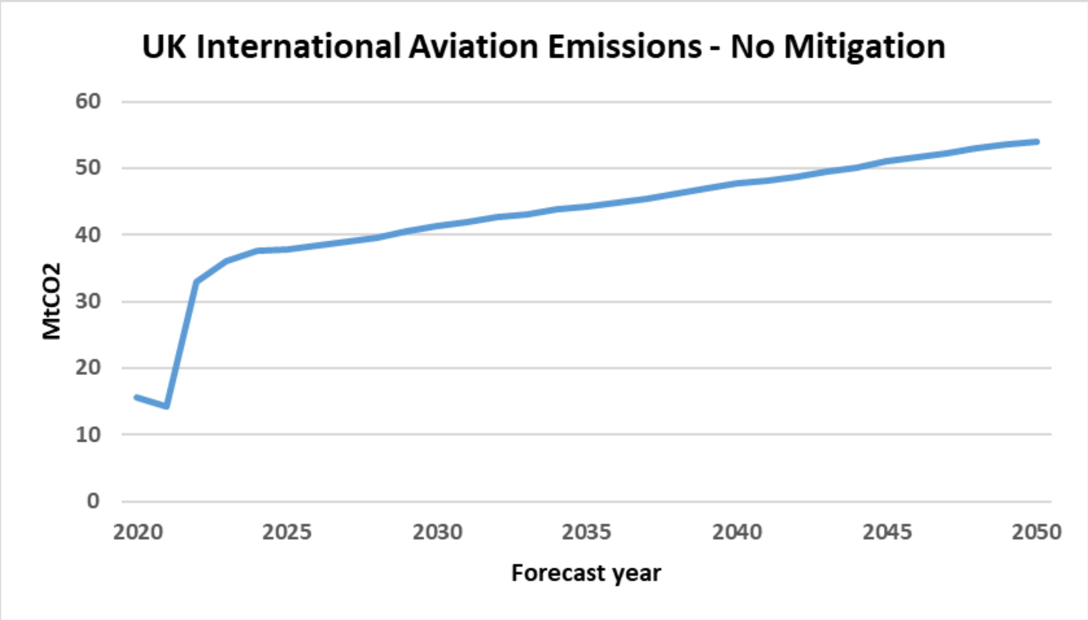
The figures presented in Table 5 represent forecast data for 2020-2050. Fuel consumption is calculated by dividing expected emissions by 3.16, the carbon intensity of kerosene.

Table 5: Forecast UK emissions from international aviation (2020-2050)

Year	Fuel consumption (Mt kerosene)	Forecast UK international aviation carbon emissions (Mt CO_2)
2020[79]	4.9	15.6
2025	12.0	37.9
2030	13.1	41.4
2035	20.0	44.2
2040	15.1	47.7
2045	16.1	51.0
2050	17.1	54.1

[79] Forecast data for 2020 differs from historical data for 2020 presented in Table 4. This is because of the inherent difficulty that arises in forecasting emissions, particularly during the COVID-19 pandemic. Details on how the pandemic was accounting for in modelling can be found in the DfT Aviation Modelling Suite, page 7: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

Figure 2: Forecast UK emissions from international aviation (2020-2050)



UK actions to mitigate the climate impact of aviation

UK policy on aviation CO_2 emissions

Legal framework and targets

The UK first established a long term, legally binding framework to cut carbon emissions to tackle climate change through its 2008 Climate Change Act. In June 2019, the Government accepted advice from the Climate Change Committee (CCC), and the UK became the first major economy in the world to set a 2050 net zero target to end its contribution to climate change. The Climate Change Act introduced a system of carbon budgets, which provide legally binding limits on the emissions that may be produced in successive five-year periods, beginning in 2008 and up to 2050. International aviation emissions are not formally included in carbon budgets up to 2032, however 'headroom' has been left for emissions from international aviation and shipping, so that these emissions are fully accounted for.

The Sixth Carbon Budget (2033-2037) was announced in 2021 as the first carbon budget to be set on a net zero trajectory, and requires emissions to be approximately 77% lower in 2035 than in 1990. For the first time, the Sixth Carbon Budget will incorporate the UK's share of international aviation and shipping emissions. Considering that these represent a significant proportion of overall UK emissions, addressing them is an important part of the UK's decarbonisation efforts and this change to the carbon budget allows for them to be accounted for consistently with emissions from other sectors.

The UK government also announced, in November 2024, a new target to reduce emissions to at least 81% of 1900 levels by 2035 in its Nationally Determined Contribution (NDC) under the Paris Agreement, although, consistent with other States, the UK does not include international aviation and shipping in its NDC.

International action

Given the globally connected nature of the aviation sector, and that the majority of UK aviation emissions come from international aviation, the UK is committed to supporting collective global action under the leadership of ICAO, as well as working through other appropriate international fora and bilaterally with other States. The UK actively supported ICAO's adoption, in 2022, of a long-term global aspirational goal for international aviation of net zero CO_2 emissions by 2050 and continues to support the development of measures and policies in ICAO to ensure this goal is achieved.

The UK has participated in CAEP since its inception and remains an active and committed contributor. The UK government considers CAEP to be the principal technical forum through which states and stakeholders can together develop the globally consistent standards and policies that play a fundamental tole in the achievement of ICAO's environmental objectives.

In 2021, during its presidency of COP26 in Glasgow, the UK launched the International Aviation Climate Ambition Coalition (IACAC). The Coalition is a diverse and inclusive group of States and organisations committed to working towards a shared goal of increasing the ambition of international climate action under the global leadership of ICAO. Its membership has more than doubled since the launch, from 25 to 64 member States and organisations from all world regions, collectively representing more than half of global aviation emissions. The Coalition played an important role in the negotiations to secure the net zero 2050 goal in 2022, and again in the agreement on the Global Framework for SAF, LCAF[80] and Other Aviation Cleaner Energies in 2023. The UK will continue to work through the Coalition to support ambitious action by ICAO as well as support and collaboration among the membership.

National strategy

The UK government has a range of policies and measures in place to support emissions reductions through operational and technological efficiencies, SAF, market-based measures, and, in the longer-term, zero-emission flight. The new government formed in July 2024 has announced kickstarting economic growth and making the UK a clean energy superpower to be among its key missions. A top priority for DfT is the delivery of greener transport, and work is ongoing to ensure the effective decarbonisation of aviation.

In November 2024, the government announced the launch of a new Jet Zero Taskforce, which builds upon the previous Jet Zero Council established in 2020. The Taskforce convenes government and stakeholders from across the UK aviation sector to identify and advise on approaches to unblocking the key barriers in delivering greener aviation. It will support the delivery of specific outcomes on SAF and zero emission technology, consider how to improve aviation systems to make them more efficient, explore the sector's demand for greenhouse gas removals, and improve understanding of the non-CO_2 climate impacts of aviation and develop approaches to mitigate their impact.

UK Emissions Trading Scheme

The UK ETS came into operation in January 2021, replacing the UK's participation in the EU ETS. The scheme puts carbon pricing at the heart of an economy-wide approach to decarbonisation, giving businesses in covered sectors the flexibility to decide how to decarbonise most effectively and at least cost, incentivising both the reduction of emissions and green innovation.

The UK ETS currently covers emissions from the UK's power sector, heavy industry and aviation. For aviation, it covers all domestic flights, flights from the UK to the European Economic Area, flights from Great Britain to Switzerland[81], and flights between the UK and Gibraltar. Over 80% of all UK departing flights were eligible for the UK ETS in 2023.[82]

The UK ETS is jointly run by the UK government, Scottish government, Welsh government and the Department of Agriculture, Environment and Rural Affairs for Northern Ireland, jointly acting as the UK ETS Authority. It is a cap-and-trade scheme that sets an overall

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[80] LCAF, lower-carbon aviation fuel, is a category recognised under the CORSIA framework for fossil-based aviation fuel that produces lower emissions over its lifecycle than traditional kerosene.
[81] It is intended to include flights departing Northen Ireland and arriving in Switzerland in the UK ETS at the earliest appropriate opportunity.
[82] DfT analysis of CAA airport data

limit (the cap) on emissions across the covered sectors with a downward trajectory over time. It establishes a market for emissions allowances, which can be purchased at auction and are tradeable among the businesses in scope, with each allowance representing one tonne of CO_2 equivalent that may be emitted. Participants are required to monitor their emissions during a calendar year and surrender allowances in respect of their annual emissions.

Since the launch of the UK ETS in 2021, the Authority has worked to develop and expand the scheme in line with the UK's net zero commitments and the long-term drive towards a decarbonised economy. In its July 2023 response to a public consultation on 'Developing the UK Emissions Trading Scheme', the Authority confirmed the decision to align the UK ETS cap with a net-zero trajectory.[83] The cap is currently legislated until 2030 and the Authority has confirmed its intention, subject to consultation, to continue the UK ETS beyond 2030 until at least 2050.

