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INTRODUCTION

- a) The ICAO Contracting State Austria is a member of the European Union¹ and of the European Civil Aviation Conference (ECAC). ECAC is an intergovernmental organisation covering the widest grouping of Member States² 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) Austria, 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) Austria recognises the value of each State preparing and submitting to ICAO an updated State Action Plan for CO₂ emissions reductions as an important step towards the achievement of the global collective goals agreed since the 38th Session of the ICAO Assembly in 2013.

¹ Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden

² 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.

- f) In that context, it is the intention that all ECAC States submit to ICAO an action plan³. This is the action plan of Austria.
- g) Austria strongly supports the ICAO basket of measures as the key means to achieve ICAO's CNG2020 target and shares the view of all ECAC States that a comprehensive approach to reducing aviation CO₂ emissions is necessary, and that this should include:
- i. emission reductions at source, including European support to CAEP work in this matter (standard setting process);
 - ii. research and development on emission reductions technologies, including public-private partnerships;
 - iii. development and deployment of sustainable aviation fuels, including research and operational initiatives undertaken jointly with stakeholders;
 - iv. improvement and optimisation of Air Traffic Management and infrastructure use within Europe, in particular through the Single European Sky ATM Research (SESAR), and also beyond European borders through participation in international cooperation initiatives; and
 - v. Market Based Measures, which allow the sector to continue to grow in a sustainable and efficient manner, recognizing that the measures at (i) to (iv) above cannot, even in aggregate, deliver in time the emissions reductions necessary to meet the ICAO 2020 CNG global goal.
- h) In Europe, many of the actions which are undertaken within the framework of this 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 Austria is described, as well as that of other stakeholders.
- i) In Austria 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).

CURRENT STATE OF AVIATION IN AUSTRIA

Civil aircraft fleet in Austria

Category	2017	2019	2020
Single-engine aircraft below 2.000 kg	647	651	661
Single-engine aircraft 2.000 kg to 5.700 kg	17	18	21
Multi-engine aircraft below 5.700 kg	136	137	140
Aircraft 5.700 kg to 14.000 kg	56	61	63
Aircraft 14.000 kg to 20.000 kg	30	28	29
Aircraft over 20.000 kg	276	385	414
Rotorcraft (helicopter)	206	238	255
Ultralight	91	84	85
Powered gliders	169	167	165
Aircraft in total	1628	1769	1833

Data source: Statistik Austria

Ownership structure of domestic airports

In Austria there are six airports served by both Austrian and foreign carriers:

- Vienna International Airport, Flughafen Wien AG: 39,8% Airports Group Europe S.à r.l., 20% Land Niederösterreich, 20% Stadt Wien, 10,2% Streubesitz, 10% Mitarbeiter-Beteiligungsprivatstiftung
- Airport Salzburg, W.A. Mozart, Salzburger Flughafen GmbH: 75% Land Salzburg Beteiligungen GmbH, 25% Stadt Salzburg Beteiligungs GmbH

- Airport Innsbruck, Tiroler Flughafenbetriebsgesellschaft m.b.H.: 51% Innsbrucker Kommunalbetriebe AG, 24,5% Land Tirol, 24,5% Stadt Innsbruck
- Airport Graz, Flughafen Graz Betriebs GmbH: 99,9% Holding Graz – Kommunale Dienstleistungen GmbH, 0,1% GSU Gesellschaft für Strategische Unternehmensberatung mbH)
- Airport Linz, Flughafen Linz GesmbH: 50% OÖ Verkehrsholding GmbH, 50% Stadt Linz
- Airport Klagenfurt, Kärntner Betriebs GesmbH: 74,90 % LILIHILL Aviation City Beteiligung GmbH, 20,08% Kärntner Beteiligungsverwaltung, 5,02% City of Klagenfurt)

Transport connections at the six Austrian Airports

Airport	Motorway	Local rail	Regional and long-distance rail	Bus
Vienna	***	***	***	***
Salzburg	***	***	***	***
Innsbruck	***	***	***	***
Graz	***	***	***	***
Linz	***	***	***	***
Klagenfurt	***	***	***	***

Very good *** good *** fair *** *** absent

Data source: Airports

Airlines' shares of passenger volume in regular service (Vienna)

Airline	share of passenger volume 2017 (%)	Airline	share of passenger volume 2019 (%)	Airline	share of passenger volume 2020 (%)
Austrian	48.5	Austrian	43.2	Austrian	38.7
Eurowings Group	9.3	Lauda	8.4	Ryanair/Lauda	14.8
airberlin Group	5.8	Eurowings	7.2	Wizz Air	11.1
Lufthansa	3.8	Wizz Air	6.6	Eurowings	4.6
easyJet Group	3.4	easyJet	3.9	Lufthansa	2.9

Data source: Vienna International Airport

Decrease in flight movements

In 2017 there were 281,585 commercial flight movements at Austrian airports representing a decrease of 3.06% since 2013 (2013: 290,481 flight movements). The total number of commercial flight movements in 2013 and 2017 can be broken down as follows:

Year	2017	2019	2020
Vienna	224,568	266,802	95,879
Salzburg	19,479	16,626	6,670
Innsbruck	12,040	12,106	4,977
Graz	14,271	14,721	4,002
Linz	6,890	6,492	2,022
Klagenfurt	4,337	3,198	878

Data source: Statistik Austria

Passenger statistics of Austrian airports

Airport	2017	2019	2020
Vienna	24,392,129	31,661,727	7,813,743
Salzburg	1,890,164	1,717,991	669,790
Innsbruck	1,092,547	1,144,541	487,437
Graz	958,848	1,036,925	199,510
Linz	402,007	436,024	51,306
Klagenfurt	218,281	209,434	49,395

Data source: Statistik Austria

Rising passenger figures before COVID-19

In 2019, a total of 36,2 million passengers were transported. This represents an increase of 25.05% in comparison with 2017. Of the total number of transported passengers in 2019, 31,7 million were handled at Vienna International Airport, followed by Salzburg (1,7 million), Innsbruck (1,1 million) and Graz (1,0 million). Due to the COVID-19 pandemic the figures of 2020 are not comparable. For the sake of completeness they are mentioned above.

Freight volume

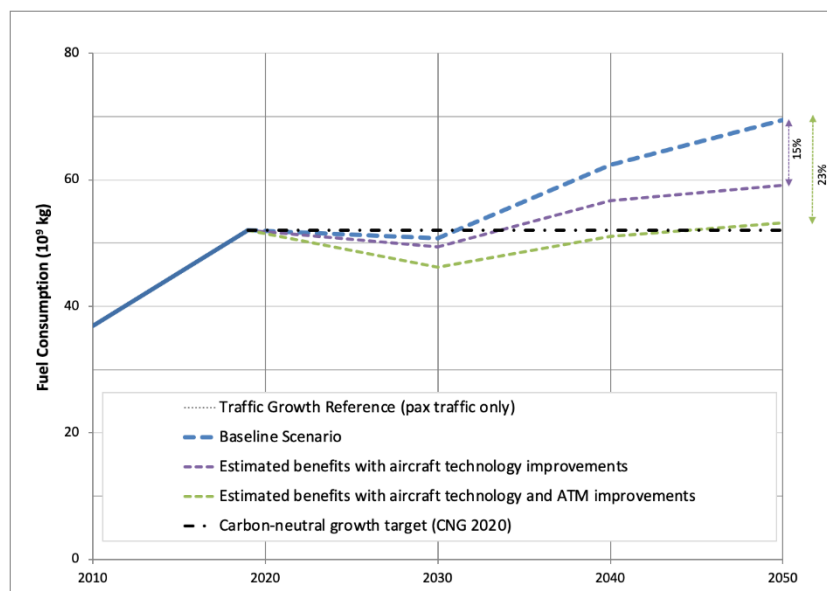
2019 saw Austria's six airports handle approximately 247,200 tonnes of freight and 16,521 tonnes of mail. This is an increase of approximately 5% for freight and 17% for mail in comparison to 2017 (235,250 tonnes of freight and 14,153 tonnes of mail).

EXECUTIVE SUMMARY

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

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

Since 2019, the COVID-19 pandemic has generated a world-wide human tragedy, a global economic crisis and an unprecedented disruption of air traffic, significantly changing European aviation's growth and patterns and heavily impacting the aviation industry. The European air transport recovery policy is aiming at accelerating the achievement of European ambitions regarding aviation and climate change.



Aircraft related technology

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

Environmental improvements across the ECAC States are knowledge-led and at the forefront of this is the Clean Sky EU Joint Undertaking that aims to develop and mature breakthrough “clean technologies”. The second joint undertaking (Clean Sky 2 – 2014-2024) has the objective to reduce aircraft emissions and noise by 20 to 30% with respect to the latest technologies entering into service in 2014. Under the Horizon Europe programme for research and innovation, the European Commission has proposed the set-up of a European Partnership for Clean Aviation (EPCA) which will follow in the footsteps of CleanSky2, recognizing and exploiting the interaction between environmental, social and competitiveness aspects of civil aviation, while maintaining sustainable economic growth. For such technology high end public-private partnerships to be successful, and thus, benefit from this and from future CO₂ action plans, securing the appropriate funding is key.

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

Sustainable Aviation Fuels (SAF)

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

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

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

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

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

Improved Air Traffic Management

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

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

Much of the research to develop these solutions is underway and published results of the many earlier demonstration actions confirm the challenge but give us confidence that the

goals will be achieved in the ECAC region with widespread potential to be replicated in other regions.

Market Based Measures (MBMs)

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

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

The 30 European Economic Area (EEA)⁴ 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.

⁴ The EEA includes EU countries and also Iceland, Liechtenstein and Norway.

ECAC Scenarios for Traffic and CO₂ Emissions

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

Despite the current extraordinary global decay on passengers' traffic due to the COVID-19 pandemic, hitting European economy, tourism and the sector itself, aviation is expected to continue to grow in the long-term, develop and diversify in many ways across the ECAC States. Air cargo traffic has not been impacted as the rest of the traffic and thus, whilst the focus of available data relates to passenger traffic, similar pre-COVID forecasted outcomes might be anticipated for cargo traffic both as belly hold freight or in dedicated freighters.

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

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.

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 forecast⁵ 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 trends⁶. It considers a moderate economic growth, with some regulation particularly regarding the social and economic demands.

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

- **Global economy** factors represent the key economic developments driving the demand for air transport.
- Factors characterising the **passengers** and their travel preferences change patterns in travel demand and travel destinations.
- **Price of tickets** set by the airlines to cover their operating costs influences passengers’ travel decisions and their choice of transport.
- More hub-and-spoke or point-to-point **networks** may alter the number of connections and flights needed to travel from origin to destination.
- **Market structure** describes size of aircraft used to satisfy the passenger demand (modelled via the Aircraft Assignment Tool).

⁵ Challenges of Growth - Annex 1 - Flight Forecast to 2040, EUROCONTROL, September 2018.

⁶ Prior to COVID-19 outbreak.

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 results⁵ (published in 2018 by EUROCONTROL). Historical data for the year 2019 are also shown later for reference.

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	Hubs: Mid-East ↗↗ Europe ↘ Turkey ↗	Hubs: Mid-East ↗↗ Europe & Turkey ↗	No change →
Network	Point-to-point: N-Atlantic. ↗↗	Point-to-point: N-Atlantic. ↗	
Market Structure	Industry fleet forecast + STATFOR assumptions	Industry fleet forecast + STATFOR assumptions	Industry fleet forecast + STATFOR assumptions

COVID-19 impact and extension to 2050

Since the start of 2020, COVID-19 has gone from a localised outbreak in China to the most severe global pandemic in a century. No part of European aviation is untouched by the human tragedy or the business crisis. This unprecedented crisis hindered air traffic growth in 2020: flight movements declined by 55% compared to 2019 at ECAC level. It continues to disrupt the traffic growth and patterns in Europe in 2021. In autumn 2020, EUROCONTROL published a medium-term forecast⁷ 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 forecast⁵. Considering the most-likely scenarios of the long-term forecast⁶ and the medium-term forecasted version of the long-term flight forecast has been derived:

- a) Replace the long-term forecast⁶ horizon by the most recent medium-term forecast⁷ to account for COVID impact;
- b) Update the rest of the horizon (2025-2040) assuming that the original growth rates of the long-term forecast⁶, 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 decay⁸.

