HELLENIC
CIVIL
AVIATION
AUTHORITY
HCAA

2024

ICAO STATE ACTION PLAN FOR AVIATION CO2 EMISSIONS GREECE

JANUARY 2025

CONTENTS

SECTION A

INTRODUCTION

SECTION A

1. CONTACT INFORMATION

Hellenic Civil Aviation Authority
Athens International Airport
Building 45, 190 19 Spata
Tel: +30 210 3541449
E-mail: info@hcaa.gov.gr
a3.c@hcaa.gov.gr

Approved by
Dr. Christos Tsitouras
Governor of Hellenic Civil Aviation Authority
E-mail: governor@hcaa.gov.gr

Review and Data Processing
Dr. Georgia Lykou
Head of Environmental Protection Regulation and Oversight Section
Member of Committee Aviation Environmental Protection, ICAO/CAEP
Tel: +30 210 3541361
E-mail: g.lykou@hcaa.gov.gr

Compiled by
Ms Katerina Tzouka
State Action Plan Focal Point
Environmental Protection Regulation and Oversight Section
Tel: +30 210 3541449
E-mail: a.tzouka@hcaa.gov.gr

Athens, January 2025

2. COMMON INTRODUCTORY SECTION FOR EUROPEAN STATES' ACTION PLANS FOR CO2 EMISSIONS REDUCTIONS

a) The ICAO Contracting State **GREECE** is a member of the European Union and the European Civil Aviation Conference (ECAC). ECAC is an intergovernmental organization covering the widest grouping of Member States[1] of any European organization 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 long-term aspirational goal (LTAG) for international aviation of net-zero carbon emissions by 2050, 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** recognizes 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 and the monitoring of the long-term aspirational goal agreed at Assembly 41

f) In that context, it is the intention that all ECAC States submit to ICAO an action plan. This is the action plan of **GREECE**.

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

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 to meet the ICAO aspirational vision of reducing CO_2 emissions by 5% by 2030 through increased use of SAF worldwide.

iv. improvement and optimization 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

---

[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.

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 long term aspirational goal of net-zero carbon emissions by 2050.

h) In Europe, many of the actions which are undertaken within the framework of this comprehensive approach are in practice taken collectively, including many 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).

CURRENT STATE OF AVIATION IN GREECE

3. CURRENT STATE OF AVIATION IN GREECE

3.1 Hellenic Civil Aviation Authority

Hellenic Civil Aviation Authority (HCAA) is the National Regulatory Authority of Civil Aviation, institutionally separated and directed by its Governor. HCAA is responsible for the regulation of all aspects of civil aviation, including air navigation and airports located in Greece.

HCAA has been established by National Law 4757/2020 (G.G. 240/01.12.2020), as an independent Civil Aviation Authority and started its operation in January of 2022. HCAA headquarters have been established at Athens International Airport.

Supported by the Ministry of Infrastructure and Transport, enjoys operational independence and financial autonomy. Subject to parliamentary control, submits annual report of its activities to the Minister of Infrastructure and Transport and the Hellenic Parliament.

3.2 Mission and Responsibilities of HCAA

The mission of the HCAA is to carry out certification, oversight, and enforcement tasks in the field of air transport including Aircraft Operators, Airports and Air Navigation Service Providers. HCAA also supervises the implementation of National and European legislation, ensuring Safety, Security and Environmental Protection from civil aviation activities.

The HCAA performs the functions of the regulatory authority for the economic activity of air transport, air navigation and airports. HCAA is responsible for:

- the development of national aviation strategy, the regulation and adoption of the regulations falling with in its responsibilities and the exercise of oversight over the operation of Civil Aviation in Greece,
- the regulation and continuous oversight of air traffic services, communication-navigation-surveillance systems, aeronautical information services, air traffic flow

& airspace management, flight procedure design and data services of any category of airspace users,

- the certification and oversight of Air Navigation Services Providers,
- registration, certification, licensing and oversight of civil aircraft, aircraft operating entities, civil aviation aircrews, aircraft maintenance personnel and equipment, aerodromes in the areas of environmental protection in civil aviation and aviation security,
- the regulation and oversight of economic activity in the field of air transport, air traffic services and airports,
- cooperation at technical level and participation in national and international organizations on matters falling within its competence, as well as cooperation with the authorities of the European Union, in particular the European Aviation Safety Agency (EASA) and the European Organization for the Safety of Air Navigation (EUROCONTROL)

More information for HCAA is in the official webpage: https://hcaa.gov.gr/en

3.3 Greek Airports

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. 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

Table 1: Greek commercial airports

City / Location	Region	ICAO	IATA	Airport name	Operated by
Alexandroupoli	Macedonia and Thrace	LGAL	AXD	Alexandroupolis / Dimokritos	HCAA
Astypalaia	South Aegean	LGPL	JTY	Astypalaia	HCAA
Athens / Spata	Attica	LGAV	ATH	Athinai / Eletherios Venizelos	AIA
Chania (Souda)	Crete	LGSA	CHQ	Chania /Ioannis Daskalogiannis	FRAPORT
Chios	North Aegean	LGHI	JKH	Chios / Omiros	HCAA
Corfu (Kerkira)	Ionian Islands	LGKR	CFU	Kerkira / Ioannis Kapodistrias	FRAPORT
Heraklion	Crete	LGIR	HER	Iraklion /Nikos Kazantzakis	HCAA
Ikaria	North Aegean	LGIK	JIK	Ikaria / Ikaros	HCAA
Ioannina	Epirus	LGIO	IOA	Ioannina /King Pyrros	HCAA
Kalamata	Peloponnese	LGKL	KLX	Kalamata	HCAA
Kalymnos	South Aegean	LGKY	JKL	Kalymnos	HCAA
Karpathos	South Aegean	LGKP	AOK	Karpathos	HCAA
Kasos (Kassos)	South Aegean	LGKS	KSJ	Kassos	HCAA
Kastelorizo (Megisti)	South Aegean	LGKJ	KZS	Kastelorizo	HCAA
Kastoria	West Macedonia	LGKA	KSO	Kastoria /Aristotelis	HCAA
Kavala / Chrysoupoli	Macedonia and Thrace	LGKV	KVA	Kavala /Megas Alexandros	FRAPORT
Kefalonia	Ionian Islands	LGKF	EFL	Kefallinia/ Anna Pollatou	FRAPORT
Kithira	Attica	LGKC	KIT	Kithira /Alexandros Aristotelous Onassis	HCAA
Kos	South Aegean	LGKO	KGS	Kos /Ippokratis	FRAPORT
Kozani	West Macedonia	LGKZ	KZI	Kozani /Filippos	HCAA
Lemnos	North Aegean	LGLM	LXS	Limnos /Ifaistos	HCAA
Leros	South Aegean	LGLE	LRS	Leros	HCAA
Milos	South Aegean	LGML	MLO	Milos	HCAA
Mykonos	South Aegean	LGMK	JMK	Mykonos	FRAPORT
Mytilene, Lesbos	North Aegean	LGMT	MJT	Mytilini /Odysseas Elytis	FRAPORT
Naxos	South Aegean	LGNX	JNX	Naxos	HCAA
Paros	South Aegean	LGPA	PAS	Paros	HCAA
Patras / Araxos	West Greece	LGRX	GPA	Araxos	HCAA
Preveza (Aktio)	Epirus	LGPZ	PVK	Preveza/Aktion	FRAPORT
Rhodes	South Aegean	LGRP	RHO	Rodos /Diagoras	FRAPORT
Samos	North Aegean	LGSM	SMI	Samos /Aristarchos of Samos	FRAPORT
Santorini (Thira)	South Aegean	LGSR	JTR	Santorini	FRAPORT
Sitia	Crete	LGST	JSH	Sitia / Vitsentzos Kornaros	HCAA
Skiathos	Thessaly	LGSK	JSI	Skiathos /Alexandros Papadiamandis	FRAPORT
Skyros	Central Greece	LGSY	SKU	Skiros	HCAA
Syros	South Aegean	LGSO	JSY	Syros /Dimitrios Vikelas	HCAA
Thessaloniki	Central Macedonia	LGTS	SKG	Thessaloniki / Makedonia	FRAPORT
Volos / Nea Anchialos	Thessaly	LGBL	VOL	Almiros/Nea Anchialos	HCAA
Zakynthos	Ionian Islands	LGZA	ZTH	Zakinthos /Dionisios Solomos	FRAPORT

Greek airports serve millions of visitors from abroad and Greece throughout the year, enabling access to various locations on the Greek mainland or the islands. Athens International Airport receives the majority of foreign visitors arriving in Greece, as do the airports of Thessaloniki and Crete. In Greece, 39 aerodromes have been established, designated as International and National Airports. These aerodromes are categorized according to their ownership status, services provided, organizational structure etc.
The following Table 1 exhibits in detail Greek Commercial Airports with regional location and city served, Airport name, ICAO and IATA code. The location of International Greek airports is illustrated at the Figure 2 below.

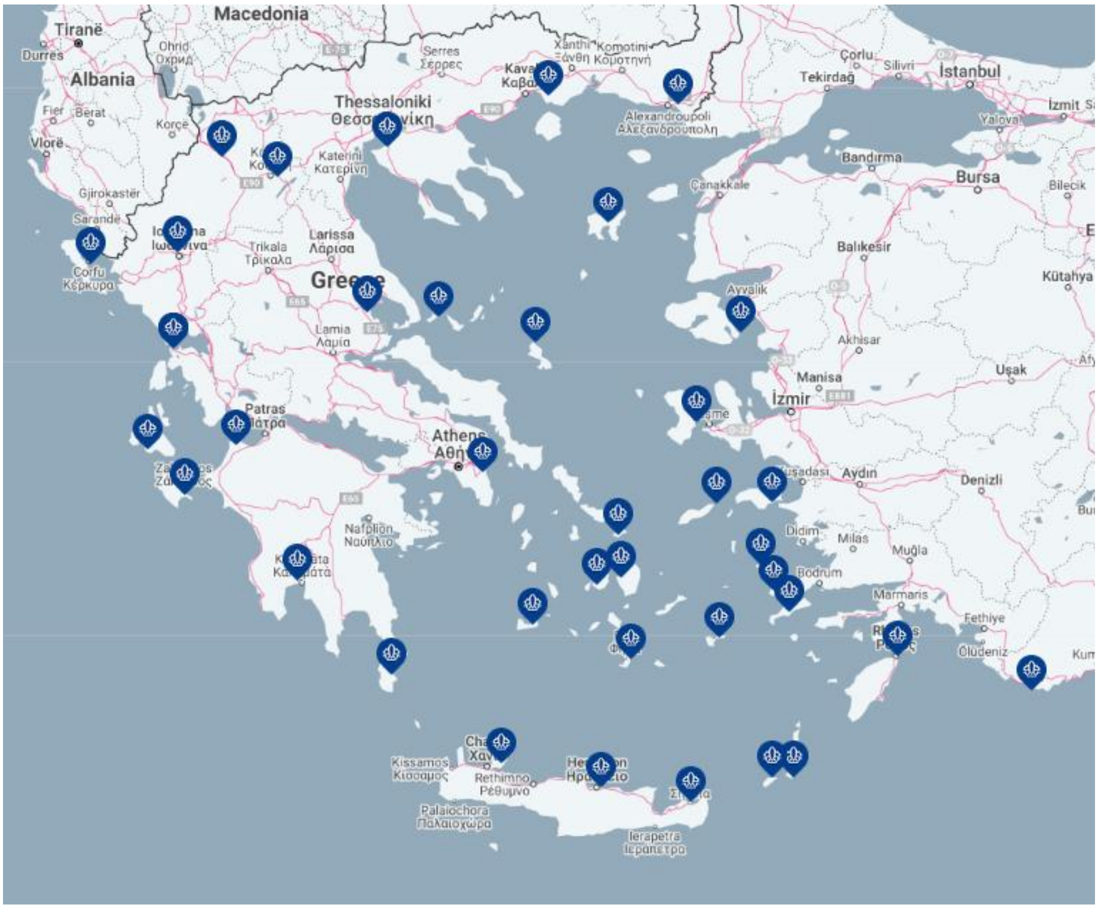


Figure 2: Map of Greece airports located over the country

Concerning the aerodromes ownership status:

- The biggest airport of Greece, Athens International Airport /Eleftherios Venizelos is owned and operated by a Public-Private Partnership Company, Athens International Airport S.A. (AIA), through a 40-year concession agreement, ratified by Greek Law 2338/1995.
- 24 aerodromes are owned and operated by the State (Ministry for Infrastructure and Transport, Hellenic Aviation Service Provider and/or Ministry of Defense)
- 14 aerodromes are operated by Fraport Greece, as responsible for maintaining, operating, managing, upgrading and developing these regional airports in Greece over a period of 40 years based on a concession agreement. Airports included in

the concession are: Aktion (LGPZ), Kavala (LGKV), Thessaloniki (LGTS), Kerkira (LGKR), Chania (LGSA), Kefallonia (LGKF), Kos (LGKO), Mytilene (LGMT), Mikonos (LGMK), Rodos (LGRP), Samos (LGSM), Santorini (LGSR), Skiathos (LGSK) and Zakinthos (LGZA).

- The New International Airport of Heraklion in Crete is under construction by TERNA GMR Joint Venture to replace the second busiest airport in Greece, as an operational continuity of the existing State Airport of Heraklion "Nikos Kazantzakis".

3.4 Commercial Aviation Market Evolution

Greece's strategic location as a gateway between Europe, Asia, and Africa has positioned it as a key hub for international flights, attracting both leisure and business travelers. This has further stimulated the growth of Aviation in Greece. Overall, Tourism and Commercial Flights market in Greece is developing rapidly, driven by changing customer preferences, emerging trends, local special circumstances, and underlying macroeconomic factors.
Table 2 illustrates the commercial aviation traffic in Greece in terms of Domestic, International and Total Flights (arriving and departing) and Passengers respectively, as it evolved during the years 2010 – 2023.

Table 2: Evolution of commercial aviation traffic in Greece, from 2010 to 2023

YEAR	DOMESTIC FLIGHTS		INTERNATIONAL FLIGHTS		TOTAL FLIGHTS	
	ARR+DEP Movements (x10^3)	PASSENGERS (x10^6)	ARR+DEP Movements (x10^3)	PASSENGERS (x10^6)	ARR+DEP Movements (x10^3)	PASSENGERS (x10^6)
2010	216,20	12,47	212,66	25,84	428,86	38,30
2011	189,37	11,20	220,85	27,63	410,23	38,83
2012	176,79	10,30	205,99	26,36	382,78	36,66
2013	163,60	9,98	211,77	28,47	375,36	38,46
2014	171,16	12,08	244,09	32,51	415,25	44,59
2015	187,52	14,53	256,73	34,28	444,25	48,81
2016	195,16	15,87	274,39	37,13	469,55	52,99
2017	192,89	16,41	291,24	41,45	484,13	57,86
2018	201,49	16,92	318,06	45,37	519,55	62,29
2019	206,26	17,01	319,90	47,16	526,16	64,17
2020	120,55	6,87	123,25	12,83	243,80	19,70
2021	164,28	10,36	216,89	25,43	381,17	35,79
2022	198,07	16,20	316,29	47,49	514,36	63,69
2023	234,99	19,41	347,00	52,96	581,99	72,37

In 2023, commercial aviation traffic in Greece reached 72,37 million Passengers, exceeding previous record years (2019 & 2023), while Total Domestic and International

Flights reached the 581.996 Movements (Arrival & Departures) during 2023. Figure 3 illustrates Aviation Commercial Aviation Traffic in Millions of Passengers (10^6) and Thousands of Flights (10^3) for historic years from 2010 to 2023.

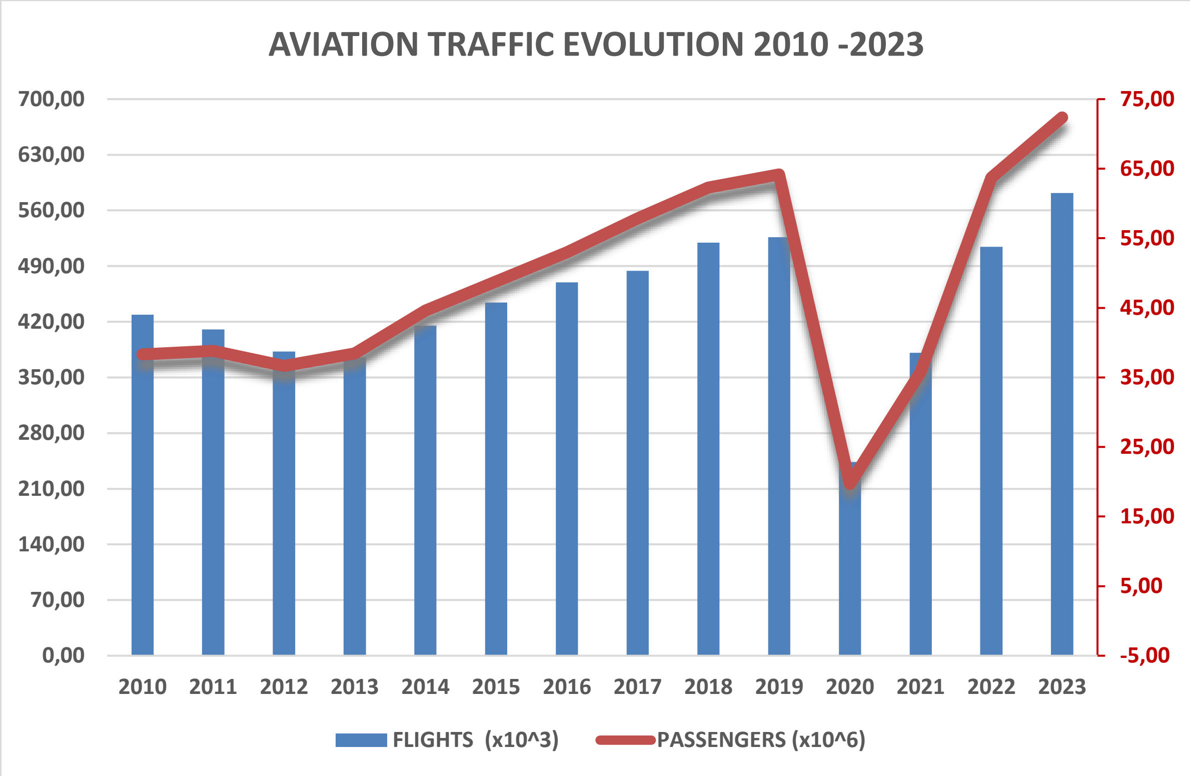


Figure 3: Aviation Commercial Aviation Evolution from 2010 to 2023

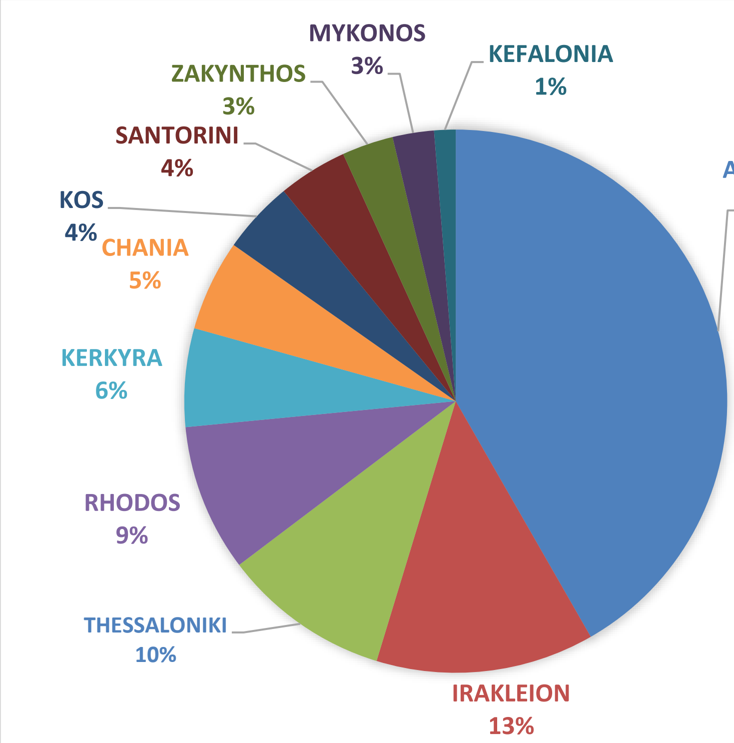
Athens International Airport is the busiest airport in Greece in terms of passenger traffic and it is followed by the airports of Heraklion (Crete), Thessaloniki, Rhodes, and Corfu. The evolution of total passenger movements (arriving and departing) at the eleven busiest airports in Greece is illustrated in Figure 4.

In 2023, the 39% of total passenger movements (arrivals & departures) happened through Athens International Airport, while the 92% of Aviation Passengers moved through the eleven (11) International Airports of Greece, as shown in Figure 4. These 11 top traffic International Airports are defined as Union Airports, under European Environmental Regulation Refuel Aviation[2].

Moreover, the most significant increases in passenger traffic at smaller domestic airports compared to last year were recorded at Kasos Airport +89.8%, Milos Airport with +33%, Naxos Airport with +30%, and Sitia Airport with +27.7%. An increase of +9.5% compared to last year is also seen in all commercial Airports which greatly supported Greece’s Tourist Development, income and GDP growth during 2023. In Greece, tourism accounts for almost 20% of its GDP and 20% of jobs. In 2023, Greece's real GDP increased by about 2% compared to previous year.

---

[2] Regulation (EU) 2023/2405 of the European Parliament and of the Council of 18 October 2023 on ensuring a level playing field for sustainable air transport. Article 3, Definition of Union Airport: An Airport where passenger traffic was higher than 800.000 passengers or where the freight traffic was higher than 100.000 tonnes in the previous reporting period.



AIRPORT NAME	ICAO CODE	Passenger Movements in 2023 (Millions)
ATHENS	LGAV	28,09
IRAKLEION	LGIR	8,75
THESSALONIKI	LGTS	6,73
RHODOS	LGRP	5,91
KERKYRA	LGKR	3,94
CHANIA	LGSA	3,65
KOS	LGKO	2,91
SANTORINI	LGSR	2,78
ZAKYNTHOS	LGZA	2,06
MYKONOS	LGMK	1,66
KEFALONIA	LGKF	0,86

Figure 4: 2023 Passenger Traffic of 11 Greek Union Airports

The evolution of Passenger's traffic in Greek Union Airports for the period 2019-2023 is illustrated in Figure 5.

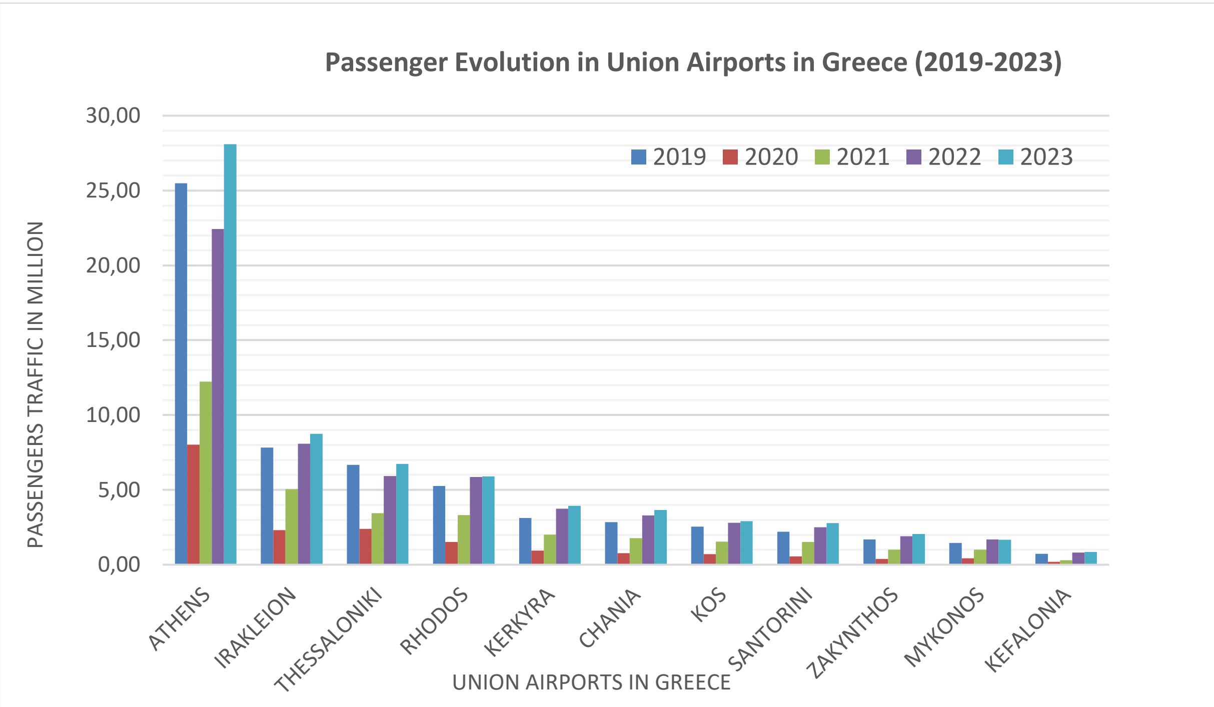


Figure 5: Union Airports Passenger Evolution in Greece for the period 2019-2023

3.5 Air Carriers – Operating Fleet and Operating Certificates (AOC)

By the end of 2023, twenty two (22) operators were holding an Air Operator Certificate (AOC) issued by HCAA, under EASA regulations. By those Aircraft Operators, the commercial operators who exceeded the threshold of 10kTons CO_2 emissions on international flights, so as to have reporting obligations for CO2 emissions, under ICAO / CORSIA scheme are the following:

Name	AO ID	>10 Kt	Flights	CO_2
AEGEAN AIRLINES	20514	✓	59,398	1,045,441
SKY EXPRESS GREECE	31109	✓	10,289	159,856
BLUE BIRD AIRWAYS	35368	✓	3,208	48,847
GAIN JET AVIATION SA	31722	✓	702	11,358

There are 202 aircrafts utilized by Aircraft Operators under HCAA supervision and they are distributed per Category of Aircraft, as shown in Table 3, which includes aircrafts managed by an operator with an AOC (Passenger/Cargo).

Table 3: Air Operators' aircraft distribution for AO with AOC

	Certification Specification	Category of Aircraft	Count
1	CS-25	Large Aeroplane	143
2	CS-23	Small Aeroplane (Normal, Commuter)	17
3	CS-27	Small Rotorcraft	40
4	CS-29	Large Rotorcraft	2
	Total		**202**

Table 4 includes Aircrafts that are actively displayed in the HCAA Data Management Systems (DMS) and includes all types of operations including Passenger/Cargo, schools, private, ATO's etc.

Table 4: Air Operators' aircraft distribution for AO

	Certification Specification	Category of Aircraft	Count
1	CS-25	Large Aeroplane	160
2	CS-23	Small Aeroplane (Normal, Utility, Aerobatic, Commuter)	125
3	CS-27	Small Rotorcraft	74
4	CS-29	Large Rotorcraft	7
	Total		**366**

3.6 Air Operators CO_2 Emissions Evolution

For Greece total AO's CO_2 emissions from international flights between States that participate in ICAO Carbon Offsetting and Reduction Scheme (CORSIA) are presented in following figures. Total emissions for the last three years are 1.284,5 kTonnes CO_2 for 2023, 1.042,9 kTonnes CO_2 for 2022 and 630.602 kTonnes CO_2 for 2021, as shown in Figure 6.

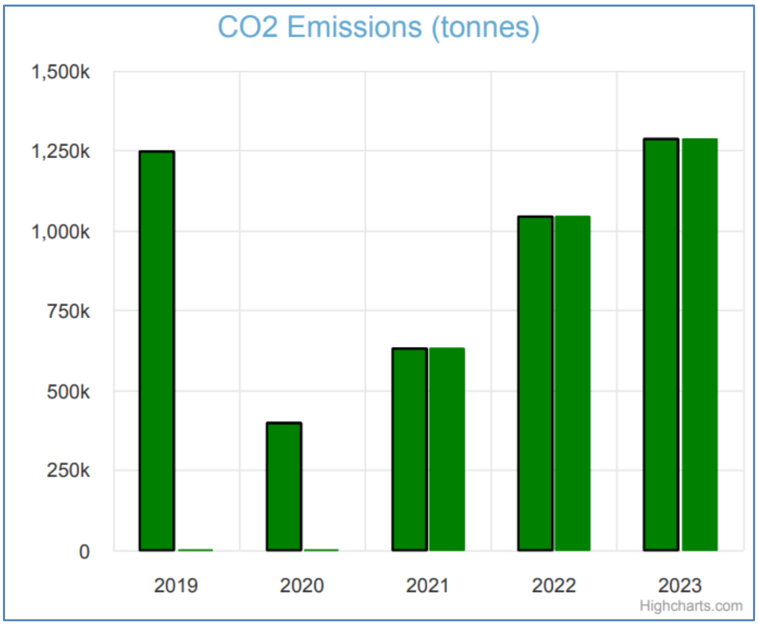


Figure 6: CO_2 emissions from international flights evolution 2019-2023

Regarding International connectivity of Greece with other States under CORSIA scheme, there were 412 State Pairs subject to CO_2 offsetting requirements in CORSIA in 2023, 206 state pairs in 2022 and 199 state pairs in 2021 as shown in Figure 7.

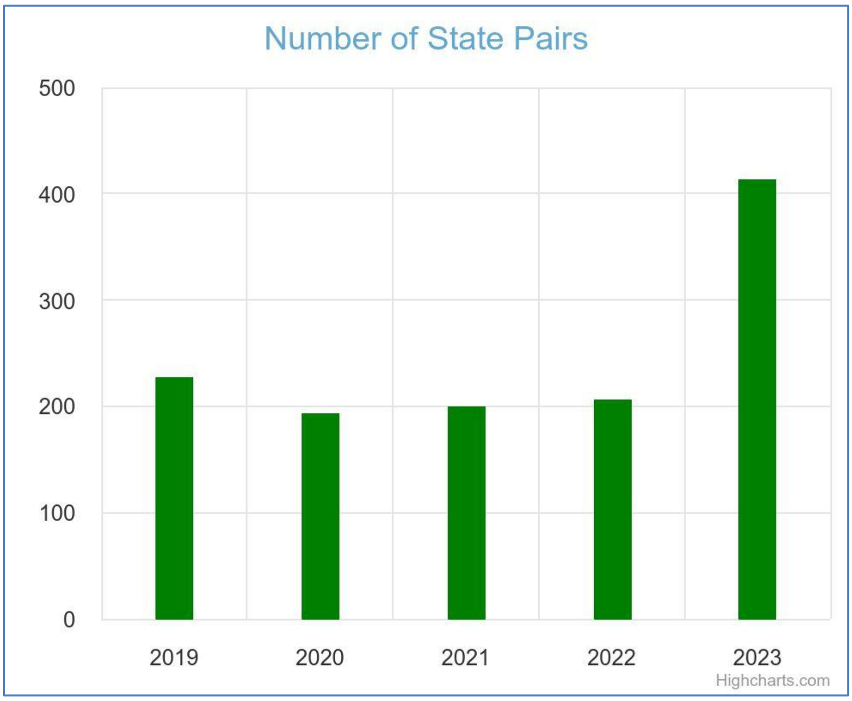


Figure 7: Number of State Pairs participating in ICAO CORSIA 2019-2023

Concerning emission from domestic flights in Greece from AO's that subject to EU Emissions Trading System obligations (EU ETS), for 2023 97,91 thousand flights were performed releasing 343,47 ktn CO_2 in total, exceeding the previous record year of 2021 with 86,6 thousand flights that reached 310,21 ktn CO_2 in total.

Table 5: Domestic fights Air Operators' emissions for the period 2019-2023

2019		2020		2021		2022		2023	
Flights	CO2 (ktn)	Flights	CO2 (ktn)	Flights	CO2 (ktn)	Flights	CO2 (ktn)	Flights	CO2 (ktn)
83.950	330,59	49.525	169,97	68.593	253,27	86.599	310,21	97.911	343,48

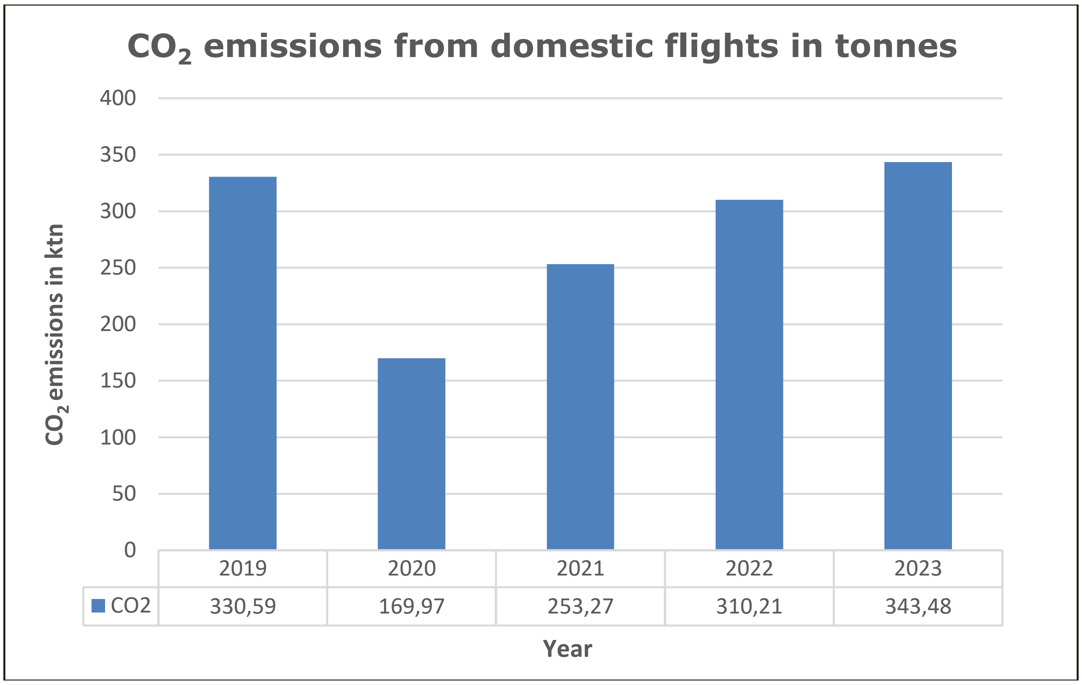


Figure 8: CO_2 emissions from domestic flights

3.7 Greek Environmental Policy

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, the 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 UNFCCC, Kyoto Protocol and the Paris Agreement. In this context, the MEEN has the overall responsibility for the national GHG inventory, and the official consideration and approval of the inventory prior to its submission. The information that is related to the annual GHG emissions inventory (activity data, emission factors, analytic results, compilation in the required analysis level of the CRT tables) is stored in MS Excel spreadsheets[3].

