



ICAO State Action Plan on CO₂ emissions from aviation

Denmark

June 2021



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Common preamble

- a) The ICAO Contracting State Denmark 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 States¹ 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) Denmark, 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) Denmark recognizes 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 Denmark.
- g) Denmark 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 optimization of Air Traffic Management and infrastructure use

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

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 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 Denmark is described, as well as that of other stakeholders.

i) In Denmark 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:

- 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.
- 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).

Introduction: Current state of aviation in Denmark

The COVID-19 crisis

The COVID-19 crisis has affected the whole world in 2020 and 2021, and international aviation has been one of the areas most affected. International travel has dropped dramatically, and it is expected that a return to the level of activity before the crisis might take years.

The effect of the COVID-19 pandemic will not be visible in this state action plan. The most recent data in the state action plan will primarily be from 2019, which is the last normal year. The next state action plan is due in 2024, and will reflect the changes in international aviation caused by the pandemic.

Basic facts

Denmark is part of the Nordic Region in Europe, and has borders with Germany to the south. Denmark has an area of 43,000 km², and with 5.8 million inhabitants it is the smallest in area but also the most densely populated country in the Nordic Region with 130 inhabitants per square kilometers. The country consists of the Jutland peninsula and over 400 islands, of which Zealand and Funen are the largest. The Capital of Denmark, Copenhagen, is situated on the east coast of Zealand. 85% of the population lives in cities.

Greenland and the Faroe Islands are part of the Kingdom of Denmark but have autonomous self-rule. Denmark is bound together by many roads, railways, bridges and ferry routes. Domestic flights play a minor, but important role in linking the various parts of the country together. Greenland does not have road- or train connections between its cities and is dependent on domestic flight connections. On the Faroe Islands some of the islands have regular helicopter connections with the main towns.

Airports in Denmark

Denmark has 9 public airports with more than 10,000 passengers per year. Copenhagen (København) Airport has the largest number of passengers, while Billund is the largest provincial airport.



Major airports in Denmark (Karup = Midtjylland, Rønne = Bornholm)

Copenhagen Airport A/S is a shareholder company, of which the Danish state owns 39.2% of the shares. The other larger provincial airports are owned by the municipalities, except Roskilde Airport, which is owned by Copenhagen Airport A/S, and Bornholms (Rønne) Airport which is owned by the Danish state.

The total number of passengers in the larger Danish airports has been increasing over the past years from around 24 million passengers in 2005 to around 37 million in 2019. The total quantity of cargo transported by airplane via Copenhagen and Billund (which are the most significant cargo airports) in the same period, has varied and amounted to 318,000 tons in 2019.

Air operators in Denmark

There are around 15 aviation operators with an EU license to operate aircrafts with an approved starting volume larger than 10 tons, more than 20 seats, or an annual turnover that exceeds 3 million euro. Moreover, there are two North Atlantic aviation companies (Atlantic Airways and Air Greenland), who have Danish concession to fly passengers, cargo, mail etc. The two largest companies measured by turnover in the last few years, are SAS Group and Sunclass Airlines.

SAS Group operates as a Scandinavian airline with one AOC and consists of the companies SAS Danmark A/S, SAS Norge ASA and SAS Sverige AB, which respectively have Danish, Norwegian, and Swedish EU license. In June 2018 the Norwegian state sold its shares in SAS Group. Consequently, Sweden and Denmark now own 21.8 % of the shares each, and the rest is privately owned. In respect of both EU ETS, CH ETS and CORSIA covered emission, SAS' operations are reported as a whole to the Swedish competent authority.

Air Traffic Services

The provision of air traffic services in the Danish airspace is mainly provided by Naviair in the form of air traffic control service. Naviair has been designated by the Danish Transport and Construction Agency to provide this aviation infrastructure, and Naviair's core activity is air navigation services. Naviair has activities both in Danish airspace and North Atlantic airspace. The activities cover four areas: En route – Denmark, En route – Greenland, Local Air Traffic Services and Other areas of activity. Expressed in terms of revenue, En route – Denmark is the biggest area of activity.

Naviair is highly engaged in taking advantage of the opportunities to contribute to a positive climate action and reduction in CO₂ emissions in the aviation industry.

Danish domestic aviation

The Danish provincial airports are placed with a short travel time to Copenhagen Airport. Currently, there are domestic routes between Copenhagen and respectively Aalborg, Aarhus, Midtjylland, Billund, Bornholm, and Sønderborg, and also between Bornholm and respectively Billund, Aalborg and Sønderborg. In addition, there are flights between Copenhagen and Kangerlussuaq in Greenland, as well as between Danish airports and Vagar Airport on the Faroe Islands, which in Denmark are also considered as domestic routes.

Since 1993 domestic aviation has been liberalized and the market conditions, the number of departures and the pricing are determined by private operators.

The total number of domestic passengers in Denmark amounted to ca. 3,543,000 in 2019, which is around 10% of the total number of passengers in the Danish airports.

Danish international aviation

Danish international aviation is dominated by two key players: SAS and Copenhagen Airport. SAS Group has, as a joint Scandinavian airline, many routes in Europe and also overseas. SAS Group is part of the Star Alliance and has in recent years felt the increasing competition from low fare airlines. One of the main hubs for the SAS Group is Copenhagen Airport.

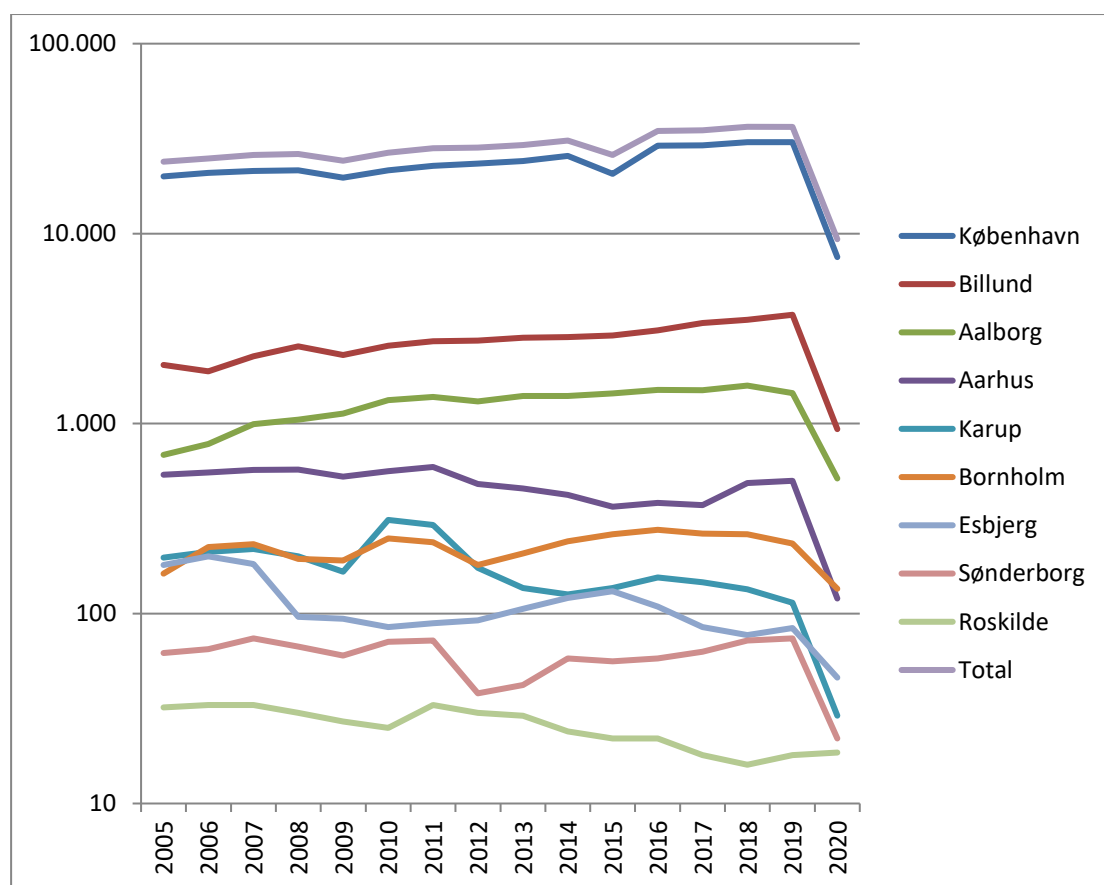
Copenhagen Airport is by far the largest airport in Denmark with ca. 30 million passengers in 2019. In 2014 Copenhagen Airport A/S presented a master plan for the future, which prepares the airport for a growth up to 40 million passengers.