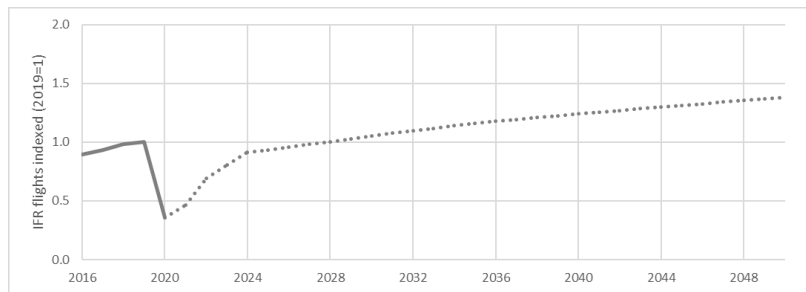
⁷ Five-Year Forecast 2020-2024, IFR Movements, EUROCONTROL, November 2020.

⁸ 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.

The method used relies on the calculation of adjustment factors at STATFOR⁹ region-pair level and have been applied to the original long-term forecast⁵. 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.

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 departing¹⁰ 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 (ICAO¹¹). This data, which is

⁹ 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.

¹⁰ 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.

¹¹ 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.

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 PRISME¹² data warehouse used by EUROCONTROL, including the actual flight distance and the cruise altitude by airport pair. These calculations were made for about 99% of the passenger flights (the remaining flights had information missing in the flight plans). Determination of the fuel burn and CO₂ emissions for historical years is built up as the aggregation of fuel burn and emissions for each aircraft of the associated traffic sample characteristics. Fuel burn and CO₂ emission results consider each aircraft's fuel burn in its ground and airborne phases of flight and are obtained by use of the EUROCONTROL IMPACT environmental model, with the aircraft technology level of each year.

Forecast years (until 2050) fuel burn and modelling calculations use the 2019 flight plan characteristics as much as possible, to replicate actual flown distances and cruise levels, by airport pairs and aircraft types. When not possible, this modelling approach uses past years traffics too, and, if needed, the ICAO CAEP forecast modelling. The forecast fuel burn and CO₂ emissions of the baseline scenario for forecast years uses the technology level of 2019.

For each reported year, the revenue per passenger kilometre (RPK) calculations use the number of passengers carried for each airport pair multiplied by the great circle distance between the associated airports and expressed in kilometres. Because of the coverage of the passenger estimation data sets (Scheduled, Low-cost, Non-Scheduled flights, available passenger information, etc.) these results are determined for about 99% of the historical 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

¹² PRISME is the name of the EUROCONTROL data warehouse hosting the flight plans, fleet and airframe data.

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 ¹³ RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported ¹⁴ FTKT (billion)	Total Revenue Tonne Kilometres ¹⁵ 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 ¹²)	Fuel efficiency (kg/RTK ¹⁴)
2010	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280
2030	50.72	160.29	0.0252	0.252
2040	62.38	197.13	0.0252	0.252
2050	69.42	219.35	0.0250	0.250

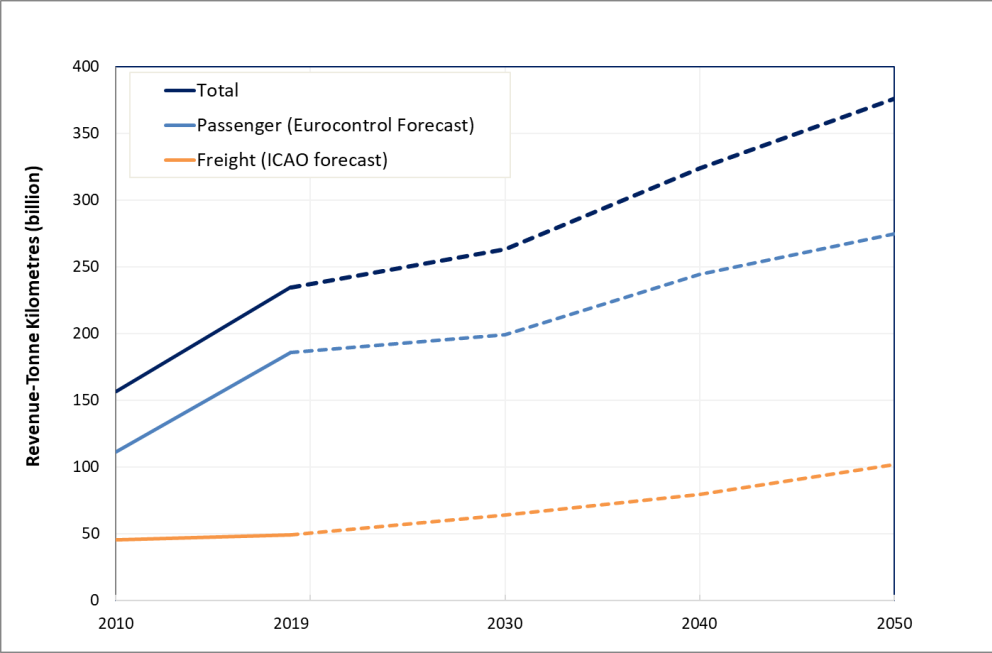
For reasons of data availability, results shown in this table do not include cargo/freight traffic.

¹³ Calculated on the basis of Great Circle Distance (GCD) between airports, for 97% of the passenger traffic for forecast years.

¹⁴ Includes passenger and freight transport (on all-cargo and passenger flights).

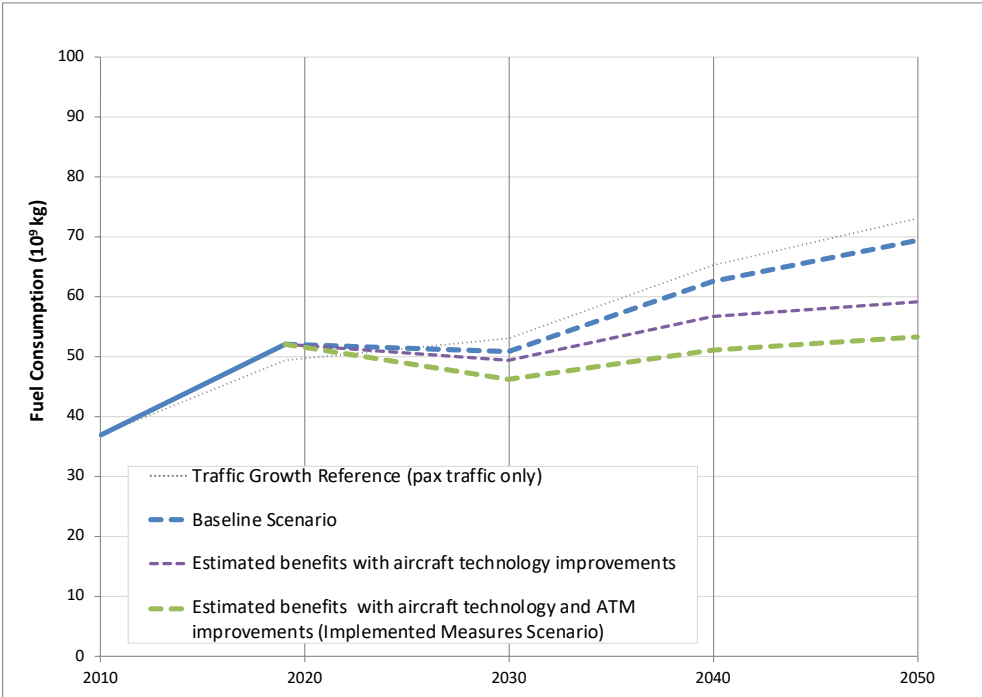
¹⁵ A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).

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 Tool¹⁶ (AAT) developed collaboratively by EUROCONTROL, EASA and the European Commission. The retirement process of AAT is performed year by year, allowing the determination of the number of new aircraft required each year. In addition to the fleet rollover, a constant annual improvement of fuel efficiency of 1.16% per annum is assumed for each aircraft type with entry into service from 2020 onwards. This rate of improvement corresponds to the 'Advanced' fuel technology scenario used by CAEP to generate the fuel trends for the Assembly. This technology improvement modelling is applied to the years 2030 and 2040. For the year 2050, as the forecast traffic reuses exactly the fleet of the year 2040, the technological improvement is determined with the extrapolation of the fuel burn ratio between the baseline scenario and the technological improvement scenario results of the years 2030 to 2040.

The effects of **improved ATM efficiency** are captured in the Implemented Measures Scenario on the basis of efficiency analyses from the SESAR project. In SESAR, a value of 5,280 kg of fuel per flight for ECAC (including oceanic region) is used as a baseline¹⁷. Based on the information provided by the PAGAR 2019 document¹⁸, and compared to a 2012 baseline,

¹⁶ <https://www.easa.europa.eu/domains/environment/impact-assessment-tools>

¹⁷ See SESAR ATM Master Plan – Edition 2020 (www.atmmasterplan.eu) - eATM.

¹⁸ See SESAR Performance Assessment Gap Analysis Report (PAGAR) updated version of 2019 v00.01.04, 31-03-2021.

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 projects¹⁹ 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 goals²⁰, 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 4²¹, 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.

¹⁹ See SESAR Exploratory Research projects - <https://www.sesarju.eu/exploratoryresearch>

²⁰ <https://www.acare4europe.org/sria/flightpath-2050-goals/protecting-environment-and-energy-supply-0>

²¹ 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).

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

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

Year	Fuel Consumption (10 ⁹ kg)	CO ₂ emissions (10 ⁹ kg)	Fuel efficiency (kg/RPK ²²)	Fuel efficiency (kg/RTK ¹²)
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%

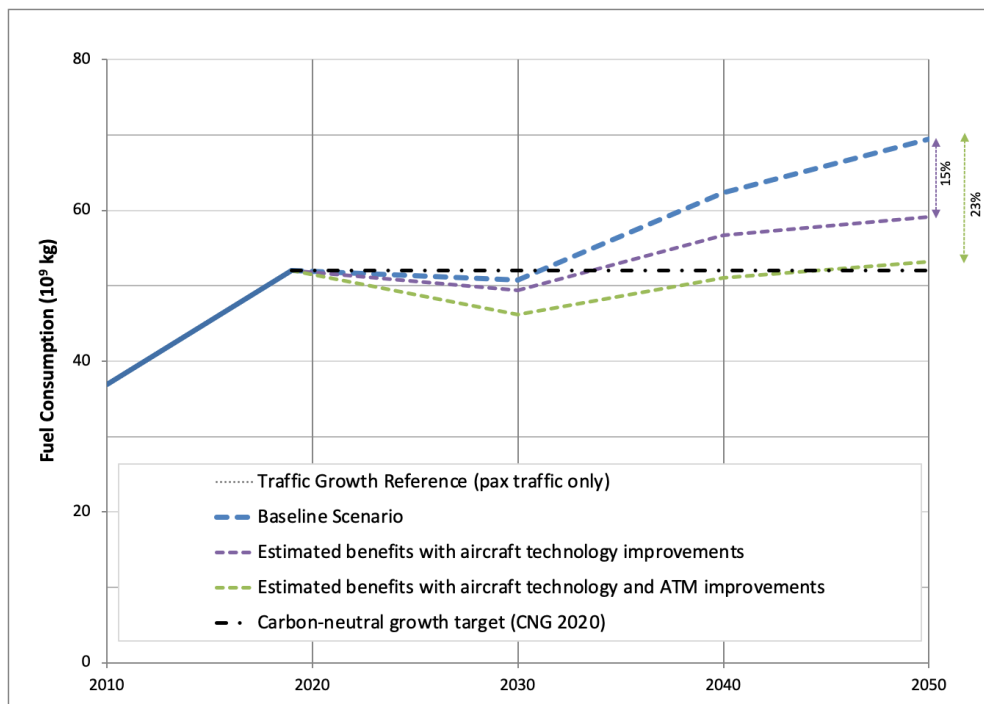
²² Calculated on the basis of Great Circle Distance (GCD) between airports, for 97% of the passenger traffic for forecast years

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	160,3	160,3	-9%
2040	197,1	197,1	197,1	-18%
2050	219,4	219,4	219,4	-23%

For reasons of data availability, results shown in this table do not include cargo/freight traffic. Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.