In 2021, the Greek government revamped its environmental legislation. The new regulations set clearer rules for environmental protection and are expected to facilitate environmental investments. More specifically, the new law changes the regulations on land use, environmental licensing and the management of protected areas.

Greece participated in the negotiations and signed the Paris Climate Agreement of December 2015. Since November 2021, Greece has also followed the COP26 guidelines in preparing to shift to a sustainable environmental regime, according to IPCCC Methodology.

In 2022, GHG emissions (without LULUCF) amounted to 78.31 Mt CO2 eq showing a decrease of 24.69% compared to 1990 levels. If emissions / removals from LULUCF were to be included, then the decrease would be 28.31%. The majority of GHG emissions (45.42%) in 2022 derived from energy industries, while the contribution of transport, manufacturing industries and construction and other sectors is estimated at 32.89%, 8.22% and 12.04% respectively. The rest 0.88% and 0.55% of total GHG emissions from Energy derived from fugitive emissions from fuels and other (mobile).

Within the fuel combustion activities, the only sector with increased emissions compared to 1990 is transport, showing an increase of 23.49%. It should be noted that GHG emissions from transport were reduced by 14% in 2020 compared to 2019 at a significant share due to COVID-19 restrictions, but in 2022 they have recovered their 2019 levels GHG emissions from international bunkers increased by 59% for international aviation. The significant reductions occurred in 2020 and continued to appear in 2021, due to the preventive measures which were being implemented in Greece, to limit the spread of the coronavirus disease in the country. However, in 2022, they recovered to their 2019 levels.

The sustainable development of air transport requires the adoption of measures and incentives to support biofuel production activity in Greece, involving both the agricultural and industrial sectors, including economic instruments for research and development of the sector. Targeted support and funding at national level, as well as public-private partnerships, can improve the availability and financial sustainability of relevant fuels to further accelerate their supply and deployment.

Emissions from international transport are calculated according to IPCC Methodology and are not included in national emissions, as shown in Table 6 for years 2012-2022.

Table 6: GHG emissions in the aviation sector for the period 2012-2022

International aviation Emissions (ktCO2 eq)										
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
2.405,2	2.485,2	2.851,5	2.890,9	3.103,6	3.461,1	3.887,9	4.019,3	1.333,6	2.530,8	3.971,8

[3] NIR and CRT tables are available in the MEEN web site (https://ypen.gov.gr/perivallon/klimatiki-allagi/ektheseis-kai-yfistameni-katastasi/etisies-ethnikes-apografes-aerion-tou-thermokipiouatth-apo-to-2005/

Table 7: Allocation of LTOs to domestic and international aviation for the period 2006-2022 (Eurocontrol Data)

Year	Domestic	International
2006	105.927	108.783
2007	111.424	116.176
2008	107.182	113.275
2009	120.063	108.790
2010	108.102	106.330
2011	94.687	110.427
2012	95.044	104.735
2013	97.392	107.841
2014	87.392	107.841
2015	91.453	123.532
2016	102.039	139.223
2017	102.479	149.254
2018	110.021	166.953
2019	113.010	168.291
2020	67.404	65.600
2021	92.714	116.608
2022	111.430	171.477

Table 8: GHG emissions, air pollutants emissions and energy consumption from domestic aviation for period 2020 – 2022 (IPCC Methodology)

Domestic Aviation	Unit	2020	2021	2022
Fuel Consumption	TJ	2991,81	4488,02	5454,09
Emissions				
CO_2	kt	213,45	320,32	389,39
CH_4	kt	0,0015	0,002	0,0027
N_2O	kt	0,0059	0,009	0,109
NO_X	kt	0,96	1,45	1,81
CO_2	kt	0,32	0,56	0,69
NMVOC	kt	0,03	0,04	0,04
SO_2	kt	0,06	0,08	0,1

Greece aims to cut CO_2 emissions by 58.6% from 1990 levels, in line with the European Union's goal of 55%. To meet these updated targets, an estimated €95 billion ($104 billion) in additional investment will be needed by 2030, funding initiatives like energy efficiency in buildings, expansion of solar and wind capacity, and energy storage enhancements. By 2050, total investment is expected to reach €330 billion ($363 billion), aiding Greece's goal of climate neutrality.

The National Energy and Climate Plan (NECP)[4], 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 European Green Deal, the fast-evolving geopolitical context and the energy crisis have led the EU and its Member States to accelerate the energy transition and set more ambitious energy and climate objectives. These developments are reflected in the legislative and policy framework adopted under both the 'Fit for 55' package and the REPowerEU Plan. Taking this new context into account, Member States are updating their National Energy and Climate Plans (NECPs) for the first time since 2019.

Greece's key objectives, targets and contributions

	2030 value submitted in the draft updated NECP	2030 target indicated by EU legislation	Assessment of 2030 ambition level
Greenhouse gas (GHG) emissions in ESR sectors (compared with 2005)	N/A	-22.7%*	No projections provided in the plan, but Greece would overachieve based on its nationally net -46% target for ESR sectors
GHG emissions in LULUCF (Mt CO_2 eq. net GHG removals)	-4.8	-1.154 (additional removals target) -4.373 (total net removals)**	Greece is projecting to meet the target
Energy Efficiency (final energy consumption)	15.4 Mtoe	14.6 Mtoe***	Greece's final energy consumption is above the indicated target resulting from EU legislation
Renewable Energy (share of renewable energy in gross final consumption)	44%	39%****	Greece's submitted contribution to the EU target is significantly above the one resulting from EU legislation

[4]https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en

ECAC/EU COMMON SECTION

BASELINE SCENARIO AND ESTIMATED BENEFITS OF IMPLEMENTED MEASURES

4. ECAC/EU COMMON SECTION

Executive summary

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

Aviation is a fundamental sector of the European economy, and a very important means of connectivity, business development and leisure for European citizens and visitors. For over a century, Europe has led the development of new technologies, and innovations to better meet society's needs and concerns, including addressing the 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 changed European aviation's growth and patterns and heavily impacted the aviation industry. The European air transport recovery can nevertheless be an opportunity to accelerate its contribution to the achievement of the global climate ambitions.

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

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

4.1 Aircraft related technology

European members have worked together to best support the progress in the ICAO Committee on Aviation Environmental Protection (CAEP). This contribution of resources, analytical capability and leadership has undoubtedly facilitated leaps in global certification standards that have helped drive the market's demand for technology improvements. Europe is now fully committed to the implementation of the 2016 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 Technology Initiative (JTI) that aims to develop and mature breakthrough "clean technologies". The second joint undertaking (Clean Sky 2 – 2014-2024) had the objective to reduce aircraft emissions and noise by 20 to 30% with respect to the latest technologies entering into service in 2014. The European Partnership for Clean Aviation (EPCA) will follow in the footsteps of Clean Sky2.

This activity recognizes and exploits the interaction between environmental, social and competitiveness aspects with sustainable economic growth. Funding and its motivation are critical to research and the public private partnership model of the EU Research and Innovation programme underpins much that will contribute to this and future CO_2 action plans across the ECAC region.

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.

4.2 Sustainable Aviation Fuels (SAF)

ECAC States are embracing the introduction of 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. It has been proven fit for purpose and the distribution system has demonstrated its capacity to handle SAF. At European Union level, the Refuel EU Aviation Regulation, which applies since 1 January 2024 will boost the supply and demand for SAF in the EU, while maintaining a level playing field in the air transport market. Refuel EU Aviation aims to put air transport on the trajectory of the EU's climate targets for 2030 and 2050, as SAF are one of the key short- and medium-term tools for decarbonizing aviation.

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 several 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 also 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.

4.3 Improved Air Traffic Management

The Single European Sky (SES) policy of the European Union is designed to overhaul Air Traffic Management (ATM) across Europe. This initiative is geared towards digitizing services, enhancing capacity, cutting ATM costs, and boosting safety, alongside reducing the environmental impact by 9.3% by 2040. The SES framework includes multiple elements, such as the development and implementation of cutting-edge technical and operational ATM solutions.

The SESAR programme, divided into three phases—SESAR 1 (2008-2016), SESAR 2020 (starting in 2016), and the ongoing SESAR 3 (2021-2031)—is central to advancing these solutions. By the end of the SESAR 3 Wave 2, the solutions developed and validated are expected to yield fuel savings per flight within the ECAC area between 3.6% (180.9 kg, at V3 maturity level only) to 4.6% (227.8 kg, with full and partial V3 maturity benefits considered), translating directly into comparable CO_2 reductions.

4.4 Market Based Measures (MBM)

Recognizing the need for a global, market-based measure for aviation emissions (to incentivize and reward good investment and operational choices), ECAC Member States have been strong supporters of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Pursuant to their 2016 Bratislava Declaration, ECAC member States have voluntarily participated in the scheme since its pilot phase in 2021 and have encouraged other States to follow suit.

To implement CORSIA while preserving the environmental integrity of EU law, the EU ETS Directive was amended in 2023. It extended the restriction of the EU ETS geographical scope to flights between States of the European Economic Area (EEA)[5] and departing flights to the United Kingdom and Switzerland until the end of 2026. EEA States apply the EU Emissions Trading System (EU ETS), while both Switzerland and the United Kingdom implement their own emissions trading systems.

Overall, 500 aircraft operators are regulated under these cap-and-trade market-based measures aimed at limiting CO_2 emissions. In the period 2013 to 2020, the EU ETS has saved an estimated 200 million tonnes of intra-European aviation CO_2 emissions.

4.5 ECAC Scenarios for Traffic and CO2 Emissions

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

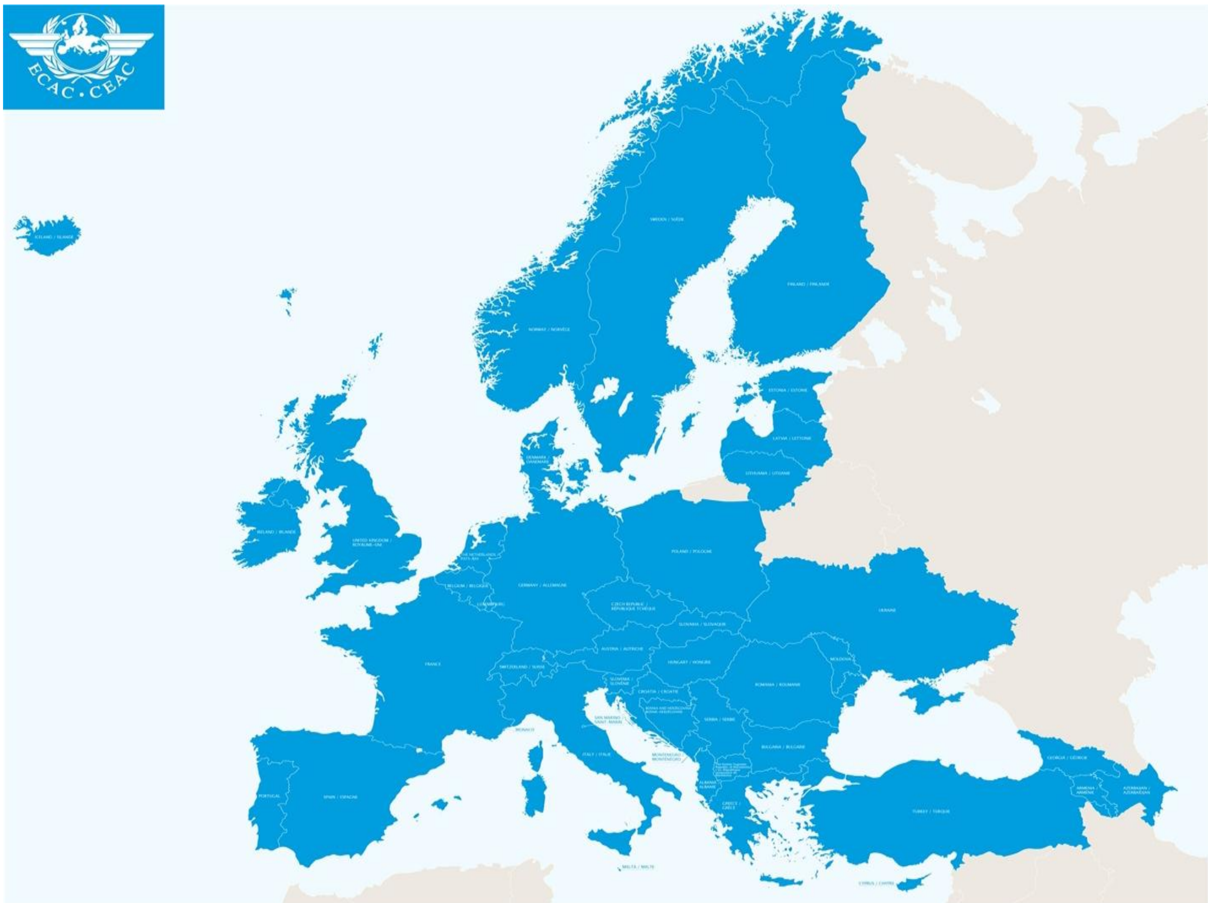
Under the baseline assumptions of traffic growth and fleet rollover with 2023 technology, CO_2 emissions would significantly grow in the long-term for flights departing ECAC airports without mitigation measures. Modelling the impact of improved aircraft technology for the scenario with implemented measures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

The potential of market-based measures and their effects have been simulated in detail in the common section of this action plan, but they will help reach the goal of carbon-neutral growth. As further developments in policy and technology are made, further analysis will improve the modelling of future emissions

[5] Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

ECAC BASELINE SCENARIO AND ESTIMATED BENEFITS OF IMPLEMENTED MEASURES

5. ECAC Baseline Scenario



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

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

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

5.1 Traffic Scenario 'Base'

As in all forecasts produced by EUROCONTROL, various scenarios are built with a specific storyline and a mix of characteristics. The aim is to improve the understanding of factors that will influence future traffic growth and the risks that lie ahead. The latest EUROCONTROL Aviation Long-Term Outlook to 2050[6] has been published in 2024 and inspects traffic development in terms of Instrument Flight Rule (IFR) movements to 2050.

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

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

- **Global economy** factors represent the key economic developments driving the demand for air transport.

- Factors characterizing the **passengers** and their travel preferences change patterns in travel demand and travel destinations.

- **Price of tickets** set by the airlines to cover their operating costs influences passengers' travel decisions and their choice of transport.

- More hub-and-spoke or point-to-point **networks** may alter the number of connections and flights needed to travel from origin to destination.

- **Market structure** considers a detailed analysis of the fleet forecast and innovative projects, hence the future size of aircraft used to satisfy the passenger demand (modelled via the Aircraft Assignment Tool).

Table 9 below presents a summary of the social, economic and air traffic related characteristics of three different scenarios developed by EUROCONTROL. The year 2023 served as the baseline year of the 30-year forecast results[7] (published in 2024 by EUROCONTROL). Historical data for the year 2010 and 2019 are also shown later for reference.

[6] EUROCONTROL Long-Term Aviation Outlook to 2050, EUROCONTROL, December 2024. (link to the report https://www.eurocontrol.int/publication/eurocontrol-forecast-2024-2050)
[7] EUROCONTROL Long-Term Aviation Outlook to 2050, EUROCONTROL, December 2024. (link to the report https://www.eurocontrol.int/publication/eurocontrol-forecast-2024-2050)

Table 9. Summary characteristics of EUROCONTROL scenarios

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

5.2 Update of the EUROCONTROL Aviation Long-Term Outlook to 2050

In November 2023, EUROCONTROL started to work on an update of its EUROCONTROL Aviation Long-Term Outlook to 2050 (EAO). It is an update of the previously published EAO[8] (April 2022), covering the long-term flights and CO_2 emissions forecast to 2050, which was based on 2019 historical flight data. The 2024 edition of the EAO forecast is now based on the latest available actual flight data (2023) and uses the EUROCONTROL seven-year forecast (2024-2030). It includes a complete review of the fleet forecast assumptions as well as a review of other inputs: high-speed rail network development, impact of Sustainable Aviation Fuels (SAF) mandate, jet fuel and CO_2 allowances on ticket prices, as well as future airport capacity constraints.

EUROCONTROL also provides an update of its modelling framework and traffic environmental assessment with the IMPACT model including:

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

Figure 9 below shows the ECAC scenario of the passenger flight forecasted international departures for both historical (solid line) and future (dashed line) years.

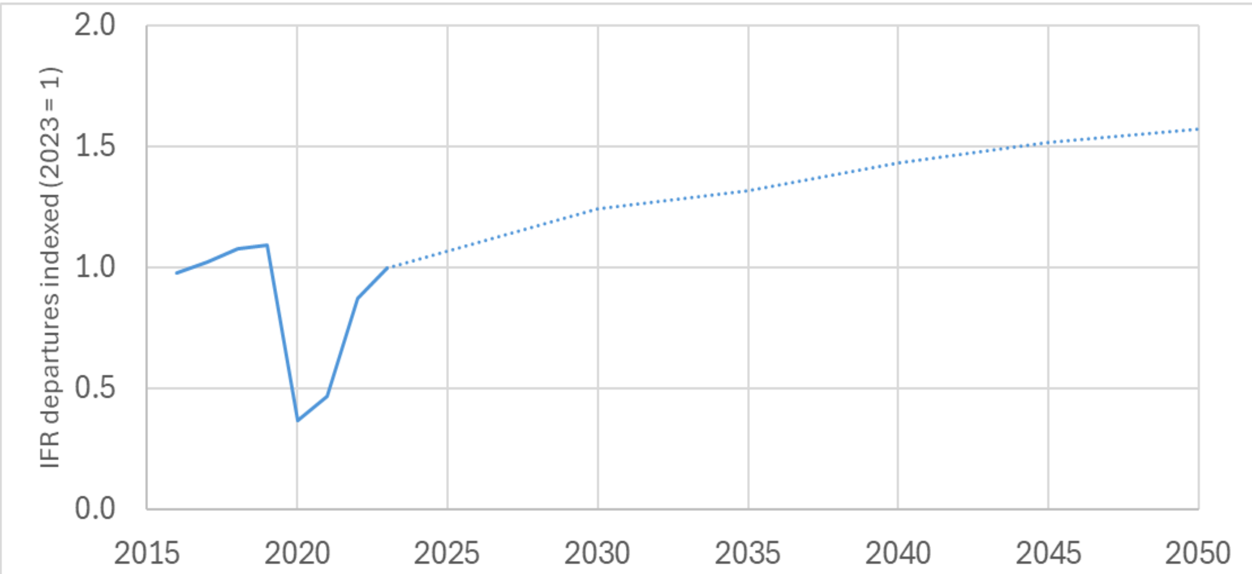


Figure 9: Updated EUROCONTROL 'Base' scenario of the passenger flight forecast for ECAC international departures from 2024 to 2050.

[8] EUROCONTROL Aviation Outlook to 2050, EUROCONTROL, April 2022.

5.3 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[9] from ECAC airports, as forecasted in the aforementioned traffic 'Base' scenario. The number of passengers per flight is derived from Eurostat data.

EUROCONTROL also generates a forecast for all-cargo flights in its baseline scenario. However, no information about the freight tonnes carried is available. Hence, historical and forecasted cargo traffic have been extracted from another source (ICAO[10]). 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[11] data warehouse used by EUROCONTROL, including the actual flight distance and the cruise altitude by airport pair. These calculations were made with a subset of total passenger traffic (with available and usable information in the flight plans) covering 98% in 2010, and 99% in 2019 and 2030. Determination of the fuel burn and CO_2 emissions for historical years is built up as the aggregation of fuel burn and emissions for each aircraft of the associated traffic sample characteristics. Fuel burn and CO_2 emission results consider each aircraft's fuel burn in its ground and airborne phases of flight and are obtained by use of the EUROCONTROL IMPACT environmental model, with the aircraft technology level of each year.

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

For each reported year, the 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 available passenger estimation datasets (Scheduled, Low-cost, Non-Scheduled flights, available passenger information, etc.) these results are determined for 96% of the historical passenger traffic in 2010, 97% in 2019, 99% in 2023, and around 99% of the passenger flight forecasts.

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

The fuel efficiency represents the amount of fuel burn divided by the RPK for each available airport pair with passenger data, for the passenger traffic only. Therefore, the fuel efficiency can only be calculated for city pairs for which the fuel burn and the RPK values exists[12].

---

[9] 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 in overseas are attached the State having the sovereignty of the territory. For example, France domestic include flights to Guadeloupe, Martinique, etc.

[10] ICAO Long-Term Traffic Forecasts, Cargo, Europe, International (excluding Russian Federation, Belarus and Greenland), 2021.

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

[12] Dividing the Fuel by the RPK results of the tables presented in this document is not suitable to estimate the fuel efficiency (traffic coverage differences). The presented result has been calculated on an airport pair basis.

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 10. Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movement) (million)	Revenue Passenger Kilometres[13] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[14] FTKT (billion)	Total Revenue Tonne Kilometres[15] RTK (billion)
2010	4.71	1,140	0.198	41.6	155.6
2019	5.88	1,874	0.223	46.9	234.3
2023	5.38	1,793	0.234	49.2	228.5
2030	6.69	2,176	0.262	55.9	273.5
2040	7.69	2,588	0.306	69.0	327.8
2050	8.46	2,928	0.367	86.7	379.5

Table 11. Fuel burn and CO_2 emissions forecast for the baseline scenario

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

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

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

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

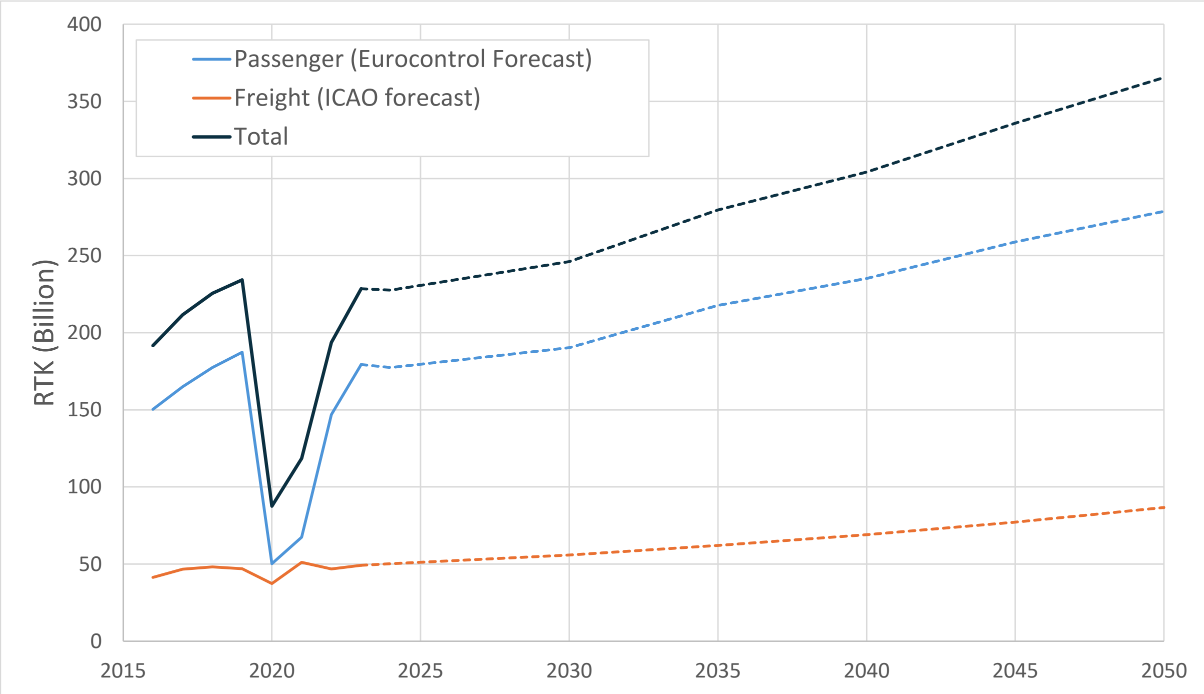


Figure 10: Forecasted traffic until 2050 (assumed both for the baseline and implemented measures scenarios)

Although data are not shown in **Table 10**, the number of flights between 2019 and 2023 in **Figure 10** reflecting the impact of the COVID-19 starting in 2020. If the passenger segment has been drastically affected by the outbreak, the freight segment seemed more immune.

As detailed by the **Table 11**, from 2010 to 2019, the CO_2 emissions increased from 120 to 168 million tonnes, corresponding to an annual growth rate of 3.8%. In 2023, due to the impact of the COVID-19 crisis on the traffic, the CO_2 emissions were lower than the 2019 level, with 153 million tonnes. For the forecast years, the estimated CO_2 emissions of the ECAC Baseline scenario would increase from 172 million tonnes in 2030 to 220 million tonnes in 2050 (corresponding to annual growth rate of 1.25%).

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

2. ECAC Scenario with Implemented Measures: Estimated Benefits

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

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

Effects of **improved aircraft technology** are captured by simulating fleet roll-over and considering the fuel efficiency improvements of the expected future aircraft types with conventional engines (e.g. Boeing 777X, reengineered Airbus A321Neo, etc..) and powered by hybrid electric and hydrogen engines. The simulated future fleet of aircraft has been generated using the Aircraft Assignment Tool[16] (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.

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

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

The yet un-estimated benefits of Exploratory Research projects[17] are expected to increase the overall future fuel savings.

While the effects of **introduction of SAF** were modelled in previous updates on the basis of the European ACARE goals[18], the expected SAF supply objectives for 2020 were not met. In the current update, the SAF benefits are modelled as a European regional common measure applied to the EU27+EFTA international traffic. It assumes that the minimum shares of SAF laid down in ReFuelEU Aviation Regulation would be met in the base scenario. According to the Regulation, the percentage of SAF used in air transport gradually ramps from 2% in 2025, up to 20% in 2035 and 70% in 2050. A decarbonation factor value of 70% of CO_2 emissions is expected for synthetic aviation fuels and 65% for aviation biofuels. As the SAF-related calculations can only be applied for countries that are expected to implement regional regulations (e.g. ReFuelEU Aviation), the tank-to-wake Net CO_2 emissions are reported in the Appendix A of this document for EU27+EFTA international traffic only.

However, numerous initiatives related to SAF (e.g. ReFuelEU Aviation) are largely described 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 explicitly in the top-down assessment of the implemented measures scenario presented here. CORSIA aims for carbon-neutral growth (CNG) of aviation, and this target is therefore shown in Figure 9[19.] The EU ETS quantifications are described in more details in Section B Chapter 4.

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

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

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

[19] Note that in a strict sense the CORSIA target of CNG is aimed to be achieved globally (and hence not necessarily in each world region).

Tables 10-14, Figure 11 and Figure 12 summarize the results for the scenario with implemented measures. It should be noted that Table 12 and Table 14 show direct combustion emissions of CO_2 (assuming 3.16 kg CO_2 per kg fuel). More detailed tabulated results are found in Appendix A, including results expressed in equivalent CO_2 emissions on a well-to-wake basis (for comparison purposes of SAF benefits).

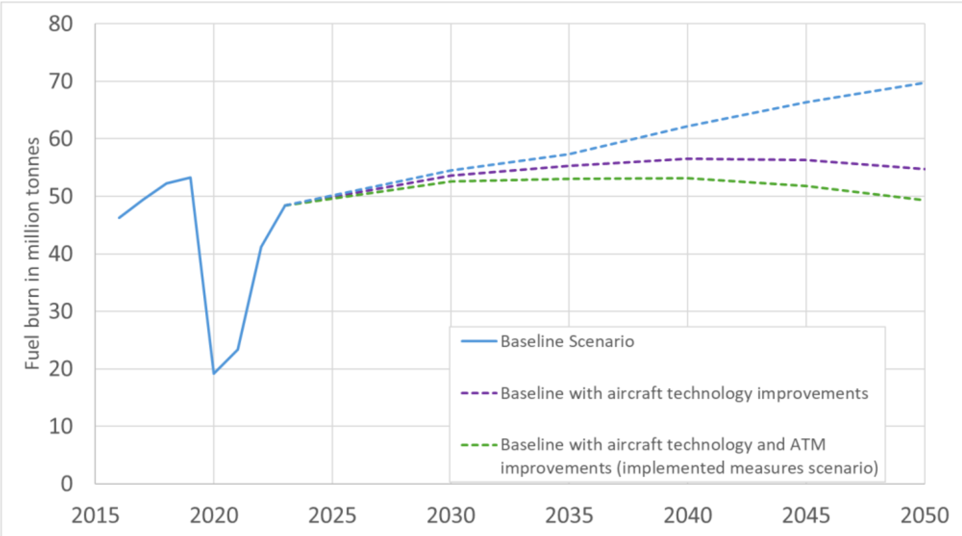


Figure 11. Fuel consumption forecast for the baseline and implemented measures scenarios (international passenger flights departing from ECAC airports).

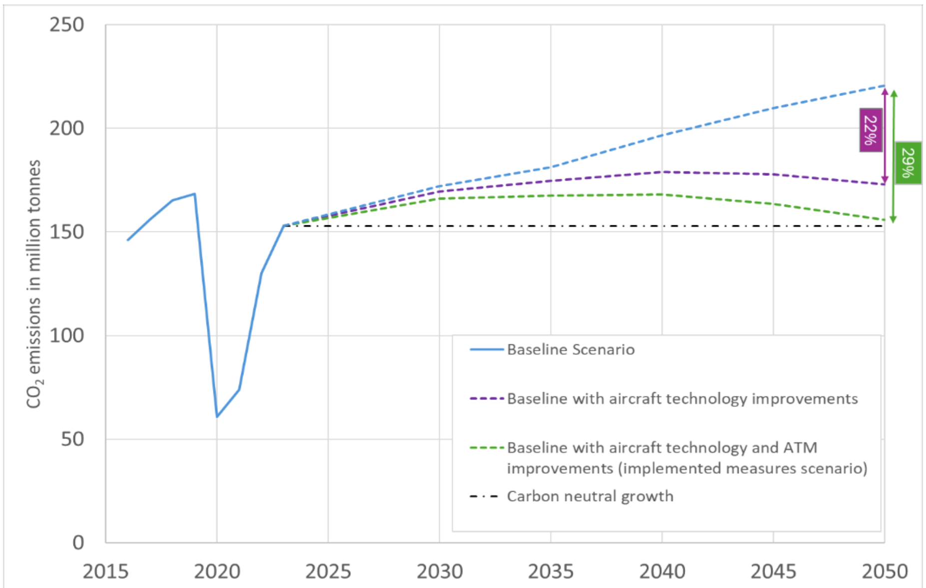


Figure 12. CO_2 emissions forecast for the baseline and implemented measures scenarios

As shown in Figure 9 and Figure 10, the impact of improved aircraft technology indicates an overall 22% reduction of fuel consumption and CO_2 emissions in 2050 compared to the baseline scenario. Overall CO_2 emissions, including the effects of new aircraft types (conventional, hybrid electric and Hydrogen) and ATM-related measures, are projected to lead to a 29% reduction in 2050 compared to the baseline.

Table 12. Fuel burn and CO_2 emissions forecast for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)

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

As detailed in Table 11, under the currently assumed aircraft and ATM improvement scenarios, the fuel efficiency is projected to lead to a 37% reduction from 2023 to 2050. The annual rate of fuel efficiency improvement is expected to be at 1.5% between 2023 and 2030 and reach 2% between 2040 and 2050. However, aircraft technology and ATM improvements alone will not be sufficient to meet the post-2020 carbon neutral growth objective of ICAO, nor will the use of alternative fuels, even if Europe's ambitious targets for alternative fuels (SAF) are met. This confirms that additional action, particularly market-based measures, are required to fill the gap.

Table 13. Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)

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

The Table 12 below summarizes the cumulated effects of each implemented measure. It identifies the weight of the technical improvement on the reduction of CO_2 emissions (from 2% in 2030 to 22% in 2050 compared to the Baseline scenario). The overall impact of the implemented measures (aircraft technology improvements and ATM) shows a reduction of CO_2 emissions by 29% in 2050 compared to the Baseline scenario.

Table 14. Summary of CO_2 emissions forecast for the scenarios described in this chapter

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

The section **Appendix A** of this document provides the detailed results for each scenario, Baseline, and by implemented measure, as well as the CO_2 equivalent and EU27+EFTA Net CO_2 emissions.