From 2026, aircraft operators will no longer receive a free allocation of allowances and will have to purchase all allowances required for compliance. There are a number of actions aircraft operators can take to reduce their emissions, and therefore the allowances they must surrender. These include operational measures, such as consolidating the number of operations, or investing in more fuel-efficient aircraft. Operators can also reduce the number of allowances they have to surrender by demonstrating the purchase and use of SAF. All eligible SAF is currently credited with an emissions factor of zero, meaning it incurs no obligations. Recognising that carbon savings from SAF can vary, the Authority will explore alternative options to SAF being zero rated in the future.

The Authority is considering several areas to further develop and enhance the scheme, such as the inclusion of maritime, energy from waste and waste incineration, and the integration of greenhouse gas removals.

Emissions reductions associated with the UK ETS

The UK ETS has crucial impact as an incentive for operators to reduce emissions through more efficient technology and operations, as well as the purchase of SAF, but it is not possible to quantify this separately from the quantification of efficiencies and SAF elsewhere in this plan.

In addition, the introduction of a carbon price associated with UK-ETS allowances represents a change in direct costs for airlines. We expect that airlines will pass on at least part of the increases in their operating costs in the form of higher airfares, resulting in a very small change to overall demand for flights, and a consequent reduction in emissions. In reality, the extent to which carbon costs are passed on to consumers is uncertain.[84]

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[83] Developing the UK Emissions Trading Scheme: Main Response (UK ETS Authority, July 2023): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1166812/uk-emissions-trading-scheme-consultation-government-response.pdf

[84] There is significant variation in potential for airlines to pass costs on to customers. The literature suggests a wide range of passthrough rates, ranging from 0% at congested airports to 100% at non-congested airports. Research estimates average passthrough rates of around 74% for intra-EEA flights, and 77% for other routes. Source: Assessment of ICAO's global market-based measure (CORSIA) pursuant to Article 28b and for studying cost passthrough pursuant to Article 3d of the EU ETS Directive (ICF et al., September 2020): https://op.europa.eu/en/publication-detail/-/publication/471ca3b9-7cca-11ec-8c40-01aa75ed71a1

Table 6 shows direct impact of UK ETS carbon pricing in reducing emissions through impact on passenger demand.

Table 6: UK Emissions Trading Scheme

Category of measure	Name of measure	Description of measure	Implementation time horizon	CO_2 savings ($MtCO_2$)		Stakeholders involved
Market-based measures	UK ETS carbon pricing	Emissions savings due to carbon cost passthrough	2021-2050	2025	0.1	UK government UK devolved administrations Aircraft operators Businesses in other covered sectors
				2030	0	
				2035	0.2	
				2040	0.5	
				2045	0.4	
				2050	0.4	

Supplemental benefits

The UK ETS delivers a co-benefit of driving the reduction of UK domestic aviation emissions, both through the incentive for technological and operational efficiencies and SAF and through demand impact of carbon pricing. The UK ETS encourages emissions reductions to be made where it is most cost-effective, and therefore also drives emissions savings across other covered sectors. Aviation's participation within the scheme, where there is a total cap on emissions for all covered sectors, facilitates emissions reductions in other sectors. The level of emissions savings driven by aviation, beyond those achieved in-sector, depends on the net purchase of UK ETS allowances by aviation from other sectors such as heavy industry.

Carbon Offsetting and Reduction Scheme for International Aviation

The UK was actively involved in ICAO's work to develop a global market-based measure for international aviation, which led to the agreement on CORSIA in 2016. It has participated since the start of the voluntary phases in 2021 and has begun national implementation of the CORSIA SARPs, with legislation covering the monitoring, reporting and verification (MRV) requirements in place since May 2021. The UK government recently began a public consultation on its plans for implementing CORSIA's offsetting requirements, including in respect of interaction with the UK ETS. The UK intends to complete implementation of CORSIA as soon as possible.

The UK continues to support ICAO in the global implementation and ongoing development of CORSIA and is committed to supporting the CORSIA Periodic Review process to assess the implementation of the scheme and consider its improvement and strengthening in alignment with ICAO's climate goals.

UK experts make a substantial contribution to CAEP Working Group 4, the group responsible for technical work on CORSIA, supporting tasks including the development of MRV tools and guidance, improvements to the guidelines for the Emissions Units Criteria, and analytical input to the Periodic Reviews.

The UK has been a supporting State under ICAO's Assistance, Capacity Building and Training for CORSIA (ACT-CORSIA) programme since 2022. In October that year, the UK launched a pilot project, in partnership with Kenya, to assist States in East Africa in implementing CORSIA effectively. Through this project, five States have received capacity building support: Uganda, Tanzania, Ethiopia, South Sudan and the Seychelles. In 2023 the UK extended its ACT-CORSIA support to six additional States, the Maldives, the Bahamas, East Timor, Jordan, the Dominican Republic and Chile. In November 2024 the government announced further funding to allow continued ACT-CORSIA support to these States until March 2025.[85]

Emissions reductions associated with CORSIA

The majority of emissions savings from CORSIA can be attributed to out-of-sector reductions, achieved through operators purchasing CORSIA Emissions Units (CEUs) to offset their emissions above the CORSIA baseline. It is estimated that the purchase of CEUs to cover emissions from UK departing international flights could total 80.5Mt CO_2 over the period 2024-2035, subject to the UK's decision on how to implement CORSIA. This has been calculated using the estimated CO_2 emissions from UK departing flights to States participating in CORSIA and the estimated Sectoral Growth Factor in a given year.[86] The emissions savings from CORSIA offsetting were estimated separately to the rest of the forecast results presented in this plan and use different forecasts of CO_2 emissions. As such, these emissions savings are presented for information only and are not directly comparable to the main UK emissions results presented in this plan.

CORSIA may have an impact on overall emissions related to any potential cost passthrough from aircraft operators to consumers. The introduction of a carbon price associated with CEUs represents a change in direct costs for airlines. It is not known how operators will recuperate these costs; however, the modelling assumes some costs are passed onto consumers in the form of higher airfares, resulting in a very small change to overall demand for flights, and a consequent reduction in emissions. There is likely to be some overlap between these quantified emissions savings and the estimated reductions through the purchase of CEUs, due to the fact that they have been calculated independently. Overlap may occur as any change in emissions from a reduction in demand would feed through into the overall sectoral growth factor used to calculated an individual aircraft operators' obligations.
CORSIA also has further impact as an incentive for operators to reduce emissions through technology and operations, as well as the purchase of SAF, but it is not possible to

[85] Revamped taskforce set to deliver a sustainable vision for aviation (GOV.UK, November 2024): https://www.gov.uk/government/news/revamped-taskforce-set-to-deliver-a-sustainable-vision-for-aviation
[86] Analysis did not attempt to calculate the effect of the Individual Growth Factor for airline operators, due to the high levels of uncertainty with individual airline operators' emissions. Estimates of emissions savings from CORSIA offsetting requirements should be understood in the context of significant wider uncertainty regarding future international aviation emissions.

quantify this separately from the quantification of efficiencies and SAF elsewhere in this plan.

Table 7 shows the emissions reductions related to the UK's participation in CORSIA.

Table 7: Carbon Offsetting Scheme for International Aviation (CORSIA)

Category of measure	Name of measure	Description of measure	Implementation time horizon	CO_2 savings ($MtCO_2$)		Stakeholders involved
Market-based measures	CORSIA offsetting	Net emissions savings through the purchase of CORSIA Emissions Units to offset emissions above the CORSIA baseline	2021-2035	2025	3.3*	UK government Other governments Aircraft operators ICAO
				2030	7.4*	
				2035	9.9*	
				2040	0	
				2045	0	
				2050	0	
Market-based measures	CORSIA carbon pricing	Emissions savings due to reduction in demand from carbon price passthrough	2021-2035	2025	0**	UK government Other governments Aircraft operators ICAO
				2030	0	
				2035	0.1	
				2040	0	
				2045	0	
				2050	0	

**Subject to the UK's decision on how to implement CORSIA offsetting in national legislation.*

*** Some emissions savings from CORSIA carbon pricing will be realised during this year, however, the overall figure rounds to zero.*

It is assumed here that CORSIA only exists until 2035, as this is the extent of the scheme as currently agreed by ICAO. However, the UK does not consider the complete cessation of the associated reductions to be a realistic expectation. This is because some form of market-based measure applying to international flights is important for achieving ambitious decarbonisation in the long term, and ICAO will conduct a Special Review of CORSIA by 2032 to consider "termination of the scheme, its extension or any other improvement of the scheme beyond 2035."[87]

Sustainable aviation fuel

The UK government considers SAF to be one of the key measures that will contribute to decarbonising the aviation sector and aims to support its upscaling through three parallel approaches of driving demand for SAF in the UK, kickstarting a UK SAF production industry, and working in partnership with industry and investors to build long-term supply.