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



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

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

B. Actions taken collectively in Europe



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 Sky²³ 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

²³ <http://www.cleansky.eu/>

commercial aviation. The objectives were to reduce aircraft CO₂ emissions by 20-40%, NO_x by around 60% and noise by up to 10dB compared to year 2000 aircraft.

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

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

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

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

- **Eco-Design:** coordinating research geared towards high eco-compliance in air vehicles over their product life and heightening the stewardship with intelligent Re-use, Recycling and advanced services.

In addition, the **Clean Sky Technology Evaluator**²⁴ 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).

1.2.2 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)**²⁵ 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

²⁴ <https://www.cleansky.eu/technology-evaluator-te>

²⁵ <https://clean-aviation.eu/>

climate-neutral aviation technologies meet the relevant aviation safety requirements, and remains a secure, reliable, cost-effective, and efficient means of passenger and freight transportation.

Specific objectives:

- a) To integrate and demonstrate disruptive aircraft technological innovations able to decrease net emissions of greenhouse gasses by no less than 30% by 2030, compared to 2020 state-of-the-art technology while paving the ground towards climate-neutral aviation by 2050.
- b) To ensure that the technological and the potential industrial readiness of innovations can support the launch of disruptive new products and services by 2035, with the aim of replacing 75% of the operating fleet by 2050 and developing an innovative, reliable, safe and cost-effective European aviation system that is able to meet the objective of climate neutrality by 2050.
- c) To expand and foster integration of the climate-neutral aviation research and innovations value chains, including academia, research organisations, industry, and SMEs, also by benefitting from exploiting synergies with other national and European related programmes.

ASSESSMENT

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

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

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 fuel²⁶. 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 decarbonisation of the transport sector in line with the objective of reaching a climate-neutral economy. The European Parliament also called for *“a clear regulatory*

²⁶ [ICAO 2016 Environmental Report](#), Chapter 4, Page 162, Figure 4.

roadmap for the decarbonisation of aviation, based on technological solutions, infrastructure, requirements for sustainable alternative fuels and efficient operations, in combination with incentives for a modal shift”.

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

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

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

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

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

ASSESSMENT

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

At the time of the submission of this action plan the legislative proposal under the ReFuelEU Aviation initiative, as well as its supporting impact assessment, were not yet adopted. As a

result, the assessment of the benefits provided by this collective European measure in terms of reduction in aviation emissions is expected to be included in a future update of the common section of this action plan.

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 incentivise the approval and use of SAF as drop-in fuels in Europe by introducing a SAF Facilitation Initiative.

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

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

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

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

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

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's²⁷ 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.

²⁷ Directive 2009/28/EC.

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 origin²⁸, the threshold is raised to 70% GHG emissions savings.

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

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

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

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

²⁸ 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).

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 Initiative²⁹, 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 bio-fuel 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 available³⁰.

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

²⁹ 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 Flightpath**. This industry-wide initiative aimed to speed up the commercialisation of aviation biofuels in Europe, with an initial objective of achieving the commercialisation of 2 million tonnes of SAF by 2020, target that was not reached due to the commercial challenges of SAF large-scale supply.
https://ec.europa.eu/energy/sites/ener/files/20130911_a_performing_biofuels_supply_chain.pdf

³⁰ <https://www.biofuelsflightpath.eu/ressources>

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.

BIO4A³¹: 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.

KEROGREEN³²: *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.

FlexJET³³: *Sustainable Jet Fuel from Flexible Waste Biomass (flexJET)* is a four-year project targeting diversifying the feedstock for SAF beyond vegetable oils and fats to biocrude oil produced from a wide range of organic waste. This is also one of the first technologies to

³¹ www.bio4a.eu

³² www.kerogreen.eu

³³ www.flexjetproject.eu

use green hydrogen from the processed waste feedstock for the downstream refining process thereby maximising greenhouse gas savings. The project aims at building a demonstration plant for a 12 t/day use of food & market waste and 4000 l/day of Used Cooking Oil (UCO), produce hydrogen for refining through separation from syngas based on Pressure Swing Absorption technology, and finally deliver 1200 tons of SAF (ASTM D7566 Annex 2) for commercial flights to British Airways. The consortium with 13 partner organisations has brought together some of the leading researchers, industrial technology providers and renewable energy experts from across Europe. The project has a total duration of 48 months from April 2018 to March 2022.

BioSFerA³⁴: *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.

BL2F³⁵: *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.

³⁴ <https://biosfera-project.eu>

³⁵ <https://www.bl2f.eu>

FLITE³⁶: The *Fuel via Low Carbon Integrated Technology from Ethanol* (FLITE) consortium proposes to expand the supply of low carbon jet fuel in Europe by designing, building, and demonstrating an innovative ethanol-based Alcohol-to-Jet (ATJ) technology in an ATJ Advanced Production Unit (ATJ-APU). The ATJ-APU will produce jet blend stocks from non-food/non-feed ethanol with over 70% GHG reductions relative to conventional jet. The Project will demonstrate over 1000 hours of operations and production of over 30,000 metric tonnes of Sustainable Aviation Fuel. The diversity of ethanol sources offers the potential to produce cost competitive SAF, accelerating uptake by commercial airlines and paving the way for implementation. The project is carried out by a consortium of five partners from six European countries and its expected duration is from 1 December 2020 till 30 November 2024.

TAKE-OFF³⁷: Is an industrially driven project aiming to be a game-changer in the cost-effective production of SAF from CO₂ and hydrogen. The unique TAKE-OFF technology is based on conversion of CO₂ and H₂ to SAF via ethylene as intermediate. Its industrial partners will team up with research groups to deliver a highly innovative process which produces SAF at lower costs, higher energy efficiency and higher carbon efficiency to the crude jet fuel product than the current benchmark Fischer-Tropsch process. TAKE-OFF's key industrial players should allow the demonstration of the full technology chain, utilising industrial captured CO₂ and electrolytically produced hydrogen. The demonstration activities will provide valuable data for comprehensive technical and economic and environmental analyses with an outlook on Chemical Factories of the Future. The project is carried out by a consortium of nine partners from five European countries and its expected duration is from 1 January 2021 till 24 December 2024.

ASSESSMENT

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

³⁶ <https://cordis.europa.eu/project/id/857839>

³⁷ <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 digitalised mobility and is projected towards their progressive achievement over the next decade. To implement the SESAR project, the Commission has set up with the industry, an innovation cycle comprising three interrelated phases: definition, development and deployment. These phases are driven by partnerships (SESAR Joint Undertaking and SESAR Deployment Manager) involving all categories of ATM/aviation stakeholders.

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

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

SESAR and the European Green Deal objectives






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

Results

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

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

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

Key performance area	SES high-level goals 2005	Key performance indicator	Performance ambition vs. baseline			
			Baseline value (2012)	Ambition value (2035)	Absolute improvement	Relative improvement
 Capacity	Enable 3-fold increase in ATM capacity	Departure 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%
 Security		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 synchronised deployment. To facilitate the deployment of these SESAR solutions, the Commission establishes common projects that mandate the synchronised implementation of selected essential ATM functionalities based on SESAR solutions developed and validated by the SESAR JU.

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

- Optimise the distancing of aircraft during landing and take-off, reducing delays and fuel burn while ensuring the safest flying conditions.
- Allow aircraft to fly their preferred and usually most fuel-efficient trajectory (free route).

- Implement an initial, yet fundamental step towards digitalising communications between aircraft and controllers and between ground stakeholders allowing better planning, predictability, thus less delays and fuel optimisation and passenger experience.

The first common project³⁸ 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.

³⁸ https://ec.europa.eu/transport/modes/air/sesar/deployment_en

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 IMPACT³⁹ 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 process⁴⁰.

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

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

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.

³⁹ <https://www.eurocontrol.int/platform/integrated-aircraft-noise-and-emissions-modelling-platform>

⁴⁰ <https://www.sesarju.eu/sites/default/files/documents/transversal/SESAR%202020%20-%20Environment%20Impact%20Assessment%20Guidance.pdf>

A catalogue of SESAR Solutions is available⁴¹ 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:

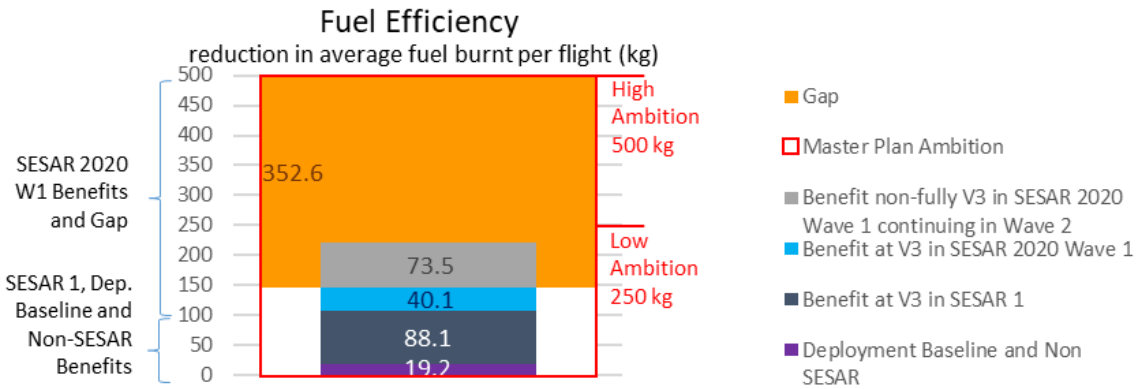


Figure 7: SESAR fuel efficiency achievement versus gap (Source: Updated version of PAGAR 2019)

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

⁴¹ <https://www.sesarju.eu/news/sesar-solution-catalogue-third-edition-now-out>

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 baseline⁴². Based on the information provided by the PAGAR 2019 document⁴³, 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 projects⁴⁴.

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).

AIRE⁴⁵ 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

⁴² See SESAR ATM Master Plan – Edition 2020 (www.atmmasterplan.eu) - eATM

⁴³ See SESAR Performance Assessment Gap Analysis Report (PAGAR) updated version of 2019 v00.01.04, 31-03-2021

⁴⁴ See SESAR Exploratory Research projects - <https://www.sesarju.eu/exploratoryresearch>

⁴⁵ [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)

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.

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 ALBATROSS⁴⁶, a consortium of major European aviation stakeholder groups to demonstrate how the technical and operational R&D achievements of the past years can transform the current fuel intensive aviation to an environment-friendly industry sector.

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

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 SRIA⁴⁷ identifies inter-alia the need to continue working on “optimum green trajectories”, on non-CO₂ impacts of aviation, and the need to accelerate decarbonisation of aviation through operational and business incentivisation.

⁴⁶ <https://www.sesarju.eu/projects/ALBATROSS>

⁴⁷ <https://www.sesarju.eu/node/3697>

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

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

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.