6. ACTIONS TAKEN COLLECTIVELY IN EUROPE

6.1 TECHNOLOGY AND DESIGN

- There have been a limited number of new certified large transport aircraft and engine types over the last few years with marginal environmental improvements, while deliveries of the latest generation of aircraft continue to penetrate the European fleet.
- Certification of all in-production aircraft types against the ICAO CO_2 standard is required by 1 January 2028, which is leading to an increase in activities within this area.
- Environmental technology standards will be important in influencing new aircraft-engine designs and contributing to future sustainability goals.
- In February 2025 the ICAO CAEP is aiming to agree on new aircraft noise and CO_2 limits that would become applicable in the next five years.
- ICAO independent experts medium-term (2027) and long-term (2037) technology goals were agreed in 2019 and are becoming outdated.
- Emissions data measured during the engine certification process acts as an important source of information to support modelling of operational emissions in cruise.
- There have been further developments within the low carbon emissions aircraft market (e.g. electric, hydrogen), with support from the Alliance for Zero-Emissions Aircraft to address barriers to entry into service and facilitate a potential reduction in short / medium-haul CO_2 emissions of 12% by 2050.
- EASA has published noise measurement Guidelines and Environmental Protection Technical Specifications in order to respond to the emerging markets of Drones and Urban Air Mobility.
- EASA has launched a General Aviation Flightpath 2030+ program to accelerate the transition of propulsion technology, infrastructure and fuels to support sustainable operations.
- Horizon Europe, with a budget of €95 billion, is funding collaborative and fundamental aviation research, as well as partnerships (e.g. Clean Aviation, Clean Hydrogen) who are developing and demonstrating new technologies to support the European Green Deal.

The European Union Aviation Safety Agency (EASA) develops and implements aircraft environmental certification standards that manufacturers have to comply with in order to register their products within the EU and EFTA States.

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

Aircraft environmental standards

Aircraft CO2 emissions

Since 1 January 2020, new aircraft types have to comply with a new type of CO_2 standard[20], although no aircraft has been certified against this standard as of the start of 2025. The focus thus far has been on certifying in-production aircraft types against a less stringent in-production CO_2 standard as all aircraft have to be certified against this new requirement if they wish to continue to be produced beyond 1 January 2028.

As of the end of 2024, Airbus continues to be the only manufacturer to have certified in-production aircraft types, such as the A330-800neo and -900neo variants (Figure 13), and so the availability of certified CO_2 data remains limited[21]. In light of the approaching production cut-off deadline in 2028, certification of other aircraft types is ongoing by EASA and other regions of the world have also implemented the CO_2 standard into their legislation with it becoming effective in the US on 16 April 2024. The 2019 ICAO Independent Experts Panel goals for leading edge CO_2 emissions performance in 2027 and 2037 would need to be reviewed soon for them to remain relevant.

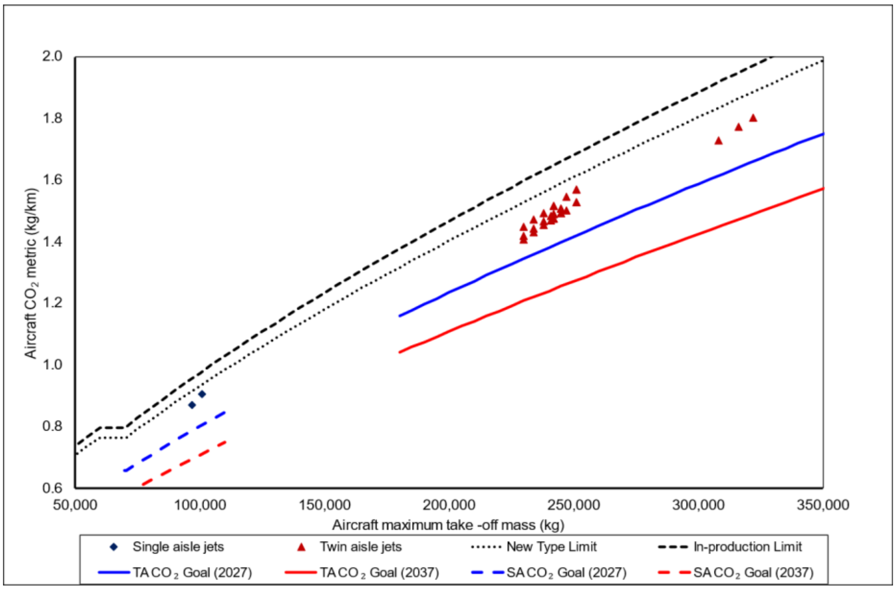


Figure 13: Certified aircraft CO_2 emissions performance

[20] ICAO Annex 16, Volume III to the Chicago Convention contains international aircraft CO_2 standards. The CO_2 metric is a specific air range-based metric (kg fuel per km flown in cruise) adjusted to take into account fuselage size.
[21] EASA (2025), EASA Aeroplane CO_2 Emissions Database.

ICAO dual Noise / CO_2 standard setting

A revision of the ICAO Annex 16 standards for aircraft noise and CO_2 emissions is currently being considered by the ICAO Committee on Aviation Environmental Protection (CAEP). This is the first time that CAEP standard setting has reviewed two standards at the same time in the form of an integrated dual stringency process taking into account design trade-offs at the aircraft level. The environmental benefits and associated costs of a broad range of options for more stringent new type standards have been assessed for an applicability date in the next 5 years. A recommendation by CAEP on new noise and CO_2 limits is due at the CAEP/13 meeting in February 2025.

Considering the long-term development and in-service timescales of new aircraft types, it will be important to set an updated new type CO_2 standard that will influence the fuel efficiency of future designs and effectively contribute to the ICAO Long-Term Aspirational Goal of net zero carbon emissions from international aviation by 2050[22].

Low carbon emissions aircraft

In recent years, EASA has received an increasing number of enquiries with regard to the certification of novel aircraft configurations and sources of propulsion with zero carbon emissions in operation when produced with renewable energy.

Electric propulsion

Regarding Vertical take-off and landing Capable Aircraft (VCA – otherwise known as Urban Air Mobility or Advanced Air Mobility vehicles), EASA has recently published two Environmental Protection Technical Specifications (EPTS), which both underwent public consultation. The first EPTS, published in 2023, addresses VCA with non-tilting rotors[23], covering designs such as the Volocopter VoloCity or Airbus CityAirbus. The second EPTS, published in 2024, was for VCA powered, at least partially, by tilting rotors[24], covering designs such as the Lilium Jet. These two EPTS cover the majority of VCA designs currently envisioned and will be utilized in the corresponding noise certification programs. They were derived from legacy noise standards for large helicopters and tilt rotors, adapted to the VCA characteristics and expanded on to include hover condition measurement points. The same noise limits as for large helicopters are being used until more data can be collected. Ultimately, an EU Delegated Act will aim at incorporating the content of these EPTS into EASA noise regulations.

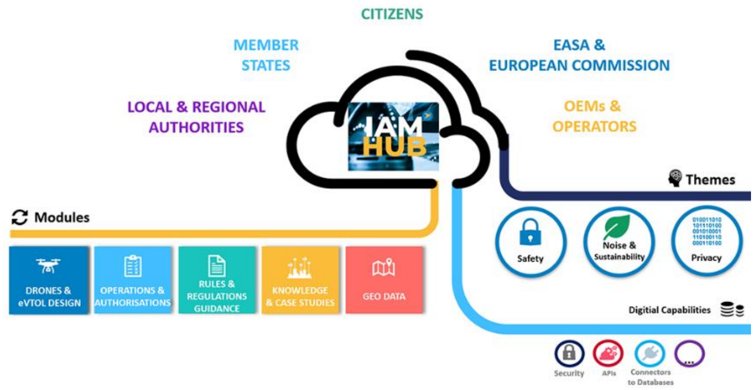
[22] ICAO (2025), ICAO Long Term Global Aspirational Goal (LTAG) for International Aviation.
[23] EASA (2023), Environmental Protection Technical Specifications applicable to VTOL-capable aircraft powered by non-tilting rotors.
[24] EASA (2024), Environmental Protection Technical Specifications applicable to VTOL-capable aircraft powered by tilting rotors.

While applications to EASA for electric powered aircraft have increased, there have been few completed general aviation programs since the noise certification of the Pipistrel Velis Electro in 2020, aside from the LAK-17 self-launching sailplane in 2023, due to continuing challenges in increasing battery energy density to reduce weight and increase range. For both products, the legacy noise standards of ICAO Annex 16, Chapter 10 were used with small adjustments. This technology can lead to a 10-decibel noise reduction compared to equivalent piston-engine aircraft, which is perceived as 50% quieter.

EASA Innovative Air Mobility Hub

The EASA Innovative Air Mobility (IAM) Hub[25] is a unique digital platform, developed by a dedicated Task Force that brings together all actors in the European system including cities, regions, National authorities, the EU, operators and manufacturers. The primary goal is to facilitate the safe, secure, efficient, and sustainable implementation of IAM (e.g. Drones, UAMs) practices.

The platform currently comprises of five modules, including Drone and eVTOL Design, Rules and Regulations, Knowledge and Info Cards, Operational Information and Geographical Data such as population data. Various strategies have been deployed to mitigate the environmental impacts from UAS and VCA (e.g. regulations, no-fly zones, geofencing, altitude restrictions, remote identification) with a goal to balance the benefits of these new technologies with the need to protect EU citizens. A methodology to underpin a full life-cycle environmental assessment of IAM aircraft, known as Environmental Footprint Aviation, is also being developed [26].



Hydrogen-powered Aircraft

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

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

[25] EASA (2025), Environmental Footprint Aviation Study for Drones & eVTOLs.
[26] AZEA (2025), Alliance for Zero Emission Aircraft

hydrogen-electric flight, using a retrofit model G1 SPYL-XL to demonstrate their technology.

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

Alliance for Zero Emission Aviation

The Alliance for Zero Emission Aviation (AZEA) was launched in June 2022 and aims to prepare the aviation ecosystem for the entry into service of hydrogen and electric aircraft. It contains 181 Members representing industry, standardization and certification agencies, research bodies, environmental interest groups and regulators. AZEA members jointly work to identify barriers to entry into commercial service of these aircraft, establish recommendations and a roadmap to address them, promote investment projects and create synergies and momentum amongst members.

In June 2023, AZEA published an overview of the current aviation regulatory landscape for hydrogen and electric aircraft[27], which describes the activities that EASA is doing to adapt the aviation regulatory framework to facilitate the entry into the market of aircraft that use electric or hydrogen propulsion. To support the introduction of disruptive technologies, innovative concepts (including ground and air operations) or products, whose feasibility may need to be confirmed, and for which an adequate regulatory framework does not yet exist or is not mature, EASA is engaging with future applicants through various Innovation Services[28].

With performance-based regulations there is a higher need for supporting industry standards for regulatory compliance and interoperability. As such, AZEA has also published a document mapping existing standards and committees working in this area, including EUROCAE, SAE and ASTM [29]. Further work to identify where new standards are needed is on-going and will serve as a resource for Standards Development Organizations and industry stakeholders to identify opportunities for collaboration and harmonization of activities. In January 2024, AZEA published its Concept of Operation (CONOPS) for the introduction of electric, hybrid-electric and hydrogen powered aircraft[30]. This addresses the challenges and opportunities arising from the integration of these new market segments into the European aviation system, covering all components of the European Air Traffic Management network, in particular airports. The CONCOPS is expected to be reassessed once robust aircraft performance data becomes available.

The AZEA vision "Flying on Electricity and Hydrogen in Europe" published in June 2024[31] has developed a baseline scenario that, while recognizing that long-haul flights relying on these power sources cannot be anticipated before 2050, predicts approximately 5000 electric and hydrogen aircraft (excluding urban air mobility vehicles and helicopters) will be delivered to European operators between now and 2050, leading to a reduction in short and medium-haul CO_2 emissions of 12%. While there are considerable challenges requiring the collaboration of all stakeholders, beyond these hurdles is an opportunity to reshape the aviation sector and to pioneer a sustainable future.

[27] AZEA (2023), Current aviation regulatory landscape for aircraft powered by hydrogen or electric propulsion.
[28] EASA (2025), Innovation Services.
[29] AZEA (2023), Current Standardisation Landscape.
[30] AZEA (2024), Concept of Operation for the Introduction of Electric, Hybrid-electric and Hydrogen powered Zero Emission Aircraft.
[31] AZEA (2024), Flying on electricity and hydrogen in Europe.

	2020	2025	2030	2035	2040	2045	2050
Commuter » 9-19 seats » < 60 minute flights » <1% of industry CO_2	SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF
Regional » 50-100 seats » 30-90 minute flights » ~3% of industry CO_2	SAF	SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF
Short haul » 100-150 seats » 45-120 minute flights » ~24% of industry CO_2	SAF	SAF	SAF	SAF potentially some Hydrogen	Hydrogen and/or SAF	Hydrogen and/or SAF	Hydrogen and/or SAF
Medium haul » 100-250 seats » 60-150 minute flights » ~43% of industry CO_2	SAF	SAF	SAF	SAF	SAF potentially some Hydrogen	SAF potentially some Hydrogen	SAF potentially some Hydrogen
Long haul » 250+ seats » 150 minute + flights » ~30% of industry CO_2	SAF	SAF	SAF	SAF	SAF	SAF	SAF

Figure 14: ATAG indicative overview of where low- and zero-carbon energy could be deployed in commercial aviation alongside that of SAF[32]

Supersonic aircraft

Following the retirement of Concorde in 2003, several manufacturers have been looking into developing supersonic business jets, with some currently looking at an entry into service date of around 2030. Key environmental challenges to address include the use of significantly more fuel on a per passenger kilometer basis compared to subsonic commercial aircraft[33], and noise, specifically the impact of the sonic boom generated when flying at supersonic speed.

General Aviation Sustainability Roadmap

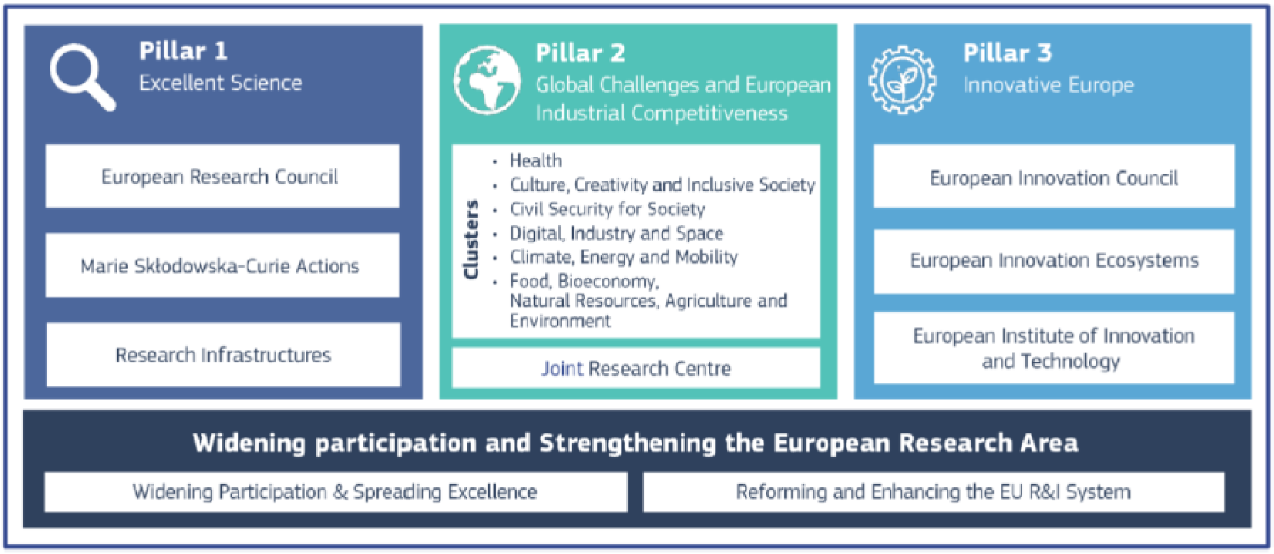
EASA is dedicated to making General Aviation (GA) more sustainable. Building on the success of the past GA Roadmap, the Agency has launched the new GA Flightpath 2030+ program in 2024[34]. GA is seen as a cradle for development, testing, and industrialization of innovations that, when tested and implemented operationally, can drive improvements across the entire aviation sector in safety and sustainability.

The 'Greener Faster' initiative is designed to achieve sector-wide agreement on what sustainable GA means and how everyone can work together to accelerate the transition of GA propulsion technology, infrastructure and fuels to support sustainable operations and the objective of carbon-free aviation by 2050. This will be complemented by the 'Fly Direct' initiative that aims to optimize GA operations in the airspace by removing unnecessary operational restrictions, allowing aircraft to safely navigate the most efficient and environmentally friendly routes.

[32] ATAG (2021), Waypoint 2050 Second Edition.
[33] ICCT (2022), Environmental limits on supersonic aircraft in 2035.
[34] EASA (2025), General Aviation Flightpath 2030+

Research and Innovation Programmes

Aviation environmental research is embedded in European, National and industry research programmes. At EU level, most research is currently funded through 'Horizon Europe' (2021-2027) with an initial budget of €95.5 billion[35]. Aviation specific research contributes primarily to the European Green Deal and the EU's digital and competitiveness strategies across all three Horizon Europe pillars.



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

The collaborative and fundamental Pillar II Cluster 5 aviation environmental research develops and derisks technologies up to a Technology Readiness Level (TRL) 4, to be taken further by Horizon Europe partnerships, national or industry programmes. The current research is focused on:

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

[35] EU (2025), Horizon Europe

One such Horizon Europe project is HESTIA[36] that focuses on increasing the scientific knowledge of the hydrogen-air combustion of future hydrogen-fueled aero-engines. Another example is BeCoM[37] which addresses the uncertainties related to the forecasting of persistent contrails and their weather-dependent individual radiative effects, in order to develop recommendations on how to implement strategies that enable air traffic management to reduce aviation's climate impact. Further information on the extensive projects funded under Horizon Europe research programme can be found on the European Commission website[38].

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

The Clean Sky 2 projects (2014-2024) had a combined public and private budget of around €4 billion, with EU funding up to €1.75 billion[39]. Its objectives were to develop, demonstrate, and accelerate the integration of technologies capable of reducing CO_2, NO_X and Noise emissions by 20 to 30% compared to 'state-of-the-art' aircraft in 2014.

The benefits and potential impact from Clean Sky 2 research at the aircraft, airport and fleet level are evaluated through a dedicated Technology Evaluator function with key assessment and reporting duties. The final assessment by the Technology Evaluator was performed in 2024[40] and the results are summarized in Table 15.

Table 15: Final Clean Sky 2 Technology Evaluator Assessment Results

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

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

[36] EU (2025), HESTIA Horizon Europe project
[37] EU (2025), BeCoM Horizon Europe project.
[38] EU (2025), EU Research Projects
[39] Clean Sky 2 (2014), Council Regulation (EU) No 558/2014 of 6 May 2014 establishing the Clean Sky 2 Joint Undertaking
[40] Clean Sky 2 (2024), Technology Evaluator

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

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

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

Clean Aviation (part of 'Horizon Europe' – 2021 to 2027)

Clean Aviation was established in November 2021 under EU Horizon Europe to support the EU ambition of climate neutrality by 2050[41]. The Clean Aviation programme aims to develop disruptive aircraft technologies that will deliver net greenhouse gas (GHG) reductions of no less than 30%, compared to 2020 state-of-the-art aircraft. The targets have been extended to CO_2 and non-CO_2 effects (nitrogen oxides, water vapour, particulates, contrails, etc.) and EASA is working with Clean Aviation to convey these benefits in the context of the ICAO Annex 16 environmental certification requirements. The technological and industrial readiness aims to allow deployment of these new aircraft no later than 2035, enabling 75% of the world's civil aviation fleet to be replaced by 2050.

CLEAN AVIATION

Clean Aviation will focus on three key areas of hybrid electric and full electric architectures, ultra-efficient aircraft architectures and disruptive technologies to enable hydrogen-powered aircraft. The targeted performance levels are summarised in Table 16[42].

[41] Clean Aviation (2021), Council Regulation (EU) 2021/2085 establishing the Joint Undertakings under Horizon Europe

[42] EASA (2024), Guidance for the implementation of the new Aircraft Classification Rating (ACR) – Pavement Classification Rating (PCR) method for the EASA Member States.

Table 16: Clean Aviation Targets

Aircraft Category	Key technologies and architectures to be validated at aircraft level in roadmaps	Entry Into Service Feasibility	CO_2 Emissions reduction (technology based)[28]	Net CO_2 Emissions reduction (i.e. including SAF effect)[29]	Current share of air transport system emissions
Regional Commercial Aircraft	> Hybrid-electric (SAF + Batteries) coupled with highly efficient aircraft configuration	~2035	-30%	-86%	~5%
	> Same with H2-electric power injection (Fuel Cells electric generation)	Beyond 2035	Up to -50%	Up to -90%	
Short-Medium Range Commercial Aircraft	Advanced ultra-efficient aircraft configuration and ultra-efficient gas turbine engines	~2035	-30%	-86%	~50%
Hydrogen-Powered Commercial Aircraft	Full hydrogen-powered aircraft (H2 Fuel Cells or H2-combution)	~2035	-100%	N/A	N/A

28. Improvement targets are defined as CO2 reduction compared to 2020 state-of-the-art aircraft available for order/delivery.
29. Assumes full use of SAF at a state-of-the-art level of net 80% carbon footprint reduction (and where applicable, zero-carbon electric energy for batteries charging and green hydrogen production).

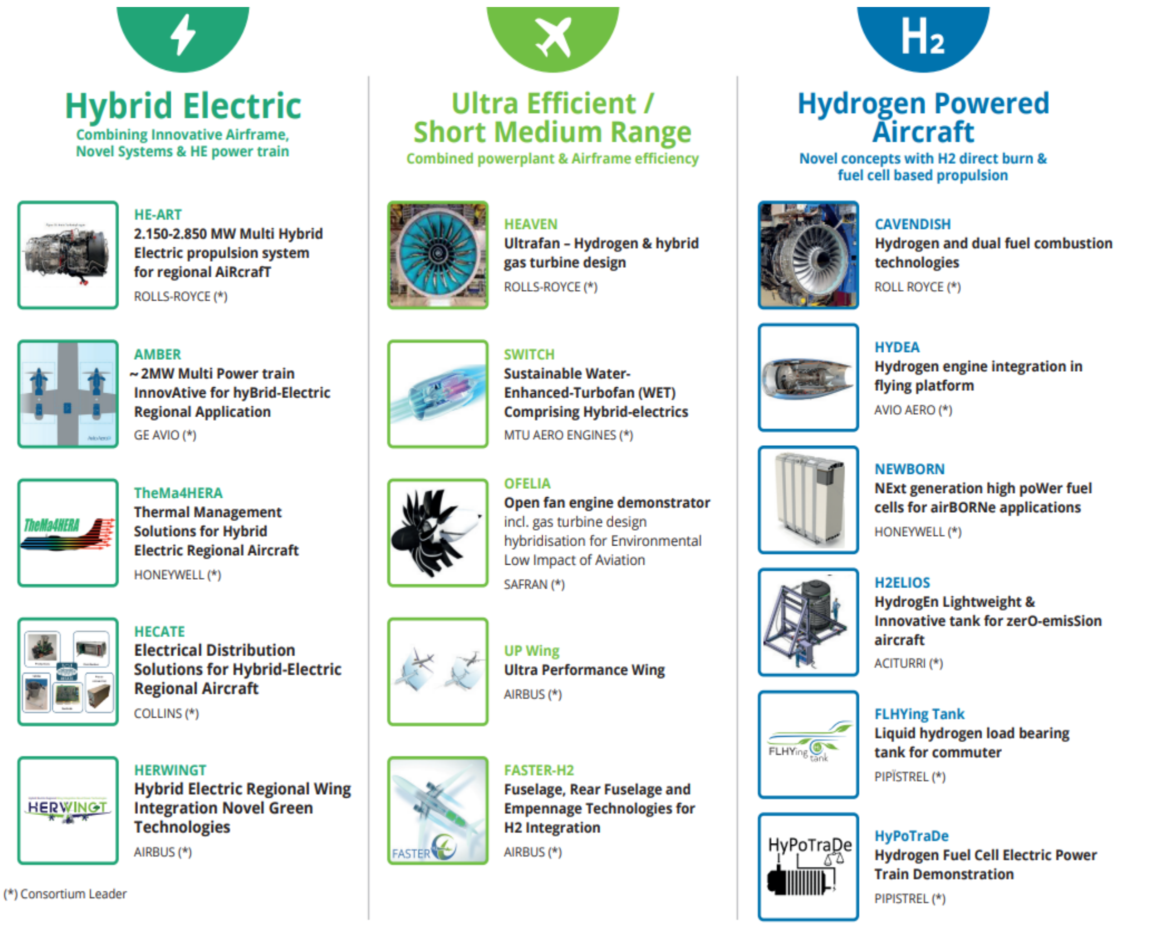


Figure 15: Initial projects launched in 2023 to deliver important technology bricks

STAKEHOLDER ACTIONS

AeroSpace and Defence Industries Association of Europe (ASD)

ASD includes 25 major European companies and 25 National Associations as our members, with an overall representation of up to 4,000 companies across 21 European countries. In 2022, ASD Members employed 921,000 people and generated a turnover of €261 billion.

UltraFan® Technology Demonstrator

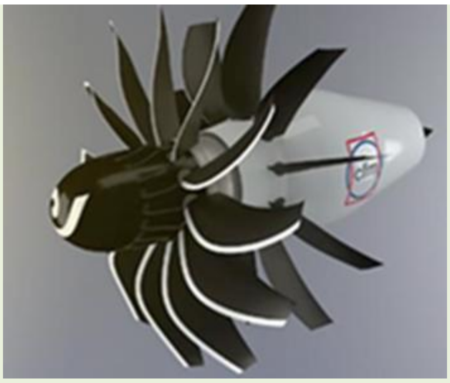
Rolls-Royce has successfully run its UltraFan® technology demonstrator to maximum power during 2023. The initial stage of the test was conducted using 100% Sustainable Aviation Fuel (SAF). UltraFan® delivers a 10% efficiency improvement over the Trent XWB engine and a 25% efficiency gain since the launch of the first Trent engine. Testing has been supported by various partners, including the EU Clean Sky programmes.

Hydrogen Fuel Cells

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

RISE Open Fan

SAFRAN is developing the CFM RISE Open Fan engine demonstrator combining lightweight equipment and advanced technologies such as hybrid electric systems. An open fan architecture has the potential to reduce fuel consumption and CO_2 emissions by more than 20% compared to today's most efficient engines. This advanced, new generation open fan architecture is expected to be able to fly at the same speed as current single-aisle aircraft (up to Mach 0.8) with a noise signature that will meet anticipated future regulations



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

6.2 SUSTAINABLE AVIATION FUELS

- ReFuelEU Aviation sets minimum supply mandate for Sustainable Aviation Fuels (SAF) in the EU, starting with 2% in 2025 and increasing to 70% in 2050.
- A sub-mandate for synthetic aviation fuels, starting at 0.7% in 2030 and increasing to 35% in 2050, underlines their significant potential for emissions reductions.
- All SAF supplied under the ReFuelEU Aviation mandate must comply with the sustainability and greenhouse gas emissions saving criteria as set out in the Renewable Energy Directive (RED) and the revised Gas Directive.
- The ICAO CAAF/3 conference agreed in 2023 on a global aspirational vision to reduce CO_2 emissions from international aviation by 5% in 2030 through the use of SAF, low-carbon aviation fuels and other aviation cleaner energies.
- As of 2024, SAF production represented only 0.53% of global jet fuel use. Significant expansion of production capacity is required to meet future mandates and goals.
- SAF must meet international standards to ensure the safety and performance of aviation fuel. Various types of SAF have been approved, with ongoing efforts to increase blending limits and support the use of 100% drop-in SAF by 2030.
- SAF has the potential to offer significant CO_2 and non-CO_2 emissions reductions on a lifecycle basis compared to conventional jet fuels, primarily achieved during the production process using sustainable feedstock. However, various factors such as land use changes can negatively impact the overall lifecycle emissions.
- The upscaling of SAF has generated concerns about potential fraudulent behavior whereby products labelled as meeting RED sustainability requirements are not compliant.
- Various measures have been put it place to support the achievement of European and ICAO goals on SAF, including a European Clearing House, financial incentives, research programmes and international cooperation.
- SAF production capacity currently under construction could supply the 3.2 Mt of SAF required under ReFuelEU Aviation in 2030, but would be required to ramp up quickly thereafter.
- SAF prices are currently 3 to 10 times more expensive than conventional fuel although they are expected to reduce substantially as production technologies scale up.

SAF Developments

The last few years have seen significant developments in the European sustainable aviation fuels landscape. With the adoption of the ReFuelEU Aviation Regulation [43], European legislators are ensuring a level playing field for sustainable air transport by establishing minimum mandates for fuel suppliers starting in 2025, including sub-mandates for e-fuels. Together with a growing number of initiatives and mandates outside of Europe, the market is now at a pivotal point and an ambitious increase of production capacity will be required to meet this mandate.

What are Sustainable Aviation Fuels?

A Sustainable Aviation Fuel (SAF) is a sustainable, non-conventional, alternative to fossil-based jet fuel. Several definitions and terminology apply, depending on regulatory context, feedstock basis, and production technology.

According to the ReFuelEU Aviation Regulation, SAF are defined as various types of drop-in aviation fuels (Table 17). For instance, aviation biofuels mean biofuels as defined in the Renewable Energy Directive (RED)[44] and excluding fuels produced from food and feed crops as well as other feedstock specified in Article 4 of the Regulation. Finally, for synthetic aviation fuels, a variety of terminologies are used, such as liquid Renewable Fuels of Non-Biological Origin (RFNBO) in ReFuelEU Aviation, but also Electrofuels, e-Fuels and Power-to-Liquid (PtL).

Both ReFuelEU Aviation and the EU Emission Trading System (ETS) use the RED as their basis and all eligible fuels need to comply with the sustainability and greenhouse gas (GHG) emissions reduction criteria set out in the RED.

Table 17: ReFuelEU Aviation fuel categories

Type of ReFuelEU Aviation fuel	Definition in RFEUA Article	Comments
Categories of sustainable aviation fuels (SAF)		
Synthetic aviation fuels	Art 3(12)	Renewable fuel of non-biological origin in Directive (EU) 2018/2001
Advanced aviation biofuels	Art 3(8)(a)	Produced from the feedstock listed in Part A Annex IX of Directive (EU) 2018/2001
Aviation biofuels	Art 3(8)(b)	Produced from feedstock listed in Part B Annex IX of Directive (EU) 2018/2001
Other aviation biofuels	Art 3(8)(c)	Produced from feedstock not listed in Annex IX of Directive (EU) 2018/2001 and except for those produced from food and feed crops
Recycled carbon aviation fuels	Art 3(9)	Produced from waste streams of non-renewable origin which are not suitable for material recovery

[43] European Commission (2023), Regulation (EU) 2023/2405 of the European Parliament and of the Council of 18 October 2023 on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation)
[44] EU (2018),Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (Text with EEA relevance.).

Categories of other eligible renewable and low-carbon aviation fuels under RFEUA		
Low-carbon hydrogen for aviation	Art 3(15)	Produced from non-fossil non-renewable sources
Renewable hydrogen for aviation	Art 3(16)	Renewable fuel of non-biological origin in Directive (EU) 2018/2001
Synthetic low-carbon aviation fuels	Art 3(13)	Produced from non-fossil non-renewable sources
Other aviation fuels under RFEUA		
Conventional aviation fuel	Art 3(14)	Aviation fuels produced from fossil non-renewable sources of hydrocarbon fuels (e.g. crude oil)

Standardization process for qualification of new SAF production pathways

The reliable performance of aviation fuel is essential to the safe operation of aircraft and is a matter of airworthiness requiring harmonized international practices. What is commonly referred to as "aviation turbine fuel", is a highly specified technical material, characterized by many chemical and physical properties defined by technical specifications, such as the ASTM D1655 and DEF STAN 91-09[45,46]. These specifications are developed and maintained by ASTM International and United Kingdom Ministry of Defense (UK MOD) respectively, with support from stakeholder groups such as Original Equipment Manufacturers (OEMs), fuel producers, fuel suppliers, airline operators and regulatory bodies. These fuel standards list the requirements for Jet A/Jet A-1, which is aviation turbine fuel for use within gas turbine engines.

Qualified production pathways are listed in ASTM D7566[47], which sets out the standard specification for "aviation turbine fuel containing synthesized hydrocarbons", meaning fuels that are of non-conventional origin. Each type of production pathway is defined in terms of feedstock, conversion technology, fuel specification properties, and maximum blending fraction. After fulfilling blending requirements in ASTM D7566 Table 1 the fuel is redeclared and treated as an ASTM D1655 Jet A/Jet A-1 fuel.

As of October 2024, eight SAF production processes have been standardized by ASTM and consequently been adopted by other fuel standards. In addition, three pathways for the co-processing of renewable feedstocks in petroleum refineries are qualified with a feedstock blending limit of up to 24%.

In order to be included in ASTM D7566, novel SAF production pathways need to go through a thorough qualification process specified in ASTM D4054[48]. This process includes the testing of fuel samples, ranging from small-scale laboratory tests with a limited amount of fuel to full rig- and engine-testing that requires thousands of liters. The resulting research reports are then reviewed and approved by the OEMs before being proposed as ballot for inclusion of a new Annex to ASTM D7566. This is both expensive and time-consuming for all involved stakeholders, which has led to the setup of several SAF Clearing Houses to support this process.

[45] ASTM (2021) D1655, 2021, Standard Specification for Aviation Turbine Fuels. DOI: 10.1520/D1655-21C.
[46] Ministry of Defence (2024), DefStan 91-091 Issue 17
[47] ASTM (2021), D7566, 2021, Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons. DOI: 10.1520/D7566-21
[48] ASTM (2021), ASTM D4054, 2021, Standard Practice for Evaluation of New Aviation Turbine Fuels and Fuel Additives. DOI: 10.1520/D4054-21A.