There are three airports with international departures in Jutland, e.g. Billund, Aalborg and Aarhus. Billund Airport had around 3.7 million international passengers in 2019.

International aviation also includes cargo transportation, which typically transports goods that are expensive, compact, and/or easily spoiled. Air cargo is an important component in the logistics included in import as well as export.

The Development in Danish Aviation

The figure below shows the development of the total number of passengers at the Danish airports with more than 10.000 passengers per year, in the years 2005-2020. The effect of the COVID-19 pandemic is clear.



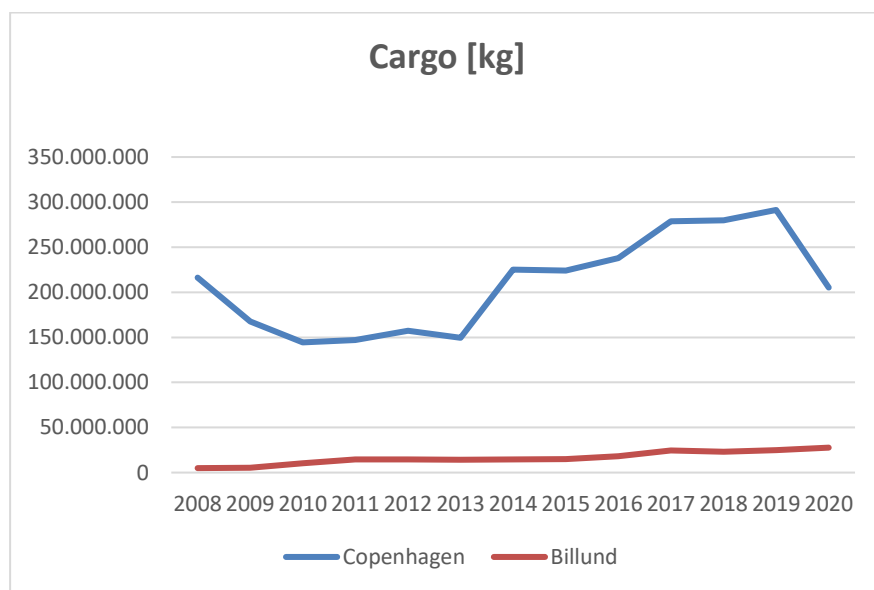
Development of total number of passengers in major Danish airports 2005-2020 (x000)

The table below shows the total number of passengers at the Danish airports with more than 10.000 passengers, in 2020. Moreover, it is divided into domestic and international passengers, and their percentage of the total number of passengers distributed to domestic and international flights.

Airports	Total	Total Domestic	% Domestic	% International
København	7525	803	10,7	89,3
Billund	935	52	5,6	94,4
Aalborg	514	366	71,2	28,8
Aarhus	120	56	46,7	53,3
Karup	29	27	93,1	6,9
Bornholm	135	134	99,3	0,7
Esbjerg	46	38	82,6	17,4
Sønderborg	22	21	95,5	4,5
Roskilde	19	13	70,0	30,0
Total	9.345	1.510	16,2	83,8

Number of passengers in the Danish airports, including domestic, in 2020 (x000)

Only the two largest airports, namely Copenhagen Airport and Billund, handle a significant amount of air cargo. The figure below shows the development in air cargo since 2008.



Air cargo at major Danish airports 2008-2020 (kg).

SECTION 1: ECAC/EU common section for European State Action Plans

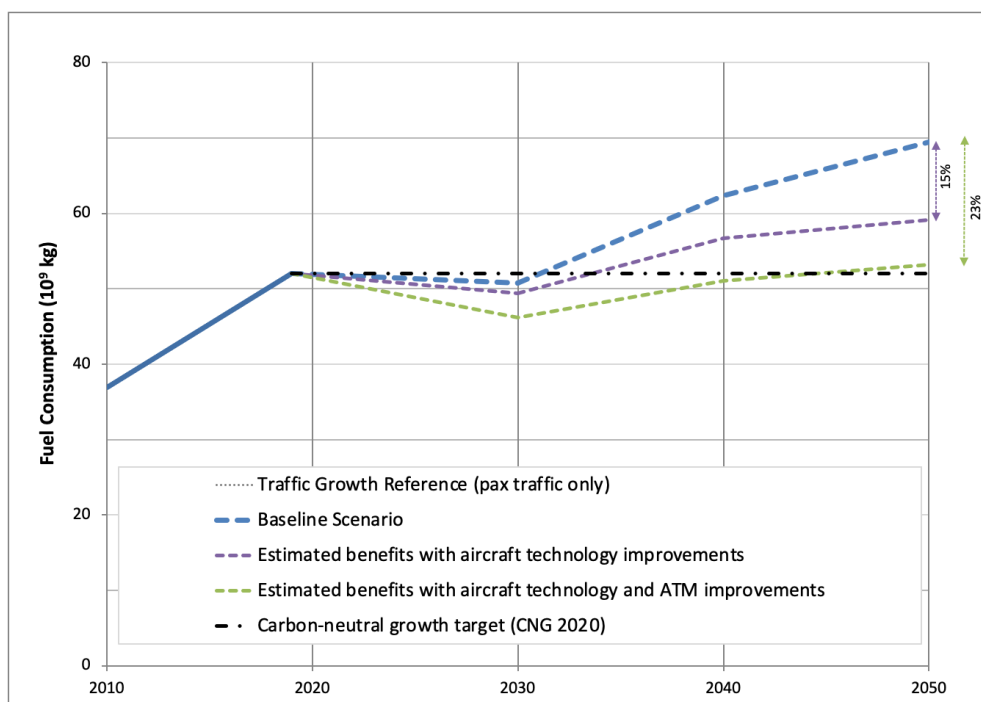
Please note that Denmark is not necessarily participating actively in all the following activities, but we are contributing to them through the financing of EU programmes, membership of Eurocontrol and general political support. Some of the Danish involvement is described in section 2 of this action plan.

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 incentivize and reward good investment and operational choices, and so welcomed the agreement on CORSIA.

The 30 European Economic Area (EEA)² 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,

² The EEA includes EU countries and also Iceland, Liechtenstein and Norway.

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.

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.

European States' Action Plans ECAC/EU Common Section

EXECUTIVE SUMMARY

A. ECAC BASELINE SCENARIO AND ESTIMATED BENEFITS OF IMPLEMENTED MEASURES

B. ACTIONS TAKEN COLLECTIVELY IN EUROPE

1. TECHNOLOGY AND STANDARDS

- 1.1. Aircraft emissions standards
- 1.2. Research and development: Clean Sky and the European Partnership for Clean Aviation

2. SUSTAINABLE AVIATION FUELS (SAF)

- 2.1. ReFuelEU Aviation Initiative
- 2.2. Addressing barriers of SAF penetration into the market
- 2.3. Standards and requirements for SAF use
- 2.4. Research and development projects

3. OPERATIONAL IMPROVEMENTS

- 3.1. The EU's Single European Sky Initiative and SESAR

4. MARKET-BASED MEASURES

- 4.1. The EU Emissions Trading System and its linkages with other systems (Swiss ETS and UK ETS)
- 4.2. The Carbon Offsetting and Reduction Scheme for International Aviation

5. ADDITIONAL MEASURES

- 5.1. ACI Airport Carbon Accreditation
- 5.2. European industry roadmap to a net zero European aviation: Destination 2050
- 5.3. Environmental Label Programme
- 5.4. Multilateral capacity building projects
- 5.5. Green Airports research and innovation projects

6. SUPPLEMENTAL BENEFITS FOR DOMESTIC SECTORS

- 6.1. ACI Airport Carbon Accreditation
- 6.2. ReFuelEU Aviation Initiative

- 6.3. SAF Research and development projects
- 6.4. The EU's Single European Sky Initiative and SESAR
- 6.5. Green Airports research and innovation projects

APPENDIX A-Detailed results for ECAC Scenarios from Section A

APPENDIX B- Note on the methods to account for the CO₂ emissions attributed to international flights



A. ECAC BASELINE SCENARIO AND ESTIMATED BENEFITS OF IMPLEMENTED MEASURES

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 forecast³ 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 trends⁴. 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 characterizing 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 results³ (published in 2018 by EUROCONTROL). Historical data for the year 2019 are also shown later for reference.

