

Finland's Action Plan to Reduce CO₂ Emissions from Aviation 2021

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1 Current state of aviation in Finland

1.1 Introduction

Air transport is an important part of an efficient and well-functioning transport system and a key factor for competitiveness of Finland. Economic growth in Finland is based on export, but the country is located far from the market areas for our products. Logistically, Finland is an island; without air transport, it would not be able to perform swift overnight carriages or move goods to the larger market areas of Europe. Flying to Central Europe takes a couple of hours, while the travel time with other forms of transport is several days.

The International Air Transport Association IATA and Oxford Economics estimated in 2019 that around 70 000 jobs in Finland were supported by air transport and tourists arriving by air, based on 2017-2018 data. In total, 2.5 per cent of Finland's GDP was estimated to be supported by inputs to the air transport sector and foreign tourists arriving by air. Europe is the largest market for passenger flows to and from Finland, followed by Asia-Pacific and North America. Finland is an important gateway for traffic to North Asia and connections to Asia-Pacific have grown the fastest over the last five years.¹ The aviation industry is also a key enabler of many other economic activities.

1.1.1 ICAO State Action Plan

The International Civil Aviation Organization ICAO launched the State Action Plan initiative over 10 years ago in 2010. This initiative enables ICAO Member States to establish a long-term strategy on climate change for the international aviation sector and to involve interested parties at national level. These parties are encouraged to work together to define a quantified **baseline scenario**, select appropriate emissions **mitigation measures** from ICAO's basket of measures, and calculate the **expected results** of implementing those measures. The aim is to enable ICAO to compile global progress towards meeting the goals set by Assembly Resolution A37-19, and reaffirmed by A38-18, A39-2, and A40-18. States are invited to update their State Action Plans every three years, so that ICAO can continue to compile the quantified information submitted. As at 9 June 2021, 120 States, representing 97.39% of global international aviation traffic in revenue tonne-kilometres (RTK), have voluntarily submitted their State Action Plans to ICAO.

This document represents Finland's Action Plan to Reduce CO₂ Emissions from Aviation. Finland's first Action Plan was published in 2012 and has since been updated three times with the latest in June 2018². As a member of the EU and the European Civil Aviation Conference (ECAC), Finland's baseline scenario as well as the expected results from common EU mitigation measures will be included in the ECAC/EU Common section for European State Action Plans (Section 1/Chapter 3).

¹ IATA: The Importance of Air Transport to Finland 1.6.2019 <https://www.iata.org/en/iata-repository/publications/economic-reports/finland--value-of-aviation/>

² State Action Plan of Finland International Aviation CO₂ Emissions, Trafi Publications 17/2018 [https://arkisto.trafi.fi/filebank/a/1531731619/cd3a5096c1aca9af86acd2a079dac9c9/31344-State Action Plan of Finland 2018 International Aviation CO₂ Emissions.pdf](https://arkisto.trafi.fi/filebank/a/1531731619/cd3a5096c1aca9af86acd2a079dac9c9/31344-State%20Action%20Plan%20of%20Finland%202018%20International%20Aviation%20CO2%20Emissions.pdf)

1.1.2 Common Introductory Section for European States' Action Plans for CO₂ emissions reductions

- a) The ICAO Contracting State Finland is a member of the European Union and of the European Civil Aviation Conference (ECAC). ECAC is an intergovernmental organisation covering the widest grouping of Member States³ of any European organisation dealing with civil aviation. It is currently composed of 44 Member States, and was created in 1955.
- b) 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, being an urgent need to achieve the ICAO goal of Carbon Neutral Growth from 2020 onwards (CNG2020), and to strive for further emissions reductions. Together, they fully support ICAO's on-going efforts to address the full range of those impacts, including the key strategic challenge posed by climate change, for the sustainable development of international air transport.
- c) All ECAC States, in application of their commitment in the 2016 Bratislava Declaration, support CORSIA implementation 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.
- d) Finland, 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.
- e) Finland recognises the value of each State preparing and submitting to ICAO an updated State Action Plan for CO₂ emissions reductions as an important step towards the achievement of the global collective goals agreed since the 38th Session of the ICAO Assembly in 2013.
- f) In that context, it is the intention that all ECAC States submit to ICAO an action plan. This is the action plan of Finland.
- g) Finland strongly supports the ICAO basket of measures as the key means to achieve ICAO's CNG2020 target and shares the view of all ECAC States that a comprehensive approach to reducing aviation CO₂ emissions is necessary, and that this should include:
 - i. emission reductions at source, including European support to CAEP work in this matter (standard setting process);
 - ii. research and development on emission reductions technologies, including public-private partnerships;
 - iii. development and deployment of sustainable aviation fuels, including research and operational initiatives undertaken jointly with stakeholders;
 - iv. improvement and optimisation of Air Traffic Management 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
- v. Market Based Measures, which allow the sector to continue to grow in a sustainable and efficient manner, recognizing that the measures at (i) to (iv) above cannot, even in aggregate, deliver in time the emissions reductions necessary to meet the ICAO 2020 CNG global goal.
- h) In Europe, many of the actions which are undertaken within the framework of this

³ 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.

comprehensive approach are in practice taken collectively, most of them led by the European Union. They are reported in Section 1 of this Action Plan, where the involvement of Finland is described, as well as that of other stakeholders.

- i) In Finland a number of actions are undertaken at the national level, including those by stakeholders. These national actions are reported in Section 2 of this Plan.
- j) In relation to European actions, it is important to note that:
 - o 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 in 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.
 - o 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 emission reduction benefits across the whole of the region (for example research, SAF promotion or ETS).

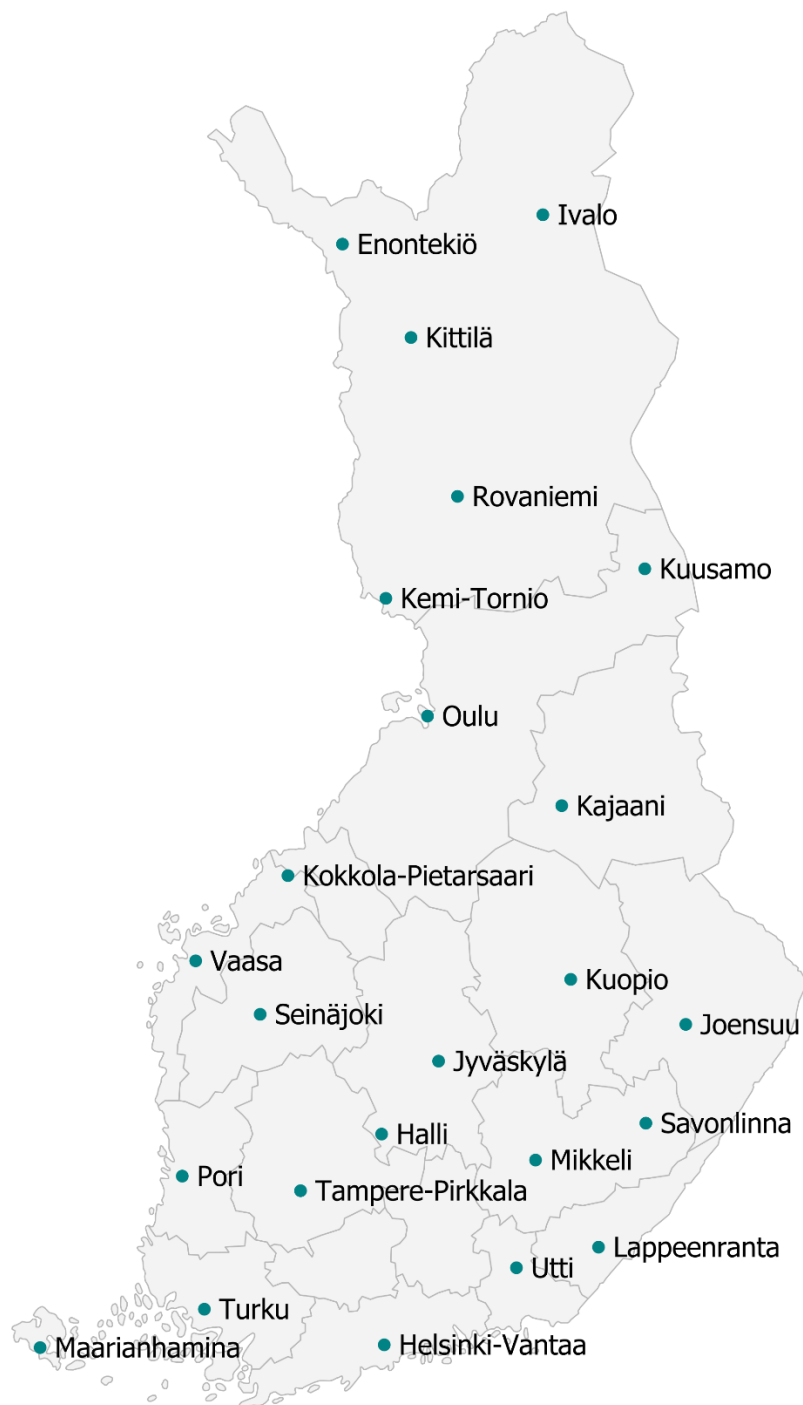
1.2 Development of air transport in Finland

Airports are pivotal to the provision of air transport services. Finland currently has 21 airports that are operated by Finavia⁴. In addition, there is a foundation-operated airport in Seinäjoki and municipal airports in Mikkeli and Lappeenranta. Finland's Air Transport Strategy 2015-2030 was published in 2015. According to the Strategy Helsinki Airport is the only profitable airport in the Finavia network: revenue from Helsinki is used to finance the entire network. The role of Helsinki Airport as an international transit hub for Asian routes ensures the continuity of travel connections to an extensive network of European destinations.⁵

⁴ <https://www.finavia.fi/en/airports>

⁵ Finland's Air Transport Strategy 2015-2030, Publications of the Ministry of Transport and Communications 2a/2015 <http://urn.fi/URN:ISBN:978-952-243-441-8>

Figure 1 Airports in Finland



* Halli, Mikkeli, Seinäjoki and Utti are used by general and/or military aviation and there are no scheduled flights.

The COVID-19 pandemic has had a large impact on civil aviation. In 2020, a total of 6.5 million passengers flew through Finnish airports. The number of passengers dropped to only one-quarter compared to year 2019, when there were 26.3 million passengers in Finnish airports. The number of passengers decreased by 66 % in domestic air transport and by 78 % in international air transport. In 2020, about 79 % of Finland's air passenger

traffic went through Helsinki Airport. Helsinki Airport accounted for 5.1 million passengers and other domestic airports 1.4 million passengers.

Figure 2 Passenger traffic at Finnish airports 2006-2020 (passengers)



Source: Statistics Finland, Finavia

In 2020, a total of 147,210 tonnes of air freight and mail went through Finnish airports. The amount decreased by one third compared to the previous year, when freight and mail transport amounted to 225,856 tonnes in total. In 2020, around 97 % of air freight traffic passed through Helsinki Airport, and around 99 % of the freight tonnes were transported between Finland and foreign countries.

Figure 3 Freight and mail at Finnish airports 2006-2020 (tonnes)



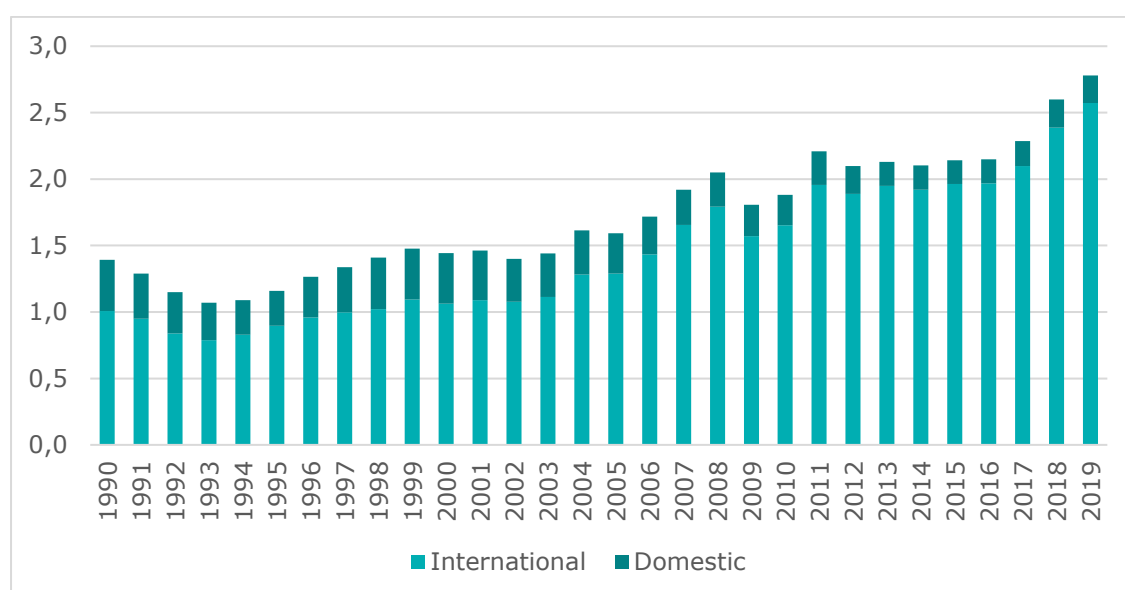
Source: Statistics Finland, Finavia

2 Aviation's contribution to greenhouse gas (GHG) emissions in Finland

2.1 Aviation CO₂-emissions in Finland 1990 - 2019

Emissions from domestic aviation accounted for less than 2 % of total transport emissions in Finland in 2019, and have decreased by about 32 % from 2005 to 2019. Emissions from domestic aviation are also not expected to increase significantly in the future, as traffic volumes are forecasted to remain at approximately current levels. It is estimated that domestic air traffic will increase slightly at airports in Northern Finland, remain at the current level in Central Finland and decrease in Southern Finland.

Figure 4 CO₂ emissions (Mt) from domestic and international aviation 1990-2019⁶



Source: Statistics Finland

The volume and emissions of international air traffic departing from Finland have increased significantly, and in 2019 were about 12 times higher than the emissions of domestic air traffic. From 2005 to 2019, the total emissions increased by 75 per cent, mainly due to the increase in long-haul routes in Asia and North America and the growth of Helsinki-Vantaa Airport into a major European hub. In total, the emissions of domestic and international air traffic departing from Finland in 2019 were 2.78 Mt CO₂.

Table 1 CO₂ emissions from international aviation 1990-2019⁷

Year	CO ₂ emissions (Mt)
1990	1,01
1995	0,90
2000	1,06

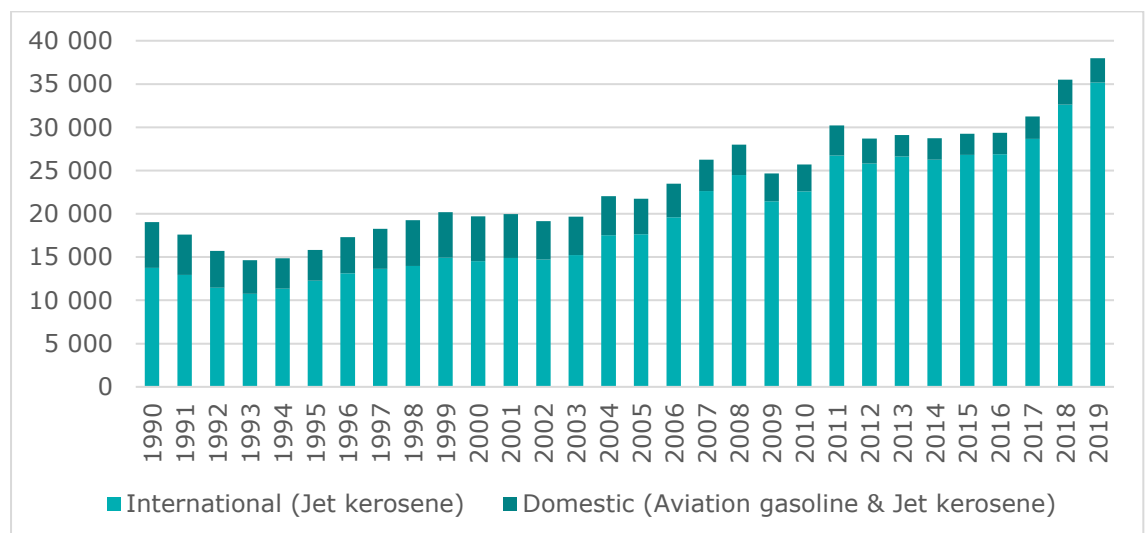
⁶ Calculation is based on IPCC methodology, and this same data is reported to the EU and UNFCCC as a part of Finland's greenhouse gas inventory report.

⁷ Calculation is based on IPCC methodology, and this same data is reported to the EU and UNFCCC as a part of Finland's greenhouse gas inventory report. Source: Statistics Finland, National Inventory Report (NIR) and standardized reporting tables, CRF-tables, Table10s2, International Bunkers Aviation https://www.stat.fi/tup/khkinv/khkaasut_raportointi_en.html

2005	1,29
2010	1,65
2011	1,96
2012	1,89
2013	1,95
2014	1,92
2015	1,96
2016	1,97
2017	2,10
2018	2,39
2019	2,57

According to the most recent greenhouse gas emission inventory, the fuel consumption for international aviation was 35,166 TJ and for domestic aviation 2,811 TJ in 2019.

Figure 5 Fuel consumption (TJ) in domestic and international aviation 1990-2019



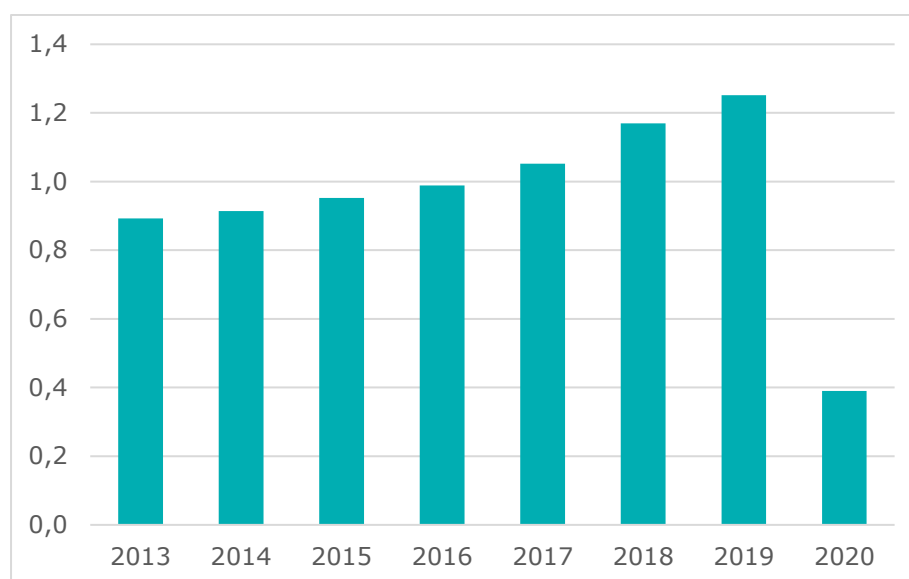
Source: Statistics Finland

The number of air traffic passengers increased significantly in Finland in the 2010s. At the same time, the number of flights and emissions remained at the same level for several years before the increase in emissions in 2017 - 2019. The reason for the pre-2017 development was the introduction of new larger and more energy-efficient aircraft and an increase in cabin capacity utilization. However, the strong growth in passenger numbers will eventually be reflected in an increase in emissions, which materialised towards the end of the decade.

The CO₂ emissions reported to Finland under the EU Emissions Trading System for aviation were a total of 0.39 Mt in 2020. There was a dramatic reduction in emissions in 2020 due to the COVID-19 pandemic. The EU ETS CO₂ emissions reported to Finland peaked in 2019 with 1.25 Mt CO₂. Before the year 2020 the emissions had grown yearly since 2013, when the scope of the aviation EU ETS was reduced to intra-EEA flights.⁸

⁸ <https://www.liikenne fakta.fi/fi/ymparisto/lentoliikenteen-paastokauppa>

Figure 6 The CO₂ emissions (Mt) reported to Finland under the EU ETS for aviation



2.2 Aviation CO₂-emission forecasts in Finland

EUROCONTROL has estimated pre-COVID that the number of flights in Finland would increase by an average of 1.4 per cent annually until 2040. The assessment includes projected emission reduction measures, such as new aircraft technology and international market-based mechanisms (EU Emissions Trading Scheme and ICAO Carbon Offsetting and Reduction Scheme for International Aviation CORSIA), as well as economic forecasts. Traffic growth is projected to be stronger in Europe in the 2020s than in the 2030s.⁹ With its airport network, Finavia was preparing for a 4 % annual increase in passenger numbers¹⁰, which would increase the number of passengers in Helsinki-Vantaa from the 21.9 million in 2019 to 30 million by 2030. In 2019, the airports operated by Finavia had a total of 26 million passengers.

Based on EUROCONTROL's forecast, it can be estimated that Finnish domestic and outbound international flights will increase by 15-20 per cent and emissions by 20-25 per cent by 2030 compared to the 2018 level if new measures to reduce emissions are not introduced. Taking into account the projected slowdown in traffic growth in the 2030s and the electrification of aircraft, it can be estimated that the number of flights will increase by 30-40% by 2045 and emissions by 25-40% compared to the 2018 level. These estimations are for illustrative purposes only and more specific baseline scenario is presented in Section 1.

The strongest growth phase of air traffic is thus expected to be over in Finland, but no shrinking is in sight if temporary market disturbances, such as the COVID-19 pandemic, are not taken into account. However, it is possible that the COVID-19 pandemic will also have longer-term effects on reducing air traffic, for example due to changes in tourism habits or the development of a virtual meeting culture. Finnair's share of Finnish air traffic

⁹ European Aviation in 2040, EUROCONTROL 2018

¹⁰ Passengers refer to arriving, departing and transfer passengers. Passenger statistics do not include infants or transit passengers (a passenger who does not change planes). The number of passengers does not mean the number of round trips. For example, on the Oulu-Helsinki-Stockholm route, a passenger is counted as a departing and arriving passenger in Finland and also as an international transfer passenger departing abroad, ie a total of three times.

is also so large (approximately 2/3) that the company's policies may have significant effects on the realisation of forecasts. Finnair's goal is to be carbon neutral by the end of 2045. Finnair's first milestone is already by the end of 2025 as Finnair aims to cut the net emissions by 50 % from the 2019 level. The development of traffic volumes and especially emissions can also be influenced by international regulations and state policy measures. In addition, forecast uncertainty is exacerbated by possible other changes in consumption behavior, such as shift between different transport modes.

More detailed forecasts are presented in the next section.