Table 18: Drop-in SAF qualified production pathways

Production pathway	Feedstocks[49]	Certification name	Maximum SAF share
Biomass Gasification + Fischer-Tropsch (Gas+FT)	Energy crops, lignocellulosic biomass, solid waste	FT-SPK[50]	50%
Hydroprocessed Esters and Fatty Acids (HEFA)	Vegetable and animal fat	HEFA-SPK	50%
Direct Sugars to Hydrocarbons (DSHC)	Conventional sugars, lignocellulosic sugars	HFS-SIP[51]	10%[52]
Biomass Gasification + FT with Aromatics	Energy crops, lignocellulosic biomass, solid waste	FT-SPK/A[53]	50%
Alcohol to Jet (AtJ)	Sugar, starch crops, lignocellulosic biomass	ATJ-SPK	50%
Catalytic Hydrothermolysis Jet (CHJ)	Vegetable and animal fat	CHJ or CH-SK[54]	50%
HEFA from algae	Microalgae oils	HC-HEFA-SPK[55]	10%
AtJ with Aromatics	Sugar, starch crops, lignocellulosic biomass	ATJ-SKA	50%
FOG Co-processing	Fats, oils, and greases	FOG	5%
FT Co-processing	Fischer-Tropsch (FT) biocrude	FT	5%
Hydroprocessed Lipids Co-processing	Hydroprocessed vegetable oils, animal fats, used cooking oils	Hydroprocessed Lipids Co-processing	10%

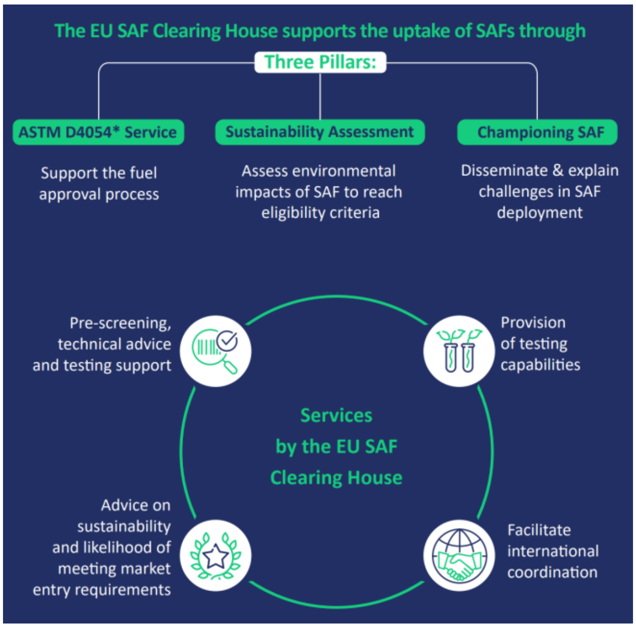
[49] The listed feedstocks are technologically feasible for the specific production pathway, but not necessarily applicable under certain regulations (e.g. ReFuelEU Aviation).
[50] FT-SPK: Fischer-Tropsch synthesised paraffinic kerosene.
[51] HFS-SIP: hydroprocessed fermented sugars to synthetic iso-paraffins.
[52] TRL 7-8 for conventional sugar feedstock; TRL 5 for lignocellulosic sugar feedstock.
[53] FT-SPK/A: Fischer-Tropsch synthesised paraffinic kerosene with Aromatics.
[54] CH-SK: catalytic hydrothermolysis synthesised kerosene.
[55] HC-HEFA-SPK: Synthesised paraffinic kerosene from hydrocarbon-hydroprocessed esters and fatty acids.

EU SAF Clearing House

The EU SAF Clearing House[56], which is funded by the EU and managed by EASA, is a 'one stop' knowledge center providing all the information, data and stakeholder connections needed by fuel producers seeking to advance through the ASTM qualification process described above and contribute to the production and supply of sustainable aviation fuels.

Each of the approved SAFs within the ASTM D7566 Annexes has its own characteristics and is tapping into certain categories of feedstock. To be able to produce enough SAF to meet the future needs of the aviation sector, more pathways that tap into new feedstock that have good sustainability characteristics and are economically viable, are required.

There is substantial work being done within fuel standard committees to increase the blending limits for both SAF and the co-processing of renewable feedstock in conventional refineries. For the latter, there are ambitions to increase the limit to 30% by 2025 as the existing infrastructure can be immediately deployed to increase the sustainable share in aviation fuels and support fulfilling the mandates without requiring major investments. The research work required to remove the blending limit and enable the use of 100% SAF is ongoing (see textbox).



Two Options for 100% SAF: Drop-in and Non-Drop-in

Approved SAF currently have associated maximum blending ratios (Table 2.2) that may limit the ability to use larger amounts of SAF in the future. As such, dedicated task groups within fuel standard committees are assessing two options to facilitate the use of 100% SAF in aircraft with an initial timeline of having fuel standards ready by latest 2030:

a. 100% Drop-In SAF: Jet Fuel Fully Comprised of Synthesized Hydrocarbon as a drop-in replacement which is identical to Jet A/Jet A-1

b. 100% Non-Drop-In SAF: Non-Drop-In Fully Synthetic Aviation Jet Fuel is aromatic free fuel, which is close to Jet A/Jet A-1 but would be a different fuel.

The 100% Drop-In SAF will be a modification to the existing ASTM D7566. One option to realize such a fuel is to blend two or more SAFs to produce a fuel with characteristics that are fit for purpose in terms of 100% use. Another option is the adaptation of currently used raw materials and production processes to produce a fully formulated 100% SAF in a single process stream (e.g. AtJ, FT- SPK/A and CHJ) or the use of new raw materials and processes yet to be developed and approved. In the last two years, the successful use of 100% Drop-In SAF was demonstrated in experimental flights by different commercial airlines in tight cooperation with OEMs and airworthiness authorities.

The 100% Non-Drop-In SAF would be a new fuel standard specification. It could be used in designated aircraft/engines only and would require a separate supply chain. A major motivation

[56] European Union (2024), EU SAF Clearing House

for this new fuel type would be to significantly reduce emissions that contribute to non-CO_2 climate impacts and local air quality. For (non-aromatic) 100% Non-Drop-In SAFs a series of research and test flights proved their positive effects on emissions and contrail formation. Furthermore, valuable data was collected that will support the specification of a 100% Non-Drop-In SAF.

A collaborative effort across the aviation ecosystem aims to maximize global impact, with standardization and technical readiness currently in progress. Ongoing impact analysis focuses on fuel production, while further studies are necessary to address infrastructure challenges associated with 100% Non-Drop-In SAF.

With a variety of feedstock categories that can be used to produce SAF, the production can be tailored to the specific circumstances of a country and thereby support diversification of fuel supplies. Four of the production pathways that are expected to play a major role in the future are Hydroprocessed Esters and Fatty Acids (HEFA) (TRL[57] 8-9), Alcohols to Jet (AtJ) (TRL 7-8), Biomass Gasification with Fischer-Tropsch (Gas+FT)

(TRL 6-8) and Power-to-Liquid (PtL) (TRL 5-8). New production pathways and suitable feedstocks are being developed. Methanol-to-Jet is one promising technology that is being worked on by several companies and is currently going through the qualification process. The advantage of this pathway is that it can be used both with biomass feedstock as well as a conversion technology for Power-to-Liquid fuels.

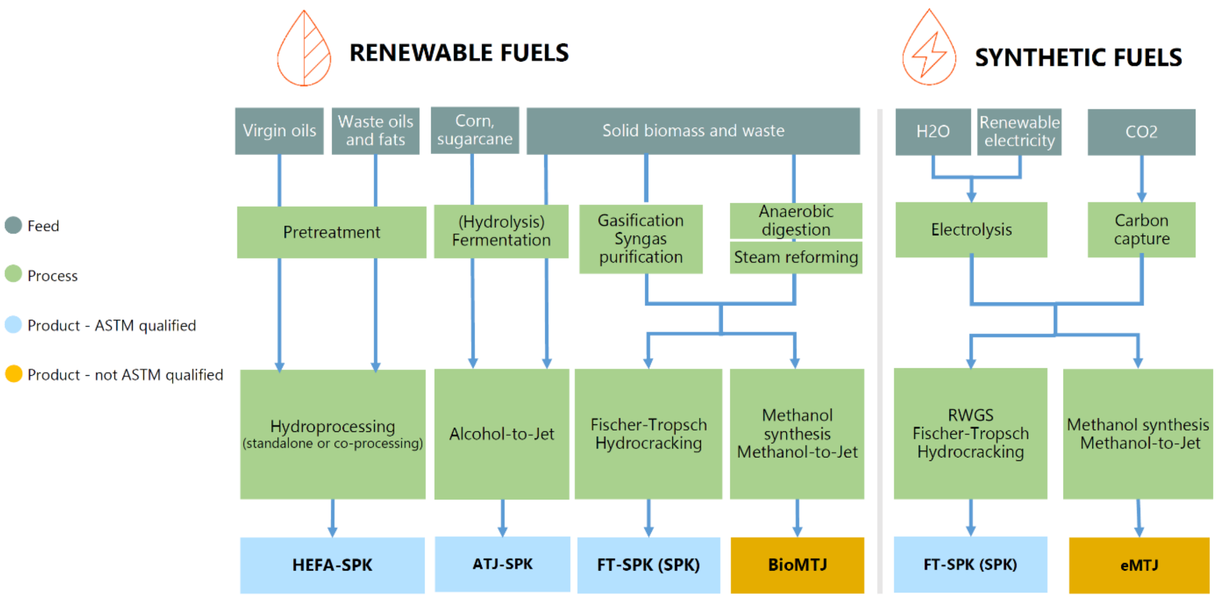


Figure16: Main SAF production pathways with similar building blocks[58]

Hydroprocessed Esters and Fatty Acids (HEFA). Currently the most viable option to produce SAF due to its commercial and technical maturity. Feedstocks include waste and residue fats, such as vegetable oil, used cooking oil, and animal fats, as well as purpose-grown crops like jatropha and camelina. These feedstocks are processed with hydrogen to remove oxygen and create hydrocarbon fuel components. However, supply will be limited by the availability of sustainable feedstock and competition from other sectors, such as road. In addition, with growing demand there is a risk of potential fraud from the use of feedstock that does not comply

[57] Technology Readiness Level.
[58] Renewable and Low-Carbon Fuels Value Chain Industrial Alliance (2024)

with the sustainability criteria (see Textbox on Sustainable Certification Schemes).

Alcohols to Jet (AtJ) and Biomass Gasification with Fischer-Tropsch (Gas+FT). AtJ fuels can be produced from agricultural residues and crops and the renewable fraction of municipal waste via an alcohol synthesis. Gas+FT converts biogas or syngas from similar feedstocks into fuel. Both methods can be produced with or without aromatics. Aromatics are essential for the performance of certain aircraft engine components (e.g. seals) but have environmental drawbacks in terms of particulate matter emissions. On the other hand, the production with aromatics would enable future 100% drop-in SAF production (see textbox) once the two pathways develop and are commercially available in the EU for aviation fuel production.

Power-to-Liquid (PtL). These fuels offer one of the highest potentials to scale-up production capacity in the future. While not being limited by sustainable biomass availability, they are reliant on access to sufficient additional renewable energy electricity, and an energy efficient conversion process, to achieve significant CO_2 emission reductions. Water and electricity are used in an electrolyser to generate hydrogen, which is then combined with CO_2 to create syngas. This syngas can then be further converted to SAF via the Fischer-Tropsch (FT) pathway or the Methanol-to-Jet pathway (currently in the ASTM D4054 qualification process). The CO_2 required for the PtL process can be obtained from industrial waste gases, biomass, or direct air capture (DAC). With DAC, the CO_2 is directly captured from the air through filters. As the concentration of CO_2 in the air is low, this process is very energy intensive but offers high CO_2 emission reduction potential, once the technology has further matured.

How sustainable are SAF?

Sustainability criteria

Table 19 provides an overview of the sustainability criteria used within both the RED and the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)[59].

Table 19: SAF sustainability criteria

Scheme	**Sustainability criteria**
Renewable Energy Directive (2023), Article 29	• *GHG reductions* – GHG emissions on a life cycle basis from biofuels must be lower than from the fossil fuel they replace (fossil fuel baseline = 94 g CO_2e/MJ): at least 50% lower for installations older than 5 October 2015, 60% lower for installations after that date and 65% lower for biofuels produced in installations starting operation after 2021. For renewable fuels from non-biological origin, and recycled carbon fuels, the savings shall be at least 70%. • *Land use change* – Carbon stock and biodiversity: raw materials for biofuels production cannot be sourced from land with high biodiversity or high carbon stock (i.e., primary and protected forests, highly biodiverse grassland, wetlands and peatlands). Other sustainability issues covered by the reporting obligation are set out in the Governance

[59] ICAO (2021), CORSIA Sustainability Criteria for CORSIA Eligible Fuels.

	regulation[60] and can be covered by certification schemes on a voluntary basis. There are also constraints on forest management. • There are additional criteria that are applicable and ensure that electricity used for the production of renewable hydrogen and RFNBOs is of renewable and additional origin. • There are also limitations on biomass production from feedstocks with high indirect land use change (ILUC) risk and using feedstock that could otherwise be used for food, in order to prevent inappropriate land usage and risk to food security.
CORSIA Sustainability Criteria for CORSIA eligible fuels (November 2022)	For batches produced on or after 1 January 2024, the following Sustainability Criteria are applicable: • *GHG reductions* – CORSIA eligible fuel / SAF must achieve net GHG emissions reductions of at least 10% compared to the baseline life-cycle emissions values for aviation fuel on a life cycle basis (fossil fuel baseline = 89 g CO_2 e/MJ), including an estimation of ILUC and/or DLUC emissions. • *Carbon Stock* - CORSIA eligible fuel / SAF will not be made from biomass obtained from land converted after 1 January 2008 that was primary forest, wetlands, or peat lands and/or contributes to degradation of the carbon stock in primary forests, wetlands, or peat lands as these lands all have high carbon stocks. • *Permanence* – The emissions reductions attributed to CORSIA SAF should be permanent. Practices will be implemented that monitor, mitigate and compensate any material incidence of non-permanence resulting from carbon capture and sequestration (CCS) activities. There are additional criteria that are applicable and are addressing the following themes: Water, Soil, Air, Conservation (biodiversity), Waste and chemicals, Human and labour rights, Seismic and Vibrational Impacts, Human and labour rights, Land use rights and land use, Water use rights, Local and social development and Food security.

GHG emissions reductions

The emissions reductions from drop-in SAF in a lifecycle analysis (LCA) are predominately achieved during the production process and more precisely through the use of sustainable feedstock. The greenhouse gases (GHG) emissions in terms of gCO_2e/MJ from its combustion in an aircraft engine are effectively the same as that those of fossil fuels. Many variables can influence the overall results of the LCA (Figure 17), but given historic concerns surrounding biofuel sustainability, it is encouraged to calculate actual life cycle emission values rather than applying a default value.

[60] EU (2018), Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action.

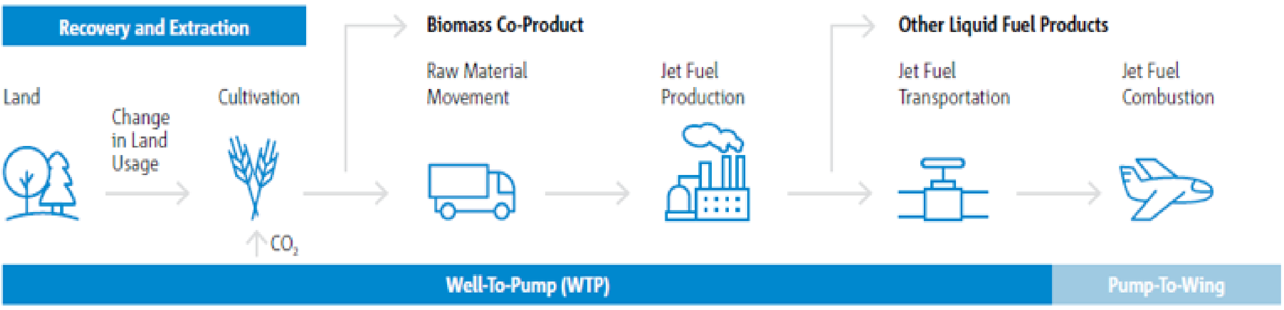


Figure 17: Components of typical well-to-wing LCA for biofuel-based jet fuel

Overestimations of GHG emissions reductions can occur if potential land use changes are not properly considered. Direct Land Use Changes (DLUC) occur when existing land is converted for the growth of feedstock for biofuel, while Indirect Land Use Change (ILUC) occurs when agricultural land used for food or feed is converted to biofuel production and the displaced production shifts to previously non-agricultural land, such as forests or grasslands[61]. Land use change, both direct and indirectly caused by crop displacements, can potentially negate any GHG savings from biofuels, or even release more CO_2-equivalent emissions than what the biomass subsequently grown on that land is able to reduce. Wastes and residues are conventionally considered as having zero DLUC or ILUC associated emissions.

The update to the RED in 2023 has tightened the rules around land use, emphasizing the protection of biodiverse areas and placing stricter controls on land conversion, and imposing restrictions on feedstocks with the higher ILUC risk. Bioenergy production is restricted on lands with high biodiversity value, such as primary forests, highly biodiverse grasslands, and areas designated for nature protection purposes. ReFuelEU Aviation is more stringent than RED by excluding feed and food crops, palm and soy-derived materials, palm fatty acid distillate (PFAD), soap stock and its derivatives as eligible.

Figure 2.3 provides an overview of modelled emissions under CORSIA for approved SAF production pathways as of March 2024, separated into Core LCA and ILUC values. Work is ongoing to approve the methodology for calculating the GHG emissions reductions for Power-to-Liquid fuels, where the main lever for emission reductions is the source of electricity to obtain the hydrogen and the source of carbon, which are both required for PtL fuels.

SAF and non-CO_2 emissions

Aviation non-CO_2 emissions refer to pollutants other than carbon dioxide (CO_2) that have a climate impact, including nitrogen oxides (NO_X), aerosol particles (soot and sulphur-based) and water vapour. Some types of SAF have the potential to offer significant non-CO_2 emissions reductions[62,63].

While it is recognised that aviation non-CO_2 emissions contribute to the overall climate impact, these non-CO_2 effects are currently only estimated with low confidence and substantial uncertainties. The revised EU ETS Directive requires aircraft operators to monitor and report once a year on the non-CO_2 aviation effects.

---

[61] European Court of Auditors (2023), The EU's support for sustainable biofuels in transport. An unclear road ahead.
[62] Teoh, Roger et al (2022), Targeted Use of Sustainable Aviation Fuel to Maximize Climate Benefits
[63] Märkl, Raphael Satoru et all (2024), Powering aircraft with 100 % sustainable aviation fuel reduces ice crystals in contrails

Research projects, such as AVIATOR and RAPTOR[64,65] have shown that the use of certain types of SAF could have positive impacts on local air quality[66] due to lower levels of sulphur and aromatic content which contribute to volatile and non-volatile particulate matter (nvPM) emissions. Evidence of contrail reduction when using SAF has been collected and scientifically acknowledged since 2015 (ECLIF I) and further substantiated in the ECLIF II and ND-MAX projects (2018)[67].

In-flight measurements between 2021 and 2024 during the European ECLIF III and VOLCAN I and II research projects extended the studies by using 100% Drop-In and 100 % Non-Drop-In SAF in both modern rich-burn and learn-burn combustors. These tests demonstrated a significant contrail reduction due to lower nvPM emissions and ice crystal formations, thereby indicating positive effects on climate change mitigation through the use of SAF[68].

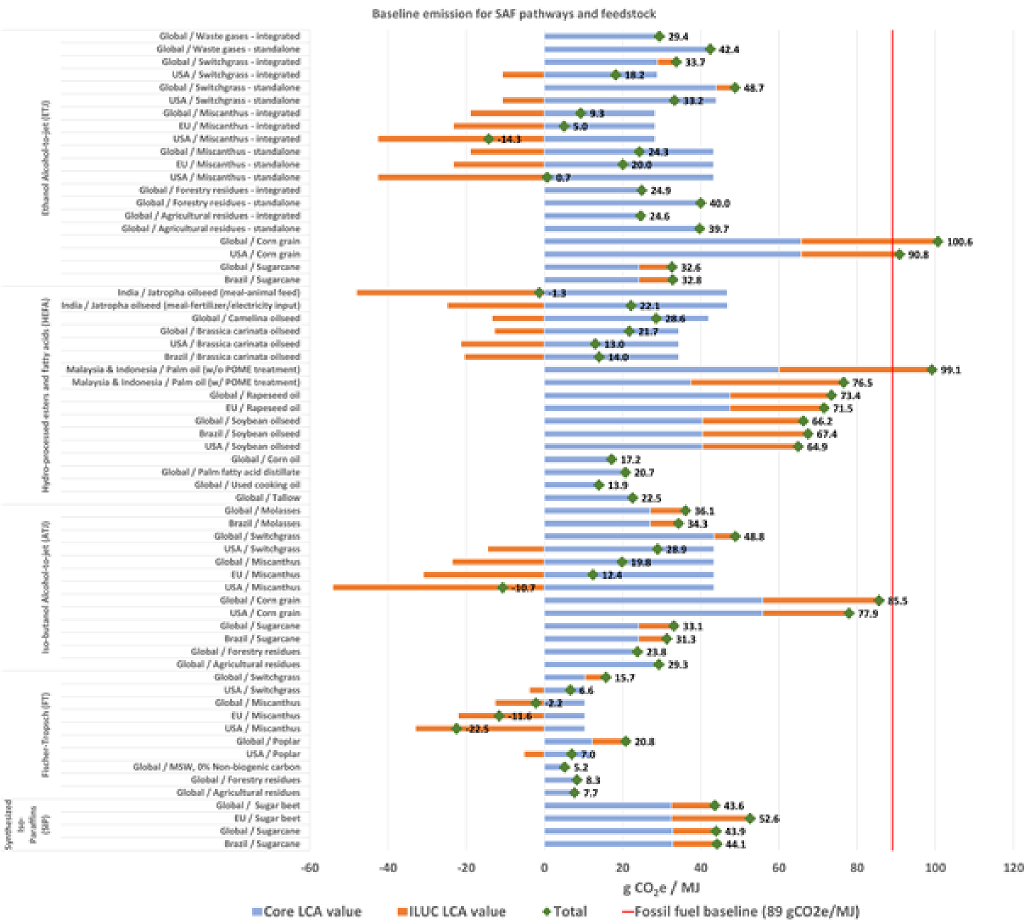


Figure 18: LCA emissions for CORSIA SAF pathways and feedstock compared to CORSIA fossil fuel reference value (89 g CO_2e/MJ)

---

[64] AVIATOR Project (2024), Assessing aViation emission Impact on local Air quality at airports: TOwards Regulation.
[65] RAPTOR (2024), Research of Aviation PM Technologies, modelling and Regulation
[66] Lukas Durdina, Benjamin T. Brem, Miriam Elser, David Schönenberger, Frithjof Siegerist, and Julien G. Anet (2021), Reduction of Nonvolatile Particulate Matter Emissions of a Commercial Turbofan Engine at the Ground Level from the Use of a Sustainable Aviation Fuel Blend.
[67] Voigt, C. et all (2021), Cleaner burning aviation fuels can reduce contrail cloudiness | Communications Earth & Environment (nature.com)
[68] Euractiv (2024), European ECLIF3 flight test study shows significant contrail reduction with 100% SAF

Sustainability Certification Schemes – Combatting fraudulent practices.

With so much emphasis being placed on SAF to help reduce aviation emissions, the 'S' in SAF needs to live up to its promise and ensure the effective delivery of emission reductions while avoiding unintended negative environmental and social impacts of its production, thus contributing to the credibility of the sector.

Major regulatory frameworks, such as the EU RED and CORSIA, therefore make use of Sustainability Certification Schemes (SCS). The objective of SCS is to ensure that SAF meet the required sustainability criteria by controlling the compliance with the sustainability requirements along the SAF value chain on a lifecycle basis. Audits are performed by ISO-accredited third-party certification bodies along the complete value chain, from raw material extraction to delivery of SAF to its point of use. In these audits, the auditor focuses on checking each economic operator's compliance with a defined set of sustainability criteria as well as traceability (Chain of Custody) and life cycle emissions criteria, thus ensuring that SAF is produced in accordance with the relevant regulatory requirements (e.g. as per the EU RED or CORSIA).

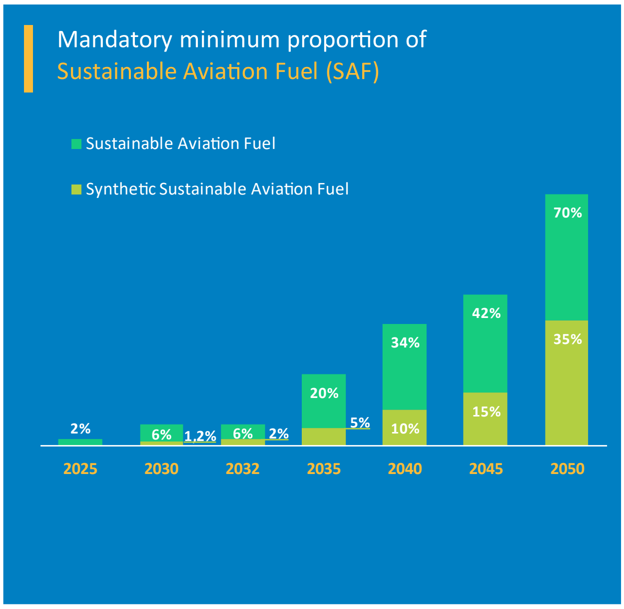
In recent years, SAF and biofuels upscaling has generated growing concerns about the fraudulent trading of non-sustainable feedstock or biofuels in the EU[69,70]. Fraudulent behaviour may ensue whereby products are labelled as meeting sustainability requirements even when they are non-compliant. This is highly problematic insofar as these practices threaten both the effectiveness and credibility of climate and renewable energy policies.

NGOs and European biofuel producers have repeatedly warned against dubious imports and raised concerns about the effectiveness of the certification schemes, which in part led to the development of the EU Union Database that will increase the transparency and reliability of the tracking system of renewable fuels along their supply chains. The Union Database is appropriately integrated in the reporting process of SAF supplied to EU airports under the ReFuelEU Aviation Regulation and the EU ETS Directive.

In response to these concerns, certification schemes have generally increased their efforts to enhance the credibility of the system, including unannounced integrity audits at randomly selected plants and economic operators. As a result, some sustainability certificates were withdrawn or temporarily suspended. They have also put in place a transaction database that is linked with the EU Union Database to prevent the relabelling of sustainability declarations, a mapping tool to support risk identification for auditors, specific guidance materials for waste and residue materials and evaluations of the technical feasibility of processing plants to deal with low-grade advanced waste/residue material[71].

[69] Euractiv (2024), Biofuel certification schemes slammed for failing to halt fraud
[70] Argus (2024), Norway says Esso misclassified animal fat biofuels
[71] ISCC (2023), Biodiesel and EU Imports from China

SAF Policy Actions - ReFuelEU Aviation



The ReFuelEU Aviation Regulation sets out EU-level harmonized obligations on aviation fuel suppliers, aircraft operators and Union airports for scaling up SAF used for flights departing from all EU airports above a certain annual traffic thresholds (passenger traffic above 800,000 or freight traffic above 100,000 tons). Starting in 2025, aviation fuel suppliers are required to supply a minimum of 2% blend of SAF with conventional fossil-based fuels to Union airports and this gradually increases to at least 70% by 2050. Synthetic aviation fuels are subject to an ambitious sub-mandate, starting with 1.2% in 2030, 2% in 2032 and reaching 35% in 2050. Aircraft operators departing from EU airports must also refuel with the aviation fuel necessary to operate the flight. This avoids the excessive emissions related to extra weight and minimizes the risks of carbon leakage caused by so-called 'economic tankering' practices. Between 2025 and 2034, aviation fuel suppliers can supply the minimum shares of SAF as an average over all the aviation fuel they have supplied across Union airports for that reporting period. This flexibility mechanism allows the industry to develop the production and supply capacity accordingly and the fuel suppliers to meet their obligations in the most cost-effective way without reducing the overall ambition. The Commission's Report will identify and assess the developments on SAF production and supply on the Union aviation fuel market, as well as assess possible improvements or additional measures to the existing flexibility mechanism, such as setting a potential accounting and trading mechanism for SAF (a so-called 'book and claim' system)[72].

In order to support the achievement of the ReFuelEU Aviation supply mandate, the EU has put in place various regulatory, financial and other supporting measures, including:

- A zero emissions rating of RED-compliant SAF used under the EU Emissions Trading System (ETS);
- A maximum of 20 million extra ETS (with an estimated value of €1.6 billion) allowances will be allocated to aircraft operators during 2024 to 2030 for the uplifting of SAF to also cover part of, or all of the price difference with fossil kerosene, depending on the type of SAF and the uplift location;
- A fuel tax structure under the proposed revision of Energy Taxation Directive that would incentivize SAF over fossil kerosene through preferential tax rates;
- A flight emissions label laying down harmonized rules for the estimation of airline emissions taking into account SAF uptake;
- The inclusion in the EU Taxonomy of SAF production and uptake to improve access to green finance;
- R&D and deployment financing support under Horizon Europe, Innovation Fund, InvestEU programmes to de-risk SAF production at all technology maturity stages;

[72] EUROCONTROL (2024), Use of sustainable aviation fuels in European States (ECAC) and airports

- The accelerated qualification of new SAF technologies and approval of new production plants through creation of EU SAF Clearing House and inclusion of SAF in the Net Zero Industry Act proposal;
- Cross-sectoral cooperation in the Renewable and Low-Carbon Fuels Value Chain Industrial Alliance (RLCF Alliance). The RLCF Alliance, as the industrial pillar of ReFuelEU Aviation to support SAF supply, and emergence of SAF projects and match-making with potential fuel offtakers, is open to all stakeholders.
- EU-funded international cooperation SAF projects with partner States in Africa, Asia, Latin America and the Caribbean. This includes a €4 million ACT-SAF project to conduct feasibility studies and capacity building activities.
- Designation of SAF as a 2024 Global Gateway Flagship initiative, supporting the development, production and use of SAF by de-risking SAF investments outside Europe via different types of funding.
- International cooperation at ICAO level, including the EU's role in the negotiations to reach an agreement at CAAF/3 in November 2023.

ICAO Conference on Aviation Alternative Fuels (CAAF/3)

The third ICAO Conference on Aviation Alternative Fuels (CAAF/3) was held in November 2023, during which ICAO Member States agreed on the ICAO Global Framework for SAF, Lower Carbon Aviation Fuels (LCAF) and other Aviation Cleaner Energies. This includes a collective global aspirational vision to reduce CO_2 emissions from international aviation by 5% in 2030 with the increased production of SAF, LCAF and other initiatives [23]. Building blocks in terms of policy and planning, regulatory framework, implementation support and financing will be key in achieving this goal. The vision will be continually monitored and periodically reviewed, including through the convening of CAAF/4 no later than 2028, with a view to updating the ambition on the basis of market developments in all regions.

The ReFuelEU Aviation Regulation also foresees a thorough monitoring and reporting system of SAF supply and usage that will provide an overview of the European SAF market and form part of future editions of this report. This reporting is linked with an enforcement mechanism consisting of penalties imposed by Member States for the cases of non-compliance from fuel suppliers and aircraft operators.

First in 2027 and every four years thereafter, the European Commission will present a detailed assessment of the SAF market and the possible need to revise the scope of the Regulation, the eligible fuels, the minimum shares and the level of fines for non-compliance. It will also include an assessment of possible support mechanisms for production and uptake of SAF.

ECAC States policy actions

Switzerland set out a SAF strategy with the goal that SAF shall contribute a minimum of 60% to net CO_2 reductions in Swiss civil aviation by 2050, contributing to the Swiss goal of reaching net-zero CO_2 emissions in 2050. It is accompanied by a legislative proposal that includes a blending mandate and provision of funding for the development of SAF production pathways, planned to enter into force in 2025. To avoid market distortion, the mandate shall be aligned with ReFuelEU Aviation. Turkey is also planning to develop dedicated SAF regulations to incentivize its uptake [24]. The United Kingdom SAF policy includes a SAF Mandate to drive an ambitious ramp-up of SAF in the aviation fuel supply, starting with 2% in 2025, increasing linearly to 10% in 2030 and reaching 22% in 2040. The Mandate includes a cap on the amount of HEFA SAF used to meet obligations, and there is a separate obligation for power-to-liquid fuels, starting in 2028 with 0.2% of the total fuel supply and reaching 3.5% in 2040[73].

SAF Market

Global SAF production represented only 0.53% of jet fuel use in 2024, up from 0.2% in 2023 [74,75,76]. The EU SAF market, incentivized following the adoption of the ReFuelEU Aviation Regulation and the revision of the EU ETS and the RED, is now in a transition phase. The regulation requires a significant expansion of the production capacity in order to avoid the EU market becoming overly reliant on imports. Starting in 2025, fuel suppliers are mandated to supply a growing amount of SAF to Union airports. EASA is tasked with monitoring and reporting under the regulation and will produce annual reports, which will include a status of the evolving SAF market.

Current and future SAF production capacity

Figure 19: Projected EU SAF facilities in 2030 under the Optimistic scenario

[73] Department for Transport (2024), Aviation fuel plan
[74] Simple Flying (2024), IATA Says SAF Production Will Reach 0.53% of Aviation 2024 Fuel Usage
[75] EUROCONTROL (2024), Use of sustainable aviation fuels in European States (ECAC) and airports
[76] Transport and Environment (2024), How is e-kerosene developing in Europe?

According to information collated with the support of ReFuelEU Aviation Member State Network (Figure 19), established by EASA to support the implementation of the Regulation, the current annual SAF production capacity in the EU is just above 1 million tonnes (Mt). Almost all this SAF production is HEFA and does not account for co-processing production using sustainable feedstock in fossil fuel plants, for which there is not enough reliable information. This could be considered to be an 'operating scenario'.