³ [Challenges of Growth - Annex 1 - Flight Forecast to 2040, EUROCONTROL, September 2018.](#)

⁴ 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 localized 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 forecast⁵ 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 forecast³. Considering the most-likely scenarios of the long-term forecast³ and the medium-term forecasted version of the long-term flight forecast has been derived:

- a) Replace the long-term forecast³ horizon by the most recent medium-term forecast⁵ to account for COVID impact;
- b) Update the rest of the horizon (2025-2040) assuming that the original growth rates of the long-term forecast³, 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 decay⁶.

The method used relies on the calculation of adjustment factors at STATFOR⁷ region-pair level and have been applied to the original long-term forecast³. 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.

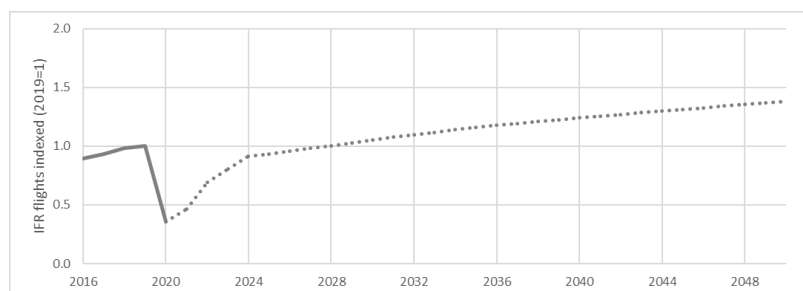
Figure 1 below shows the ECAC scenario of the passenger flight forecasted international departures for both historical (solid line) and future (dashed line) years.

⁵ Five-Year Forecast 2020-2024, IFR Movements, EUROCONTROL, November 2020.

⁶ 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.

⁷ 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 departing⁸ 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 (ICAO⁹). 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 PRISME¹⁰ 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

⁸ 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.

⁹ 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.

¹⁰ PRISME is the name of the EUROCONTROL data warehouse hosting the flight plans, fleet and airframe data.

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 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 ¹¹ RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported ¹² FTKT (billion)	Total Revenue Tonne Kilometres ¹³ 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 ¹¹)	Fuel efficiency (kg/RTK ¹³)
2010	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280

¹¹ Calculated on the basis of Great Circle Distance (GCD) between airports, for 97% of the passenger traffic for forecast years.

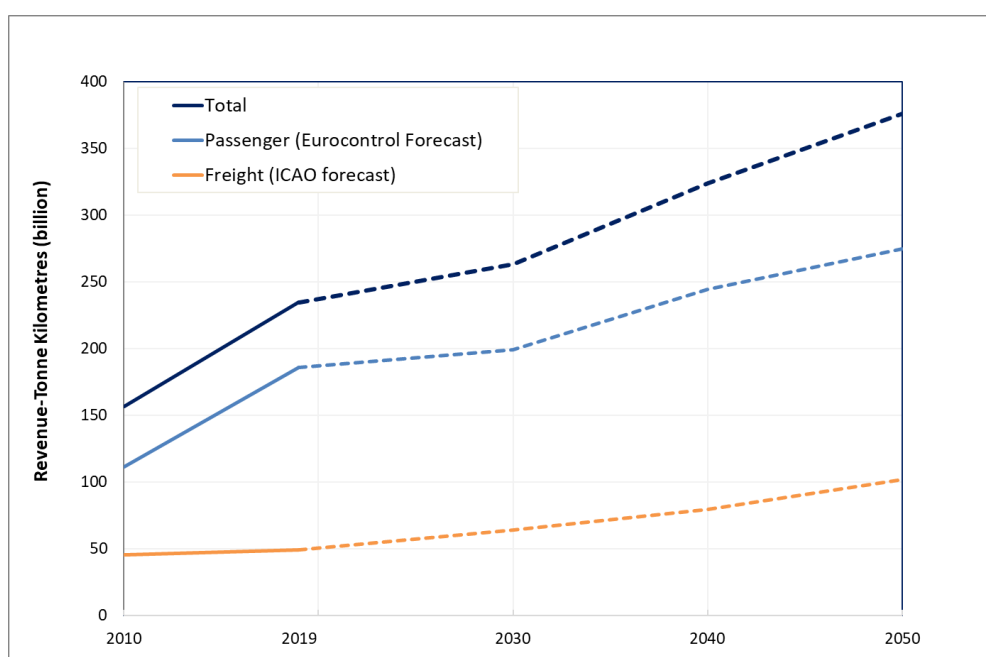
¹² Includes passenger and freight transport (on all-cargo and passenger flights).

¹³ A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).

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

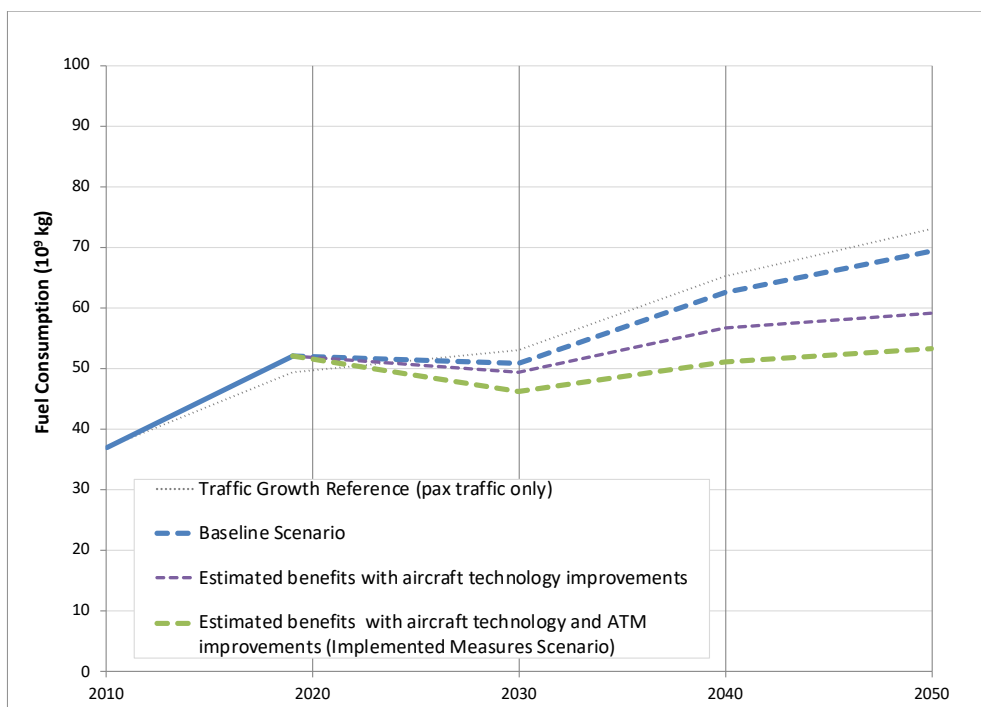
For reasons of data availability, results shown in this table do not include cargo/freight traffic.

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



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).



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 Tool¹⁴ (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

¹⁴ <https://www.easa.europa.eu/domains/environment/impact-assessment-tools>

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 baseline¹⁵. Based on the information provided by the PAGAR 2019 document¹⁶, 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 projects¹⁷ 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 goals¹⁸, 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.