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[87] ICAO Assembly Resolution A41-22 (2022): https://www.icao.int/environmental-protection/CORSIA/Documents/Resolution_A41-22_CORSIA.pdf

SAF Mandate

The SAF Mandate is the UK's principal policy mechanism to generate demand for SAF and works by obligating the supply of an increasing amount of SAF in the overall UK aviation fuel mix. It will incentivise supply through the award of tradeable certificates with a cash value. Relevant legislation passed through the UK Parliament in 2024 and came into force on 1 January 2025.

The Mandate places an obligation on aviation fuel suppliers, with ambitious but realistic targets, starting at 2% of the UK fuel mix in 2025 and reaching 22% by 2040. It includes a buy-out mechanism, which provides a way for suppliers to discharge their Mandate obligation in cases where they are unable to secure a supply of SAF, preventing excessive costs being passed on to consumers. The buy-out is set at a level that will provide a sufficient incentive to supply SAF into the UK market, encouraging this over the use of the buy-out and supporting investor confidence in UK SAF projects. However, it also sets a maximum cost for the scheme, thereby ensuring emissions reductions are delivered at an acceptable cost.

Starting from 2025, a cap on the amount of hydroprocessed esters and fatty acids (HEFA) SAF that can be used to meet the Mandate will be introduced to encourage technology diversity. HEFA SAF, made from segregated oils and fat, is already being produced and supplied in the UK, and the government recognises it will play a vital role in decarbonisation and welcomes further development. However, certain feedstocks, such as used cooking oil, from which HEFA is made, are limited in volume and will not be able to provide the amounts of SAF expected to be needed in the long term. The HEFA cap is therefore intended to create space for a range of SAF technologies and feedstocks to develop, and to encourage investment in alternative pathways, whilst also recognising that HEFA is currently the only source of commercially available SAF. For the first two years, the cap will allow 100% of a fuel supplier's obligation to be met with HEFA SAF. This then reduces annually, decreasing to 71% in 2030 and 35% in 2040.

Power-to-liquid (PtL) fuels have a high greenhouse gas (GHG) emissions reduction potential, lower competition for feedstocks, and low risk of wider environmental issues such as land-use change. However, they are not yet produced at commercial scale. To incentivise investment in this new pathway and encourage a diverse mix of technologies, a separate PtL obligation will be introduced in 2028, starting at 0.2% of total UK aviation fuel, rising to 0.5% in 2030 and 3.5% in 2040.

Given that the SAF market is still in the early stages of its development and there is considerable uncertainty around its long-term development, the Mandate trajectory is currently only set to 2040. The target beyond 2040 therefore remains at the same level, but this will be kept under review and updated to reflect the reality of the developing market.

In the UK, SAF has previously been incentivised though the Renewable Transport Fuels Obligation (RTFO), although no obligation to supply SAF was in place. The SAF Mandate supersedes the RTFO in the treatment of SAF. This aligns with the 'polluter pays principle', ensuring that the costs of supplying SAF fall on the jet fuel supply chain rather than the road fuel supply chain. The administration of the Mandate aligns with the RTFO where possible, given fuel suppliers are also subject to obligations to supply low carbon fuels under that scheme.

Advanced Fuels Fund

The Advanced Fuels Fund (AFF) was launched in July 2022 to support first-of-a-kind SAF production plants through the development pipeline to reach investment-ready stage and achieve commercial scale. It has allocated over £135m to support private investment in UK SAF projects by overcoming perceived technological and construction risks. An industry competition was conducted, with applicants invited to bid for grant funding available across three financial years.

Central to the design of the AFF are the lessons learnt and the progress made through previous competitions that supported projects at lower technology readiness levels and at the feasibility stages in the project lifecycle. Since 2014, £171m of grant funding has been allocated across four competitions to support the development of advanced fuels.

Previous funding, including the Green Fuels, Green Skies (GFGS) competition, has helped progress several different pathways for advanced fuel production, which use a range of waste materials with good sustainability credentials and offer significant GHG savings through fuels that can be used in existing aircraft.

The AFF supports projects that are now further along their journey. It supports demonstration to first-of-a-kind commercial scale plants at the feasibility to engineering, procurement, and construction stages of the project lifecycle.

This grant funding will directly contribute towards the establishment of a UK SAF production industry, helping to meet the UK demand generated by the SAF Mandate, as well as contributing to the growth of the global SAF market.

The AFF is supporting 13 SAF production projects across the UK. If all reach full operational scale, funded projects could collectively produce over 700,000 tonnes of SAF every year, with associated lifecycle CO_2 emissions savings of 2.7m tonnes.

The UK government has announced that the AFF will be extended for a year to provide funding in 2025/2026.

UK SAF Clearing House

The UK government has established a UK SAF Clearing House to support fuel producers through the testing and qualification of new advanced fuels for aviation. The Clearing House is a national hub capable of facilitating aviation fuel testing and providing expert advice and grant funding, for producers looking to enter testing of their SAF at all qualification stages and across all pathways. This will help remove barriers to new advanced fuels coming to market.

The Clearing House was launched in November 2023, alongside an offer of grant funding to support testing costs for eligible fuels.

SAF commercialisation support

In July 2024, following a consultation that received responses from a wide variety of stakeholders, the UK government announced its intention to prepare legislation to introduce a revenue certainty mechanism for SAF production.

A revenue certainty mechanism will help de-risk SAF projects in the UK by addressing the barriers to investment that exist in a nascent market that relies on innovative technologies. It will provide greater certainty for investors of future revenue and thus attract investment in commercial scale SAF plants within the UK. Lack of a revenue certainty mechanism to provide price stability has been widely considered by stakeholders as the main reason for the slow progress in attracting investment into SAF production plants in the UK.

Concerns about price stability stem from the fact that there is currently no clear UK or global market price for SAF, as it is not yet being produced at a large scale anywhere. The nascent market and potential for significant variation in trading prices means that predicting the price SAF will command in the UK over the medium- to long-term (the next 10 to 20 years) is extremely difficult. There is also uncertainty regarding global production volumes and, given SAF is a highly fungible commodity and transport costs are relatively low, a ramp up in SAF production globally could significantly deflate UK SAF prices. Such uncertainty, coupled with nervousness around technological risks, can mean that potential investors are more likely to choose other, more proven and established technologies than SAF. Additionally, investors can be cautious where there is potential risk of policy and regulatory uncertainty, which could impact on future price dynamics and thus returns on investment.

The revenue certainty mechanism will be industry funded. The government considers it important that the costs of decarbonising air travel should at least partially be borne by those sectors that predominantly use air transport. No decision has been taken yet on the specifics of the funding mechanism that will be used to support the revenue certainty scheme.

It is expected that the legislation for a revenue certainty mechanism will be in place by the end of 2026. The government will continue to monitor the estimated delivery date and will work with industry to deliver an effective mechanism as soon as possible.

Building the global SAF market

The UK government recognises the importance of building a truly global market for SAF, with production in all regions of the world to maximise diversity and resilience in the supply chain, and in the long-term expects the UK to participate in an active global market as both an exporter and importer of SAF. In support of this, the UK is closely engaged with ICAO’s work on SAF, and fully committed to the implementation of the Global Framework for SAF, LCAF and Other Aviation Cleaner Energies agreed at CAAF/3 in 2023 – including the global vision to achieve a 5% reduction in emissions through the use of cleaner fuels by 2030.[88]

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[88] ICAO Global Framework for Aviation Cleaner Energies (ICAO, November 2023) https://www.icao.int/Meetings/CAAF3/Documents/ICAO%20Global%20Framework%20on%20Aviation%20Cleaner%20Energies_24Nov2023.pdf

UK experts contribute to the Fuels Task Group (FTG) within CAEP, supporting a range of important technical work including the ongoing development of the sustainability framework for alternative fuels eligible under CORSIA, which the Global Framework sets out to more broadly be the basis for the eligibility of these fuels in international aviation.

The UK has been an official partner in ICAO's Assistance, Capacity Building and Training for SAF (ACT-SAF) programme since December 2022. Since joining ACT-SAF, the UK has provided SAF training to six African States, fostering collaboration and exploring the potential for regional SAF production.[89] The training has provided foundational knowledge to help strengthen the understanding of SAF. In September 2023, the UK announced a voluntary contribution of $750,000 Canadian dollars (ca. £450,000) to the ICAO Environment Fund, to enable two feasibility studies and one business implementation report for States at the beginning of their 'SAF journey'. Agreements have since been concluded by ICAO to deliver these studies to Zimbabwe, Ghana and Uganda.