If facilities that are currently under construction are taken into account, the amount of SAF production capacity in 2030 could reach 3.5 Mt. This could be considered a 'realistic scenario'. Again, almost all this production would be dominated by the HEFA production pathway and does not include any Power-to-Liquid (PtL) production, as no plant has yet evolved beyond a pilot stage. Other studies come to different conclusions, mostly due to a different set of assumptions and methodologies. The recent SkyNRG Market Outlook from June 2024[77] estimates 3.8 Mt by 2030, including 0.3 Mt of PtL as well as some co-processing production, while IEA predicts roughly 3.8 Mt by 2038[78]. In both cases, a significant acceleration in the construction of PtL plants will be needed to meet the first sub-mandate of 0.7% in 2030.

In addition to the operating and realistic scenarios, both the ReFuelEU Aviation Member State Network and the SkyNRG Market Outlook collected information to build up an 'optimistic scenario'. This includes all projects in the pipeline to be in operation by 2030 and includes PtL projects, leading to a projected SAF capacity of 5.9 Mt and 5.5 Mt respectively.

Figure 20 illustrates all of the above scenarios out to 2030. While the realistic scenario (3.5 Mt) would be able to meet the projected demand of the 6% mandate by 2030 (2.8 Mt), significant growth in production capacity is required to fulfil the very ambitious ramp-up to 20% in the subsequent 2030-2035 period.

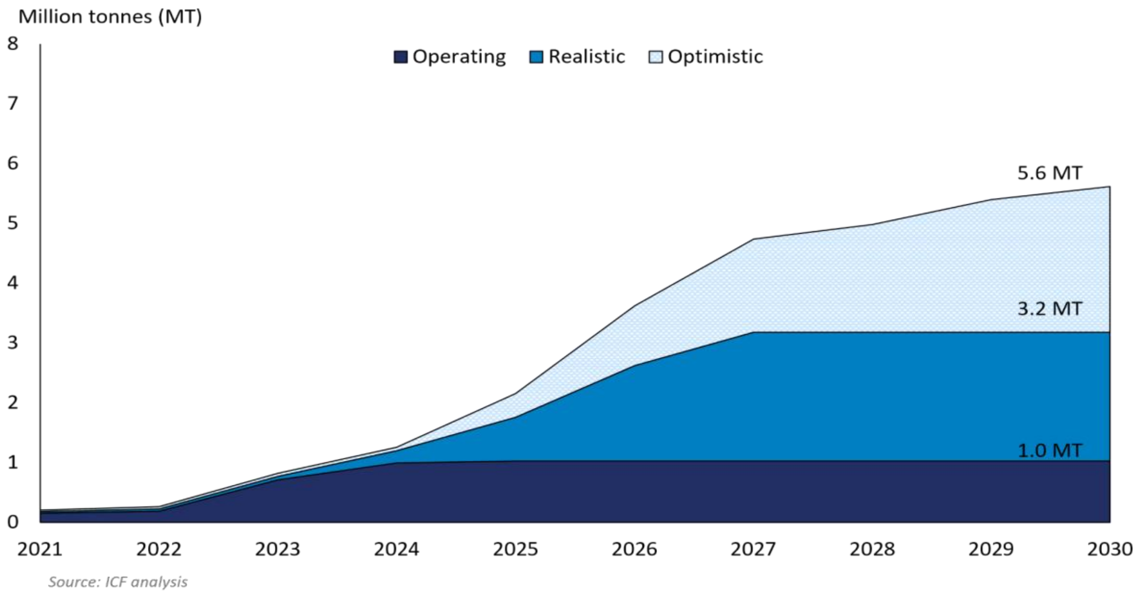


Figure 20: Projected EU SAF capacity in 2030 by scenario

Beyond 2030, projections of production capacity are more challenging and the potential SAF production will depend on the availability of feedstocks (e.g. HEFA, green hydrogen, renewable

[77] SkyNRG (2024), Sustainable Aviation Fuel Market Outlook – June 2024 Update
[78] International Energy Agency (2023), Renewables 2023 Analysis and forecast to 2028

energy). The aviation industry will be competing with other sectors as part of the economy wide decarbonization efforts where these feedstocks could be used to directly decarbonize the primary energy supply. As a result, securing these sources of renewable energy will be critical to ensure the ramp-up of PtL SAF production within Europe. There are positive signals in particular from the solar industry, where the growth of global installation capacity is accelerating faster than anticipated and becoming the largest source of new electricity, with solar capacity doubling every three years and hence growing ten-fold every decade. Overall, renewable energy passed 30% of the total global energy supply for the first time in 2023. By the 2030s, solar energy is likely to become the biggest source of electrical power and by the 2040s it may be the largest source of all energy.

Another limiting factor for SAF deployment towards 2050 is the capital expenditure required to build the production facilities. It is estimated that between 500-800 SAF facilities[79] will be needed globally by 2050, which, assuming €1.8 billion per facility, would result in around €36 billion capital expenditure annually between 2025 and 2050[80].

Estimations of the future SAF landscape have concluded that indeed PtL fuels have the potential to cover 50% of the global SAF production capacity by 2050. Whereas HEFA production will be around 7% and AtJ / FT the remaining 43%. Projections by region also highlight the varying availabilities for feedstocks in the different parts of the world[81].

CO_2 emissions reductions

To estimate the potential CO_2 emission savings from the ReFuelEU Aviation Regulation, a comparison has been made between the carbon intensity reduction of global aviation fuel taking into account the SAF supplied and the EU RED fossil fuel baseline intensity of 94 gCO_2e/MJ. Two scenarios were assessed, a 'minimum' emissions saving and a more 'ambitious' scenario. The scenarios differ in the assumed emission reductions achieved by the (advanced) biofuels mandate and the RFNBO (PtL) fuel sub-mandate. The minimum scenario assumes a 65% and 70% emission reduction for biofuels and RFNBOs over their lifecycle respectively, which aligns with the minimum requirements set out in the ReFuelEU Aviation Regulation. The second, more ambitious scenario assumes 80% and 90% emission reductions respectively for the two SAF types.

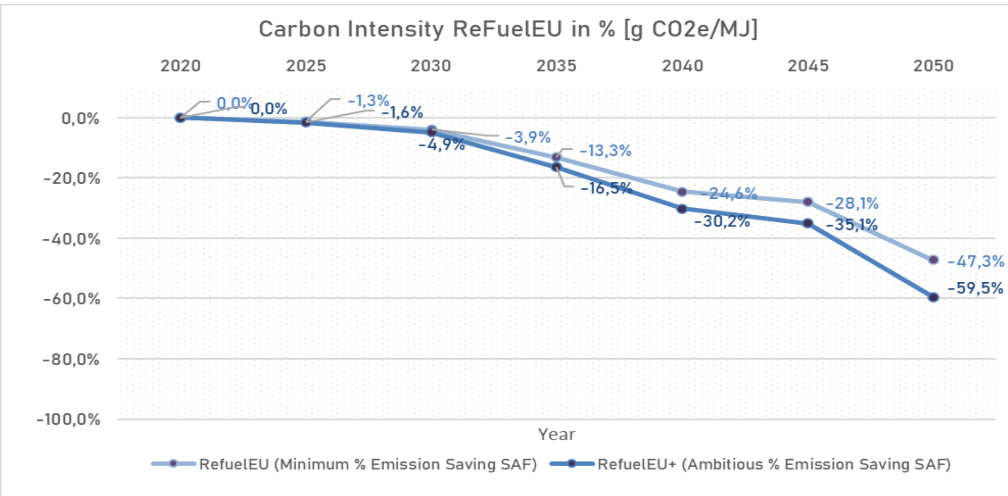


Figure 21: % CO_2eq emissions reductions from the uptake of SAF under ReFuelEU Aviation scenarios

[79] Assuming 0.3 – 0.5 Mt average SAF output per year per facility.
[80] SkyNRG (2024), Sustainable Aviation Fuel Market Outlook – June 2024 Update
[81] ICF (2021), Fueling Net Zero – How the aviation industry can deploy sufficient sustainable aviation fuel to meet climate ambitions. An ICF Report for ATAG Waypoint 2050

SAF Price

The price of SAF is one of the most critical factors when it comes to its uptake, as fuel costs currently represent a large share of the operational cost of aircraft operators (approx. 30%). In 2023, the price of conventional jet fuel averaged around €816 per tonne and is a figure that is readily available from Price Reporting Agencies (PRA) indexes[82,83,84] When assessing the prices for ReFuelEU Aviation eligible SAF, a differentiation was made with SAF that are currently available on the market, and SAF for which only production cost estimations can be performed due to the market not being mature enough yet. For the former, only aviation biofuels that are produced from feedstock listed in Part B Annex IX of the Renewable Energy Directive have a market availability in 2023. The average price for these SAF was around €2768 per tonne in 2023, using as a reference the relevant indexes from the PRAs.

For fuels that had no market availability in 2023, production cost estimations were developed based on feedstock, energy and technology deployment costs resulting in prices that range from €1600 per tonne for advanced aviation biofuels to €8700 per tonne for PtL fuels. Figure 6.9 illustrates the estimated price ranges for the different eligible fuels under ReFuelEU Aviation in 2023. These production costs are expected to reduce substantially as emerging SAF and hydrogen production technologies scale up, and associated costs reduce.

Especially for PtL fuels, for which the energy price is a key cost driver, the differences in energy prices across Europe may play a role in where the production is most attractive and competitive for such fuels in the future[85,86].

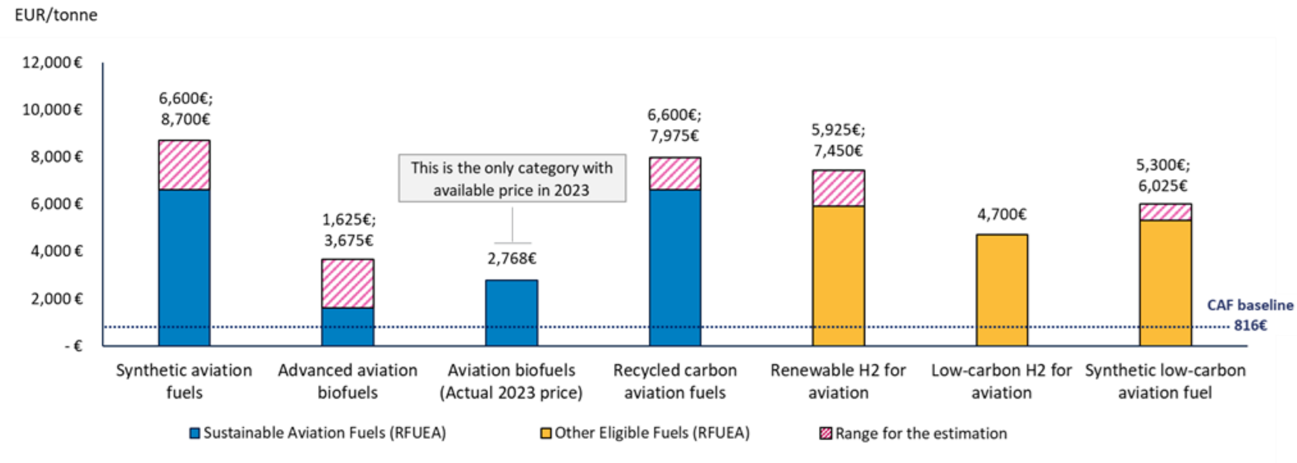


Figure 22: Estimated prices and production costs in 2023 for ReFuelEU Aviation eligible fuels

82 IATA (2024), Unveiling the biggest airline costs
83 Price Reporting Agencies (PRA) used as data source: S&P Global Commodity Insights (Platts), Argus Media and General Index.
84 With the density of kerosene of around 0.8 g/cm3, this results in a price of around 1.02€/l.
85 EASA (2024), ReFuelEU Aviation Market Report
86 Politico (2024), Franco-German energy cash splash strains EU single market

STAKEHOLDER ACTIONS

Central Europe Pipeline System: First delivery of SAF

The Central Europe Pipeline System (CEPS)[87] is the largest fuel supply system in NATO and crosses Belgium, France, Germany, Luxemburg and the Netherlands and comprises of approx. 5,300 km of pipeline. It delivers jet fuel to major civil airports such as Frankfurt, Brussels, Luxembourg, Zurich and Schiphol (Amsterdam). Following the permission of NATO, the connected airports have been able to receive SAF blends through CEPS since 2023.

Neste cooperated with Brussels Airlines to deliver sustainable aviation fuel to the airline at Brussels Airport on January 1, 2023. This marked the first time that SAF was supplied to an airline at a European airport using the NATO CEPS. It shows cases how existing fuel infrastructure can be used to supply SAF to airports.

Delivering CORSIA certified SAF to airlines[88]

In July 2022, Neste delivered the first ever CORSIA certified batch of SAF (Neste MY Sustainable Aviation Fuel™) to American Airlines at San Francisco International Airport in July 2022. This was part of a pilot to certify SAF as a CORSIA Eligible Fuel that can be used by an airline to meet its emissions obligation under the Carbon Offsetting and Reduction Scheme for International Aviation(‘CORSIA’), which is a market-based measure to lower CO_2 emissions for international flights and reduce aviation’s contribution to climate change.

First flight in history with 100% sustainable aviation fuel on a regional commercial aircraft[89]

Regional aircraft manufacturer ATR, Swedish airline Braathens Regional Airlines and Neste have collaborated to enable the first ever 100% SAF-powered test flight on a commercial regional aircraft.

The flight took place in Sweden in July 2022 and is part of the 100% SAF certification process of ATR aircraft that started in September 2021.

Bringing together airlines and corporates[90]

Project Runway is an initiative launched by SkyNRG in June 2024 and brings together airlines and corporates to provide easy access to SAF. The project will support airlines in navigating the complexities of SAF procurement and provide an effective way to reduce their greenhouse gas emissions. Project Runway facilitates airlines access to SAF

[87] CIM&CCMP (2024), The CEPS network
[88] Neste (2022), Delivering CORSIA certified SAF to airlines
[89] Neste (2022), First flight in history with 100% sustainable aviation fuel on a regional commercial aircraft
[90] SkyNRG (2024), SkyNRG launches Project Runway with Microsoft as a founding member

and allows them to share the SAF price premium with ambitious corporates aiming to reduce their own Scope 3 aviation emissions.

Modular Power-to-X plants[91]

The modular chemical plants for power-to-X and gas-to-liquid applications developed by INERATEC use hydrogen from renewable electricity and greenhouse gases such as CO_2 to produce, among other products, Power-To-Liquid fuels. The modular approach is being used for the first time in a pioneer plant and large-scale industrial PtL project in Germany. The modular concept of the plants allows scalability over several stages, keeping the planning and construction efforts manageable and improving the cost-benefit ratio.

First trans-Atlantic flight on 100% Drop-In Sustainable Aviation Fuel[92]

In 2023, Virgin Atlantic Flight 100 flew on 100% SAF from London to New York, marking the culmination of a year of collaboration to demonstrate the capability of SAF as a safe drop-in replacement for fossil derived jet fuel that is compatible with today’s engines, airframes, and fuel infrastructure. Flown on a Boeing 787, using Rolls-Royce Trent 1000 engines, the flight marked a world first on 100% Drop-In SAF by a commercial airline across the Atlantic. The SAF used was 88% HEFA (Hydro processed Esters and Fatty Acids) made from waste fats and 12% SAK (Synthetic Aromatic Kerosene) made from plant sugars. It is estimated that the use of SAF reduced nvPM emissions by 40% and CO_2 emissions by 64%, as well as an overall improvement in fuel burn efficiency as the SAF produced 1% more energy compared to the same mass of fossil fuel.

[91] INERATEC (2023), Groundbreaking for e-fuel production plant in Frankfurt
[92] The Guardian (2023), First transatlantic flight using 100% sustainable jet fuel takes off

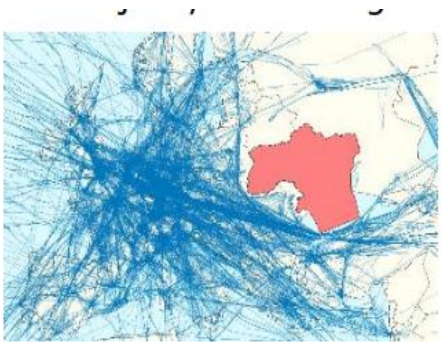
6.3 AIR TRAFFIC MANAGEMENT AND OPERATIONAL IMPROVEMENTS

- The Single European Sky (SES2+) proposal of the Commission was formally adopted by the Council and the European Parliament in 2024, although only modest progress was made, and various issues were left unresolved.
- Implementation of SES2+, and a focus on continuous improvement to address unresolved issues, is critical to enhance capacity, efficiency and sustainability.
- RP4 (2025-2029) SES performance targets reflect the ambition to enhance environmental performance, as does the desire to develop improved environmental monitoring indicators while building up resilience and strengthening capacity.
- It is recognized that the SES performance scheme needs to be improved in terms of the ATM-related performance indicators for environment. Work is ongoing to identify a more robust KPI which, after a period of monitoring and analysis during RP4, will be ready for performance target setting in RP5.
- Updated SES ATM Master Plan has been aligned with the RP4 ambitions such that ANSPs invest in technologies to provide greener, smarter and more effective air traffic.
- Ambitious environmental performance targets cannot be achieved unless the ATM system supports and incentivizes all stakeholders to optimize the efficiency of their operations.
- 400 million tonnes of CO_2 emissions (9.3% less CO_2 per flight) could be saved with the completion of the SES ATM Master Plan vision by 2050.
- The war in Ukraine and the Middle East conflict, and the subsequent impact on EU airspace, has made it more difficult to assess whether ATM actions towards improving environmental performance indicators have resulted in tangible benefits.
- During busy periods, Air Traffic Controllers may need to use alternative procedures to maintain required aircraft separation, thereby limiting the capacity to accommodate fuel efficient Continuous Descent Operations.
- Total gate to gate CO_2 emissions broken down by flight phase indicates that highest emissions originate from cruise phase (62.9%) and climb phase (23.2%).

- The implementation of cross-border, free route airspace (FRA) significantly improves en-route environmental performance. Up to 94,000 tonnes of annual CO_2 emissions are estimated to be saved by 2026 through the Borealis Alliance FRA implementation among 9 States.
- Air traffic control strikes in 2023 had a significant environmental impact with an additional 96,000 km flown and 1,200 tonnes of CO_2 emissions due to knock-on effects across neighboring States and the wider SES Network.
- SESAR study estimated that €1 invested in Common Project 1 (CP1) ATM functionalities during 2023 resulted in €1.5 in monetizable benefits and 0.6 kg of CO_2 savings, and these benefits are expected to increase overtime as CP1 is fully implemented.

Single European Sky

In the last few years, air traffic has continued to recover following the COVID pandemic and the number of flights to or from EU27+EFTA airports was 8.35 million during 2023. This is a 8.5% increase compared to 2022 (7.69 million) but still 9.1% below the level of 2019 (9.19 million). Growth rates at the State level have been unevenly distributed due to changes in traffic flows resulting from the war in Ukraine since 2022, changes in holiday traffic and less domestic traffic in several States.



The closure of Ukraine's airspace to commercial traffic was amplified by reciprocal airspace bans for Russian and many Western operators. While most of the European traffic is not directly affected by the airspace closures, east-west flights between Europe and Asia that previously travelled through Russian airspace need to divert, which adds travel time and fuel burn thereby lowering flight efficiency.

In 2004, the Commission launched the Single European Sky (SES)[93] representing a holistic framework to harmonize and improve the performance of Air Traffic Management (ATM) in terms of safety, capacity, cost-efficiency and the environment. The SES builds on five interrelated pillars: economic regulation, airspace organization/network management, technological innovation, safety and Human Dimension. The SESAR (Single European Sky ATM Research and Development) project is the technological innovation pillar of the SES aiming to modernize ATM through the innovation cycle of defining, developing and deploying innovative technological systems and operational procedures. The goal is to achieve the 'digital European sky' defined in the European ATM Master Plan[94], which is a common roadmap to establish Europe as the most efficient and environmentally friendly sky in the world. It includes the goal to reduce the average CO_2 emission per flight by 9.3% (600 kg) by 2050. A key element in achieving that is goal is the

[93] EC (2004), Regulation (EC) No 549/2004 laying down the framework for the creation of the Single European Sky; R**egulation (EC) No 550/2004 of the European Parliament and of the Council of 10 March 2004 on the provision of air navigation services in the Single European Sky**; Regulation (EC) No 551/2004 of the European Parliament and of the Council of 10 March 2004 on the organization and use of the airspace in the single European sky (the airspace Regulation)
[94] SESAR (2020), European ATM Master Plan.

deployment of Common Project One (CP1)[95], which facilitate service provision along optimized routes from gate to gate and thereby reduce both CO_2 and non-CO_2 emissions.

The SES has evolved over time and has significantly benefited ATM in Europe. Nevertheless, a profound reform of the SES was considered necessary to more effectively reach the above-mentioned objectives, which led to the Commission launching the 'SES2+' proposal in 2020. The process for adopting the SES2+ was challenging and heavily discussed, but a political agreement was finally reached between the European Parliament and the Council and the new Regulation was adopted in 2024.

While the SES2+ outcome strengthens economic performance regulation and incentivizes environmental performance by establishing the Performance Review Body (PRB) on a permanent basis, only modest progress was made and many issues were left unresolved. For example, the Network Manager[96] lacks the means to ensure that ANSPs deliver the promised and much needed capacity to the network when demand from airlines is high. In addition, while SESAR has enhanced coordination between stakeholders through the ATM innovation cycle, the transition from development to deployment of SESAR solutions by ANSPs, airport operators and airspace users across Europe has proven difficult and subsequently led to insufficient progress in modernizing the ATM system. This may be due to national requirements in airspace design and security issues, thereby making it complex in identifying universal solutions for monopolistic and state-owned Air Navigation Service Providers (ANSPs). All these points could contribute to challenges in terms of adopting technological innovation, responsiveness to demand and cost base adjustments, and cooperation between ANSPs.

The goal of climate neutrality by 2050 calls for the EU to ensure decarbonization of the air transport sector. Likewise, the Zero Pollution Action Plan includes goals for reducing impacts from noise and air quality. Ambitious targets such as these cannot be achieved unless the ATM system supports and incentivizes air navigation service providers (ANSPs), airport operators and aircraft users to optimize the efficiency of their operations and thus reduce excess fuel burn and emissions to a minimum.

Enhanced airspace organization that minimizes the inefficient use of available airspace, primarily through improved airspace and air traffic control sector design and effective airspace management procedures (civil-military coordination), are additional ATM tools to enable and allow for fuel efficient flight trajectories. Continuous improvement should be fostered at both local and network level.

While a significant progress has already been made in the ATM domain, it is important to now implement the SES2+ reform and focus on continuous improvements in infrastructure and operational procedures, notably through closer cooperation between all stakeholders and faster deployment of SESAR solutions.

---

[95] EU (2021), Regulation (EU) 2021/116 - Common Project 1 Regulation.

[96] Commission Implementing Decision (EU) 2019/709 [4] renewed the appointment of EUROCONTROL as Network Manager (NM) for the period 2020-2029. EASA continues to act as the competent authority that certifies and oversees the NM. The NM coordinates operational stakeholders in order to manage demand through flow and capacity management, thereby optimising the network performance to limit unnecessary fuel burn and emissions.

SES environmental performance and targets

Reference Period 2 (RP2)	2015-2019
Reference Period 3 (RP3)	2020-2024
Reference Period 4 (RP4)	2025-2029
Reference Period 5 (RP5)	2030 -2034

Overall context

The SES Performance and Charging Scheme[97] defines key performance indicators (KPIs) for air navigation services and network functions, which are used for performance target setting at Union-wide and local levels in the key performance areas (KPAs) of environment, safety, cost efficiency and capacity. SES Performance Scheme Reference Periods (RP) are divided into five-year periods. This report captures the results of RP2 and RP3, while highlighting intentions for RP4 and preparations for future RP5 changes (e.g. safety monitoring but no KPA, climate and environmental KPA). The environmental performance dimension of SES involves both target setting to drive improvements as well as and the monitoring and reporting on environmental performance indicators.

Key Performance Indicator for environment (with targets)

During RP3, environmental performance has been measured through one KPI, namely horizontal en-route flight efficiency of the actual flight path (KEA). KEA measures the additional distance flown in comparison to the great circle distance (shortest distance between two airports).

The higher the KEA inefficiency value, the worse the performance. However, other factors such as wind, weather, airspace structures, and network constraints influence the optimum trajectory. One of the objectives of the SES2+ proposal from the Commission was to develop a more suitable KPI on environmental performance for RP4. However, due to the duration of the negotiations and adoption of the SES2+ legislation, this was not possible and is now planned for RP5.

Following the COVID pandemic, environmental performance measured against the KEA KPI deteriorated significantly in 2022 and 2023 (Figure 23). EU Member States were not able to meet, by a wide margin, the Union-wide environmental performance targets set for 2022 (2.37%) and for 2023 (2.40%). Unfortunately, the impact of the war in Ukraine and the subsequent restrictions in parts of EU airspace made it more difficult to assess whether ATM actions towards improving the KEA actually resulted in tangible benefits. The PRB estimates that over 26 million kilometres of additional distance was flown in 2022 as a result of missing the Union-wide target by 0.59%. This equates to approximately 118 million kilograms of excess fuel burnt (375 million kilograms of CO_2).

[97] EU (2019), Regulation (EU) 2019/317 of 11 February 2019 laying down a performance and charging scheme in the single European sky

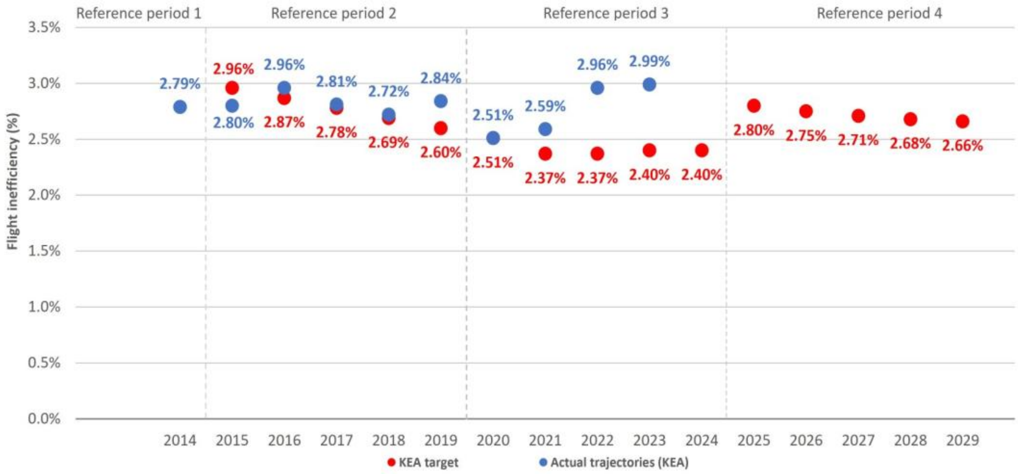


Figure 23: KEA horizontal en-route flight inefficiency and targets for 2014 to 2029

Performance Indicators for monitoring (without targets)

The Performance Scheme includes various indicators that are only monitored at either EU-level or local level but with no binding targets. These include the average horizontal en-route flight efficiency of the last filed flight plan trajectory (KEP)[98] and the shortest constrained trajectory (KES/SCR)[99]. As with all other indicators, KEP and KES/SCR (Figure 24) have been significantly affected by the war in Ukraine leading to general increases of inefficiency during 2022 and 2023, although there has been a reduction in the delta between KES/SCR and KEP. As with KEA, it is recognized that more suitable indicators are needed to give a clearer indication on the effectiveness of ANSP and Network Manager actions.

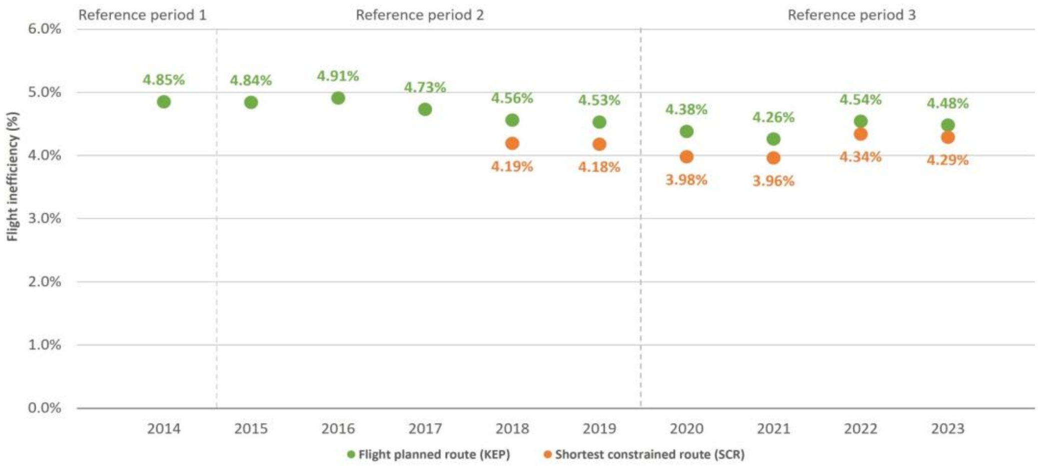


Figure 24: KEP horizontal en-route flight inefficiency and KES/SCR for 2014 to 2023

[98] The difference between the length of the en-route part of the last filed flight plan trajectory and the corresponding portion of the great circle distance, summed over all IFR flights within or traversing the European airspace.
[99] The difference between the length of the en-route part of the shortest constrained route available for flight planning, as calculated by the path finding algorithms and flight plan validation systems of the Network Manager, measured between the exit and entry points of two terminal manoeuvring areas, and the corresponding portion of the great circle distance summed over all IFR flights within or traversing the European airspace.

The share of flights completing Continuous Descent Operations (CDOs) in 2023 fell by only 0.03% compared to 2022 data. The trend in terms of monthly share of CDO flights during 2023 (Figure 25) was fairly steady at around 30-35%, even during the summer period with a significantly higher number of flights. Air Traffic Controllers (ATCOs) will endeavor to clear aircraft for a CDO when they can guarantee safe separation all the way to final approach. However, during busy periods, ATCOs may need to use alternative ATC procedures to maintain the required separation, such as radar vectoring and speed control, which are not compatible with CDOs. As such, Figure 3.3 illustrates that there is a limited capacity to accommodate CDOs during busier periods.

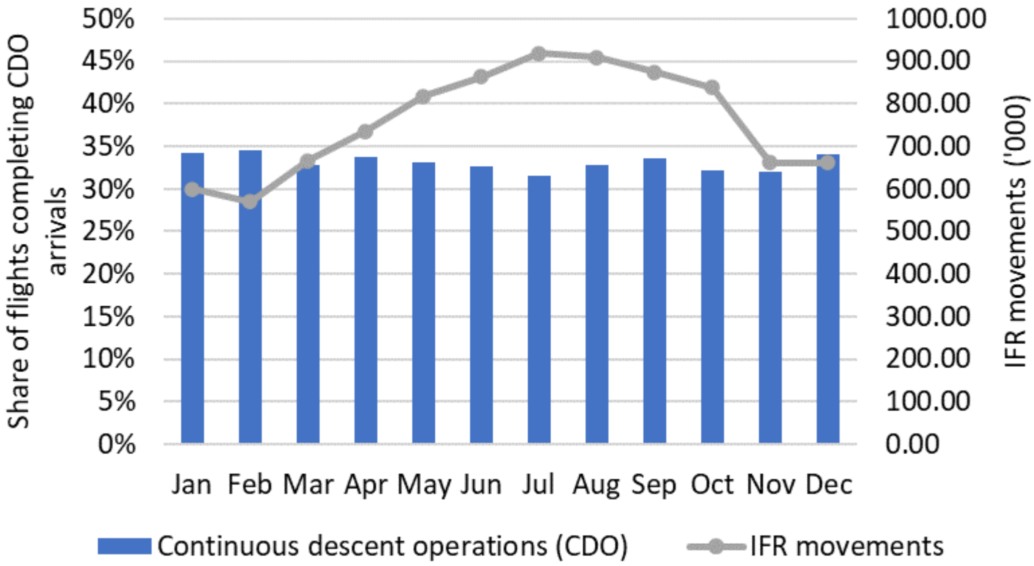


Figure 25: CDO vertical flight efficiency indicator for 2023

Restrictions on the number of CDOs are linked to the current ATM system. It is expected that with future Time-Based Operations (TBO), more CDOs would be facilitated by embedding them in aircraft fuel efficient trajectories.

Additional time in the Arrival Sequencing and Metering Area (ASMA time)

Additional ASMA time, otherwise known as airborne holdings, has a direct impact in terms of increased fuel burn. There is a clear interest in finding a balance between regulating arrivals by absorbing delays on the ground and airborne delays during the approach phase. Airborne delays allow for tactical management of the arrival flow, potentially optimizing the approach sequence and maximizing runway throughput. However, excessive airborne delays are unnecessary and have a clear impact on emissions. As per ASMA, extended taxi-out durations contribute to higher fuel consumption and CO_2 emissions. Recognizing that establishing a departure sequence enhances runway efficiency and that airports may occasionally need to clear stands for arriving flights, striking a balance between ATC pre-departure delays to regulate runway traffic and added taxi-out times is essential for minimizing environmental impacts.

The evolution of both indicators follows a similar trend (Figure 26) with a slight increase during 2014-2019 followed by a significant decrease due to the drastic reduction in traffic during COVID. Traffic has since recovered such that it is only 10% below 2019 at the 40 busiest EU27+EFTA airports in 2023, while additional ASMA and taxi-out times are also increasing at the same time.