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 4¹⁹, 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).

¹⁵ See SESAR ATM Master Plan – Edition 2020 (www.atmmasterplan.eu) - eATM.

¹⁶ See SESAR Performance Assessment Gap Analysis Report (PAGAR) updated version of 2019 v00.01.04, 31-03-2021.

¹⁷ See SESAR Exploratory Research projects - <https://www.sesarju.eu/exploratoryresearch>

¹⁸ <https://www.acare4europe.org/sria/flightpath-2050-goals/protecting-environment-and-energy-supply-0>

¹⁹ 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).

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 ²⁰)	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%

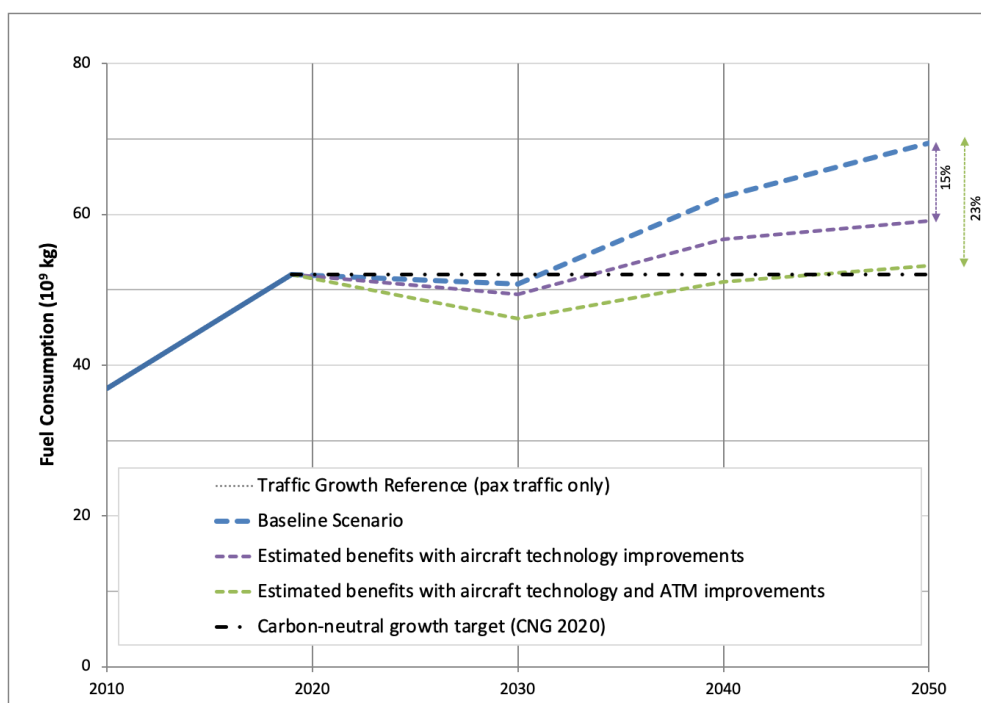
Table 6. CO₂ emissions forecast for the scenarios described in this chapter.

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.				

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

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.

B. ACTIONS TAKEN COLLECTIVELY IN EUROPE

1. TECHNOLOGY AND STANDARDS

- 1.1. Aircraft emissions standards
- 1.2. Research and development: Clean Sky and the European Partnership for Clean Aviation

2. SUSTAINABLE AVIATION FUELS (SAF)

- 2.1. ReFuelEU Aviation Initiative
- 2.2. Addressing barriers of SAF penetration into the market
- 2.3. Standards and requirements for SAF use
- 2.4. Research and development projects

3. OPERATIONAL IMPROVEMENTS

- 3.1. The EU's Single European Sky Initiative and SESAR

4. MARKET-BASED MEASURES

- 4.1. The EU Emissions Trading System and its linkages with other systems (Swiss ETS and UK ETS)
- 4.2. The Carbon Offsetting and Reduction Scheme for International Aviation

5. ADDITIONAL MEASURES

- 5.1. ACI Airport Carbon Accreditation
- 5.2. European industry roadmap to a net zero European aviation: Destination 2050
- 5.3. Environmental Label Programme
- 5.4. Multilateral capacity building projects
- 5.5. Green Airports research and innovation projects

6. SUPPLEMENTAL BENEFITS FOR DOMESTIC SECTORS

- 6.1. ACI Airport Carbon Accreditation
- 6.2. ReFuelEU Aviation Initiative
- 6.3. SAF Research and development projects
- 6.4. The EU's Single European Sky Initiative and SESAR
- 6.5. Green Airports research and innovation projects



1. TECHNOLOGY AND STANDARDS

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.

1.2 Research and development

1.2.1 Clean Sky

Clean Sky²¹ 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.

²¹ <http://www.cleansky.eu/>

- **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.

In addition, the **Clean Sky Technology Evaluator**²² 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).

1.2.1 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)**²³ 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.

²² <https://www.cleansky.eu/technology-evaluator-te>

²³ <https://clean-aviation.eu/>

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 (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%



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 fuel²⁴. 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.

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 decarbonization 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 decarbonization 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"*.

²⁴ [ICAO 2016 Environmental Report](#), Chapter 4, Page 162, Figure 4.

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.

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 decarbonize.

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.

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.

2.2.1 Sustainable Aviation Fuel 'Facilitation Initiative'

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

The report begins by analyzing 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'](#)'.

2.2.2. 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.

2.3 Standards and requirements for SAF

2.3.1. 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's²⁵ 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 origin²⁶, 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;

²⁵ Directive 2009/28/EC.

²⁶ 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).

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

2.3.2. 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.

2.4 Research and Development projects on SAF

2.4.1 European Advanced Biofuels Flightpath

An updated and renewed approach to the 2011 Biofuels FlightPath Initiative²⁷, 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 available²⁸.

²⁷ 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 commercialization of aviation biofuels in Europe, with an initial objective of achieving the commercialization 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

²⁸ <https://www.biofuelsflightpath.eu/ressources>

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

2.4.2 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.

BIO4A²⁹: 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.

KEROGREEN³⁰: *Production of sustainable aircraft grade kerosene from water and air powered by renewable electricity, through the splitting of CO₂, syngas formation and 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.

FlexJET³¹: *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

²⁹ www.bio4a.eu

³⁰ www.kerogreen.eu

³¹ www.flexjetproject.eu

technologies to use green hydrogen from the processed waste feedstock for the downstream refining process thereby maximizing 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 organizations 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.

BioSFerA³²: 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.

BL2F³³: 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.

FLITE³⁴: 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-

³² <https://biosfera-project.eu>

³³ <https://www.bl2f.eu>

³⁴ <https://cordis.europa.eu/project/id/857839>

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-OFF³⁵: 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, utilizing 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.

³⁵ <https://cordis.europa.eu/project/id/101006799>



3. OPERATIONAL IMPROVEMENTS

3.1 The EU's Single European Sky Initiative and SESAR

3.1.1 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 digitalized 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 modernize 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), optimized use of runway configuration for multiple runway airports, or even optimized 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 industrialization 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 endeavor.

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 delay¹, min/dep	9.5 min	6.5-8.5 min	1-3 min	10-30%
		IFR movements at most congested airports², million	4 million	4.2-4.4 million	0.2-0.4 million	5-10%
		Network throughput IFR flights³, million	9.7 million	~15.7 million	~6.0 million	~60%
		Network throughput IFR flight hours⁴, 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 flight¹, EUR(2012)	EUR 960	EUR 580-670	EUR 290-380	30-40%
		Gate-to-gate fuel burn per flight², 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 CO₂ 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 contribution⁴, #/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	-

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 synchronized deployment. To facilitate the deployment of these SESAR solutions, the Commission establishes common projects that mandate the synchronized 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 project³⁶ 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.