Emissions reductions associated with expected SAF uptake

The UK aviation industry is strongly supportive of SAF as a decarbonisation measure and is already taking action to scale up its usage, however policy incentives including the SAF Mandate are expected to drive increased uptake significantly beyond that which would occur through industry action alone. Table 8 shows the CO_2 savings from the level of SAF uptake that is estimated to occur in the absence of any policy measures, and the additional uptake attributable to the SAF Mandate. A detailed explanation of the assumptions can be found in Table 3.

Table 8: Uptake of Sustainable Aviation Fuel

Category of measure	Name of measure	Description of measure	Implementation time horizon	CO_2 savings* ($MtCO_2$)		Stakeholders involved
Fuels	SAF uptake from UK industry without policy incentive	Industry action –e.g. aircraft operators purchasing SAF, aircraft and engine manufactures ensuring greater SAF compatibility, fuel suppliers producing SAF to sell on the basis of	2020-2050	2025	0.2	Aircraft operators Aircraft manufacturers Fuel suppliers
				2030	0.6	
				2035	1.1	
				2040	1.8	
				2045	3.1	
				2050	5.2	

[89] The UK ACT-SAF programme has delivered foundational SAF training and policy implementation workshops to: Angola, Cameroon, Democratic Republic of the Congo, Equatorial Guinea, Gabon and Tanzania.

		environmental credentials				
Fuels	Additional uptake driven by UK SAF Mandate	SAF Mandate creates increased demand for SAF among fuel suppliers, encouraging an increasing supply	2025-2050	2025	0.3	UK government Aircraft operators Fuel suppliers
				2030	2.7	
				2035	4.1	
				2040	6.0	
				2045	9.1	
				2050	14.0	

**The approach to SAF accounting taken in this table is consistent with that set out in detail in Table 3. It assumes all SAF achieves a lifecycle emissions reduction of 70% compared with the use of kerosene.*

While the trajectory for the SAF Mandate is currently only set to increase until 2040, the UK government expects SAF use to continue to increase beyond this point. For the purposes of this analysis an assumption is therefore made on the continuation of a high-ambition trajectory to 2050. Should the confirmed SAF Mandate trajectory continue to increase beyond 2040 at the same rate it would meet 50% in 2050. Confirming the trajectory to 2050 will be subject to consultation and reflect the development of the market and outcome of any formal reviews of the Mandate.

Government funding to support the establishment of a UK SAF production industry, the revenue certainty mechanism, and the SAF Clearing House, will all help to ensure the supply of SAF is sufficient to meet demand under the SAF Mandate, as well as increasing supply for the global market. Emissions reductions from these measures are not quantified directly, as it would not be possible to separate them from the reductions associated with the Mandate.

Supplemental benefits

As the SAF Mandate applies to fuel suppliers there is no distinction between the SAF they produce being used for international or domestic flights, while measures to increase production in the UK will increase the supply available to both the international and domestic sectors. SAF measures will therefore deliver a co-benefit of reducing emissions in domestic as well as international aviation.

The development of a SAF production industry in the UK is also expected to bring significant wider benefits in the form of green jobs, skills, energy security and investment.

Airspace modernisation

Working together, DfT and the CAA have developed a shared vision for the modernisation of UK airspace. The Airspace Modernisation Strategy (AMS) was first published in 2018 and refreshed in 2023, and aims to deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. It will utilise new technologies to create more direct routes, faster climbs, and reduced need for holding stacks. This will mean the aviation industry can grow safely and with opportunities to reduce noise and carbon emissions and can provide better access to airspace for all users.

The programme of airspace modernisation will deliver a once-in-a generation upgrade to important UK national infrastructure and is critical in supporting a sustainable future for UK aviation.

The Airspace Modernisation Strategy has four strategic objectives relating to safety, integration of diverse users, simplification and efficiency, and environmental sustainability:

- Maintaining and, where possible, improving the UK's high levels of aviation safety has priority over all other 'ends' to be achieved by airspace modernisation.
- Satisfy, where possible, the requirements of operators and owners of all classes of aircraft, including existing users (e.g. commercial, General Aviation, military) and new or rapidly developing users (e.g. remotely piloted aircraft systems).
- Secure the most efficient use of airspace and the expeditious flow of traffic, accommodating new demand and improving system resilience to the benefit of airspace users, thus improving choice and value for money for consumers.
- Modernisation should deliver the government's key environmental objectives with respect to air navigation as set out in the government's Air Navigation Guidance, and in doing so will take account of the interests of all stakeholders affected by the use of airspace.

The UK is currently considering reforms to how it delivers future airspace change, particularly in relation to terminal airspace, through the creation of a new Airspace Design Service to provide a guiding mind. It is proposed that this new service would be based within NATS En Route Ltd.

While the AMS is a specific UK strategy, the government aims for it align with the European ATM Master Plan. The operational improvements that will help to reduce emissions, and the expected level of reductions, are broadly equivalent. Emissions reductions from operational improvements, based on the European Master Plan but extrapolated to all ECAC flights including those from the UK, are collectively quantified in the ECAC Common Section, and so are not quantified as part of the main data submitted to ICAO in this UK National Section. However, for completeness, the expected combined impact of technological and operational efficiencies on UK emissions is provided in the Expected Results chapter in Table 13.

UK experts from NATS contribute to the CAEP Airports and Operations Group (Working Group 2), supporting its work on the assessment of environmental impacts on operations, best practices for addressing environmental impacts through operational measures, and the development of related guidance materials.

The UK has been an associate country to Horizon Europe since 1 January 2024, enabling it to continue to be part of the SESAR research programme, building on its contributions before departing the European Union on 31 January 2020.

Technological improvements

Technological improvements delivering improved fuel efficiency in conventional aircraft are expected to make an important contribution to the progressive decarbonisation of UK aviation. Such improvements are realised through the renewal of the existing fleet, as operators replace older aircraft with newer, more fuel-efficient aircraft types. The resulting emissions savings will be compounded where SAF is used in the fuel mix. Fuel efficiency typically improves with each new generation of aircraft, and this has clear cost benefits for operators alongside the environmental benefits, with upgrading of aircraft for performance reasons and at the end of their lifespan being a part of the business-as-usual cycle. Fleet renewal cannot therefore be considered as an environmental measure in itself; however, the desire to reduce CO_2 emissions is a key consideration for the UK aerospace industry in designing new engines and aircraft or making improvements to existing product lines. Engine and aircraft manufacturers, including companies with a significant UK presence like Rolls Royce and Airbus, are involved in the development of more efficient conventional aircraft technologies, as described in the ECAC Common Section.

The UK strongly supported ICAO's development of the first global aircraft certification standard for CO_2 and its adoption in 2016, and this is fully implemented in UK legislation. UK experts contribute to CAEP groups including Working Group 3 (Emissions Technical) and the Modelling and Databases Group, and through these played an important role in the development of the standard in the CAEP work cycle prior to its adoption. More recently, UK experts have played leading roles in the review of the standard in the 2022 to 2025 CAEP cycle, a process working towards recommendations for more stringent regulatory levels of CO_2 emissions.

The Aerospace Technology Institute (ATI) Programme sees joint investment by the UK government and industry. Its purpose is to competitively offer funding for research and technology development, to maintain and grow the UK's competitive position in civil aerospace and accelerate the transition to net zero aviation. It includes funding strands for both ultra-efficiency and zero-emission flight.

The period between 2013 and 2024 saw £3.6bn of joint government and industry investment, and in October 2024 the UK government committed to a five-year extension of the ATI Programme with £975m of additional investment.

When the UK was a member of the EU it contributed to its Horizon Europe programme and Clean Sky 2 research on innovative technologies. As an associate country to Horizon Europe from January 2024, the UK is now engaged with its Clean Aviation programme[90] and UK entities can apply for funding through its Calls for Proposals.

Emissions reductions from technological improvements in conventional aircraft are collectively quantified in the ECAC Common Section, and so are not quantified as part of the main data submitted to ICAO in the UK National Section. However, for completeness, the combined impact of technological and operational efficiencies is provided, in the Expected Results chapter in Table 13.

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[90] EU Clean Aviation programme: https://www.clean-aviation.eu/clean-aviation-to-launch-its-third-call-for-proposals-in-february-2025

Zero-emission flight

The UK government expects that innovative new technologies capable of delivering zero-carbon emission flight can make an important contribution to the decarbonisation of aviation. UK industry is already spearheading the development of such technologies, with efforts across the established aerospace sector and from new enterprises seeking to capitalise on opportunities for innovation.

Research, such as the ATI's FlyZero report[91], suggests the optimum propulsion means for zero-emission aviation will be hydrogen but that battery-electric aircraft may also have commercial applications for short-haul aviation and in new market sectors such as 'advanced air mobility'.

