2021

ICAO ACTION PLAN FOR AVIATION CO_2 EMISSIONS REDUCTION GREECE

MINISTRY OF INFRASTRUCTURES AND TRANSPORT

HELLENIC CIVIL AVIATION AUTHORITY

MINISTRY OF INFRASTRUCTURES AND TRANSPORT

HELLENIC CIVIL AVIATION AUTHORITY

DIRECTORATE GENERAL OF AIR TRANSPORT

ENVIRONMENTAL PROTECTION SECTION

Leontos 4 & Eleftherias str,

164 52 Argyroupolis, Greece

tel. +30 210 997 3360

e-mail. prope@hcaa.gr

Approved by

Georgios I. Dritsakos

Governor of Hellenic Civil Aviation Authority

Reviewed by

Konstantina Chrysikopoulou

State Action Plan Focal Point

Act. Head of Environmental Protection Section

Compiled by

Dr. Eva Sgourou

Mechanical Engineer/Health Engineer

Environmental Protection Section

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INTRODUCTION

1. Preamble

a) The ICAO Contracting State Greece is a member of the European Union and of the European Civil Aviation Conference (ECAC). ECAC is an intergovernmental organisation covering the widest grouping of Member States[1] 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) Greece, 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) Greece recognises the value of each State preparing and submitting to ICAO an updated State Action Plan for CO_2 emissions reductions as an important step towards the achievement of the global collective goals agreed since the 38th Session of the ICAO Assembly in 2013.

f) In that context, it is the intention that all ECAC States submit to ICAO an action plan[2]. This is the action plan of Greece.

g) Greece 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 CO_2 emissions is necessary, and that this should include:

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

[2] ICAO Assembly Resolution A40-18 also encourages States to submit an annual reporting of international aviation CO_2 emissions, which is a task different in nature and purpose to that of action plans, strategic in their nature. Also this requirement is subject to different deadlines for submission and updates as annual updates are expected. For that reason, the reporting to ICAO of international aviation CO_2 emissions referred to in paragraphs 10 & 14 of ICAO Resolution A40-18 is not necessarily part of this Action Plan, and may be provided separately, as part of routine provision of data to ICAO, or in future updates of this action plan.

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

i) In Greece 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).

2. Current state of aviation in Greece

Greece is strategically located at the crossroads of Europe, Asia, and Africa. Situated on the southern tip of the Balkan Peninsula, Greece shares land borders with Albania, North Macedonia and Bulgaria to the north and Turkey to the northeast (**Figure 1**).

Greece has the longest coastline on the Mediterranean Basin (13,676 km) in length, featuring a vast number of islands. Most of the Greek islands and many cities of Greece are connected by aviation and marine transportation.

Figure 1. Map of Greece

The **Hellenic Civil Aviation Authority (HCAA)** is a Civil Service under the Ministry for Infrastructure and Transport, directed by its Governor and Deputy Governors, and has as a mission the *organisation, development* and *control* of the country`s air transport infrastructure, as well as the study and laying of proposals to the Minister of Infrastructure and Transport, concerning the overall policy formulation in air transport.

HCAA has a strong collaboration with the Permanent representative of Greece in ICAO, to which Greece is a member since the beginning of Chicago convention in 1945, and is elected as a member of ICAO Council for the triennium 2019 – 2022. HCAA represents Greece in ECAC and in EASA and provides all the assistance to Greek Ministers in EU level in the air transport field.

However, a new national legislation framework which has commenced in 2016 with Greek Law 4427 and has been further specified in 2020 with Greek Law 4757, is reorganizing HCAA, creating one new entity, under the name Hellenic Civil Aviation Authority and reorganizing the existing one under the name Hellenic Civil Aviation Service (HCAS). The new HCAA will consist an Independent Authority, responsible for performing certification, supervision and enforcement tasks in the field of aviation, air navigation and airports, according to the national and EU legislation. The new reformed Hellenic Civil Aviation Service (HCAS) will be responsible for the operation of Greek airports and of Air Navigation, implementing all national and EU legislation and the International Conventions.

In Greece, there are fifty-six aerodromes, available for public use and designated as **Airports** (International and National). These fifty-six (56) aerodromes are categorised according to their ownership status, services provided, organisational structure etc. [3]

Of the 56 aerodromes, 28 are available for international and national civil aircraft operations, 15 are available for national civil aircraft operations and 13 are not open for civil aircraft operations unless a special permission has been granted.

In regards to their ownership, 37 are owned and operated by the State (HCAA, Ministry of Defence), 4 are owned by municipalities and operated by the State (HCAA). Athinai/Eleftherios Venizelos airport is owned and operated by a Public-Private Partnership Company, Athens International Airport S.A. (AIA), through a 30-year concession agreement, ratified by Greek Law 2338/1995. Fourteen regional airports are operated by Fraport Greece, which is responsible for maintaining, operating, managing, upgrading and developing these regional airports in Greece over a period of 40 years based on a concession agreement.

Figure 2 presents the thirty-nine (39) commercial airports in Greece, located all over the country. **Appendix A** presents these 39 Greek commercial airports, categorised by regional location, ICAO & IATA code, Airport name and operating entity.

Figure 2. Commercial Airports in Greece

3 https://www.eurocontrol.int/sites/default/files/2020-04/eurocontrol-lssip-2019-greece-level1.pdf

Commercial flights in Greece were following an annual increasing trend, until 2020 when the COVID-19 pandemic and the respective restrictions in aviation resulted in a drastic decrease in all air traffic routes. **Table 1** illustrates the commercial aviation traffic in Greece in terms of domestic, international and total flights and passengers (arriving and departing), as it evolved during the years 2010 – 2020. The annual statistical data are publicly available in HCAA's website[4]. At the time of issuing this report, data for 2020 are published as "provisional".

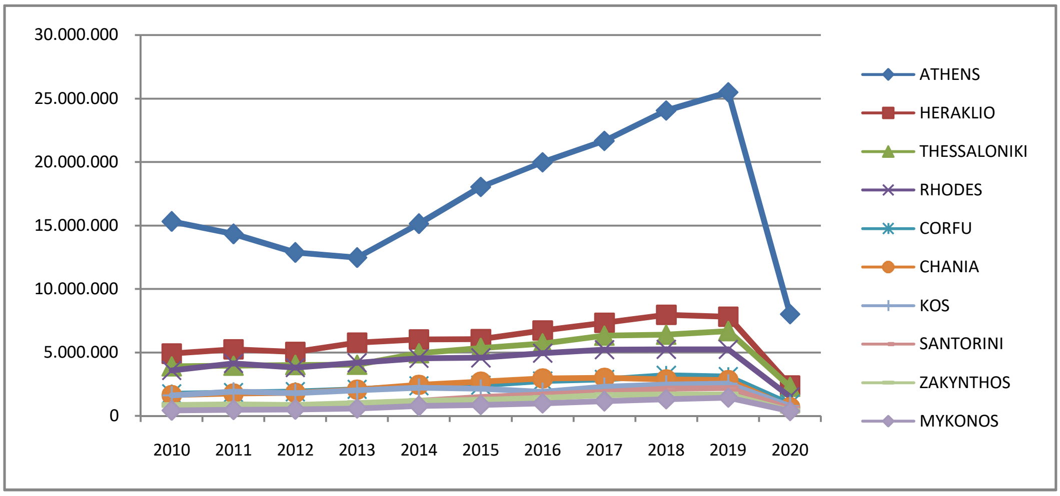
Table 1. Evolution of commercial aviation traffic in Greece, from 2010 to 2020

	DOMESTIC			INTERNATIONAL			TOTAL	
	FLIGHTS	PASSENGERS		FLIGHTS	PASSENGERS		FLIGHTS	PASSENGERS
	ARR+DEP	ARR	DEP	ARR+DEP	ARR	DEP	ARR+DEP	ARR+DEP
2010	216.203	6.200.867	6.266.594	212.660	12.882.480	12.953.632	428.863	38.303.573
2011	189.373	5.564.753	5.632.815	220.853	13.758.094	13.875.659	410.226	38.831.321
2012	176.792	5.103.727	5.192.540	205.989	13.156.585	13.205.279	382.781	36.658.131
2013	163.595	4.933.769	5.049.976	211.767	14.239.508	14.234.088	375.362	38.457.341
2014	171.157	5.955.714	6.125.267	244.093	16.286.717	16.224.576	415.250	44.592.274
2015	187.522	7.183.602	7.345.272	256.727	17.160.024	17.122.702	444.249	48.811.600
2016	195.161	7.812.566	8.053.345	274.392	18.634.235	18.492.250	469.553	52.992.396
2017	192.892	8.182.823	8.231.220	291.237	20.822.013	20.628.537	484.129	57.864.593
2018	201.489	8.458.436	8.462.716	318.059	22.752.820	22.618.219	519.548	62.292.191
2019	206.255	8.512.489	8.498.552	319.900	23.606.801	23.551.163	526.155	64.169.005
2020	120.547	3.437.773	3.432.488	123.248	6.380.329	6.447.290	243.795	19.697.880

Athens International Airport is the busiest airport in Greece in terms of passenger traffic and it is followed by the airports of Heraklion (Crete), Thessaloniki, Rhodes, and Corfu. The evolution of total passenger movements (arriving and departing) in the **ten busiest airports in Greece** during the years 2010-2020 is shown in **Figure 3**.

In 2019, the 40% of total passenger traffic was travelling through Athens International Airport and the 92% was attributed to the ten busiest airports shown in Figure 3.

Figure 3. Top ten passenger movement airports



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4 http://www.ypa.gr/profile/statistics/

In mid 2021, there were twenty-five (25) **operators** holding an Air Operator Certificate (AOC) issued by HCAA, under EASA regulations. The total number of **aircrafts** utilized by the operators is 148 and their distribution is shown in **Table 2**.

Table 2. Air Operators' aircraft distribution

	CATEGORY OF AIRCRAFT	NUMBER OF AIRCRAFT
1.	Large Jet Aeroplanes	80
2.	Business Jet Aeroplanes (19 pax max)	12
3.	Turboprop Aeroplanes MTOM above 5700 kgr	27
4.	Turboprop Aeroplanes MTOM below or equal 5700 kgr	3
5.	Propeller (Piston Engine) Aeroplanes	2
6.	Rotorcraft Large	1
7.	Rotorcraft Small	23
	Total	**148**

The **European Aviation Environmental Report** (EAER)[5], prepared by the European Union Aviation Safety Agency (EASA), the European Environment Agency (EEA) and EUROCONTROL, provides an overview of the aviation sector in EU28+EFTA and an assessment of the environmental performance of the aviation sector, based on data updated in 2019. Detailed information on the actions undertaken at a European and at a National level for the reduction of CO_2 emissions from the aviation system are presented in **Section 1** and **Section 2** respectively.

[5] The European Aviation Environmental Report can be found at: https://www.easa.europa.eu/eaer/system/files/usr_uploaded/219473_EASA_EAER_2019_WEB_LOW-RES_190311.pdf

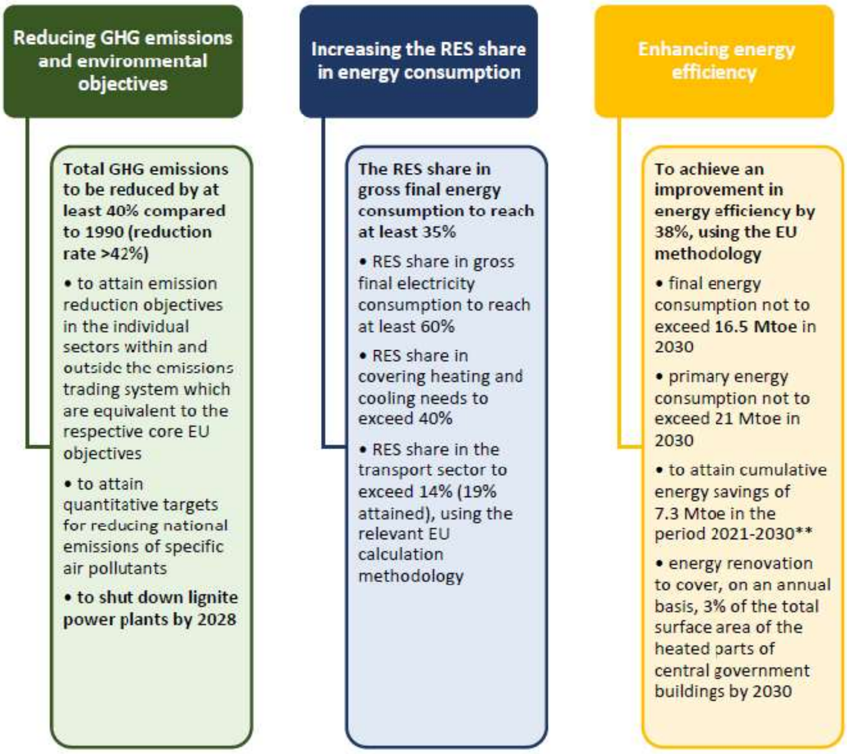
3. Greek Environmental Policy

In response to the emerging evidence that climate change could have a major global impact, the United Nations Framework Convention on Climate Change was adopted on 9 May 1992 and was opened for signature in Rio de Janeiro in June 1992. Greece signed the Convention in Rio and ratified it in 1994 with Greek Law 2205.

The Ministry of Environment and Energy (MEEN) is the governmental body responsible for the development and implementation of environmental policy in Greece, as well as for the provision of information concerning the state of the environment in Greece in compliance with relevant requirements defined in international conventions, protocols and agreements. Moreover, MEEN is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organization, in relation to the implementation of the provisions of the Kyoto Protocol, according to the Greek Law 3017/2002, with which Greece ratified the Kyoto Protocol. In this context, the MEEN has the overall responsibility for the National Greenhouse Gas (GHG) inventory, and the official consideration and approval of the inventory prior to its submission (see below).

The **National Energy and Climate Plan** (NECP)[6] is the Greek government's strategic plan for climate and energy issues, setting out a detailed roadmap regarding the attainment of European Union's energy and climate objectives by 2030. The NECP sets out and describes priorities and policy measures in respect of a wide range of development and economic activities intended to benefit Greek society, and therefore it is a reference text for the forthcoming decade. The key policy priorities for each dimension of the NECP are presented in **Figure 4**.

Figure 4. National energy and environmental objectives for the period 2021-2030 (Source: National Energy and Climate Plan[6])

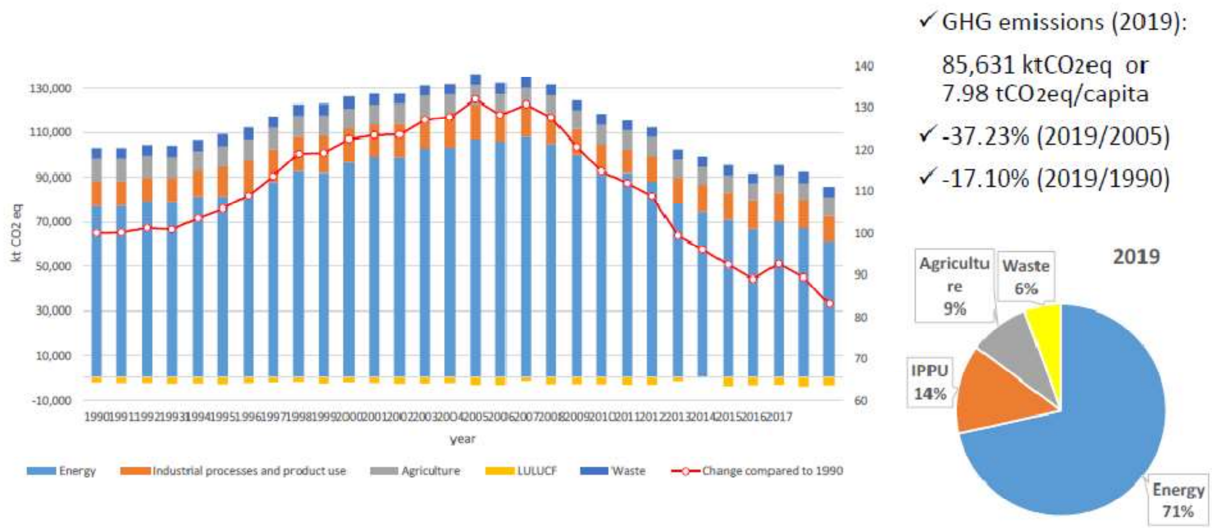


6 The National Energy and Climate Plan can be found at: https://ec.europa.eu/energy/sites/ener/files/el_final_necp_main_en.pdf

Greece has in place a **National Greenhouse Gas (GHG) Inventory** covering anthropogenic emissions by sources and removals by sinks. The annual National Inventory Report (NIR) contains Greece's annual greenhouse gas emission estimates dating back to 1990[7]. The GHG emissions profile for the period 1990-2019 in Greece is shown in **Figure 5**.