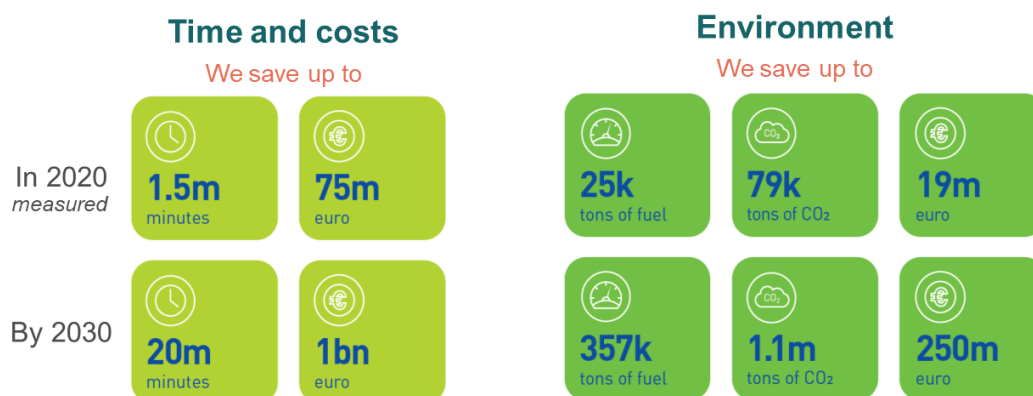


Figure 6: First results of the first common project implemented.

3.1.2 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.

3.1.3 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 IMPACT³⁷ 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 process³⁸.

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

³⁶ https://ec.europa.eu/transport/modes/air/sesar/deployment_en

³⁷ <https://www.eurocontrol.int/platform/integrated-aircraft-noise-and-emissions-modelling-platform>

³⁸ <https://www.sesarju.eu/sites/default/files/documents/transversal/SESAR%202020%20-%20Environment%20Impact%20Assessment%20Guidance.pdf>

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.

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 available³⁹ and those addressing environment impacts are identified by the following pictogram:



3.1.4 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:

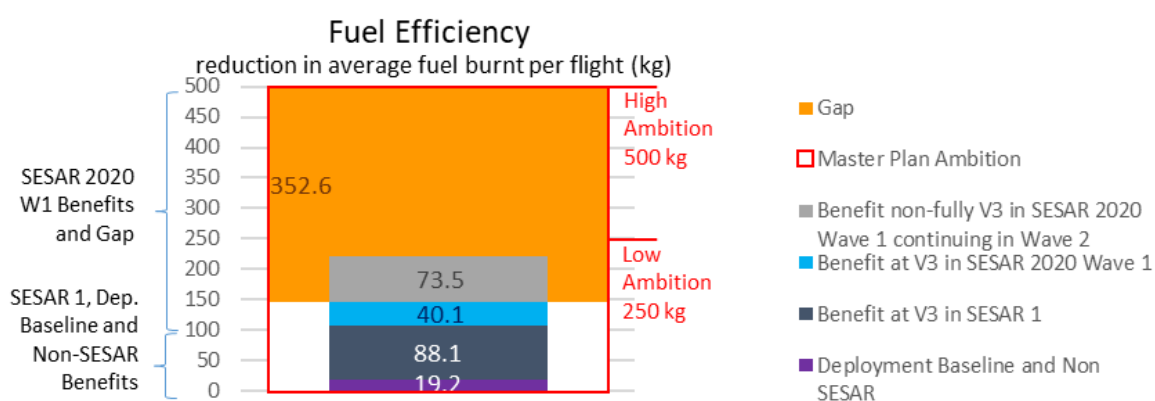


Figure 7: SESAR fuel efficiency achievement versus gap (Source: Updated version of PAGAR 2019)

³⁹ <https://www.sesarju.eu/news/sesar-solution-catalogue-third-edition-now-out>

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.

In SESAR, a value of 5,280 Kg of fuel per flight for the ECAC (including oceanic region) is used as a baseline⁴⁰. Based on the information provided by the PAGAR 2019 document⁴¹, 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 projects⁴².

3.1.5 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).

AIRE⁴³ 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.

⁴⁰ See SESAR ATM Master Plan – Edition 2020 (www.atmmasterplan.eu) - eATM

⁴¹ See SESAR Performance Assessment Gap Analysis Report (PAGAR) updated version of 2019 v00.01.04, 31-03-2021

⁴² See SESAR Exploratory Research projects - <https://www.sesarju.eu/exploratoryresearch>

⁴³ [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)

3.1.6 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 ALBATROSS⁴⁴, 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 utilize over 1,000 demonstration flights.

3.1.7 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 SRIA⁴⁵ identifies inter-alia the need to continue working on “optimum green trajectories”, on non-CO₂ impacts of aviation, and the need to accelerate decarbonization of aviation through operational and business incentivization.

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

⁴⁴ <https://www.sesarju.eu/projects/ALBATROSS>

⁴⁵ <https://www.sesarju.eu/node/3697>

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.



4. MARKET-BASED MEASURES

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 stabilizing 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 2019/2020⁴⁶ 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.

4.1.1 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.

⁴⁶ As a consequence of the COVID-19 situation the baseline year for the voluntary phase has been changed by the ICAO Council to only 2019.

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.

4.1.2 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.

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, heat stations, combined heat and power plants, 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 2014⁴⁷ that confirmed that the EU ETS will be the main European instrument to achieve the EU's binding 2030 target of at

⁴⁷ <http://www.consilium.europa.eu/en/meetings/european-council/2014/10/23-24/>

least 40%⁴⁸, and will be revised to be aligned with the latest Conclusions in December 2020⁴⁹, 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. 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 Council⁵⁰.

Following the 2013 ICAO agreement on developing CORSIA, the EU decided⁵¹ 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 2017⁵².

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

⁴⁸ 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>

⁴⁹ [1011-12-20-euco-conclusions-en.pdf \(europa.eu\)](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011L1220)

⁵⁰ 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>

⁵¹ 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>

⁵² 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

of July 2019⁵³. 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"⁵⁴.

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 Switzerland⁵⁵ 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

The EU ETS has delivered around 200 MT of CO₂ emission reductions between 2013 and 2020⁵⁶. 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 equivalent⁵⁷.

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

⁵³ 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

⁵⁴ [2021 commission work programme new policy objectives factsheet en.pdf \(europa.eu\)](#)

⁵⁵ 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.

⁵⁶ 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>

⁵⁷ https://ec.europa.eu/clima/news/carbon-market-report-emissions-eu-ets-stationary-installations-fall-over-9_en

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-ETS⁵⁸

<i>Year</i>	<i>Reduction in CO₂ emissions</i>
<i>2013-2020</i>	<i>~200 MT⁵⁹</i>

Those benefits illustrate past achievements.

⁵⁸ Include aggregated benefits of EU ETS and Swiss ETS for 2020.

⁵⁹ 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>



5. ADDITIONAL MEASURES

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 improvements⁶⁰.

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”.

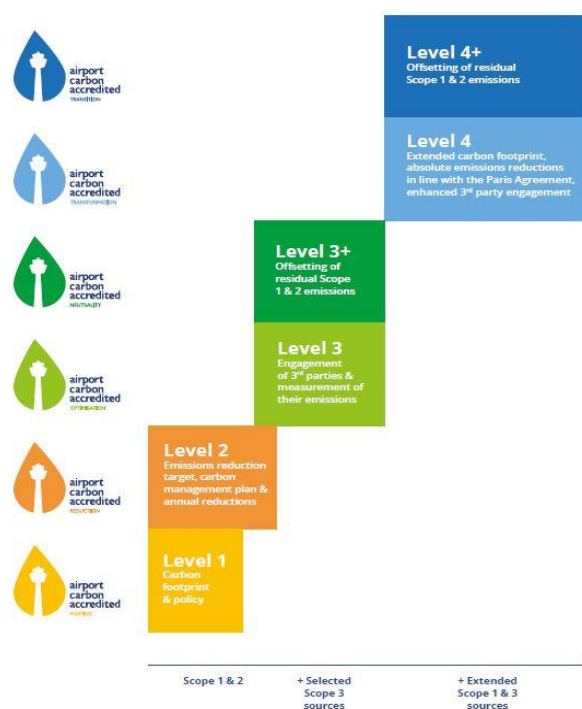


Figure 8 Six steps of *Airport Carbon Accreditation*

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

⁶⁰ Interim Report 2019 – 2020, *Airport Carbon Accreditation 2020*

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. 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.