The ATI programme has supported a range of industry led projects focused on zero-emission flight involving both battery-electric and hydrogen technologies.

The government has also supported independent research into airport preparedness for handling hydrogen aircraft through £4.2m of funding to the Zero Emission Flight Infrastructure (ZEFI) programme. Findings from the programme set out the operational changes and infrastructure requirements needed for different airport archetypes to adopt hydrogen-powered flight. In addition, the government has supported the CAA to undertake a Hydrogen in Aviation Regulatory Challenge. Under this initiative the CAA is working with industry and academia to improve the understanding of hydrogen related risks in aviation and ensure that regulation is fit for purpose.

Current industry projects seeking to bring hydrogen aircraft into commercial service, and which have a presence in the UK, include:

- **Airbus ZEROe:** Airbus intend to bring into service the world's first zero-emission commercial aircraft by 2035. Launched in 2022, their ZEROe Demonstrator project will explore how hydrogen propulsion technology can be configured and utilised within their three unique concept aircraft designs to meet their 2035 goal.
- **Project Fresson:** A consortium led by Cranfield Aerospace Solutions (CaeS) seeking to design, manufacture and integrate a hybrid-electric propulsion system into a 9-seat Britten-Norman (B-N) Islander aircraft using hydrogen fuel cells. The project, supported by £7m of Government funding through the ATI Programme, is seeking to introduce a passenger carrying zero emission service in 2026.
- **ZeroAvia:** A UK-US company with its UK base at Cotswold Airport. Through their HyFlyer II project, ZeroAvia are seeking to demonstrate their hydrogen-electric concept on a 19-seat aircraft, with an aim to achieve certification this decade. ZeroAvia have received £12.5m of co-investment from the ATI Programme.

A strong example of activity underway in the UK to develop a zero-emission flight sector is the Hydrogen in Aviation Alliance, which brings together aerospace manufacturers, airlines, airports and energy producers. The alliance published its first report in March

[91] FlyZero,Our Vision for Zero-Carbon Emission Air Travel (ATI, March 2022): https://www.ati.org.uk/wp-content/uploads/2022/03/FZO-ALL-REP-0004-FlyZero-Our-Vision-for-Zero-Carbon-Emission-Air-Travel.pdf

2024, and this set out a series of recommendations for how the UK could lead the implementation of zero-emission flight[92].

While a member of the EU, the UK contributed to research related to zero-emission flight technologies under Horizon Europe and Clean Sky 2, and as an associate country to Horizon Europe from 2024 is now engaged with its Clean Aviation programme, with UK entities able to apply for funding under this.

Emissions reductions associated with zero-emission flight

The contribution of zero-emission flight technology to emissions reductions is quantified in the ECAC Common Section, within the overall quantification of technological measures. For illustration, and not for the purposes of data submitted to ICAO, DfT modelling expects zero-emission technology to generate annual emissions reductions for UK international aviation of 0.2 Mt CO_2 in 2040 and 1.5Mt CO_2 in 2050. This quantification is based on a 2035 entry-into-service date for commercial hydrogen aircraft, an estimate based on engagement with UK industry. The specific date of entry into service varies depending on the class of aircraft, as described in detail in Table 3. Once available, if an aircraft of an appropriate class retires, the DfT aviation modelling suite assumes it would be replaced by a zero-emission aircraft, with 27% of air traffic movements being zero emission by 2050.

Supplemental benefits

The establishment of a zero-emission flight sector is expected to bring notable co-benefits. Given that hydrogen technology may be tested and developed on smaller planes and shorter routes first, emissions reductions would be delivered in the domestic sector ahead of, and as part of the journey towards, commercial deployment on international routes. The new industry also has the potential to deliver significant economic benefits to the UK. The ATI have estimated that zero emission flight could form a £0.6 trillion global market by 2050, creating 60,000 aerospace jobs in the UK.[93]

Non-CO_2 Climate Impacts

Tackling the climate impact of aviation is about more than just reducing CO_2 emissions. In the UK and around the world, awareness is growing that flying also has non-CO_2 climate impacts, which could have a greater warming effect than CO_2 emissions. The non-CO_2 climate impacts of aviation include contrails, nitrogen oxides (NO_x), water vapour, soot (particulates), and sulphur aerosols.

Whilst the impact of CO_2 emissions is well understood and can be clearly quantified, there remains significant uncertainty about the nature and magnitude of aviation's non-CO_2 climate impacts, how to measure and monitor them, how to compare them against CO_2 emissions, and how they could be mitigated. Many of the technological, fuel and

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[92] Launching Hydrogen-Powered Aviation (Hydrogen in Aviation, March 2024): https://hydrogeninaviation.co.uk/wp-content/uploads/2024/03/Launching-Hydrogen-Powered-Aviation-Report.pdf

[93] Destination Zero, The Technology Journey to 2050 (ATI, 2022): https://www.ati.org.uk/wp-content/uploads/2022/04/ATI-Tech-Strategy-2022-Destination-Zero.pdf

operational levers to reduce CO_2 emissions, as well as measures aimed at addressing local air quality impacts, could have co-benefits of reducing non-CO_2 climate impacts, but further research is required to fully understand these correlations.

In light of this, since October 2023, the UK government has undertaken a multi-year multi-million-pound research programme alongside the ATI, which aims to improve understanding of aviation's non-CO_2 climate impacts and to identify and develop potential mitigation options. The programme supports both academic and industry-led research. Ten projects were awarded funding in the first call for academic projects, and the winners from the first industry call for projects will be announced in early 2025.

DfT also provided funding for further projects in November 2023. These included one project covering a literature review of existing research on aviation's non-CO_2 impacts and evaluation of methodologies for measuring and monitoring them, and one investigating the impact of reducing the aromatic content of kerosene on contrail formation. The reports have now concluded, and findings will feed into the wider research programme.

Alongside this, a Non-CO_2 Task and Finish Group was established in 2023, which brings together experts from industry and academia to identify and progress tasks to help better understand aviation's non-CO_2 impacts and agree what mitigating actions government and industry should take.

As the scope of State Action Plans is limited to CO_2 emissions, any expected reductions from actions on non-CO_2 impacts have not been quantified.

Actions from specific stakeholders

CAA

The CAA published its current Environmental Sustainability Strategy in 2022, which sets out how it will work with industry to improve its environmental sustainability.[94] The CAA has also established an internal Environmental Sustainability Panel to act as a 'critical friend', supporting, advising and challenging the CAA in delivery of its Environmental Sustainability Strategy.

The CAA's strategic aims in relation to the environment are to:

- Enable industry to improve its sustainability performance by encouraging and incentivising the aviation sector to manage and reduce its negative impacts, including emissions and noise.
- Co-sponsor and set direction for the modernisation of UK airspace to deliver access, efficiency, and environmental sustainability benefits, and safely enable new users.
- Enable new, more environmentally friendly technologies to be safely introduced.
- Provide transparent information about aviation's sustainability performance.

The CAA is delivering these strategic aims in seven areas:

- Enabling development of zero-emission technology (largely hydrogen and electric powered aircraft), working with industry, government and academia to develop the regulatory requirements for the safe use of these new fuels, both in the air and on the ground.
- Co-leading the modernisation of airspace, through the 4th strategic objective of the AMS that environmental sustainability will be an overarching principle applied through all airspace modernisation activities. This includes consideration of emissions, air quality and noise.
- Reporting on the environmental performance of industry, including emissions, air quality and noise, and developing principles on how airlines should calculate and present information to consumers on the environmental impact of aviation so they can make informed choices about their travel arrangements. To achieve this, the CAA is consulting on the types and level of detail in information it should be providing in its own reporting and also on the principles for airlines' information provision.
- Advising and supporting the UK Government on domestic and international policy in relation to mitigating and, where possible, reducing the emissions, air quality and noise impacts on the environment from aviation and aerospace.
- Reducing the impact of corporate activities and operations.
- Assessing local environmental impacts from relevant regulatory activities (on both biodiversity and people), and monitoring and reporting on how industry is adapting to climate change.

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[94] CAA Environmental Sustainability Strategy: https://www.caa.co.uk/passengers-and-public/environment/environmental-sustainability-strategy/#

- Using its powers and duties across its functions to take the environment into account in its regulation and oversight.

As the CAA considers its environmental roles going forward, it remains closely engaged with the UK government to ensure that its activities are aligned with DfT policy goals and are able to work effectively within the international environmental context.