The living standards improvement, due to the economic growth, the important growth of the services sector and the introduction of natural gas in the Greek energy system represent the basic factors affecting emissions trends from energy for the period 1990 – 2007. Finally, a reduction of emissions by 41.9% is observed in 2019 compared to 2008, due to the economic recession at the beginning of the period, but also due to measures as the increase of renewable energy sources and natural gas share of the energy mixture, along with energy efficiency improvement actions.

Figure 5. GHG emissions profile for the period 1990-2019 in Greece (Source: UNFCCC Multilateral Assessment - Greece[8])



Since 2005, GHG emissions from domestic aviation were taken from EUROCONTROL, based on the combination of energy consumption data and air traffic data, as well as from aircraft fleet composition. EUROCONTROL calculations use Tier 3 approach to assess air pollutants from air traffic. For consistency reasons, the whole series from 1990 to 2004 was recalculated. **Table 3** illustrates domestic aviation GHG emissions for the years 2010-2019 (in ktCO2).

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[7] The 2021 National Inventory Report of Greece can be found at: https://unfccc.int/documents/272918

[8] https://unfccc.int/documents/278531

Table 3. Domestic aviation GHG emissions for the period 2010-2019 in Greece (Source: 2021 National Inventory Report[7])

Domestic Aviation	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Fuel Consumption	TJ	6591.71	7293.60	6703.73	4736.81	5064.22	5459.42	5750.35	5656.31	5900.09	5749.77
Emissions											
CO2	kt	470.12	520.39	478.59	338.08	361.46	389.63	410.48	403.52	421.32	409.97
CH4	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
N2O	kt	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NOx	kt	1.56	1.73	1.59	1.12	1.20	1.30	2.04	1.34	1.93	1.85
CO	kt	1.21	1.34	1.23	0.87	0.93	1.00	0.64	1.04	0.64	0.65
NMVOC	kt	0.28	0.31	0.29	0.20	0.22	0.23	0.08	0.24	0.06	0.06
SO2	kt	0.14	0.16	0.14	0.10	0.11	0.12	0.11	0.12	0.11	0.11

It is noted that according to the IPCC Guidelines, emissions estimates for international marine and aviation bunkers were not included in the national totals of the NIR, but are reported separately. **Table 4** illustrates international aviation GHG emissions for the years 2010-2019 (in ktCO2).

Table 4. International aviation GHG emissions for the period 2010-2019 in Greece (Source: 2021 National Inventory Report[7])

Memo items 1) – International bunkers Emissions (kt CO_2 eq)										
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
International aviation	2205	2279	2005	2187	2531	2547	3079	3435	3858	3989

The 4th Biennial Report of Greece, as required under Decision 2/CP.17 of the Conference of the Parties under the United Nations Framework Convention on Climate Change (UNFCCC) was prepared by the MEEN, with the external consultancy assistance of the National Technical University of Athens (School of Chemical Engineering). In accordance with the UNFCCC biennial reporting guidelines for developed country Parties, this report includes information on GHG emissions and trends and the GHG inventory, on quantified economy-wide emission reduction targets and progress in their achievement, projections, and provision of financial, technological and capacity building support to developing countries[9].

[9] The 4th UNFCCC Biennial Report of Greece can be found at: https://unfccc.int/sites/default/files/resource/BR4_Greece.pdf

SECTION 1

MEASURES TAKEN COLLECTIVELY IN EUROPE

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 CO_2 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 CO_2 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 CO_2 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 CO_2 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-CO_2 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)[10] 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 CO_2 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 CO_2 emissions.

ECAC Scenarios for Traffic and CO_2 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.

[10] The EEA includes EU countries and also Iceland, Liechtenstein and Norway.

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 CO_2 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, CO_2 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 CO_2 emissions in 2050 compared to the baseline. Whilst the data to model the benefits of ATM improvements may be less robust, they are nevertheless valuable contributions to reduce emissions further. Overall CO_2 emissions, including the effects of new aircraft types and ATM-related measures, are projected to 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 CO_2 emissions of European aviation in the absence of any of the mitigation actions described later in this document. The following sets of data (2010, 2019) and forecasts (for 2030, 2040 and 2050) were provided by EUROCONTROL for this purpose:

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

The sets of forecasts correspond to projected traffic volumes in a scenario of "Regulation and Growth", while corresponding fuel consumption and CO_2 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 forecast[11] 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 trends[12]. 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 air craft used to satisfy the passenger demand (modelled via the Aircraft Assignment Tool).

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[11] Challenges of Growth - Annex 1 - Flight Forecast to 2040, EUROCONTROL, September 2018.

[12] Prior to COVID-19 outbreak.

Table 5 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 results[11] (published in 2018 by EUROCONTROL). Historical data for the year 2019 are also shown later for reference.

Table 5. Summary characteristics of EUROCONTROL scenarios

	Global Growth	***Regulation and Growth***	***Fragmenting World***
2023 traffic growth	High ↗	Base →	Low ↘
Passenger			
Demographics (Population)	Ageing UN Medium-fertility variant	Ageing UN Medium-fertility variant	Ageing UN Zero-migration variant
Routes and Destinations	Long-haul ↗	No Change →	Long-haul ↘
Open Skies	EU enlargement later +Far & Middle East	EU enlargement Earliest	EU enlargement Latest
High-speed rail (new & improved connections)	20 city-pairs faster implementation	20 city-pairs	20 city-pairs later implementation.
Economic conditions			
GDP growth	Stronger ↗	Moderate →	Weaker ↘↘
EU Enlargement	+5 States, Later	+5 States, Earliest	+5 States, Latest
Free Trade	Global, faster	Limited, later	None
Price of travel			
Operating cost	Decreasing ↘↘	Decreasing ↘	No change →
Price of CO_2 in Emission Trading Scheme	Moderate	Lowest	Highest
Price of oil/barrel	Low	Lowest	High
Change in other charges	Noise: ↗ Security: ↘	Noise: ↗ Security: →	Noise: → Security: ↗
Structure			
Network	Hubs: Mid-East ↗↗ Europe ↘ Turkey↗ Point-to-point: N-Atlantic.↗↗	Hubs: Mid-East ↗↗ Europe & Turkey ↗ Point-to-point: N-Atlantic.↗	No change →
Market Structure	Industry fleet forecast + STATFOR assumptions	Industry fleet forecast + STATFOR assumptions	Industry fleet forecast + STATFOR assumptions

COVID-19 impact and extension to 2050

Since the start of 2020, COVID-19 has gone from a localised outbreak in China to the most severe global pandemic in a century. No part of European aviation is untouched by the human tragedy or the business crisis. This unprecedented crisis hindered air traffic growth in 2020: flight movements declined by 55% compared to 2019 at ECAC level. It continues to disrupt the traffic growth and patterns in Europe in 2021. In Autumn 2020, EUROCONTROL published a medium-term forecast[13] 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 forecast[11]. Considering the most-likely scenarios of the long-term forecast[11] and the medium-term forecasted version of the long-term flight forecast has been derived:

a) Replace the long-term forecast[11] horizon by the most recent medium-term forecast[13] to account for COVID impact;

b) Update the rest of the horizon (2025-2040) assuming thatthe original growth rates of the long-term forecast[11], 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 decay[14].

The method used relies on the calculation of adjustment factors at STATFOR[15]region-pair level and have been applied to the original long-term forecast[11]. 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 6 below shows the ECAC scenario of the passenger flight forecasted international departures for both historical (solid line) and future (dashed line) years.

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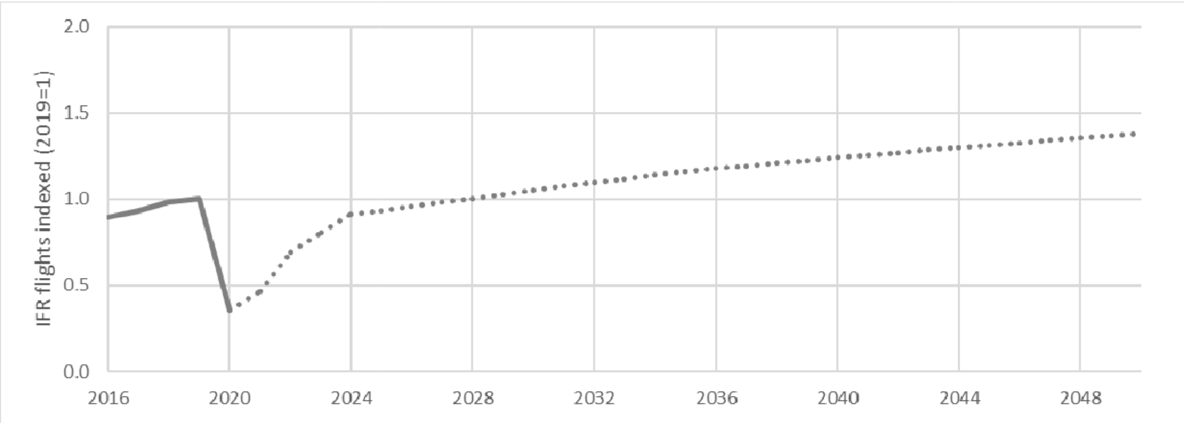
13 Five-Year Forecast 2020-2024, IFR Movements, EUROCONTROL, November 2020.

14 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.

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

Figure 6. 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 departing[16] 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 (ICAO[17]). This data, which is presented below, includes both belly cargo transported on passenger flights and freight transported on dedicated all-cargo flights.

Historical fuel burn and emission calculations are based on the actual flight plans from the PRISME[18] 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 CO_2 emissions for historical years is built up as the aggregation of fuel burn and emissions for each aircraft of the associated traffic sample characteristics. Fuel burn and CO_2 emission results consider each aircraft's fuel burn in its ground and airborne phases of flight and are obtained by use of the EUROCONTROL IMPACT environmental model, 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

16 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.

17 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.

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

burn and CO_2 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 datasets (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 correspond to the aggregation of these values for the whole concerned traffic years.

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

Table 6. Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres[19] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[20] FTKT (billion)	Total Revenue Tonne Kilometres[21] 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 7. Fuel burn and CO_2 emissions forecast for the baseline scenario

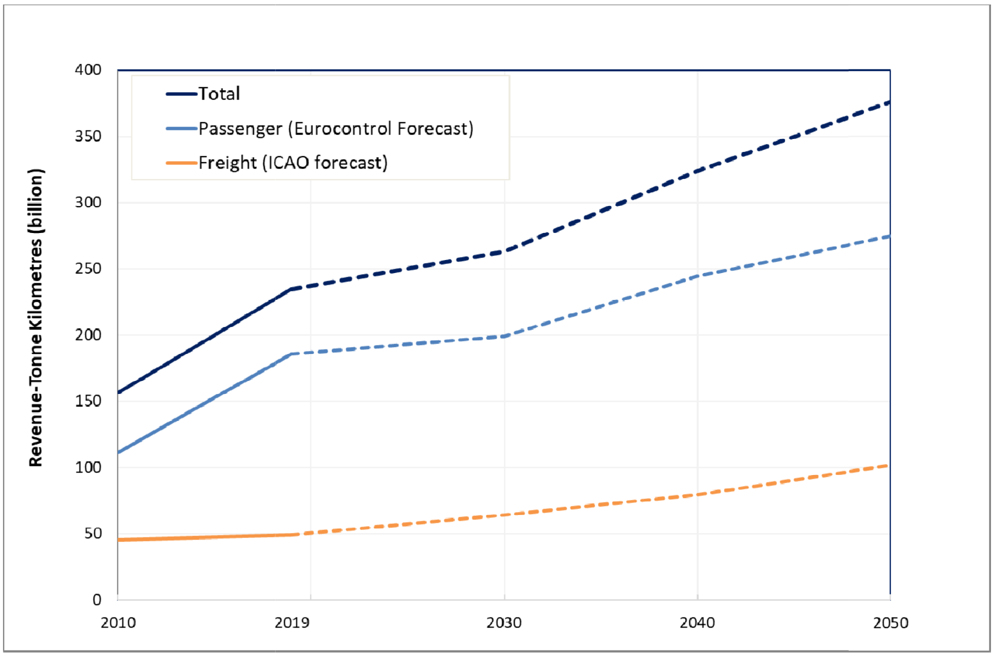
Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Fuel efficiency (kg/RPK[19])	Fuel efficiency (kg/RTK[21])
2010	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280
2030	50.72	160.29	0.0252	0.252
2040	62.38	197.13	0.0252	0.252
2050	69.42	219.35	0.0250	0.250
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

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

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

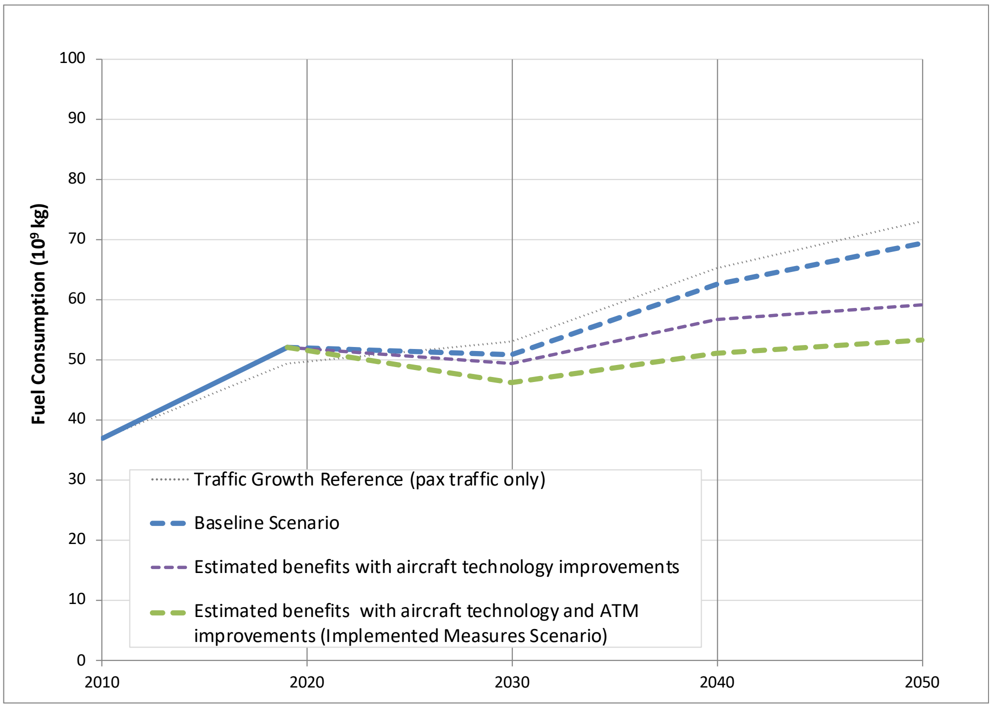
21 A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).

Figure 7. 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 7, as this representation is oversimplified through a straight line between 2019 and 2030. The same remark applies for Figure 8 and Figure 9.

Figure 8. 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 CO_2 emissions up to the year 2050.

Effects of **improved aircraft technology** are captured by simulating fleet roll-over and considering the fuel efficiency improvements of 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 Tool[22] (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 baseline[23]. Based on the information provided by the PAGAR 2019 document[24], and compared to a 2012 baseline, the benefits at the end of Wave 1 could be about 3% CO_2/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 CO_2/fuel savings (352.6 kg of fuel) to reach the initial Ambition target of about 10% CO_2/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 projects[25] are expected to increase the overall future fuel savings.

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[22] https://www.easa.europa.eu/domains/environment/impact-assessment-tools

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

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

[25] See SESAR Exploratory Research projects - https://www.sesarju.eu/exploratoryresearch

While the effects of **introduction of Sustainable Aviation Fuels (SAF)** were modelled in previous updates on the basis of the European ACARE goals[26], 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 Subsection 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 CO_2 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 8[27], while recalling that this is just a reference level, given that CORSIA was designed to contribute to the CNG2020 globally and not in individual States or regions.

Tables 8-10 and Figure 9 summarise the results for the scenario with implemented measures. It should be noted that **Table 8** shows direct combustion emissions of CO_2 (assuming 3.16 kg CO_2 per kg fuel). More detailed tabulated results are found in **Appendix B**, including results expressed in equivalent CO_2 emissions on a well-to-wake basis (for comparison purposes of SAF benefits).

Table 8. Fuel burn and CO_2 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[28])	Fuel efficiency (kg/RTK[17])
2010	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280
2030	46.16	145.86	0.0229	0.229
2040	51.06	161.35	0.0206	0.206
2050	53.18	168.05	0.0192	0.192
2050 vs 2019			*-32%*	
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

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

27 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).