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



The Destination 2050⁶¹ 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 baseline⁶². 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.

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.

⁶¹ www.destination2050.eu

⁶² 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.

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.

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 organizations. 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 harmonized, reliable and easily understandable information on their choices' environmental impacts, coordinated 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.

5.4 Multilateral capacity building projects

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

5.4.1 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 projects⁶³ 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 finalize 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.

⁶³ <https://www.easa.europa.eu/domains/international-cooperation/easa-by-country/map#group-easa-extra>

5.4.1 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 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 plans⁶⁴.

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.



⁶⁴ https://www.icao.int/environmental-protection/Documents/ICAO-EU_Project_FinalReport.pdf

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.



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.

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.

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 fuel⁶⁵.

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 paying particular attention to the overall environmental integrity of the SAF incentivized, 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.

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 PROJECT⁶⁶: 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 characterize 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.

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.

⁶⁵ [ICAO 2016 Environmental Report](#), Chapter 4, Page 162, Figure 4.

⁶⁶ <https://aviatorproject.eu>

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.

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.

SECTION 2: National actions in Denmark

This section is for information and illustration purpose only. The contributions to this section has been provided by the Danish stakeholders themselves, and it cannot be considered the official policy adopted by the Danish government. Any numbers or data on CO₂ emissions should not be counted in when aggregating the emissions from Denmark. Only data from Section 1, the common section, in this report should be used for further assessment of the CO₂ emissions from international aviation from Denmark.

Airlines

SAS

SAS short-term environmental sustainability goal is to reduce its absolute climate affecting carbon emissions by 25% in 2025 compared to 2005. Long-term SAS has identified the potential to achieve 50% absolute reductions by 2030 compared to 2005. In order to achieve the later improved prerequisites needs to be developed and aligned beyond SAS control. SAS fully supports the IATA/ATAG roadmap towards 50% emission reduction in 2050 and will contribute positively.

The main drivers for the transition in the coming decade are fleet renewal, further fuel saving and usage of alternative sustainable aviation fuel (SAF). Development of intermodal transport solutions and usage of bio carbon capture are also mechanisms anticipated to be used.

SAS is currently in an ongoing fleet replacement process. On the short-haul segment less efficient B737NG and A320ceo-family aircraft are replaced with more efficient A320neo. On the long-haul segment A340 has been decommissioned and are being replaced by A350, as well as smaller A321LR are being introduced.

Furthermore, SAS is working actively with fuel saving activities which includes almost all operations. The activities range from all types of efficiency enhancements incorporated in the flight procedures in the daily operation to modification of existing aircraft, for example with upgraded engines and lighter interior. If SAS does not control the process itself work is done through stakeholder collaboration with for example airports and air navigations service providers.

The last and maybe most important long-term work is SAS contribution and efforts to accelerate the commercialization of sustainable aviation fuels. SAS has been using SAF in limited extend over a number of year and has the goal to use SAF to the equivalent amount used on SAS domestic routes (approximately 18% in average over the last five years) in 2030. SAS is involved in multiple SAF initiatives on the Nordic market where the initiatives cover the identified and most material certified production methods. Since a couple of year SAS offers a SAF upgrade product to its customers who demand a service with even lower emissions.

In addition to above SAS is engaged in numerous initiatives aiming at commercializing aircraft using hydrogen, electricity, SAF or a combination as energy in aircraft with considerable increased energy efficiency.

(Please note that this information about SAS is valid for the whole of SAS and is submitted in the Action Plans for Denmark, Norway and Sweden)

Sustainable aviation fuels

Climate partnership for aviation

The Climate Partnership for Aviation is one of 13 climate partnerships initiated by the Danish government in 2019 in cooperation with the business community. The overall purpose of the partnerships is to establish a 2030 vision and a plan for the sector to contribute to the national 70% CO₂ reduction target (domestic only). However, since emissions from domestic aviation only account for a marginal share of the footprint from the Danish Aviation sector the partnership decided to include international emissions as well.

The Climate Partnership for Aviation is headed by Simon Pauck Hansen, COO, SAS (Chairman), and Thomas Woldbye, CEO, Copenhagen Airports (Vice Chairman), supported by a secretariat headed by the trade association Danish Aviation in the framework of the Confederation of Danish Industry – DI. Other partnership members stem from the aviation industry (airlines, airports), unions, NGOs, universities, consultancies etc.

The overall vision for the climate partnership (and Danish aviation as a whole) is to achieve climate neutrality no later than 2050. One important milestone is to contribute to the fulfilment of Denmark's overall climate objective of 70% CO₂e reduction by 2030 compared with 1990.

The proposed instruments are technological and operational, such as aircraft renewal and, not least, a process of establishing a supply chain for sustainable aviation fuels (gas-to-liquid and PtX). From a national perspective there are three key initiatives and recommendations:

1. National climate fund for aviation

Initiating a national fund to create a market for sustainable aviation fuels by financing the price gap between conventional jet fuels and sustainable aviation fuels. The fund should facilitate a robust platform for investors to engage in production facilities, including wind power facilities (for green H₂). The fund is to be financed by a climate contribution (DKK 20 – 30) from each passenger departing from Danish airports.

2. A national blending requirement for sustainable aviation fuel

Setting national blending levels to support research, development and supply of sustainable aviation fuels, as well as reducing CO₂ emissions from aviation. Levels should be aligned with the structure of the climate fund.

3. National master plans for green power and carbon capture

A national master plan for expanding green power production capacity for hydrogen production, the allocation of biogas as interim carbon source and, overall, for carbon usage and storage as feedstock for PtX.

NISA (Nordic Initiative for Sustainable Aviation)

In 2019 NISA initiated the electrofuel project Gas to Liquid Nordic GTL - a pre-feasibility study on sustainable aviation fuel from biogas, hydrogen and CO₂, prepared together with NIRAS and SDU and funded by ARC, Danish Energy, Nature Energy, CPH, SAS and BDL

In 2020, NISA took an active part in the preparation of an updated version of the Nordic report "Sustainable jet fuel for aviation" and later in 2020 also involved in the report "Nordic Sustainable Aviation" commissioned by the Danish presidency of the Nordic Council of Ministers,

prepared by the Institute of Transport Economics (TØI) and overseen by Nordic Energy Research (NER). The report presents current policy frameworks in each Nordic country and outlines five areas with potential for a common Nordic political approach: 1) a fuel blending mandate, 2) CO₂ equivalent reduction requirements, 3) establishing a Sustainable Aviation Fuel-fund, 4) fuel taxes and 5) passenger taxes.

NISA is also participating in NEA, the Nordic network for electric aircraft, also in collaboration with Nordic airports, airlines and electric aircraft developers in the Nordics. The purpose is to prepare airports, airlines and other players for future use of aircraft with other propellant, electric, hybrid and hydrogen, all of which require major changes in infrastructure and energy access.

Air Traffic Services: Naviair

The provision of air traffic services in the Danish airspace is mainly provided by Naviair in the form of air traffic control service. Naviair has been designated by Trafikstyrelsen to provide aviation infrastructure.

Naviair is striving to be in the forefront of sustainable aviation transformation by significantly reducing Naviair's CO₂ footprint by 2023, be CO₂-neutral by 2030 and actively contributing to the entire aviation sector being CO₂-neutral by 2050. Naviair works closely with their customers, users, and suppliers on developing CO₂ reduction initiatives for the aviation industry to achieve the ambitious goals.

Improved ATM and infrastructure use

Naviair's climate initiatives are completed in ongoing dialogues and collaboration with Naviair's customers, and Naviair participates in the climate work in several contexts, including COOPANS, BOREALIS, CANSO and Single European Sky. Based on the Government Climate Plans and Eurocontrol and IATA's joint Flight Efficiency Plan, Naviair's primary approaches to reduction of greenhouse gas emissions are done through:

- short routes, continuous flights towards the destination and fuel saving flight levels
- minimum of on ground waiting time with engines running through efficient traffic management at the airports
- fuel saving approach to Danish airports
- Continuous Climb Operations (CCO), wherever possible – with continuous climb to cruising level
- partnership in the world's first satellite-based global air traffic surveillance system which increases fuel savings and optimizes flight path efficiency.