NATS

NATS action on climate change

NATS' decarbonisation goals are set out as part of its environmental strategy which targets the improvement of its emissions performance, both in terms of the airspace it manages and from running the overall business. NATS targets being a net zero emissions company by 2035, being carbon negative by 2040, and to work with its customers, partners and suppliers to achieve a net zero aviation industry by 2050.[95] These goals build on past environmental targets and programmes that have been in place since 2008. In addition to the benefits realised through airspace modernisation,[96] NATS continues to influence aviation CO_2 emissions in numerous ways, including the development of oceanic airspace, the day-to-day management of airspace, and the tactical delivery of efficient flight profiles by air traffic controllers.

NATS mitigation measures

NATS introduced its 3Di (or 'Three Dimensional insight') environmental performance metric in 2012, when it became the first air traffic service provider to be financially incentivised on its environmental performance[97]. Since then, the metric has allowed NATS to measure the efficiency of its airspace and to identify areas for improvement.

NATS continues to work to deliver airspace modernisation, with other initiatives also being regularly implemented to ensure it meets its emissions goals. Recent examples of improvements delivered by NATS include:

- Deploying the UK's biggest airspace modernisation changes over Wales and southwest England in March 2024.[98] Systemisation and Free Route Airspace (FRA) were deployed simultaneously, transforming 54,000 square nautical miles of airspace.
- Improving the structure of airspace through minor changes to procedures and airspace redesign to deliver more direct routes and vertically efficient flight profiles. The most recent changes have included the introduction of further night-time fuel savings routes and lifting vertical airspace restrictions.

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[95] Transition Plan: 5 Year Plan (NATS, 2023): https://www.nats.aero/wp-content/uploads/2023/07/TransitionPlan5YearPlanFinal.pdf
[96] The Future of Airspace (NATS): https://www.nats.aero/airspace/future/
[97] What is 3Di? (NATS, 2021): https://nats.aero/blog/2021/04/what-is-3di-how-we-measure-airspace-environmental-efficiency/
[98] NATS deploys once in a generation airspace upgrade (NATS, 2023): https://www.nats.aero/news/nats-deploys-once-in-a-generation-airspace-upgrade/

- Developing and implementing new airspace management techniques and tools, such as Intelligent Approach[99], a tool used to optimise arrival flight profiles which continues to be evolved and implemented at airfields.

Initiatives at an advanced stage of planning for implementation this decade include:

- Upgrading the Scottish, London and Manchester Terminal Control Areas (TMAs) in a ‘once in a generation’ redesign. Deployments are set to transform approximately 42,000 square nautical miles of airspace including areas that host some of the busiest airspace in the world.
- Sharing its 3Di data with all airline customers, giving them the ability to access their own 3Di performance data.[100]
- Introducing ‘Sustainability Tracks’ across the North Atlantic Ocean. The introduction of these routes, designed to take account of the most fuel-efficient profiles for key city pairings, has been tested by NATS in collaboration with partners NAVCANADA, FAA, IATA, airline customers and industry experts.

Transparency in reporting

To provide consistency and transparency to interested stakeholders and to track progress against the targets in its environmental strategy, NATS publishes its ‘Greenhouse Gas Report’[101] each year, reporting on its airspace, energy and environmental performance data.

The report includes all sources of emissions, not just those related to airspace or air traffic management, covering everything from location-based emissions, purchased goods and services and capital goods, to business travel, employee commuting and homeworking. The emissions statement is mapped against NATS’ emissions targets which have been validated by the Science Based Targets Initiative[102] to be consistent with the Paris agreement. This ensures full transparency of NATS’ progress towards these goals.

SESAR

NATS is currently involved in 21 of the first set of projects in the SESAR 3 Programme, including projects addressing environmental improvements such as CICONIA (non-CO_2 project to understand and mitigate the environmental impact of contrails) and GEESE (formation flight to develop concepts to provide environmental benefit through wake energy retrieval where the NATS focus is on oceanic airspace).

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[99] Intelligent Approach (NATS): https://www.nats.aero/services-products/n/intelligent-approach/
[100] Transition Plan: 5 Year Plan (NATS, 2023): https://www.nats.aero/wp-content/uploads/2023/07/TransitionPlan5YearPlanFinal.pdf
[101] NATS GHG Report 2023-24 (published 2024): https://www.nats.aero/wp-content/uploads/2024/07/GHGReport2023-24.pdf
[102] Science Based Targets Initiative: https://sciencebasedtargets.org/

Industry

UK industry continues to complement the government's actions to secure a sustainable future for aviation with its own ambitious plans, partnership working, the development of innovative technologies, and through pioneering the use of SAF.

Sustainable Aviation was launched in 2005 as a coalition bringing together major UK airlines, airports, manufacturers, air navigation service providers and key business partners. Its aim is to establish a long-term strategy for a collective approach to tackling environmental issues within the industry. In April 2023 it published a refresh of its Net Zero Carbon Road-Map, setting out the latest pathway to net zero UK aviation by 2050, including through: improved airspace and aircraft operations, aircraft technology improvements, SAF, carbon removals, market-based measures, and demand reduction impact of decarbonisation costs.[103] A subsequent Progress Report in 2024 highlighted several important developments within the UK and international policy landscape and recommended further action in four areas: commercialising SAF, innovation in aerospace technologies, accelerating airspace modernisation, and meeting required energy and carbon removal demands.[104]

Sustainable Aviation is supporting wider industry initiatives to improve understanding of the best ways to reduce overall climate impacts. Beyond operational changes that are being explored to reduce contrail formation, the switch to SAF is recognised as offering opportunities to reduce particulate emissions and potentially contrails. Sustainable Aviation members are currently engaged in a range of company specific projects on addressing non-CO_2 climate impacts as well as supporting the UK Non-CO_2 Task and Finish Group. In the next 12 months Sustainable Aviation plans to publish an updated industry position paper on this topic and will work on plans to best support follow up project work from the current Task and Finish Group.

Academia

The UK has a world-leading university sector with notable strengths in aviation, aerospace and atmospheric science. Multiple academic institutions across the UK are involved in research exploring the potential of new fuels and technologies, whilst others are making critical contributions to the science of climate change and understanding of aviation's role within it. Since January 2024 the UK has been an associate country to Horizon Europe, enabling UK scientists, innovators, business and institutions to work with partners from across Europe, including within the Clean Aviation programme.

In many cases academia is working in partnership with industry and government to bring different skills and knowledge together to tackle shared challenges. For example, in March 2024, £69m of funding by Research England and industry was announced to develop a

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[103] Net Zero Carbon Road-Map, Summary Report (Sustainable Aviation, April 2023): https://www.sustainableaviation.co.uk/wp-content/uploads/2023/04/SA9572_2023CO2RoadMap_Brochure_v4.pdf

[104] Net Zero Carbon Road-Map, One Year On Progress Report (Sustainable Aviation, 2024): https://www.sustainableaviation.co.uk/wp-content/uploads/2024/05/Sustainable-Aviation-One-Year-On-Policy-Progress-Report.pdf

Hydrogen Technology Hub at Cranfield University.[105] The university is renowned for its aerospace facilities and expertise, and the programme will develop new testbeds and laboratories at its airport to enable the demonstration of hydrogen in an airside environment. Partners in the programme include Heathrow Airport, Airbus and Imperial College London.

Non-governmental organisations

The UK has an established and well-respected non-government organisation (NGO) sector, which is actively engaged on aviation and climate change issues.

The Aviation Environment Federation (AEF) is a principal UK NGO campaigning on aviation's impacts for people and the environment. They were formed in 1975, and their aim is to protect the environment, public health and quality of life through securing policies and measures that ensure effective limits on noise, emissions and other environmental impacts from the aviation sector. AEF has campaigned on reviewing airport expansion, the need for effective carbon pricing, options to encourage behavioural change in favour of low carbon travel, measures to reduce non-CO_2 effects, and policies to ensure the aviation industry accelerates research and development into zero carbon energy options for aviation. AEF also represents environmental NGOs at ICAO, through its leading role in the International Coalition for Sustainable Aviation (ICSA), and actively participates in the work of CAEP.

Other NGOs actively engaged with aviation and climate change in the UK include Green Alliance and Transport & Environment (T&E)

[105] £69 million boost for hydrogen at Cranfield (Cranfield University, March 2024): https://www.cranfield.ac.uk/press/news-2024/69-million-boost-for-hydrogen-at-cranfield#:~:text=The%20%C2%A369%20million%20investment%20creating%20the%20Cranfield%20Hydrogen

UK mitigation scenario – expected results

The aim of the mitigation scenario and this chapter is to estimate the overall level of UK international aviation emissions, after the mitigation measures described throughout this plan, including actions from both UK government and industry, have been accounted for.

This chapter firstly presents emissions forecasts in the mitigation scenario to complement data provided through the ECAC Common Section with quantification of additional UK-specific abatement measures.