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 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 2014⁴⁸ that confirmed that the EU ETS will be the main European instrument to achieve the EU's binding 2030 target of an at least 40%⁴⁹, and will be revised to be aligned with the latest Conclusions in December 2020⁵⁰, 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

⁴⁸ <http://www.consilium.europa.eu/en/meetings/european-council/2014/10/23-24/>

⁴⁹ 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>

⁵⁰ [1011-12-20-euco-conclusions-en.pdf \(europa.eu\)](https://www.consilium.europa.eu/media/1011-12-20-euco-conclusions-en.pdf)

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 Council⁵¹.

Following the 2013 ICAO agreement on developing CORSIA, the EU decided⁵² 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 2017⁵³.

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

⁵¹ 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>

⁵² 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>

⁵³ 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

ETS Directive of July 2019⁵⁴. 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"⁵⁵.

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 Switzerland⁵⁶ 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.

⁵⁴ 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>

⁵⁵ [2021 commission work programme new policy objectives factsheet en.pdf \(europa.eu\)](#)

⁵⁶ 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.

Impact on fuel consumption and/or CO₂ emissions

The EU ETS has delivered around 200 MT of CO₂ emission reductions between 2013 and 2020⁵⁷. 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 equivalent⁵⁸.

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

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

⁵⁷ 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>

⁵⁸ https://ec.europa.eu/clima/news/carbon-market-report-emissions-eu-ets-stationary-installations-fall-over-9_en

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-ETS⁶⁰

Year	Reduction in CO ₂ emissions
2013-2020	~200 MT ⁵⁹

Those benefits illustrate past achievements.

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>

⁶⁰ Include aggregated benefits of EU ETS and Swiss ETS for 2020.

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 improvements⁶¹.

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

⁶¹ Interim Report 2019 – 2020, *Airport Carbon Accreditation 2020*

a Level 2, 63 a Level 3 and 60 a Level 3+ accreditation. Furthermore, five airports have already achieved accreditation at the newly introduced levels: 1 a Level 4 and 4 airports a Level 4+ accreditation.

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

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

The Annual Report, which is published in the fall of each year, typically covers the previous reporting year (i.e., mid-May to mid-May) and presents the programme's evolution and achievements. However, because of the extraordinary conditions faced in 2020 due to COVID-19 pandemic, special provisions are applied to all accredited airports, including the merge of programme years 11 and 12, which implies the extension of accreditation validity by one year. 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 (ktCO₂)	51.7	54.6	48.7	140	130	169	156	155	169	158
Total aggregate scope 3 reduction (ktCO₂)	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+ (tCO₂)	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 ₂ e	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 2050⁶² 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

⁶² www.destination2050.eu

baseline⁶³. 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.

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 organisations. The proposals will be aligned with the European Green Deal, established in December 2019 and that strives to make Europe the first climate-neutral continent. The overall objective of the EASA Environmental Labelling Programme is to increase awareness and transparency, and ultimately to support passengers and other actors in making informed sustainable choices by providing

⁶³ 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.

harmonised, reliable and easily understandable information on their choices' environmental impacts, co-ordinated within EASA Member States. It should allow rewarding those air transport operators making efforts to reduce their environmental footprint. The label initiative covers a wide range of components of the aviation sector, including aircraft, airlines and flights.

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

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

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

ASSESSMENT

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

5.4 Multilateral capacity building projects

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

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 projects⁶⁴ is to enhance the partnership between the EU and partner States in the areas of civil aviation environmental protection and climate change, and to achieve long-lasting results that go beyond the duration of the projects. The specific objectives of the two projects are to develop or support existing policy dialogues with partner States on mitigating GHG emissions from civil aviation, to contribute to the CORSIA readiness process of partner States, as well as to implement CORSIA in line with the agreed international schedule, including considerations of joining the voluntary offsetting phase starting in 2021 or at the earliest time possible. On top of the CORSIA-related support, these projects are assisting the partner States in the development and update of the State Action Plans to reduce CO₂ emissions from civil aviation, as well as providing support in the development of emission data management tools supporting the implementation of State Action Plans and CORSIA.

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

⁶⁴ <https://www.easa.europa.eu/domains/international-cooperation/easa-by-country/map#group-easa-extra>

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.

5.4.2 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 plans⁶⁵.

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.



⁶⁵ 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 fuel⁶⁶.

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 incentivised, as it is the case of the ReFuelEU Initiative.

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

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.

⁶⁶ [ICAO 2016 Environmental Report](#), Chapter 4, Page 162, Figure 4.

AVIATOR PROJECT⁶⁷: The project “Assessing aviation emission Impact on local Air quality at airports: Towards Regulation” aim to better understand air quality impacts of aviation issues, developing new tools and regulation, and linking with the health community, providing unbiased data to society.

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

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

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

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

6.4 The EU's Single European Sky Initiative and SESAR

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

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

⁶⁷ <https://aviatorproject.eu>

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.

NATIONAL ACTIONS IN AUSTRIA

AUSTRIAN AIRLINES

Austrian Airlines recognizes its responsibility to the environment; acting in a sustainable and responsible manner is part of the Austrian Airlines corporate culture. As an airline, Austrian Airlines has an impact on the environment in various areas and processes - from ground handling to technology. Therefore, an essential element in dealing with our impact on the environment is a clearly formulated environmental policy, which is also reflected in our guiding principles and objectives. For this reason, Austrian Airlines is committed to achieving the climate goals of the aviation industry

In line with the Aviation Round Table Report on the Recovery of European Aviation and on the basis of the Destination 2050 roadmap, A4E, ACI EUROPE, ASD, CANSO and ERA commit to work together with all stakeholders and policy-makers to achieve the following climate objectives:

- Reaching net zero CO₂ emissions by 2050 from all flights within and departing from the EU. 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 EU by 45% by 2030 compared to the baseline. 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 EU.

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 aviation sector is also effectively contributing to the European Green Deal and EU's climate neutrality objective.

In addition to that we continue to support the goals of the International Air Transport Association IATA to yearly improve fuel efficiency by 1.5% and carbon neutral growth from 2020 on in CORSIA.

Beyond that, Austrian Airlines seeks to comply with the following self-imposed climate protection requirements. By 2030:

- Austrian Airlines will invest at least EUR 150 million in climate- and noise-efficient technologies.
- Austrian Airlines will halve its domestic CO₂ emissions compared to 2018 and transfers short-haul flights to rail, if adequate infrastructure is available.
- Austrian Airlines will ensure to improve the CO₂ efficiency of its fleet by at least 30% compared to 2005 levels.
- Austrian Airlines also participates in all Lufthansa Group-wide sustainability projects relevant to the airline. In the course of its fleet rollover, Austrian Airlines is emphasizing the reduction of CO₂ and noise emissions.
- With regard to the use of alternative fuels, Austrian Airlines plans to achieve a blending quota of 2% on short- and medium-haul flights, assuming that the required infrastructure and supply of Sustainable Aviation Fuels (SAF) is available at the hub Vienna.

In order to achieve these environmental goals, Austrian Airlines is implementing the following measures:

IMPROVEMENT OF FUEL EFFICIENCY

Fleet renewal:

- In 2016 and 2017 Austrian replaced its 21 Fokker-aircraft by 17 Embraer Jets. These aircrafts have an average age of four years and a seating capacity for 120 passengers. The conversion of older aircraft to newer, more fuel-efficient models has had a major impact, enabling an 18% reduction in fuel consumption per seat, which translates into annual CO₂ savings of 51,000 metric tons.
- Since 2019, the fleet retirement of 18 Dash turboprops and seven A319 jets has been in progress, and they are currently being replaced by ten A320s. An Airbus A320 consumes an average of only 3.98 liters of kerosene per 100 passenger kilometers, 1.6 liters less than the fuel-intensive Dash turboprops. In addition,

three B767-300ER long-haul aircraft are leaving the fleet. Overall, the OS fleet is shrinking from 83 to 60 aircraft. As the network is served with larger aircraft and fewer frequencies, this also reduces emissions per passenger.

Operational Efficiency & Technical Innovation: Austrian Airlines was able to achieve efficiency improvements and thus fuel consumption savings through more efficient seat configurations or technical innovations in engines.

- Winglets installed on the long-haul fleet reduce CO₂ consumption by 5%.
- As of 2019/2020, seven efficiency projects are ongoing at Austrian Airlines that achieve reductions of at least 11,000 CO₂ per year, they include weight reduction initiatives (lighter life jackets and screens, less print media) and flight route optimization software.
- Single taxi-in procedures without APU carried out in Airbus aircraft have already yielded positive effects. Austrian also supports efforts to shorten approach and departure flight paths in order to minimize fuel consumption and emissions in the Vienna/Lower Austria and Burgenland region.
- Vortex generators have additionally been fitted to the wings of all aircraft in the Airbus fleet (A319, A320 and A321) in order to benefit local residents. These reduce overflight noise by 10dB (A).

VOLUNTARY COMPENSATION PROGRAMM FOR PASSENGERS, EMPLOYEES & BUSINESS PARTNERS

Compensaid – Compensation with Sustainable Aviation Fuels

- As of 2021, Passengers of Austrian Airlines can offset the CO₂ emissions of their respective flights with Compensaid Austrian by either contributing to the usage of sustainable aviation fuels or by investing in offsetting projects of Climate Austria. Compensaid is a project initiated by the Lufthansa Innovation Hub.
- The CO₂ emissions of an upcoming trip can be offset directly in the booking process. A CO₂ calculator determines the emissions and calculates an amount that neutralizes these emissions by financing alternative fuels or investing in other climate projects, offsetting the emissions.
- Our passengers have had the opportunity to offset their CO₂-emissions via our partner Climate Austria since 2008.
- Around 70% of the investments is directed towards national projects.

- Business partners have the option of booking direct compensation via corporate value fares.

Compensation of Business Travel of all LHG Airline employees: Since 01.01.2019, all business travel of Lufthansa Group Airlines employees is compensated as well. The donations go to certified climate protection projects that meet the highest standards and, in addition to reducing CO₂ reduction, they also make a positive contribution to sustainable development. A compensation program for business partners has been in place since 2017.

INTERNATIONAL CO₂-REGIMES

EU Emissions Trading Scheme (ETS): Since January 1, 2012, aviation has been the only mode of transport included in the European emissions trading system (EU ETS). This means that since that date, airlines have been paying for CO₂ emissions within the European Union and, from 2020, also Switzerland.

Carbon Offsetting & Reduction Scheme for International Aviation (CORSIA): Starting in 2021, CORSIA represents the addition of another international CO₂ scheme. In CORSIA, all airlines worldwide must offset their growth-based CO₂ emissions from 2020 on. CORSIA is a CO₂ compensation system, meaning that the money airlines pay for their emissions is invested directly in climate projects, thus offsetting the CO₂ emissions. By 2035, 2.5 billion tons of CO₂ are to be offset by investing around 40 billion USD in environmental projects.

SUSTAINABLE AVIATION FUELS

The long-term goal of reducing CO₂ emissions from aviation to zero can realistically only be achieved if fossil kerosene is replaced by sustainable aviation fuels (SAF), which have an emissions reduction potential of up to 80%. The aviation industry has been supporting research into alternative fuels for years. Austrian Airlines currently supports two SAF projects in Austria.

Research Collaboration SUJECO - Sustainable Jet Fuel from CO₂:

- Currently Austrian is participating in a research project on synthetic kerosene. Together with project partners such as OMV, TU Vienna, Montanuniversität Leoben, and Voest, the further development of production technologies for synthetic jet fuels is researched.
- The central objective of SUJECO is to establish a three-step biotechnological-chemical process in which carbon from industrial CO₂ and green hydrogen are used to produce standard jet fuel with the same properties as kerosene via biological and chemical conversions. The fuel is to be indistinguishable in its chemical-physical properties from jet fuel used today and can therefore be used in any mixing ratio with fossil kerosene (up to 100%).