On all the most fuel-reducing areas Naviair is far on development and use of new traffic concepts. This applies both within the free route airspace (FRA), Continuous Climb Operations (CCO), fuel efficient approaches to airports (Continuous Descent Operations, CDO), Extended Arrival Management and Required Navigation Performance.

Naviair's contribution

Naviair contributes directly to the airlines' climate footprint to the extent that Naviair is the direct cause of restrictions in the maximum capacity and/or flexibility in form of delays in the form airspace or restrictions issued in the form of longer flight paths. Therefore, it is Naviair's main environmental focus always to optimize processes, so that Naviair's customers get the opportunity to fly environmentally friendly and safe at one and the same time.

By offering Free Route Airspace in Danish-Swedish airspace Naviair participate indirectly to reduce aviation CO₂ emissions. There has been Free Route Airspace in the Danish-Swedish FAB since 2011, and since then Naviair has actively participated in the international cooperation to expand the field within free route airspace. In 2021 free route airspace was expanded to include all the Nordic European area. FRA in the DK-SE FAB reduces CO₂ emissions with 40.000 ton annually according to simulations done by Eurocontrol. Besides securing harmonization and streamlining of traffic control, the objective is to reduce fuel consumption with flights in DK/-SE FAB, reducing the emission of environmentally damaging gases.

Naviair is part of the Borealis Alliance. The Borealis Alliance is a leading Alliance of Air Navigation Service Providers (ANSPs) that enables its members to drive better performance for stakeholders through business collaboration. The Borealis Alliance delivers free route airspace across the whole of Northern Europe extending from the eastern boundary of the North Atlantic to the western boundary of Russian airspace in the North of Europe, delivering significant customer benefits in terms of fuel efficiency, environmental performance and cost savings.

Naviair is subject to several requirements from the EU, set for five years in so-called reference periods. For each reference period, specific agreements are agreed requirements for aviation, and Naviair is subject to, among other things, environmental requirements for traffic flow in Danish airspace, and in Copenhagen ACC and at Copenhagen Airport. Reference period 3 (RP3) runs from 2020 to 2024 and for this period, Naviair has these requirements for Copenhagen ACC and Copenhagen Airport:

- Less than 0.10 minutes on average delay in the terminal area for arriving flights to Copenhagen Airport.
- Less than 1.21 percent horizontal flight efficiency in Danish airspace.
- Less than 0.07 minutes on average delay on a route flights in Danish airspace.

The requirements for RP3 on the above areas are identical for all years in the reference period.

Copenhagen Airport and Naviair will implement PBN STARs and SIDs for all runways in Kastrup Airports in 2022. The design and validation activities already conducted indicates that the PBN procedures will lead to:

- Average reduction of flying time of 60 seconds for all departures without continuous climb potentials.
- Increased situational awareness, enabling pilots to better determine optimum Top of Descend point.
- Steeper approach patterns, in particular higher altitudes at downwind and less level flight at low level.

Aireon

Naviair is co-owner of Aireon LLC, the developer of the world's first satellite-based global air traffic surveillance system (Global flight tracking), enabling - for the first time ever - a truly global, pole-to-pole aircraft tracking and surveillance capability.

Aireons real-time global monitoring data have a positive economic impact on air operations - increasing fuel savings, optimizing flight path efficiency, and improving safety. All of which results in the eco-benefit of substantially reduced greenhouse gas emissions. For example, with the Aireon real-time flight tracking it is possible to reduce separation for the North Atlantic air traffic. This will - according to estimation based on Iridium-commissioned independent studies -

lead to fuel savings worth USD 6-8 billion and following substantial reductions in greenhouse gas emissions.

Other tangible climate initiatives

Use of Continuous Climb Operations (CCO) by departure from Copenhagen Airport saves the environment from emissions of approximately 32.000 ton of CO₂ annually and the airlines' fuel consumption of approximately 10.000 ton annually. More than 98% of departing flights out of Copenhagen Airport are given permission to deviate from the Standard Instrument Departure (SID) procedure. Instead, they use Naviair's offer for CCO, where aircraft are given permission to climb directly to their preferred cruising level and head directly for their destination as quickly as possible during the departure procedure.

Naviair is also improving the possibility of using Continuous Descent Operations (CDO) at Copenhagen Airport. CDO is one of several tools available to aircraft operators and ANSPs to increase safety, flight predictability and airspace capacity, while reducing noise, fuel burn, emissions. In periods with low traffic density, it is possible to increase the use of CDO. Over the years, different route models have been developed to facilitate CDO, and several attempts have been made to strike a balance between ideal fuel-efficient and environmentally friendly procedures and the capacity requirements of a specific airport or airspace.

CDO is enabled by airspace design, procedure design and facilitation by ATC, in which an arriving aircraft descends continuously, to the greatest possible extent, by employing minimum engine thrust, ideally in a low drag configuration, prior to the final approach. An optimum CDO starts from the top-of-descent and uses descent profiles that reduce controller-pilot communications and segments of level flight.

Destination 2050

The initiative from the European aviation sector, Destination 2050, shows a possible pathway combining new technologies, improved operations, sustainable aviation fuels and economic measures to achieve net zero CO₂ emissions from all flights within and departing from the EU. Absolute emissions are reduced by 92 %, while the remaining 8 % is removed from the atmosphere through negative emissions, achieved through natural carbon sinks or dedicated technologies.

Royal Netherlands Aerospace Centre and SEO Amsterdam Economics conducted this study commissioned by the representatives of European airports, airlines, aerospace manufacturers and air navigation service providers including Naviair. It assesses to what extent four groups of sustainability measures can reduce carbon emissions until 2050, strongly influenced by policies and actions. The effects of these measures are compared to a hypothetical reference scenario considering continuous demand growth and the COVID-19 impact.

These sustainability measures result in the following net CO₂ emissions reductions in the year 2050:

- 111 MtCO₂ through improvements in aircraft and engine technology:
- 60 MtCO₂ by hydrogen-powered aircraft on intra-European routes and
- 51 MtCO₂ by kerosene-powered or (hybrid-)electric aircraft
- 18 MtCO₂ through improvements in air traffic management (ATM) and aircraft operations
- 99 MtCO₂ through using drop-in sustainable aviation fuels (SAF)
- 22 MtCO₂ through economic measures (carbon removal projects only).

The combined cost of these sustainability measures is modelled to impact ticket prices, resulting in a lower air travel demand. This would avoid 43 MtCO₂ whilst maintaining an average compound annual passenger growth rate of 1.4%.

Market based measures - MBM

Denmark is part of the EU, and thus participates in the EU Emissions Trading Scheme (EU ETS). Denmark has signed the Bratislava Declaration and will be participating in CORSIA from the beginning, including in the voluntary phase. The offsetting requirements will have effect from 2021, and will be reported in the next version of the State Action Plan, foreseen in 2024.

Ground related activities

Copenhagen Airport

Copenhagen Airports A/S (CPH) operates Copenhagen Airport, the airport with the highest number of passengers in Denmark. However, due to the Covid-19 epidemic, 2020 was the worst year since 1970 for Copenhagen Airport. Passenger numbers plummeted from 30.3 million in 2019 to 7.5 million in 2020.

The aviation industry remains under pressure – both globally and in Denmark. The future is uncertain and difficult to predict. One thing that has not changed is the need to adapt our sector in the light of climate change, which is why CPH is upholding the climate strategy and targets set in 2019, which will generate real, future-proof solutions to the climate challenges faced by the aviation industry. The goals of the strategy are:

CPH has been a CO₂-neutral airport since 2019. This is being realized by means of continued efforts to reduce the emissions over which CPH has control (in other words, energy and fuel consumption and staff business trips) and the implementation of climate compensation to neutralize CPH's remaining emissions by supporting projects, both in Denmark and other countries, which reduce CO₂. To underline this, CPH achieved an airport carbon accreditation at level 3+, "neutrality" in 2019, and has upheld the accreditation at this level since then.