This chapter also provides supplementary information, including estimates of the impact of operational and technological efficiencies and zero-emission flight on UK emissions. These should not be considered as further data submissions to ICAO as they are duplicative of data presented in the ECAC Common Section. They are instead presented to illustrate a more complete picture of expected UK action on emissions.

Results

Forecast emissions data from 2020 to 2050 is taken from the DfT aviation modelling suite to represent UK departing freight and passenger flights. The data presented in Table 9 reflects the total expected CO_2 emissions in the mitigation scenario.

Table 9: Total expected impact of mitigation measures to reduce UK international aviation CO_2 emissions

Year (all forecast)	Fuel consumption in mitigation scenario (Mt)	Forecast UK international aviation carbon emissions in mitigation scenario (Mt CO_2)
2020	4.9	15.6
2025	12.0	37.2
2030	12.9	38.2
2035	13.4	38.7
2040	14.2	39.5
2045	14.5	38.5
2050	15.0	34.7

In summary, the mitigation scenario assumes central carbon pricing assumptions for the UK ETS, and for CORSIA out to 2035, and uptake of SAF in line with the SAF Mandate. A more detailed explanation of assumptions used in the mitigation scenario can be found in Table 3.

For all years, fuel consumption is calculated by dividing expected emissions by a carbon intensity factor. This factor starts at 3.16, the carbon intensity of kerosene as per ICAO guidance, and reduces over time taking into account the proportion of SAF in the fuel mix and its carbon intensity. Table 9 shows that fuel consumption increases between 2040 and 2050, however CO_2 emissions reduce, due to the lower lifecycle carbon intensity of the fuel mix.

Table 10 shows the emissions savings from these individual measures and in total.

Table 10: Expected impact of mitigation measures to reduce UK international aviation CO_2 emissions (2020-2050)

Year (all forecast)	UK international aviation emissions – baseline scenario (Mt CO_2)	Savings from UK ETS carbon price (Mt CO_2)	Savings from CORSIA carbon price (Mt CO_2)	Savings from SAF (Mt CO_2)	UK international aviation emissions – mitigation scenario (MtCO_2)	Total in-sector emissions savings (MtCO_2)*
2020	15.6	0	0	0	15.6	0
2025	37.9	0.1	0	0.5	37.2	0.7
2030 **	41.4	0	0	3.3	38.2	3.2
2035	44.2	0.2	0.1	5.2	38.7	5.5
2040	47.7	0.5	0	7.8	39.5	8.1
2045	51.0	0.4	0	12.2	38.5	12.4
2050	54.1	0.4	0	19.2	34.7	19.4

**Not including technology and operations efficiencies and the impact of zero emission aircraft, or out-of-sector reductions through CORSIA offsetting. In some years, the emissions savings from the individual measures summed together does not equal the total in sector emissions savings figure. This is due in part to rounding, and in part to the impact of emissions increasing on routes outside Europe post 2035, due to the analytical assumption that CORSIA is absent.*

***Table 10 shows no emissions savings from carbon pricing in 2030. In reality, the UK government expects emissions reductions from carbon pricing in 2030 to lie somewhere between the values presented for 2025 and 2035. However, due to noise in the aviation model, arising from complexities, relatively small changes and multiple factors influencing future emissions, it has not been possible to accurately estimate emissions saving from carbon pricing in 2030.*

Emissions savings resulting from assumptions relating to aircraft and operational efficiencies are excluded from Tables 9 and 10 as they are accounted for in the data provided through the ECAC Common Section. However, the impact of efficiencies according to UK modelling is presented in Table 12 for completeness.

CORSIA offsetting

In addition to the emissions savings presented in Table 10, it is estimated that out-of-sector carbon offsetting on UK-departing international flights through CORSIA could total 80.5Mt CO_2e over the period 2024-2035, subject to the UK's decision on how to implement CORSIA.

Table 11 presents expected out-of-sector emissions reductions from CORSIA offsetting, calculated using estimated CO_2 emissions from UK departing flights on CORSIA eligible routes multiplied by the estimated Sectoral Growth Factor in a given year.[106] The emissions savings from CORSIA offsetting were estimated separately to the rest of the forecast results presented in this plan and use different estimates of CO_2 emissions. As such, these emissions savings are presented for information only.

Table 11: Emissions savings from the purchase of CORSIA Emissions Units on UK departing flights

Year (all forecast)	Emissions savings from CORSIA offsetting (Mt CO_2e)*
2020	0
2025	3.3
2030	7.4
2035	9.9

**Subject to the UK's decision on how to implement CORSIA.*

Supplementary results (not for purposes of data submitted to ICAO)

All mitigation measures (including technology, operations and zero emission flight)

Table 12 and Figure 3 reflect the impact of policies outlined in Table 10, plus improvements in aircraft and operational efficiencies, and the progressive introduction of zero emission flight starting in 2035, in line with the UK's decarbonisation ambitions and as detailed in Table 3. This has been included for completeness to illustrate the expected total UK international aviation CO_2 emissions after all mitigation measures. The data here is for information only and should not be taken as additional to that in the ECAC Common Section.

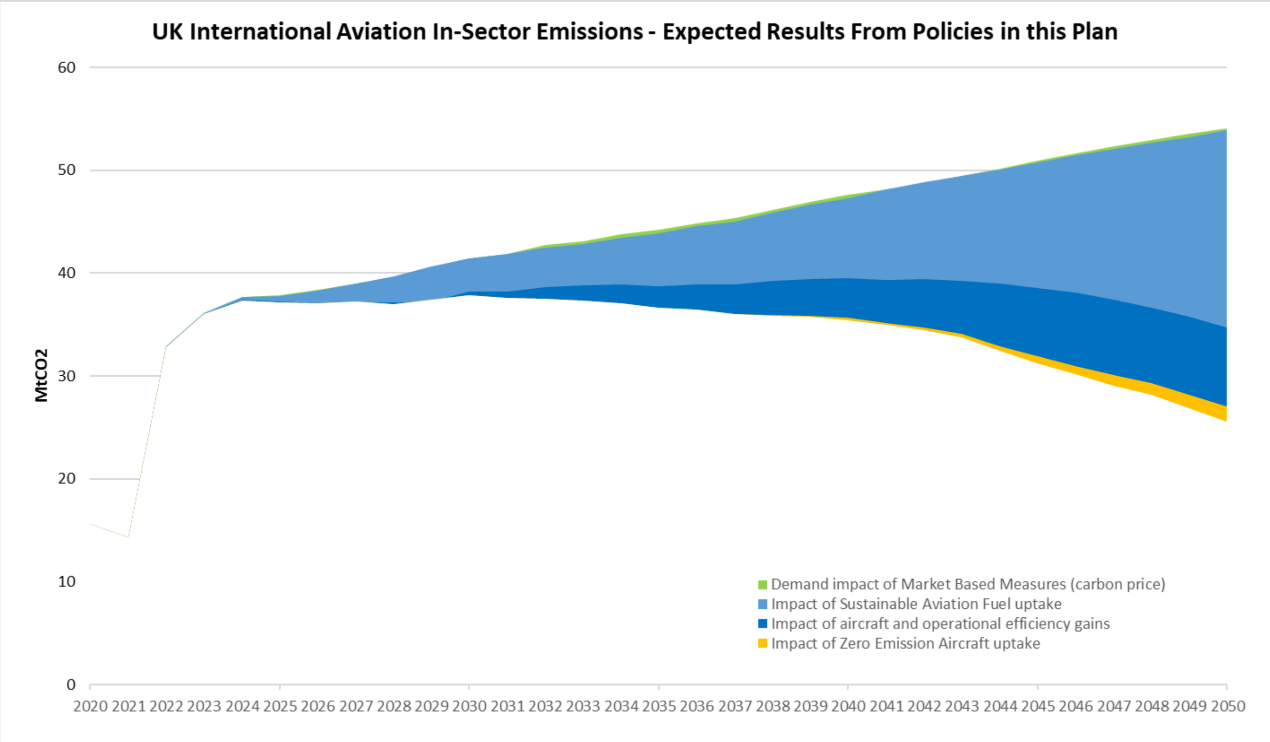
Table 12: Expected impact of mitigation measures to reduce UK international aviation CO_2 emissions, including aircraft and operational efficiency improvements and zero emission flight for completeness

Year (all forecast)	Fuel consumption in mitigation scenario (Mt)	Forecast UK international aviation emissions in mitigation scenario (Mt CO_2)
2020	4.9	15.6
2025	11.9	37.2
2030	12.8	37.9
2035	12.7	36.6
2040	12.7	35.4

[106] Analysis did not attempt to calculate the Individual Growth Factor for airline operators, due to the high levels of uncertainty with individual airline operators' emissions. Estimates of emissions savings from CORSIA offsetting requirements should be understood in the context of significant wider uncertainty regarding future international aviation emissions.