3 Section 1: ECAC/EU Common section for European State Action Plans

EUROPEAN STATES' ACTION PLANS

ECAC/EU COMMON SECTION

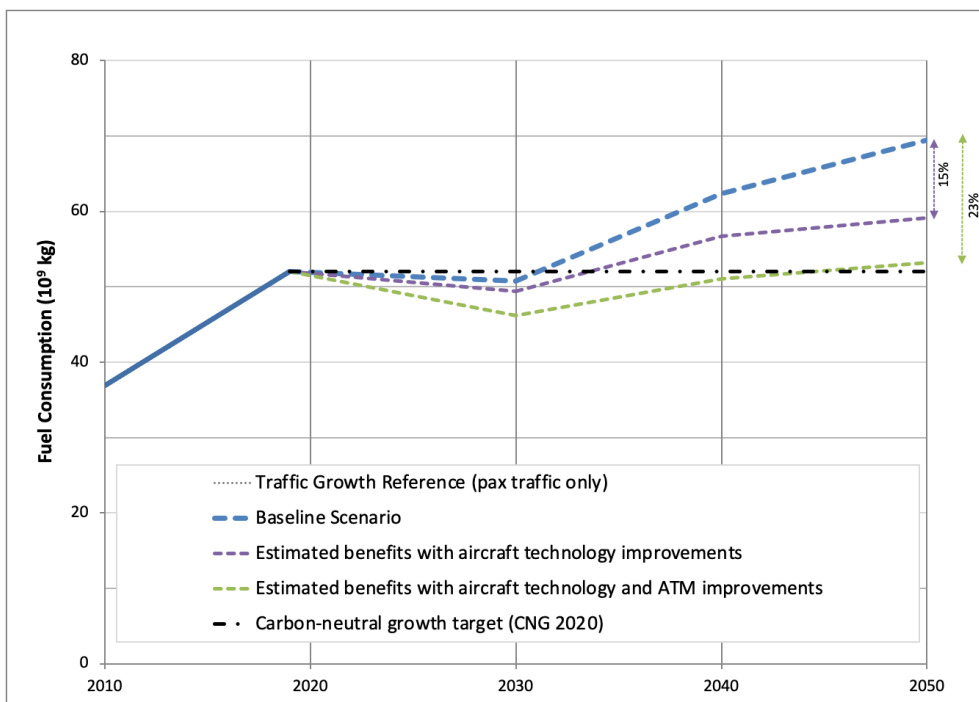
4th Edition – 2 June 2021

3.1 Executive summary

The European section of this action plan presents a summary of the actions taken collectively throughout the 44 States of the European Civil Aviation Conference (ECAC) to reduce CO₂ emissions from the aviation system and which are relevant for each State, and provides an assessment of their benefit against an ECAC baseline. It also provides a description of future measures aimed to provide additional CO₂ savings.

Aviation is a fundamental sector for 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 promoted the development of new technology, and innovations to better meet societies' needs and concerns, including addressing the sectorial 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 policy is aiming at accelerating the achievement of European ambitions regarding aviation and climate change.



Aircraft related technology

European members have actively contributed to support progress in the ICAO Committee on Aviation Environmental Protection (CAEP). This contribution of resources, analytical capability and co-leadership has facilitated leaps in global certification standards that have helped drive the markets demand for technology improvements. Europe is now fully committed on the implementation of the 2017 ICAO CO₂ standard for newly built aircraft and on the need to review it on a regular basis in light of developments in aeroplane fuel efficiency.

Environmental improvements across the ECAC States are knowledge-led and at the forefront of this is the Clean Sky EU Joint Undertaking that aims to develop and mature breakthrough "clean technologies". The second joint undertaking (Clean Sky 2 – 2014-

2024) has the objective to reduce aircraft emissions and noise by 20 to 30% with respect to the latest technologies entering into service in 2014. Under the Horizon Europe programme for research and innovation, the European Commission has proposed the set-up of a European Partnership for Clean Aviation (EPCA) which will follow in the footsteps of CleanSky2, recognizing and exploiting the interaction between environmental, social and competitiveness aspects of civil aviation, while maintaining sustainable economic growth. For such technology high end public-private partnerships to be successful, and thus, benefit from this and from future CO₂ action plans, securing the appropriate funding is key.

The main efforts under Clean Sky 2 include demonstrating technologies: for both large and regional passenger aircraft, improved performance and versatility of new rotorcraft concepts, innovative airframe structures and materials, radical engine architectures, systems and controls and consideration of how we manage aircraft at the end of their useful life. This represents a rich stream of ideas and concepts that, with continued support, will mature and contribute to achieving the goals on limiting global climate change. The new European Partnership for Clean Aviation (EPCA) has objectives in line with the European Green Deal goals to reach climate neutrality in 2050 and will focus on the development of disruptive technologies and maximum impact.

Sustainable Aviation Fuels (SAF)

ECAC States are embracing the introduction of sustainable aviation fuels (SAF) in line with the 2050 ICAO Vision and are taking collective actions to address the many current barriers for SAF widespread availability or use in European airports.

The European collective SAF measures included in this Action Plan focuses on its CO₂ reductions benefits. Nevertheless SAF has the additional benefit of reducing air pollutant emissions of non-volatile Particulate Matter (nvPM), which can provide important other non-CO₂ benefits on the climate which are not specifically assessed within the scope of this Plan.

At European Union (EU) level, the ReFuelEU Aviation regulatory initiative aims to boost the supply and demand for SAF at EU airports, while maintaining a level playing field in the air transport market. This initiative is expected to result in a legislative proposal in the course of 2021. The common European section of this action plan also provides an overview of the current sustainability and life cycle emissions requirements applicable to SAF in the European Union's States as well as estimates of life cycle values for a number of technological pathways and feedstock.

Collective work has also been developed through EASA on addressing barriers of SAF penetration into the market.

The European Research and Innovation programme is moreover giving impulse to innovative technologies to overcome such barriers as it is highlighted by the number of recent European research projects put in place and planned to start in the short-term.

Improved Air Traffic Management

The European Union's Single European Sky (SES) policy aims to transform Air Traffic Management (ATM) in Europe towards digital service provision, increased capacity reduced ATM costs with high level of safety and 10% less environmental impact. SES policy has several elements, one of which is developing and deploying innovative technical and operational ATM solutions.

SESAR 1 (from 2008 to 2016), SESAR 2020 (started in 2016) and SESAR 3 (starting in 2022) are the EU programmes for the development of SESAR solutions. The SESAR solutions already developed and validated are capable of providing: 21% more airspace capacity; 14% more airport capacity; a 40% reduction in accident risk; 2.8% less greenhouse emissions; and a 6% reduction in flight costs. Future ATM systems will be based on 'Trajectory-based Operations' and 'Performance-based Operations'.

Much of the research to develop these solutions is underway and published results of the many earlier demonstration actions confirm the challenge but give us confidence that the goals will be achieved in the ECAC region with widespread potential to be replicated in other regions.

Market Based Measures (MBMs)

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

ECAC States have always been strong supporters of a market-based measure scheme for international aviation to incentivise and reward good investment and operational choices, and so welcomed the agreement on CORSIA.

The 30 European Economic Area (EEA)¹¹ States in Europe have implemented the EU Emissions Trading System (ETS), including the aviation sector with around 500 aircraft operators participating in the cap-and-trade approach to limit CO₂ emissions. Subject to preserving the environmental integrity and effectiveness it is expected that the EU ETS legislation will continue to be adapted to implement CORSIA.

As a consequence of the linking agreement with Switzerland, from 2020 the EU ETS was extended to all departing flights from the EEA to Switzerland, and Switzerland applies its ETS to all departing flights to EEA airports, ensuring a level playing field on both directions of routes.

In accordance with the EU-UK Trade and Cooperation Agreement reached in December 2020, the EU ETS shall continue to apply to departing flights from the EEA to the UK, while a UK ETS will apply effective carbon pricing on flights departing from the UK to the EEA.

In the period 2013 to 2020, EU ETS has saved an estimated 200 million tonnes of intra-European aviation CO₂ emissions.

ECAC Scenarios for Traffic and CO₂ Emissions

The scenarios presented in this common section of State Action Plans of ECAC States take into account the impacts of the COVID-19 crisis on air transport, to the extent possible, and with some unavoidable degree of uncertainty. The best-available data used for the purposes of this action plan has been taken from EUROCONTROL's regular publication of comprehensive assessments of the latest traffic situation in Europe.

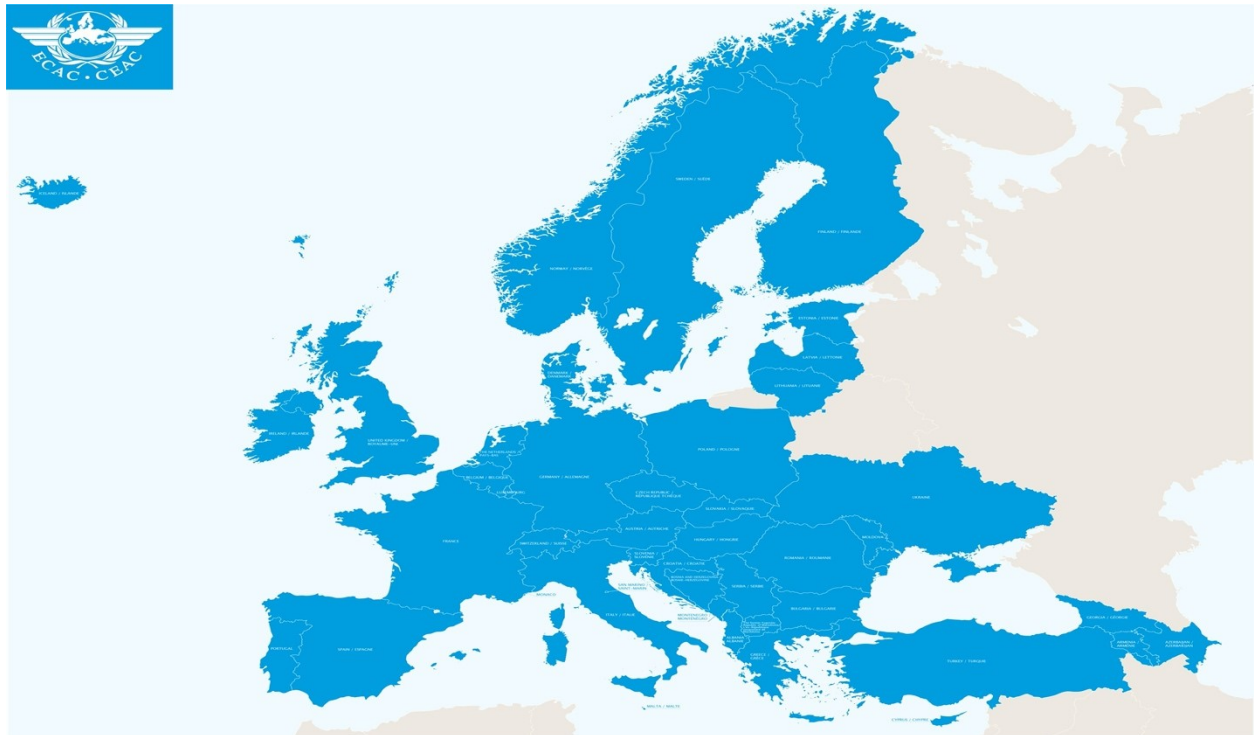
Despite the current extraordinary global decay on passengers' traffic due to the COVID-19 pandemic, hitting European economy, tourism and the sector itself, aviation is expected to continue to grow in the long-term, develop and diversify in many ways across the ECAC States. Air cargo traffic has not been 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.

The analysis by EUROCONTROL and EASA have identified the most likely scenario of influences on future traffic and modelled these assumptions out to future years. On the basis of this traffic forecast, fuel consumption and CO₂ emissions of aviation have been estimated for both a theoretical baseline scenario (without any additional mitigation action) and a scenario with estimated benefits from mitigation measures implemented since 2019 or provided benefits beyond 2019 that are presented in this action plan.

¹¹ The EEA includes EU countries and also Iceland, Liechtenstein and Norway.

Under the baseline assumptions of traffic growth and fleet rollover with 2019 technology, CO₂ emissions would significantly grow in the long-term for flights departing from ECAC airports without mitigation measures. Modelling the impact of improved aircraft technology for the scenario with implemented measures indicates an overall 15% reduction of fuel consumption and CO₂ 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 CO₂ emissions, including the effects of new aircraft types and ATM-related measures, are projected to improve to lead to a 23% reduction in 2050 compared to the baseline.

In the common section of this action plan the potential of sustainable aviation fuels and the effects of market-based measures have not been simulated in detail. Notably, CORSIA being a global measure, and not a European measure, the assessments of its benefits were not considered required for the purposes of the State Action Plans. But they should both help reach the ICAO carbon-neutral growth 2020 goal. As further developments in policy and technology are made, further analysis will improve the modelling of future emissions.



3.2 **A: ECAC BASELINE SCENARIO AND ESTIMATED BENEFITS OF IMPLEMENTED MEASURES**

3.2.1 ECAC Baseline Scenario

The baseline scenario is intended to serve as a reference scenario for CO₂ 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) 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 CO₂ emissions.

The sets of forecasts correspond to projected traffic volumes in a scenario of “Regulation and Growth”, while corresponding fuel consumption and CO₂ emissions assume the technology level of the year 2019 (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 “Regulation and Growth”

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 long-term forecast¹² was published in June 2018 and inspects traffic development in terms of Instrument Flight Rule (IFR) movements to 2040.

In the latter, the scenario called ‘Regulation and Growth’ is constructed as the ‘most likely’ or ‘baseline’ scenario for traffic, most closely following the current trends¹³. It considers a moderate economic growth, with some regulation particularly regarding the social and economic demands.

Amongst the models applied by EUROCONTROL for the forecast, the passenger traffic sub-model is the most developed and is structured around five main group 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.
- 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** describes size of aircraft used to satisfy the passenger demand (modelled via the Aircraft Assignment Tool).

Table 1 below presents a summary of the social, economic and air traffic related characteristics of three different scenarios developed by EUROCONTROL. The year 2016 served as the baseline year of the 20-year forecast results¹² (published in 2018 by EUROCONTROL). Historical data for the year 2019 are also shown later for reference.

¹² [Challenges of Growth - Annex 1 - Flight Forecast to 2040, EUROCONTROL, September 2018.](#)

¹³ Prior to COVID-19 outbreak.

Table 1. Summary characteristics of EUROCONTROL scenarios.

	<i>Global Growth</i>	<i>Regulation and Growth</i>	<i>Fragmenting World</i>
2023 traffic growth	High ↗	Base →	Low ↘
Passenger			
Demographics (Population)	Ageing UN Medium-fertility variant	Ageing UN Medium-fertility variant	Ageing UN Zero-migration variant
Routes and Destinations	Long-haul ↗	No Change →	Long-haul ↘
Open Skies	EU enlargement later +Far & Middle East	EU enlargement Earliest	EU enlargement Latest
High-speed rail (new & improved connections)	20 city-pairs faster implementation	20 city-pairs	20 city-pairs later implementation.
Economic conditions			
GDP growth	Stronger ↗	Moderate →	Weaker ↘↘
EU Enlargement	+5 States, Later	+5 States, Earliest	+5 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	Lowest	Highest
Price of oil/barrel	Low	Lowest	High
Change in other charges	Noise: ↗ Security: ↘	Noise: ↗ Security: →	Noise: → Security: ↗
Structure			
Network	Hubs: Mid-East ↗↗ Europe ↘ Turkey ↗ Point-to-point: N-Atlantic. ↗↗	Hubs: Mid-East ↗↗ Europe & Turkey ↗ Point-to-point: N-Atlantic. ↗	No change →
Market Structure	Industry fleet forecast + STATFOR assumptions	Industry fleet forecast + STATFOR assumptions	Industry fleet forecast + STATFOR assumptions

COVID-19 impact and extension to 2050

Since the start of 2020, COVID-19 has gone from a localised outbreak in China to the most severe global pandemic in a century. No part of European aviation is untouched by the human tragedy or the business crisis. This unprecedented crisis hindered air traffic growth in 2020: flight movements declined by 55% compared to 2019 at ECAC level. It continues to disrupt the traffic growth and patterns in Europe in 2021. In Autumn 2020, EUROCONTROL published a medium-term forecast¹⁴ to 2024, taking into account the impact of the COVID-19 outbreak. The latter is based on three different scenarios depending on how soon an effective vaccine would be made widely available to (air) travellers. Other factors have been included amongst which the economic impact of the crisis or levels of public confidence, to name a few. The Scenario 2: vaccine widely made available for travellers by Summer 2022, considered as the most likely, sees ECAC flights only reaching 92% of their 2019 levels in 2024.

In order to take into account the COVID-19 impact and to extend the horizon to 2050, the following adaptations have been brought to the original long-term forecast¹². Considering the most-likely scenarios of the long-term forecast¹² and the medium-term forecasted version of the long-term flight forecast has been derived:

- a) Replace the long-term forecast¹² horizon by the most recent medium-term forecast¹⁴ to account for COVID impact;
- b) Update the rest of the horizon (2025-2040) assuming that the original growth rates of the long-term forecast¹², would remain similar to those calculated pre-COVID-19; and
- c) Extrapolate the final years (2040-2050) considering the same average annual growth rates as the one forecasted for the 2035-2040 period, but with a 0.9 decay¹⁵.

The method used relies on the calculation of adjustment factors at STATFOR¹⁶ region-pair level and have been applied to the original long-term forecast¹². Adjusting the baseline enables to further elaborate the baseline scenario as forecasted future fuel consumption and to 2030, 2040 and 2050, in the absence of action.

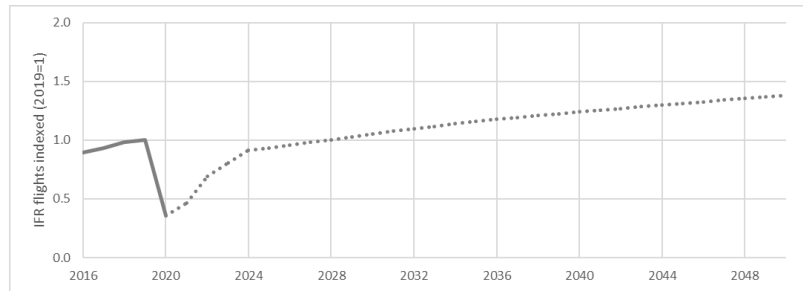
Figure 1 below shows the ECAC scenario of the passenger flight forecasted international departures for both historical (solid line) and future (dashed line) years.

¹⁴ Five-Year Forecast 2020-2024, IFR Movements, EUROCONTROL, November 2020.

¹⁵ As the number of flights has not been directly forecasted via the system but numerically extrapolated, it does not include any fleet renewal, neither network change (airport pairs) between 2040 and 2050. This factor is aimed at adjusting the extrapolation to capture the gradual maturity of the market.

¹⁶ STATFOR (Statistics and Forecast Service) provides statistics and forecasts on air traffic in Europe and to monitor and analyse the evolution of the Air Transport Industry.

Figure 1. Updated EUROCONTROL “Regulation and Growth” scenario of the passenger flight forecast for ECAC international departures including the COVID-19 impact in 2020 and the following 4 years.



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 departing¹⁷ from ECAC airports, as forecasted in the aforementioned traffic scenario. The number of passengers per flight is derived from Eurostat data.

EUROCONTROL also generates a number of 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 (ICAO¹⁸). 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 PRISME¹⁹ data warehouse used by EUROCONTROL, including the actual flight distance and the cruise altitude by airport pair. These calculations were made for about 99% of the passenger flights (the remaining flights had information missing in the flight plans). Determination of the fuel burn and CO₂ 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 CO₂ 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, with the aircraft technology level of each year.

Forecast years (until 2050) fuel burn and modelling calculations use the 2019 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 CO₂ emissions of the baseline scenario for forecast years uses the technology level of 2019.

For each reported year, the revenue per passenger kilometre (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 passenger estimation data sets (Scheduled, Low-cost, Non-Scheduled flights, available passenger information, etc.) these results are determined for about 99% of the historical

¹⁷ 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.

¹⁸ ICAO Long-Term Traffic Forecasts, Passenger and Cargo, July 2016. Cargo forecasts have not been updated as new ICAO forecast including COVID-19 effects will be made available after the end of June 2021, so those cannot be considered in this action plan common section.

¹⁹ PRISME is the name of the EUROCONTROL data warehouse hosting the flight plans, fleet and airframe data.

passenger traffic, and 97% of the passenger flight forecasts. From the RPK values, the passenger flights RTK were calculated as the number of tonnes carried by kilometers, assuming that 1 passenger corresponds to 0.1 tonne.

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. Here, the RPK and fuel efficiency results corresponds to the aggregation of these values for the whole concerned traffic years.

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 CO₂ emissions of European aviation in the absence of mitigation actions.

Table 2. Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres ²⁰ RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported ²¹ FTKT (billion)	Total Revenue Tonne Kilometres ²² RTK (billion)
2010	4.56	1,114	0.198	45.4	156.8
2019	5.95	1,856	0.203	49.0	234.6
2030	5.98	1,993	0.348	63.8	263.1
2040	7.22	2,446	0.450	79.4	324.0
2050	8.07	2,745	0.572	101.6	376.1

Table 3. Fuel burn and CO₂ emissions forecast for the baseline scenario

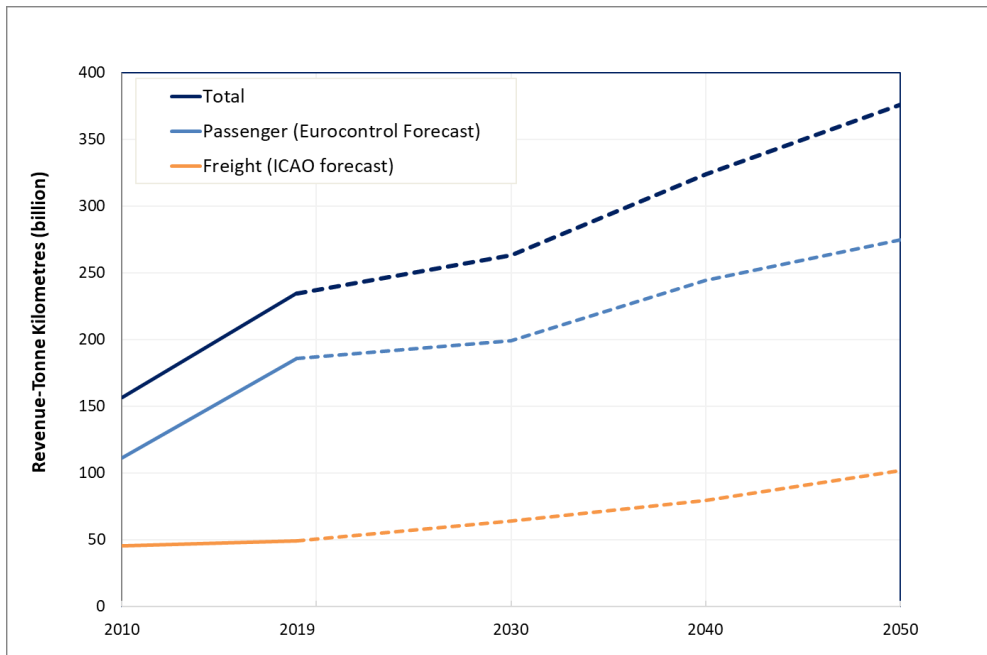
Year	Fuel Consumption (10 ⁹ kg)	CO ₂ emissions (10 ⁹ kg)	Fuel efficiency (kg/RPK ²⁰)	Fuel efficiency (kg/RTK ²²)
2010	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280
2030	50.72	160.29	0.0252	0.252
2040	62.38	197.13	0.0252	0.252
2050	69.42	219.35	0.0250	0.250
<i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i>				

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

²⁰ Calculated on the basis of Great Circle Distance (GCD) between airports, for 97% of the passenger traffic for forecast years.