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

Table 9. Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)

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

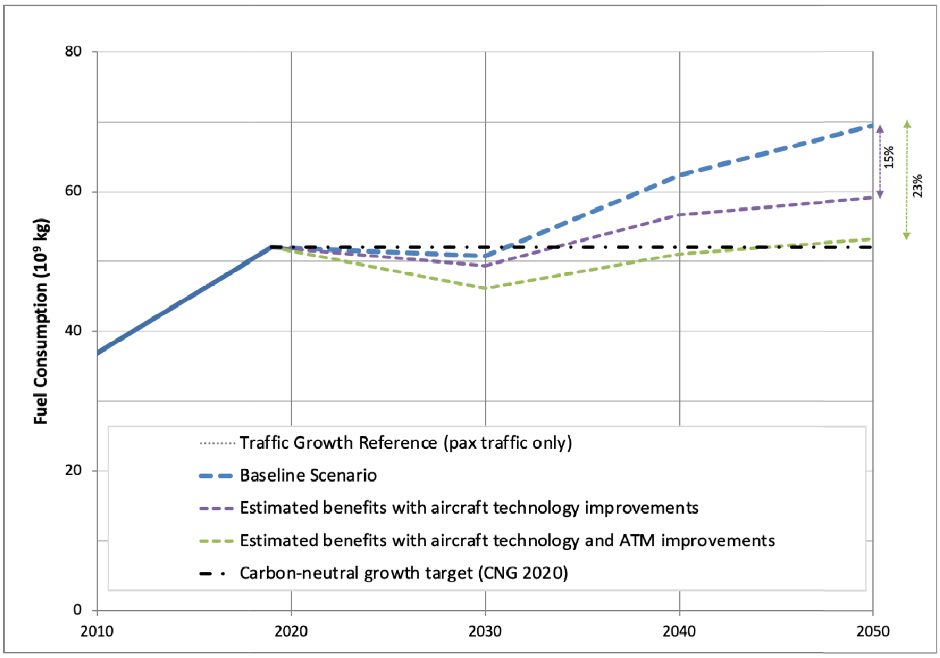
Table 10. CO_2 emissions forecast for the scenarios described in this chapter.

Year	CO_2 emissions (10^9 kg)			% improvement by Implemented Measures (full scope)
	Baseline Scenario	Implemented Measures Scenario		
		Aircraft 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 9. Fuel consumption forecast for the baseline and implemented measures scenarios.



As shown in **Figure 9**, the impact of improved aircraft technology indicates an overall 15% reduction of fuel consumption and CO_2 emissions in 2050 compared to the baseline scenario. Overall CO_2 emissions, including the effects of new aircraft types and ATM-related measures, are projected to improve to lead to a 23% reduction in 2050 compared to the baseline.

From **Table 8**, 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 CO_2 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 (CO_2 standard). Its contribution to the global aspirational goals is available in CAEP.

1.2 Research and development

1.2.1 Clean Sky

Clean Sky[29] is an EU Joint Undertaking that aims to develop and mature breakthrough "clean technologies" for air transport globally. Joint Undertakings are Public Private Partnership set up by the European Union on the EU research programmes. By accelerating their deployment, the Joint Undertaking will contribute to Europe's strategic environmental and social priorities, and simultaneously promote competitiveness and sustainable economic growth. The first Clean Sky Joint Undertaking (**Clean Sky 1 -** 2011-2017) had a budget of €1.6 billion, equally shared between the European Commission and the aeronautics industry. It aimed to develop environmental-friendly technologies impacting all flying-segments of commercial aviation. The objectives were to reduce aircraft CO_2 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.

[29] http://www.cleansky.eu/

- **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 SkyTechnology Evaluator**[30] 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)**[31] will follow in the footsteps of CleanSky2. The EU contribution proposed is again €1.7 billion. The stakeholder community has already formulated a Strategic Research and Innovation Agenda (SRIA), which is intended to serve as a basis of the partnership once established. Subject to the final provisions of the partnership and the EU budget allocation, industry stakeholders have proposed a commitment of €3 billion from the private side.

General objectives of EPCA:

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

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

Specific objectives:

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

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

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

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[30] https://www.cleansky.eu/technology-evaluator-te

[31] https://clean-aviation.eu/

ASSESSMENT

The quantitative assessment of the technology improvement scenario from 2020 to 2050 has been calculated by EUROCONTROL and EASA and it is included in Subsection A above (ECAC Baseline Scenario and Estimated Benefits of Implemented Measures) and in Appendix B.

Table 11. Fuel consumption and CO_2 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_2e 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 12. 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 CO_2 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 fuel[32].As a result, the large-scale use of SAF can have important other non-CO_2 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 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.

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32 ICAO 2016 Environmental Report, Chapter 4, Page 162, Figure 4.

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

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

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

ASSESSMENT

A meaningful deployment of SAF in the aviation market will lead to a net decrease of the air transport sector's CO_2 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 CO_2 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´s[33] Article 17, *Sustainability criteria for biofuels and bioliquids*. Those requirements remain applicable on the revised RED II (Directive (EU) 2018/2001)38, Article 29 *Sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels* paragraphs 2 to 7, although the RED II introduces some new specific criteria for forestry feedstocks.

Transport renewable fuels (thus, including SAF) produced in installations starting operation from 1 January 2021 must achieve 65% GHG emissions savings with respect to a fossil fuel comparator for transportation fuels of 94 g CO_2eq/MJ. In the case of transport renewable fuels of non-biological origin[34], 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-biobased 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), though the ICAO Committee on Aviation and Environmental Protection (CAEP), establishing global Sustainability Requirements

[33] Directive 2009/28/EC.

[34] 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 asPower to Liquid -PtL-, Electro-fuels and Synthetic fuels). b) Waste gases, which are under the category of REcycledFUel from NOn-BIOlogical origin (also known as REFUNIOBIO).

applicable to SAF as well as to the CORSIA Methodology for Calculating Actual Life Cycle Emissions Values and to the calculation of CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels; CORSIA standards are applicable to any SAF use to be claimed under CORSIA in order to reduce offsetting obligations by aeroplane operators.

ASSESSMENT

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

2.4 Research and Development projects on SAF

2.4.1 European Advanced Biofuels Flightpath

An updated and renewed approach to the 2011 Biofuels FlightPath Initiative[35], was required to further impulse its implementation. As a result, the European Commission launched in 2016 the new Biofuels FlightPath to take into account recent evolutions and to tackle the current barriers identified for the deployment of SAF.

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

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

A number of communications and studies were delivered and are available[36].

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

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

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

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

https://ec.europa.eu/energy/sites/ener/files/20130911_a_performing_biofuels_supply_chain.pdf

[36] https://www.biofuelsflightpath.eu/ressources

BIO4A[37]: 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.

KEROGREEN[38]: *Production of sustainable aircraft grade kerosene from water and air powered by renewable electricity, through the splitting of* CO_2*, 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 CO_2 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.

FlexJET[39]: *Sustainable Jet Fuel from Flexible Waste Biomass* (flexJET) is a four-year project targeting diversifying the feedstock for SAF beyond vegetable oils and fats to biocrude oil produced from a wide range of organic waste. This is also one of the first technologies to use green hydrogen from the processed waste feedstock for the downstream refining process thereby maximising greenhouse gas savings.

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

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

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37 www.bio4a.eu

38 www.kerogreen.eu

39 www.flexjetproject.eu

BioSFerA[40]: 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.

BL2F[41]: 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% CO_2 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.

FLITE[42]: 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-OFF[43]: Is an industrially driven project aiming to be a game-changer in the cost-effective production of SAF from CO_2 and hydrogen. The unique TAKE-OFF technology is based on conversion of CO_2 and H_2 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

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40 https://biosfera-project.eu

41 https://www.bl2f.eu

42 https://cordis.europa.eu/project/id/857839

43 https://cordis.europa.eu/project/id/101006799

key industrial players should allow the demonstration of the full technology chain, utilising industrial captured CO_2 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.

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 CO_2 and non-CO_2 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 CO_2 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 CO_2 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 CO_2 reduction, highlighted by the green dotted rectangle of **Figure 10** below.

Figure 10. Performance Ambitions for 2035 for Controlled airspace (Source: European ATM Master Plan 2020 Edition).

Key performance area	SES high-level goals 2005	Key performance indicator	Performance ambition vs. baseline: Baseline value (2012)	Ambition value (2035)	Absolute improvement	Relative improvement
Capacity	Enable 3-fold increase in ATM capacity	**Departure delay**[4], min/dep	9.5 min	6.5-8.5 min	1-3 min	10-30%
		IFR movements at most congested airports[5], million	4 million	4.2-4.4 million	0.2-0.4 million	5-10%
		Network throughput IFR flights[5], million	9.7 million	~15.7 million	~6.0 million	~60%
		Network throughput IFR flight hours[5], million	15.2 million	~26.7 million	~11.5 million	~75%
Cost efficiency	Reduced ATM services unit costs by 50% or more	**Gate-to-gate direct ANS cost per flight**[1] - EUR(2012)	EUR 960	EUR 580-670	EUR 290-380	30-40%
Operational efficiency		**Gate-to-gate fuel burn per flight**[2], kg/flight	5280 kg	4780-5030 kg	250-500 kg	5-10%
		Additional gate-to-gate flight time per flight, min/flight	8.2 min	3.7-4.1 min	4.1-4.5 min	50-55%
		Within the: Gate-to-gate flight time per flight[3], min/flight	(111 min)	(116 min)		
Environment	Enable 10% reduction in the effects flights have on the environment	**Gate-to-gate CO_2 emissions**, tonnes/flight	16.6 tonnes	15-15.8 tonnes	0.8-1.6 tonnes	5-10%
Safety	Improve safety by factor 10	**Accidents with direct ATM contribution**[6], #/year Includes in-flight accidents as well as accidents during surface movement (during taxi and on the runway)	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.

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.

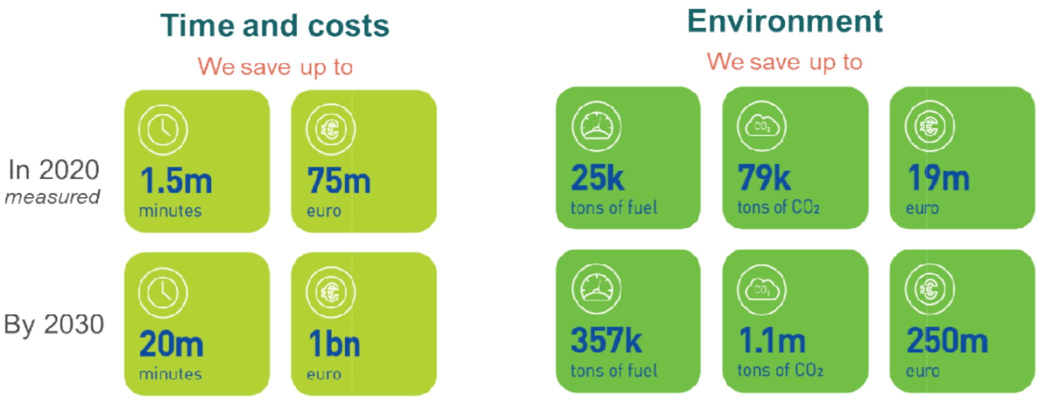
The first common project was launched in 2014 and its implementation is currently being coordinated by the SESAR Deployment Manager throughout the entire European ATM network. It includes six ATM functionalities aiming in particular to:

- 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 project[44] is planned to be completed by 2027. However, the benefits highlighted in **Figure 11** below have been measured where the functionalities have already been implemented.

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

Figure 11. First results of the first common project implemented.



3.1.2 SESAR Exploratory Research (V0 to V1)

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

3.1.3 SESAR Industrial Research & Validation Projects (environmental focus)

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

- The initial development by EUROCONTROL of the IMPACT[45] 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 process[46].

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.

45 https://www.eurocontrol.int/platform/integrated-aircraft-noise-and-emissions-modelling-platform

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

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

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

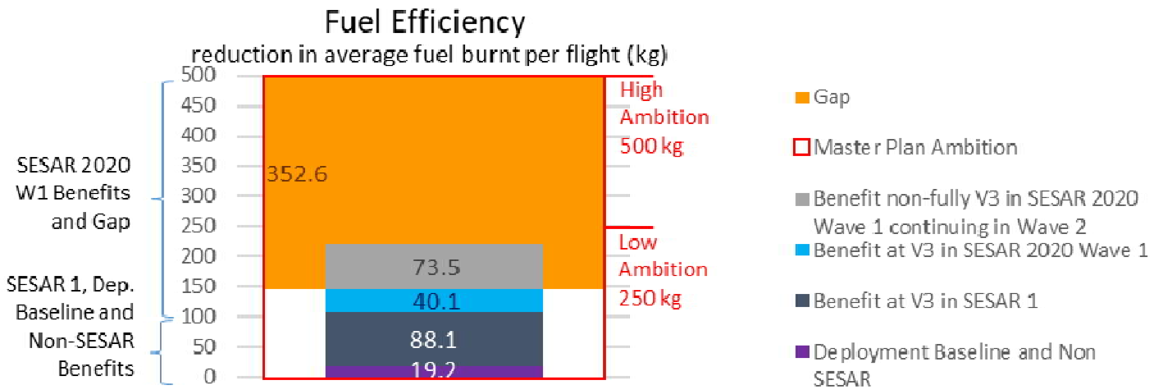
A catalogue of SESAR Solutions is available[47] and those addressing environment impacts are identified by the following pictogram:

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/CO_2 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 12. SESAR fuel efficiency achievement versus gap (Source: Updated version of PAGAR 2019)



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

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

A fuel saving of 40.1 kg per ECAC flight equates to about 0.76% of the 5,280kg of fuel burnt on average by an ECAC flight in 2012 (SESAR baseline). Although this might seem marginal, in 2035, ECAC-wide, it would equate to 1.9 million tonnes of CO_2 saved, equivalent to the CO_2 emitted by 165,000 Paris-Berlin flights; or a city of 258,000 European citizens; or the CO_2 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 baseline[48]. Based on the information provided by the PAGAR 2019 document[49], the benefits at the end of Wave 1 could be about 3% CO_2/fuel savings achieved by 2025 equivalent to 147.4kg of fuel/flight. So far, the target for Wave 2 remains at about 7% more CO_2/fuel savings (352.6kg of fuel) to reach the initial Ambition target of about 10% CO_2/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 projects[50].

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 CO_2 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).

AIRE[51] 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 CO_2), and improvements in day-to-day operations. Another nine demonstration projects took place from 2012 to 2014, also focusing on the environment, and during 2015/2016 the SESAR JU co-financed fifteen additional large-scale demonstration projects, which were more ambitious in geographic scale and technology.

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.

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

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

50 See SESAR Exploratory Research projects - https://www.sesarju.eu/exploratoryresearch

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

SESAR JU has recently awarded ALBATROSS[52], 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 SRIA[53] identifies inter-alia the need to continue working on "optimum green trajectories", on non-CO_2 impacts of aviation, and the need to accelerate decarbonisation of aviation through operational and business incentivisation.

ASSESSMENT

The quantitative assessment of the operational and ATM improvement scenario from 2020 to 2050 has been included in the modelled scenarios by EUROCONTROL on the basis of efficiency analyses from the SESAR project indicated in Figure 12 above and it is included in Subsection A above (ECAC Baseline Scenario and Estimated Benefits of Implemented Measures).

Table 13. CO_2 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.

[52] https://www.sesarju.eu/projects/ALBATROSS

[53] https://www.sesarju.eu/node/3697

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 CO_2 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 CO_2 emissions above average 2019/2020 levels through standard international CO_2 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 CO_2 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 CO_2 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 CO_2 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 CO_2 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 2014[54] 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%[55], and will be revised to be aligned with the latest Conclusions in December

[54] http://www.consilium.europa.eu/en/meetings/european-council/2014/10/23-24/

[55] 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

2020[56], prescribing at least 55% domestic reduction (without using international credits) of greenhouse gases compared to 1990.

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

For aviation, the cap is calculated based on the average emissions from the years 2004-2006, while the free allocation to aircraft operators is based on activity data from 2010. The cap for aviation activities for the 2013-2020 phase of the ETS was set to 95% of these historical aviation emissions. Starting from 2021, free allocation to aircraft operators is reduced by the linear reduction factor (currently of 2.2%) now applicable to all ETS sectors. Aircraft operators are entitled to free allocation based on a benchmark, but this does not cover the totality of emissions. The remaining allowances need to be purchased from auctions or from the secondary market. The system allows aircraft operators to use aviation allowances or general (stationary installations) allowances to cover their emissions. Currently, 82% of aviation allowances are distributed through free allocation, 3% are part of a special reserve for new entrants and fast growers, and 15% are auctioned.