By 2030, CPH will be an emission-free airport with emission-free transport to and from the airport. This will be realized partly by CPH's continued increase of renewable energy such as from solar panel systems and support of green conversion of land transport by improving the charging infrastructure for electric vehicles both within and outside the airport area.

By 2050, CPH will be entirely free of CO₂ emissions from the airport itself, air traffic, companies operating in the airport and land traffic to and from the airport. This will be realized by means of strategic partnerships across the aviation industry, decision-makers and researchers, aiming at greater availability of sustainable aviation fuel and the development of climate-friendly technologies.

In 2020, CPH entered into several promising partnerships that will help to ensure the development of sustainable fuels in Denmark and the zero-emissions airport of the future. As part of the Danish government's climate partnership with the aviation industry, CPH presented an ambitious plan to achieve significant CO₂ reductions as early as 2030.

In 2020, CPH was able to announce the innovative Green Fuels for Denmark partnership, which also includes a number of other large Danish companies, such as A.P. Møller - Mærsk, DSV Panalpina, DFDS, SAS, Nel, Everfuel, Haldor Topsøe and Ørsted. The partnership, which

represents both the supply and demand sides, plans to build one of the world's largest PtX electrolysis plants to produce sustainable fuels for lorries, ships and aircraft. The vision is to develop the project in three stages over the next 10 years. The first stage will involve a 10 MW electrolyzer plant to produce renewable hydrogen for buses and lorries. The second stage will see the facility expanded to 250 MW and capture of sustainable CO₂ linked to the process to be able to produce renewable methanol for waterborne transport and sustainable jet fuel for aircraft. When completed, the 1.3 GW facility could potentially supply 30% of the fuel we expect to need for the aircraft at Copenhagen Airport by 2030.

Working closely with the Danish Technological Institute, in 2020 a consortium of 16 European partners headed by CPH won an EU tender to design the sustainable airport of the future. The project is called ALIGHT - A Lighthouse for the introduction of sustainable aviation solutions for the future. With funding of close to DKK 90 million, over the next four years the consortium will develop and demonstrate concrete solutions and examples of how to facilitate a zero-emissions airport and deliver infrastructure for carbon neutral aircraft. The results will lead to best practice tools that can inspire across Europe.

ALIGHT will secure solutions to two overriding challenges: The first concerns operations and logistics for handling sustainable fuels for aircraft in an operational context, including purchasing, blending, fuelling, quality control and safety processes. The second concerns smart energy solutions for other airport operations, including increased own production of renewable energy, energy storage and electrification. A design manual for the aircraft stand of the future will also be developed to support electric and hydrogen-powered aircraft. Read more about the project: <https://www.alight-aviation.eu/>.

Billund Airport

Billund Airport has in 2020 formulated an ambitious climate and environmental policy that also links to relevant UN global goals.

Climate and environmental policy address 4 main areas:

- 1) Noise. Billund Airport will continuously work to minimize the noise propagation from Billund Airport.
- 2) Drainage. Billund Airport will ensure responsible handling of surface water from Billund Airport.
- 3) Resources. Billund Airport will further develop circular and responsible resource consumption in the daily operation and development of Billund Airport
- 4) Energy. Billund Airport will compensate the company's direct emissions of CO₂ from 2020 and work towards "zero emission airport" in 2030.

Re 4) In 2020, the goal was that the direct energy consumption for Billund Airport is CO₂-neutral. It was also an ambition to achieve level 1 (mapping) accreditation under the Airport Carbon Accreditation (ACA) program.

During the second quarter of 2021, Billund Airport will receive accreditation in ACA at level 1.

The ACA program obliges Billund Airport to continuously update the CO₂ footprint, just as there is a requirement for a CO₂ reduction policy that shows continuous improvements.

Billund Airport has i.a. achieved the following results:

Authority approval to change starting position for smaller jets. The changed starting position has meant a smaller need for taxiing and aviation fuel.

The share of electric vehicles has increased year by year. In 2020, 10 traditional diesel vehicles have been replaced by electricity. A new electric towing truck has also been purchased to replace a diesel-powered one.

The share of LED lighting continues to rise continuously.

Billund Airport has applied to the environmental authorities for a renewed permit for groundwater cooling of the airport's buildings with the desire to cool a larger building area.

Billund Airport now receives CO₂-neutral district heating from Billund heating plant.

Billund Airport has climate compensation through tree planting and ongoing deletion of climate quotas of the type VCU (Verified Carbon Units) under the program Verified Carbon Standard.

Aalborg Airport

As the 3rd largest airport in Denmark, with 1.5 mio. passengers a year (2019), Aalborg Airport plays a significant part in supporting the need for a greener and more environmentally conscious industry. As such, Aalborg Airport has developed an ambitious environmental action plan which involves the airport becoming carbon neutral by 2025.

Aalborg Airport is in the process of achieving an "Airport Carbon Accreditation" at level 2, as only the second airport in Denmark. To achieve this, Aalborg Airport must:

- Update carbon footprints and compile reports for scope 1 and 2 for Aalborg Airport year-on-year.
- Provide evidence of effective carbon management procedures.
- Maintain a functional CO₂ reduction policy for scope 1 and 2 and show improvements and reductions.

Aalborg Airport has engaged in several collaborations throughout the region, to meet the increasing climate demands. Aalborg Airport is working together with Green Hub Denmark in a major network of organizations, to support the green agenda in the entire region, across sectors and industries. This allows for Aalborg Airport to take part in a variety of green projects on a larger scale, which both benefit the region and the airport.

Aalborg Airport is engaging in local recreational and green initiatives, which is for the benefit of the population region, but also enables the airport to CO₂-compensate for their remaining emissions, thus becoming carbon neutral.

Improvements

Some of the results Aalborg Airport has achieved within scope 1 and 2, are:

- 50% of all ground handling material is now electrical-powered. The material will continuously be changed until 100% is el-powered.
- All lights in the terminal and in the airfield is continuously being changed into LED.
- Aalborg Airport is supplied with 100% "green-power".

- Aalborg Airport has invested in an extensive energy-screening and a system for monitoring the spending and to effectively make changes towards improving the energy-use and reduce emissions.

In addition to this, Aalborg Airport has initiated scope 3 related activities, such as:

- Providing charging stations for passengers with electrical cars. Aalborg Airport is working towards a capacity of 600 charging stations in the parking area.
- Aalborg Airport has engaged in collaboration with developers and producers of low carbon fuel, to be able to supply aircrafts with emission-free fuel.

Aalborg Airport has made it a priority and part of their strategy to be environmentally conscious about all projects and investments being made across the airport. This way, the airport ensures the green agenda is supported and incorporated in every part of the airport and its operations.

SECTION 3: Emissions Data

The Danish emissions data have been calculated by the Danish Centre for Environment and Energy, Aarhus University. The data are based on all flights inside the state of Denmark and all flights out of Denmark, irrespective of the nationality of the air carrier. The data are in [ktonnes/year].

Flights to Greenland and the Faroe Islands are counted as domestic traffic. Flights inside Greenland and flights from Greenland and the Faroe Islands are not counted in.

Year	Domestic	International
2000	175	2329
2001	186	2361
2002	157	2042
2003	156	2123
2004	140	2436
2005	150	2559
2006	160	2564
2007	181	2627
2008	187	2622
2009	179	2290
2010	186	2390
2011	178	2460
2012	156	2486
2013	152	2462
2014	147	2670
2015	139	2615
2016	145	2812
2017	147	2896
2018	148	3031
2019	150	3098
*2020	80	1056

*: Data from 2020 are preliminary and should not be used for further calculations and assessments.

Conclusion

This action plan provides an overview of the actions undertaken by the Kingdom of Denmark and Danish stakeholders – either alone or in collaboration with others – to mitigate the effects of aviation's contribution to climate change. This Action Plan was finalized in June 2021 and shall be considered as subject to update after that date.