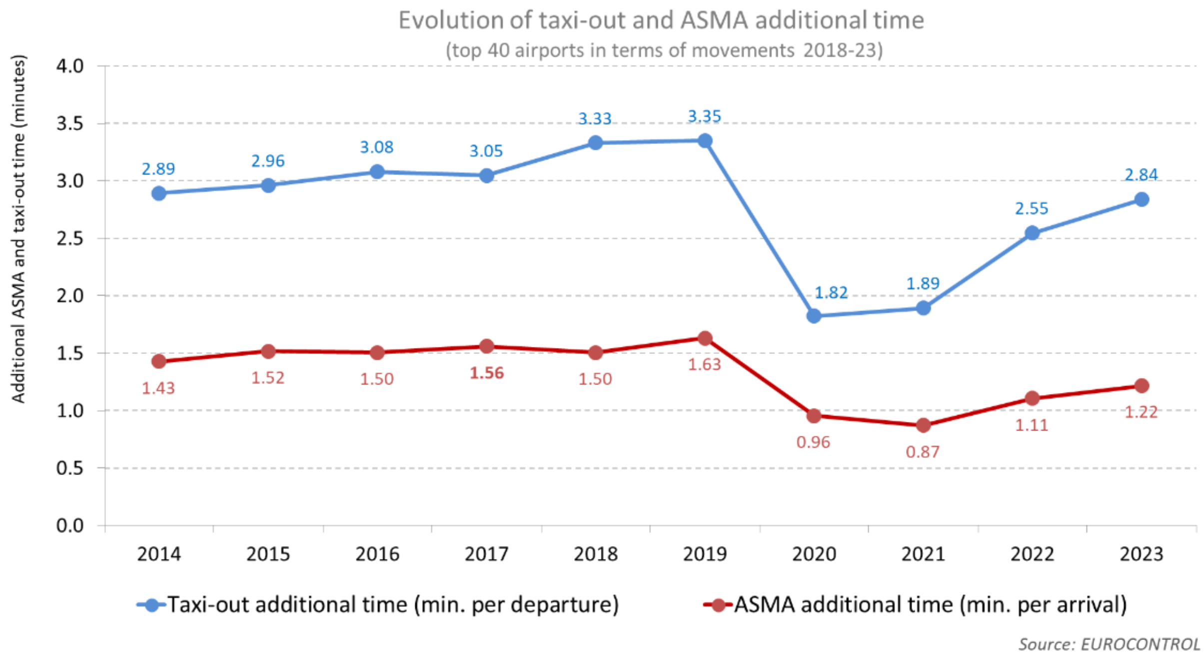


Figure 26: Average additional ASMA and taxi-out times for the busiest EU27+EFTA 40 airports in terms of flight movements

Significant variations exist between the top 40 busiest EU27+EFTA airports in terms of additional ASMA time (Figure 27).

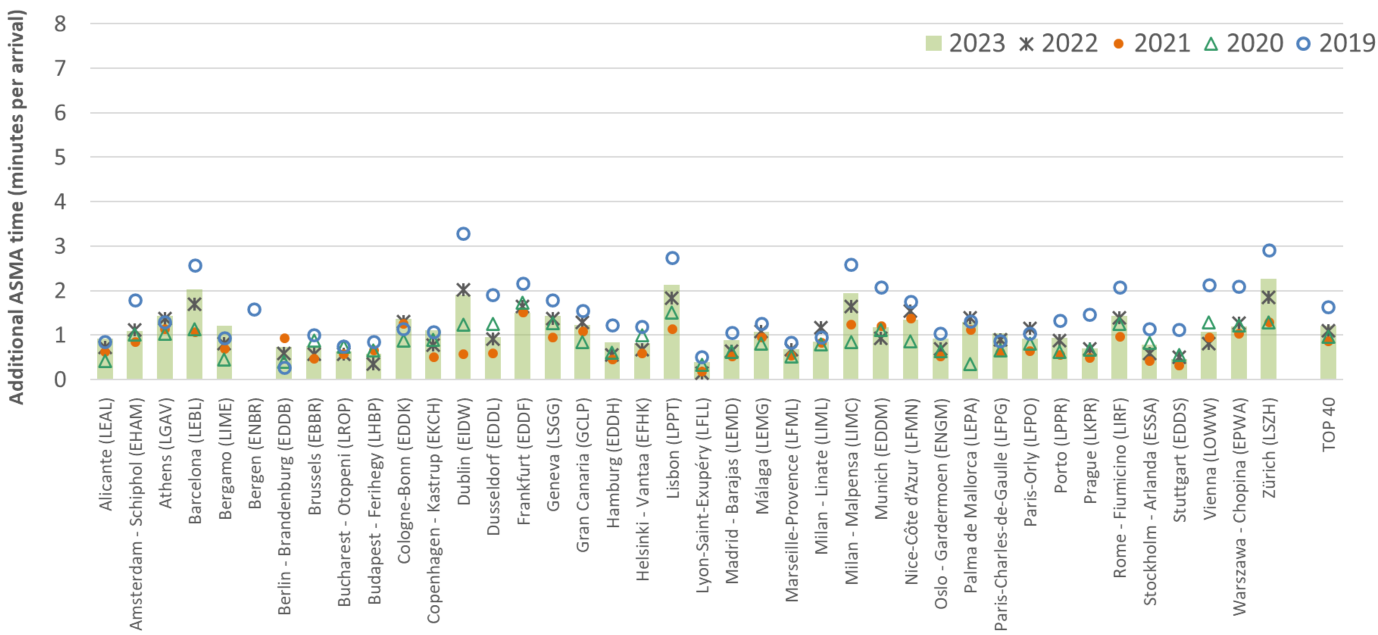


Figure 27: ATM related inefficiencies on the arrival flow (AMSA) at the 40 busiest EU27+EFTA airports (2019-2023)

Forthcoming Reference Period 4 (2025-2029)

It remains essential for the ATM industry to maintain and even strengthen its commitment to contribute to the achievement of the European Green Deal goals and a more sustainable future of the aviation. The RP4 Union-wide performance targets[100] reflect the ambition of enhancing environmental performance and sustainability while building up resilience and strengthening capacity as well as reducing costs. It is also should be noted that PRB has developed a Traffic Light System to assess Member States environmental performance[101].

The PRB advice to the European Commission regarding the performance indicators for RP4 placed a focus on improving the ATM environmental performance by prioritising actions which enable airspace users to fly the most fuel-efficient trajectories and thus reduce the fuel burn gate-to-gate [41]. In the interest of better flight efficiency in European airspace, all efforts need to be made by ANSPs and the Network Manager to support fuel-efficient trajectories, avoiding detours and delays due capacity hotspots.

Given the interdependency between the environment and capacity KPAs, it is crucial to address the long-term capacity shortages faced by certain ANSPs in order to enable the required environmental performance improvements. Such capacity issues have been observed since the second SES Reference Period (2015-2019), and they have re-emerged during the recovery from the COVID-19 crisis due to insufficient ATCOs in the core area of Europe to adequately meet traffic demand.

Recognizing the forecasted traffic growth during RP4, which may impact the complexity of operations, and the continued consequences of the war in Ukraine, the future RP4 environmental targets improve following a step-wise approach with KEA targets reducing from 2.80% for 2025 to 2.66% for 2029. Progress has also been made in the development of new and revised performance monitoring indicators (PIs), including within the environmental area, that draw on the results of a study conducted by the Commission. These are currently being discussed by the Single Sky Committee with a view to their possible use during RP4.

Preparations for Reference Period 5 (2030-2034)

The new rules to be developed for the performance and charging scheme on the basis of the SES2+ Regulation will start to apply during RP5. This includes a single key performance area that would cover both environmental and climate aspects, as well as a requirement for binding targets for terminal air navigation services provided that adequate environmental indicators are identified and put in place.

The SES performance and charging scheme aims to capture the relationship between flight routing and environmental impacts, and existing indicators were previously regarded as reasonable proxy measures to incentivise ANSP efficiency. However, limitations with the current environmental KPI/PIs have been identified and were confirmed during the COVID pandemic, when some Member States were unable to meet their environmental targets despite a dramatic

[100] EC (2024), Commission Implementing Decision (EU) 2024/1688 of 12 June 2024 setting Union-wide performance targets for the air traffic management network for the fourth reference period from 1 January 2025 to 31 December 2029.
[101] PRB (2024), Traffic light system for environmental performance 2023.

reduction in traffic. These weaknesses should be borne in mind when drawing conclusions on the basis of the existing KEA KPI, especially when considering the performance achieved at the level of an individual EU Member State's airspace.

It is recognized that the SES performance scheme needs to be improved in terms of the ATM-related performance indicators for environment. KEA does not provide the needed granularity at national level to specifically assess the contribution of ATM to environmental efficiency. However, while this main KPI is not considered fit for purpose, gaining agreement on alternative has proved complicated. Work is now ongoing to find a more robust KPI which, after a period of monitoring and analysis during RP4, will be ready for performance target setting in RP5 and beyond.

Operational performance indicators

Total gate to gate CO_2 emissions

The total gate to gate CO_2 emissions within the EUROCONTROL area[102], or the part of the trajectory within the airspace for flights to and from the area, were 180.2 million tonnes in 2023, which represents an increase of 14% over 2022. Figure 28 illustrates the breakdown of these CO_2 emissions by flight phase and, as expected, the cruise and climb phases have the highest share of emissions with 63% and 23% respectively. While much less inefficiencies are detected in the climb phase than in the descent phase, and consequently more attention was given to the descent phase, it is important to note that even a small percentage of inefficiency during the climb can result in a significant amount of additional CO_2.

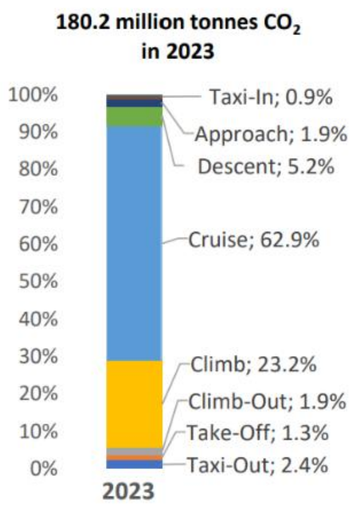


Figure 28: Total CO_2 emissions by flight phase within the EUROCONTROL area during 2023

Network Fuel Burn

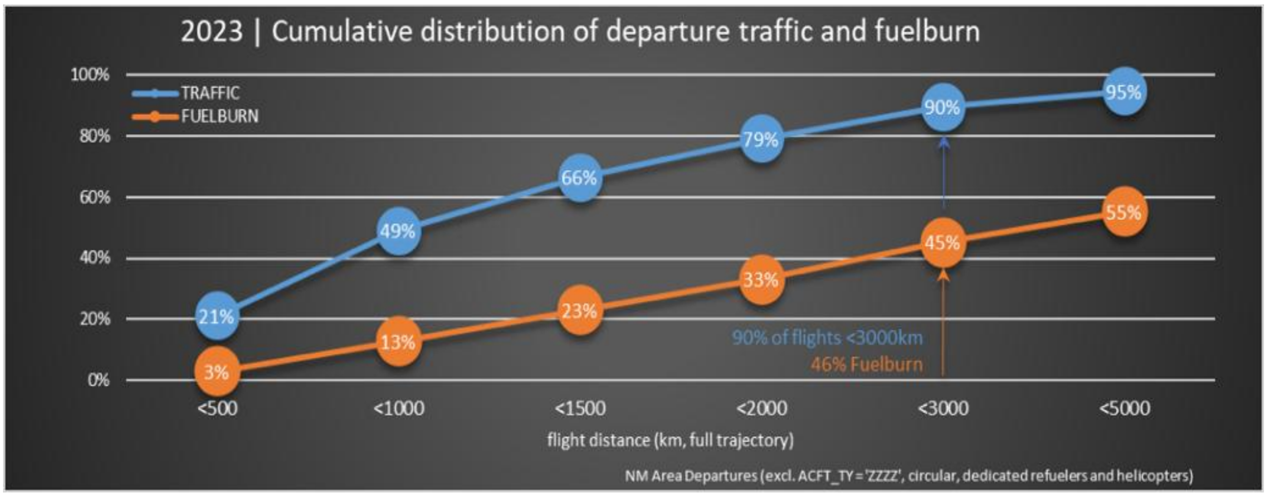
The SES Network Manager (NM) has developed an Excess Fuel Burn (XFB) metric as a measure of the fuel inefficiency on a particular route for a particular aircraft type, compared to a reference based on the best performer on that city pair / aircraft type combination.

Subsequently, the NM has enhanced its fuel burn dataset with fuel profiles for all flights, including fuel burn at specific points along the flight profile, and presents it in different ways on the NM's

[102] EUROCONTROL (2025), EUROCONTROL Area.

CO_2MPASS dashboard[103]. Figure 29 highlights that 95% of NM departures fly less than 5,000km and represent 55% of total fuel burn, meaning that just 5% of departures representing long-haul flights greater than 5,000km burn 45% of total fuel.

Figure 29: Cumulative distribution of departure and fuel burn in 2023



Free Route Airspace

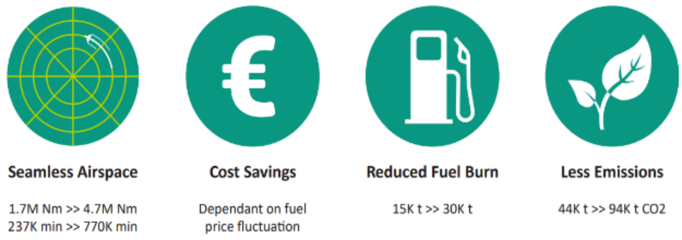
Free Route Airspace (FRA) is a SESAR solution that is defined as a volume of airspace within which users may freely plan a route between any defined entry and exit points, subject to airspace availability[104]. The continuous implementation of FRA in Europe over the past years has been an enabler for improved flight efficiency, as it provides airlines with greater flexibility to file more efficient flight plans. However, FRA must not only be implemented but also applied by airlines to reap the benefits.

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

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

[103] EUROCONTROL (2024), CO_2MPASS Interactive Dashboard.
[104] EUROCONTROL (2022), Free route airspace

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



Impact of strikes on European Aviation

Between 1 March and 9 April 2023, there were 34 days with industrial action impacting air transport in Europe, mostly in France but also, to a lesser extent, in Germany. As context, for the whole of 2022, there were 5 days of industrial action in France. The 34 days of strikes in 2023 potentially impacted 237,000 flights (flights to, from or across the countries mentioned above, mainly France). By comparison, the airspace closures in Europe resulting from the eruption of the Eyjafjallajökull volcano in 2010 (15-22 April) led to the disruption of some 100,000 flights.

In addition to the impact on passengers, strikes can also have a large environmental footprint. EUROCONTROL estimates that an extra 96,000 km were flown each strike day in 2023, with an average additional 386 tons of fuel burnt and 1,200 tons of CO_2 emissions[105] . The average cost to aircraft operators of cancellations and delays was €14 million per day.

Each Strike Day (during 7 March - 9 April)
96,000 additional km flown
386 tons of additional fuel burnt
1,200 additional tons of CO_2 emissions

[105] EUROCONTROL (2023), Impact of strikes on European Aviation.

As an example, on 12 March, around 40 flights had to extend their path by at least 370 km in order to avoid French airspace (when compared to their flight plans on 5 March, a non-strike day). These strikes also impacted up to 30% of flights across the continent, highlighting the disproportionate impact that disruptions in one country can have on neighbouring countries and the European Network as a whole. Although France does have minimum service provisions, preventing the complete closure of its ATC operations, these do not protect overflights. Minimum service regulations across Europe that protect overflights (such as are seen in, for example, Italy and Spain) would go some way to protect the flying public from the type of disruption as well as the associated environmental impact.

SESAR: Towards the digital European sky

SESAR Research and Development

The first SESAR Joint Undertaking was established in 2007 as the EU body responsible for the research and development phase of the SESAR innovation cycle. It has produced over 100 solutions with an estimated combined benefit that could enable a 4% reduction in CO_2 emissions per flight. The online SESAR solutions catalogue contains technical information on these solutions and their level of deployment as reported by European states[106].

The current SESAR 3 Joint Undertaking[107] has a 10-year mandate (2021-2031) to continue this work. During 2024, the European ATM Master Plan was updated to define the critical path for establishing Europe as the most efficient and environmentally friendly sky to fly in the world. It defines the Strategic Deployment Objectives and Development Priorities, providing a framework to facilitate the roll out of SESAR solutions and shaping the European position to drive the global agenda for ATM modernisation at ICAO level.

The implementation of a first critical sub-set of SESAR solutions is mandated by the Common Project 1 (CP1), ensuring a coordinated and timely deployment of key enablers for Trajectory-Based Operations (TBO) and for establishing a digital backbone for the Single European Sky (SES).

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

106 SESAR (2021), SESAR Solutions Catalogue.
107 EU (2021), SESAR Single Basic Act.

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

- **CLIMB and DESCENT phases**. The focus in this phase is to leverage the availability of the optimum profile for each individual flight through the Extended Projected Profile (EPP), where aircraft tend to start their descent on average 35-70 nautical miles (nmi) before what would be their optimum Top-of-Descent (ToD) point[108]. This leads to long thrust descent, which is inefficient even if it does not include intermediate level-offs (Figure 30). The EPP provides visibility of the optimum top-of-climb and top-of-descent points on the ground, making it possible for air traffic controllers to facilitate a better trajectory. In addition, SESAR advocates a transition from conventional fixed arrival routes commonly used today, towards a more dynamic deployment of RNP (Required Navigation Performance) route structures within the Terminal Manoeuvring Area. Utilizing these dynamic routes increases capacity during peak periods, optimizes fuel consumption during off-peak hours, and decreases the noise footprint particularly during nighttime operations. Moreover, the adoption of these dynamic routes enables agile responses to fluctuations in operational conditions.

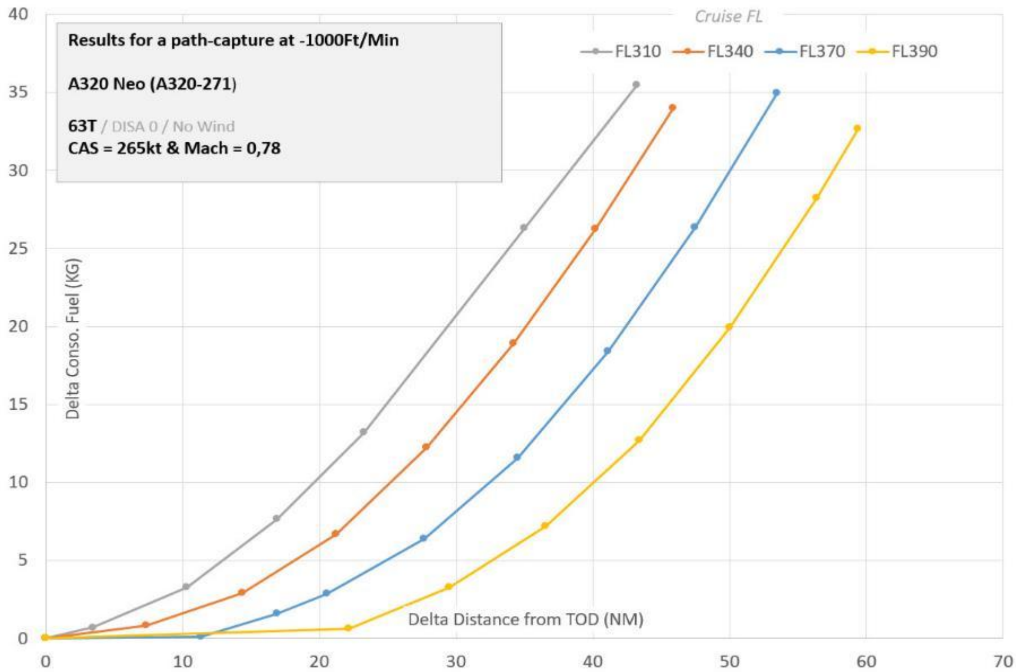


Figure 30: Increased fuel consumption as a function of the distance before the optimum Top of Descent that the descent phase is started, without intermediate level-offs (e.g. when a descent from cruise at FL370 is started 50nmi early, the additional fuel burn is 30 kg).

- **CRUISE phase**. Free route in the horizontal domain is already widely available in Europe. As such, the enhancement of vertical flight efficiency is a priority through the provision of sufficient airspace capacity for aircraft to fly at their optimum altitude. While the exact increase

108 SESAR (2025), SESAR Deployment Manager

in emissions varies based on aircraft type and specific flight conditions, studies suggest that flying at lower altitudes can increase fuel consumption by approximately 6-12% compared to optimal cruising altitudes[109,110]. An increase in capacity can be achieved via digital and automation support for all ATM processes, including air traffic controllers, such as Dynamic Route Availability Document (RAD) that results in fewer vertical restrictions both at flight-planning and during the flight[111]. ATM may also evolve to support the deviation of flights to avoid cruising within airspace where non-CO2 impacts are disproportionately high (referred to as eco-sensitive volumes).

The SESAR 3 Joint Undertaking has also provided support to operational stakeholders in the monitoring and management of their environmental performance in the planning, execution, and post-operation phases. At the airport level, this includes the full integration of environmental performance monitoring with the Airport Operations Plan (AOP)[112].

Trajectory optimization in a digital environment

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

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

[109] SESAR (2021), SESAR Solutions Catalogue charting progress towards the Digital European Sky.
[110] SESAR (2020), Albatross Project.
[111] SESAR (2024), Dynamic Route Availability Document (RAD)
[112] SESAR (2024), Airport Operations Plan (AOP)

SESAR Deployment

The SESAR Deployment Manager[113] [36] plans, synchronizes, coordinates and monitors the implementation of the 'Common Projects' that mandate the synchronized deployment of selected ATM functionalities (AF) based on SESAR solutions. The current Common Project (CP1) [EU 2021/116] has 6 AF (Figure 31) aiming to reduce inefficiencies and thus generate fuel and CO_2 savings in different phases of the flight, especially cruise. The SESAR Deployment Programme [38] defines how the operational stakeholders will implement CP1 AF, which is due to be completed by 31 December 2027. The expected performance benefits from CP1 AF represent approximately 20% of the European ATM Master Plan performance ambitions for 2035 [40] and will be a critical step towards sustainable ATM-related aviation in Europe. 65% of CP1 CO_2 savings are expected to be found in the cruise phase, 25% in the descent phase and 10% in the taxi-out phase. By the end of 2023, [CP1] already delivered € 4.6bn worth of cumulative benefits. This value is set to reach € 19.4bn by 2030, once [the CP1] is fully deployed, whilst in a longer timespan [CP1] is expected to bring € 34.2bn worth of cumulative benefits by 2035 and € 52.3bn by 2040.

Figure 31: Overview of Common Projects 1 (CP1) ATM Functionalities

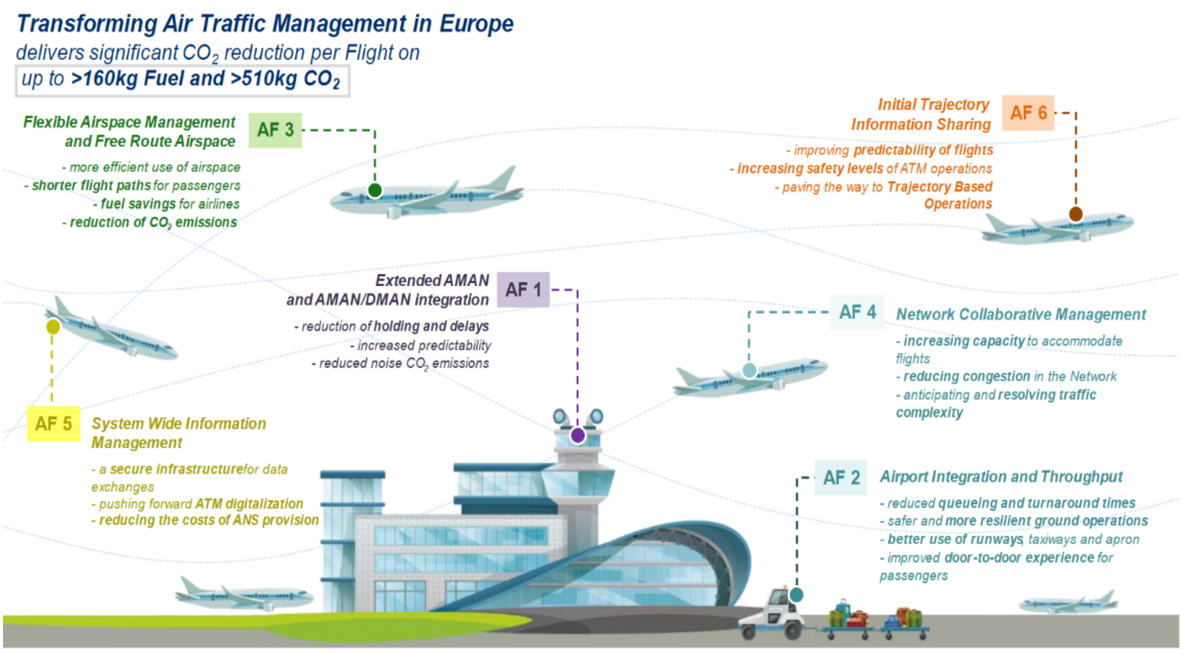


Table 19 below details the total CO_2 savings potential of concerned flights, that could be expected should all CP1 sub-AF concepts be deployed in the future ATM system with all technologies mature and realizing their full benefits. The values in the table below represent an order of magnitude of CO_2 savings that can be expected from different sub-functionalities, and which highly depend on the specific conditions of the flight and the local situation.

[113] EU (2021), SESAR Single Basic Act

Table 19: CO_2 savings per Common Project 1 ATM Functionality

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

The benefit-cost ratio (BCR) of the investment in CP1 AF shows the value of the investment by comparing the costs of a project with the benefit that it generates. In this case, it has been estimated that every euro invested into CP1 deployment brought 1.5 euros in return during 2023 to the stakeholders in terms of monetizable benefits, as well as 0.6 kg of CO_2 savings (Table 20). Furthermore, the BCR and CO_2 savings are expected to increase overtime as CP1 AF are fully implemented (Table 21).

Table 20: Benefit-Cost Ratio and CO_2 savings from CP1 AF implementation

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

Table 21: Savings in fuel and CO_2 emissions per flight in 2023 and the forecast to 2040

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

STAKEHOLDER ACTIONS

Improving flight efficiency in Skyguide's airspace

Skyguide introduced Free Route Airspace (FRA) within the area under its responsibility at the end of 2022 (Switzerland and parts of France, Italy, Germany and Austria). One of the objectives of Skyguide's FRA project was to optimise flight trajectories between Switzerland and Germany, independent of airspace boundaries. A post-implementation analysis confirmed significant improvements in horizontal flight efficiency. Compared with the pre-COVID period, planned flight paths within Swiss airspace have been improved by 22%. As a result of cross-border FRA, horizontal flight efficiency performance at the Skyguide-DFS interface has also improved significantly, with planned and flown trajectories at the entry points improving by 16% and 19% respectively. In 2023, despite a 5% increase in traffic compared with 2022, planned and flown trajectories improved by 13% and 2% respectively, thanks mainly to Skyguide's cross-border FRA.

iCERO – Citizen and Community Empowerment in Route Optimization

Austro Control, in collaboration with the Federal Government, is enhancing transparency and public involvement regarding air traffic noise in Austrian airspace. In 2024, an innovative public participation process was launched, inviting citizens to engage and actively shape instrument flight rules (IFR) arrival and departure procedure changes in Austria. Through this initiative, citizens can propose enhancements to existing IFR routes and provide valuable feedback on new or modified routes. Submissions are reviewed by an expert panel, ensuring every input is considered and assessed. In the first two months of operation, more than 500 inputs were recorded and processed. The entire process is transparently documented, with Austro Control keeping the public informed every step of the way. It aims to enhance quality of life by reducing noise and fostering a safer, punctual, and environmentally friendly air traffic system.

CONCERTO – Dynamic Collaboration to Generalize Eco-friendly Trajectories

The CONCERTO project aims to make eco-friendly trajectories an everyday occurrence in order to reduce the CO_2 and non-CO_2 impact of aviation. The project will look to integrate green air traffic control capacity into the system, and support stakeholders in balancing regularity and environmental performance at local and network levels. The project will do so by leveraging state-of-the-art climate science and data to allow ATM stakeholders to take their “eco-responsibility” to the next level. At the same time the project aims to demonstrate that mitigation measures can be deployed progressively at network level, in sync with scientific progress.

6.4 MARKET-BASED MEASURES

- Market-based measures incentive in-sector’ emissions reductions from technology, operational measures and sustainable aviation fuels, while also addressing residual emissions through ‘out-of-sector’ measures.
- Emissions trading systems (e.g. ETS) have a greenhouse gas emissions cap covering various economic sectors, while offsetting schemes (e.g. CORSIA) compensate for emissions via reductions in other sectors but without an associated cap.
- During 2013 to 2023, the EU ETS led to a net CO_2 emissions reduction in aviation of 206 Mt through funding of emissions reductions in other sectors, of which 47 Mt in 2021-2023.
- EU ETS allowance prices have increased in the recent years, reaching an average annual price of more than €80 per tonne of CO_2 in 2022 and 2023.
- Revisions were agreed to the EU ETS in 2023, including a gradual phase-out of free allowances to airlines and a reduction to the aviation emissions cap from 2024 onwards.
- Monitoring, reporting and verification of CO_2 emissions under CORSIA began in 2019. As of 2025, 128 out of 193 ICAO States have volunteered to participate in the CORSIA offsetting scheme.
- Offsetting under the CORSIA scheme is expected to start in 2024. A total of 19Mt of CO_2 emissions are forecast to be offset for flights departing from Europe during CORSIA’s first phase in 2024-2026.
- The first emissions units have now been authorized for use in CORSIA, complying with the UNFCCC rules on avoidance of double counting of emissions reductions.
- Technology to capture carbon from the air and store it underground is being developed to support the broader decarbonization efforts of the aviation sector.
- The EU Taxonomy System sustainable finance initiative has been amended to include aviation activities.
- No agreement has been reached on proposals to revise the Energy Taxation Directive to introduce minimum rates of taxation for intra-EU passenger flights.

Future goals to address the climate impact of the aviation sector are expected to be achieved by in-sector measures (technology, operations, fuels) that are incentivized by Market-based Measures (MBMs) through pricing of carbon emissions. This chapter provides an overview of the key MBMs that have been put in place for the aviation sector, including the EU's Emissions Trading System (ETS) and ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), as well as other sustainable finance initiatives.

EU Emissions Trading System

The cornerstone of the EU's policy to combat climate change is the EU Emissions Trading System. Various economic sectors (e.g. power, heat, manufacturing industries, maritime, aviation) have been included within this cap-and-trade system to incentivize CO_2 reduction within each sector, or through trading of allowances with other economic sectors included in the EU ETS where emission reduction costs are lower.

Aviation and the EU ETS

The EU decided to include aviation activities within the EU ETS in 2008[114], and the system has been applied to aviation activities since 2012. As such, they are subject to the EU's greenhouse gas emissions reduction target of at least minus 55% by 2030 compared to 1990. The initial scope of the EU ETS covered all flights arriving at, or departing from, airports in the European Economic Area (EEA)[115]. However, flights to and from airports in non-EEA countries or in the outermost regions were subsequently excluded until the end of 2023 through a temporary derogation. This exclusion facilitated the negotiation of a global market-based measure for international aviation emissions at the International Civil Aviation Organization (ICAO).

In July 2021, the European Commission adopted the 'Fit for 55' Legislative Package to make the EU's climate, energy, transport and taxation policies fit for achieving the 2030 greenhouse gas emissions reduction target. This included proposed amendments to the EU ETS Directive for aviation activities, which entered into force on 5 June 2023[116]. The main changes to the aviation ETS are applicable from 2024 onwards, and include the following:

- Applying EU ETS for flights within and between countries in the European Economic Area, as well as departing flights to Switzerland and to the United Kingdom, while applying CORSIA for flights to and from third countries.
- Applying EU ETS for flights between countries in the European Economic Area and the outermost regions, as well as between the outermost regions, unless they connect to the respective Member State's mainland. EU ETS also applies to flights from the outermost regions to Switzerland and the United Kingdom.
- Gradual phase-out of the free ETS allocation to airlines as follows: 25% in 2024; 50% in 2025; and 100% from 2026, meaning full auctioning of EU Allowances to the aviation sector from 2026. The free allocation for the years 2024 and 2025 is distributed according to the aircraft operators' share of verified emissions in the year 2023.
- Applying an annual linear reduction factor of 4.3% to the EU Allowances issued for aviation from 2024 onwards.
- Creation of a new incentive scheme for Sustainable Aviation Fuels (SAF). For the period from 2024 to 2030, a maximum of 20 million ETS allowances will be allocated to aircraft operators for

[114] EC (2008), 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

[115] The European Economic Area includes EU27, Norway, Iceland and Liechtenstein.

[116] EU (2023), Directive (EU) 2023/958 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/87/EC as regards aviation's contribution to the Union's economy-wide emission reduction target and the appropriate implementation of a global market-based measure.

the uplifting of SAF to cover part or all of the price difference between SAF and fossil kerosene, depending on the type of SAF used.

- Setting up a monitoring, reporting and verification system for non-CO_2 aviation effects[117]
- Assessment of CORSIA's environmental performance after the 2025 ICAO Assembly. The Commission will report in 2026 on the progress at ICAO negotiations every three years, accompanied by legislative proposals, where appropriate.