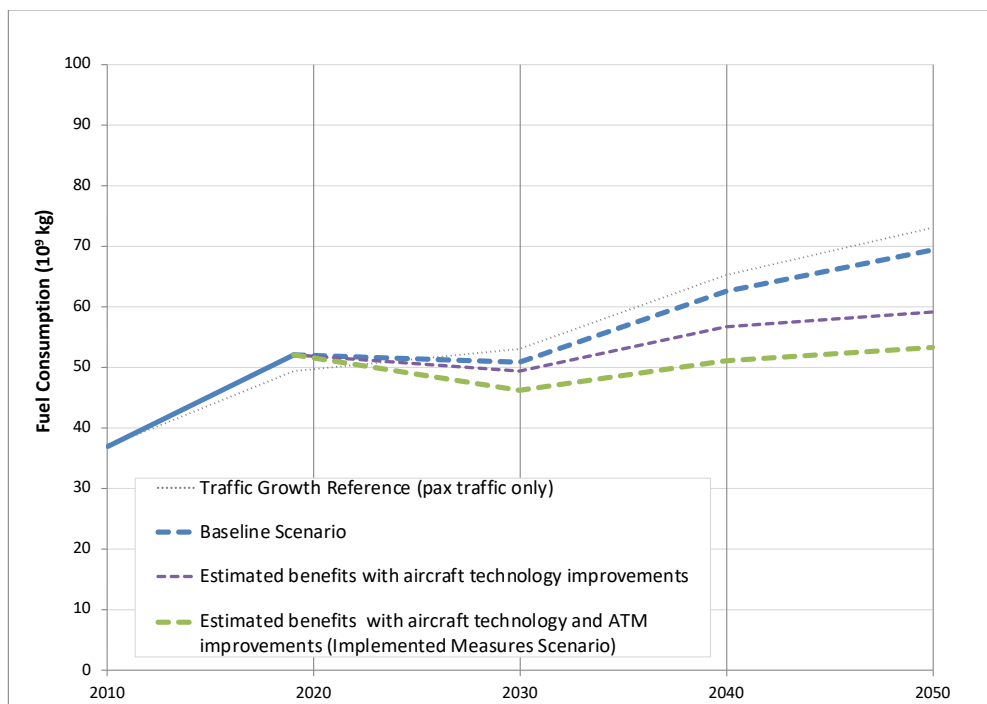
²¹ Includes passenger and freight transport (on all-cargo and passenger flights).

²² A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).



The impact of the COVID-19 in 2020 is not fully reflected in Figure 2, as this representation is oversimplified through a straight line between 2019 and 2030. The same remark applies for Figure 3 and Figure 4.

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



3.2.2 ECAC Scenario with Implemented Measures: Estimated Benefits

In order to improve the 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 effects of mitigation actions are presented here, based on modelling results by EUROCONTROL and 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 'Regulation and Growth' 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 CO₂ 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 new aircraft types of the latest generation (e.g. Airbus A320NEO, Boeing 737MAX, Airbus A350XWB etc.). The simulated future fleet of aircraft has been generated using the Aircraft Assignment Tool²³ (AAT) 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. In addition to the fleet rollover, a constant annual improvement of fuel efficiency of 1.16% per annum is assumed for each aircraft type with entry into service from 2020 onwards. This rate of improvement corresponds to the 'Advanced' fuel technology scenario used by CAEP to generate the fuel trends for the Assembly. This technology improvement modelling is applied to the years 2030 and 2040. For the year 2050, as the forecast traffic reuses exactly the fleet of the year 2040, the technological improvement is determined with the extrapolation of the fuel burn ratio between the baseline scenario and the technological improvement scenario results of the years 2030 to 2040.

The effects of **improved ATM efficiency** are captured in the Implemented Measures Scenario on the basis of efficiency analyses from the SESAR project. In SESAR, a value of 5,280 kg of fuel per flight for ECAC (including oceanic region) is used as a baseline²⁴. Based on the information provided by the PAGAR 2019 document²⁵, and compared to a 2012 baseline, the benefits at the end of Wave 1 could be about 3% CO₂/fuel savings achieved by 2025 equivalent to 147.4 kg of fuel/flight. So far, the target for Wave 2 remains at about 7% more CO₂/fuel savings (352.6 kg of fuel) to reach the initial Ambition target of about 10% CO₂/fuel savings (500 kg fuel) per flight by 2035. The 2030 efficiency improvement is calculated by assuming a linear evolution between 2025 and 2035. As beyond 2035, there is no SESAR Ambition yet, it is assumed that the ATM efficiency improvements are reported extensively for years 2040 and 2050.

The as yet un-estimated benefits of Exploratory Research projects²⁶ are expected to increase the overall future fuel savings.

While the effects of **introduction of Sustainable Aviation Fuels (SAF)** were modelled in previous updates on the basis of the European ACARE goals²⁷, the expected SAF supply objectives for 2020 were not met, and in the current update the SAF benefits have not been modelled as a European common measure in the implemented measures scenario. However, numerous initiatives related to SAF (e.g. ReFuelEU Aviation) are largely described in Section B chapter 2 and it is expected that future updates will include an assessment of its benefits as a collective measure.

²³ <https://www.easa.europa.eu/domains/environment/impact-assessment-tools>

²⁴ See SESAR ATM Master Plan – Edition 2020 (www.atmmasterplan.eu) – eATM.

²⁵ See SESAR Performance Assessment Gap Analysis Report (PAGAR) updated version of 2019 v00.01.04, 31-03-2021.

²⁶ See SESAR Exploratory Research projects - <https://www.sesarju.eu/exploratoryresearch>

²⁷ <https://www.acare4europe.org/sria/flightpath-2050-goals/protecting-environment-and-energy-supply-0>

Effects on aviation's CO₂ emissions of **market-based measures** including the EU Emissions Trading System (ETS) with the linked Swiss ETS, the UK ETS and the ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) have not been modelled in the top-down assessment of the implemented measures scenario presented here as, at the time of the submission of this action plan, a legislative proposal for the revision of the EU ETS Directive concerning aviation, is under development to complete the implementation of CORSIA by the EU and to strengthen the ambition level of the EU ETS. CORSIA is not considered a European measure but a global one. It aims for carbon-neutral growth (CNG) of aviation as compared to the average of 2019 and 2020 levels of emissions in participating States, and an indication of a corresponding (hypothetical) target applied to Europe is shown in Figure 4²⁸, while recalling that this is just a reference level, given that CORSIA was designed to contribute to the CNG 2020 globally and not in individual States or regions.

Tables 4-6 and Figure 4 summarise the results for the scenario with implemented measures. It should be noted that **Table 4** show direct combustion emissions of CO₂ (assuming 3.16 kg CO₂ per kg fuel). More detailed tabulated results are found in Appendix A, including results expressed in equivalent CO₂ emissions on a well-to-wake basis (for comparison purposes of SAF benefits).

Table 4. Fuel burn and CO₂ emissions forecast for the Implemented Measures Scenario (new aircraft technology and ATM improvements only).

Year	Fuel Consumption (10 ⁹ kg)	CO ₂ emissions (10 ⁹ kg)	Fuel efficiency (kg/RPK ²⁹)	Fuel efficiency (kg/RTK ¹⁷)
2010	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280
2030	46.16	145.86	0.0229	0.229
2040	51.06	161.35	0.0206	0.206
2050	53.18	168.05	0.0192	0.192
2050 vs 2019			-32%	
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

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 (%)
2010-2019	-1.86%
2019-2030	-1.82%
2030-2040	-1.03%
2040-2050	-0.74%

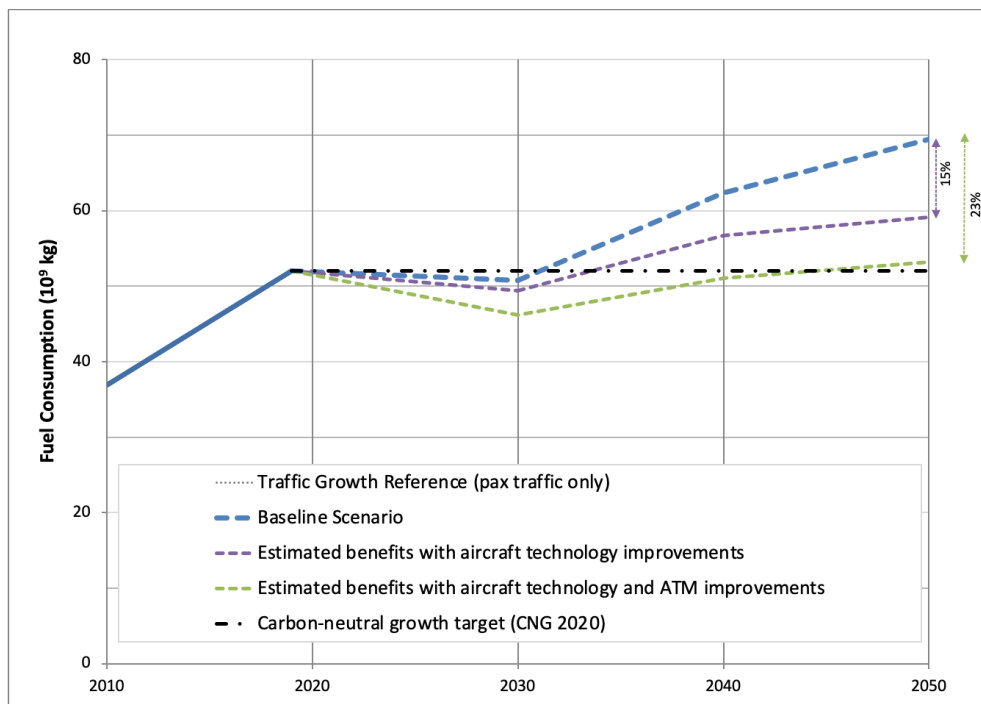
Table 6. CO₂ emissions forecast for the scenarios described in this chapter.

²⁸ 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).

²⁹ Calculated on the basis of Great Circle Distance (GCD) between airports, for 97% of the passenger traffic for forecast years.

Year	CO ₂ 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	116,78			NA
2019	164,35			NA
2030	160,3	156,0	145,9	-9%
2040	197,1	179,3	161,4	-18%
2050	219,4	186,7	168,0	-23%
For reasons of data availability, results shown in this table do not include cargo/freight traffic. Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.				

Figure 4. Fuel consumption forecast for the baseline and implemented measures scenarios.



As shown in Figure 4, the impact of improved aircraft technology indicates an overall 15% reduction of fuel consumption and CO₂ emissions in 2050 compared to the baseline scenario. Overall CO₂ emissions, including the effects of new aircraft types and ATM-related measures, are projected to improve to lead to a 23% reduction in 2050 compared to the baseline.

From Table 4, under the currently assumed aircraft technology and ATM improvement scenarios, the fuel efficiency is projected to lead to a 32% reduction from 2019 to 2050. Indeed, the annual rate of fuel efficiency improvement is expected to progressively slow down from a rate of 1.82% between 2019 and 2030 to a rate of 0.74% between 2040 and 2050. Aircraft technology and ATM improvements alone will not be sufficient to meet the post-2020 carbon neutral growth objective of ICAO. This confirms that additional action, particularly market-based measures and SAF, are required to fill the gap. There are among the ECAC Member States additional ambitious climate strategies where carbon neutrality by 2050 is set as the overall objective. The aviation sector will have to contribute to this objective.

3.3 B: Actions Taken Collectively in Europe



3.3.1 *TECHNOLOGY AND STANDARDS*

3.3.1.1 Aircraft emissions standards

European Member States fully support ICAO's Committee on Aviation Environmental Protection (CAEP) work on the development and update of aircraft emissions standards, in particular to the **ICAO Aircraft CO₂ Standard** adopted by ICAO in 2017. Europe significantly contributed to its development, notably through the European Aviation Safety Agency (EASA). It is fully committed to its implementation in Europe and the need to review the standard on a regular basis in light of developments in aeroplane fuel efficiency. EASA has supported the process to integrate this standard into European legislation (2018/1139) with an applicability date of 1 January 2020 for new aeroplane types.

ASSESSMENT

This is a European contribution to a global measure (CO₂ standard). Its contribution to the global aspirational goals are available in CAEP.

3.3.1.2 Research and development

Clean Sky³⁰ is an EU Joint Undertaking that aims to develop and mature breakthrough “clean technologies” for air transport globally. Joint Undertakings are Public Private Partnership set up by the European Union on the EU research programmes. By accelerating their deployment, the Joint Undertaking will contribute to Europe’s strategic environmental and social priorities, and simultaneously promote competitiveness and sustainable economic growth. The first Clean Sky Joint Undertaking (**Clean Sky 1** - 2011-2017) had a budget of €1.6 billion, equally shared between the European Commission and the aeronautics industry. It aimed to develop environmental-friendly technologies impacting all flying-segments of commercial aviation. The objectives were to reduce aircraft CO₂ emissions by 20-40%, NO_x by around 60% and noise by up to 10dB compared to year 2000 aircraft.

This was followed up with a second Joint Undertaking (**Clean Sky 2** – 2014-2024) with the objective to reduce aircraft emissions and noise by 20 to 30% with respect to the latest technologies entering into service in 2014. The current budget for the programme is approximately €4 billion.

The two Interim Evaluations of Clean Sky in 2011 and 2013 acknowledged that the programme is successfully stimulating developments towards environmental targets. These preliminary assessments confirm the capability of achieving the overall targets at completion of the programme.

Main remaining areas for Research and Technological Development (RTD) efforts under Clean Sky 2 were:

- **Large Passenger Aircraft:** demonstration of best technologies to achieve the environmental goals whilst fulfilling future market needs and improving the competitiveness of future products.
- **Regional Aircraft:** demonstrating and validating key technologies that will enable a 90-seat class turboprop aircraft to deliver breakthrough economic and environmental performance and a superior passenger experience.
- **Fast Rotorcraft:** demonstrating new rotorcraft concepts (tilt-rotor and compound helicopters) technologies to deliver superior vehicle versatility and performance.
- **Airframe:** demonstrating the benefits of advanced and innovative airframe structures (like a more efficient wing with natural laminar flow, optimised control surfaces, control systems and embedded systems, highly integrated in metallic and advanced composites structures). In addition, novel engine integration strategies and innovative fuselage structures will be investigated and tested.
- **Engines:** validating advanced and more radical engine architectures.
- **Systems:** demonstrating the advantages of applying new technologies in major areas such as power management, cockpit, wing, landing gear, to address the needs of a future generation of aircraft in terms of maturation, demonstration and Innovation.
- **Small Air Transport:** demonstrating the advantages of applying key technologies on small aircraft demonstrators to revitalise an important segment of the aeronautics sector that can bring new key mobility solutions.
- **Eco-Design:** coordinating research geared towards high eco-compliance in air vehicles over their product life and heightening the stewardship with intelligent Re-use, Recycling and advanced services.

³⁰ <http://www.cleansky.eu/>

In addition, the **Clean Sky Technology Evaluator**³¹ will continue to be upgraded to assess technological progress routinely and evaluate the performance potential of Clean Sky 2 technologies at both vehicle and aggregate levels (airports and air traffic systems).

3.3.1.3 Disruptive aircraft technological innovations: European Partnership for Clean Aviation

With the Horizon 2020 programme coming to a close in 2020, the Commission has adopted a proposal to set up a new Joint Undertaking under the Horizon Europe programme (2021-2027). The **European Partnership for Clean Aviation (EPCA)**³² will follow in the footsteps of CleanSky2. The EU contribution proposed is again €1.7 billion. The stakeholder community has already formulated a Strategic Research and Innovation Agenda (SRIA), which is intended to serve as a basis of the partnership once established. Subject to the final provisions of the partnership and the EU budget allocation, industry stakeholders have proposed a commitment of €3 billion from the private side.

General objectives of EPCA:

(a) To contribute to reduce the ecological footprint of aviation by accelerating the development of climate neutral aviation technologies for earliest possible deployment, therefore significantly contributing to the achievement of the general goals of the European Green Deal, in particular in relation to the reduction of Union-wide net greenhouse gas emissions reduction target of at least 55% by 2030, compared to 1990 levels and a pathway towards reaching climate neutrality by 2050.

(b) To ensure that aeronautics-related research and innovation activities contribute to the global sustainable competitiveness of the Union aviation industry, and to ensure that climate-neutral aviation technologies meet the relevant aviation safety requirements, and remains a secure, reliable, cost-effective, and efficient means of passenger and freight transportation.

Specific objectives:

(a) To integrate and demonstrate disruptive aircraft technological innovations able to decrease net emissions of greenhouse gasses by no less than 30% by 2030, compared to 2020 state-of-the-art technology while paving the ground towards climate-neutral aviation by 2050.

(b) To ensure that the technological and the potential industrial readiness of innovations can support the launch of disruptive new products and services by 2035, with the aim of replacing 75% of the operating fleet by 2050 and developing an innovative, reliable, safe and cost-effective European aviation system that is able to meet the objective of climate neutrality by 2050.

(c) To expand and foster integration of the climate-neutral aviation research and innovations value chains, including academia, research organisations, industry, and SMEs, also by benefitting from exploiting synergies with other national and European related programmes.

ASSESSMENT

The quantitative assessment of the technology improvement scenario from 2020 to 2050 has been calculated by EUROCONTROL and EASA and it is included in Section A above

³¹ <https://www.cleansky.eu/technology-evaluator-te>

³² <https://clean-aviation.eu/>

(ECAC Baseline Scenario and Estimated Benefits of Implemented Measures) and in Appendix A.

Table 7 Fuel consumption and CO₂ emissions of international passenger traffic departing from ECAC airports, with aircraft technology improvements after 2019 included:

Year	Fuel Consumption (10 ⁹ kg)	CO ₂ emissions (10 ⁹ kg)	Well-to-wake CO ₂ e emissions (10 ⁹ kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	36.95	116.78	143.38	0.0332	0.332
2019	52.01	164.35	201.80	0.0280	0.280
2030	49.37	156.00	191.54	0.0232	0.232
2040	56.74	179.28	220.13	0.0217	0.217
2050	59.09	186.72	229.26	0.0202	0.202
<i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i>					

Table 8 Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology only):

Period	Average annual fuel efficiency improvement (%)
2010-2019	-1.86%
2019-2030	-1.22%
2030-2040	-0.65%
2040-2050	-0.74%



3.3.2 SUSTAINABLE AVIATION FUELS

Sustainable aviation fuels (SAF) including advanced biofuels and synthetic fuels, have the potential to significantly reduce aircraft emissions and ECAC States are embracing their large-scale introduction in line with the 2050 ICAO Vision.

The European collective SAF measures included in this Action Plan focuses on its CO₂ reductions benefits. Nevertheless SAF has the additional benefit of reducing air pollutant emissions of non-volatile Particulate Matter (nvPM) with up to 90% and sulphur (SO_x) with 100%, compared to fossil jet fuel³³. As a result, the large-scale use of SAF can have important other non-CO₂ benefits on the climate which are not specifically assessed within the scope of this Plan.

3.3.2.1 ReFuelEU Aviation Initiative

On 15 January 2020, the European Parliament adopted a resolution on the European Green Deal in which it welcomed the upcoming strategy for sustainable and smart mobility and agreed with the European Commission that all modes of transport will have to contribute to the decarbonisation of the transport sector in line with the objective of reaching a climate-neutral economy. The European Parliament also called for *"a clear regulatory roadmap for the decarbonisation of aviation, based on technological solutions, infrastructure, requirements for sustainable alternative fuels and efficient operations, in combination with incentives for a modal shift"*.

The Commission's work programme for 2020 listed under the policy objective on Sustainable and smart mobility, a new legislative initiative entitled *"ReFuelEU Aviation – Sustainable Aviation Fuels"*.

This initiative aims to boost the supply and demand for sustainable aviation fuels (SAF) in the EU including not only advanced biofuels but also synthetic fuels. This in turn will reduce aviation's environmental footprint and enable it to help achieve the EU's climate targets.

³³ [ICAO 2016 Environmental Report](#), Chapter 4, Page 162, Figure 4.

The EU aviation internal market is a key enabler of connectivity and growth but is also accountable for significant environmental impact. In line with the EU's climate goals to reduce emissions by 55% by 2030 and to achieve carbon neutrality by 2050, the aviation sector needs to decarbonise.

While several policy measures are in place, significant potential for emissions savings could come from the use of SAF, i.e. liquid drop-in fuels replacing fossil kerosene. However, currently only around 0.05% of total aviation fuels used in the EU are sustainable.

The ReFuelEU Aviation initiative aims to maintain a competitive air transport sector while increasing the share of SAF used by airlines. The European Commission aims to propose in spring 2021 a Regulation imposing increasing shares of SAF to be blended with conventional fuel. This could result in important emission savings for the sector, given that some of those fuels (e.g. synthetic fuels) have the potential to save up to 85% or more of emissions compared to fossil fuels, over their total lifecycle.

ASSESSMENT

A meaningful deployment of SAF in the aviation market will lead to a net decrease of the air transport sector's CO₂ emissions. SAF can achieve as high as 85% or more emissions savings compared to conventional jet fuel, and therefore, if deployed at a large scale, have important potential to help aviation contribute to EU reaching its climate targets.

At the time of the submission of this action plan the legislative proposal under the ReFuelEU Aviation initiative, as well as its supporting impact assessment, were not yet adopted. As a result, the assessment of the benefits provided by this collective European measure in terms of reduction in aviation emissions is expected to be included in a future update of the common section of this action plan.

3.3.2.2 Addressing barriers of SAF penetration into the market

SAF are considered to be a critical element in the basket of measures to mitigate aviation's contribution to climate change in the short-term using the existing global fleet.

However, the use of SAF has remained negligible up to now despite previous policy initiatives such as the [European Advanced Biofuels Flightpath](#), as there are still significant barriers for its large-scale deployment.

The [European Aviation Environmental Report \(EAER\)](#) published in January 2019, identified a lack of information at European level on the supply and use of SAF within Europe. [EASA](#) completed two studies in 2019 to address the lack of SAF monitoring in the EU.

3.3.2.3 Sustainable Aviation Fuel 'Facilitation Initiative'

The first study, addressing the barriers of SAF penetration into the market, examines how to incentivise the approval and use of SAF as drop-in fuels in Europe by introducing a SAF Facilitation Initiative.