ReOil: From Waste to Fuel: Since October 2018, flight attendants have been collecting passengers' used plastic cups separately from residual waste. In March 2021, Austrian Airlines expanded the scope to include all single use plastic items, such as combs, toothbrushes, napkins, and packaging materials. These are cleaned and shredded and then delivered to the ReOil® pilot plant at OMV's Schwechat refinery. With a thermal cracking process, synthetic crude oil is generated from plastic waste. This crude oil is further processed into fuels or other refinery products at the Schwechat refinery. Using ReOil instead of normal crude reduces our CO₂ emissions by 45% and energy consumption by 20% in the refining process. With this campaign, Austrian Airlines supports a resource-saving circular economy. OMV is currently in the process of certifying ReOil for Jet A1 Fuel.

OTHER SUSTAINABILITY PROJECTS

Fly Greener: Reduction, Reusing and Recycling of in-flight waste: Fly Greener is a Group-wide project of the Lufthansa Group. Flight attendants aim to reduce the amount of waste and environmental pollution and to optimize the corresponding processes in the aircraft. Each Lufthansa Group airline develops its own ideas and concepts in this regard. Several years ago, Austrian Airlines began separating a wide variety of materials on board and feeding them into the recycling process. This applies to PET bottles, glass bottles, Tetrapak, cans, as well as waste paper and newspapers. Since the end of 2018, plastic cups and other plastic items are also collected separately from residual waste to be fed into OMV's ReOil process. Currently, Austrian Airlines and Lufthansa Group elaborates a variety of projects to make air traffic more efficient and environmentally friendly.

CO₂-neutral operations on the ground: Austrian Airlines uses 100% green electricity at all locations in Austria. In addition, the Lufthansa Group aims at reaching CO₂-neutral operations on the ground in its home markets of Germany, Austria and Switzerland by 2030. This includes converting vehicles to electric or other emission-free propulsion.

AIRAIL – AUSTRIAN AIRLINES & ÖBB INTERMODALITY

Austrian Airlines has committed itself to halve domestic CO₂ emissions by 2030 compared to today and to shift short-haul flights to rail, if adequate infrastructure is available.

In order to achieve this goal, Austrian works with in the "AIRail" project. Since December 2014, Austrian passengers can travel to Vienna Airport by train - in the form of codeshare connections. The service was initially available on the route between Linz and Vienna Airport, and was in 2017 expanded to include the connection to Salzburg. AIRail has been extremely well received by customers, with Austrian Airlines and its cooperation partners recording annual double-digit increases in passenger numbers (approx. 20%). By shifting the route from air to rail between Linz and Vienna, approximately 720 tons of fuel could be saved annually - equivalent to 2,266 tons of CO₂.

Since 2020, the cooperation was extended to the route Graz – Vienna. For the time being, 4 trains per day (2 per direction) run complementary to 6 oneway flights.

Passengers can select the AIRail connection in the normal booking process, thus the transit from train to plane is also guaranteed with a minimum connecting time of 80 minutes. Currently, the baggage drop-off concept is under revision. As of July 2021, baggage can be labeled and securely stowed on the train, and upon arrival, airport staff will securely transfer it from the train to the baggage facility in Vienna.

"For us as an airline in particular, it is important to treat the environment responsibly. This also includes offering our passengers an alternative by rail for short distances. With the successful AIRail connections, we show that trains and flights are not in competition with each other, but that the networking of different means of transport ideally complements each other," says Alexis von Hoensbroech, CEO of Austrian Airlines.

FUEL AND ENERGY EFFICIENCY REPORTS 2014 – 2021

Project	Reduction of Fuel Burn (t/year)	Reduction of CO ₂ emissions (t/year)
Measures 2014		
Engine efficiency improvement for B767 Fleet	889	2.809
Pushback at VIE: Start of Engines after disconnecting from vehicle	518	1.637
No coffee machines on Board of A320	143	452
Measures 2015		
Flights VIE-LNZ-VIE operated by rail	802	2.534
Early retracting of landing lights during start	466	1.473
Exchange of two-chamber lifejackets by one-chamber lifejackets	192	607
No newspaper service on board	162	512
Measures 2016		
Replacement of 21 Fokker aircraft (21 years old) by 17 Embraer (4 years old)	23 800	75.208
Flight Profile Optimizer Boeing Fleet	3 657	11.556
Measures 2017		
Weight reduction of Standard Beverage Trolleys	114	359
Introduction of Premium Economy Class	667	2101
Measures 2018		
Implementation of Airport Elevation Tool for Airbus and Boeing	93	293
Measures 2019		
ReOil	59	186

Fuel & Energy Efficiency Projects & Impact from 2020 onwards

Project	Reduction Potential [GWh/a]	Energy Cost-Savings [€/a]	Fuel Reduction (t/year)	Reduction of CO ₂ emissions (t/year)
Implementation Period 2020 onwards				
A32 F, APU & Engines	6,076	318.000	504t	1.587
Flight Profile Optimizer	6,466	420.724	1.855	5.843
E195 Wheel Fairing Modification	5,133	265.453	437	1.376
Implementation Period 2021 onwards				
CI-Ops E95	21,836	1.124.847	n.a.	
Scavenge Pump	3,313	142.688	297	935
E- Shuttlebus	0,01	1.444	n.a.	
E-Cars	0,004	555	n.a.	

VIENNA INTERNATIONAL AIRPORT

Airports worldwide are certified by Airport Council International (ACI) under an Airport Carbon Accreditation Program at four progressively stringent levels of participation. The underlying aim of the program is to encourage and enable airports to implement best practice carbon and energy management processes and to gain public recognition of their achievements.

Vienna International Airport scores Level 3 OPTIMISATION **since autumn 2016**.

Environment protection at Vienna International Airport

The Flughafen Wien Group (FWAG) is committed to protective and conscientious interaction with the environment and pledges to comply with all environmental laws, regulations, binding agreements and official requirements and to continuously minimise its negative

ecological impact. Above all, the Flughafen Wien Group has set itself the target of further reducing its energy consumption, minimising the impact of noise emissions, further cutting the CO₂ emissions attributable to Vienna Airport and becoming climate-neutral in the medium term. Meanwhile, constant dialogue with stakeholders is of the utmost importance to the Flughafen Wien Group. In many cases, the airport's measures also have a positive influence on the behaviour of customers and passengers, e.g. in the areas of energy saving, facility management or waste disposal.

FWAG has established a comprehensive and systematic energy and environmental management system (EMS) and subjects itself to an environmental audit in line with the Eco-Management and Audit Scheme (EMAS) with which the European Union places the highest requirements in the world on environmental management systems, as well as to the ISO 14001.

Initial entry in the EMAS register took place in December 2015, with monitoring audits being conducted in October 2016 and October 2017. The company was recertified in 2018. 2019 and 2020 monitoring audits have been conducted. The company will be recertified in 2022.

In addition, with EMAS the airport meets the requirements of the Austrian Energy Efficiency Act.

Within the scope of EMS, environmental aspects and their impact are recorded, relevant topics identified and assessed on the basis of cost-benefit analyses. Subsequently environmental policy, objectives and measures are determined and their progress and the performance of the overall system regularly examined on the basis of specified key performance indicators, annual management reviews and in the context of internal and external audits. EMS also secures legal compliance of the operation in respect to environmental law. To do this all regulations relating to the environment (laws, directives, and notifications) are identified, recorded in an environmental database with the resulting obligations being implemented and monitored. Responsibility for the successful implementation of EMS is with the Management Board and the executives according to the Flughafen Wien AG line organisation. The environmental manager in the Operations Environmental Management department coordinates and manages all internal and external activities relating to environmental protection. The environmental manager is supported here by an environmental team constituted from those responsible for specific topics in the various corporate divisions. As part of sustainability management, the environment manager is also the interface to the sustainability management of the company.

Environmental policy of Flughafen Wien AG and its subsidiaries

Our corporate policy is aimed at pursuing economic, social and ecological objectives in a balanced relationship. The following central strategic guidelines are derived from this for our environmental policy:

We are committed to protective and conscientious interaction with the environment and pledges to comply with all environmental laws, regulations, official requirements and binding agreements as well to continually improve the measures that minimise negative ecological impact.

This means:

- Treating the environment and natural resources as efficiently and as carefully as possible, primarily also by employing a comprehensive environmental management programme, and new technologies and using alternative sources of energy. If the company can exert an influence, efforts will also be made to involve partners and customers at the site in the environmental activities;
- Giving the highest priority to the continual dialogue with all stakeholders and citizens affected by the air traffic and safeguarding the quality of life in the region in a sustainable way especially by continuing the work in the Dialogue Forum and in the Neighbourhood Advisory Board as well as by using all technical and actual possibilities to minimise the pollution from emissions and immissions despite the trend towards increasing traffic volume;
- Practising social responsibility in our relations with all stakeholders. This applies in particular to our employees, but also for suppliers and service providers in the context of our regional and social role, but also all relations with stakeholders in our immediate vicinity and beyond. We promote and respect ethnic and ideological diversity to the highest degree and endeavour in particular to support women and to make working conditions easier for elderly employees. Our social responsibility also acts as a guideline for our donation and sponsorship activities.

2020 was marked by the COVID pandemic. Air traffic at Vienna Airport fell by 75% compared to 2019, so the year 2020 is to be considered an exceptional year. The consumption figures in relation to the traffic units are therefore not representative for the year 2020.

Energy

The Flughafen Wien Group has implemented an energy efficiency programme and has already realised numerous projects.

In 2020, approximately 66.6 million kilowatt-hours of electricity were consumed by Flughafen Wien AG and its subsidiaries at the site. The electrical power is drawn on the one hand from the photovoltaic systems installed at Vienna Airport (around 2%) and on the other hand from the grid of the utility company EAA (Energieallianz Austria) with no nuclear power. 98% (98.6 GWh) were supplied from green electricity, i.e. electricity from renewable sources (EAA Aqua). In order to further minimise energy consumption, the use of energy in Car Parks 3, 4, 7, and 8 was improved by converting conventional light sources to LED technology and installing user-oriented lighting control.

In the event of a power cut, four emergency power generators with a total capacity of 6.5 MW take over the supply of the key facilities. The capacity was increased to 8.9 MW in autumn 2018. Taxiway and runway lighting stays on with no power interruption with the help of battery-operated UPS systems, and the power from the emergency power generators comes online within 15 seconds.

The heating energy, totalling 37.4 million kilowatt-hours in 2020, has been transported to the airport since 1982 as waste heat from the Schwechat refinery. The individual heating systems of the airport grounds are supplied here through an underground pipeline system.

All air-conditioned buildings are cooled via an in-house pipeline network for air conditioning water, which is supplied by three separate cooling plants with a total output of 23.9 GWh in 2020.

The company's own vehicles were filled with a total of around 1.7 million litres of fuel, of which 1.6 million litres of diesel, at Vienna Airport in 2020. More than 80% of this was used to fill the roughly 580 ramp handling vehicles and machines.