The legislation to include aviation in the EU ETS was adopted in 2008 by the European Parliament and the Council[57].

Following the 2013 ICAO agreement on developing CORSIA, the EU decided[58] 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 2017[59].

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

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[56] 1011-12-20-euco-conclusions-en.pdf (europa.eu)

[57] 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

[58] 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

[59] 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

delegated act under the EU ETS Directive of July 2019[60]. 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"[61].

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 Switzerland[62] following the agreement to link their respective emissions trading systems, which entered into force on 1 January 2020.

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

Impact on fuel consumption and/or CO_2 emissions

The EU ETS has delivered around 200 MT of CO_2 emission reductions between 2013 and 2020[63]. While the in-sector aviation emissions for intra-EEA flights kept growing, from 53,5 million tonnes CO_2 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 CO_2 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 CO_2 equivalent[64].

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

60 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

61 2021_commission_work_programme_new_policy_objectives_factsheet_en.pdf (europa.eu)

62 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.

63 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

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

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 CO_2 emissions will continue to increase in the future under the new legislation. Other emission reduction measures taken, either collectively throughout Europe or by any of the states implementing the EU ETS, will also contribute towards the ICAO global goals. Such measures are likely to moderate the anticipated growth in aviation emissions.

ASSESSMENT

A quantitative assessment of the EU Emissions Trading System benefits based on the current scope (intra-European flights) is shown in Table 14.

Table 14: Summary of estimated EU-ETS emission reductions

Estimated emissions reductions resulting from the EU-ETS[65]

Year	*Reduction in CO_2 emissions*
2013-2020	*~200 MT[66]*

Those benefits illustrate past achievements.

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

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

5. ADDITIONAL MEASURES

5.1 ACI Airport Carbon Accreditation

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

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

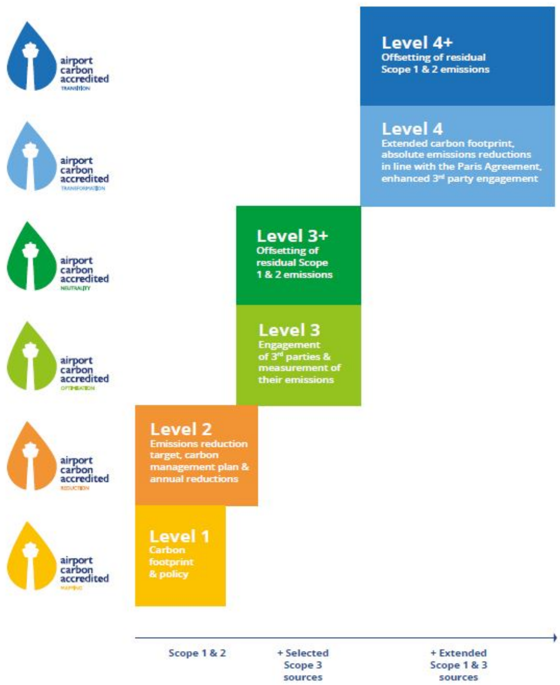
airport
carbon
accreditation
MAPPING I REDUCTION I OPTIMISATION I NEUTRALITY

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 CO_2 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 improvements[67].

The six steps of the programme are shown in **Figure 13** and are as follows: Level 1 "Mapping", Level 2 "Reduction", Level 3 "Optimisation", Level 3+ "Neutrality", Level 4 "Transformation" and Level 4+ "Transition".

Figure 13. Six steps of *Airport Carbon Accreditation*



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

One of its essential requirements is the verification by external and independent auditors of the data provided by airports. The Administrator of the programme has been collecting CO_2 data from participating airports since the programme

[67] Interim Report 2019 – 2020, *Airport Carbon Accreditation* 2020

launch. This has allowed the absolute CO_2 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 CO_2 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 15: Emissions reduction highlights for the European region

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Total aggregate scope 1 & 2 reduction ($ktCO_2$)	51.7	54.6	48.7	140	130	169	156	155	169	158
Total aggregate scope 3 reduction ($ktCO_2$)	360	675	366	30.2	224	551	142	899	1160	1763

Table 16: Emissions offset for the European region

	2015-2016	2016-2017	2017-2018	2018-2019
Aggregate emissions offset, Level 3+ (tCO_2)	222339	252218	321170	375146

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

Table 17: *Airport Carbon Accreditation* key performance indicators 2018/2019

Indicator	Unit	Time Period (2018/2019)	Absolute change compared to the 3-year rolling average	Change (%)
Aggregate scope 1 & 2 emissions from airports at Levels 1-3+	tCO_2	6,520,255	-322,297	-4.9%
Scope 1 & 2 emissions per passenger from airports at Levels 1-3+	kgs of CO_2	1.81	-0.09	-4.3%
Scope 1 & 2 emissions per traffic unit from airports at Levels 1-3+	kgs of CO_2	1.55	-0.08	-4.3%
Indicator	**Unit**	**Time Period (2018/2019)**	**Absolute change (vs. previous year)**	**Change (%)**
Offsetting of aggregate scope 1 & 2 & staff business travel emissions from airports at Level 3+	tCO_{2e}	710,673	38.673	5.8%
Indicator	**Unit**	**Time Period (2018/2019)**	**Absolute change (vs. previous year)**	**Change (%)**
Scope 3 emissions from airports at Levels 3 and 3+	tCO_2	60,253,685	6,895,954	12.9%

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

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

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

ASSESSMENT

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

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

The Destination 2050[68] 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 CO_2 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 CO_2 emissions from all flights within and departing from the European Economic Area, Switzerland and the UK by 45% by 2030 compared to the baseline[69]. In 2030, net CO_2 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 CO_2 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.

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68 www.destination2050.eu

69 A hypothetical 'no-action' scenario whereby CO_2 emissions are estimated based on the assumption that aircraft deployed until 2050 have the same fuel efficiency as in 2018.

5.3 Environmental Label Programme

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

In the proof-of-concept phase, EASA developed potential technical criteria and label prototypes for aircraft technology and design as well as airline operations, to inform European citizens on the environmental performance of aviation systems. Such information would be provided on a voluntary basis by aviation operators that have chosen to use the label. Different scenarios were developed and tested to consider how citizens could interact with labelling information, e.g. on board the aircraft and/or during the booking process as well as on a dedicated website and smartphone application. Various key environmental indicators were reviewed, including the absolute CO_2 emissions and average CO_2 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 CO_2 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 CO_2 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 CO_2 Emissions Mitigation in the African and Caribbean Region**, launched in 2020.

The overall objective of these projects[70] 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 CO_2 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 CO_2 Emissions Reports to ICAO. 4 CORSIA verification bodies had been accredited in the region with dedicated support to their respective National Accreditation Bodies to finalise the accreditation process.

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

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

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

5.4.2 ICAO - European Union Assistance Project

The assistance project *Capacity Building on CO_2 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 CO_2 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 plans[71].

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.

[71] 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 CO_2 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 CO_2 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-CO_2 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-CO_2 effects on the climate can also be reduced, implying important potential supplemental benefits beyond CO_2 emissions reductions. In addition to the reduction of CO_2 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 fuel[72].

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[72] ICAO 2016 Environmental Report, Chapter 4, Page 162, Figure 4.

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.

AVIATOR PROJECT[73]: 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, NOx, SOx 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 CO_2 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-CO_2 emissions and noise impacts**.

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73 https://aviatorproject.eu

It should be noted that although no targets have yet been set for non-CO_2 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 CO_2 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-CO_2 impacts:

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

SECTION 2

NATIONAL ACTIONS IN GREECE

ACTIONS FOR THE REDUCTION OF CO_2 EMISSIONS FROM AVIATION IN GREECE

The National Section of this Action Plan presents the actions undertaken in Greece, by the State and by stakeholders, in order to reduce CO_2 emissions from the aviation system, as well as future measures aimed at further CO_2 reduction.

It also highlights the contribution of Greece to the implementation of European common measures, described in detail in Section 1. The description of these national contributions to measures taken collectively throughout Europe is an illustration of the State's involvement in their implementation and any quantified benefits were included in the benefits presented in part A of Section 1.

The development of this section has taken into consideration the 3rd edition of ICAO Doc 8899 "Guidance on the Development of States' Action Plans on CO_2 Emissions" (2019) and the 4th edition of the ECAC/EU Guidelines for the update and submission to ICAO of European Action Plans for CO_2 Emissions Reduction (2021).

For the composition of this section, the Environmental Protection Section of HCCA requested the input of the involved Divisions of HCAA and from the stakeholders. Upon the reception of these inputs, this Section of the Action Plan was compiled accordingly.

1. AIRCRAFT RELATED TECHNOLOGY IMPROVEMENTS

1.1 Certification of Aircrafts for CO_2 Emissions

Greece, in accordance with Article 9 of European Regulation (EU) 2018/1139, ensures that aircraft referred to in points (a) and (b) of Article 2(1) of the Regulation, other than unmanned aircraft, and their engines, propellers, parts and non-installed equipment comply with the ICAO environmental protection requirements, including the ICAO Aircraft CO_2 Standard.

For this purpose, the Environmental Protection Section of HCAA is responsible for issuing CO_2 Emissions Certificates, according to the above legislation and in consultation with EASA and other EU bodies.

1.2 Fleet modernisation

Two Greek air operators, Aegean Airlines and Sky Express, have commenced since 2019 the renewal of their fleet. Moreover, these two airline companies have taken additional mitigation measures aiming at an enhanced environmental performance. An overview of these additional actions and future plans is given in Chapter 5 "Additional Measures" of the National Section.

1.2.1 Aegean Airlines

For Aegean Airlines it is a strategic imperative to continue to operate a young, modern and efficient fleet. It is committed to the Airbus order of a minimum of 46 (+12 options) A320neo aircraft powered by the Pratt & Whitney GTF Turbofan. It already took delivery of 8 a/c in 2020, one more A321neo to be delivered by July 2021.

The New Engine Option offers:

- a benefit of 15% in fuel consumption per flight
- 19-23% less CO_2 emissions per passenger seat than previous generation Airbus

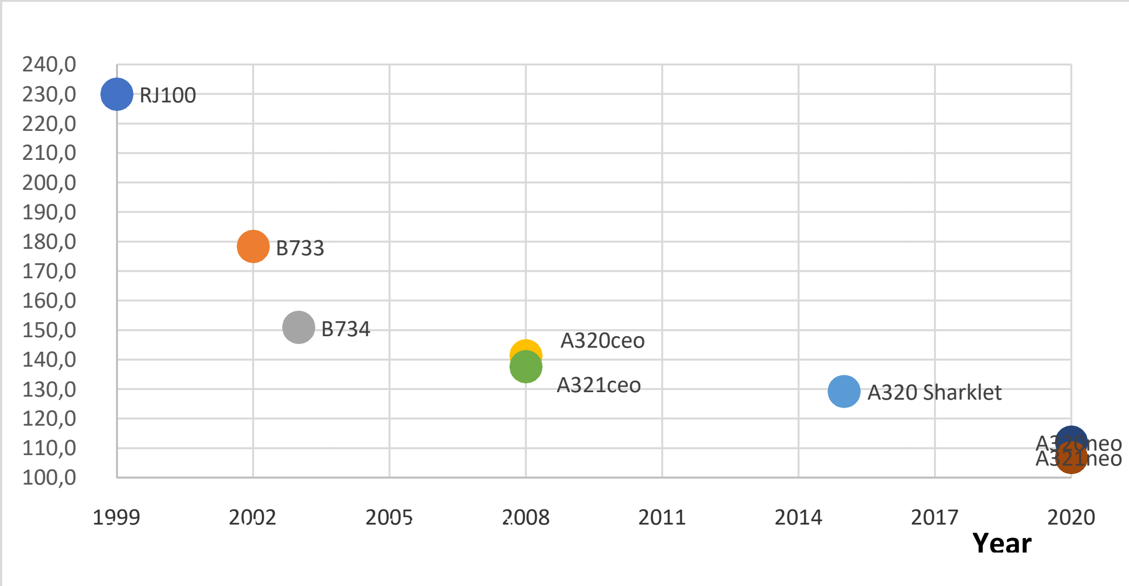
New aircraft with new fuel efficient engines is a proven and measurable solution to curb emissions. It is also a significant capital investment of $6-6.5 bn. in list prices, $2.5-3 bn. in market prices.

In terms of the evolution of Aegean's jet fleet in CO_2 emissions, starting with the RJ aircraft type in 1999, the fleet is more carbon-efficient by approx. 50% due to technology improvements (engine, airframe) and cabin density over a 20-year period (see **Figure 14**)

Aegean Airlines continues to investigate and conduct feasibility and technology studies with the leading aircraft manufacturers and monitors developments in the area of electric/hydrogen powered aircraft and next generation turbine engines. For the foreseeable future Aegean expects to rely heavily upon gas turbines.

Aegean Airlines is also currently performing evaluation studies for the turboprop fleet and potential fleet solutions for replacement of the current generation turboprop fleet.

Figure 14. Jet Fleet Emissions (kg CO_2/seat)

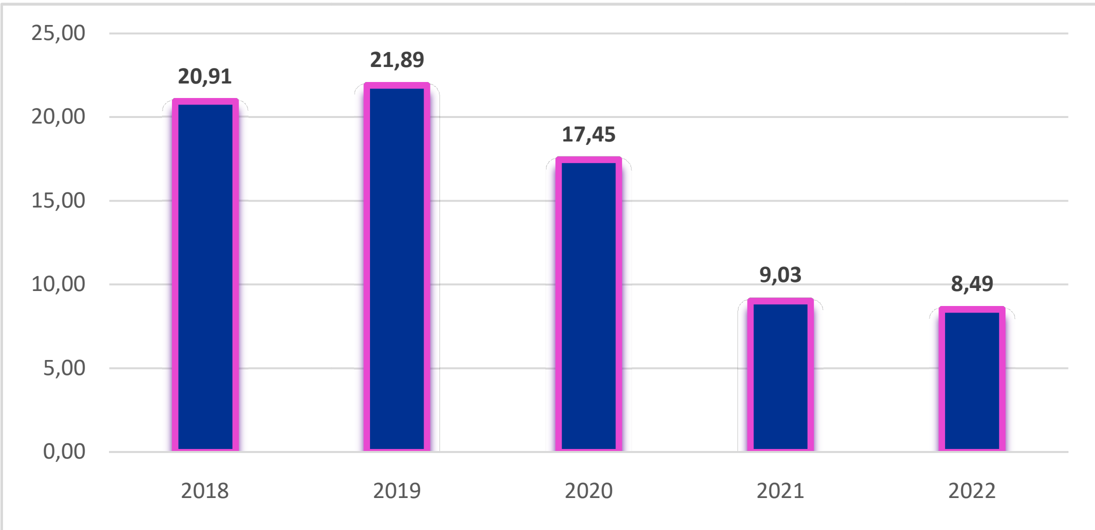


1.2.2 Sky Express

Sky Express incorporated in company's developmental strategy the highest environmental standards. One of the strategy's environmental targets is the renewal of their fleet (ongoing since 2019 and will continue till 2022).

The evolution of Sky Express fleet age is depicted in **Figure 15**. Projections for years 2021 and 2022 include the withdrawal of two ATR aircrafts, one ATR 42-500 will be removed from the fleet on 29th of June 2021 and one ATR 72-500 will be removed on 31st of August 2021, while six new ATR 72-600 will join the fleet by the end of 2021.

Figure 15. Average age of Sky Express fleet



The drastic reduction at the fleet average age is also accompanied by expansion of the fleet and the list of destinations Sky Express operates, which is in line with company's economic strategical targets.

This economic achievement is considered also an environmental success for the following reasons. With the six brand new A320neo in the fleet, Sky Express is the most fast growing air operator in Greece, manifestating thus, company's devotion to fighting climate change. The new engine option, LEAP-1A from CFM International, gives one of the world's most advanced and fuel-efficient single-aisle aircraft family. All of the A320neo aircrafts have large, fuel-saving wingtip devices (Sharklets). These 2.4-metre-tall wingtip devices are standard on NEO aircraft, and result in up to four per cent reduced fuel burn over longer sectors, corresponding to an annual reduction in CO_2 emissions of around 900 tonnes per aircraft.

Taking into account all the above, Sky Express expects – according to the manufacturer - 20 per cent savings in fuel burn per seat by 2021, two tonnes of additional payload, 500 nautical miles of more range, lower operating costs, along with a nearly 50 per cent reduction NOx emissions below the current industry standard.