The remaining significant industrial and economic barriers limit the penetration of SAF into the aviation sector. To reduce the costs and risk that economic operators face in bringing SAF to the aviation market, this study examined how to incentivise the approval and use of SAF as drop-in fuels in Europe by introducing a SAF Facilitation Initiative.

The report begins by analysing the status of SAFs in Europe today, including both more established technologies and ones at a lower Technology Readiness Level (TRL). It reviews one of the major solutions to the obstacle of navigating the SAF approval process, namely the US Clearing House run by the University of Dayton Research Institute and funded by the Federal Aviation Administration (FAA). The issue of sustainability is also examined, via an analysis of the role of Sustainability Certification Schemes (SCS) and how they interact

with regulatory sustainability requirements, particularly those in the EU's Renewable Energy Directive (RED II) and ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

Through interviews with a wide range of stakeholders the best form of European facilitation initiative has been identified. This study recommends that such an initiative be divided into two separate bodies, the first acting as an EU Clearing House and the second acting as a Stakeholder Forum.

The report is available at EASA's website: '[Sustainable Aviation Fuel 'Facilitation Initiative'](#)'.

3.3.2.4 Sustainable Aviation Fuel 'Monitoring System'

In response to a lack of information at the EU level on the supply and use of SAF within Europe identified by the [European Aviation Environmental Report](#), EASA launched a second study to identify a cost effective, robust data stream to monitor the use and supply of SAF, as well as the associated emissions reductions. This included identifying and recommending performance indicators related to the use of SAF in Europe, as well as the associated aviation CO₂ emissions reductions achieved.

The study followed five steps:

1. Identification of possible performance indicators by reviewing the current 'state of the art' SAF indicators and consultation with key stakeholders.
2. Identification of regulatory reporting requirements, and other possible sources of datasets and information streams in the European context, with the potential to cover the data needs of the proposed performance indicators.
3. Examination of sustainability requirements applicable to SAF, and potential savings in greenhouse gas (GHG) emissions compared to fossil-based fuels.
4. Review of SAF use today and future expectations for SAF use within Europe.
5. Definition of a future monitoring and reporting process on SAF use in Europe and related recommendations to implement it.

The results will be used as a basis for subsequent work to include SAF performance indicators in future EAERs, which will provide insight into the market penetration of SAF over time in order to assess the success of policy measures to incentivize uptake.

The report is available at EASA's website: '[Sustainable Aviation Fuel 'Monitoring System'](#)'.

ASSESSMENT

While these studies are expected to contribute to addressing barriers of SAF penetration into the market, its inclusion is for information purposes and the assessment of its benefits in terms of reduction in aviation emissions is not provided in the present action plan.

3.3.2.5 Standards and requirements for SAF

European Union standards applicable to SAF supply

Within the European Union there are currently applicable standards for renewable energy supply in the transportation sector, which are included in the revised Renewable Energy Directive (RED II) that entered into force in December 2018 ([Directive 2018/2001/EU](#)).

It aims at promoting the use of energy from renewable sources, establishing mandatory targets to be achieved by 2030 for a 30% overall share of renewable energy in the EU and a minimum of 14% share for renewable energy in the transport sector, including for aviation but without mandatory SAF supply targets.

Sustainability and life cycle emissions methodologies:

Sustainability criteria and life cycle emissions methodologies have been established for all transport renewable fuels supplied within the EU to be counted towards the targets, which are fully applicable to SAF supply.

These can be found in RED's³⁴ Article 17, *Sustainability criteria for biofuels and bioliquids*. Those requirements remain applicable on the revised RED II (Directive (EU) 2018/2001)³⁸, Article 29 *Sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels* paragraphs 2 to 7, although the RED II introduces some new specific criteria for forestry feedstocks.

Transport renewable fuels (thus, including SAF) produced in installations starting operation from 1 January 2021 must achieve 65% GHG emissions savings with respect to a fossil fuel comparator for transportation fuels of 94 g CO₂eq/MJ. In the case of transport renewable fuels of non-biological origin³⁵, the threshold is raised to 70% GHG emissions savings.

To help economic operators to declare the GHG emission savings of their products, default and typical values for a number of specific pathways are listed in the RED II Annex V (for liquid biofuels). The European Commission can revise and update the default values of GHG emissions when technological developments make it necessary.

Economic operators have the option to either use default GHG intensity values provided in RED II (Parts A & B of Annex V) so as to estimate GHG emissions savings for some or all of the steps of a specific biofuel production process, or to calculate "actual values" for their pathway in accordance with the RED methodology laid down in Part C of Annex V;

In the case of non-bio based fuels, a specific methodology is currently under development to be issued in 2021.

ICAO standards applicable to SAF supply

Europe is actively contributing to the development of the ICAO CORSIA Standards and Recommended Practices (SARPs), through the ICAO Committee on Aviation and Environmental Protection (CAEP), establishing global Sustainability Requirements applicable to SAF as well as to the CORSIA Methodology for Calculating Actual Life Cycle Emissions Values and to the calculation of CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels; CORSIA standards are applicable to any SAF use to be claimed under CORSIA in order to reduce offsetting obligations by aeroplane operators.

ASSESSMENT

The inclusion of European requirements for SAF respond to ICAO Guidance (Doc 9988) request (Para. 4.2.14) to provide estimates of the actual life cycle emissions of the SAF which are being used or planned to deploy and the methodology used for the life cycle analysis. It is therefore provided for information purposes only and no further assessment of its benefits in terms of reduction in aviation emissions is provided in this action plan common section.

³⁴ Directive 2009/28/EC.

³⁵ In the case of renewable fuels of non-biological origin, two types are considered: a) Renewable liquid and gaseous transport fuels of non-biological origin (including categories commonly referred as Power to Liquid - PtL-, Electro-fuels and Synthetic fuels). b) Waste gases, which are under the category of REcycled FUEL from NON-BIOlogical origin (also known as REFUNIOBIO).

3.3.2.6 Research and Development projects on SAF

European Advanced Biofuels Flightpath

An updated and renewed approach to the 2011 Biofuels FlightPath Initiative³⁶, was required to further impulse its implementation. As a result, the European Commission launched in 2016 the [new Biofuels FlightPath](#) to take into account recent evolutions and to tackle the current barriers identified for the deployment of SAF.

The Biofuels FlightPath was managed by its Core Team, which consists of representatives from Airbus, Air France, KLM, IAG, IATA, BiojetMap, SkyNRG and Lufthansa from the aviation side and Mossi Ghisolfi, Neste, Honeywell-UOP, Total and Swedish Biofuels on the biofuel producers' side.

A dedicated executive team, formed by SENASA, ONERA, Transport & Mobility Leuven and Wageningen UR, coordinated for three years the stakeholder's strategy in the field of aviation by supporting the activities of the Core Team and providing sound recommendations to the European Commission.

A number of communications and studies were delivered and are available³⁷.

The project was concluded with a Stakeholders conference in Brussels on 27 November 2019, and the publication of a [report](#) summarizing its outcomes.

Projects funded under the European Union's Horizon 2020 research and innovation programme

Since 2016, seven new projects have been funded by the Horizon 2020, which is the biggest Research and Innovation program of the EU.

BIO4A³⁸: The "Advanced Sustainable Biofuels for Aviation» project plan to demonstrate the first large industrial-scale production and use of SAF in Europe obtained from residual lipids such as Used Cooking Oil.

The project will also investigate the supply of sustainable feedstocks produced from drought-resistant crops such as Camelina, grown on marginal land in EU Mediterranean areas. By adopting a combination of biochar and other soil amendments, it will be possible to increase the fertility of the soil and its resilience to climate change, while at the same time storing fixed carbon into the soil.

BIO4A will also test the use of SAF across the entire logistic chain at industrial scale and under market conditions, and it will finally assess the environmental and socio-economic sustainability performance of the whole value chain.

Started in May 2018, BIO4A will last until 2022, and it is carried out by a consortium of seven partners from five European countries.

KEROGREEN³⁹: *Production of sustainable aircraft grade kerosene from water and air powered by renewable electricity, through the splitting of CO₂, syngas formation and*

³⁶ In June 2011 the European Commission, in close coordination with Airbus, leading European airlines (Lufthansa, Air France/KLM, & British Airways) and key European biofuel producers (Choren Industries, Neste Oil, Biomass Technology Group and UOP), launched the **European Advanced Biofuels Flight-path**. This industry-wide initiative aimed to speed up the commercialisation of aviation biofuels in Europe, with an initial objective of achieving the commercialisation of 2 million tonnes of SAF by 2020, target that was not reached due to the commercial challenges of SAF large-scale supply.
https://ec.europa.eu/energy/sites/ener/files/20130911_a_performing_biofuels_supply_chain.pdf

³⁷ <https://www.biofuelsflightpath.eu/ressources>

³⁸ www.bio4a.eu

³⁹ www.kerogreen.eu

Fischer-Tropsch synthesis (KEROGREEN), is a Research and Innovation Action (RIA) carried out by six partners from four European countries aiming at the development and testing of an innovative conversion route for the production of SAF from water and air powered by renewable electricity.

The new approach and process of KEROGREEN reduces overall CO₂ emission by creating a closed carbon fuel cycle and at the same time creates long-term large-scale energy storage capacity which will strengthen the EU energy security and allow creation of a sustainable transportation sector.

The KEROGREEN project expected duration is from April 2018 to March 2022.

FlexJET⁴⁰: *Sustainable Jet Fuel from Flexible Waste Biomass* (flexJET) is a four-year project targeting diversifying the feedstock for SAF beyond vegetable oils and fats to biocrude oil produced from a wide range of organic waste. This is also one of the first technologies to use green hydrogen from the processed waste feedstock for the downstream refining process thereby maximising greenhouse gas savings.

The project aims at building a demonstration plant for a 12 t/day use of food & market waste and 4000 l/day of Used Cooking Oil (UCO), produce hydrogen for refining through separation from syngas based on Pressure Swing Absorption technology, and finally deliver 1200 tons of SAF (ASTM D7566 Annex 2) for commercial flights to British Airways.

The consortium with 13 partner organisations has brought together some of the leading researchers, industrial technology providers and renewable energy experts from across Europe. The project has a total duration of 48 months from April 2018 to March 2022.

BioSFerA⁴¹: The *Biofuels production from Syngas Fermentation for Aviation and maritime use* (BioSFerA) project, aims to validate a combined thermochemical - biochemical pathway to develop cost-effective interdisciplinary technology to produce sustainable aviation and maritime fuels. At the end of the project next generation aviation and maritime biofuels, completely derived from second generation biomass, will be produced and validated by industrial partners at pilot scale. The project will undertake a full value chain evaluation that will result in a final analysis to define a pathway for the market introduction of the project concept. Some crosscutting evaluations carried out on all tested and validated processes will complete the results of the project from an economic, environmental and social point of view.

The project is carried out by a consortium of 11 partners from 6 European countries and its expected duration is from 1 April 2020 to 31 March 2024.

BL2F⁴²: The *Black Liquor to Fuel* (BL2F) project will use "Black Liquor" to create a clean, high-quality biofuel. Black liquor is a side-stream of the chemical pulping industry that can be transformed into fuel, reducing waste and providing an alternative to fossil fuels. Launched in April 2020, BL2F will develop a first-of-its-kind Integrated "Hydrothermal Liquefaction" (HTL) process at pulp mills, decreasing carbon emissions during the creation of the fuel intermediate. This will then be further upgraded at oil refineries to bring it closer to the final products and provide a feedstock for marine and aviation fuels.

BL2F aims to contribute to a reduction of 83% CO₂ emitted compared to fossil fuels. A large deployment of the processes developed by BL2F, using a variety of biomass, could yield more than 50 billion litres of advanced biofuels by 2050.

The project brings together 12 partners from 8 countries around Europe and its expected duration is from 1 April 2020 till 31 March 2023.

⁴⁰ www.flexjetproject.eu

⁴¹ <https://biosfera-project.eu>

⁴² <https://www.bl2f.eu>

FLITE⁴³: The *Fuel via Low Carbon Integrated Technology from Ethanol* (FLITE) consortium proposes to expand the supply of low carbon jet fuel in Europe by designing, building, and demonstrating an innovative ethanol-based Alcohol-to-Jet (ATJ) technology in an ATJ Advanced Production Unit (ATJ-APU). The ATJ-APU will produce jet blend stocks from non-food/non-feed ethanol with over 70% GHG reductions relative to conventional jet. The Project will demonstrate over 1000 hours of operations and production of over 30,000 metric tonnes of Sustainable Aviation Fuel.

The diversity of ethanol sources offers the potential to produce cost competitive SAF, accelerating uptake by commercial airlines and paving the way for implementation.

The project is carried out by a consortium of five partners from six European countries and its expected duration is from 1 December 2020 till 30 November 2024.

TAKE-OFF⁴⁴: Is an industrially driven project aiming to be a game-changer in the cost-effective production of SAF from CO₂ and hydrogen. The unique TAKE-OFF technology is based on conversion of CO₂ and H₂ to SAF via ethylene as intermediate. Its industrial partners will team up with research groups to deliver a highly innovative process which produces SAF at lower costs, higher energy efficiency and higher carbon efficiency to the crude jet fuel product than the current benchmark Fischer-Tropsch process. TAKE-OFF's key industrial players should allow the demonstration of the full technology chain, utilising industrial captured CO₂ and electrolytically produced hydrogen. The demonstration activities will provide valuable data for comprehensive technical and economic and environmental analyses with an outlook on Chemical Factories of the Future.

The project is carried out by a consortium of nine partners from five European countries and its expected duration is from 1 January 2021 till 24 December 2024.

ASSESSMENT

This information on SAF European Research and Development projects are included in this common section of the action plan to complement the information on Sustainable Aviation Fuels measures and to inform on collective European efforts. No further quantitative assessment of the benefits of this collective European measure in terms of reduction in aviation emissions is provided in the common section of this action plan.

⁴³ <https://cordis.europa.eu/project/id/857839>

⁴⁴ <https://cordis.europa.eu/project/id/101006799>



3.3.3 OPERATIONAL IMPROVEMENTS

3.3.3.1 The EU's Single European Sky Initiative and SESAR

SESAR Project SES and SESAR

The European Union's Single European Sky (SES) policy aims to reform Air Traffic Management (ATM) in Europe in order to enhance its performance in terms of its capacity to manage variable volumes of flights in a safer, more cost-efficient and environmentally friendly manner.

The SESAR (*Single European Sky ATM Research*) programme addresses the technological dimension of the single European sky, aiming in particular to deploy a modern, interoperable and high-performing ATM infrastructure in Europe.

SESAR contributes to the Single Sky's performance targets by defining, validating and deploying innovative technological and operational solutions for managing air traffic in a more efficient manner. SESAR coordinates and concentrates all EU research and development (RTD) activities in ATM.

SESAR is fully aligned with the Union's objectives of a sustainable and digitalised mobility and is projected towards their progressive achievement over the next decade. To implement the SESAR project, the Commission has set up with the industry, an innovation cycle comprising three interrelated phases: definition, development and deployment. These phases are driven by partnerships (SESAR Joint Undertaking and SESAR Deployment Manager) involving all categories of ATM/aviation stakeholders.

Guided by the European ATM Master Plan, the SESAR Joint Undertaking (SJU) is responsible for defining, developing, validating and delivering technical and operation solutions to modernise Europe's ATM system and deliver benefits to Europe and its citizens. The SESAR JU research programme is developed over successive phases, SESAR 1 (from 2008 to 2016) and SESAR 2020 (started in 2016) and SESAR 3 (starting in 2022). It is delivering SESAR solutions in four key areas, namely airport operations, network operations, air traffic services and technology enablers.

The SESAR contribution to the SES high-level goals set by the Commission are continuously reviewed by the SESAR JU and are kept up to date in the ATM Master Plan.

SESAR and the European Green Deal objectives







The European Green Deal launched by the European Commission in December 2019 aims to create the world's first climate-neutral bloc by 2050. This ambitious target calls for deep-rooted change across the aviation sector and places significantly stronger focus on the environmental impact of flying. Multiple technology pathways are required, one of which is the digital transformation of air traffic management, where SESAR innovation comes into play. Over the past ten years the SESAR JU has worked to improve the environmental footprint of air traffic management, from CO₂ and non-CO₂ emissions, to noise and local air quality. The programme is examining every phase of flight and use of the airspace and seeing what technologies can be used to eliminate fuel inefficiencies. It is also investing in synchronised data exchange and operations on the ground and in the air to ensure maximum impact. The ambition is to reduce by 2035 average CO₂ emissions per flight by 0.8-1.6 tonnes, taking into account the entire flight from gate to gate, including the airport.

Results

To date, the SESAR JU has delivered over 90 solutions for implementation, many of which offer direct and indirect benefits for the environment, with more solutions in the pipeline in SESAR 2020. Outlined in the SESAR Solutions Catalogue, these include solutions such as wake turbulence separation (for arrivals and departure), optimised use of runway configuration for multiple runway airports, or even optimised integration of arrival and departure traffic flows for single and multiple runway airports. Looking ahead, it is anticipated that the next generation of SESAR solutions will contribute to a reduction of some 450 kg CO₂ per flight.

Considering the urgency of the situation, the SESAR JU is working to accelerate the digital transformation in order to support a swift transition to greener aviation. Large-scale demonstrators are key to bridging the industrialisation gap, bringing these innovations to scale and encouraging rapid implementation by industry. Such large-scale efforts have started now with the recently launched ALBATROSS project. They will also be the focus of the future SESAR 3 Joint Undertaking, which is expected to give further and fresh impetus to this important endeavour.

The **Performance Ambitions for 2035** compared to a **2012 baseline** for Controlled airspace for each key performance area are presented in the figure below, with the ambition for environment, expressed in CO₂ reduction, highlighted by the green dotted rectangle of **Figure 5** below:

Key performance area	SES high-level goals 2005	Key performance indicator	Performance ambition vs. baseline			
			Baseline value (2012)	Ambition value (2035)	Absolute improvement	Relative improvement
 Capacity	Enable 3-fold increase in ATM capacity	Departure delay ⁴ , min/dep	9.5 min	6.5-8.5 min	1-3 min	10-30%
		IFR movements at most congested airports ⁵ , million	4 million	4.2-4.4 million	0.2-0.4 million	5-10%
		Network throughput IFR flights ⁵ , million	9.7 million	~15.7 million	~6.0 million	~60%
		Network throughput IFR flight hours ⁵ , million	15.2 million	~26.7 million	~11.5 million	~75%
 Cost efficiency	Reduced ATM services unit costs by 50% or more	Gate-to-gate direct ANS cost per flight ¹ , EUR(2012)	EUR 960	EUR 580-670	EUR 290-380	30-40%
		Gate-to-gate fuel burn per flight ² , kg/flight	5280 kg	4780-5030 kg	250-500 kg	5-10%
 Operational efficiency		Additional gate-to-gate flight time per flight, min/flight	8.2 min	3.7-4.1 min	4.1-4.5 min	50-55%
		Within the: Gate-to-gate flight time per flight ³ , min/flight	[111 min]	[116 min]		
 Environment	Enable 10% reduction in the effects flights have on the environment	Gate-to-gate CO ₂ emissions, tonnes/flight	16.6 tonnes	15-15.8 tonnes	0.8-1.6 tonnes	5-10%
 Safety	Improve safety by factor 10	Accidents with direct ATM contribution ⁴ , #/year <small>Includes in-flight accidents as well as accidents during surface movement (during taxi and on the runway)</small>	0.7 (long-term average)	no ATM related accidents	0.7	100%
		ATM related security incidents resulting in traffic disruptions	unknown	no significant disruption due to cyber-security vulnerabilities	unknown	-
 Security						

¹ Unit rate savings will be larger because the average number of Service Units per flight continues to increase.
² "Additional" means the average flight time extension caused by ATM inefficiencies.
³ Average flight time increases because the number of long-distance flights is forecast to grow faster than the number of short-distance flights.
⁴ All primary and secondary (reactionary) delay, including ATM and non-ATM causes.
⁵ Includes all non-segregated unmanned traffic flying IFR, but not the drone traffic flying in airspace below 500 feet or the new entrants flying above FL 600.
⁶ In accordance with the PRR definition: where at least one ATM event or item was judged to be DIRECTLY in the causal chain of events leading to the accident. Without that ATM event, it is considered that the accident would not have happened.

Figure 5: Performance Ambitions for 2035 for Controlled airspace (Source: European ATM Master Plan 2020 Edition).

While all SESAR solutions bring added value to ATM performance, some have a higher potential to contribute the performance of the entire European ATM network and require a coordinated and synchronised deployment. To facilitate the deployment of these SESAR solutions, the Commission establishes common projects that mandate the synchronised implementation of selected essential ATM functionalities based on SESAR solutions developed and validated by the SESAR JU.

The first common project was launched in 2014 and its implementation is currently being coordinated by the SESAR Deployment Manager throughout the entire European ATM network. It includes six ATM functionalities aiming in particular to:

- Optimise the distancing of aircraft during landing and take-off, reducing delays and fuel burn while ensuring the safest flying conditions.
- Allow aircraft to fly their preferred and usually most fuel-efficient trajectory (free route).
- Implement an initial, yet fundamental step towards digitalising communications between aircraft and controllers and between ground stakeholders allowing better planning, predictability, thus less delays and fuel optimisation and passenger experience.

The first common project⁴⁵ is planned to be completed by 2027. However, the benefits highlighted in **Figure 6** below have been measured where the functionalities have already been implemented.

⁴⁵ https://ec.europa.eu/transport/modes/air/sesar/deployment_en



Figure 6: First results of the first common project implemented.

SESAR Exploratory Research (V0 to V1)

SESAR Exploratory Research projects explore new concepts beyond those identified in the European ATM Master Plan or emerging technologies and methods. The knowledge acquired can be transferred into the SESAR industrial and demonstration activities. SESAR Exploratory Research projects are not subject to performance targets but should address the performances to which they have the potential to contribute.

SESAR Industrial Research & Validation Projects (environmental focus)

The main outcomes of the industrial research and validation projects dedicated to the environmental impacts of aviation in SESAR 1 were:

- The initial development by EUROCONTROL of the IMPACT⁴⁶ web-based platform which allows noise impact assessments and estimates of fuel burn and resulting emissions to be made from common inputs, thus enabling trade-offs to be conducted. IMPACT has since been continuously maintained and developed by EUROCONTROL, used for ICAO Committee on Aviation Environmental Protection Modelling and Database Group (CAEP) assessments, the conduct of studies in support of the European Aviation Environment Report (EAER) editions 2016 and 2019, and has been adopted by a large range of aviation stakeholders.
- The initial development/maintenance Open-ALAQS that provides a mean to perform emissions inventory at airports, emissions concentration calculation and dispersion.
- The development of an IMPACT assessment process⁴⁷.

It should be noted that these tools and methodology were developed to cover the research and the future deployment phase of SESAR, as well as to support European states and agencies in conducting environmental impact assessments for operational or regulatory purposes. They are still in use in SESAR.