While aviation fuel (kerosene) is pumped via a pipeline directly from the Schwechat refinery (OMV) to the airport, automotive fuels are supplied to the three company petrol stations by petrol tanker. The complete property-related measurement of all energy transfers and consumption provides the precondition for modern energy management at the airport. The

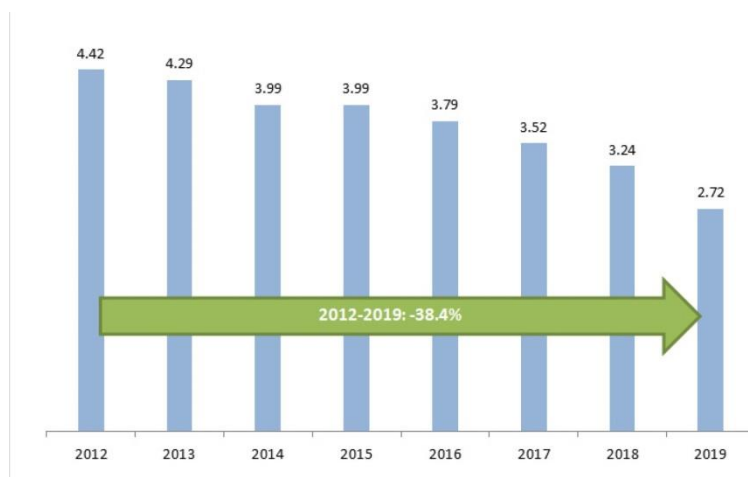
various forms of consumption are described, reviewed and analysed using special software programs.

Since 2016, five photovoltaic systems have been put into operation on the roofs of Hangar 7, the old winter service hall, the Air Cargo Center, the area of the former sewage treatment plant and most recently on the roof of the new Office Park 4. This year, in 2021, three more plants will be built at the airport: two smaller ones on the multi-storey car parks 3 and 8, as well as Austria's largest photovoltaic plant south of runway 11/29 on an area of around 24 hectares. Construction of the new plant will begin in spring 2021, and commissioning is planned for next year.

The rated output of the 5 solar modules is 2,000 kWp, meaning that an annual yield of approximately 2 GWh can be generated.

Other measures in the years to come include the further conversion of the vehicle fleet to electric drive and the associated research project, the erection of further photovoltaic systems and the realisation of the research project with the Technical University Vienna (TU Wien) on the topics of “smart airport city” and “virtual city”.

Electricity consumption FAWG in kWh/Traffic unit



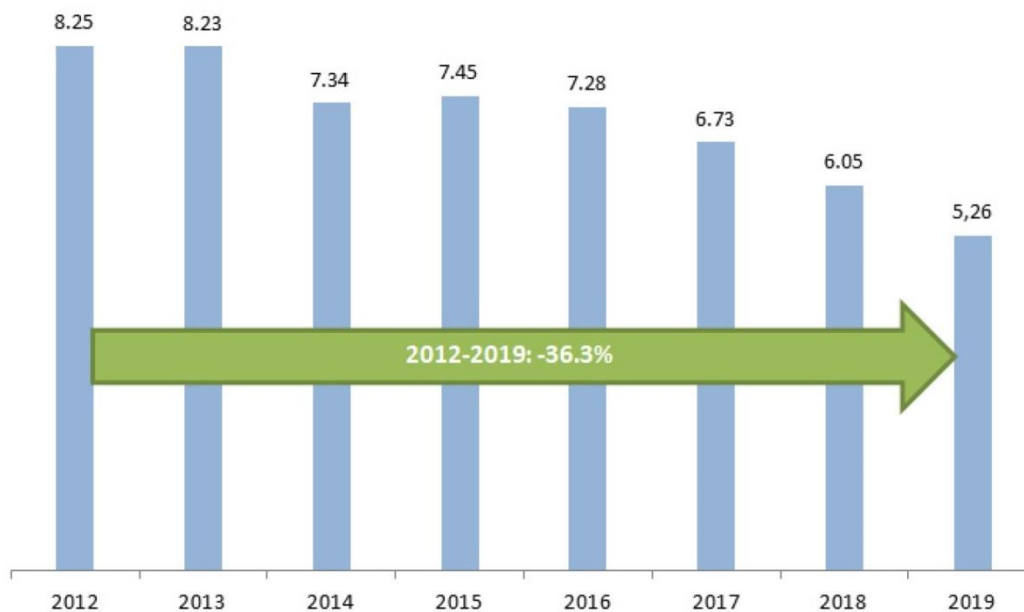
2012 – 2019: Electricity consumption **down by 38.4%**

Key performance indicators 2015 – 2019

Environmental Aspect	Unit	2015	2016	2017	2018	2019
Traffic units	[-]	24,763,288	25,415,025	26,496,620	29,238,913	33,716,888
Passengers	[-]	22,775,054	23,352,016	24,392,805	27,037,292	31.662,189
Electricity consumption FWAG	kWh/TU	3.99	3.79	3.52	3.24	2.72
Electricity consumption FWAG	MWh	98,747	96,278	93,358	94,739	91,855
Heat consumption FWAG	kWh/TU	2.33	2.29	2.01	1.66	1.46
Heat consumption FWAG	MWh	57,734	58,315	53,304	48,591	49,329
Cooling consumption FWAG	kWh/TU	1.31	1.25	1.09	1.1	0.92
Cooling consumption FWAG	MWh	32,557	31,856	28,846	32,146	30,967
Fuel consumption FWAG	kWh/TU	1.13	1.20	1.20	1.15	1.07
Fuel consumption FWAG	MWh	28,041	30,447	31,733	33,587	36,093
Total energy requirements FWAG	kWh/TU	7.45	7.28	6.73	6.05	5.26
Total energy requirements FWAG	MWh	184,522	185,040	178,395	176,918	177,277
Total energy requirements from renewable sources FWAG1	kWh/TU	2.40	2.28	2.68	3.24	2.72
Total energy requirements from renewable sources FWAG ⁶⁸	MWh	59,439	58,050	70,883	94,739	91,855
Share of renewable energy in total energy requirements FWAG ⁵⁴	%	32.2%	31.4%	39.7%	53.5%	51.8%

⁶⁸ Restructuring of consumption of renewable energy (photovoltaics)

Total energy requirement kWh/TU



2012 – 2019: Total energy requirements **down by 36.3%**

Energy efficiency targets of the Flughafen Wien Group

Environmental aspect	Unit	Initial 2012 value	2022 target value	Targeted 2012 - 2022 efficiency increase	Value as of 2019
Electrical energy Flughafen Wien Group	kWh/TU	4.42	3.49	21%	2.72
Heat consumption Flughafen Wien Group	kWh/TU	2.42	2.01	17%	1.46
Cooling consumption Flughafen Wien Group	kWh/TU	1.72	1.24	28%	0.92
Fuel consumption Flughafen Wien Group	kWh/TU	1.41	1.17	17%	1.07
Greenhouse gas CO ₂ Flughafen Wien Group	kg/TU	1.95	1.36	30%	0.58

For the continuous improvement of the company’s environmental performance, Flughafen Wien AG has set itself the following **environmental targets** with regard to individual environmental aspects.

Emissions and climate protection

Although aircraft are today being built with greater fuel efficiency than ever before thanks to constant technical innovations, the enormous growth of the industry continues to create increasing emissions and environmental pollution. It is for that reason that the aviation sector has set itself ambitious climate targets: the intention is that growth in air traffic will be climate-neutral from 2020 onwards. In other words: fewer or constant emissions despite increasing aircraft movements (source: IATA – International Air Transport Association – climate targets). More information can be found at: <http://www.iata.org/policy/environment/Pages/climate-change.aspx>

The operation of an airport, especially aircraft handling operations and landside traffic, contributes, albeit to a lesser degree, to general airborne emissions from the aviation industry. All emissions are recorded without gaps in the area around the airport as part of air quality monitoring and through the production of an annual carbon footprint. Measures and programmes are developed on an ongoing basis with airlines to systematically minimise emissions. With the help of a carbon footprint, FWAG also takes part in the Airport Carbon Accreditation System (ACAS) programme managed by the Airports Council International Europe (ACI Europe) www.airportcarbonaccreditation.org). Vienna Airport was given Level 1 certification back in 2013, in 2015 there was the move up to Level 2 and in October 2016 Level 3 certification was achieved for the first time, which was reaffirmed by ACI in October 2019. Level 3 certification involves a further reduction of CO₂ emissions with greater involvement of all companies operating at the airport. To reach this Level 3 all companies located at the site had to be integrated in measures to reduce CO₂.

Greenhouse gas CO₂ emissions of the Flughafen Wien Group (in tonnes)

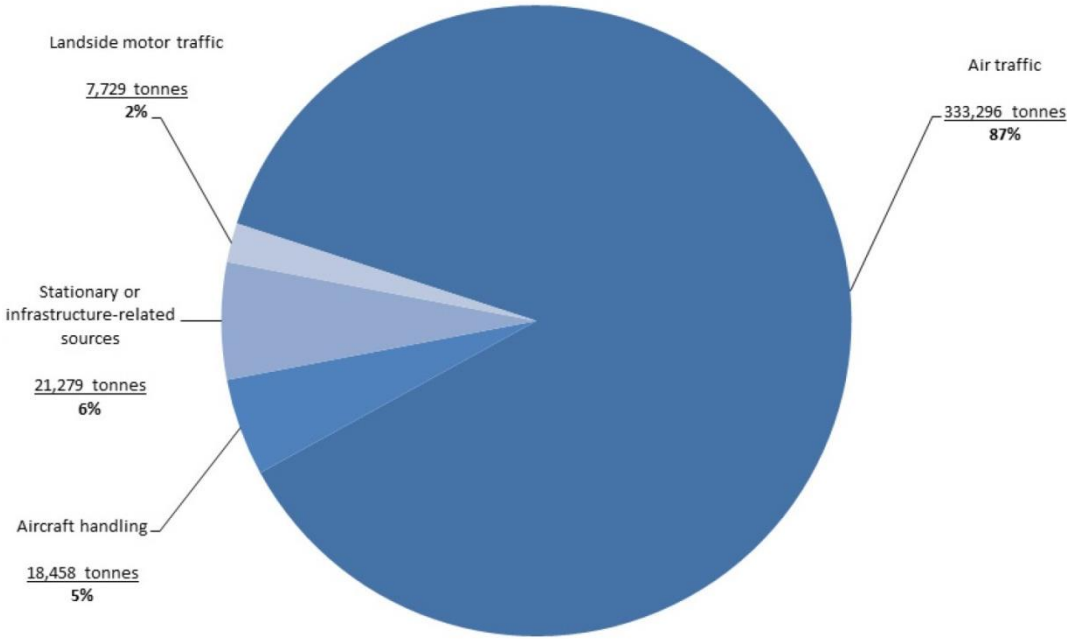
	Units	2015	2016	2017	2018	2019
CO₂ in tonnes (Flughafen Wien Group)	tonnes	33,941	34,175	29,784	19,952	19,612
CO₂ emissions in kilograms per traffic unit (TU)	kg/TU	1,37	1,34	1,12	0,68	0,58

The carbon footprint was compiled in 2019 by the Laboratorium für Umweltanalytik.

Only around 5% of the emissions generated at the airport site can be directly influenced by the airport, with the majority attributable to the energy supply. The results furthermore show that, at 87%, air traffic accounts for the major share of the CO₂ emissions.

For each of the emission sources specified above, the CO₂ emissions are divided in line with international standards into three areas. Thus the CO₂ emissions from the company’s own operating activities are shown on the one hand, as are those arising from the supply of energy and those created by third-party companies on the site. A distinction is additionally drawn between the ability to influence emissions directly or indirectly.