Also, as a result of the optimized cabin space and increased exit limits, the A320neo accommodates between 150 and 180 passengers in two classes or up to 194 in a high-density configuration, meaning that Sky Express will be able to become more efficient in terms of TKMs carried per route[74].

Moreover, Sky Express will acquire in 2021 six new ATR72-600 aircrafts (the first one is expected by the end of June 2021) with Turboprops technology, which are highly efficient and tend to operate at lower speeds making ATR72-600 the most fuel efficient aircrafts in their category according to the manufacturer (ATR). Also, ATR72-600 has an excellent landing and take-off performance, giving the ability to pilots to use the shorter runways reducing in this way air traffic congestion and decreasing fuel consumption[75].

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[74] The environmental performance of A320neo is publicly available here: https://www.airbus.com/aircraft/passenger-aircraft/a320-family/a320neo.html

[75] The environmental performance of ATR 72-600 is publicly available here: https://www.atr-aircraft.com/our-aircraft/aircraft-family/

1.3 Research activities

Clean Sky 2 Joint Undertaking signed a Memorandum of Understanding (MoU) with Greece, at national level, on 21 November 2017[76]. The MoU was signed by the Greek Secretary General for Research and Technology, Mrs Patricia Kyprianidou, and Clean Sky 2 Interim Executive Director, Tiit Jürimäe, in the presence of the President of Hellenic Aerospace Industry, representatives from the competent authorities, and stakeholders from universities, research organisations, SMEs and industry.

The MoU aims at setting cooperation on synergies between Clean Sky 2 and the European Structural and Investment Funds (ESIF) managed by the General Secretariat of Research and Technology, Ministry of Education, Research and Religious Affairs, under the National Operational Programme 2014-2020. In this regard, a budget of €2 million is dedicated to complementarities with Clean Sky 2 activities[77].

This cooperation strengthens the Greek research and innovation ecosystem in the area of aeronautics and other related technologies and promotes complementarities with the Clean Sky 2 programme. A number of Greek stakeholders are already participating in various projects of Clean Sky 2, like the NEWCORT project[78] which successfully developed new heating processes and equipment focused on improved repairs, and the "ecoTECH" innovative eco-friendly airframe project[79].

In the context of Horizon 2020 Framework Programme, HCAA, as the owner of Astypalea Airport took part in a proposal titled "A multi-angled approach towards a sustainable airport integrating smart energy, smart logistics and smart vehicle solutions (SmartAELV)", aiming at making traffic at and around three airports in Germany, UK and Greece, more sustainable. The overall goal of SmartAELV was to evaluate a variety of measures regarding their GHG-reduction potential, in order to learn what works best and most effectively in the airport environment. Despite the final rejection of the proposal, HCAA believes that there will be new opportunities to implement this work, at least partially.

Regarding the Horizon 2020 Programme, the National Documentation Centre (NDC) acts as National Contact Point, supporting the participation of Greek organisations to it. Greek participation in Horizon 2020 is documented in the special reports and studies published by NDC, along with indicators highlighting important aspects of domestic research activities[80].

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[76] https://cleansky.eu/news/clean-sky-2-signs-mou-with-greece-at-national-level-to-promote-synergies-with-esif

[77] http://www.gsrt.gr/central.aspx?sId=125I490I1407I646I516590&olID=777&neID=965&neTa=10041_112156_1&ncID=0&neHC=0&tbid=0&lrID=2&oldUIID=aI777I0I119I428I1089I0I3&actionID=load&JScript=1

[78] https://cleansky.eu/news/novel-heating-processes-for-better-repairs-explored-in-newcort-project

[79] https://cleansky.eu/material-gain-clean-skys-ecotech-innovative-eco-friendly-airframe

[80] http://innovation.ekt.gr/en/horizon2020

2. SUSTAINABLE AVIATION FUELS

The European Directive 2003/30/EC has been introduced in Greek legislation in 2005 with Greek Law 3423 on the insertion of biofuels and other alternative fuels in the Greek market. In 2016, the Directive 2014/94/EU on the deployment of alternative fuels infrastructure has also been adopted with Greek Law 4439.

The Ministry of Environment and Energy is responsible for monitoring the implementation of the Renewable Energy Directive-RED (2009/28/EC) and its revision RED II (Directive 2018/2001/EU) which establish minimum thresholds for the share of energy from renewable sources in the transport sector, including aviation[81].

The National Energy & Climate Plan[82] of Greece for the years 2021-2030 states that "*policy measures in the transport sector, which are expected to be further specified in the context of the strategic plan for transport, are a priority for the new period, just like the completion of the infrastructure needed to promote alternative fuels in transport, the consideration of new regulatory measures, the revision of the existing institutional framework for the development of a market in alternative fuel infrastructures and the adoption of tax incentives for all types of alternative fuel".*

Regarding the use of sustainable aviation fuels (SAF), Greek air operators participating in the EU Emissions Trading Scheme (EU-ETS), have the option to reduce their allowance surrender obligation through the use of SAF. Moreover, the ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which is still in its pilot phase, includes the possibility to reduce emissions from international aviation through the use of SAF (approved as CORSIA Eligible Fuels), thus decreasing operators' offsetting requirements.

Aegean Airlines has recognized that the use of SAF is one of the most important assets in its toolbox on the way to the decarbonization of the aviation industry. In this respect it has taken various initiatives with stakeholders in order to address the current challenges associated with the use of SAFs on a commercial scale.

Some of these challenges for Aegean Airlines are:

- The missing long-term policy and framework for the use of SAF
- The fact that SAF must remain truly sustainable
- The cost of SAF vs JET A-1
- The fact that it remains a challenge for airlines to modernize their fleets AND introduce SAFs at the same time
- Limited availability at airports Infrastructure/Logistics
- The smooth integration of SAF procedures within the context of emissions trading schemes (proof of SAF sustainability, book & claim process etc.)

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[81] https://ypen.gov.gr/energeia/prasines-metafores/viokafsima/

[82] The National Energy and Climate Plan can be found at: https://ec.europa.eu/energy/sites/ener/files/el_final_necp_main_en.pdf

Aegean Airlines, building on the huge amount of work already done by the industry (est. more than 200K flights since 2011) has taken specific actions in order to understand the use of SAF and prepare for a test flight.

- It appears that HEFA is the most viable option currently as a SAF fuel
- In 2019 the company investigated with Athens International Airport and Hellenic Petroleum the logistics of storage and supply of SAF (HEFA) at AIA.
- In 2019 the V2500 engine on the A320ceos was cleared for trials.
- Similarly, in 2020 the GTF engine was cleared for trials on the A320neo.
- We have investigated various blend strategies, taking into account that at the moment only up to 50% blend is allowed for use on aircraft engines.

Aegean Airlines expects the first test flight using SAF to take place by the end of 2021, using one of the newer Airbus aircraft in the fleet.

In the framework of Athens International Airport’s efforts to promote use of cleaner energy sources, a meeting was held in 2017 with Olympic Fuel Company to discuss the possibility of the deployment of sustainable aviation fuel (SAF) at the airport. A meeting was also held in 2019, as mentioned above, between Aegean Airways and Athens International Airport on the possibility of a pilot flight with SAF from Athens airport. Communication with other relevant stakeholders needed to realize the project is on-going.

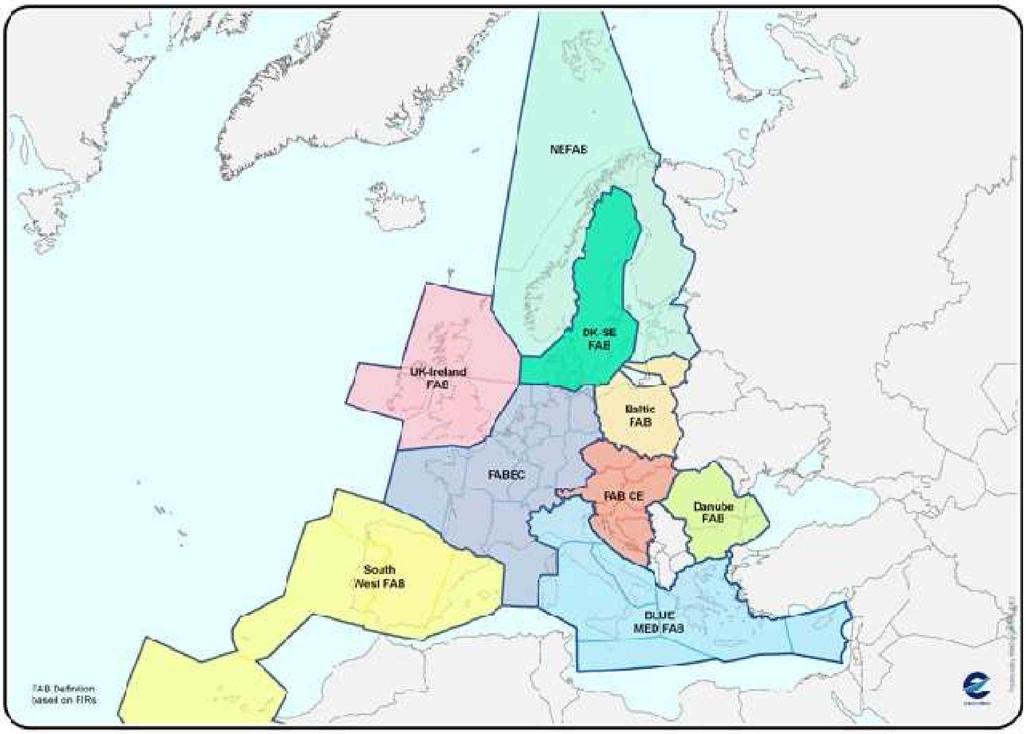
3. OPERATIONAL IMPROVEMENTS

3.1 BLUE MED FAB Environmental Performance

The Single European Sky Service Provision Regulation 2004/550/EC requires that by 4 December 2012, Member States shall take all necessary measures in order to ensure the implementation of functional airspace blocks (FAB) with a view to achieving the required capacity and efficiency of the air traffic management network within the Single European Sky and maintaining a high level of safety and contributing to the overall performance of the air transport system and a reduced environmental impact.

Greece is a Member of the BLUE MED FAB together with Italy, Cyprus, Malta (**Figure 16**). BLUE MED FAB is the European south-eastern FAB representing the natural European gate dedicated to air traffic flows coming from Africa and the Middle East, namely among the regions with the prospective fastest growing trend in the next future.

Figure 16: Single European Sky Functional Airspace Blocks (FAB)



All the benefits coming from the implementation of the activities described within the BLUE MED Implementation Programme are recorded in the annual Flight Efficiency Plan in terms of flight time, fuel consumption and carbon dioxide emissions by aircraft reductions. The following results are highlighted from the 2020 BLUE MED Flight Efficiency Plan regarding the environmental performance of BLUE MED FAB.

The implementation of the Hellas Free Route Airspace (FRA) during the night hours, greatly favored the improvement of the planned trajectory. Quantitative strategical analysis as well as post analysis of the traffic flows that affected the BLUE MED FRA airspace (such as new City Pairs that previously did not interest the Airspace of any of the ANSPs of the BLUE MED FAB) confirmed the expectations mainly in terms of occupancy, i.e., a trajectory that persists longer in the BLUE MED FAB Airspace, or other optimization on flight trajectories in terms of Vertical Flight Efficiency, also incentivized by bilateral collaboration among ATCOs (EnRoute and Aerodrome).

Figure 17: Total Distance Savings Entering BLUE MED FRA (2020)

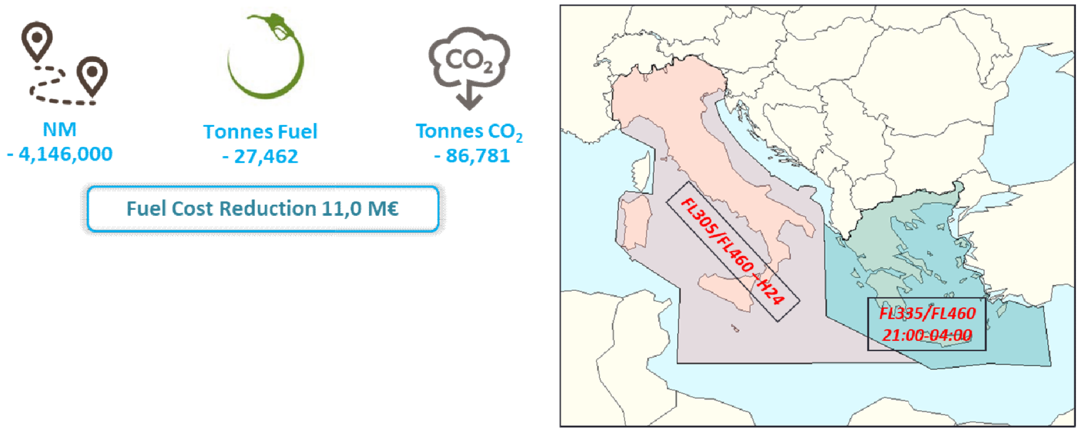
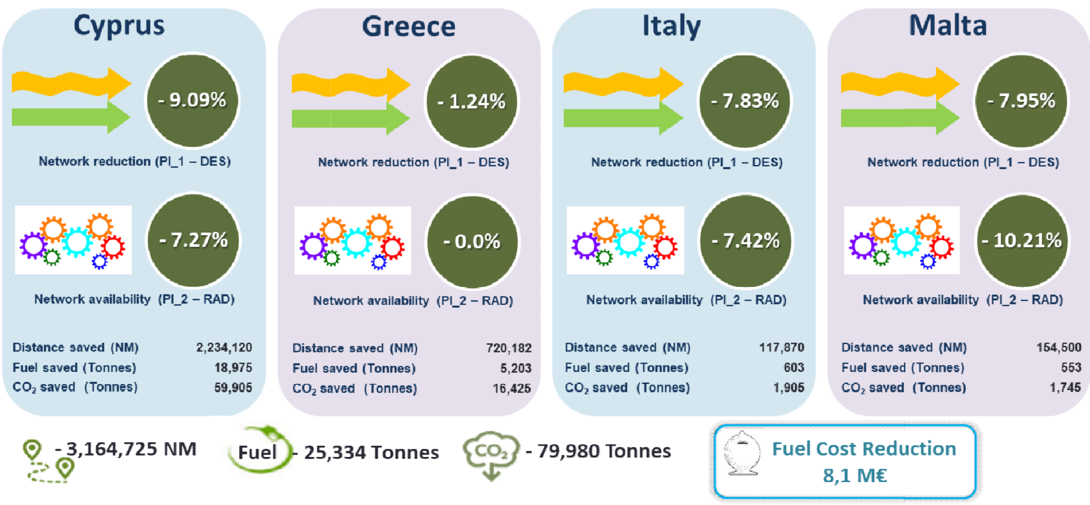


Figure 17 validates the assumption; an interesting overview in terms of NM saved as a direct consequence of an airspace (FRA) no more characterized by any constraints of the Network, with the possibility for Airspace Users (AUs) to choose the best entry/exit point from FRA airspace mixed with the opportunity to select their optimal Network both before and after entering the FRA as well as the opportunity to reduce congestions in 'bottleneck' areas on the southern part of the ECAC Area by being able to optimize their Flight Efficiency due to best available network, and so on.

These consolidated results are significant, even if we consider the lack of traffic (see **Figure 18**).

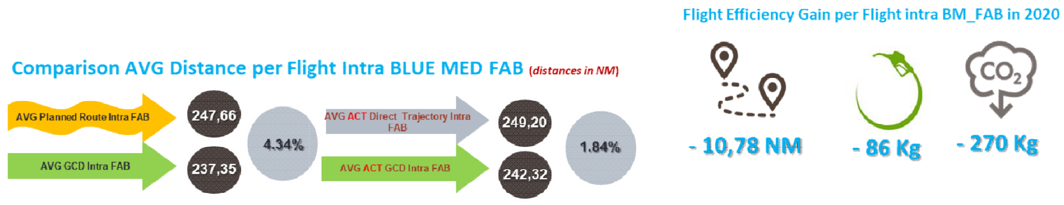
Figure 18: Total Distance Savings per BLUE MED Member (2020)



When considering the difference in flight trajectories of AUs, it is evident the variation (quantified in -1.84%) between direct trajectories allowed by BLUE MED ATCOs compared to the Great Circle Distance (GCD) on the same routing; a similar analysis can be done of the difference between routings planned by AUs compared to the GCD, that equals -4.34%.