SESAR Industrial Research and Validation assesses and validates technical and operational concepts in simulated and real operational environments according to a set of key performance areas. These concepts mature through the SESAR programme from V1 to V3 to become SESAR Solutions ready for deployment.

⁴⁶ <https://www.eurocontrol.int/platform/integrated-aircraft-noise-and-emissions-modelling-platform>

⁴⁷ <https://www.sesarju.eu/sites/default/files/documents/transversal/SESAR%202020%20-%20Environment%20Impact%20Assessment%20Guidance.pdf>

SESAR has a wide range of solutions to improve the efficiency of air traffic management, some of which are specifically designed to improve environmental performance, by reducing noise impact around airports and/or fuel consumption and emissions in all phases of flight.

A catalogue of SESAR Solutions is available⁴⁸ and those addressing environment impacts are identified by the following pictogram:



SESAR2020 Industrial Research and Validation - Environmental Performance Assessment

The systematic assessment of environmental impacts of aviation are at the heart of SESAR Industrial Research and Validation activities since SESAR 1, with a very challenging target on fuel/CO₂ efficiency of 500kg of fuel savings on average per flight.

SESAR Pj19.04 Content Integration members are monitoring the progress of SESAR Solutions towards this target in a document call Performance Assessment and Gap Analysis Report (PAGAR). The Updated version of PAGAR 2019 provides the following environmental achievements:

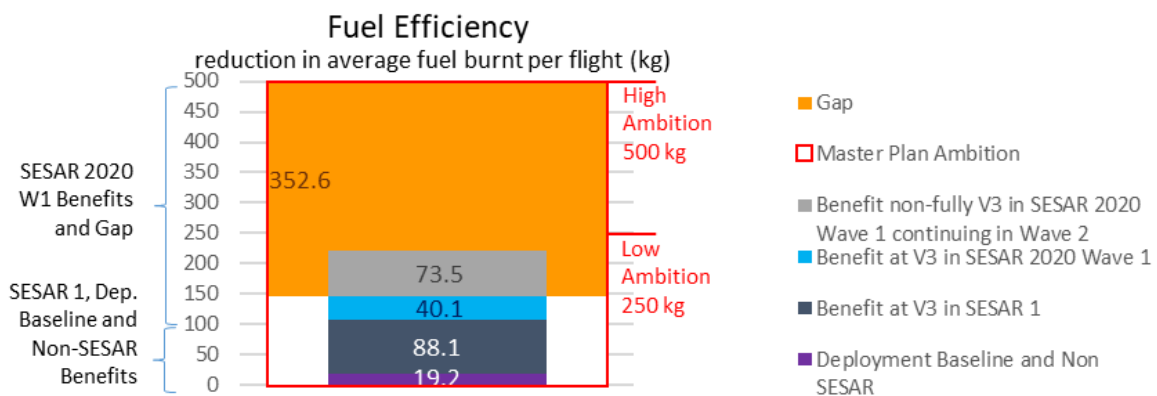


Figure 7: SESAR fuel efficiency achievement versus gap (Source: Updated version of PAGAR 2019)

The Fuel Efficiency benefits at V3 maturity level in SESAR 2020 Wave 1 represents an average of 40.1 kg of fuel savings per flight. There would therefore be a gap of 352.6 kg in fuel savings per flight to be filled by Wave 2, compared to the high fuel savings Ambition target (and a gap of 102.6 kg with respect to the low Ambition target, as the Master Plan defines a range of 5-10% as the goal). Potentially 73.5 kg might be fulfilled from Wave 1 Solutions non-fully V3 continuing in Wave 2.

A fuel saving of 40.1 kg per ECAC flight equates to about 0.76% of the 5,280kg of fuel burnt on average by an ECAC flight in 2012 (SESAR baseline). Although this might seem marginal, in 2035, ECAC-wide, it would equate to 1.9 million tonnes of CO₂ saved, equivalent to the CO₂ emitted by 165,000 Paris-Berlin flights; or a city of 258,000 European citizens; or the CO₂ captured by 95 million trees per year.

⁴⁸ <https://www.sesarju.eu/news/sesar-solution-catalogue-third-edition-now-out>

In SESAR, a value of 5,280 Kg of fuel per flight for the ECAC (including oceanic region) is used as a baseline ⁴⁹. Based on the information provided by the PAGAR 2019 document⁵⁰, the benefits at the end of Wave 1 could be about 3% CO₂/fuel savings achieved by 2025 equivalent to 147.4kg of fuel/flight. So far, the target for Wave 2 remains at about 7% more CO₂/fuel savings (352.6kg of fuel) to reach the initial Ambition target of about 10% CO₂/fuel savings (500kg fuel) per flight by 2035. Beyond 2035, there is no SESAR Ambition yet. To this could be added the as yet non-estimated benefits of Exploratory Research projects⁵¹.

SESAR AIRE demonstration projects

In addition to its core activities, the SESAR JU co-financed projects where ATM stakeholders worked collaboratively to perform integrated flight trials and demonstrations of solutions. These aimed to reduce CO₂ emissions for surface, terminal, and oceanic operations and substantially accelerate the pace of change. Between 2009 and 2012, the SESAR JU co-financed a total of 33 “green” projects in collaboration with global partners, under the Atlantic Interoperability Initiative to Reduce Emissions (AIRE).

AIRE⁵² is the first large-scale environmental initiative bringing together aviation players from both sides of the Atlantic. So far, three AIRE cycles have been successfully completed.

A total of 15 767 flight trials were conducted, involving more than 100 stakeholders, demonstrating savings ranging from 20 to 1 000kg of fuel per flight (or 63 to 3150 kg of CO₂), and improvements in day-to-day operations. Another nine demonstration projects took place from 2012 to 2014, also focusing on the environment, and during 2015/2016 the SESAR JU co-financed fifteen additional large-scale demonstration projects, which were more ambitious in geographic scale and technology.

SESAR 2020 Very Large-Scale Demonstrations (VLDs)

VLDs evaluate SESAR Solutions on a much larger scale and in real operations to prove their applicability and encourage the early take-up of V3 mature solutions.

SESAR JU has recently awarded ALBATROSS⁵³, a consortium of major European aviation stakeholder groups to demonstrate how the technical and operational R&D achievements of the past years can transform the current fuel intensive aviation to an environment-friendly industry sector.

The ALBATROSS consortium will carry a series of demonstration flights, which the aim to implementing a “perfect flight” (in other words the most fuel-efficient flight) will be explored and extensively demonstrated in real conditions, through a series of live trials in various European operating environments. The demonstrations will span through a period of several months and will utilise over 1,000 demonstration flights.

⁴⁹ See SESAR ATM Master Plan – Edition 2020 (www.atmmasterplan.eu) - eATM

⁵⁰ See SESAR Performance Assessment Gap Analysis Report (PAGAR) updated version of 2019 v00.01.04, 31-03-2021

⁵¹ See SESAR Exploratory Research projects - <https://www.sesarju.eu/exploratoryresearch>

⁵² [https://ec.europa.eu/transport/modes/air/environment/aire_en#:~:text=The%20joint%20initiative%20AIRE%20\(Atlantic,NEXTGEN%20in%20the%20United%20States](https://ec.europa.eu/transport/modes/air/environment/aire_en#:~:text=The%20joint%20initiative%20AIRE%20(Atlantic,NEXTGEN%20in%20the%20United%20States)

⁵³ <https://www.sesarju.eu/projects/ALBATROSS>

Preparing SESAR

Complementing the European ATM Master Plan 2020 and the High-Level Partnership Proposal, the Strategic Research and Innovation Agenda (SRIA) details the research and innovation roadmaps to achieve the Digital European Sky, matching the ambitions of the 'European Green Deal' and the 'Europe fit for the digital age' initiative.

The SRIA⁵⁴ identifies inter-alia the need to continue working on "optimum green trajectories", on non-CO₂ impacts of aviation, and the need to accelerate decarbonisation of aviation through operational and business incentivisation.

ASSESSMENT

The quantitative assessment of the operational and ATM improvement scenario from 2020 to 2050 has been included in the modelled scenarios by EUROCONTROL on the basis of efficiency analyses from the SESAR project indicated in Figure 7 above and it is included in Section A above (ECAC Baseline Scenario and Estimated Benefits of Implemented Measures).

Table 9. CO₂ emissions forecast for the ATM improvements scenarios.

Year	CO ₂ emissions (10 ⁹ kg)	
	Baseline Scenario	Implemented Measures Scenario
		ATM improvements
2030	160.29	149.9
2040	197.13	177.4
2050	210.35	197.4
<i>For reasons of data availability, results shown in this table do not include cargo/freight traffic. Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.</i>		

⁵⁴ <https://www.sesarju.eu/node/3697>



3.3.4 MARKET-BASED MEASURES

3.3.4.1 The Carbon Offsetting and Reduction Scheme for International Aviation

ECAC Member States have always been strong supporters of a market-based measure scheme for international aviation to incentivise and reward good investment and operational choices, and so welcomed the agreement on the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

The 39th General Assembly of ICAO (2016) reaffirmed the 2013 objective of stabilising CO₂ emissions from international aviation at 2020 levels. In addition, the States adopted the introduction of a global market-based measure, namely the '*Carbon Offsetting and Reduction Scheme for International Aviation*' (CORSIA), to offset and reduce international aviation's CO₂ emissions above average 2019/2020 levels through standard international CO₂ emissions reductions units which would be put into the global market. This major achievement was most welcome by European States which have actively promoted the mitigation of international emissions from aviation at a global level.

Development and update of ICAO CORSIA standards

European Member States have fully supported ICAO's work on the development of Annex 16, Volume IV to the Convention on International Civil Aviation containing the Standards and Recommended Practices (SARPs) for the implementation of CORSIA, which was adopted by the ICAO Council in June 2018.

As a part of the ICAO's Committee on Aviation Environmental Protection (CAEP) work programme for the CAEP/12 cycle, CAEP's Working Group 4 (WG4) is tasked to maintain the Annex 16, Volume IV and related guidance material, and to propose revisions to improve those documents as needed.

Europe is contributing with significant resources to the work of CAEP-WG4 and EASA in particular by providing a WG4 co-Rapporteur, and by co-leading the WG4 task on maintaining the Annex 16, Volume IV and related guidance material.

CORSIA implementation

In application of their commitment in the 2016 "Bratislava Declaration" the 44 ECAC Member States have notified ICAO of their decision to voluntarily participate in CORSIA from the start of the pilot phase in 2021 and have effectively engaged in its implementation. This shows the full commitment of the EU, its Member States and the other Member States of ECAC to counter the

expected in-sector growth of total CO₂ emissions from air transport and to achieving overall carbon neutral growth.

On June 2020, the European Council adopted [COUNCIL DECISION \(EU\) 2020/954](#) on the position to be taken on behalf of the European Union within the International Civil Aviation Organization as regards the notification of voluntary participation in the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) from 1 January 2021 and the option selected for calculating aeroplane operators' offsetting requirements during the 2021-2023 period.

ASSESSMENT

CORSIA is a global measure which assessment is undertaken globally by ICAO. Thus, the assessment of the benefits provided by CORSIA in terms of reduction in European emissions is not provided in this action plan.

3.3.4.2 The EU Emissions Trading System and its linkages with other systems (Swiss ETS and UK ETS)

The EU Emissions Trading System (EU ETS) is the cornerstone of the European Union's policy to tackle climate change, and a key tool for reducing greenhouse gas emissions cost-effectively, including from the aviation sector.

The 30 EEA States in Europe have already implemented the EU Emissions Trading System (ETS), including the aviation sector with around 500 aircraft operators participating in the cap-and-trade approach to limit CO₂ emissions. It was the first and is the biggest international system capping greenhouse gas emissions. In the period 2013 to 2020 EU ETS has saved an estimated 200 million tonnes of intra-European aviation CO₂ emissions.

It operates in 30 countries: the 27 EU Member States, Iceland, Liechtenstein and Norway. The EU ETS currently covers half of the EU's CO₂ emissions, encompassing those from around 11 000 power stations and industrial plants in 30 countries, and, under its current scope, around 500 commercial and non-commercial aircraft operators that fly between airports in the European Economic Area (EEA). The EU ETS Directive was revised in line with the European Council Conclusions of October 2014⁵⁵ that confirmed that the EU ETS will be the main European instrument to achieve the EU's binding 2030 target of an at least 40%⁵⁶, and will be revised to be aligned with the latest Conclusions in December 2020⁵⁷, prescribing at least 55% domestic reduction (without using international credits) of greenhouse gases compared to 1990.

The EU ETS began operation in 2005, for aviation in 2012; a series of important changes to the way it works took effect in 2013, strengthening the system. The EU ETS works on the "cap and trade" principle. This means there is a "cap", or limit, on the total amount of certain greenhouse gases that can be emitted by the factories, power plants, other installations and aircraft operators in the system. Within this cap, companies can sell to or buy emission allowances from one another. The limit on allowances available provides certainty that the environmental objective is achieved and gives allowances a market value.

For aviation, the cap is calculated based on the average emissions from the years 2004-2006, while the free allocation to aircraft operators is based on activity data from 2010. The cap for aviation activities for the 2013-2020 phase of the ETS was set to 95% of these historical aviation emissions. Starting from 2021, free allocation to aircraft operators is reduced by the linear reduction factor (currently of 2.2%) now applicable to all ETS sectors. Aircraft operators are entitled to free allocation based on a benchmark, but this does not cover the totality of emissions. The remaining allowances need to be purchased from auctions or from the secondary market.

⁵⁵ <http://www.consilium.europa.eu/en/meetings/european-council/2014/10/23-24/>

⁵⁶ Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018L0410>

⁵⁷ [1011-12-20-euco-conclusions-en.pdf \(europa.eu\)](#)

The system allows aircraft operators to use aviation allowances or general (stationary installations) allowances to cover their emissions. Currently, 82% of aviation allowances are distributed through free allocation, 3% are part of a special reserve for new entrants and fast growers, and 15% are auctioned.

The legislation to include aviation in the EU ETS was adopted in 2008 by the European Parliament and the Council⁵⁸.

Following the 2013 ICAO agreement on developing CORSIA, the EU decided⁵⁹ to limit the scope of the EU ETS to flights between airports located in the European Economic Area (EEA) for the period 2013-2016, and to carry out a new revision in the light of the outcome of the 2016 ICAO Assembly. The European Commission assessed the outcome of the 39th ICAO Assembly and, in that light, a new Regulation was adopted in 2017⁶⁰.

The legislation maintains the scope of the EU ETS for aviation limited to intra-EEA flights and sets out the basis for the implementation of CORSIA. It provides for European legislation on the monitoring, reporting and verification rules through a delegated act under the EU ETS Directive of July 2019⁶¹. It foresees that a further assessment should take place and a report be presented to the European Parliament and to the Council considering how to implement CORSIA in Union law through a revision of the EU ETS Directive. The European Green Deal and 2030 Climate Target Plan clearly set out the Commission's intention to propose to reduce the EU ETS allowances allocated for free to airlines. This work is currently ongoing and is part of the "Fit for 55 package"⁶².

The EU legislation foresees that, where a third country takes measures to reduce the climate change impact of flights departing from its airports, the EU will facilitate interaction between the EU scheme and that country's measures and flights arriving from the third country could be excluded from the scope of the EU ETS. This is the case between the EU and Switzerland⁶³ following the agreement to link their respective emissions trading systems, which entered into force on 1 January 2020.

As a consequence of the linking agreement with Switzerland, from 2020 the EU ETS was extended to all departing flights from the EEA to Switzerland, and Switzerland applies its ETS to all departing flights to EEA airports, ensuring a level playing field on both directions of routes. In accordance with the EU-UK Trade and Cooperation Agreement reached in December 2020, the EU ETS shall continue to apply to departing flights from the EEA to the UK, while a UK ETS will apply effective carbon pricing on flights departing from the UK to the EEA.

Impact on fuel consumption and/or CO₂ emissions

⁵⁸ 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, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0101>

⁵⁹ Decision No. 377/2013/EU derogating temporarily from Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, <http://eur-lex.europa.eu/LexUriServLexUriServ.do?uri=CELEX:32013D0377:EN:NOT>

⁶⁰ Regulation (EU) 2017/2392 of the European Parliament and of the Council of 13 December 2017 amending Directive 2003/87/EC to continue current limitations of scope for aviation activities and to prepare to implement a global market-based measure from 2021, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2017.350.01.0007.01.ENG&toc=OJ.L:2017:350:TOC

⁶¹ Commission Delegated Regulation (EU) 2019/1603 of 18 July 2019 supplementing Directive 2003/87/EC of the European Parliament and of the Council as regards measures adopted by the International Civil Aviation Organisation for the monitoring, reporting and verification of aviation emissions for the purpose of implementing a global market-based measure https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2019.250.01.0010.01.ENG

⁶² [2021 commission work programme new policy objectives factsheet en.pdf \(europa.eu\)](#)

⁶³ Commission Delegated Decision (EU) 2020/1071 of 18 May 2020 amending Directive 2003/87/EC of the European Parliament and of the Council, as regards the exclusion of incoming flights from Switzerland from the EU emissions trading system, OJ L 234, 21.7.2020, p. 16.

The EU ETS has delivered around 200 MT of CO₂ emission reductions between 2013 and 2020⁶⁴. While the in-sector aviation emissions for intra-EEA flights kept growing, from 53,5 million tonnes CO₂ in 2013 to 69 million in 2019, the flexibility of the EU ETS, whereby aircraft operators may use any allowances to cover their emissions, meant that the CO₂ impacts from these flights did not lead to overall greater greenhouse gas emissions. Verified emissions from aviation covered by the EU Emissions Trading System (ETS) in 2019 compared to 2018 continued to grow, albeit more modestly, with an increase of 1% compared to the previous year, or around 0.7 million tonnes CO₂ equivalent⁶⁵.

To complement the EU ETS price signal, EU ETS auctioning revenues should be used to support transition towards climate neutrality. Under the EU ETS (all sectors covered), Member States report that from 2012 until 2020, over €45 billions of ETS auction revenue has been used to tackle climate change, and additional support is available under the existing ETS Innovation Fund that is expected to deploy upwards of €12 billion in the period 2021-2030. The EU ETS' current price incentive per tonne for zero emission jet fuel, is by itself insufficient to bridge the price gap with conventional kerosene. However, by investing auctioning revenues through the Innovation Fund, the EU ETS can also support deployment of breakthrough technologies and drive the price gap down.

In terms of its contribution towards the ICAO carbon neutral growth goal from 2020, the states implementing the EU ETS have delivered, in "net" terms, the already achieved reduction of around 200 MT of aviation CO₂ emissions will continue to increase in the future under the new legislation. Other emission reduction measures taken, either collectively throughout Europe or by any of the states implementing the EU ETS, will also contribute towards the ICAO global goals. Such measures are likely to moderate the anticipated growth in aviation emissions.

ASSESSMENT

A quantitative assessment of the EU Emissions Trading System benefits based on the current scope (intra-European flights) is shown in **Table 10**.

Table 10: Summary of estimated EU-ETS emission reductions

Estimated emissions reductions resulting from the EU-ETS⁶⁶

<i>Year</i>	<i>Reduction in CO₂ emissions</i>
<i>2013-2020</i>	<i>~200 MT⁶⁷</i>

Those benefits illustrate past achievements.

⁶⁴ See the 2019 European aviation environmental report: "Between 2013 and 2020, an estimated net saving of 193.4 Mt CO₂ (twice Belgium's annual emissions) will be achieved by aviation via the EU ETS through funding of emissions reduction in other sectors.", <https://www.eurocontrol.int/publication/european-aviation-environmental-report-2019>

⁶⁵ https://ec.europa.eu/clima/news/carbon-market-report-emissions-eu-ets-stationary-installations-fall-over-9_en

⁶⁶ Include aggregated benefits of EU ETS and Swiss ETS for 2020.

⁶⁷ See the 2019 European aviation environmental report: "Between 2013 and 2020, an estimated net saving of 193.4 Mt CO₂ (twice Belgium's annual emissions) will be achieved by aviation via the EU ETS through funding of emissions reduction in other sectors.", <https://www.eurocontrol.int/publication/european-aviation-environmental-report-2019>



3.3.5 ADDITIONAL MEASURES

3.3.5.1 ACI Airport Carbon Accreditation

Airport Carbon Accreditation is a certification programme for carbon management at airports, based on international carbon mapping and management standards, specifically designed for the airport industry. It was launched in 2009 by Airport Council International (ACI) EUROPE, the trade association for European airports. Since then, it has expanded globally and is today available to members of all ACI Regions.

This industry-driven initiative was officially endorsed by EUROCONTROL and the European Civil Aviation Conference (ECAC). The programme is overseen by an independent Advisory Board comprised of many distinguished, independent experts from the fields of aviation and environment, including the European Commission, ECAC, ICAO and the UNFCCC.



The underlying aim of the programme is to encourage and enable airports to implement best practice carbon and energy management processes and to gain public recognition of their achievements. It requires airports to measure their CO₂ emissions in accordance with the World

Resources Institute and World Business Council for Sustainable Development GHG Protocol and to get their emissions inventory assured by an independent third party.

In addition to the already existing four accreditation levels, in 2020 two new accreditation levels were introduced: Level 4 and Level 4+. The introduction of those two new levels aims on one hand to align the programme with the objectives of the Paris Agreement and on the other hand to give, especially to airports that have already reached a high level of carbon management maturity, the possibility to continue their improvements⁶⁸.

The six steps of the programme are shown in **Figure 8** and are as follows: Level 1 "Mapping", Level 2 "Reduction", Level 3 "Optimisation", Level 3+ "Neutrality", Level 4 "Transformation" and Level 4+ "Transition".

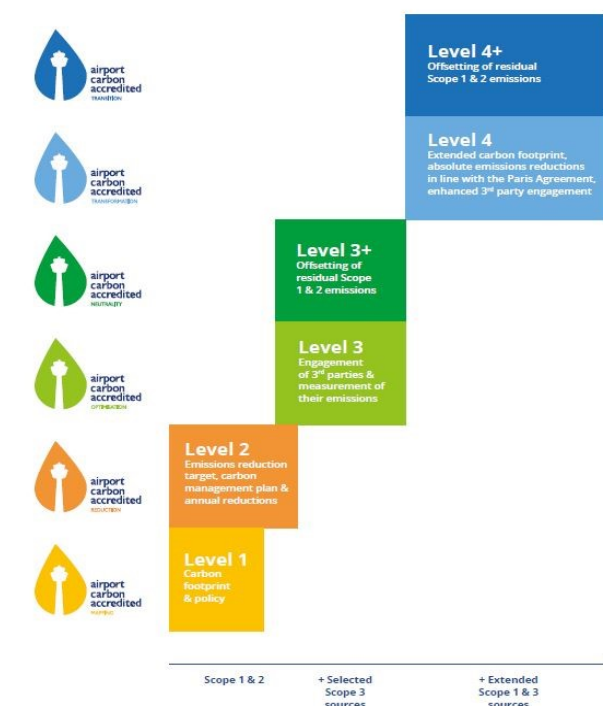


Figure 8 Six steps of Airport Carbon Accreditation

As of 31 March 2021, there are in total 336 airports in the programme worldwide. They represent 74 countries and 45.9% of global air passenger traffic. 112 reached a Level 1, 96 a Level 2, 63 a Level 3 and 60 a Level 3+ accreditation. Furthermore, five airports have already achieved accreditation at the newly introduced levels: 1 a Level 4 and 4 airports a Level 4+ accreditation.