More detailed amendments to the ETS Directive are implemented though various delegated and implementing acts, which are referenced in the Directive itself.
Linking the EU ETS to other emissions trading systems is permitted provided that these systems are compatible, mandatory and have an absolute emission cap. An agreement to link the systems of the EU and Switzerland entered into force on 1 January 2020. Accordingly, flights from the EEA area to Switzerland are subject to the EU ETS, and flights from Switzerland to the EEA area fall under the Swiss ETS. Allowances from both systems can be used to compensate for emissions occurring in either system.
The Environmental Management Information Service (EMIS) of EUROCONTROL, which superseded the EU ETS Support Facility in 2023, continues to provide 28 States with access to EU ETS and ICAO CORSIA related data, as well as traffic and emissions data to over 400 aircraft operators.

Historic and forecasted aviation emissions under EU ETS

The initial total amount of aviation allowances within the EU ETS in 2012 was 95% of the average annual emissions between 2004 and 2006 of flights within the full ETS applicability scope (all flights departing from or arriving in the European Economic Area), representing 221.4 million tonnes (Mt) of CO_2 per year. The EUAAs issued for aviation activities in the ETS's third phase (2013-2020) was adjusted for the applicability scope. While aircraft operators may use EUAAs as well as EU Allowances (EUAs) from the stationary sectors, stationary installations are not permitted to use EUAAs. In addition, aircraft operators were entitled to use certain international credits (CERs) until 2020 up to a maximum of 1.5% of their verified emissions. In 2023, there were 254 aircraft operators reporting a total of 53 million tonnes (Mt) of CO_2 emissions under the EU ETS.

Aircraft operators are required to report verified emissions data from flights covered by the scheme on an annual basis. As is shown in Figure 4.1, total verified CO_2 emissions from aviation covered by the EU ETS increased from 53.5 Mt in 2013 to 68.2 Mt in 2019. This implies an average increase of CO_2 emissions of 4.15% per year. The impact of the COVID-19 pandemic on international aviation saw this figure fall to 25.3 Mt in 2020, representing a decrease of 63% from 2019 levels. From 2013 to 2020, the amount of annual EUAAs issued was around 38.3 Mt of which about 15% have been auctioned by the Member States, while 85% have been allocated for free. The purchase of EUAs by the aviation sector for exceeding the EUAAs issued went up from 20.4 Mt in 2013 to 32.4 Mt in 2019 contributing thereby to a reduction of around 155.6 Mt of CO_2 emissions from other sectors during 2013-2019. As a result of the COVID-19 pandemic, the verified emissions of 25.3Mt in 2020 were below the freely allocated allowances for the first time (see Figure 32).

Since 2021, a gradual recovery of aviation activities has been observed: total verified aviation CO_2 emissions covered by the EU ETS in 2021, 2022 and 2023 were 27.7Mt, 48.8Mt and 53.0Mt respectively. The free allowances allocated to the aviation sector were 23.9Mt in 2021, 23.1Mt in 2022 and 22.5Mt in 2023. Following the rebound of aviation sector's CO_2 emissions from the COVID-19 pandemic, the sector became a net purchaser of EUAs again in 2022 (22.0Mt) and in 2023 (24.8Mt). From 2021 until 2023, a linear reduction factor of 2.2% has been applied to the Allowances issued for aviation, and this factor will increase to 4.3% for the period of 2024-2027.

As also shown in Figure 4.1, the modelled CO_2 emissions under the aviation ETS are expected to grow to 59.5Mt in 2026. In line with the gradual phase out of the free allowances to the aviation sector, the annual amount of freely allocated EUAs for aviation is expected to reduce from 16.1 Mt in 2024 to 10.7Mt in 2025 and then become zero from 2026 onwards. Purchase of EUAs is expected to grow from 27.1Mt in 2024 to 28.7Mt in 2026. Emissions benefits from the claiming of Sustainable Aviation Fuels (SAF) could grow from 0.5Mt in 2024 to 1.7Mt in 2026, assuming a zero emissions factor of SAF as per the EU ETS Directive. Moreover, there could be a relative demand reduction within the aviation sector over the years 2024-2026 of 9.8Mt as a result of the carbon price incurred due to the EU ETS[118].

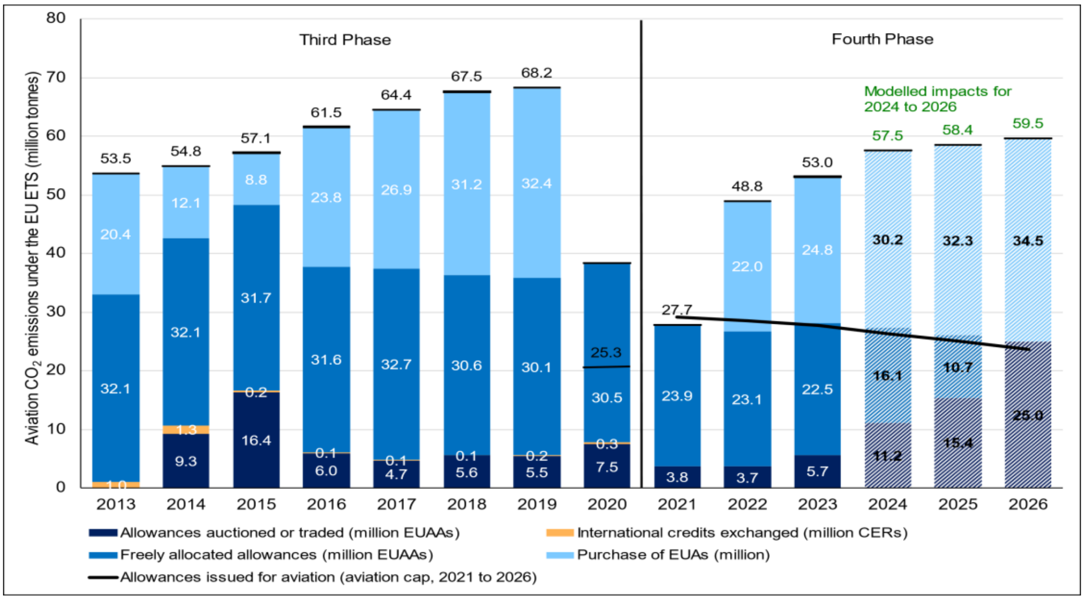


Figure 32: Aviation CO_2 emissions under the EU ETS in 2013-2023 and modelled impact of the revised ETS Directive for years 2024-2026, where 1 EUAA/EUA equals 1 tonne of CO_2 emissions[119]

Note: Data in Figure 4.1 reflects the years in which the EUAAs were effectively released to the market. This applies especially for allowances attributable to years 2013, 2014 and 2015, which were all auctioned in 2015. The 2014 auctions of EUAAs relate to auctioning of EUAAs due to the postponement of 2012 auctions. Modelled data for years 2024-2026 from the updated AERO-MS model.

As shown in Figure 33, the annual average EU ETS carbon price varied between €4 and €30 per tonne of CO_2 during the 2013-2020 period. Consequently, total aircraft operator costs linked to purchasing EU Allowances (EUAs) have gone up from around €84 million in 2013 to around €955 million in 2019. Since 2021, the EUA price has increased significantly, reaching average annual EUA prices of more than €80 in 2022 and 2023, resulting in total aircraft operator cost of approximately €1.8 billion in 2022 and €2.1 billion in 2023. Peak EUA prices exceeding €90 per tonne of CO_2 were observed in early 2022 and again in 2023. For the period of 2024-2026, it is

[118] Estimation from EASA AERO-MS model. See Appendix C for more details.
[119] In addition, the Swiss ETS is forecast to result in a purchase of ETS allowances by aviation sector as follows: 0.3 million in 2023; 0.4 million in 2024; 0.5 million in 2025 and 0.6 million in 2026.

estimated that the ETS cost could represent 4-6% of airlines' total annual operating costs[120].

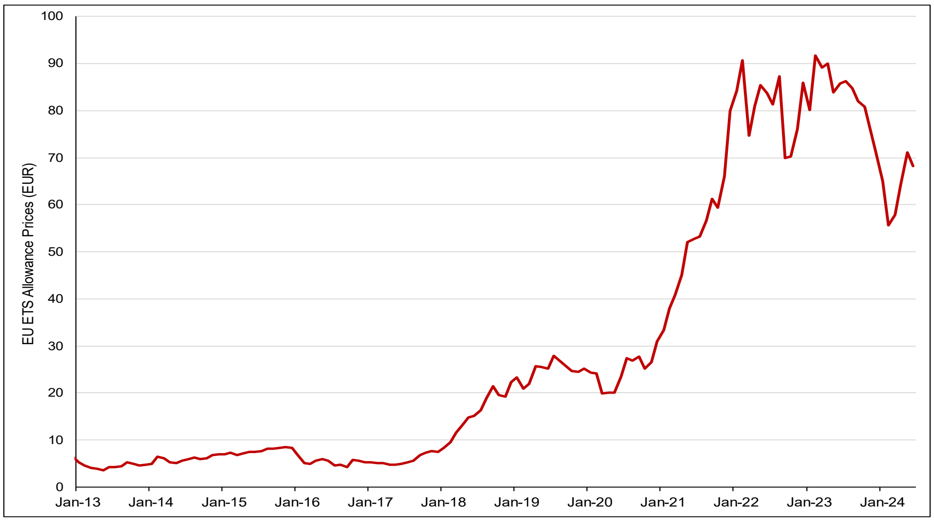


Figure 33: EU ETS Allowance Prices (2013-2024)

From 2024 until 2030, airlines can apply for additional ETS allowances to cover part or all of the price differential between the use of fossil kerosene and SAF on their flights covered by the EU ETS. A maximum amount of 20 million allowances will be reserved for such a support mechanism, and airlines can apply for an allocation on an annual basis. The Commission will calculate the price differentials annually, taking into account information provided within the annual ReFuelEU Aviation report from EASA.

European Model for Impact Assessments of Market-based Measures

The EASA AERO Modelling System (AERO-MS) has been developed to assess the economic and environmental impacts of a wide range of policy options to reduce international and domestic aviation GHG emissions. These policies include taxes (e.g. fuel and ticket taxation), market-based measures (e.g. EU ETS, CORSIA), as well as the introduction of sustainable aviation fuels and air traffic management improvements. The model can provide insight into the effect of policy options on both the supply side and demand side of air travel due to higher prices, and the forecasted impact on emission reductions.

During the last 20 years, the AERO-MS has been a key part of more than 40 international studies where the model results have informed policy discussions and decisions. Beneficiaries of the AERO-MS include a wide range of organizations, including the European Commission, Member States, EASA, IATA, ICAO, aviation industry and NGOs. As a part of a project funded by the EU Horizon 2020 research programme, an update to AERO-MS was completed in 2024 to enhance its capabilities for future studies. This included a new base year of 2019 traffic and emissions, latest information on price elasticities, the addition of particulate matter emissions modelling and the inclusion of the impacts of SAF. Modelling results from AERO-MS have been used as input for various Figures included within this Chapter.

[120] Estimation from EASA AERO-MS model.

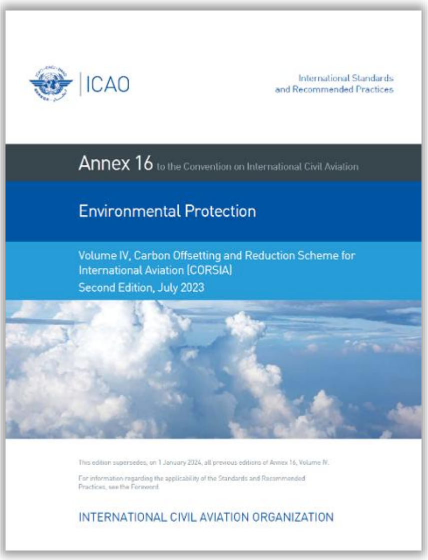
CARBON OFFSETTING & REDUCTION SCHEME FOR INTERNATIONAL AVIATION (CORSIA)

Background

In 2016, the 39th ICAO General Assembly reconfirmed the 2013 aspirational objective of stabilizing CO_2 emissions from international aviation at 2020 levels. In light of this, ICAO States adopted Resolution A39-3 which introduced a global market-based measure called the 'Carbon Offsetting and Reduction Scheme for International Aviation' (CORSIA). ICAO Assembly Resolutions are reassessed every three years, and the current Resolution A41-22 for CORSIA implementation was adopted by the 41st ICAO Assembly in 2022, following the outcome of the first CORSIA periodic review by the ICAO Council[121].

CORSIA is being implemented through the associated ICAO Standards and Recommended Practices (SARPs) contained in ICAO Annex 16, Volume IV, the 1st Edition of which became applicable on 1 January 2019. In March 2023, the 2nd Edition of Volume IV was approved by the Council and became applicable 1 January 2024. There were two main sources for the 2nd Edition updates: technical amendments arising from the 12th meeting of ICAO's Committee on Aviation Environmental Protection (CAEP) in February 2022, and consequential amendments to reflect the outcome of the 41 ICAO Assembly in October 2022.

12th ICAO CAEP Meeting



- Clarification on technical matters related to monitoring, reporting and verification provisions.
- Definition of an offsetting threshold of 3,000 tonnes of offsetting requirements per 3-year compliance cycle for aeroplane operators with low levels of international aviation activity.
- Clarification on the calculation of offsetting requirements for new aeroplane operators that do not qualify as new entrants.
- Alignment of verification-related contents with the latest applicable editions of International Organization for Standardization (ISO) documents referenced in Annex 16, Volume IV.

41st ICAO Assembly

- Use 2019 emissions as CORSIA's baseline emissions for the pilot phase years in 2021-2023; and 85% of 2019 emissions after the pilot phase in 2024-2035.
- Decision on the share of individual/sectoral growth factors: 100% sectoral growth factor until 2032; 85% sectoral / 15% individual growth factor in 2033-2035.
- Use of 2019 emissions for the determination of the new entrant operators threshold.

[121] ICAO (2022), Resolution A41-22: Consolidated statement of continuing ICAO policies and practices related to environmental protection — CORSIA.

The SARPs are supported by guidance material included in the Environmental Technical Manual (Doc 9501), Volume IV and so called "Implementation Elements", which are directly referenced in the SARPs [4]. ICAO Member States are required to amend their national regulations in line with the amended SARPs, if necessary.

Europe's participation in CORSIA

In line with the 'Bratislava Declaration' signed on 3 September 2016, and following the adoption of the CORSIA SARPs by the ICAO Council, EU Member States and the other Member States of the European Civil Aviation Conference (ECAC) notified ICAO of their intention to voluntarily participate to CORSIA offsetting from the start of the pilot phase in 2021, provided that certain conditions were met, notably on the environmental integrity of the scheme and global participation. EU member states have implemented CORSIA's MRV provisions since 2019 and, as per the revised EU ETS Directive, are implementing CORSIA's offsetting requirements since 2021 for routes between the European Economic Area (EEA) and States that are participating in CORSIA offsetting, as well as for flights between two such States[122]. Implementation of CORSIA's monitoring, reporting and verification rules within the EU has been through the relevant ETS Regulations[123,124,125].

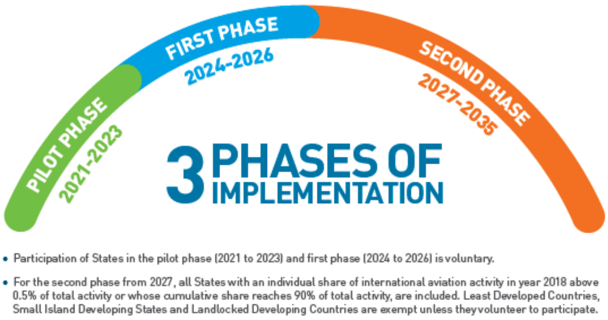
CORSIA scope and timeline

CORSIA operates on a route-based approach and applies to international flights, i.e. flights between two ICAO States. The route is covered by CORSIA offsetting requirements if both the State of departure and the State of destination are participating in the Scheme and is applicable to all aeroplane operators on the route (i.e. regardless of the administering State).

All aeroplane operators with international flights producing annual CO_2 emissions greater than 10,000 tonnes CO_2 emissions covered by CORSIA's offsetting requirements above from aeroplanes with a maximum take-off mass greater than 5700 kg, are required to monitor, verify and report their CO_2 emissions on an annual basis from 2019. The CO_2 emissions reported for year 2019 represent the baseline for carbon neutral growth for CORSIA's pilot phase (2021-2023), while for the first and second phases in 2024-2035, the baseline is 85% of the CO_2 emissions reported for year 2019. The aviation sector is required to offset any international these baseline levels.

[122] As per the ETS Directive, EU ETS is being applied for flights within and between countries in the European Economic Area, as well as departing flights to Switzerland and to the United Kingdom.
[123] EU (2024), Implementing Regulation (EU) 2018/2066 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC and amending Commission Regulation (EU) No 601/2012
[124] EU (2018), Implementing Regulation (EU) 2018/2067 on the verification of data and on the accreditation of verifiers pursuant to Directive 2003/87/EC.
[125] EU (2019), Commission Delegated Regulation (EU) 2019/1603 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.

CORSIA includes three implementation phases. During the pilot and first phases, offsetting requirements will only be applicable to flights between States which have volunteered to participate in CORSIA offsetting. There has been a gradual increase of States volunteering to join CORSIA offsetting, rising from 88 States in 2021 to 129 in 2025[126]. The second phase applies to all ICAO Contracting States, with certain exemptions.



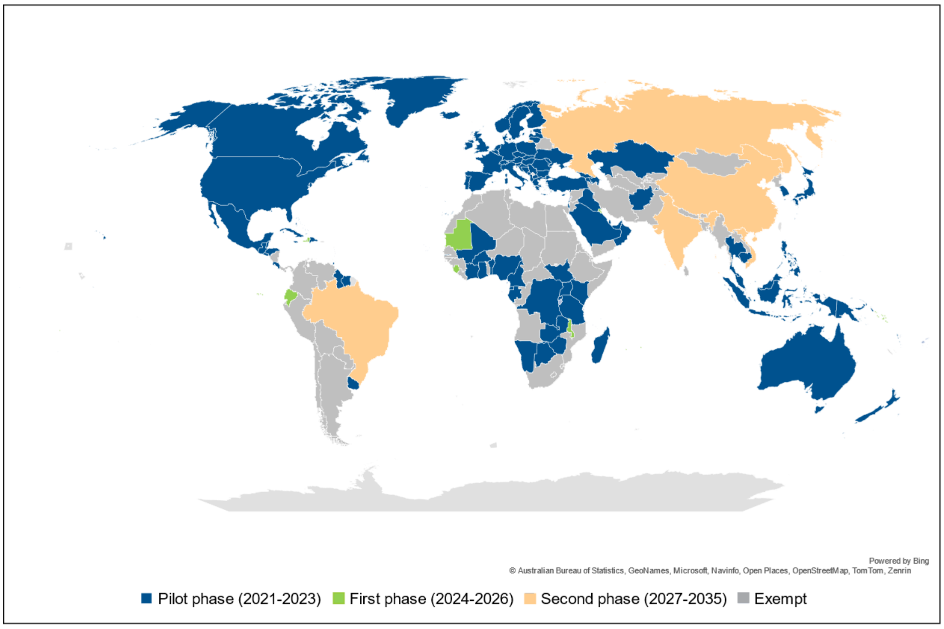


Figure 34: ICAO Member States participation in CORSIA offsetting in various phases

Due to the change in CORSIA baseline to 2019 emissions for years 2021-2023, and the fact that international aviation emissions covered by routes between two States that have volunteered to join CORSIA offsetting have not reached 2019 levels by 2023, there has not been any offsetting requirements to airlines from CORSIA during its pilot phase. Figure 35 illustrates the reported CO_2 emissions from all international flights (blue bars) and a subset of these emissions (green bars) between States that have volunteered to join CORSIA offsetting in respective years. For years 2021-2023, CORSIA's baseline emissions are the total CO_2 emissions covered by CORSIA offsetting in 2019. This baseline emissions will be re-calculated for every given year, based on the routes covered by CORSIA offsetting requirements in that given year.

[126] ICAO (2024), CORSIA States for Chapter 3 State Pairs

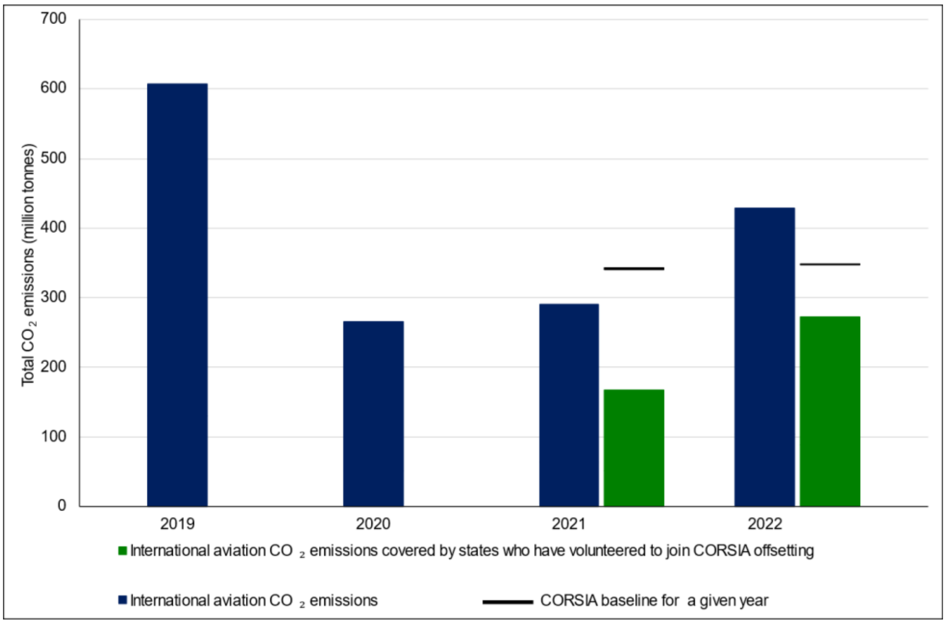


Figure 35: International aviation CO_2 emissions reported through the CORSIA Central Registry

The revised EU ETS will be applied to flights within and between countries in the European Economic Area, as well as departing flights to Switzerland and to the United Kingdom, while applying CORSIA offsetting for flights to, from and between third countries that participate in CORSIA offsetting. It is estimated that the offsetting requirements for flights departing from Europe will increase from 5.2 tonnes in 2024 to 7.3 tonnes in 2026[127] (Figure 35).

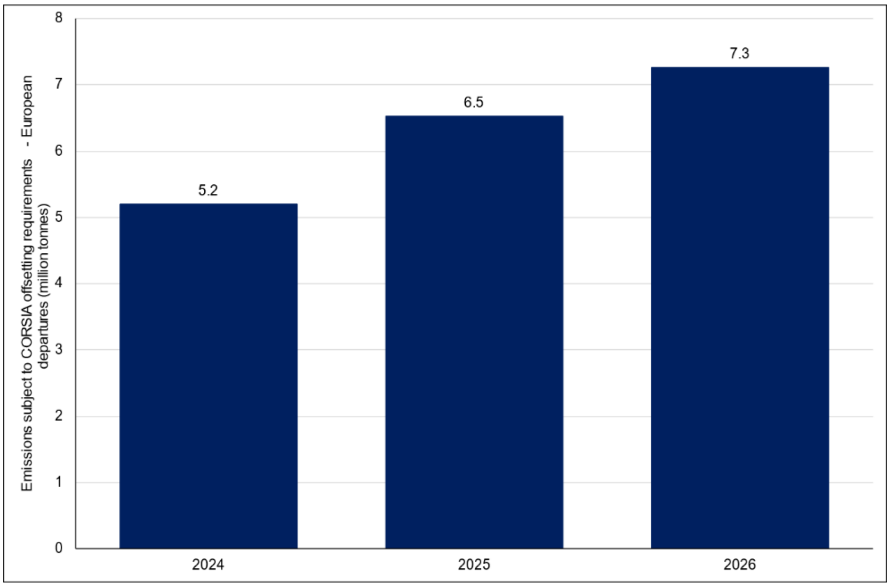


Figure 36: Estimated CORSIA offsetting requirements for departing flights from Europe[128]

[127] Estimation by EASA AERO-MS model.
[128] Covers departing traffic for all airlines from EEA countries and Switzerland to third countries that participate in CORSIA offsetting, except for flights to the United Kingdom, which are covered by EU and CH ETS.

CORSIA in practice

International flights within the scope of CORSIA are attributed to an aeroplane operator, and each operator is attributed to an administrating State to which it must submit an Emissions Monitoring Plan. Since 1 January 2019, an aeroplane operator is required to report its annual CO_2 emissions to the State to which it has been attributed, irrespective of whether it has offsetting obligations. As of 1 January 2021, the State calculates annual offsetting requirements for each operator that has been attributed to it by multiplying the operator's CO_2 emissions covered by CORSIA offsetting obligations with a Growth Factor. For years 2021-2032, the Growth Factor represents the percentage growth of the aviation sector's international CO_2 emissions covered by CORSIA's offsetting requirements in a given year compared to the sector's baseline emissions. For the period of 2033-2035, the Growth Factor is calculated by using 85% of the sector's growth against the baseline and 15% of individual aeroplane operator's growth against the baseline.

At the end of each 3-year compliance period (2021-2023, 2024-2026, etc.), an aeroplane operator must meet its offsetting requirements by purchasing and cancelling certified CORSIA eligible emissions units. Each emissions unit represents a tonne of CO_2 avoided or reduced. In order to safeguard the environmental integrity of offset credits used under CORSIA, the emission units must comply with the Emission Unit Criteria approved by the ICAO Council. The price of a CORSIA eligible emissions unit has varied greatly depending on the type of the project ($0.50 to $45/t$CO_2$e during 2020-2021 with a weighted average of $3.08/t CO_2eq in 2021)[129]. For the period 2024-2026, it is estimated that the cost of purchasing CORSIA offset credits could be limited at 0.07-0.15% of the total annual operating costs for airlines. Aeroplane operators can also reduce their offsetting requirements by using CORSIA eligible fuels (CEF) that meet the CORSIA sustainability criteria, which includes at least 10% less CO_2e emissions on a life-cycle basis compared to a reference fossil fuel value of 89.1g CO_2e/MJ.

ICAO has established a Technical Advisory Body (TAB) to undertake the assessment of Emissions Unit Programmes against the approved Emissions Units Criteria, and to make annual recommendations on their use within CORSIA. To date, based on the TAB's recommendations, the ICAO Council has approved 11-emissions unit programmes to supply CORSIA Eligible Emissions Units for CORSIA's pilot phase in 2021-2023, and two programmes to supply Units for the first phase in 2024-2026[130].

In addition to avoidance and reduction projects, removal projects that are designed to remove carbon from the atmosphere can include both natural (e.g., planting trees) and technological carbon removal processes (e.g. Direct Air Capture – DAC or Direct Air Carbon Capture and Storage – DACCS) and have a potential to produce high-quality carbon offsets in the future. Carbon capture and storage technologies can also potentially be utilized for the production of sustainable aviation fuels. The EU has put forward a carbon removal certification framework[131], which aims to scale up carbon removal activities by empowering businesses to show their action in this field. Such certified removals can potentially become eligible in schemes such as CORSIA or when offsetting internal aviation emissions.

In order to address concerns on double counting, rules for international carbon markets under Article 6 of the Paris Agreement were adopted at the UN COP26 meeting in 2021. These rules require a host country to authorize carbon credits for 'international mitigation purposes', such

[129] Ecosytem Marketplace (2024), CORSIA Carbon Market Data
[130] ICAO (2024), CORSIA Eligible Emissions Units
[131] EC (2022), Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a Union certification framework for carbon removals

as CORSIA, and to ensure that these emission reductions are not used to achieve its National Determined Contribution (NDC) under the UNFCCC process. These rules are designed to guarantee that corresponding adjustments take place prior to these emission reductions being used to demonstrate compliance with CORSIA. First announcements of authorizations of carbon credits for CORSIA compliance purposes have been observed in early 2024[132].

What are the differences and similarities between the EU ETS and CORSIA?

The EU ETS is a **cap-and-trade** system, which sets a limit on the number of emissions allowances issued, and thereby constrains the total amount of emissions of the sectors covered by the system. In the EU ETS, these operators comprise stationary installations (e.g. heat, power, industry), maritime transport operators and aircraft operators. The total sum for aviation allowances in the EU ETS is 95% of the average emissions between 2004 and 2006, adjusted for the applicability scope and reduced by the linear reduction factor annually. The total number of emissions allowances is limited and reduced over time, thereby driving operators in need of additional allowances to buy these on the market from other sectors in the system – hence 'cap-and-trade'. This ensures that the objective of an **absolute decrease of the level of CO_2 emissions** is met at the system level. The revised EU ETS Directive is expected to lead to emission reductions of 61% in 2030 compared to 2005 levels for the sectors covered by the Directive. The supply and demand for allowances establishes their price under the ETS, and the higher the price, the higher the incentive to reduce emissions in order to avoid having to purchase more allowances. Aircraft operators can also use Sustainable Aviation Fuels to comply with their ETS obligations.

The ICAO CORSIA is an **offsetting** scheme with an objective of carbon neutral growth designed to ensure that CO_2 emissions from international aviation do not exceed 2019 levels in 2021-2023 and 85% of 2019 levels in 2024-2035. To that end, aeroplane operators will be required to purchase **offset credits** to compensate for emissions above the CORSIA baseline or use CORSIA Eligible Fuels. The observed spread of the cost of CORSIA eligible emission units has been high and dependent on the project category.

EU ETS allowances are not accepted under CORSIA, and international offset credits, including those deemed eligible under CORSIA, are not accepted under the EU ETS as of 1 January 2021.

Both the EU ETS and CORSIA include similar **Monitoring, Reporting and Verification (MRV) systems,** which are aimed to ensure that the CO_2 emissions information collected through the scheme is robust and reliable. The MRV system consists of three main components: first, an airline is required to draft an Emissions Monitoring Plan, which needs to be approved by a relevant Competent Authority. After the Plan has been approved, the airline will **monitor** its CO_2 emissions either through a fuel burn monitoring method or an estimation tool. The necessary CO_2 information will be compiled on an annual basis and **reported** from airlines to their Competent Authorities by using harmonized templates. A third-party **verification** of CO_2 emissions information ensures that the reported data is accurate and free of errors. A verifier must be independent from the airline, follow international standards in their work and be accredited to the task by a National Accreditation Body.

[132] Government of Guyana (2024), World's First Carbon Credits for Use in UN Airline Compliance Programme, CORSIA

Sustainable Finance and Energy Taxation Initiatives

In addition to the EU ETS and CORSIA, there are recent regulatory developments in the area of sustainable finance and energy taxation that are relevant for the aviation sector, notably the introduction of aviation-related activities under the EU Taxonomy system, as well as proposal to introduce minimum rates of fuel taxation for intra-EU passenger flights.

EU Taxonomy

In order to direct investments towards sustainable products and activities, the EU has introduced a classification system, or "EU Taxonomy". This EU Taxonomy is expected to play a crucial role in scaling up sustainable investment and implementing the EU Green Deal by providing companies, investors and policymakers with definitions of which economic activities can be considered as environmentally sustainable. Under the Taxonomy Regulation[133], "Technical Screening Criteria (TSC)" have been developed for economic activities in various sectors. These TSC determine the conditions under which an economic activity qualifies as Taxonomy aligned and should be reviewed on a regular basis, and at least every 3 years.

On 9 December 2021, a first delegated act on sustainable activities for climate change mitigation and adaptation objectives of the EU Taxonomy ("Climate Delegated Act") was published in the Official Journal[134]. It included the activity on low carbon airport infrastructure as well as on manufacture of hydrogen and hydrogen-based synthetic fuels.

The Climate Delegated Act[135] was amended in 2023 to include the following additional aviation-related activities: manufacturing of aircraft, leasing of aircraft, passenger and freight air transport and air transport ground handling operations.

The new TSC focus on incentivizing the development and market introduction of aircraft with zero direct (tailpipe) CO_2emissions, and best-in-class aircraft (See Figure 7.6 presenting a part of the Technical Screening Criteria for "best in class" aircraft). In addition, and as transitional activities, the TSC also incentivize the manufacturing and uptake of the latest generation aircraft that replace older, less fuel-efficient models without contributing to fleet expansion. The latest generation aircraft are identified by referring to a certain margin to the ICAO New Type Aeroplane CO_2 standard, several other requirements and 'do no significant harm' (DNSH) criteria, including on emissions and noise. In addition, the TSC also puts a strong emphasis on the replacement of fossil jet fuel with Sustainable Aviation Fuels (SAF) and the technical readiness of the aircraft fleet to operate with 100% SAF.

EU Energy Taxation Directive

Aviation fuel, other than in private pleasure-flying, is currently exempted from taxation under the EU Energy Taxation Directive. EU Member States could tax fuel used for domestic flights or for intra-EU transport if agreed between the Member States concerned on a bilateral basis,

[133] EU (2020), Regulation (EU) 2020/852 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088

[134] EU (2021), Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives.

[135] EU (2023), Delegated Regulation (EU) 2023/2485 of 27 June 2023 amending Delegated Regulation (EU) 2021/2139 establishing additional technical screening criteria for determining the conditions under which certain economic activities qualify as contributing substantially to climate change mitigation or climate change adaptation and for determining whether those activities cause no significant harm to any of the other environmental objectives.

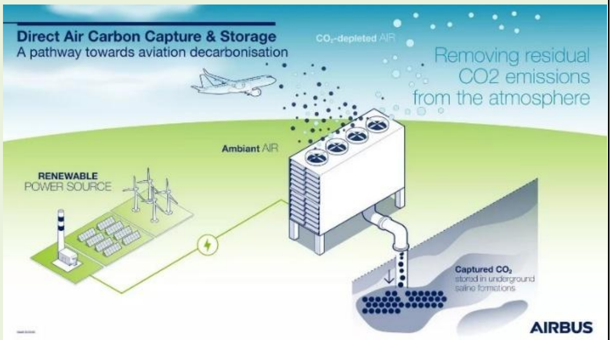
although none currently do so. As part of the 'Fit for 55' Legislative Package, the European Commission has proposed to introduce minimum rates of taxation for intra-EU passenger flights that would encourage a switch to sustainable fuels as well as more fuel-efficient aircraft[136]. According to the proposal, the tax for aviation fuel would be introduced gradually over a period of 10 years before reaching the final minimum rate of €10.75/GJ (approximately €0.38 per litre). In comparison, sustainable aviation fuels would incur a zero-tax rate during this same period and after that benefit from a lower minimum tax rate. No agreement on a final Directive has been achieved to date.