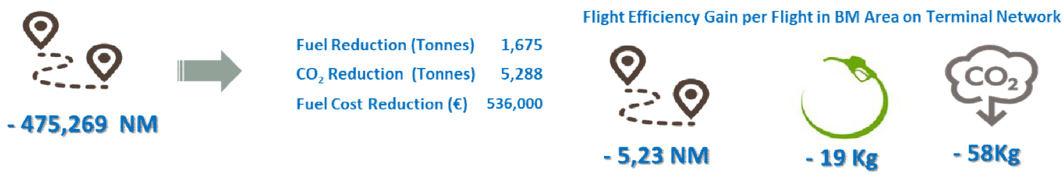
Both values are significant in terms of flight efficiency for AUs involved in the BLUE MED Airspace. The efforts addressed by ANSPs to improve Airspace Design and Availability into their Area of Responsibility are evident when comparing the BLUE MED FAB consolidated results to those of previous years and to other FABs results (**Figure 19**).

Figure 19: Flight Efficiency Gain per Flight Intra BLUE MED FAB (2020)



Additional, flight efficiency gains are evident in the BLUE MED FAB Area of Responsibilities with regard to the Terminal and Airport segment of flights, where flight efficiency benefits were allowed thanks to the implementations introduced by national Airspace Design Teams both to the Terminal Network and to the ARR/DEP procedures. (**Figure 20**).

Figure 20: Flight Efficiency Gain per Flight in BM Area on Terminal Network (2020)



Other significant flight efficiency benefits resulted from PBN procedures implemented on many Greek airports, especially on the islands, and on some Italian airports, some of them in anticipation of the planned changes to the airspace structure scheduled for 2021.

3.2 Single European Sky Implementation

The Local Single Sky ImPlementation (LSSIP) document constitutes a short/medium term implementation plan containing each ECAC State's actions to achieve the implementation objectives as set out by the European Master Plan in order to improve the performance of the national Air Traffic Management (ATM).

The 2020 LSSIP document describes the situation in Greece at the end of December 2020, together with plans for the next years[83]. Further to the main objectives' implementation status, a number of local objectives are set in order to address solutions that are considered beneficial for specific operating environments, therefore for which a clear widespread commitment has not been expressed yet. These are characterised with no deadline and voluntary applicability area.

In **Table 18**, local objective ENV02 "Airport Collaborative Environmental Management" is described. This objective is planned to be completed at the end of 2021. Similar objectives have been described for the airports of Thessaloniki (LGTS), Iraklion (LGIR), Kerkira (LGKR) and Rhodes (LGRP) but are not yet planned.

Table 18. Local Environmental Objective (Source: 2020 LSSIP of Greece)

ENV02	Airport Collaborative Environmental Management *Applicability and timescale: Local*	40%	Ongoing
LGAV - Athinai Eleftherios Venizelos Airport			
APO, ANSPs and Users collaborate for the minimisation of noise and emissions resulting from aircraft operations at the terminal airspace and ground. Noise abatement procedures have been established with the participation of the Environmental Dpt. of HCAA (PROPE). Formal partnership arrangements are pending.			31/12/2021

[83] The 2020 Greece LSSIP can be found at : https://www.eurocontrol.int/publication/greece-local-single-sky-implementation-lssip-document-2020

3.3 SESAR Deployment Projects in Greece

Greece is contributing to ATM modernisation through SESAR deployment. Recent SESAR deployment projects in Greece are the following[84].

i. Implementation of FRA in Greece (#095AF3) - Completed

   Description: Enable users preferred trajectories within the airspace of HELLAS UIR, Upgrade of ATM Systems, Seamless integration of two Greek ACCs, ATS-route network optimisation, including arrival and departure procedures, Sectors adaptation to accommodate the changes in traffic flows where needed.

ii. DLS Implementation Project - Path 1 "Ground" stakeholders (GND) (2016_161_AF6_GND) - Completed

   Description: The Project focuses on the implementation of the VDL (Very High Frequency Datalink) Mode 2 multi-frequency capability that will enable to optimise the load of the radio frequency channel ensuring the best performance ratio to support the air traffic flows increasing and avoiding frequency congestion.

iii. SWIM Common PKI and policies & procedures for establishing a Trust framework (2017_084_AF5) - Ongoing

   Description: The main objective of the Implementing Project (IP) is to develop and deploy a common framework for both integrating local PKI deployments in an interoperable manner as well as providing interoperable digital certificates to the users of SWIM. The resulting PKI and its associated trust framework, which will be part of the cyber security infrastructure of aviation systems, are required to sign, emit and maintain digital certificates and revocation lists as required in the family 5.1.4. The digital certificates will allow user authentication and encryption/decryption when and where needed in order to ensure that information can be securely transferred. All aviation stakeholders (ANSPs, Airspace users, military, Airport, etc) will benefit from the project.

iv. Procurement of new DPS/ATM and VCRS systems to support DCTs and FRA (2015_029_AF3) - Ongoing

   Description: New DPS/ATM system, New VCRS System, Sectors adaptation to accommodate the changes in traffic flows where needed

[84] https://www.sesardeploymentmanager.eu/countries/greece

4. MARKET-BASED MEASURES

4.1 The Carbon Offsetting and Reduction Scheme for International Aviation

ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), aims at reducing international aviation's CO_2 emissions by offsetting emissions above average 2019/2020 levels. Greece, like the rest of the ECAC Member States, is voluntarily participating in CORSIA from the start of its pilot phase in 2021 (see also Section 1, par.4.1).

ICAO's CORSIA Central Registry provides information on Aeroplane Operators attributed to Greece[85], Verification Bodies accredited in Greece[86], Annual CO_2 Emissions[87], and Annual Sector's Growth Factor[88]. The air operators attributed to Greece for the purposes of CORSIA are shown in **Table 19** for the year 2020.

Table 19. List of aeroplane operators attributed to Greece for CORSIA (2020)

Aeroplane Operator Name	ICAO Designator
AEGEAN AIRLINES	AEE
AIR MEDITERRANEAN	MAR
BLUEBIRD AIRWAYS	BBG
ELLINAIR S.A.	ELB
GAINJET AVIATION S.A.	GNJ
OLYMPIC AIR	OAL
OLYMPUS AIRWAYS	OLY
ORANGE2FLY AIRLINES	OTF
SKY EXPRESS S.A.	SEH
ASTRA AIRLINES (inactive)	AZI

Greece is participating as an Observer in ICAO's Committee on Aviation Environmental Protection (CAEP) and is also participating through HCAA's Environmental Protection Section in CAEP's Working Group 4 on CORSIA, which provides technical guidance on CORSIA implementation and documentation.

HCAA's Environmental Protection Section is responsible for performing the Order of Magnitude Check of the Verified CO_2 Emissions Reports, submitted annually by the air operators attributed to Greece for CORSIA purposes. It is also responsible for all necessary CORSIA reporting to ICAO, including aggregated annual CO_2 Emissions.

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85 The latest edition of CORSIA Aeroplane Operators to State Attributions can be found at: https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_Aeroplane_Operator_to_State_Attributions_Dec2020.pdf

86 The list of Verification Bodies Accredited in States (7th Edition) can be found at: https://www.icao.int/environmental-protection/CORSIA/Documents/CCR%20Information%20and%20Data%20for%20Transparency_Dec2020.pdf

87 The total international aviation CO_2 emissions for 2020 will become available, following approval by the ICAO Council, as soon as practicable during the second half of 2021 at: https://www.icao.int/environmental-protection/CORSIA/Pages/CCR.aspx

88 The first edition of the ICAO document "CORSIA Annual Sector's Growth Factor (SGF)", containing SGF for year 2021, will become available, following approval by the ICAO Council, by 31 October 2022.

4.2 The EU Emissions Trading System

In line with the European legislation and policy, Greece implements the EU Emissions Trading System (EU ETS) since 2005 and has included aviation emissions since 2012 (see also Section 1, par.4.2).

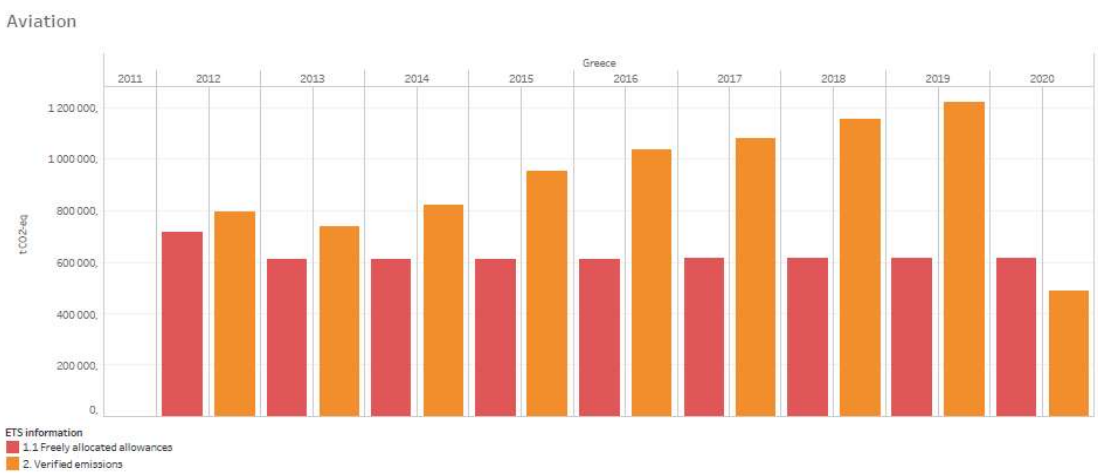
The Greek Greenhouse Gas Registry is part of the Union Registry[89], which is the online database that holds accounts for stationary installations as well as for aircraft operators and ensures accurate accounting for all allowances issued under, precise tracking of holdings, issuances, transfers, cancellations and retirements of general allowances and Kyoto units. Therefore, all companies registered in the Greek Registry can perform all the necessary actions (e.g. transactions, surrendering), in this way.

The Greek Greenhouse Gas Registry is managed by the Office for Greek Greenhouse Gas Emissions Allowances[90] of the Ministry of Environment and Energy. This Office also serves as a contact point for national and international authorities.

HCAA's Environmental Section is responsible for reviewing and approving the CO_2 Emissions Monitoring Plans, submitted by air operators attributed to Greece for EU ETS purposes.

In **Figure 21**, data on verified emissions (orange column) and freely allocated units (red column) for the years 2011-2020 in Greece are given.

Figure 21. Emission Trading Data for the years 2011-2020 in Greece (Source: European Union Transaction Log[91])



[89] Allocations to Aircraft Operators under EU ETS can be found at: https://ec.europa.eu/clima/ets/caatMgt.do?languageCode=en

[90] https://ypen.gov.gr/perivallon/klimatiki-allagi/systima-eborias-dikaiomaton-ekpobon/

[91] https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1

5. ADDITIONAL MEASURES

5.1 Greek Air Operators Environmental Initiatives

5.1.1. Aegean Airlines and Olympic Air

Aegean Airlines is Greece's largest airline, it was established in 1999 and since then it follows a continuous growth. In 2013, it acquired Olympic Air, thus expanding their network in national and international destinations.

An integral part of the company's overall policy is not only the full compliance and adherence to all applicable legal requirements pertaining to every business activity, but also the constant attempt to improve the company's environmental performance, in the context of company's attempt to reduce its environmental footprint.

The company's environmental compliance and environmental performance are demonstrated through its certification according to the requirements of international standard ISO14001:2015, thus providing complete and full transparency in terms of the environmental care and protection provided.

Route optimization strategies

Aegean continues to invest in its flight planning system, which offers significant operational benefits, since it calculates and optimizes operations during flight (e.g. aircraft flight at optimal altitude and speed for every individual route). The new software contributes significantly to the environmental management process, by reducing CO_2 emissions by about 800 tons per month.

Operational procedures

The department of Flight Operations has adopted procedures that are recommended by International Organizations, the manufacturer (Airbus Green Operating Procedures) and the aviation industry, always in cooperation with air traffic control, to improve fuel efficiency and reduce emissions of air pollutants. Some of the techniques that help improve Aegean's environmental footprint include approach techniques upon arrival, taxiing techniques before take-off and after landing, careful use of the aircraft's auxiliary power supply unit while on the ground and take-off profile. The fuel savings resulting from the use of these techniques amounts to 350 tons of CO_2 per month.

Weight Minimization

Minimization of Operating Weight is key and margins are slim, so any small weight reductions add up. Aegean put a large effort to minimize weight during the customization and configuration process of the new A320neo program (see par.1.2.1. of Section 2).

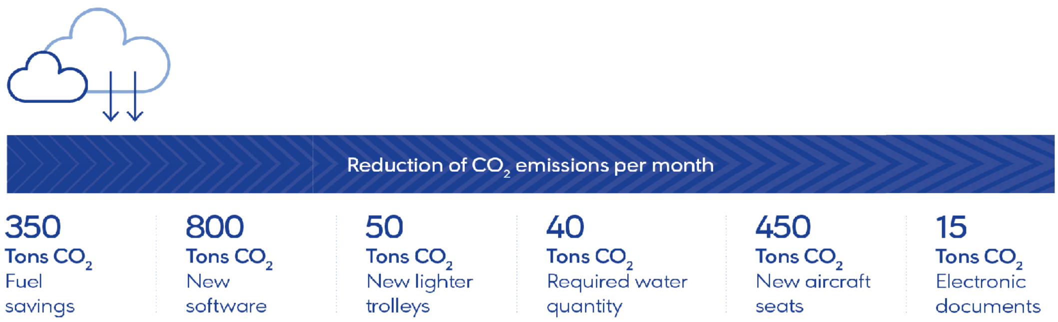
For example, on Aegean's A320neo Weight was a key driver in the new cabin design process, one example being the decision to forego a heavy fixed in-flight entertainment system.

The CO_2 reduction potential of such measures is on average 0,5% per year, which could be significant.

Aegean continues to enforce previous weight reduction efforts such as potable water management onboard the aircraft (a reduction of CO_2 emissions by about 50 tons per month).

The practice of aircraft engine washes as part of the company's aircraft maintenance practices, using an eco-friendly engine wash system, continues at regular basis for the new engines as well.

Figure 22. Monthly CO_2 savings from all AEGEAN's mitigation measures (Source: Aegean 2019 Sustainability Report[92])



Consultation over regulatory measures

Aegean Airlines (and its 100% owned subsidiary Olympic Air) are committed and recognize the need to adopt intermediate market-based measures on the path to full decarbonization. In this context, the company participates in the EU-ETS Scheme since its inception. The airline also participates in the Swiss ETS scheme and recently started participating in the UK-ETS scheme.

Aegean Airlines (and its 100% owned subsidiary Olympic Air) also participate in the ICAO CORSIA scheme.

Currently the company has initiated a program to document and analyze the impact of such market measures, subject to ongoing market and policy changes. Some key highlights are noted below:

- The impact of the pandemic will be long-lasting, affecting aircraft operators' capacity to embrace and accelerate their sustainable transformation. The sector's decreasing resources and its competitiveness challenge are major obstacles to achieving its transformation goals.
- A balanced approach is crucial to promote sustainability, encourage and enable the future decarbonization of the industry, while preserving economic competitiveness and social benefits to citizens and consumers all throughout. The challenge of the decarbonization is not to reduce emissions at all costs, but to do so, whilst in the same time increase welfare, and leave no one behind: social groups, regions or remote islands.

92 https://en.about.aegeanair.com/corporate-responsibility/csr-report/csr-report-2019/

- Carbon Leakage remains a concern for Greece (and Greek airlines in general), meaning the diversion of traffic to neighboring countries or non-EU destination with a smaller policy cost. The attractiveness of Greek islands as tourist destinations in particular may be affected.
- Increasing cost of compliance in the future.
- Offsetting requirements and commitments going forward and relevance of offsetting initiatives in the Greek market.

5.1.2 Sky Express

Further to the environmental benefits related with Sky Express' fleet renewal, as described in par. 1.2.2 of Section 2, the company has also undertaken the following measures aiming at improving both its operational and environmental performance.

Route optimization

Sky Express acquired NAV BLUE for all flights, which is the flight planning system software designed specifically for A320neo, in order to refine route planning.

Aircraft Weight Reduction

Sky Express has revised all internal processes in the light of the European Green Deal and the collective efforts for the first climate neutral continent and economy by 2050. In this view weight reduction policies are incorporated in operational procedures. These resulted to the following actions:

- A new more efficient fuel policy in order to minimize both fuel consumption and emissions due to optimum fuel carriage.
- Removal of printed manuals from all flights by substituting those with electronic versions.
- Lighter trolleys replaced old ones to all aircrafts, while the new A320neo are equipped lighter seats.
- A new algorithm is used in order to calculate the necessary quantity of drinkable water per flight.