One of its essential requirements is the verification by external and independent auditors of the data provided by airports. The Administrator of the programme has been collecting CO₂ data from participating airports since the programme launch. This has allowed the absolute CO₂ reduction from the participation in the programme to be quantified.

Aggregated data are included in the *Airport Carbon Accreditation* Annual Reports thus ensuring transparent and accurate carbon reporting. At Level 2 of the programme and above, airport operators are required to demonstrate CO₂ reductions associated with the activities they control.

The Annual Report, which is published in the fall of each year, typically covers the previous reporting year (i.e., mid-May to mid-May) and presents the programme's evolution and achievements. However, because of the extraordinary conditions faced in 2020 due to COVID-19 pandemic, special provisions are applied to all accredited airports, including the merge of programme years 11 and 12, which implies the extension of accreditation validity by one year.

⁶⁸ Interim Report 2019 – 2020, *Airport Carbon Accreditation* 2020

Thus, the current *Airport Carbon Accreditation* certification period covers the timespan May 2019 to May 2021. For this reason, the last published Report is considered as an Interim Report which addresses only a part of the on-going reporting period (i.e., from 16th May 2019 to 11th December 2020), and as such does not include the usual carbon Key Performance Indicators, but only valuable information regarding key achievements and developments, the most significant global and regional trends, and case studies highlighting the airports' commitment to continued climate action in spite of the current crisis. Therefore, the tables below show carbon performance metrics until the 2018/2019 regular reporting cycle.

For historical reasons European airports remain at the forefront of airport actions to voluntarily mitigate and reduce their impact on climate change. The strong growth momentum is still being maintained as there are 167 airports in the programme. These airports account for 69.7% of European air passenger traffic.

Table 11: Emissions reduction highlights for the European region

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Total aggregate scope 1 & 2 reduction (ktCO ₂)	51.7	54.6	48.7	140	130	169	156	155	169	158
Total aggregate scope 3 reduction (ktCO ₂)	360	675	366	30.2	224	551	142	899	1160	1763

Table 12: Emissions offset for the European region

	2015-2016	2016-2017	2017-2018	2018-2019
Aggregate emissions offset, Level 3+ (tCO ₂)	222339	252218	321170	375146

The table above presents the aggregate emissions offset by airports accredited at Level 3+ of the programme in Europe. The programme requires airports at Levels 3+ and 4+ to offset their residual Scope 1 & 2 emissions as well as Scope 3 emissions from staff business travel.

Table 13: *Airport Carbon Accreditation* key performance indicators 2018/2019

Indicator	Unit	Time Period (2018/2019)	Absolute change compared to the 3-year rolling average	Change (%)
Aggregate scope 1 & 2 emissions from airports at Levels 1-3+	tCO ₂	6,520,255	-322,297	-4.9%
Scope 1 & 2 emissions per passenger from airports at Levels 1-3+	kgs of CO ₂	1.81	-0.09	-4.3%
Scope 1 & 2 emissions per traffic unit from airports at Levels 1-3+	kgs of CO ₂	1.55	-0.08	-4.3%
Indicator	Unit	Time Period (2018/2019)	Absolute change (vs. previous year)	Change (%)
Offsetting of aggregate scope 1 & 2 & staff business travel emissions from airports at Level 3+	tCO _{2e}	710,673	38,673	5.8%
Indicator	Unit	Time Period (2018/2019)	Absolute change (vs. previous year)	Change (%)
Scope 3 emissions from airports at Levels 3 and 3+	tCO ₂	60,253,685	6,895,954	12.9%

The programme's main immediate environmental co-benefit is the improvement of local air quality.

Costs for the design, development and implementation of *Airport Carbon Accreditation* have been borne by ACI EUROPE. *Airport Carbon Accreditation* is a non-for-profit initiative, with participation fees set at a level aimed at allowing for the recovery of the aforementioned costs.

The scope of *Airport Carbon Accreditation*, i.e. emissions that an airport operator can control, guide and influence, implies that as of Level 3, aircraft emissions are also covered. Thus, airlines can benefit from the gains made by more efficient airport operations to see a decrease in their emissions. This is consistent with the ambition of the European Green Deal, the inclusion of aviation in the EU ETS and the implementation of CORSIA and therefore can support the efforts of airlines to reduce these emissions.

ASSESSMENT

The inclusion of this collective European measure is descriptive for information purposes, and no quantitative assessment of its benefits in terms of reduction in aviation emissions is provided in the common section of this action plan.

3.3.5.2 European industry roadmap to a net zero European aviation: *Destination 2050*



The Destination 2050⁶⁹ is an initiative and roadmap developed by aviation industry stakeholders (A4E, ACI EUROPE, ASD, CANSO and ERA) showing an ambitious decarbonisation pathway for European aviation.

These European industry organizations commit to work together with all stakeholders and policymakers to achieve the following climate objectives:

- Reaching net zero CO₂ emissions by 2050 from all flights within and departing from the European Economic Area, Switzerland and the UK. This means that by 2050, emissions from these flights will be reduced as much as possible, with any residual emissions being removed from the atmosphere through negative emissions, achieved through natural carbon sinks (e.g., forests) or dedicated technologies (carbon capture and storage). For intra-EU flights, net zero in 2050 might be achieved with close to no market-based measures.
- Reducing net CO₂ emissions from all flights within and departing from the European Economic Area, Switzerland and the UK by 45% by 2030 compared to the baseline⁷⁰. In 2030, net CO₂ emissions from intra-EU flights would be reduced by 55% compared to 1990 levels.
- Assessing the feasibility of making 2019 the peak year for absolute CO₂ emissions from flights within and departing from the European Economic Area, Switzerland and UK.

With the Destination 2050 roadmap and through these commitments, the European aviation sector contributes to the Paris Agreement, recognising the urgency of pursuing the goal of limiting global warming to 1.5°C.

⁶⁹ www.destination2050.eu

⁷⁰ A hypothetical 'no-action' scenario whereby CO₂ emissions are estimated based on the assumption that aircraft deployed until 2050 have the same fuel efficiency as in 2018.

By doing so, the European aviation sector is also effectively contributing to the collective European Green Deal and EU's climate neutrality objectives.

This roadmap is complementary to the WayPoint 2050 Air Transport Action Group (ATAG) global pathway for the decarbonization of aviation.

ASSESSMENT

The inclusion of this collective European measure is descriptive for information purposes, and no quantitative assessment of its benefits in terms of reduction in aviation emissions is provided in the common section of this action plan.

3.3.5.3 Environmental Label Programme

In response to the growing expectations of citizens to understand the environmental footprint of their flights, the European Union Member States, Switzerland, Norway, Lichtenstein, the United Kingdom and the European Commission have mandated EASA to explore voluntary environmental labelling options for aviation organisations. The proposals will be aligned with the European Green Deal, established in December 2019 and that strives to make Europe the first climate-neutral continent. The overall objective of the EASA Environmental Labelling Programme is to increase awareness and transparency, and ultimately to support passengers and other actors in making informed sustainable choices by providing harmonised, reliable and easily understandable information on their choices' environmental impacts, co-ordinated within EASA Member States. It should allow rewarding those air transport operators making efforts to reduce their environmental footprint. The label initiative covers a wide range of components of the aviation sector, including aircraft, airlines and flights.

In the proof-of-concept phase, EASA developed potential technical criteria and label prototypes for aircraft technology and design as well as airline operations, to inform European citizens on the environmental performance of aviation systems. Such information would be provided on a voluntary basis by aviation operators that have chosen to use the label. Different scenarios were developed and tested to consider how citizens could interact with labelling information, e.g. on board the aircraft and/or during the booking process as well as on a dedicated website and smartphone application. Various key environmental indicators were reviewed, including the absolute CO₂ emissions and average CO₂ emissions per passenger-kilometre of airlines.

The pilot phase covering the period 2021-2023 will further expand the scope of indicators and take into account life-cycle considerations, e.g. to cover aspects from the extraction of raw materials to recycling and waste disposal. The pilot phase also foresees an impact assessment of the label.

While the potential CO₂ emissions reductions generated by such a label were not quantified at this stage, it is proposed to keep the ICAO updated on future developments concerning the European environmental labelling initiative, including on potential CO₂ emissions savings.

ASSESSMENT

The inclusion of this collective European measure is descriptive for information purposes, and no quantitative assessment of its benefits in terms of reduction in aviation emissions is provided in the common section of this action plan.

3.3.5.4 Multilateral capacity building projects

The European Union is highly committed to ensuring sustainable air transport in Europe and worldwide. In this endeavour, the EU is launching a number of initiatives in different areas to assist partner States in meeting the common environmental commitments.

EASA capacity-building partnerships

EASA has been selected as an implementing Agency for several of these initiatives, including the **EU-South East Asia Cooperation on Mitigating Climate Change impact from Civil Aviation** (EU-SEA CCCA), launched in 2019, and a **Capacity Building Project for CO₂ Emissions Mitigation in the African and Caribbean Region**, launched in 2020.

The overall objective of these projects⁷¹ is to enhance the partnership between the EU and partner States in the areas of civil aviation environmental protection and climate change, and to achieve long-lasting results that go beyond the duration of the projects. The specific objectives of the two projects are to develop or support existing policy dialogues with partner States on mitigating GHG emissions from civil aviation, to contribute to the CORSIA readiness process of partner States, as well as to implement CORSIA in line with the agreed international schedule, including considerations of joining the voluntary offsetting phase starting in 2021 or at the earliest time possible. On top of the CORSIA-related support, these projects are assisting the partner States in the development and update of the State Action Plans to reduce CO₂ emissions from civil aviation, as well as providing support in the development of emission data management tools supporting the implementation of State Action Plans and CORSIA.

By January 2021, the EU-SEA CCCA had improved the technical readiness of all the 10 partner States in the region, as well as their aeroplane operators' capabilities to comply with CORSIA requirements. Five States had implemented emission data management solutions to generate CORSIA Emission Reports, and eight States had successfully submitted their 2019 CORSIA CO₂ Emissions Reports to ICAO. 4 CORSIA verification bodies had been accredited in the region with dedicated support to their respective National Accreditation Bodies to finalise the accreditation process.

In addition, EASA is implementing, on behalf of the Commission, technical cooperation projects in the field of aviation in Asia, Latin-America and the Caribbean, which include an environmental component aiming at cooperation and improvement of environmental standards.

These projects have been successful in supporting regional capacity building technical cooperation to the partner States with regard to environmental standards. With regard to CORSIA, support is provided for the development or enhancement of State Action Plans, as well as for the implementation of the CORSIA MRV system. Projects have also been successful in engaging with key national and regional stakeholders (regulatory authorities, aeroplane operators, national accreditation bodies, verification bodies), thereby assessing the level of readiness for State Action Plan and CORSIA implementation on wider scale in the respective regions, and to identify further needs for additional support in this area.

ICAO - European Union Assistance Project

The assistance project *Capacity Building on CO₂ mitigation from International Aviation* was launched in 2013 with funding provided by the European Union, while implementation was carried out by ICAO Environment.

Fourteen States from Africa and the Caribbean were selected to participate in this 5-year programme, successfully implemented by ICAO from 2014 to 2019, achieving all expected results and exceeding initial targets.

The first objective of the ICAO-EU project was to create national capacities for the development of action plans. ICAO organized specific training-seminars, directed the establishment of National

⁷¹ <https://www.easa.europa.eu/domains/international-cooperation/easa-by-country/map#group-easa-extra>

Action Plan Teams in the selected States, and assisted each civil aviation authority directly in the preparation of their action plans.

By June 2016, the 14 selected States had developed action plans fully compliant with ICAO's guidelines, including robust historical data and a reliable baseline scenario. A total of 218 measures to reduce fuel consumption and CO₂ emissions were proposed in the action plans, including those related to aircraft technology, operational measures, and sustainable aviation fuels.

Four pilot mitigation measures and five feasibility studies were executed with project funding in the beneficiary States. In addition to those, the beneficiary States implemented 90 mitigation measures within the project timeframe, which had been included in their action plans⁷².

With the support provided by the ICAO-EU project, ICAO has succeeded in assisting the beneficiary States transform the organizational culture towards environmental protection in aviation, through the establishment of Environmental Units with dedicated staff in the Civil Aviation Authorities along with the voluntary decision of seven selected States of the project to join the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) from its outset.

The Phase two of this project is currently being implemented by ICAO and EASA. It covers ten African States: Benin, Botswana, Cabo Verde, Comoros, Côte d'Ivoire, Madagascar, Mali, Rwanda, Senegal and Zimbabwe. The project will run between 2020 and 2023.

ASSESSMENT

The inclusion of this collective European measure is descriptive for information purposes, and no quantitative assessment of its benefits in terms of reduction in aviation emissions is provided in the common section of this action plan.



⁷² https://www.icao.int/environmental-protection/Documents/ICAO-EU_Project_FinalReport.pdf

3.3.5.5 Green Airports research and innovation projects

Under the EU research and innovation actions in support of the European Green Deal and funded by the Horizon 2020 Framework Programme, the European Commission has launched in 2020 the call for tenders: ***Green airports and ports as multimodal hubs for sustainable and smart mobility***.

A clear commitment of the European Green Deal is that “transport should become drastically less polluting”, highlighting in particular the urgent need to reduce greenhouse gas emissions (GHG) in aviation and waterborne transport.

In this context, airports play a major role, both as inter-connection points in the transport networks, but also as major multimodal nodes, logistics hubs and commercial sites, linking with other transport modes, hinterland connections and integrated with cities.

As such, green airports as multimodal hubs in the post COVID-19 era for sustainable and smart mobility have a great potential to immediately contribute to start driving the transition towards GHG-neutral aviation, shipping and wider multimodal mobility already by 2025.

The scope of this research program is therefore addressing innovative concepts and solutions for airports and ports, in order to urgently reduce transport GHG emissions and increase their contribution to mitigating climate change.

Expected outcomes

The projects will perform large-scale demonstrations of green airports, demonstrating low-emission energy use (electrification or sustainable aviation fuels) for aircraft, airports, other/connected and automated vehicles accessing or operating at airports (e.g. road vehicles, rolling stock, drones), as well as for public transport and carpooling, with re-charging/re-fuelling stations and use of incentives.

They will also put the focus on the development of SAF for its use at airports.

The deadline to receive project proposals was closed in January 2021 and at the time of this action plan update the proposals are under revision. Future action plan updates will provide further information on the benefits of the implementation of this measure.

ASSESSMENT

The inclusion of this collective European measure is descriptive for information purposes, and no quantitative assessment of its benefits in terms of reduction in aviation emissions is provided in the common section of this action plan.



3.3.6 SUPPLEMENTAL BENEFITS FOR DOMESTIC SECTORS

Although the benefits of all the European collective measures included in this action plan are focused on international aviation, they are also applicable to domestic aviation (except CORSIA) and thus, will bring supplemental benefits in terms of CO₂ emissions reductions in the domestic European air traffic.

In addition, a number of those measures taken collectively in Europe and contained in this action plan offer as well additional supplemental benefits for domestic sectors beyond CO₂ savings. Those are summarized below.

3.3.6.1 ACI Airport Carbon Accreditation

Airport Carbon Accreditation is referred among the measures contained in this action plan aiming to encourage and enable airports to implement best practice carbon and energy management processes.

While its main objective is supporting airport actions to voluntarily mitigate and reduce their impact on climate change, the programme's main immediate environmental co-benefit is the improvement of local air quality linked to the non-CO₂ additional emissions benefits from the reduction of fuel burn that an airport operator can control, guide and influence.

3.3.6.2 ReFuelEU Aviation Initiative

Through the large-scale use of SAF, emissions of other pollutants impacting local air quality and other non-CO₂ effects on the climate can also be reduced, implying important potential supplemental benefits beyond CO₂ emissions reductions.

In addition to the reduction of CO₂ emissions, SAF has the additional benefit of reducing air pollutant emissions around airports when emitted during take-off and landing as emissions of non-volatile Particulate Matter (nvPM) with up to 90% and sulphur (SO_x) with 100%, compared to fossil jet fuel⁷³.

Preserving the quality of natural resources can be considered an additional benefit of any policy measure aiming to increase the sustainability of aviation by boosting the SAF market while

⁷³ [ICAO 2016 Environmental Report](#), Chapter 4, Page 162, Figure 4.

paying particular attention to the overall environmental integrity of the SAF incentivised, as it is the case of the ReFuelEU Initiative.

Finally, the production of SAF notably from biogenic waste could contribute and be an incentive for more effective waste management in the EU.

3.3.6.3 SAF Research and development projects

One European research project funded by the Horizon 2020 Research and Innovation program of the EU, is currently assessing, among other objectives, the additional supplemental benefits for domestic sectors of the use of sustainable aviation fuels, beyond its climate benefits.

AVIATOR PROJECT⁷⁴: The project “*Assessing aviation emission Impact on local Air quality at airports: Towards Regulation*” aim to better understand air quality impacts of aviation issues, developing new tools and regulation, and linking with the health community, providing unbiased data to society.

The project will measure, quantify and characterise airborne pollutant emissions from aircraft engines under parking (with functioning APU), taxiing, approach, take-off and climb-out conditions, with specific reference to total UFPs, NO_x, SO_x and VOC under different climatic conditions.

It includes among its objectives measuring emissions from aircraft engines using commercially available sustainable aviation fuels to investigate its impact on total Particulate Matter formation and evolution in the plume as well as the wider airport environment.

Will perform measurements of air quality in and around three international airports: Madrid-Barajas, Zurich and Copenhagen, to validate model developments under different operational and climatic conditions and develop a proof of concept low-cost and low-intervention sensor network to provide routine data on temporal and spatial variability of key pollutants including UFP, total PM, NO_x and SO_x.

With 17 partners from 7 countries involved, the project started in June 2019 and it is expected to finalize in 2022.

3.3.6.4 The EU's Single European Sky Initiative and SESAR

The European Union's Single European Sky (SES) initiative and its SESAR (*Single European Sky ATM Research Programme*) programme are aiming to deploy a modern, interoperable and high-performing ATM infrastructure in Europe, as has been described above in detail in this action plan, among its key operational measures to reduce CO₂ emissions.

But the environmental outcomes of SESAR implementation go far beyond reducing fuel burn, and the key deliverables from the SESAR Programme have also a significant potential to mitigate **non-CO₂ emissions and noise impacts**.

It should be noted that although no targets have yet been set for non-CO₂ emissions (at local or global level) and noise impacts, the ATM Master Plan requires that each SESAR solution with an impact on these environmental aspects assesses them to the extent possible and within available resources.

In this context, for example the EUROCONTROL *Integrated aircraft noise and emissions modelling platform* [IMPACT](#), which delivers noise contour shape files, surface and population counts based on the European Environment Agency population database, estimates of fuel burn and emissions for a wide range of pollutants, and geo-referenced inventories of emissions within the landing and take-off portion, is one of the recommended models for conducting environmental impact assessments in SESAR.

⁷⁴ <https://aviatorproject.eu>

3.3.6.5 Green Airports research and innovation projects

The European Commission's Green Airports research and innovation projects referred in this action plan among the "Other measures" commonly implemented in Europe has key objectives to achieve important supplemental benefits beyond CO₂ emissions reductions, among them:

Circular Economy:

- Developing the built environment (construction/demolition) using more ecologically friendly materials and processes and incorporating these improvements in the procurement processes to sustainably decrease the ecological footprint.
- Promoting the conversion of waste to sustainable fuels.
- Addressing the sustainable evolution of airports, also in the context of circular economy (e.g. activities linked to aircraft decommissioning and collection/sorting of recyclable waste), considering institutional and governance aspects, ownership, regulation, performance indicators and balance of force between regulators, airlines and airport operators.
- Addressing the feasibility of a market-based instrument to prevent/reduce Food Loss and Waste (FLW) and to valorise a business case of transformation of FLW into new bio-based products. This includes FLW measurement and monitoring methodologies and the subsequent mapping of FLW total volume at stake in the considered airport.

Biodiversity:

- Enhancing biodiversity, green land planning and use, as well as circular economy (e.g. repair, reuse and recycling of buildings and waste, in the context of zero-waste concepts).

Non-CO₂ impacts:

- Addressing air quality (indoor, outdoor, including decontamination from microbiological pathogens) and noise trade-off.
- Assessing non-technological framework conditions, such as market mechanisms and potential regulatory actions in the short and medium term, which can provide financial/operational incentives and legal certainty for implementing low emission solutions.
- Developing and promoting new multi-actor governance arrangements that address the interactions between all airport-related stakeholders, including authorities, aircraft owners and operators, local communities, civil society organisations and city, regional or national planning departments.

3.4 Appendix A: Detailed results for ECAC Scenarios from Section A

3.4.1 BASELINE SCENARIO

a) Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres ⁷⁵ RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported ⁷⁶ FTKT (billion)	Total Revenue Tonne Kilometres ⁷⁷ RTK (billion)
2010	4.56	1,114	0.198	45.4	156.8

⁷⁵ Calculated on the basis of Great Circle Distance (GCD) between airports, for 97% of the passenger traffic for forecast years.

⁷⁶ Includes passenger and freight transport (on all-cargo and passenger flights).

⁷⁷ A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).