2045	11.7	31.2
2050	11.0	25.6

Figure 3: Expected in-sector reductions from UK mitigation measures on UK international aviation CO_2 emissions (2020-2050)



Uncertainties

There is significant inherent uncertainty associated with modelling future aviation emissions reductions, which should be considered when interpreting the results presented in this plan.

These uncertainties include:

- The mitigation scenario does not consider the impact of any new measures or policies that may be adopted by the UK in the future.
- It is possible there will be some consumer behavioural change over the period 2024 to 2050, but DfT does not have a sufficient understanding of how that change could impact on demand for flights or how airline operators will respond for it to be included in quantified modelling. Therefore, the results presented in this plan exclude any consideration of behavioural change.
- Airport capacity assumptions are necessary to facilitate aviation modelling. Given the private ownership of airports within the UK, airport development is not at the discretion of policymakers. Capacity assumptions do not reflect DfT's view on future capacity proposals, nor do they indicate maximum appropriate levels of capacity growth at specific airports for the purpose of planning decisions.

- Most options for aviation decarbonisation rely on new technology, the development and uptake of which is extremely uncertain, owing to the uncertain nature of technology readiness and cost of technology over time.

4. Conclusion

This State Action Plan provides an overview of the UK's actions to reduce CO_2 emissions from international aviation, including those being taken collectively in Europe that the UK contributes to and those being taken at the national level. It has been prepared by DfT on behalf of the UK government, with input from UK stakeholders. It illustrates that there is a broad range of actions from government, industry and other stakeholders that will contribute to achievement of the ICAO long-term aspirational goal of net zero CO_2 emissions by 2050, alongside ensuring that the sector, which has such an important social and economic value to the UK, can continue to thrive in a sustainable future.

Since the previous update in June 2021, the UK has made significant progress in implementing policies in support of its decarbonisation ambitions. This is reflected in the Expected Results chapter, where CO_2 emissions after in-sector reductions (the mitigation scenario) are 25.57Mt in 2050, compared to 34.24Mt in the previous update. For 2035, the emissions are now estimated to be 36.62Mt compared to 38.24Mt in the previous update. These estimates include UK-specific measures on SAF, and carbon pricing from UK ETS and CORSIA, as well as operational and technological efficiencies and zero-emission flight. As overall UK emissions figures, they should be considered independently from any conclusions drawn from the ECAC Common Section, given that the mitigation results in that section also account for technology and ATM improvements and zero-emission flight across all ECAC States.

The biggest factor in the change to the overall results is the increased expectation of savings from SAF, now showing 19.23Mt saved in 2050, compared to 1.72Mt in the previous update. This reflects the introduction of the UK SAF Mandate as well as the broader commitment that has been made through a range of new policy measures to upscale SAF production and deployment in the UK.

Continued ambition from industry, combined with government support to research and development, has also now provided a sufficient level of confidence to include quantification of expected results from zero-emission technologies, which were not quantified in the previous update. This is provided as supplementary information and not intended to be additional to quantification in the ECAC Common Section.

Due to improved assumptions in the modelling, emissions savings from carbon pricing are shown as lower than in the previous update. This does not reflect any actual decrease in policy ambition or confidence in specific measures. Rather, it simply reflects improved assumptions since the previous update. Considering this, the actual increase in overall expected emissions savings between the current and previous updates is even greater than that indicated by comparing the respective results.

This updated plan shows that, in the medium to long term, emissions are expected to reduce at an increasing rate from in-sector measures, compared to a baseline scenario where they would rise steadily due to traffic growth. This is based on measures already legislated and actions currently being taken by industry, as well as broader ambitions, plans and commitments. Substantial cumulative and annual reductions are expected to be achieved by 2050, but there will remain a significant level of residual emissions. While future actions and increased ambition on in-sector measures from both government and industry may drive further reductions, the UK recognises the importance of also taking action to address the residual emissions. Measures and policies that encourage and enable aviation to compensate for its residual emissions, for example through the purchase of carbon removals, are therefore an important consideration for the future.

The description of national actions and the expected results in this Action Plan were finalised in January 2025 and shall be considered as subject to update after this date.

Appendix: Detailed results for ECAC scenarios from Section 2

Baseline scenario

Table A1: Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movement) (million)	Revenue Passenger Kilometres[107] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[108] FTKT (billion)	Total Revenue Tonne Kilometres[109] RTK (billion)
2010	4.71	1,140	0.198	41.6	155.6
2019	5.88	1,874	0.223	46.9	234.3
2023	5.38	1,793	0.234	49.2	228.5
2030	6.69	2,176	0.262	55.9	273.5
2040	7.69	2,588	0.306	69.0	327.8
2050	8.46	2,928	0.367	86.7	379.5
Note that the traffic scenario shown in the table is assumed for both the baseline and implemented measures scenarios.					

[107] Calculated on the basis of Great Circle Distance (GCD) between the airports of the available passenger reports (subset of the global traffic ; from 97% in 2010 up to 99% for the forecast years).

[108] Includes passenger and freight transport (on all-cargo and passenger flights).

[109] A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).

Table A2: Fuel burn and CO_2 emissions forecast for the baseline scenario

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	38.08	120.34	0.0327	0.327
2019	53.30	168.42	0.0280	0.280
2023	48.41	152.96	0.0268	0.268
2030	54.46	172.10	0.0250	0.250
2040	62.19	196.52	0.0240	0.240
2050	69.79	220.54	0.0238	0.238
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

Table A4: Average annual fuel efficiency improvement for the Baseline scenario

Period	Average annual fuel efficiency improvement (%)
2010-2023	-1.50%
2023-2030	-1.01%
2030-2040	-0.40%
2040-2050	-0.08%

Implemented measures scenario

Effects of aircraft technology improvements after 2023

Table A5: Fuel consumption, CO_2, and CO_2 equivalent emissions of international passenger traffic departing from ECAC airports, with aircraft technology improvements after 2023 included (well-to-wake emissions are determined by assuming 3.88 Kg of CO_2 equivalent emissions for 1 Kg of Jet-A fuel burn).[110]

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Well to Wake CO_2 equivalent emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	38.08	120.34	147.77	0.0334	0.334
2019	53.30	168.42	206.80	0.0284	0.284
2023	48.41	152.96	187.82	0.0270	0.270
2030	53.64	169.50	208.12	0.0246	0.246
2040	56.60	178.84	219.59	0.0218	0.218
2050	54.77	173.06	212.50	0.0187	0.187
For reasons of data availability, results shown in this table do not include cargo/freight traffic.					

Table A6: Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology only)

Period	Average annual fuel efficiency improvement (%)
2010-2023	-1.50%
2023-2030	-1.22%
2030-2040	-1.19%
2040-2050	-1.55%

[110] "Well-to-wake CO_2e emissions of fossil-based JET fuel are calculated by assuming an emission index of 3.88 kg CO_2e per kg fuel (see DIN e.V., "Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)", German version EN 16258:2012), which is in accordance with 89 g CO_2e per MJ suggested by ICAO CAEP AFTF."

Effects of aircraft technology and ATM improvements after 2023

Table A7: Fuel consumption, CO_2 and CO_2 equivalent emissions of international passenger traffic departing from ECAC airports, with aircraft technology and ATM improvements after 2023 (well-to-wake CO_2 equivalent emissions are determined by assuming 3.88 Kg of CO_2 equivalent emissions for 1 Kg of Jet-A fuel burn)

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Well-to-Wake CO_2 equivalent emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	38.08	120.34	148.02	0.0327	0.327
2019	53.30	168.42	207.16	0.0280	0.280
2023	48.41	152.96	188.14	0.0268	0.268
2030	52.57	166.11	204.31	0.0241	0.241
2040	53.20	168.11	206.78	0.0205	0.205
2050	49.29	155.75	191.58	0.0168	0.168
For reasons of data availability, results shown in this table do not include cargo/freight traffic.					

Table A8: Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology and ATM improvements)

Period	Average annual fuel efficiency improvement (%)
2010-2023	-1.50%
2023-2030	-1.51%
2030-2040	-1.60%
2040-2050	-1.98%

Table A9: Equivalent CO_2e emissions forecasts for the scenarios described in this common section, assuming 3.88 Kg of CO_2 equivalent emissions for 1 Kg of Jet-A fuel burn:

Year	Well-to-wake CO_2e emissions (10^9 kg)			% improvement by Implemented Measures (full scope)
	Baseline Scenario	Implemented Measures Scenario		
		Aircraft techn. improvements only	Aircraft techn. and ATM improvements	
2010	147.77			
2019	206.80			
2023	187.82			
2030	211.32	208.12	203.95	-3%
2040	241.30	219.59	206.41	-14%
2050	270.79	212.49	191.24	-29%
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				