Noise Reduction

Sky Express, as a regional airline flying also in small airports all over Greece is really sensitive and pays too much attention to noise emissions and compliance noise levels (dB contours) set in environmental licenses for each airport. The new airplanes A320neo offers significant environmental performance with nearly 50% reduction in noise footprint compared to previous generation aircraft. Also, the ATR aircrafts have low cumulative noise emission. For both types of aircrafts, EASA certificates have been published[93],[94]. Moreover, Flight Standards department engineered new procedures for landing and takeoffs resulting to lower noise emissions.

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[93] ATR: https://www.easa.europa.eu/sites/default/files/dfu/EASA.A.084%20Issue13.pdf

[94] A320neo: https://www.easa.europa.eu/sites/default/files/dfu/TCDSN%20EASA.A.064.3_Issue31.pdf

Consultation over regulatory measures

Sky Express is actively involved in policy making, directly or through collective bodies like ERAA[95], regarding market based climate instruments (EU ETS and CORSIA). Sky Express participated in public consultation "EU ETS - updated rules for aviation" held by European Commission during 2020-2021. Sky Express also follows European and international developments regarding SAF and CO_2 and supports the decarbonization of aviation sector through the company's involvement in initiative Destination2050 signed by ERAA.

[95] https://www.eraa.org/about/overview

5.2 Environmental Management in Greek Airports

According to European Directives 2011/92 and 2014/52 and national legislation (Greek Law 4014/2011 and its amendments), all projects (including construction, expansion, remodeling of airport facilities) and activities (including the operation of an airport or an air navigation facility) must have an environmental license.

For all the above projects and activities, national legislation requires the elaboration of an Environmental Impact Assessment (EIA). This assessment is submitted to the Ministry of Environment and Energy for approval. After completion of a consultation phase with other authorities and stakeholders, and once all comments are covered, a Ministerial Decision of Approval of Environmental Terms and Conditions (AETC) is issued. This Decision describes all the activities that are allowed in an airport and imposes the measures that have to be taken to prevent any environmental damage from these activities. This Decision is valid for fifteen years, and it is possible to be renewed, extended or amended in case of significant changes. All steps of environmental licensing are now digitalised and results are available at the online Environmental Registry[96].

The Airport Operators Managers are responsible for adhering to the Airport's AETC, for preparing an annual Environmental Report and, if required, in conducting local air quality monitoring programs.

5.2.1. Athens International Airport

Athens International Airport S.A. (AIA) was established in 1996 as a Public-Private Partnership with a 50-year concession agreement. Ratified initially by Greek Law 2338/95 and at a later stage by Law 4594/2019, the concession agreement grants the right to use the airport site for the purpose of the "design, financing, construction, completion, commissioning, maintenance, operation, management and development of the airport". AIA is a privately managed company, with the Greek State holding 55% of shares, while the private shareholders collectively hold 45%.

AIA's Environmental Services Department has an Environmental Management System that's been certified according to the ISO 14001 standard since 2000, prior to the airport opening in 2001. It targets environmental compliance and continuous improvement of all environmental aspects including noise, air quality & climate change, water & soil quality, waste management & recycling, the natural environment and social initiatives. It regularly monitors surface and groundwater, treat wastewater onsite and adopt measures to reduce water consumption. In addition, ecosystems at and in the vicinity of the airport have been monitored continuously since 1997, well before the airport opened. An annual Environmental Plan consisting of Environmental Management Programs with medium- and long-term targets for all environmental aspects is implemented.

AIA is one of very few airports worldwide that monitors air quality both inside and outside the airport fence. Measures are taken to reduce emissions of air pollutants of concern for local air quality as well as climate change, including a series of successful initiatives to reduce energy and fuel consumption in airport

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[96] https://eprm.ypen.gr/

buildings as well as mobile and stationary equipment.

Noise Abatement Procedures have been developed with and are implemented in collaboration with relevant stakeholders. An active dialogue with local communities on noise issues is maintained and concerned citizens can register their complaints via a 24-hour "We Listen" telephone line or via AIA's website, where they can also retrieve data from AIA's Noise Monitoring System.

An integrated waste management system based on the "Polluter Pays" principle is established, with economic incentives for companies that recycle. This combined with awareness, training and other initiatives has helped increase AIA's recycling rate from 3% in 2001 when the airport opened to 66% in 2020.

AIA implements a Community Engagement Plan that is updated annually with specific actions addressing communication (regular meetings), society (helping those in need), the environment (public green areas), infrastructure (roads), education (school buildings), culture (events to preserve cultural heritage) and athletics (equipment and events). The plan includes projects that meet both community needs and AIA's requirements, namely a long-lasting impact. In fact, communication with local communities has led in several instances to modifying the way we operate, especially regarding noise issues (e.g. preferential runway use during the afternoon as well as during exam periods).

Moreover, Brussels Airport as project leader, together with 21 partners, among them AIA, submitted to the European Commission an ambitious plan with concrete projects to help the industry accelerate the sustainable transition and were granted funding. This partnership, which brings together partner airports and other companies, government bodies as well as research and academic institutions, will realise the Stargate project in the next 5 years.

Transparent carbon reporting

AIA has been disclosing its carbon footprint in a number of its corporate publications for the past several years, including:

- Annual and Sustainability Report[97].
- Care for the Environment, an annual publication dedicated entirely to environmental issues[98].
- Green Care, an annual publication distributed to passengers and visitors as part of the Green issue of AIA's 2Board magazine

These publications are distributed in hard copy (apart from Care for the Environment, which is only available in electronic format) and are also available from AIA's corporate website[99] and corporate Intranet. Information about AIA's activities to reduce its carbon footprint and to engage other members of the airport community to do the same are also reported in the aforementioned publications. The same information is also communicated to state authorities and regulators (e.g. in a biannual Environmental Report to the Greek Ministry of Energy and Environment).

[97] https://www.aia.gr/ebooks/annualreport/ar2019/mobile/index.html

[98] https://www.aia.gr/ebooks/enc/carefortheenvironment/issue22/mobile/index.html

[99] www.aia.gr

In addition, further to AIA's involvement in *Airport Carbon Accreditation* (see next paragraph), AIA also requires that all Third Parties (airlines, ground handlers, caterers, retail, etc.) submit a carbon footprint to AIA on an annual basis. In order to facilitate Third Parties in this process, AIA organized a number of training sessions with guidance on how to construct carbon footprints, which emission factors to use, etc. Currently, more than 60 companies submit an annual carbon footprint.

Airport Carbon Accreditation

AIA played an instrumental role in helping shape the concept for Airport *Carbon Accreditation*, a voluntary initiative for airports to manage and reduce their carbon emissions that was launched by Airports Council International Europe in 2009[100]. Furthermore, AIA was amongst the first airports to become accredited when *Airport Carbon Accreditation* was launched in June 2009. AIA was initially accredited at the Mapping level having mapped its carbon emissions from the following sources:

- Electricity consumption (from purchased electricity)
- Natural gas consumption (for heating purpose)
- Petrol, diesel and LPG consumption by AIA's vehicle fleet
- Heating oil consumed by AIA's boilers
- Diesel consumed by AIA's generators

The work is coordinated by AIA's Environmental Services Department, which collects the required data from the relevant departments on an annual basis. CO_2 emissions from each activity are calculated using the emission factors provided in the *Airport Carbon Accreditation* guidance and, in the case of electricity and natural gas, specific emission factors for Greece are calculated and applied. In line with the requirements of the program, AIA's annual CO_2 emissions are verified by an external auditor.

AIA upgraded its accreditation to Level 2 (Reduction) in 2010 after having set itself an ambitious target of reducing its carbon emissions by 25% by the year 2020 using 2005 as a baseline. Between 2010 and 2013, AIA renewed its certification for Level 2 on an annual basis and in early 2014 AIA upgraded to Level 3. Finally, in 2016 AIA zeroed its carbon emissions for 2015 and thus became the 1st carbon neutral airport in Greece and ultimately was accredited in Level 3+ of the programme, Neutrality, maintaining the accreditation ever since.

And last but not least, in 2017 AIA certified its Energy Management Standard in accordance with the ISO 50001 standard for the operation and maintenance of assets and systems pertaining to its activities, maintaining the certification ever since. AIA is one of very few airports worldwide with an Energy Management System certified according to ISO 50001. The certification is the capping stone symbolising AIA’s dedication to energy efficiency.

[100] www.airportcarbonaccreditation.org

Conferences/workshops/training

Since the company was founded, a large emphasis has been placed on training AIA's staff with respect to environmental protection. All employees take part in an induction training course that includes a session on environmental awareness and protection. To date, over 90% of AIA's current staff has attended this seminar. In addition, similar training is also provided to the staff of Third Parties operating at the airport. An e-training course has also been created to facilitate attendance, especially during the COVID-19 pandemic.

In addition, corporate emails are sent to all employees every year on the occasion of World Environment Day that highlight AIA's activities concerning environmental protection. Furthermore, volunteers are frequently sought for environmentally-related activities such as cleaning up local wetlands, planting new shrubs and trees in local parks, etc. This is further reinforced by the electronic distribution of Care for the Environment, AIA's primary publication concerning its activities related to environmental protection, which includes an entire chapter devoted to the topics of climate change and air quality and presents AIA's annual carbon footprint.

Finally, at various times different means have been used to educate AIA's staff as well as the staff of Third Parties operating at the airport (e.g. airlines, ground handlers, F&B, retail, etc.) concerning environmental monitoring and protection. For instance, site visits to AIA's environmental monitoring (noise, air quality, water quality) and other installations (e.g., Sewage Treatment Plant) have been organised. Since 2010, a more personal approach has been applied, namely face-to-face meetings with small numbers of co-workers to present and discuss different environmental challenges, such as recycling and climate change.

Regarding Third Parties, AIA works closely with them in order to raise awareness and improve environmental protection and performance across the airport site. This applies not only to the issue of carbon management, but also to other environmental aspects such as proper waste management, recycling, legal compliance, etc. In this framework, there is on-going environmental awareness training to Third Parties which also includes site tours. Since the airport opening, representatives from over 133 companies have attended such training sessions.

Finally, since 2009, regular workshops have been organised for Third Parties on the subject of environmental management. The 2009 Workshop placed a large emphasis on the issue of climate change. For example, AIA's actions concerning the creation of its first-ever carbon footprint and its verification by an external body in the context of its participation in *Airport Carbon Accreditation* were presented and discussed. Third Parties were encouraged to consider assessing their carbon footprints. During the 2010 Workshop, AIA presented its actions related to its upgrade to Level 2, namely setting an emissions reduction target and defining specific initiatives. At the 2013 Third Party Environmental Workshop, AIA presented the results of its work to develop its Scope 3 carbon footprint and further encouraged Third Parties to share vital information regarding fuel consumption, staff transport, etc. At the 2014 Third Party Environmental Workshop, AIA presented the results of the first year of the submission of detailed surface access data. The 2015 Workshop emphasised legislation issues concerning fluorinated gases and also showcased Third Parties' experience on handling environmental issues such as energy saving. The Workshop organized at the end of 2016 focused on energy issues and more specifically on energy audits and ISO 50001. The 2017 Workshop focused on Sustainability and the first Third

Party Environmental Excellence Award was presented to Olympic Fuel Company in recognition of its excellent performance and cooperation with all stakeholders, thus contributing to minimizing the impact of its operations on the environment. change adaptation as it relates to airports, including projections on how the local climate is expected to change over the next 50-100 years. An additional workshop was organized on the topic on climate change adaptation as it relates to airports, including projections on how the local climate is expected to change over the next 50-100 years.

The 2018 Workshop focused on the issues of waste management and plastic pollution as well as water management with presentations made by AIA, Third Parties, the National Technical University of Athens and the Decentralized Administration of Attica.The 2019 Workshop was dedicated to climate change with guest speakers from Attiki Odos, Olympia Odos and Aegean Airlines. In addition, AIA’s 2019 Third Party Environmental Excellence Award was presented to Goldair Handling S.A. in recognition of its excellent performance. The 2020 Workshop was postponed due to the quarantine measures in effect at the time.

And last but not least, great effort has been given during the last years to raise the environmental awareness of students from schools in the local communities around the airport. Trips to the airport are subsidized by the airport where students have the chance to attend an environmental awareness seminar followed by a site-tour to places of environmental interest at the airport (PV park, sewage treatment plant, recycling centre, etc.).

Emissions charges or modulation of landing/take-off (LTO) charges, in accordance with relevant international instruments

AIA periodically assesses the potential for modulation of its charges in accordance with environmental criteria, but no such modulation has been applied to date.

Airport improvements

i. Airfield improvements

In the context of AIA's Climate Change Corporate Action Plan, which consists of measures to reduce consumption of electricity, natural gas and vehicle fuels (gasoline and diesel) from sources under its direct control that are proposed by AIA employees and implemented in collaboration with the responsible departments, a number of important initiatives have been undertaken since 2008 that have led to significant reductions in AIA's carbon footprint: In the period between 2005 and 2020, AIA has managed to reduce its carbon footprint by 48%.

These measures that AIA has taken include, but are not limited to, the following:

- replacement of traditional lighting technology with LED technology for signage (decorative lighting, illumination of exhibition areas, etc.) in the Main Terminal Building as well as for obstruction lights -- following the success of these pilot projects, additional projects to introduce LED technology are being planned (e.g. runway lighting)
- restriction of the usage of Ground Power Units (GPUs) and Auxiliary Power Units (APUs) by airlines through the provision of Fixed Electrical Ground Power and Pre-Conditioned Air
- replacement of older vehicles with more fuel-efficient models, including

hybrid technology

- replacement of older equipment used to remove rubber deposits from runways with more fuel-efficient models
- optimization of people movers (e.g. escalators)
- optimization of AIA's Baggage Handling System (one of AIA's most energy-demanding systems)
- conversion of a significant portion of AIA’s physical servers (computer equipment) to virtual ones

ii. Operational improvements

The Airport Collaborative Decision Making (A-CDM) activity integrates procedures, processes and systems aiming at improving the overall efficiency of operations, particularly focusing on the aircraft turn-round and pre-departure sequencing process. This not only enables more efficient use of resources and translates into reduced fuel burn during taxi and runway holding and thus reduced CO_2 emissions, with economic and environmental benefits but also helps to unlock capacity.

iii. Reduced energy demand and preferred cleaner energy sources

Carbon reduction is an important factor taken under consideration in AIA's corporate decision-making processes as demonstrated by a number of key projects including its investment in the construction and operation of an 8MWp Photovoltaic Park (PV), which was the largest unified facility at an airport worldwide when it began operation in mid-2011. In 2012, its first full year of operation, it produced 13.6 million kWh of clean energy, 19% more than expected. The PV covers more than 10% of the airport community's energy demands and over 20% of AIA's energy demands.

In 2019, Athens International Airport announced “ROUTE 2025”, its official commitment to achieve net zero carbon emissions by 2025, prior to the target of 2050 set by Europe’s Airports in June 2019.

ROUTE 2025 includes:

- a detailed roadmap for the self-production of clean electricity within the airport boundaries via solar power for self-consumption purposes, aiming to cover 100 percent of the Airport Company’s electricity needs
- a detailed roadmap to address the remaining of its carbon footprint corresponding to direct emissions from fuel consumption onsite (via initiatives such as the use of electric vehicles, biodiesel, heat pumps, etc).

To date, AIA has acquired a producer’s certificate in order to proceed with the construction of a 16 MW PV park. The clean electricity produced will be used for auto-consumption.

In addition, AIA has proceeded with the replacement of its management fleet by EV and PHEV vehicles and the installation of the necessary charging infrastructure, not only for corporate vehicles but also for employees using EVs and PHEVs. Furthermore, AIA is engaging a wide range of stakeholders across the airport site regarding plans to expand the network of e-chargers and thus facilitate electrification.

AIA has also undertaken a number of initiatives to reduce the energy required for heating and especially cooling its buildings during the warm Greek summers as well as for operation of other infrastructure. These measures include, but are not limited to, the following:

- installation of harmonic filters in the electricity network of AIA's Main Terminal Building in order to improve efficiency and reduce unnecessary electricity production
- exploitation of AIA's extensive network of energy meters and its advanced Building Automation System (BAS) to reduce energy consumption for heating, cooling, lighting and ventilation of airport buildings, operation of people movers as well as other infrastructure
- replacement of six (6) of the Main Terminal Building's existing Air-Cooled Chillers with four (4) much more energy efficient Water-Cooled Chillers

iv. Improved transportation to and from airport

AIA has sought to reduce the emissions associated with the transport of passengers, visitors and staff to and from the airport through the following measures:

- collaboration with surface transport organizations to provide special incentives to airport employees that use mass transit
- special incentives to promote environmentally-friendly means of transport to/from work such as staff coaches, financial incentives for staff that carpool, subsidy of the use of mass transit
- ensuring that the airport maintains its well-developed mass transit infrastructure (Metro, suburban rail, public bus, etc.)