CO₂ Emissions of the various source groups 2019



Greenhouse Gas Protocol

Scope	Greenhouse gas emissions arise ...
Scope 1	... in the course of the business operations of the company from sources that the company itself owns and/or operates, e.g. vehicles, combustion plants
Scope 2	... as part of the generation by third parties of the energy consumed by the company, e.g. electricity, district heating and cooling
Scope 3	... in the supply chain or in the course of using the products or services sold by the company, arrival and departure of passengers and employees, transportation of goods, use of the airport by airlines

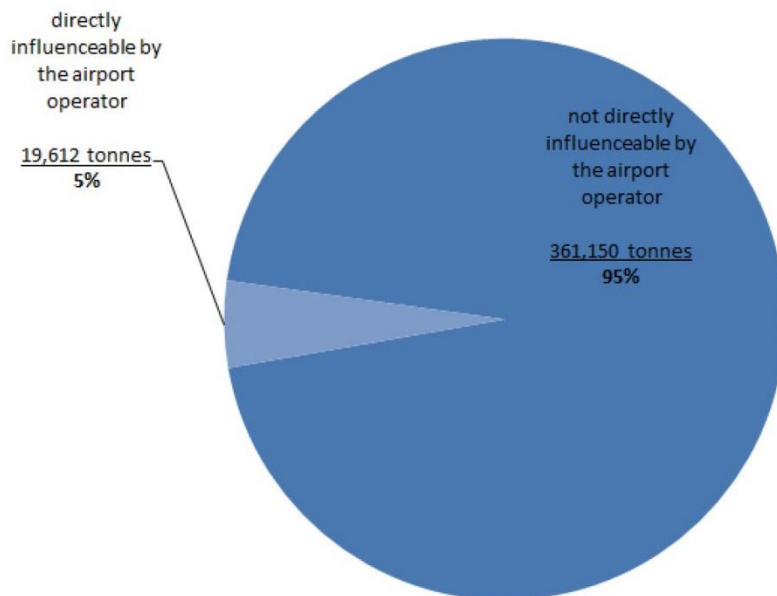
The Flughafen Wien Group can influence Scope 1 emissions directly, Scope 2 emissions only partially and Scope 3 emissions not at all.

Emissions per scopes at the Vienna Airport site (in tonnes)

	2015	2016	2017	2018	2019
Scope 1	11,461	11,796	8,455	8,958	9,648
Scope 2	46,714	46,710	45,732	42,587	21,216
Scope 3	258,050	262,743	322,735	293,124	349,898
TOTAL	316,225	321,249	376,992	344,669	380,762

Data source: Annual carbon footprint "LUA"

CO₂ emissions which can be either influenced or not be influenced by the airport operator



Other airborne emissions

In addition to CO₂, mainly NO_x and CO but to a lesser extent also SO_x, particulate matter (PM₁₀) and benzene are emitted into the atmosphere by aircraft. With regard to particulate matter, it should be noted that Vienna Airport is located in a particulate redevelopment area, with particulate pollution in Lower Austria demonstrably being caused primarily by domestic fuel, followed by industry, transport and infrastructure. Comparing the particulate matter values with the town of Krems in Lower Austria shows that aviation has only a marginal influence of particulate pollution. In the “Aquella Study” (long-distance transport of airborne pollutants), Prof. Puxbaum from TU Wien has proven that the proportion of particulate matter in Lower Austria imported from neighbouring countries in the east amounts to around 50%.

An emissions inventory of these airborne pollutant parameters was drawn up by the Laboratorium für Umweltanalytik from 2015 onwards on the basis of the respective carbon footprint. In contrast to the carbon footprint, indirect emissions caused by the consumption of electrical energy and heating energy were not taken in to account.

Measurement of pollutants

Air quality measurements have been taken at the site in the immediate apron and runway area for 25 years. The pollutant monitoring system is managed by the state government of Lower Austria and is integrated in the regional air quality monitoring network. This consists of a total of 39 stations, which supply the current measurement data to the central facility every half hour. The measured values of the individual measuring stations – and thus also those of Vienna Airport – can be accessed at www.numbis.at. The values for sulphur dioxide and nitrogen dioxides are thus available at all times and can be compared with the measured values of other pollutant measuring stations in Lower Austria. The measured values are additionally compared with statutory threshold values and thus provide information about air quality. The situation at the site is consistent with the outskirts of a major city with low emissions of carbon monoxide, sulphur dioxide, particulates, benzene and heavy metals as well as moderate pollution from nitrogen oxides. Slightly higher concentrations consistent with an urban level arise only in the central apron area of the airport. The ozone values in the airport grounds are consistent with the large-scale situation in the Vienna Basin.

Airborne emissions 2015-2019

	2015	2016	2017	2018	2019
SO₂ in kilograms Flughafen Wien Group	451	484	61	479	608
SO₂ in grams per traffic unit	0.0182	0.0190	0.0023	0.0181	0.018
NO_x in kilograms Flughafen Wien Group	55,117	58,420	54,737	61,019	68,125
NO_x in grams per traffic unit	2.23	2.30	2.07	2.30	2.02
PM₁₀ in kilograms Flughafen Wien Group	6,740	7,310	6,862	7,758	8,375
PM₁₀ in grams per traffic unit	0.27	0.29	0.26	0.29	0.25
Total emissions in kilograms Flughafen Wien Group	62,308	66,214	61,660	69,256	77,108
Total emissions in grams per traffic unit	2.51	2.61	2.33	2.37	2.29

- 1) The change in figures for the year 2018 was caused by an updated version of the software used and by a change of the emission factor. The previous year's figures are therefore not directly comparable.
- 2) The general rise in the figures for 2019 was caused by the high growth in traffic figures.

Sustainable procurement

Sustainable and ecological procurement, i.e. the purchasing of environmentally friendly products and services where social standards are complied with in their production or performance, is an important company objective. Local sources are also taken into consideration here. The “Nationale Aktionsplan für nachhaltige Beschaffung” (“National action plan for sustainable procurement”, known for short as the “naBe-Aktionsplan”) has been launched in Austria under the aegis of the Ministry of the Environment. The aim of the plan is to procure sustainable products and services and to promote the development of the sustainable market offer through this major purchasing power. The action plan has been implemented since the autumn of 2010 at the Bundesbeschaffung GmbH (BBG for short), and all contracts of the BBG will be adapted to this new standard – during re-tendering processes at the latest. Some of Flughafen Wien AG’s procurement is also made through the BBG. In this way, sustainable criteria are taken into consideration in the procurement process, and the naBe action plan is jointly implemented. In addition, Vienna Airport is subject to the stipulations of the Bundesvergabegesetz (Austrian Federal Public Procurement Act). The 35 largest suppliers account for around 45% of this order value. The largest suppliers (in terms of the order value) belong to the sectors of construction, petroleum processing, metal working, special vehicles, technology and various services such as IT and airport handling. Measured by the order value, the majority of the contractors come from the region immediately surrounding the airport: 69% of the 35 largest suppliers come from Vienna and Lower Austria, 14% come from other federal states in Austria and 17% from Europe.

Mobility

The airport can be reached in a short time by motorway and train as well as by local transport connections such as the bus, the rapid transit train and the City Airport Train. A long-distance train station at the airport facilitates and speeds up the arrival of passengers from metropolitan areas such as Linz, Salzburg and St. Pölten.

Since 2003, the City Airport Train (CAT) – a subsidiary of FWAG (50.1%) owned jointly with Österreichische Bundesbahnen (ÖBB - Austrian Federal Railways) (49.9%) – has linked the city centre of Vienna with Vienna Airport. The City Air Terminal at Vienna’s Mitte-Landstrasse train station offers the option of checking luggage in 24 hours before departure. Specially adapted double-decker coaches and a journey time of just 16 minutes make this air-rail link a comfortable option for travelling to the airport directly from the city centre.

The good public transport options for travelling to the airport are also reflected in the modal split: in 2019, approximately 60% of all passengers and visitors to the airport travelled there or back by public transport.

Modal split at Vienna Airport

Means of transport to the airport	2015	2016	2017	2018	2019
Private/company car	25.60%	25.00%	24.00%	20.80%	21.10%
Rental car (e.g. Sixt, Avis, Europcar)	2.60%	2.40%	1.70%	1.50%	2.63%
Car sharing	n.a.	n.a.	0.70%	1.60%	1.05%
Taxi and chauffeured rental car	20.80%	22.30%	19.30%	18.30%	10.25%
Public bus (e.g. Vienna Airport Lines, Blaguss)	9.50%	8.50%	8.30%	9.70%	10.65%
Coach	2.60%	3.50%	2.50%	4.20%	3.15%
Rail (Rapid transit train, City Airport Train, Long-distance transport)	38.80%	38.20%	43.40%	43.80%	45.90%
New forms of mobility (e.g. Uber, Bolt)	n.a.	n.a.	n.a.	n.a.	4.33%
Transfer from/to Hotel, Transfer from/to airport	n.a.	n.a.	n.a.	n.a.	0.48%
Other	0.10%	0.10%	0.10%	0.10%	0.48%

Flughafen Wien AG e-fleet

Flughafen Wien AG is working continuously to improve air quality at the airport and has – where financially sustainable – gradually converted its fleet to electric vehicles. The following electric vehicles were in use in 2019:

Equipment type	Number	Brands
Electric towing vehicles	190	Spijkstaal, Fuma, Jungheinrich, Still
Floor conveyors/electric stackers	50	Jungheinrich, Linde
Electric mopeds	8	Govecs, Emax, IO
Scooters	46	U-Carver
Cars	4	BMW, Mercedes, Renault
Passenger stairs	7	Tips
Baggage conveyors	65	Caljan, Meyer, Tips

Sustainable building – life cycle consideration of properties

“Planning, Construction & Facility Management” also includes strategic facility management, which proceeds in a concerted and coordinated manner. The life cycle consideration of all landside properties is thus ensured, a particular result of which is that the operating costs and the periodic modernisation measures are incorporated in the overall consideration of the costing, planning and implementation of construction projects.

In the field of real estate, a balanced development strategy geared towards the concept of an “Airport City” is being pursued. The product segments with an attractive risk/return profile will be expanded aggressively in the next few years and supplemented with urbanising elements in order to ensure sustainable development. Vienna Airport is the first business location in Austria to have been awarded the sustainability certificate of the German Sustainable Building Council (DGNB) by the Austrian Sustainable Building Council (ÖGNI), and the “Airport City Vienna” brand was recognised as Austria’s strongest business location brand.

The new office building Office Park 4, which was opened in 2020, was awarded a Platinum Pre-Certificate by ÖGNI in 2017. In addition, the project team observed ecological principles in the building services and selection of materials in order to guarantee the minimisation of energy requirements. The use of regenerative energy is also a priority. Office Park 4 is the first property in Austria to have been pre-certified according to the new “New Office and Administration Building, Version 2017” system variant.

AIRPORT INNSBRUCK

All emissions that are emitted directly at the airport and those that result from energy consumption (supply by third parties) are recorded. The calculation of CO₂ emissions is based on the requirements of the ICAO Guidance on Airport Air Quality (ICAO Doc 9889). However, the airport operator can primary only influence the airport's own vehicles, equipment and machinery as well as emissions that are directly related to the energy consumption of the airport. This amounts to 20% of total CO₂ emissions at the airport. The remaining 80% of CO₂ emissions can only be influenced by the airport operator through indirect measures. In general, Innsbruck Airport is a relatively small CO₂ emitter. The average per capita CO₂ emissions of an Austrian citizen are 8.9 t per year. The total CO₂ emissions at Innsbruck Airport in 2020 roughly correspond to the total annual emissions of a municipality of about 416 inhabitants. As part of the airport's participation in the Community Eco-Management and Audit Scheme (EMAS), the airport is audited annually for compliance with all requirements under Regulation (EC) No 1221/2009. Since 2015, an energy management has been installed in accordance with ISO 50001: 2011.

AIRPORT SALZBURG, W.A. MOZART

Salzburg Airport has been certified to the environmental managementsystems EMAS and ISO 14001 since the mid 1990's. In 2012 Salzburg Airport was the first regional airport in the German-speaking countries to meet the requirements of ISO 50001.

Environment and Energy are one of six strategy groups of the airport and show the importance of these themes.

The electricity provided by the power supplier is free of carbon dioxide. The airport itself produces 300 kW peak per year using its own photovoltaic plants. Expansions of the PV plants are being planned. In addition, some of our building roofs are leased for PV plants.