2019	5.95	1,856	0.203	49.0	234.6
2030	5.98	1,993	0.348	63.8	263.1
2040	7.22	2,446	0.450	79.4	324.0
2050	8.07	2,745	0.572	101.6	376.1

Note that the traffic scenario shown in the table is assumed for both the baseline and implemented measures scenarios.

b) Fuel burn and CO₂ 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	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280
2030	50.72	160.29	0.0252	0.252
2040	62.38	197.13	0.0252	0.252
2050	69.42	219.35	0.0250	0.250
<i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i>				

3.4.2 IMPLEMENTED MEASURES SCENARIO

A) EFFECTS OF AIRCRAFT TECHNOLOGY IMPROVEMENTS AFTER 2019

a) Fuel consumption and CO₂ emissions of international passenger traffic departing from ECAC airports, with aircraft technology improvements after 2019 included:

Year	Fuel Consumption (10 ⁹ kg)	CO ₂ emissions (10 ⁹ kg)	Well-to-wake CO ₂ e emissions (10 ⁹ kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	36.95	116.78	143.38	0.0332	0.332
2019	52.01	164.35	201.80	0.0280	0.280
2030	49.37	156.00	191.54	0.0232	0.232
2040	56.74	179.28	220.13	0.0217	0.217
2050	59.09	186.72	229.26	0.0202	0.202
<i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i>					

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

Period	Average annual fuel efficiency improvement (%)
2010-2019	-1.86%
2019-2030	-1.22%
2030-2040	-0.65%
2040-2050	-0.74%

B) EFFECTS OF AIRCRAFT TECHNOLOGY AND ATM IMPROVEMENTS AFTER 2019

a) Fuel consumption and CO₂ emissions of international passenger traffic departing from ECAC airports, with aircraft technology and ATM improvements after 2019:

Year	Fuel Consumption (10 ⁹ kg)	CO ₂ emissions (10 ⁹ kg)	Well-to-wake CO ₂ e emissions (10 ⁹ kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	36.95	116.78	143.38	0.0332	0.332
2019	52.01	164.35	201.80	0.0280	0.280
2030	46.16	145.86	179.09	0.0217	0.217
2040	51.06	161.35	198.12	0.0196	0.196
2050	53.18	168.05	206.33	0.0182	0.182
<i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i>					

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

Period	Average annual fuel efficiency improvement (%)
2010-2019	-1.86%
2019-2030	-1.82%
2030-2040	-1.03%
2040-2050	-0.74%

c) Equivalent (well-to-wake) CO₂e emissions forecasts for the scenarios described in this common section

Year	Well-to-wake CO ₂ e 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	143.38			NA
2019	201.80			NA
2030	196.8	191.5	179.1	-9%
2040	242.0	220.1	198.1	-18%
2050	269.3	229.3	206.3	-23%
For reasons of data availability, results shown in this table do not include cargo/freight traffic. Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.				

3.5 **Appendix B: Note of the Methods to Account for the CO₂ Emissions Attributed to International Flights**

3.5.1 **Background**

The present note addresses recommendations on the methodologies to account the CO₂ emissions, for the guidance on the development of the common European approach for ECAC States to follow, in view of the submission to ICAO of their updated State Action Plans for CO₂ Emissions Reduction (APER).

The ECAC APER guidance shall be established on the basis of the ICAO 9988 Guidance on the Development of States' Action Plans on CO₂ Emissions Reduction Activities document (3rd edition). One of its objectives is to define a common approach for accounting CO₂ emissions of international flights: two different methods are proposed for CO₂ accounting, namely ICAO and IPCC. Because of their intrinsic definitions, it is expected that these two different approaches induce both accounting differences, and practical issues, and furthermore, two ways to target the CO₂ Emissions Reduction Activities, and to define the action plans, de facto.

As the objective of the definition of the common section of the ECAC APER guidance consists into determining a common approach for all the foreseen activities, including CO₂ accounting and monitoring, the ECAC APER Task Group required to assess the details of each methods and to propose recommendations in this present note.

3.5.2 **Accounting methods**

The ICAO Doc 9988 document 3rd edition defines the two CO₂ accounting methods (§3.2):

- a) ICAO: each State reports the CO₂ emissions from the international flights operated by aircraft registered in the State (State of Registry).
- b) IPCC: each State reports the CO₂ emissions from the international flights departing from all aerodromes located in the State or its territories (State of Origin).

The international flights concern aircraft movements from a country to another country. Each method determines the country assignment of the movement.

Method	ICAO	IPCC
Definition	The ICAO methodology is based on the State of nationality of the airline, and defines an "international" flight as one undertaken to or from an airport located in a State other than the airline's home State, i.e. each State reports only on the international activity of its own commercial air-carriers.	The IPCC methodology defines international aviation as flights departing from one country and arriving in another, i.e. each State report to IPCCs in respect of all flights departing from their territory, irrespective of the nationality of the operator.
Use in projects	CORSIA/ETS (partially)	IPCC EAER UNFCCC

3.5.3 **Comparisons: flown distance and number of operations**

The comparison of the number of operations and flown distance of 2019, aggregated at ECAC or State levels provide a good indication of the possible differences for CO₂ accounting.

At the ECAC area level, the relative difference between the ICAO and IPCC methods, is -0.66% for operations number and + 0.26% on flown distance (Source EUROCONTROL/CRCO). This is explained by the fact that movements of the operators registered outside the ECAC area member states are not counted in.

The table hereafter lists the countries for which the relative differences of counting the number of operations or flown distance is more than 50% or less than -50% (Source EUROCONTROL/CRCO).

DEPARTURE COUNTRY	(ICAO – IPCC) % difference number of operations	(ICAO – IPCC) % difference number of flown distance
ALBANIA	-71.04%	-75.34%
ARMENIA	-80.76%	-84.64%
AUSTRIA	114.51%	104.81%
BOSNIA AND HERZEGOVINA	-83.45%	-80.73%
CROATIA	-52.08%	-65.54%
CYPRUS	-84.06%	-92.75%
DENMARK	-68.07%	-53.81%
ESTONIA	-67.93%	-53.48%
FAROE ISLANDS	-100.00%	-100.00%
GEORGIA	-68.62%	-66.45%
GREECE	-58.26%	-65.83%
HUNGARY	213.95%	245.36%
IRELAND	509.31%	478.00%
ITALY	-71.45%	-63.90%
LIECHTENSTEIN	2100.00%	8572.91%
LITHUANIA	-78.83%	-65.95%
LUXEMBOURG	55.29%	54.05%
NORTH MACEDONIA	-98.69%	-98.90%
MALTA	97.00%	125.78%
MONACO	100.17%	708.97%
SLOVAKIA	-73.46%	-72.30%

The previous table highlights the possible relative differences for a country-by-country approach:

- High differences for low-cost origin countries (Ireland, Austria, Hungary) as all the movements exceed the departures capacity: nb operations ICAO >> nb operations IPCC
 - Example: Ireland (Ryanair), Austria (EasyJet), Hungary (Wizzair)
- High differences for business jet country locations: nb operations ICAO > nb operations IPCC
 - Example: Monaco, Malta, Liechtenstein

- Difference for countries with lot of low-cost departures: nb operations ICAO < nb operations IPCC
 - Example: Greece, Italy

3.5.4 *Impact on the action plan definitions*

The choice of the method entails two significantly different approaches. The ICAO approach would bring the focus on the capability of a State to manage the emissions evolution of only its own “flag carriers”. A State having a significant aviation activity operated by non-flag carriers would therefore not be able to reflect in the plan its possible policy on the evolution of its overall aviation activity. Also, if the State flag carriers have an important aviation activity between third countries, this would become a “responsibility” of the State in terms of emissions reduction plans.

The IPCC method, on the contrary, brings the focus on the management of the emissions reductions for the State related aviation activity, integrating the State’s policy in terms of evolution and importance of the aviation business for it and national plans to reduce emissions (e.g., promotion of operations with more fuel-efficient aircraft).

Allowing States to use the ICAO or the IPCC method has the risk of under estimation for some as well as double counting for others if consolidating the States action plans.

It is also worth noting that the IPCC method actually allows consolidating and correlating the data with the CORSIA reporting. Indeed, under CORSIA emissions are reported by States aggregated at country pair level with no info on the operator. If all States were reporting action plans based on the IPCC approach aggregating at country pair level, this info can be consolidated and correlated with the CORSIA reported one. The ICAO method for the action plans would not allow this.

3.5.5 *Impact on the baseline definition (ECAC)*

The selection of the ICAO/IPCC method also affects the definition and estimation of the CO₂ emissions of the international flights at the ECAC level.

The Base year dataset and the forecasts dataset that EUROCONTROL shall define and assess (at the ECAC level), are based on the IPCC. The ICAO method cannot be used for such assessments.

4 Section 2: National actions in Finland

In addition to the supranational actions introduced in Section 1 of this action plan, a number of actions are taken at a national level in Finland. This section introduces Finnish stakeholders' CO₂ reduction actions. Text in Section 2 describes selected actions, and estimated emissions reductions resulting from some of the actions are listed in Chapter 4.7 of this action plan.

The Government of Finland adopted a resolution⁷⁸ on 6 May 2021 that confirms measures to reduce greenhouse gas emissions from aviation and the priorities for exerting influence internationally. The resolution draws on the work on the Roadmap for fossil-free transport, which was the first national analysis of emission reduction possibilities and their effects, covering a wide range of transport modes, including air transport.⁷⁹

According to the Government resolution, emissions from domestic air traffic and international air traffic departing from Finland will be reduced by 15 per cent from 2018 levels by 2030 and by 50 per cent by 2045.⁸⁰ The emissions reduction target concerns emissions within the sector; in addition to these, aviation delivers emission savings in other sectors through various market mechanisms. Finland's domestic target is to be carbon neutral by 2035. In order to achieve the targets set in the Paris Agreement, we need effective measures to reduce emissions at the national level, in the EU and in the International Civil Aviation Organization (ICAO).

Emissions from aviation will be reduced by renewable fuels, energy efficiency and pricing. The Government resolution includes 23 measures. The national section of Finland's Action Plan to Reduce CO₂ Emissions from Aviation 2021 is largely based on the work of the Roadmap's Air Transport Working Group, which involved a large number of stakeholders.

It is more difficult to electrify aviation than passenger car traffic, which is why the introduction of sustainable aviation fuels will be emphasised. The Government Programme aims to reduce emissions from aviation by introducing a distribution obligation for sustainable aviation fuels.⁸¹ Along with the implementation of the Government Programme, it will be assessed how the different levels of obligations influence the sector, as well as the more detailed ways to implement the obligations and international developments. Finland will also promote binding decisions in the EU and the ICAO to make sustainable aviation fuels more widely introduced. As road transport becomes electrified, the use of renewable fuels should be steered by national and international decisions to aviation, as this will achieve the greatest climate benefits.

Energy efficiency can be promoted, in particular, by improving the functioning of airspace and by introducing emission-reducing flight methods. Finland supports the reform of the Single European Sky (SES) to encourage emissions reduction more efficiently than at present. In addition, by expanding the free routing airspace, flight routes can be shortened and emissions reduced. The State Travel

⁷⁸ <https://www.lvm.fi/en/-/government-decided-on-measures-to-reduce-greenhouse-gas-emissions-from-aviation-focus-on-renewable-aviation-fuels-and-carbon-pricing-1295073>

⁷⁹ Road map for fossil-free transport – Working group final report, Publications of the Ministry of Transport and Communications 2020:17 <http://urn.fi/URN:ISBN:978-952-243-598-9>

⁸⁰ The emission reductions listed here are for illustrative purposes only, as some of the measures have already been taken into account at the European-level baseline scenario, presented in Section 1 of this Action Plan and cannot be added to the benefits presented in the European section.

⁸¹ <http://urn.fi/URN:ISBN:978-952-287-811-3> (page 125)

Strategy will also be changed so that the volume of air travel will be reduced by using remote connections. In addition, environmental sustainability will be increased by favoring low-emission alternatives in state travel procurement.

The pricing of emissions can promote sustainable consumption. The countries of the world are committed to halting the growth of air traffic emissions to 2019 levels. This will be implemented through the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which entered into force in 2021, and to which Finland and the other 43 Member States of the European Civil Aviation Conference have acceded. In the future, it will be important, in international cooperation, to find ways to improve the efficiency of CORSIA's operations and, in other respects, to promote the pricing of greenhouse gas emissions from air traffic. Air transport was the first mode of transport to join the EU's emissions trading system in 2012. In 2021, the European Commission is expected to propose legislative amendments to increase the efficiency of emissions trading. The aim for Finland is that the free allocation of allowances of the emissions trading for air transport is gradually reduced and eventually abandoned altogether.

The Ministerial Working Group on Climate and Energy Policy will monitor every six months the implementation of the resolution. The key indicator for this work is the statistics on air transport emissions by Statistics Finland.

4.1 Technology and standards

4.1.1 Aircraft related technology development

The energy efficiency of aircraft can be improved, for example, by developing aerodynamics, otherwise changing the structure of the aircraft to improve efficiency, reducing the weight of the aircraft and developing engines to be more energy efficient. Historically, the energy efficiency of aircraft has improved significantly. Per passenger-kilometer, current aircraft are more than 80 per cent more energy efficient than those used in the 1960s. In 2017, aircraft consumed an average of 3.4 liters of fuel per 100 passenger-kilometers, which is 24 % less than in 2005.⁸² The latest aircraft, such as the Airbus A380, Boeing 787, ATR-72-600 and the Airbus A350 used by Finnair, consume less than three liters of fuel per 100 passenger kilometers, which is lower than the corresponding value of a passenger car in Finland, for example.

However, the fleet renewal is relatively slow, with an average lifespan of around 20-25 years, so currently certified aircraft types can still be in traffic in the 2050s. Improving the energy efficiency of aircraft is an important part of reducing aviation emissions, but due to the projected increase in traffic volumes and the need to reduce greenhouse gas emissions, the introduction of new technology alone is not enough, as can be seen from Finnish aviation emissions data. The magnitude of the future growth remains to be seen, as the COVID-19 pandemic may have longer-term impacts on the demand for air transport services and the financial conditions for airlines to invest in new equipment.

Majority of the environmental impact of aviation comes from engine emissions, so the introduction of new, low-emission technology can have a significant impact on emissions. The new generation of aircraft may be up to 15-25 % more efficient than its predecessor, but IATA estimates that in practice the result will be a few per cents lower. Aircraft types are also developed to some extent during series production, in addition to which modifications can be made to aircraft as retrofits or in connection with the renewal of parts. Between 1968 and 2014, the average increase in fuel efficiency per passenger-kilometer was 1.3 per cent per year. However, the pace of development varies considerably. In the late 2010s, several

⁸² The Aviation Network – Decarbonisation issues, EUROCONTROL Think Paper #4, 9/2019

new and energy-efficient aircraft models were introduced, and it is estimated that energy efficiency improvements will slow in the 2020s until demand for new aircraft models increases again. The aircraft are also expected to remain roughly in their current models until around 2035, after which the likelihood of major structural changes in new aircraft models will increase.⁸³ In Europe, aircraft research and development has been taken forward, in particular by the Clean Sky Joint Technology Initiative between the European Commission and the European aviation industry.

It is difficult to estimate the actual impact of the new technology on Finnish aviation emissions, as airlines decide on the purchase of equipment on the basis of several different factors, such as the market and pricing environment. Uncertainty is increased due to the unknown duration and extent of the effects of the COVID-19 pandemic.

However, Finnair's share of emissions is so large that by looking at the company's fleet purchases, indicative estimates can be made. Finnair has ordered a total of 19 Airbus A350s for long-haul use, which are up to a quarter more energy-efficient than previously used aircraft. Of the aircraft ordered, 16 were in use by the end of 2020 and the remaining three were scheduled to be commissioned by 2022, but the date may be delayed due to reduced demand caused by the COVID-19 pandemic. Part of the impact of new, more energy-efficient aircraft was therefore already included in the 2018 emissions statistics. Finnair has also announced that it will renew its narrow-body fleet for shorter flights by 2025, but the current exceptional situation delays the schedule. On the other hand, Finnair has estimated that solvent airlines would have the opportunity to take advantage of the expected decline in aircraft demand in their purchases in the next few years. The new aircraft would be estimated to be 10-15 percent more energy efficient than their predecessors. Based on the above, a rough estimate can be made that airlines' purchases of equipment could reduce projected emissions growth by 10-15 % by 2030.

Assessing the situation in relation to 2045, it can be stated that the need to renew Finnair's long-haul fleet is topical, possibly in the mid-2030s or at the latest at the end of the decade. Decisions are greatly influenced by the energy-efficiency improvements of the aircraft models available at that time, the market situation and the transport pricing system. However, it is almost certain that the next generation of long-haul aircraft will not be electrically powered or even electrically assisted, so no significant energy efficiency improvements are expected. In contrast, with the renewal of narrow-body aircraft possibly in the early 2040s at the latest, there are likely to be full 150-seat all-electric aircraft for short-haul flights and larger hybrid aircraft for Central European flights. Therefore, due to technological development, it would seem possible for domestic air transport in 2045 to be mainly electric. However, the share of domestic aviation in emissions is so small that, as a rough overall estimate, new, more energy-efficient aircraft models can be estimated to reduce projected emissions growth by 15-25 % by 2045.

4.1.2 Electric aviation

There are several cooperation networks around the development of electric aviation technology and its introduction. Finavia and Finnair participate in the Nordic Network for Electric Aviation (NEA), which promotes electric aviation. However, it is practically certain that the electrification of aircraft will not affect the emissions situation before 2030s in Finland. Instead of fully electric aircraft, a hybrid aircraft could be the first to be used in domestic traffic and on other short routes. In terms of technology, this could probably happen in 2030-2035, but will depend on the strategies of airlines based on, among other things, the market

⁸³ Aircraft Technology Roadmap 2050, IATA 2019

and pricing situation and when the aircraft will be renewed. Aircraft are very expensive and have a long service life, which slows down the introduction of new technologies.

Finnair has signed a letter of interest with pioneering Swedish sustainable aviation company Heart Aerospace and could acquire up to 20 of its 19-seater ES-19 electric aircraft for use on shortest haul routes. The planes, which are currently in development, could be a part of the toolbox of new technologies in helping Finnair meet its plans to be carbon neutral by 2045.⁸⁴

In Europe, aircraft are on average 10.8 years old and the average age of the aircraft fleet operated by Finnair is 10.6 years. It is estimated that with the introduction of new electronic technologies, for example, the average age of the fleets would decrease, but this will depend on the current competitive and pricing environment and estimates of the development of demand. Finnair has planned to start its narrow-body fleet renewal at 2020's, so if this were to happen, it would probably be economically unprofitable to acquire replacement aircraft before 2040's. Full-electric aircraft are unlikely to be seen on domestic routes until the end of the 2030s.

In aviation, electrification must be promoted, but it is important to combine the measure with use of sustainable aviation fuels, as this is the only way to significantly reduce emissions from longer flights. In particular, electric fuels correspond to fully electric aircraft with emission reduction potential, although the efficiency of electric engines is clearly better than that of an internal combustion engine. The benefits of e-flying must also be seen in the reduction of emissions and noise affecting airports in the vicinity of airports.

The Government resolution of 6 May 2021 introduced the following measures related to technology and standards:

- Finland actively supports the efforts of ICAO and EASA (European Union Aviation Safety Agency) to create a standardisation basis for all-electric and hybrid aircraft and their alternative propulsion solutions.
- A report will be prepared on the electrification of aviation and the development needs of the charging infrastructure required for it at Finnish airports. In the same context, the longer-term possibilities for utilizing other alternative propulsion solutions for air transport, especially hydrogen, in Finland will be assessed.
- Finland seeks to increase the focus of European research and innovation framework program Horizon European funding on the development and promotion of new energy-efficient technologies in aviation.

4.2 Sustainable aviation fuels (SAF)

In air transport, the lack of alternative propulsion and the slow pace of electrification due to insufficient energy density of batteries underline the importance of introducing sustainable aviation fuels. According to current information, liquid aviation fuels will be used on a large scale until at least the 2050s, so in order to reduce emissions, it is essential to work towards replacing fossil kerosene with sustainable aviation fuels as soon as possible.

In addition to the introduction of a national distribution obligation, it would be important to promote the introduction of ambitious international obligations and targets in the EU and ICAO. As road transport becomes more electrified and other alternative propulsion systems are increasingly used, renewable fuels should be

⁸⁴ <https://www.finnair.com/fi-en/bluewings/sustainability/finnair-strengthens-collaboration-with-pioneering-electric-aviation-startup-heart-aerospace--2253632>

directed specifically at air transport, where there are fewer options for reducing emissions. The availability and costs of sustainable aviation fuels must also be carefully assessed so that policies for different modes of transport can be properly targeted and climate benefits maximized in a cost-effective way. It is also essential to provide an incentive to increase the development and production of sustainable aviation fuels through credible and long-term national and international action.

The European Commission is preparing the ReFuelEU package, which aims to increase the currently very low use of sustainable aviation fuels in the European Union. To this end the Commission is expected to present a legislative proposal in 2021. As preliminary options, the Commission has highlighted, inter alia, a distribution obligation, the increase in various incentives and the introduction of a centralised auction mechanism for sustainable aviation fuels. The price of sustainable aviation fuels is currently up to three times that of fossil kerosene, which is why its use is unlikely to continue to increase without binding policies or strong incentives.

As for Finland, the Program of Prime Minister Sanna Marin's Government aims to reduce aviation emissions by introducing a blending obligation for sustainable aviation fuels, with a target of 30% renewables by 2030⁸⁵. The Roadmap Working Group estimated that blending or distribution obligation is the most effective national tool for increasing the share of renewable aviation fuels in the short and long term. In this context, an impact assessment report presenting a variety of distribution obligation implementation paths to reduce air traffic emissions was published in December 2020.⁸⁶ During the legislative process for the implementation of the Government Program, the level of a distribution obligation of sustainable aviation fuels, or of an equivalent greenhouse gas emissions reduction obligation, are assessed, as well as the impact on the industry and the international development. The Ministry of Economic Affairs and Employment is currently evaluating more detailed ways of implementing the distribution obligation in aviation.

The obligation could be implemented as a distribution obligation for the energy content of the fuel, as is the case for road transport in Finland. Another option could be an obligation to reduce a certain amount of CO₂ emissions from fuel use. The latter approach could encourage the use of the most sustainable fuels with the highest CO₂ reductions. This would support, for example, the development and production of electric fuels produced from renewable electricity. The role of electric fuels in reducing aviation emissions is very important in the longer term, as it is otherwise difficult to effectively reduce emissions, especially from long-haul flights. The obligation would gradually increase the use of sustainable aviation fuel, with a small share in the first years, but rising sharply towards 2030. This would also take into account the effects of the COVID-19 pandemic and allow the industry to prepare for sustainable growth.

Finnish companies have significant know-how and production capacity for sustainable aviation fuels. Neste's sustainable aviation fuel production capacity at the Porvoo, Rotterdam and Singapore refineries is estimated to be, through on-going investments, at about 1.5 Mt by the end of 2023, which is the largest production volume of an individual company in the world in the light of current information. Neste is also targeting a final investment decision on its next renewable products refinery in Rotterdam by the end of 2021 or early 2022, which would further increase Neste's sustainable aviation fuel production capacity by 2025. ST1 Oy is building a refinery in Gothenburg capable of producing 0.2 Mt of sustainable aviation fuels or other transport renewable fuels. Some other companies also have refineries producing renewable diesel in Finland, either in

⁸⁵ <http://urn.fi/URN:ISBN:978-952-287-811-3> (page 125)

⁸⁶ <http://urn.fi/URN:NBN:fi-fe20201214100540>

operation or planned, which could also be utilized in the production of aviation fuels. In addition, technology related to synthetic electric fuels (PtL, Power to Liquid or PtX, Power to X) are being developed in Finland by, for example, Lappeenranta-Lahti University of Technology (LUT), which is done in cooperation with Finnish companies. LUT estimates that the price of green electricity needed for the electric fuels' production will come down, as wind power production costs in particular have fallen significantly in recent years. This narrows the current price gap between electric fuels and other renewable fuels. However, in international estimates, electric fuels are still clearly considered more expensive than other renewable fuels, and it is only in the 2030s that electric fuels will have a larger impact on reducing aviation emissions.