5.2.2. Greek Airports operated by Fraport Greece

Fraport Greece (FG) was created in 2015 and is responsible for maintaining, operating, managing, upgrading and developing 14 regional airports in Greece over a period of 40 years. The operational transfer of the airports to FG took place on April 11th, 2017.

FG consists of two concession companies with their corporate seats in Athens, one company for Cluster A[101] named "Fraport Regional Airports of Greece A S.A." ("Fraport Greece A", FGA) and one company for Cluster B[102] named "Fraport Regional Airports of Greece B S.A." ("Fraport Greece B", FGB). A third company with its corporate seat in Athens, is acting as management company and is responsible for central functions on behalf of Fraport Greece A and Fraport Greece B, such as employment of staff and contracting of advisors or suppliers.

[101] Cluster A: Thessaloniki (SKG), Kerkira (CFU), Zakinthos (ZTH), Kefallinia (EFL), Aktion (PVK), Kavala (KVA), Chania (CHQ)

[102] Cluster B : Rodos (RHO), Kos (KGS), Santorini (JTR), Mikonos (JMK), Mitiline (MJT), Samos (SMI), Skiathos (JSI)

FG Sustainable development

The Management of Fraport Greece has adopted an integrated environmental and social policy for all our business locations (headquarters and airports), having defined environmental and social protection as one of our main company goals. Environmental & Social Protection is the responsibility of all employees who need to realize the importance of their duties, take active participation in meeting the common goals and willingly commit to the results of their activities. In the framework of the climate change aspect, FG engages to manage and reduce carbon emissions.

Energy conservation aspects have already been incorporated in the design of the refurbishment, expansion or remodelling works in all of 14 airports with measures such as:

- Terminal use minimization during winter period by isolating unnecessary parts of the buildings with minimal use.
- Adjustable energy consumption to variable load demand (variable flow systems).
- Upgrade to low energy consuming lighting fixtures and automated lighting controls.
- Energy Management System in place for monitoring consumption, providing trends and correlation data and introducing effective related controls.

FG Development of Carbon footprint and targets

Since 2018 (1st complete calendar year of operation) FG calculates the carbon emissions of all 14 airports (see **Table 20**) from sources over which it has control, i.e.:

- Stationary sources: Boilers, furnaces, burners, engines, firefighting exercises, generators etc.
- Mobile sources: automobiles (airside/landside), trucks, employee cars etc.
- Indirect emissions: Emissions from purchased electricity.

One of FG's first short-term goals was to join Airport Carbon Accreditation scheme. Six (6) airports (Thessaloniki, Rhodes, Chania, Samos, Mytiline and Kefallinia) have earned the accreditation level 1 of MAPPING.

The 2017 traffic forecast for FG airports according to the approved Master Plans had foreseen an average growth rate of passenger traffic at approximately 1,9% per annum while the forecasted Air Traffic Movements showed the same tendency. Due to the large impact of COVID-19 outbreak, expected traffic growth has not materialised and a new traffic forecast will be elaborated in 2022 in the context of the Master Plan update.

Following the recent completion of FG's initial investment program (Imminent Works), the action plan for carbon management in order to reduce every airport's carbon footprint will be initiated within 2021 in order to meet the first reduction goal which will be set for 2030.

Furthermore, it must be noted that Fraport Greece, as an ACI member, has committed to the pledge to reach Net Zero Carbon Emissions by 2050.

Table 20. CO_2 Emissions in airports operated by Fraport Greece

	TOTAL CO2 EMISSIONS (Scope 1 &2) in tons		
REFERENCE PERIOD	**2018**	**2019**	**2020**
CLUSTER A			
CFU	2,783.3	2,772.9	2,896.0
CHQ	4,493.4	5,202.5	3,241.6
EFL	757.1	1,055.9	909.6
KVA	1,198.0	1,442.0	1,009.0
PVK	1,026.2	1,250.3	799.0
SKG	7,375.3	7,784.4	7,147.1
ZTH	2,213.9	2,626.8	1,644.7
TOTAL EMISSIONS CLUSTER A	**19,847.2**	**22,134.9**	**17,647.0**
CLUSTER B			
JMK	855.4	1,189.5	1,164.9
JSI	626.0	998.5	689.4
JTR	1,230.8	1,417.7	999.2
KGS	1,612.6	1,656.9	1,634.0
MJT	647.5	922.8	959.8
RHO	6,972.9	7,088.3	4,748.6
SMI	1,040.0	1,183.0	1,022.2
TOTAL EMISSIONS CLUSTER B	**12,985.2**	**14,456.8**	**11,218.1**
TOTAL EMISSIONS FRAPORT GREECE	**32,832.4**	**36,591.7**	**28,865.1**

5.1.3. Ground Handlers

Goldair Handling (GH) is the first private ground handling company, which operates in the liberalized Greek market since 1999. Aiming at the effective management of all environmental issues and threats, GH has adopted and implements an Environmental Management System, certified in accordance with ISO 14001:2015. Strengthening its environmental strategy, GH invested during 2018 in the creation of environmental applications to record and monitor its environmental performance at all the airports where it operates[103].

In 2019, GH received AIA's Third Party Environmental Excellence Award in recognition of its excellent performance and cooperation with all stakeholders, thus contributing to minimising the impact of its operations on the environment[104].

In Athens International Airport, as well as in the 14 regional airports operated by Fraport Greece, two more companies that provide ground handling services, **Skyserv** and **Swissport**, started consuming electricity provided by renewable energy sources (supported by Green Certificate) reducing this way the carbon footprint from ground operations. Moreover, these two handlers plan to electrify their fleet in order to support the fight against climate change.

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103 https://www.goldair-handling.gr/Reports/2018/EN/mobile/index.html

104 https://www.aia.gr/ebooks/enc/carefortheenvironment/issue22/mobile/index.html#p=1

CONCLUSION

The Greek Government and Hellenic Civil Aviation Authority are fully committed to address the climate change impacts of commercial aviation and achieve CO_2 emissions reductions through an integrated strategy of technology, operations and policy framework.

Greece has already achieved significant reductions in Green House Gas emissions and energy efficiency improvements in the aviation sector over the past years, through public and private efforts, and is on a trajectory to continue that progress in coming years.

This Action Plan provides an overview of past and future actions decided both at European and national level in order to mitigate climate change and to develop a resource efficient, competitive and sustainable aviation system. The national actions presented in Section 2 of this Action Plan cover measures taken at state level by State authorities and by stakeholders of aviation industry.

Both Sections 1 and 2 were finalised on June 2021, and shall be considered as subject to update after that date.

APPENDIX A

GREEK COMMERCIAL AIRPORTS

City / Location	Region	ICAO	IATA	Airport name	Operated by
Alexandroupoli	Macedonia and Thrace	LGAL	AXD	Alexandroupolis Int'l Airport "Dēmókritos/Democritus"	HCAA
Astypalaia	South Aegean	LGPL	JTY	Astypalaia Island National Airport	HCAA
Athens / Spata	Attica	LGAV	ATH	Athens Int'l Airport "Elefthérios Venizélos"	AIA
Chania (Souda)	Crete	LGSA	CHQ	Chania Int'l Airport "Ioánnis Daskalogiánnis"	Fraport Greece
Chios	North Aegean	LGHI	JKH	Chios Island National Airport "Hómēros/Homer"	HCAA
Corfu (Kerkira)	Ionian Islands	LGKR	CFU	Corfu Island Int'l Airport "Ioánnis Kapodístrias"	Fraport Greece
Heraklion	Crete	LGIR	HER	Heraklion Int'l Airport "Níkos Kazantzákis"	HCAA
Ikaria	North Aegean	LGIK	JIK	Ikaria Island National Airport "Íkaros/Icarus"	HCAA
Ioannina	Epirus	LGIO	IOA	Ioannina National Airport "Basileus Pýrrhos/King Pyrrhus"	HCAA
Kalamata	Peloponnese	LGKL	KLX	Kalamata Int'l Airport "Captain Vassílis Constantakópoulos"	HCAA
Kalymnos	South Aegean	LGKY	JKL	Kalymnos Island National Airport	HCAA
Karpathos	South Aegean	LGKP	AOK	Karpathos Island National Airport	HCAA
Kasos (Kassos)	South Aegean	LGKS	KSJ	Kassos Island Public Airport	HCAA
Kastelorizo (Megisti)	South Aegean	LGKJ	KZS	Kastelorizo Island Public Airport	HCAA
Kastoria	West Macedonia	LGKA	KSO	Kastoria National Airport "Aristotélēs/Aristotle"	HCAA
Kavala / Chrysoupoli	Macedonia and Thrace	LGKV	KVA	Kavala Int'l Airport "Mégas Aléxandros/Alexander the Great"	Fraport Greece
Kefalonia	Ionian Islands	LGKF	EFL	Kefalonia Island Int'l Airport "Ánna Pollátou"	Fraport Greece
Kithira	Attica	LGKC	KIT	Kithira Island National Airport "Aléxandros Aristotélous Onássis"	HCAA
Kos	South Aegean	LGKO	KGS	Kos Island Int'l Airport "Hippokrátēs/Hippocrates"	Fraport Greece
Kozani	West Macedonia	LGKZ	KZI	Kozani National Airport "Phílippos/Philip"	HCAA
Lemnos	North Aegean	LGLM	LXS	Lemnos Island Int'l Airport "Hēphaistos/Hephaestus"	HCAA
Leros	South Aegean	LGLE	LRS	Leros Island Public Airport	HCAA
Milos	South Aegean	LGML	MLO	Milos Island National Airport	HCAA
Mykonos	South Aegean	LGMK	JMK	Mykonos Island National Airport	Fraport Greece
Mytilene (Lesbos)	North Aegean	LGMT	MJT	Mytilene Island Int'l Airport "Odysséas Elýtis"	Fraport Greece
Naxos	South Aegean	LGNX	JNX	Naxos Island National Airport	HCAA
Paros	South Aegean	LGPA	PAS	Paros Island National Airport	HCAA

City / Location	Region	ICAO	IATA	Airport name	Operated by
Patras / Araxos	West Greece	LGRX	GPA	Araxos National Airport "Agamémnon"	HCAA
Preveza (Aktio)	Epirus	LGPZ	PVK	Aktion National Airport (Preveza Airport)	Fraport Greece
Rhodes	South Aegean	LGRP	RHO	Rhodes Island Int'l Airport "Diagóras"	Fraport Greece
Samos	North Aegean	LGSM	SMI	Samos Island Int'l Airport "Aristarchus of Samos"	Fraport Greece
Santorini (Thira)	South Aegean	LGSR	JTR	Santorini (Thira) Island National Airport	Fraport Greece
Sitia	Crete	LGST	JSH	Sitia Public Airport "Vitséntzos Kornáros"	HCAA
Skiathos	Thessaly	LGSK	JSI	Skiathos Island National Airport "Aléxandros Papadiamántis"	Fraport Greece
Skyros	Central Greece	LGSY	SKU	Skyros Island National Airport	HCAA
Syros	South Aegean	LGSO	JSY	Syros Island National Airport "Dēmḗtrios Vikélas/Demetrius Vikelas"	HCAA
Thessaloniki / Mikra	Central Macedonia	LGTS	SKG	Thessaloniki Int'l Airport "Makedonía/Macedonia"	Fraport Greece
Volos / Nea Anchialos	Thessaly	LGBL	VOL	Nea Anchialos National Airport	HCAA
Zakynthos	Ionian Islands	LGZA	ZTH	Zakynthos Island Int'l Airport "Dionýsios Solomós"	Fraport Greece

APPENDIX B

DETAILED RESULTS FOR ECAC SCENARIOS

1. BASELINE SCENARIO

a) Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres[105] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[106] FTKT (billion)	Total Revenue Tonne Kilometres[107] 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.

b) Fuel burn and CO_2 emissions forecast for the baseline scenario

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	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.				

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

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

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

2. IMPLEMENTED MEASURES SCENARIO

2A) EFFECTS OF AIRCRAFT TECHNOLOGY IMPROVEMENTS AFTER 2019

a) *Fuel consumption and CO_2 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_2e 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 CO_2 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_2e 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) CO_2e emissions forecasts for the scenarios described in this common section

Year	Well-to-wake CO_2e emissions (10^9 kg)			% improvement by Implemented Measures (full scope)
	Baseline Scenario	Implemented Measures Scenario		
		Aircraft techn. improvements only	Aircraft techn. and ATM improvements	
2010	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.				

LIST OF ABBREVIATIONS

AAT	-	Aircraft Assignment Tool
ACA	-	Airport Carbon Accreditation
ACARE	-	Advisory Council for Research and Innovation in Europe
ACCs	-	Area Control Centers
ACI	-	Airport Council International
AETC	-	Decision of Approval of Environmental Terms and Conditions
AIA	-	Athens International Airport
AIRE	-	Atlantic Interoperability Initiative to Reduce Emissions
ANSP	-	Air Navigation Service Provider
AOC	-	Air Operator Certificate
APER TG	-	Action Plans for Emissions Reduction Task Group of the ECAC/EU Aviation and Environment Working Group (EAEG)
APU	-	Advanced Production Unit
ASTM	-	American Society for Testing and Material
ATCO	-	Air Traffic Controller
ATJ	-	Alcohol-to-Jet
ATM	-	Air Traffic Management
ATS	-	Air Traffic Service
AU	-	Airspace User
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 Union Aviation Safety Agency
EC	-	European Commission
ECAC	-	European Civil Aviation Conference
EEA	-	European Environment Agency
EFTA	-	European Free Trade Association
EIA	-	Environmental Impact Assessment
EPCA	-	European Partnership for Clean Aviation
ERAA	-	European Regions Airline Association
ESIF	-	European Structural and Investment Funds
EU	-	European Union
EU ETS	-	the EU Emissions Trading System
EU-SEA CCCA	-	EU-South East Asia Cooperation on Mitigating Climate Change impact from Civil Aviation
FAA	-	Federal Aviation Administration
FBA	-	Functional Airspace Blocks
FG	-	Fraport Greece
FLITE	-	Fuel via Low Carbon Integrated Technology from Ethanol
FLW	-	Food Loss and Waste
FRA	-	Free Route Airspace
FTKT	-	Freight Tonne Kilometres
GCD	-	Great Circle Distance

GDP	**-**	Gross Domestic Product
GHG	**-**	Greenhouse Gas
HCAA	**-**	Hellenic Civil Aviation Authority
HCAS	**-**	Hellenic Civil Aviation Services
HTL	**-**	Hydrothermal Liquefaction
IAG	**-**	International Airlines Group
IATA	**-**	International Air Transport Association
ICAO	**-**	International Civil Aviation Organization
IFR	**-**	Instrument Flight Rule
IPCC	**-**	Intergovernmental Panel on Climate Change
IPR	**-**	Intellectual Property Right
JU	**-**	Joint Undertaking
LPG	**-**	Liquified Petroleum Gas
LSSIP	**-**	Local Single Sky ImPlementation
MBM	**-**	Market Based Measures
MEEN	**-**	Ministry of Environment and Energy
MRV	**-**	Monitoring Reporting Verification
MT	**-**	Million tonnes
MTOM	**-**	Maximum TakeOff Mass
NDC	**-**	National Documentation Centre
NECP	**-**	National Energy and Climate Plan
NIR	**-**	National Inventory Report
NM	**-**	Nautical Miles
nvPM	**-**	non-volatile Particulate Matter
PAGAR	**-**	Performance Assessment and Gap Analysis Report
PBN	**-**	Performance Based Navigation
PM	**-**	Particulate Matter
PRISME	**-**	Pan European Repository of Information Supporting the Management of EATM
RED	**-**	Renewable Energy Directive
RIA	**-**	Research and Innovation Action
RPK	**-**	Revenue Passenger Kilometres
RTD	**-**	Research and Technological Development
RTK	**-**	Revenue Tonne-Kilometres
SAF	**-**	Sustainable Aviation Fuels
SARPs	**-**	Standards and Recommended Practices
SCS	**-**	Sustainability Certification Schemes
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
SRIA	**-**	Strategic Research and Innovation Agenda
STATFOR	**-**	Statistics and Forecast Service
TRL	**-**	Technology Readiness Level
UFPs	**-**	UltraFine Particles

UIR	**-**	Upper Information Region
UNFCCC	**-**	United Nations Framework Convention on Climate Change
VDL	**-**	Very High Frequency Datalink
VLDs	**-**	Very Large-Scale Demonstrations
VOC	**-**	Volatile Organic Compounds
WG	**-**	Working Group