Therefore, the attention is focused on heating, air-conditioning and the vehicle fleet.

Heating and air-conditioning with renewable resources is part of the airport's master plan.

Salzburg Airport is a regional airport with short distances on the ground, which means that electrically driven vehicles have a significant advantage in comparison to gasoline-practiced vehicles. Currently (2021):

- 89 % of the lift trucks
- 81% of the towing vehicles
- 68 % of the passenger-stairs
- 63 % of the aircraft towing vehicles
- 25 % of the passenger busses

are already electric driven.

AVIATION TECHNOLOGIES IN AUSTRIA

As a result of the dynamic growth and changes within this sector in recent years, the field of Austrian aeronautics has assumed increasing significance. In 2009, the aeronautics (supplier) industry achieved a turnover of 1.6 billion Euros and employed 8500 people. To a large extent, Austria's aeronautics industry is export-oriented, with an average quota of around 72%. The greatest export market is currently Europe (57%); followed by North America with 31%. In addition to other equipment manufacturers such as the Airbus Group, Boeing, Embraer and Bombardier Aerospace, and supplier companies such as BAE Systems, Rolls Royce, MTU Aero Engines, General Electric, Pratt&Whitney and Snecma, the list of customers also includes airports, airlines and air traffic control facilities.

The Austrian aeronautics (supplier) industry and air transport sector exhibits several areas of expertise in the fields of general aviation, complex aircraft structures and components, innovative materials, production technology, cabin equipment (including infotainment), aircraft electronics/avionics, intelligent aircraft infrastructure, ground testing and other testing equipment, propulsion, air traffic infrastructure and air traffic control applications (ATM and airport technology, air- and landside).

In Austria as well, the air transport sector has undergone marked growth in recent years. In 2019, Vienna airport, the largest airport in Austria, recorded 31,7 million passengers. This

corresponds to 87% of the total air traffic in all of Austria. The remainder was divided between the airports in Salzburg (5%), Innsbruck (3%), Graz (3%), Linz (1%) and Klagenfurt (1%).

The European Commission still expects a doubling in air traffic over the next 10 years; this growth will follow the temporary slump due to the economic and financial crisis. The amount could even grow to three times as much traffic within the next 20 years.

In order to deal with this growth in Europe, central issues have to be confronted. These include the impact on the environment, safety, customer satisfaction, affordability and expansion of air transportation capacity with Europe-wide harmonized and optimized air traffic management. This requires the application of new technologies and innovative advances in operational methodologies. These are the basis for higher performance, greater environmental compatibility, reduced air traffic noise, the aircraft used, air traffic management systems and airport technologies. Such advances are also in the interest of time and costs saving.

The Austrian Aviation Strategy for Research, Technology and Innovation

The societal, economic and technological environment is rapidly changing and the need for action has been accelerated by the Covid crisis. We are at a technology crossroads, which needs “end to end solutions” to enable sustainable aviation competitiveness.

At the beginning of 2021, the Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) initiated a broad stakeholder consultation process in order to set up a new strategy for research, technology and innovation in the field of aeronautics and air transportation. Around 200 actors of the Austrian R&I sector, international experts, and representatives of the European Commission are invited to participate.

This strategy will pave the way for developing and implementing a new, future-oriented Strategic Research and Innovation Agenda (SRIA) in order to facilitate innovative solutions for the greening of aviation and to support recovery after the pandemic.

The Austrian strategy process goes hand in hand with the development of the new vision for aviation in Europe. In line with actions taken by ACARE - the Advisory Council for Aviation Research and Innovation in Europe. The launch of both strategies is envisaged by early 2022.

The Take Off Initiative for Research, Technology and Innovation in Aviation

Between 1999 and 2020, about 551 research projects were funded with a public and private budget of around 450 mio Euros. These projects offered Austrian organisations the chance to extend their existing know-how in air transportation and aeronautics.

To foster the greening of aviation and boost economic recovery Take Off emphasised on the following goals:

- Reduction of Emissions for a sustainable and future oriented aviation
- Digitalisation for an environmentally friendly, competitive, safe & secure aviation
- Human-centred approaches for a highly productive & user friendly aviation

Austria shows research competences in the following strategic market segments:

Aircraft: This market segment concentrates on innovative developments regarding aircraft as such as well as on realizing new potential areas of application. This predominantly concerns single- and multi-engine light aircraft, sporting and business aircraft as well as unmanned aerial vehicles (UAVs). With regard to passenger and cargo aircraft, the focus is predominantly on system integration, which is also being addressed by other market segments (BMVIT, 2015).

Structures: This segment is among Austria's dominant segments. It aims at optimizing construction elements, components, subsystems and systems for application in the airframe's primary structures. This includes fuselage, wings, empennage, engine hoisting and landing gear. Structure technology has considerable potential for generating an increase in efficiency (BMVIT, 2015).

Engines: Another strong position is held by the engine segment, which is specifically oriented towards new or improved propulsion systems and alternative fuels. Research topics here include, among others, increasing thermal as well as propulsion efficiency, or optimizing the airflow in high- and low-pressure turbines. The novel aircraft engines that are scheduled to be on the market by 2020 will decrease aircraft emissions by 10 to 15%. From 2025/2030, emissions are expected to be lowered by as much as 40% (BMVIT, 2015)

Cabin: In the cabin segment, another strong segment in Austrian aeronautics industry, businesses work on innovative solutions for on-board information and entertainment. The focus

here is on innovations that facilitate a comfortable and barrier-free voyage. Another aim lies in integrating entirely new and modern design elements (BMVIT, 2015).

Materials & Manufacturing Technologies: This is the market concentrates on new and improved materials, material alloys and coating technology, which are ever in great demand. Innovative ideas on intelligent tooling, intelligent production and highly automated assembly are essential in optimising cost efficiency (BMVIT, 2015).

Cockpit & Aircraft Electronics: In this segment research activities comprise cockpit equipment such as seats, displays and lightening as well as a wide range of aircraft electronic systems, such as flight control and management systems, radar and other sensor systems, communication and navigation systems, data recording units, bus systems and mission systems (www.aeronautics.at).

Systems: In this segment research topics range from optimizing hydraulics and pneumatics to air conditioning and ventilation to de-icing and rain protection systems. The development of improved ground-based flight control of UAS also falls into this category (BMVIT, 2015).

Air Traffic Infrastructure & Control: The growing demand for mobility, the increase in scheduled air transport and the expanding number of flight routes within the EU requires an efficient and intelligent infrastructure in the air as well as on ground. In this sector research is centred on optimised vehicles and other equipment to be employed on the airfield, new light and wayfinding systems, fuel loading and de-icing systems, power supply, communication, location, information systems and system monitoring as well as new methods of dealing with weather conditions. This segment is the most employment-intensive in the aeronautics supply industry (BMVIT, 2015).

Ground Test & Training & Research Infrastructures: This segment focusses on the development and production of test facilities, ground test equipment as well as training devices and flight simulators. Research is conducted on enhancing their cost efficiency in maintenance, repair and overhaul, with particular emphasis on increasing the service life and reusability of components, on the feasibility of self/assessment, and on advanced diagnosis with non-destructive testing (BMVIT, 2015). Among others Austria provides unique testing infrastructures in the fields of aircraft icing and unmanned aircraft systems incl. communication infrastructures. More detailed information under HOME - aeronautics.at: austrian aeronautics technology and research or open4aviation - open4aviation.

APPENDIX A

DETAILS RESULTS FOR ECAC SCENARIOS FROM SECTION A

1. Baseline scenario

a) Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres ⁶⁹ RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported ⁷⁰ FTKT (billion)	Total Revenue Tonne Kilometres ⁷¹ 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

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

⁶⁹ Calculated on the basis of Great Circle Distance (GCD) between airports, for 97% of the passenger traffic for forecast years.

⁷⁰ Includes passenger and freight transport (on all-cargo and passenger flights).

⁷¹ A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).

b) Fuel burn and CO₂ emissions forecast for the baseline scenario

Year	Fuel Consumption (10 ⁹ kg)	CO ₂ emissions (10 ⁹ kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280
2030	50.72	160.29	0.0252	0.252
2040	62.38	197.13	0.0252	0.252
2050	69.42	219.35	0.0250	0.250

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

2. Implemented measures scenario

2A) Effects of aircraft technology improvements after 2019

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

Year	Fuel Consumption (10 ⁹ kg)	CO ₂ emissions (10 ⁹ kg)	Well-to-wake CO ₂ e emissions (10 ⁹ kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	36.95	116.78	143.38	0.0332	0.332
2019	52.01	164.35	201.80	0.0280	0.280
2030	49.37	156.00	191.54	0.0232	0.232
2040	56.74	179.28	220.13	0.0217	0.217
2050	59.09	186.72	229.26	0.0202	0.202

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

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

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

2B) Effects of aircraft technology and ATM improvements after 2019

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

Year	Fuel Consumption (10 ⁹ kg)	CO ₂ emissions (10 ⁹ kg)	Well-to-wake CO ₂ e emissions (10 ⁹ kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	36.95	116.78	143.38	0.0332	0.332
2019	52.01	164.35	201.80	0.0280	0.280
2030	46.16	145.86	179.09	0.0217	0.217
2040	51.06	161.35	198.12	0.0196	0.196
2050	53.18	168.05	206.33	0.0182	0.182

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

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

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

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

Year	Well-to-wake CO ₂ e emissions (10 ⁹ kg)			% improvement by Implemented Measures (full scope)
	Baseline Scenario	Implemented Measures Scenario		
		Aircraft techn. improvements only	Aircraft techn. and ATM improvements	
2010			143.38	NA
2019			201.80	NA
2030	196.8	191.5	179.1	-9%
2040	242.0	220.1	198.1	-18%
2050	269.3	229.3	206.3	-23%

For reasons of data availability, results shown in this table do not include cargo/freight traffic. Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.

APPENDIX B

NOTE ON THE METHODS TO ACCOUNT FOR THE CO₂ EMISSIONS ATTRIBUTED TO INTERNATIONAL FLIGHTS

1. Background

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

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

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

2. Accounting methods

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

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

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

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

2.1 Comparisons: flown distance and number of operations

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

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

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

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

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

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

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

3. Impact on the action plan definitions

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

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

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

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

3.1 Impact on the baseline definition (ECAC)

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

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

Abbreviations

AAT	Aircraft Assignment Tool
ACARE	Advisory Council for Research and Innovation in Europe
ACA	Airport Carbon Accreditation
ACI	Airports Council International
AIRE	The Atlantic Interoperability Initiative to Reduce Emissions
APER TG	Action Plans for Emissions Reduction Task Group of the ECAC/EU Aviation and Environment Working Group (EAEG)
ATM	Air Traffic Management
CAEP	Committee on Aviation Environmental Protection
CNG	Carbon neutral growth
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
EAER	European Aviation Environmental Report
EASA	European Aviation Safety Agency
EC	European Commission
ECAC	European Civil Aviation Conference
EEA	European Economic Area
EFTA	European Free Trade Association
EU	European Union
EU ETS	EU Emissions Trading System
GHG	Greenhouse Gas
ICAO	International Civil Aviation Organisation
IFR	Instrumental Flight Rules
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Right
JU	Joint Undertaking
MBM	Market-based Measure
MT	Million tonnes
PRISME	Pan European Repository of Information Supporting the Management of EATM
RED	Renewable Energy Directive
RPK	Revenue Passenger Kilometre
RTK	Revenue Tonne Kilometre
RTD	Research and Technological Development
SAF	Sustainable Aviation Fuels
SES	Single European Sky
SESAR	Single European Sky ATM Research
SESAR JU	Single European Sky ATM Research Joint Undertaking
SESAR R&D	SESAR Research and Development
SMEs	Small and Medium Enterprises

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