The amount of aviation fuel to be refueled in Finland is estimated to be at 1.125 Mt in 2030.⁸⁷ The slowdown in the electrification of road transport and thus its increasing use of renewable fuels may pose challenges to availability. In practice, the share of sustainable aviation fuel would probably be relatively low until 2025 and then rise towards the possible 2030 target.

The Government resolution of 6 May 2021 introduced the following measures related to SAF:

- The level of the obligation to distribute sustainable aviation fuels or a similar obligation to reduce greenhouse gas emissions, the impact on the industry and international developments, will be assessed in the context of the legislative process for the implementation of the Government Program.
- Finland actively promotes the introduction of sustainable aviation fuels in ICAO through international binding decisions, also as part of the long-term global aspirational goal for international aviation under preparation and the related measures.
- Finland supports the introduction of ambitious measures in the EU to promote the use of sustainable aviation fuels, such as a minimum distribution obligation.
- Finland considers it important that the promotion and sustainability of renewable aviation fuels are taken into account more widely in EU legislation, for example in the amendments of regulations on EU ETS for aviation and CORSIA and in the Renewable Energy Directive.
- With the electrification of road transport, the use of renewable fuels shall be directed to air transport through national and international decisions.
- Promoting technology and production related to sustainable renewable aviation fuels, and in particular electric fuels, in Finland through research and innovation funding.

4.3 Operational measures

In air transport, the energy efficiency of the transport system can be promoted, in particular by improving the functioning of airspace and introducing various flight methods and practices that reduce emissions. Since the early days of air transport, these so-called operational measures have been developed primarily from the safety point of view, but as traffic volumes have increased, the minimisation of emissions has also become increasingly important. In general, operational emission reduction measures can be considered relatively cost-

⁸⁷ Assessment of the Commission's Renewable Aviation Fuels Roundtable based on EUROCONTROL data presented on 4.3.2020

effective, as their introduction does not usually require, for example, the introduction of new aircraft technology.

4.3.1 Air Traffic Management and Air Navigation Services

The Single European Sky (SES) legislative framework aims to reduce the fragmentation of European airspace. The purpose of the project is to improve air traffic management and air navigation services. The Single European Sky has the potential to deliver significant benefits in terms of increased capacity and safety, as well as reduced air navigation costs and emissions. For example, shortening flight routes and preventing delays will reduce flight costs and emissions, so it is in Finland's interest to further develop SES. The development of airspace management and more energy-efficient operating methods emphasises the need for international cooperation, the open exchange of information between actors and the introduction of new digital and automatic operating methods.

The SES framework has contributed to the restructuring of European airspace and the provision of air navigation services. Among other things, they have separated regulatory functions and service provision, made military and civilian airspace more flexible, improved equipment interoperability, harmonised upper airspace classification, agreed on a common charging scheme for air navigation services and set common requirements for air traffic controller licenses. Under the framework functional airspace blocks have been developed. The purpose of functional airspace blocks is to reduce the fragmentation of European airspace by reorganising it according to traffic flows rather than national borders. To date, nine functional airspace blocks covering 31 countries have been established. Finland is part of the North-European Functional Airspace Block (NEFAB) together with Estonia, Latvia and Norway.

Cooperation within NEFAB has intensified in recent years. For example, since 2018, in the Finnish flight information region above flight level 95 the air traffic service on the radio frequency used by regional air traffic control has been provided only in English, as in other NEFAB countries. A common language facilitates the provision of cross-border air navigation services. Another concrete example is the intensification of co-operation between Finnish and Norwegian air navigation service providers, especially in the north, when in November 2016 the so-called Kirkenes approach area was extended to Finnish airspace, which facilitated traffic handling. In addition, the FINEST program of the Finnish and Estonian air navigation companies aims to provide a uniform, dynamic, cost-effective and competitive cross-border air navigation service to airspace users.

In 2015, NEFAB, together with the Danish and Swedish functional airspace blocks, also formed the Common European Free Route Airspace (NEFRA), in which airlines can fly either the most direct route possible or use additional waypoints, for example to benefit from wind. Free-routing airspace is very advanced in terms of airspace management and examinations have shown it to reduce aviation emissions, so the operating model should be expanded. Elsewhere, the airline must follow its pre-designated routes by flying through designated waypoints. NEFAB and NEFRA have been a significant improvement in air traffic management and it is estimated to reduce 62,500 tonnes of CO₂ per year compared to 2011.

The free routing airspace is to be gradually expanded so that in 2024 the airspace will cover the airspace of the United Kingdom, Ireland and Iceland in addition to the NEFRA area. This project is managed by the Borealis Alliance of service providers from these nine states. Flexible use of airspace and air traffic management network capacity is therefore an important means of reducing aviation emissions, as it not only benefits from wind and jet flows, but also optimises fuel consumption to avoid congestion, airspace restrictions and bad weather conditions. For long-haul flights, the potential emission benefits can be significant, but currently the airspace regulations do not offer sufficient flexibility,

especially for the Asian connections that are important from Helsinki-Vantaa's point of view. Fintraffic Air Navigation Services Ltd, which is responsible for air navigation services in Finland, has shared information with airlines and air navigation authorities of other countries about the possibilities of route optimisation. Besides reducing CO₂ emissions, airlines would save on fuel costs and make it easier to stay on schedule.

The Airspace Architecture study, completed in 2019, and the report of the Wise Persons Group⁸⁸ contain concrete ways to improve the use of airspace and air traffic management. The report of the Group of Wise Men sets out ten recommendations for improving the situation, divided into four themes: 1) a network-centric approach, 2) a digital European sky, 3) a change in the role of air traffic controllers, and 4) simplification of the regulatory framework. Implementing the recommendations would also reduce aviation emissions in Europe. It would be important to promote the adoption of the latest SES 2+ proposal for the Single European Sky legislative project, in order to increase the efficiency of European airspace while reducing emissions. However, the project as a whole is so large that the European Parliament has estimated that it will not be completed before 2030-2035.

A new challenge for the development of airspace management and aviation safety is the rapid development of unmanned aviation. However, unmanned aerial vehicles do not generally have the effect of increasing aviation emissions, as drones and other unmanned aerial vehicles are generally battery-powered. However, unmanned aeronautical solutions can achieve emission reductions at the level of the transport system, in particular as a more environmentally friendly alternative to road transport.

4.3.2 *Flight methods and other operational improvements*

In Finland, air navigation services are of a high international standard and co-operation with airlines is close. By further developing operations, open information exchange and co-operation, emissions can be reduced, for example by increasing the use of more energy-efficient flight methods. New flight methods in the vicinity of airports can only be implemented within the framework of noise control boundary conditions, which is now well taken into account in the cooperation of different actors. The efficient use of airspace is also promoted by close cooperation and exchange of information between civil and military aviation actors, which increases the efficiency of the temporal and regional allocation of airspace restrictions. However, national action has a rather limited impact compared to the opportunities for international cooperation. In addition to promoting decision-making on the Single European Sky, it is essential to promote airspace cooperation within ICAO and with individual countries. This could also support Helsinki-Vantaa Airport's position as a climate-friendly and punctual shuttle route between Europe and Asia.

Operational means can be used to reduce fuel consumption and emissions by, among other things, reducing flight speed, using energy-efficient landing and take-off methods, taxiing with one engine and utilising optimal flight surfaces. In the so-called Continuous Descent Operation (CDO), the power consumption and speed control of the aircraft are optimised so that the altitude of the aircraft decreases continuously, avoiding the horizontal flight phase and the intermittent power increases required by it. For example, the landing of a narrow-body aircraft at Helsinki-Vantaa Airport can save up to 100 kilograms of fuel, which corresponds to about 315 kilograms of CO₂ emissions. Finnair, in co-operation with air traffic control, is already able to utilize the method in about 80 per cent of landings, and annually it produces a significant emission reduction at Helsinki-

⁸⁸ <https://ec.europa.eu/transport/sites/transport/files/2019-04-report-of-the-wise-persons-group-on-the-future-of-the-single-european-sky.pdf>

Vantaa. The Continuous Climb Operation (CCO) method can be implemented by aircraft almost always in Helsinki-Vantaa's airspace, as take-off and approach routes and air traffic control are designed in such a way that departing aircraft rarely need to be subject to slowing altitude restrictions due to other traffic.

The allocation of slots at airports and measures to regulate air traffic flows aim to promote the efficient use of congested airports and airspace. The goal of these measures is to allow aircraft to wait at the departure airport and thus avoid waiting patterns with higher fuel consumption and emissions. Collaborative Decision Making (CDM) at the airport between different actors improves the flow of information and shortens the taxiing and waiting times of aircraft when aircraft can wait for departure at the gate instead of taxiways. This saves fuel consumption and emissions. At Helsinki-Vantaa, the annual emission reduction obtained through the CDM is estimated at 2,000 tonnes of CO₂. In addition to greenhouse gas emissions, these measures have the potential to reduce other emissions and noise, which is beneficial for the environmental and health impacts of airports and the comfort of living in neighboring areas.

Computer optimisation of aircraft routes has become more common. For example, the Airbus A350 aircraft used by Finnair have the option of introducing the computer program PACE, which helps in route selection and energy saving. In addition to optimising air routes, Airbus is trying to reduce emissions by two aircraft flying together for long-haul flights. The follower aircraft will retrieve the energy lost by the wake of a leader aircraft, by flying in the smooth updraft of air it creates. This provides lift to the follower aircraft allowing it to decrease engine thrust and therefore reduce fuel consumption in the range of 5-10% per trip. Airbus hopes that the method could be introduced as early as the mid-2020s.

Managing aircraft weight and fuel efficiency plays an important role in reducing CO₂ emissions from airlines' aviation operations. Finnair has drawn up a plan to systematically reduce the weight of aircraft and operate flights more fuel-efficiently. The goal is to reduce fuel consumption by 15,000 tonnes per year. As part of this plan, Finnair discontinued duty-free sales on its flights in the EU in April 2020. This will reduce the average weight of each intra-EU flight by 50-100 kg, which is estimated to reduce fuel consumption by 70 tonnes and CO₂ emissions by 220 tonnes per year. Finnair has also estimated that if each of their passengers reduced the weight of their luggage by one kilogram, they could fly 20 round trips between Helsinki and Tokyo with the saved fuel.

The impact of airspace management and other operational improvements in reducing domestic aviation emissions is unlikely to be significant in the coming decades, as operations are already high-quality and Finnish airspace is not expected to suffer from congestion. On the other hand, development measures will have a slightly greater impact on the emissions of international traffic leaving Finland. EUROCONTROL has estimated that it would be possible to achieve an emission reduction of 1.7-3.2 % in Europe by 2025, after which it would be possible to reduce the estimated 6-10 % airspace efficiency gap through airspace harmonisation and SESAR development activities. According to EUROCONTROL, the new routing could save around 30-60 million tonnes of CO₂ at European level between 2019 and 2035.⁸⁹ In the case of long-haul flights, the emission reduction potential is particularly relevant for Asian routes, if international cooperation can increase the route optimisation potential. It is difficult to accurately assess the overall impact of operational measures on Finnish aviation emissions, as the most effective measures require a broader regional and global consensus, the achievement of which is uncertain. Compared to the current level, however, it would be possible to increase the efficiency of the transport system, especially in

⁸⁹ The Aviation Network – Decarbonisation issues, EUROCONTROL Think Paper #4, 9/2019

congested airspace areas, by about ten per cent by 2045, but the impact on emission reductions in Finland is likely to be smaller.

The Government resolution of 6 May 2021 introduced the following measures related to operational measures:

- Finland supports the reform of performance and charging schemes contained in the SES2 + proposal in a way that encourages better achievement of environmental objectives and reduction of emissions.
- Finland promotes the regulation of unmanned aviation in a way that enables flexible use of airspace and the operation of unmanned aviation even without visual contact in a safe and controlled manner.
- Finland supports the expansion of free routing airspace in order to shorten flight routes and reduce emissions.

4.4 Market-based measures

As an international mode of transport, air transport has been a pioneer in the introduction of international pricing and market-based mechanisms. As the first mode of transport, air transport joined the EU Emissions Trading Scheme in 2012. With the historic decision of the ICAO General Assembly in 2016, international aviation also became the first industry to decide to introduce a global market-based mechanism for its emissions. The offsetting obligations of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) start from the beginning of 2021. In addition to these, there have been occasional discussions at national and EU level about the introduction of various air passenger or fuel taxes. In Finland, a citizens' initiative on the introduction of a passenger flight tax was submitted to Parliament in February 2020 and it is currently under the Parliament's consideration. The Government has also launched a study on taxation in air transport as a steering mechanism to reduce emissions, estimated to be completed by 2022.

4.4.1 EU Emissions Trading Scheme for Aviation

The EU Emissions Trading Scheme (EU ETS) currently covers all intra-European Economic Area flights. Finland as a member of the European Union has participated in the EU ETS from its outset. The EU Emissions Trading Scheme has generally been seen as a cost-effective way to reduce emissions from the activities it covers, as it provides a better incentive to reduce emissions and improve energy efficiency, than for example through air passenger taxes. On the other hand, the system enables additional purchases of emission rights if it would be very expensive or impossible to reduce emissions by means of new technology, for example.

The Commission has estimated that the EU ETS has reduced CO₂ emissions from aviation by more than 17 million tonnes per year⁹⁰. Despite this, emissions from aviation have continued to grow both in the EU in general and in Finland. As part of the European Green Deal, the Commission will propose to reduce the EU Emissions Trading System allowances allocated for free to airlines. The Commission is expected to present legislative proposals in 2021 to increase the efficiency of the system.

Reducing and possibly eliminating free allocation would improve the effectiveness of emissions trading and create a greater incentive for airlines to reduce emissions and improve energy efficiency. This would also increase the cost to airlines. The Emissions Trading Scheme will very likely remain a key climate

⁹⁰ https://ec.europa.eu/clima/policies/transport/aviation_en

measure for aviation in the EU until, through technological development and the introduction of alternative power sources, aviation is potentially zero emission in the future.

It is difficult to assess the potential national emission reductions from aviation resulting from the EU ETS, as some of the reductions occur in other sectors and it is difficult to identify the impact of ETS on intra-sectoral emissions reductions. However, the EU ETS will undoubtedly support emission reductions in the aviation sector and the positive impact will clearly increase as conditions for the EU ETS tighten, supporting the transition to new low-emission technologies and alternative power sources.

4.4.2 CORSIA

In 2016, the 39th session of the ICAO Assembly concluded with the adoption of a global market-based measure scheme to address CO₂ emissions from international aviation. The ICAO resolution creates an offsetting system for international aviation to cap aviation emissions at 2019 levels. The CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) agreement complements the other emission reduction measures used in aviation. Finland will voluntarily participate in CORSIA from its outset.

The success of CORSIA is very important for ICAO and other actors in the aviation sector, which are under increasing pressure to reduce emissions. Finland and Europe have actively contributed to the implementation of CORSIA and to the promotion of its efficiency. CORSIA, as a global system, complements the EU emissions trading scheme and it is important to ensure that the systems work together.

Raising awareness and competence will play an important role in the implementation of CORSIA in ICAO Member States during the voluntary phase of the system. To promote this goal, Finland, for example, organised an ICAO regional CORSIA seminar in 2019.

The Government resolution of 6 May 2021 introduced the following measures related to market-based measures and pricing:

- Finland's objective is to gradually reduce and eventually phase out the free allocation of aviation allowances in the EU ETS. The EU ETS shall be developed to reduce emissions from aviation in the European Economic Area.
- Finland will influence the EU Commission to provide as quickly as possible the necessary legislative proposals related to CORSIA.
- In ICAO, Finland actively promotes the effectiveness of CORSIA in reducing aviation emissions. Particular emphasis should be placed on the quality of emission units, the avoidance of double counting and the widespread introduction of the system among ICAO Member States.
- Finland's goal is to agree at the ICAO General Assembly in 2022 on an ambitious long-term aspirational goal for international aviation to reduce CO₂ emissions and agree on the means to achieve it.
- Finland plays an active role in the EU and ICAO in promoting the pricing of greenhouse gas emissions from aviation.
- A study will be carried out on the impact and effectiveness of the introduction of a national aviation tax in reducing aviation emissions in relation to other emission reduction measures.

- The role of airport charges in reducing greenhouse gas emissions from aviation will be assessed following the adoption of legislative proposals by the Commission.

4.5 Other regulatory measures

The Government of Finland adopted the National Transport System Plan for 2021–2032⁹¹ and submitted it in the form of a report to Parliament in April 2021. The National Transport System Plan aims to add a longer-term perspective to development of the transport system throughout Finland. The plan was now drawn up for the first time and has been prepared interactively with stakeholders, under the leadership of a parliamentary steering group. The objective is that the transport system guarantees accessibility to all parts of Finland and responds to the needs of industries, commuting and housing. People should be able to choose more sustainable modes of mobility, especially in urban areas. In addition, the aim is to improve the socio-economic efficiency of the transport system.

The Government resolution of 6 May 2021 introduced the following measures related to other regulatory measures:

- Implementation of the proposals of the National Transport System Plan for the development of key transport hubs, such as airports, into parts of sustainable and seamless travel chains, making full use of the potential of digitalisation.
- In connection with the implementation of the National Transport System Plan, comprehensive and low-emission public transport services will be developed as an alternative to domestic air transport.
- Prioritize the implementation of a Logistics Digitalisation Strategy⁹² to promote the sustainability of transport chains through the production, sharing and use of information, applying in particular new transport system-level operating models such as unmanned aeronautics solutions.
- Amend the state's travel strategy to reduce air travel by using virtual meeting solutions. In addition, sustainability will be increased by favoring low-emission alternatives in government travel procurement.

4.6 Airport improvements

Finavia Plc operates 21 airports in Finland and is responsible for their maintenance. In addition to Finavia's airport network, there are locally maintained airports in Lappeenranta, Mikkeli and Seinäjoki. In addition, ground handling companies serve the airlines. The airport network is carbon neutral with Finavia's emission reduction measures and emission compensation. It would still be possible to reduce emissions by, for example, increasing the use of renewable motor fuel in work equipment, promoting the electrification of ground handling equipment and increasing environmental transparency.

At the interface between air transport and other modes of transport, it is possible to reduce the total emissions of the transport system by developing sustainable travel chains and new logistical solutions made possible by unmanned aviation. Active opening of data interfaces and co-operation aimed at utilizing data can

⁹¹ <https://www.lvm.fi/en/-/national-transport-system-plan-towards-an-achievable-sustainable-and-efficient-transport-system-1267005>

⁹² <http://urn.fi/URN:ISBN:978-952-243-582-8>

promote the popularity of sustainable passenger services and ensure seamless logistics between trunk transport and hubs.

Airports, and especially Helsinki-Vantaa, are important transport hubs, the development of which into a sustainable transport system must be taken into account in the implementation of the National Transport System Plan. It is also important to develop the transport system so that comprehensive and low-emission public transport services are available as an alternative to air transport.

4.7 **Estimated emission reductions from selected measures**

The aim of this plan is to assess Finland's possibilities for reducing CO₂ emissions from aviation. The emission reductions listed here are for illustrative purposes only, as some of the measures have already been taken into account at the European-level baseline scenario, presented in Section 1 of this Action Plan and therefore cannot be added to the benefits presented in the European section.

Title	SAF distribution obligation
Category	Sustainable aviation fuels
Date of implementation	In the 2020s and onwards
Action	The Program of Prime Minister Sanna Marin's Government aims to reduce aviation emissions by introducing a blending obligation for sustainable aviation fuels, with a target of 30% renewables by 2030. The eventual level of the obligation to distribute sustainable aviation fuels or a similar obligation to reduce greenhouse gas emissions, the impact on the industry and international developments, will be assessed in the context of the legislative process for the implementation of the Government Program.
Economic cost	High
List of stakeholders involved	All stakeholders
Reduction in CO₂ emissions	Potentially significant

Title	NEFAB
Category	Improved Air Traffic Management and Infrastructure Use
Date of implementation	2012 onwards
Action	More efficient airspace structure and more direct routes
Economic cost	High

List of stakeholders involved	Finavia, Traficom, Airlines
Reduction in CO₂ emissions	62 500 tonnes annually (by 2020)

Title	Finnair Fuel Efficiency Programme
Category	More Efficient Operations
Date of implementation	2017 onwards
Action	Numerous programs, projects and single items for improving fuel efficiency and reducing operative weight
Economic cost	Considerable
List of stakeholders involved	Finnair, Nordic Regional Airlines, Finavia, Fintraffic ANS, EUROCONTROL
Reduction in CO₂ emissions	Approx. 15-30 000 tonnes of CO ₂ annually

Title	Continuous Descent Operations
Category	Improved Air Traffic Management and Infrastructure Use
Date of implementation	Started in 2008, continuous
Action	Offering CDOs at all of Finavia's 21 airports
Economic cost	Medium
List of stakeholders involved	Finavia, Fintraffic ANS, Airlines
Reduction in CO₂ emissions	Approx. 315 kilos of CO ₂ per landing at Helsinki Airport

Title	Airport Collaborative Decision Making (A-CDM)
Category	Improved Air Traffic Management and Infrastructure Use
Date of implementation	Started in 2012, continuous
Action	Offering shorter taxiing times at Helsinki-Vantaa airport
Economic cost	Medium
List of stakeholders involved	Finavia, Airlines

5 List of abbreviations

AAT - Aircraft Assignment Tool

ACARE – Advisory Council for Research and Innovation in Europe

ACA – Airport Carbon Accreditation

ACI – Airports Council International

AIRE – The Atlantic Interoperability Initiative to Reduce Emissions

APER TG - Action Plans for Emissions Reduction Task Group of the ECAC/EU Aviation and Environment Working Group (EAEG)

ATM – Air Traffic Management

CAEP – Committee on Aviation Environmental Protection

CNG – Carbon neutral growth

CORSIA - Carbon Offsetting and Reduction Scheme for International Aviation

EAER – European Aviation Environmental Report

EASA – European Aviation Safety Agency

EC – European Commission

ECAC – European Civil Aviation Conference

EEA – European Economic Area

EFTA – European Free Trade Association

EU – European Union

EU ETS – the EU Emissions Trading System

GHG – Greenhouse Gas

ICAO – International Civil Aviation Organisation

IFR – Instrumental Flight Rules

IPCC – Intergovernmental Panel on Climate Change

IPR – Intellectual Property Right

JU – Joint Undertaking

MBM – Market-based Measure

MT – Million tonnes

PRISME - Pan European Repository of Information Supporting the Management of EATM

RED – Renewable Energy Directive

RPK – Revenue Passenger Kilometre

RTK – Revenue Tonne Kilometre

RTD – Research and Technological Development

SAF – Sustainable Aviation Fuels

SES – Single European Sky

SESAR – Single European Sky ATM Research

SESAR JU – Single European Sky ATM Research Joint Undertaking

SESAR R&D – SESAR Research and Development

SMEs - Small and Medium Enterprises

— END —

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