Voluntary Offsetting

In recent years, some airlines have introduced voluntary offsetting initiatives aimed at compensating, partly or in full, those CO_2 emissions caused by their operations that are not mitigated by other measures. Such voluntary initiatives have the potential to contribute to a more sustainable aviation sector, assuming that investments are channelled to high quality offset credits that meet certain quality criteria, e.g. are additional[138]. However, there has been some criticism of the quality of offset credits in this unregulated voluntary market, as well as skepticism of such voluntary activity enhancing aviation sustainability[139,140,141].

STAKEHOLDER ACTIONS

Airbus Carbon Capture Offer (ACCO)



Airbus developed ACCO with the aim to bring to the aviation industry high-environmental integrity, scalable and affordable carbon dioxide removal credits[137]. ACCO looks to support
t the management of the remaining and residual CO_2 emissions of aircraft with the latest carbon removal technologies.

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

[136] EC (2021), Proposal for a COUNCIL DIRECTIVE restructuring the Union framework for the taxation of energy products and electricity

[137] Airbus (2024), Airbus Carbon Capture Offer

[138] "Additionality" means that that the carbon offset credits represent greenhouse gas emissions reductions or carbon sequestration or removals that exceed any greenhouse gas reduction or removals required by law, regulation, or legally binding mandate, and that exceed any greenhouse gas reductions or removals that would otherwise occur in a conservative, business-as-usual scenario. [20]

[139] Bloomberg (2024), Inside the Controversy That's Divided the Carbon Offsets Market - BNN Bloomberg

[140] Washington Post (2023), Airlines want you to buy carbon offsets. Experts say they're a 'scam.' - The Washington Post.

[141] De Mello, Fabiana Peixoto (2024), Voluntary carbon offset programs in aviation: A systematic literature review, Transport Policy, Volume 147, Pages 158-168

6.5 ADDITIONAL MEASURES

- Significant airport initiatives are being taken forward to invest in onsite production of renewable energy to electrify ground support equipment, thereby mitigating noise and emissions.
- Airport infrastructure will need to be adapted to accommodate SAF and zero emissions aircraft (electric, hydrogen) to meet ReFuelEU Aviation requirements. Various research projects and funding mechanisms are leading the way.
- Some airports are supporting the uptake of SAF through investment in production, supply chain involvement, raising awareness, financial incentives and policy engagement.
- 132 airports in Europe have announced a net zero CO_2 emissions target by 2030 or earlier, and 13 airports have already achieved it.
- In 2023, a new Level 5 was added to the Airport Carbon Accreditation programme requiring 90% CO_2 emissions reductions in Scopes 1 and 2, a verified carbon footprint and a Stakeholder Partnership Plan underpinning the commitment of net zero CO_2 emissions in Scope 3.
- Global environmental challenges require global cooperation to achieve agreed future goals.
- International Cooperation is a key element to reach the global objective of net-zero CO_2 emissions by 2050 including the aim to achieve a 5% reduction of CO_2 emissions from the use of Sustainable Aviation Fuels (SAF), Low Carbon Aviation Fuels and other aviation cleaner energies by 2030.
- Since 2022, EU entities (e.g. States, Institutions and Stakeholders) have committed more than €20M to support environmental protection initiatives in civil aviation across Africa, Asia, Latin America and the Caribbean.
- Collaboration with Partner States has contributed to the sound implementation of CORSIA-Monitoring Reporting and Verification in more than 100 States and facilitated new States joining its voluntary pilot and first phases.
- Technical support contributed to the development of a first or updated State Action Plan for CO_2 emissions reduction within 18 States, and to an enhanced understanding of SAF and the associated opportunities worldwide.
- Future efforts with Partner States in Africa, Asia, Latin America and the Caribbean are expected to focus on the implementation of CORSIA offsetting and building capacity to increase SAF production.
- SAF, which has the biggest potential to significantly reduce the carbon footprint of air transport in the short- and long-term, are also an opportunity for States to develop their green economy and to boost job creation. Hence, initiatives like the EU Global Gateway are providing financial support (initially on feasibility studies) to help realise viable SAF production projects in Partner States.
- Awareness, coordination, and collaboration in International Cooperation initiatives among supporting partners are essential factors to maximise the value of the resources provided to Partner States.
- The Aviation Environmental Protection Coordination Group (AEPCG) provides a forum to facilitate this coordination of European action with Partner States.

Airport Measures

Aircraft Operations

Performance Based Navigation (PBN)

The use of Performance Based Navigation (PBN) enables an optimum aircraft flight path trajectory to mitigate environmental impacts, particularly in the vicinity of airports, without having to overfly ground-based navigation aids. Implementation of the PBN Regulation [15] has shown a positive trend since the last report. As of July 2024, 75% of instrument runways are now fully compliant with the requirements and the implementation of PBN has respectively started for 81% Standard Instrument Departures (SIDs) and 82% Standard Terminal Approach Routes (STAR) at these runways. Completion is due by 2030.

The implementation of the PBN Regulation is expected to result in a number of environmental benefits, although neither their evaluation nor their quantification is mandated. As such, it has proven challenging to identify relevant data for this report. Stakeholders responsible for putting in place the required PBN routes and procedures are encouraged to optimize airspace design and the potential environmental benefits, in particular for flight efficiency and route placement flexibility.

Green Operational Procedures

Building on the previous ALBATROSS research project [16], the goal of the SESAR project HERON launched in 2023 is to reduce the environmental impact from aviation through the deployment of already-mature solutions that range from more efficient aircraft operations to optimize management of air traffic during flights[142]. This includes the Green Apron Management demonstration, which uses sensors and artificial intelligence for more predictable and efficient aircraft handling during airport stopovers.

Noise Abatement Departure Procedures (NADPs)

NADPs aim to reduce the noise impact of departing aircraft by selecting the appropriate moment to clean the aircraft (i.e. retract flaps), which has an impact on the flown vertical profile. NADP1 results in noise reductions close to the airport, while NADP2 reduces noise further away and has lower fuel consumption (Figure 37). Depending on the operational context (aircraft type, take-off weight, weather, etc) and on the location of the noise sensitive areas, the best balance between noise and emission reductions needs to be determined.

[142] SESAR (2023), HERON research project

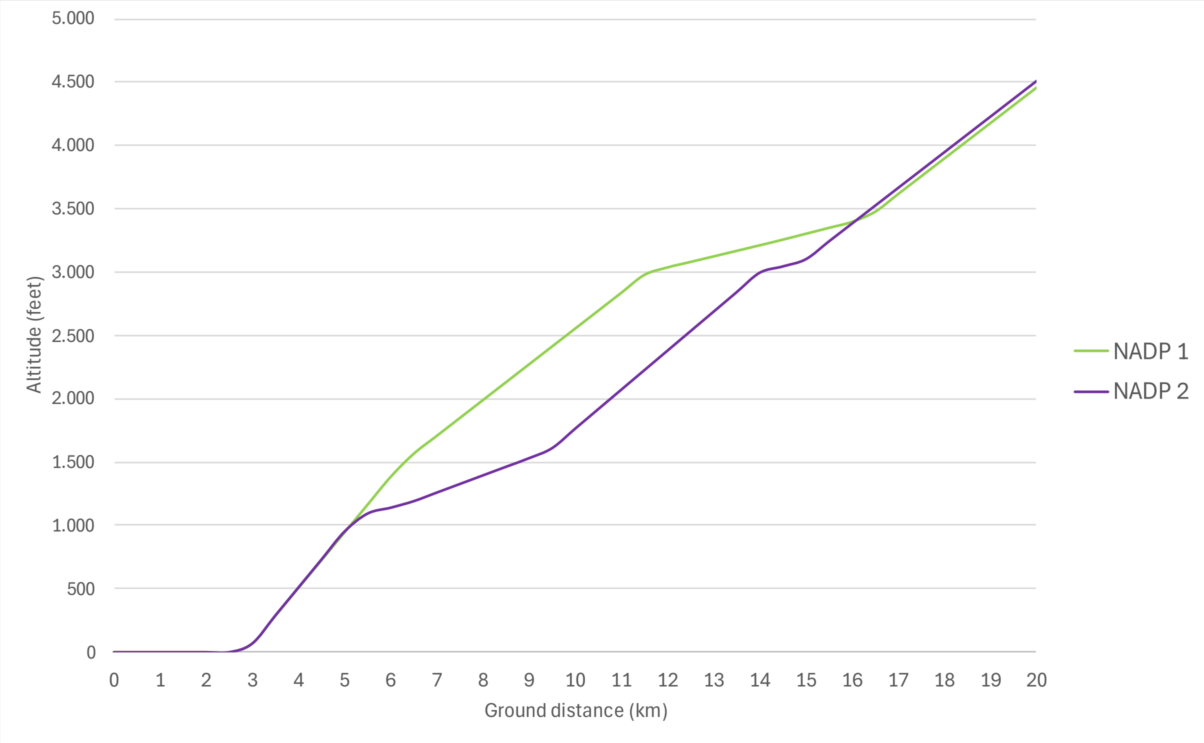


Figure 37: Example of the difference between NADP 1 and 2 for a wide body aircraft with thrust reduction at 1,000ft.

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

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

Sustainable Taxiing

Trials linked to sustainable taxiing are ongoing at various airports (e.g. Amsterdam Schiphol, Eindhoven, Paris Charles-de-Gaulle and Brussels) through various SESAR research projects as well as national projects. To incentivize implementation and to synchronize developments, a EUROCONTROL / ACI-EUROPE Sustainable Taxiing Taskforce developed a Concept of Operations in 2024[143].

[143] EUROCONTROL (2024), Sustainable Taxiing Operations – Concept of Operations and Industry Guidance

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

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

Airport Infrastructure

Various EU research projects, including TULIPS[144], OLGA[145] and STARGATE[146], are currently demonstrating innovative environmental solutions at airports, which can be replicated on a European scale.

Ground Support Equipment

Sustainable ground operations at airports have received growing attention in the last few years as a way to address concerns regarding health and working conditions of airport operational staff, as well as the impact on communities in the vicinity of airports. States are already in the process of adopting more stringent regulations to address these concerns resulting in airports looking to fully electrify their ground operations[147] [22].

To advance carbon neutrality of ground operations, Skytanking and Brussels Airport have been developing electric hydrant fuel dispensers, which deliver aviation fuel from the underground hydrant system into the aircraft. After a successful test period in 2023 during which two diesel fuel dispensers were retrofitted to run on electricity, Skytanking commissioned two custom made fully electric hydrant fuel dispenser, which were delivered in 2024 leading to a significant reduction in noise and exhaust gases, which is important for both the local environment and for the ground handling staff. As part of the same research

[144] EU (2025), TULIPS Horizon 2020 research project
[145] EU (2025), OLGA Horizon 2020 research project
[146] EU (2025), STARGATE Horizon 2020 research project
[147] Schiphol (2024), Emissions Free by 2030.

project, DHL Express has replaced a third of its ground handling fleet (tractors, container lifts, belly loaders and pushbacks) with fully electric equivalents.

In 2024, Frankfurt Airport commissioned an expansion to its vertical photovoltaic solar energy system beside Runway 18 West in order to supply renewable energy to power electrified ground support equipment [23]. This facility has provided such encouraging results that its gradually expanded from 8.4kW to 17.4MW, and is now considered the world's largest facility of its kind at an airport. The airport is also using charging infrastructure bidirectionally, which means it's possible to turn electric vehicles into mobile power storage units[148].

Zero Emission Aircraft

The European Commission has established the Alliance for Zero Emission Aircraft (AZEA) to prepare the aviation ecosystem for the entry into service of hydrogen and electric aircraft (see Technology-Design chapter). This will require major investment in energy infrastructure is required to prepare for the introduction of zero-emission aircraft with electric and hydrogen propulsion. The large-scale introduction of zero-emission aircraft will be a crucial pillar in reaching net zero carbon emissions by 2050.

GOLIAT is an EU project that brings together all relevant aviation stakeholders to demonstrate small-scale liquid hydrogen aircraft ground operations at three European airports[149]. Launched in 2024, the group will support the aviation industry's adoption of liquid hydrogen (LH2) transportation and energy storage solutions by:

- Developing and demonstrating LH2 refueling technologies scaled-up for future large aircraft;
- Demonstrating small-scale LH2 aircraft ground operations at airports;
- Developing the standardization and certification framework for future LH2 operations; and
- Assessing the sizing and economics of the hydrogen value chains for airports.

New airport pavement bearing strength calculation to optimize maintenance works

In order to ensure safe aircraft operations, airports need to continuously monitor the lifetime and life cycle of critical pavement infrastructure (runways, taxiways and aprons) based on the impact caused by different types of aircrafts with different weights, tyre geometry and tyre

[148] Fraport (2024), Frankfurt Airport Using Charging Infrastructure Bidirectionally
[149] EU (2024), GOLIAT (Ground Operations of LIquid hydrogen AircrafT) research project.

pressure. In 2024 EASA published guidance to European airports and competent authorities that changed the Aircraft Classification Rating - Pavement Classification Rating (ACR-PCR) methodology used to calculate pavement bearing strength[150]. These changes are expected to optimise the use of pavement, reduce maintenance needs and costs and also reduce greenhouse gas emissions through a well-managed and better targeted pavement life cycle management by airports.

Sustainable Aviation Fuels

The European policy framework for the deployment of SAF is ReFuelEU Aviation Regulation, which sets out a supply mandate for aviation fuel suppliers and an obligation on Union airports to facilitate this supply of aviation fuels containing the minimum shares of SAF to aircraft operators. European airports are also taking voluntary actions to support the uptake of SAF through various means (Table 22). A detailed overview of these types of SAF incentive initiatives by European airports has been compiled by ACI EUROPE[151].

Table 22: Overview of airport initiatives to support the uptake of SAF

Supply Chain Investment
• Support airlines on logistic issue to facilitate the delivery of SAF. • Engage in joint negotiations with SAF suppliers, carriers and other airports to develop SAF projects. • Invest in SAF production facilities.
Raise Awareness
• Inform passengers and corporations on opportunities to purchase SAF for their flights and/or support SAF projects to compensate for their CO_2 emissions.
Financial Incentives
• Provide airlines with SAF incentive programmes (e.g. cost sharing of SAF price premium, differentiated landing and take-off fees based on SAF use, free SAF storage).
Policy Engagement
• Engage with government and local stakeholders to support SAF development and financial incentives for airlines, but not through any kind of minimum shares of SAF other than those of ReFuelEU Aviation.

The EU ALIGHT research project, led by Copenhagen airport, is looking into how to address the barriers to the supply and handling of SAF at major airports by improving the logistics chain in the most efficient and cost-effective manner[152].

[150] EASA (2024), Guidance for the implementation of the new Aircraft Classification Rating (ACR) – Pavement Classification Rating (PCR) method for the EASA Member States
[151] ACI-E (2024), European airports' initiatives to incentivise SAF
[152] EU (2025), ALIGHT Horizon 2020 research project

Greening Aviation Infrastructure

As the aviation sector evolves to address environmental challenges, this transition is being supported through Member State actions and EU support, notably the Trans-European Transport Network[153], the Alternative Fuels Infrastructure Regulation[154] and their 'financial arm' in the form of the Connecting Europe Facility[155].

Trans-European Transport Network (TEN-T)

The revision of the TEN-T Guidelines[156] introduces requirements on Member States that include the improvement of airport connections to the trans-European railway network, air traffic management infrastructure to enhance the performance and sustainability of the Single European Sky, alternative fuels infrastructure and pre-conditioned air supply to stationary aircraft.

Alternative Fuels Infrastructure Regulation (AFIR)

The AFIR introduces mandatory targets for Member States on the provision of electricity to stationary aircraft at TEN-T network airports and requires Member States to define national strategies on deployment of ground infrastructure for electric and hydrogen aircraft.

Connecting Europe Facility (CEF)

Under CEF Transport Alternative Fuel Infrastructure Facility, 20 projects representing 63 airports from across the EU were selected since 2021, with a total EU Grant support exceeding €160 million[157,158]. The support has been directed to electricity and pre-conditioned air supply to stationary aircraft, electric charging of ground support equipment, electricity grid connections and green electricity generation.

[153] EU (2025), Trans European Transport Network (TEN-T)
[154] EU (2023), Alternative Fuels Infrastructure Regulation
[155] EU (2025), Connecting Europe Facility
[156] EU (2024), Regulation (EU) 2024/1679 of 13 June 2024 on Union guidelines for the development of the trans-European transport network, amending Regulations (EU) 2021/1153 and (EU) No 913/2010 and repealing Regulation (EU) No 1315/2013.
[157] EC (2023), Transport infrastructure: over EUR 352 million of EU funding to boost greener mobility
[158] EU (2024), CEF Transport Alternative Fuels Infrastructure Facility (AFIF) call for proposal.

Net Zero CO_2 Emissions

The ACI EUROPE Sustainability Strategy was launched in 2019[159] [35], which included the Net Zero Resolution that has been updated in 2024[160] [36]. 303 European airports have since committed to net zero[161] carbon emissions from airport operations within their control by 2050 and provided a roadmap detailing how this will be achieved[162] [37].

This net zero commitment covers Scope 1 direct airport emissions and Scope 2 indirect emissions (e.g. consumption of purchased electricity, heat or steam). 132 airports have announced a net zero target by 2030 or earlier, and 13 airports have already achieved net zero. In 2022, guidance on reducing Scope 3 emissions from others operating at the airport which are the largest share of emissions (e.g. aircraft, surface access, staff travel) was published[163] [38] and this was followed in 2023 with guidance on developing Net Zero carbon roadmaps[164] [39].

STAKEHOLDER ACTIONS

Airport Carbon Accreditation Programme

The Airport Carbon Accreditation (ACA) programme[165] [40] was launched in 2009 by the Airports Council International Europe and, as of June 2024, now includes 564 airports on a global basis. The ACA is a voluntary industry led initiative, overseen by an independent Administrator and Advisory Board, that provides a common framework for carbon management with the primary objective to encourage and enable airports to reduce their CO_2 emissions. All data submitted by airports is externally and independently verified. As of the latest 2022-2023 reporting period, there were **290 European airports** participating in the programme corresponding to 77.8% of European passenger traffic (Figure 37).

[159] ACI-E (2020), Sustainability Strategy for Airports
[160] ACI-E (2024), What is Net Zero? – ACI-E Net Zero Resolution 2024
[161] Net zero carbon dioxide (CO_2) emissions are achieved when CO_2 emissions from human activities are balanced globally by CO_2 removals from human activities over a specified period. Net zero CO_2 emissions are also referred to as carbon neutrality.
[162] ACI-E (2022), Repository for airport net zero CO_2 roadmaps
[163] ACI-E (2022), Guidance on Airports' Contribution to Net Zero Aviation
[164] ACI-E (2023), Developing an Airport Net Zero Carbon Roadmap
[165] ACI-E (2022), Airport Carbon Accreditation programme

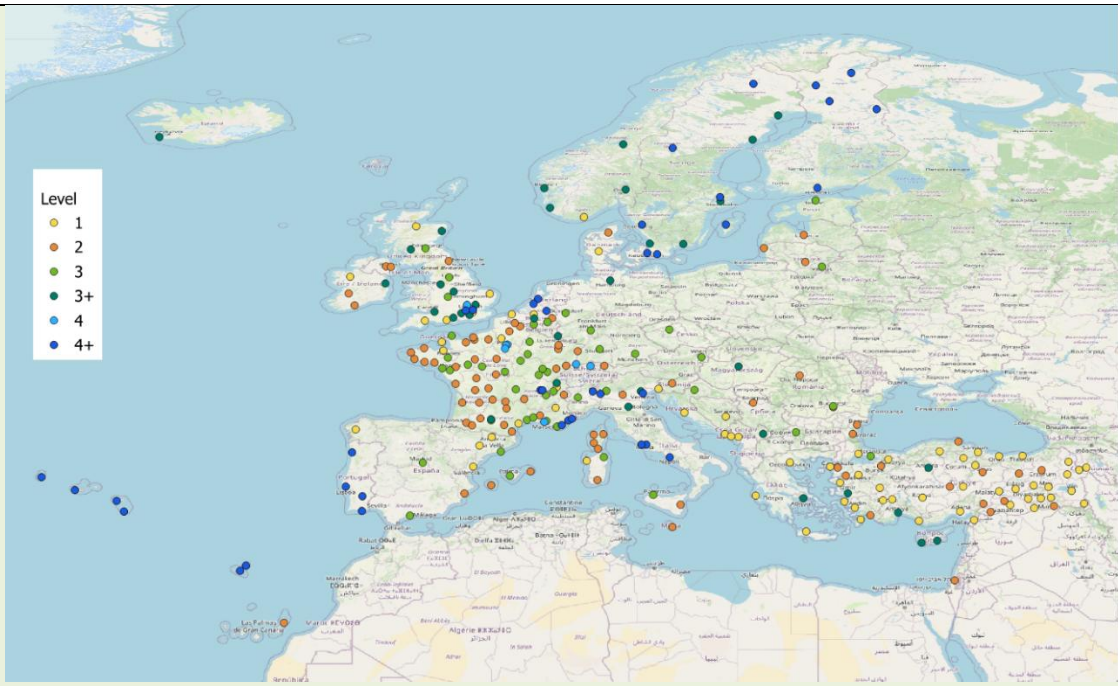


Figure 37 – European airports participating in the ACA programme

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

In 2020, Levels 4 (Transformation[166]) and 4+ (Transition[167]) have been added as interim steps towards the long-term goal of achieving net zero CO_2 emissions and to align it with the objectives of the Paris Agreement. Guidelines were also published to inform airports about offsetting options, requirements and recommendations, as well as dedicated guidance on the procurement of offsets.

In 2023, a new Level 5 was added to the ACA programme. When applying for Level 5 airports are required to reach and maintain ≥ 90% absolute CO_2 emissions reductions in Scopes 1 and 2 in alignment with the ISO Net Zero Guidelines, as well as commit to achieving net zero CO_2 emissions in Scope 3 by 2050 or sooner. Any residual emissions need to be removed from the atmosphere through investment in credible carbon removal projects. To support airports in this endeavour, an update to the Airport Carbon Accreditation Offset Guidance Document[168] was published on carbon removal options and most effective removal strategies. Level 5 accredited airports need to outline detailed steps to achieve their emissions reduction targets, as part of their Carbon Management

[166] Definition of a long-term carbon management strategy oriented towards absolute emissions reductions and aligned with the objectives of the Paris Agreement. Demonstration of actively driving third parties towards delivering emissions reductions.
[167] All Levels 1 to 4 plus offsetting of the residual carbon emissions over which the airport has control.
[168] ACA (2023), Offset Guidance Document

Plan.

Level 5 also requires airports to submit a verified carbon footprint for Scopes 1 and 2, and all relevant categories of Scope 3 as per the requirements of the GHG Protocol Guidance[169], notably covering all significant upstream and downstream activities from third parties, including airlines. Finally, airports must establish a Stakeholder Partnership Plan underpinning their commitment to net zero CO_2 emissions in Scope 3, by engaging with the entire airport ecosystem and actively driving third parties towards delivering emissions reductions with regular milestone to gauge progress.

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

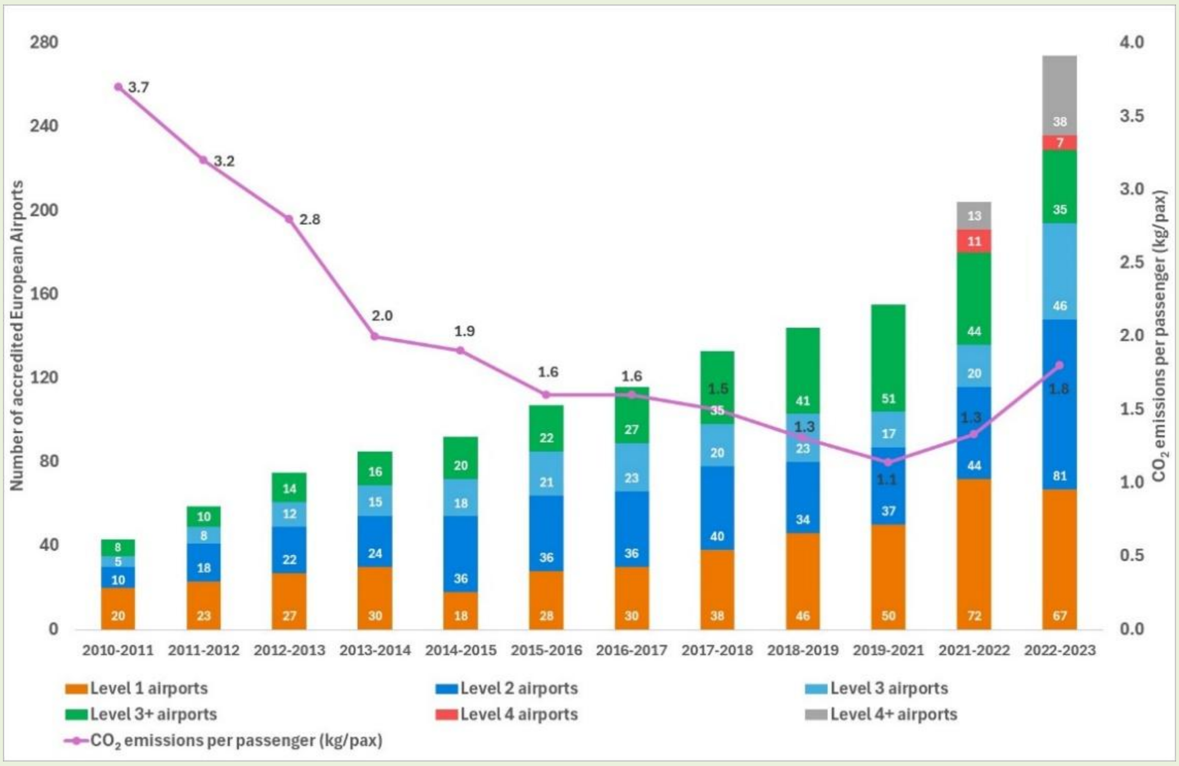


Figure 38 – Increasing number of accredited European airports and decreasing CO_2 emissions per passenger

The carbon emission per passenger travelling through European airports at all levels of Airport Carbon Accreditation has increased to **1.8 kg CO_2/passenger** (Figure 38). A total reduction in Scope 1 and 2 emissions compared to a three year rolling average[170] of **452,893 tonnes of CO_2** for all accredited airports in Europe was also reported (Figure 39). This represents about 20% reduction compared to the three-year rolling average.

[169] GHG Protocol (2025), Scope 2 and 3 Calculation Guidance

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

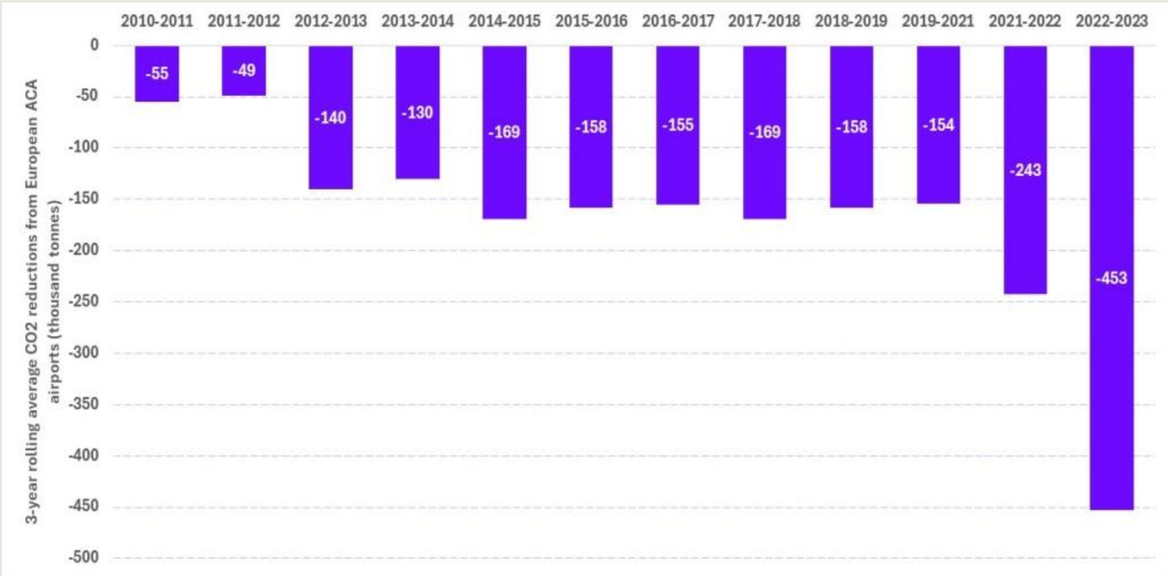


Figure 39 – Scope 1 and 2 emissions reductions in airport CO_2 emission

Further developments in the ACA programme are envisaged in 2025 that will focus on the efforts of airport supply chains to reduce their CO_2 emissions.

STAKEHOLDER ACTIONS

Airport Council International Europe (ACI EUROPE)

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

Digital Green Lane

The Digital Green Lane[171] was launched in 2023 and is a fully digital system for the delivery and collection of goods between freight forwarders and ground handlers, facilitated using cloud-based applications. This process offers numerous benefits, including shorter waiting times for the trucks that deliver and collect goods, a reduction in CO_2 emissions, increased transparency and less paper. The Digital Green Lane was further expanded by cargo community organization Air Cargo Belgium and some 95% of all cargo in the Brussels Airport cargo zone is now processed via this system. A pilot programme incorporating this same system has also been launched at Athens airport.

Airport Regions Council (ARC)

ARC is an association of local and regional authorities hosting or adjacent to both major European hub airports and smaller airports. The organisation’s expertise is at the intersection of airport operations and local/regional policies, and it supports maximizing benefits and minimizing environmental impact, ultimately striving to improve the well-being of residents in airport regions.

[171] Air Cargo Belgium (2024), Digital Green Lane

Digital Twin

Within the EU Horizon 2020 research project 'Stargate'[172], IES and Brussels Airport have developed a Digital Twin of the airport's 40 most energy-intensive buildings before modelling scenarios such as installing solar panels, electric vehicle chargers and replacing gas boilers with heat pumps to find the most effective routes to net zero carbon emissions by 2030. This marks a significant step up from the current use of digital twin technology, where it has most commonly been used to optimize commercial operations. Through rigorous modelling stages, it was verified that energy saving measures had the potential for up to 63% CO_2 savings against the 2019 baseline year. This approach will also be replicated at Athens, Budapest and Toulouse airports and promoted across ARC Members.

Non-Governmental Organizations (NGOs)

Environmental NGOs are actively involved in policy-making discussions to address the environmental impacts of aviation. They communicate civil society concerns and positions associated with noise, air pollution, climate change and social justice. They also contribute to raising awareness on aviation's environmental impact through transparency of data.

Tracking progress of business travel emissions savings

Travel Smart is a global campaign aiming at reducing corporate air travel emissions by 50% or more from 2019 levels by 2025, led by a coalition of NGOs in Europe, North America and Asia. The campaign ranks over 327 companies based on the sustainability of their business travel practices and holds them accountable through an Emissions Tracker[173] [45]. This tool uses Carbon Disclosure Project[174] [46] corporate emissions database and allows users to track the progress of a company's business air travel emissions reduction target.

The tracker shows through colored bars whether companies have returned to levels of emissions above their targets or whether they have maintained reductions of -50% or more, thereby highlighting leaders and incentivizing competition between companies. Through this Travel Smart campaign, various company best practices have highlighted that reducing flying is compatible with continued development of profitable business[175] [47].

[172] STARGATE (2025), Digital Twin project
[173] Travel Smart (2025), Emissions Tracker
[174] CDP (2025), Carbon Disclosure Project
[175] CDP (2025), Carbon Disclosure Project

SECTION B
National Actions in GREECE

SECTION B – NATIONAL ACTIONS IN GREECE

Actions for the Reduction of CO_2 Emissions from Aviation in Greece

This Section presents the actions undertaken in Greece, by Greek Government, Ministries of Transport, Environment & Energy, Hellenic Civil Aviation Authority (HCAA) and all aviation stakeholders, to reduce CO2 emissions from the aviation industry.
Greece like all ECAC States shares the view that the environmental impacts of the aviation sector must be mitigated, and long-term carbon neutrality should be achieved leading to sustainable aviation development. By preparing and submitting to ICAO an updated State Action Plan for CO2 emissions reductions, each State makes an important step towards the achievement of ICAO Long-term Aspirational Goal (LTAG) for international aviation of net-zero carbon emissions by 2050.

Greece fully supports 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 and the ICAO basket of measures, as the key means to achieve ICAO's CNG2020 target, that should include:

1. **Emission reductions at source**, including European support to CAEP work in standard setting process.
2. Research and development on **emission reductions technologies**, including public private partnerships.
3. Development and deployment of **sustainable aviation fuels**, including research and operational initiatives undertaken jointly with stakeholders.
4. Improvement and optimization of Air Traffic Management and infrastructure use within Europe, in particular through the **Single European Sky ATM Research (SESAR),** and beyond European borders through participation in international cooperation initiatives.
5. **Market Based Measures**, which allow the sector to continue to grow in a sustainable and efficient manner, achieving emissions reductions needed to meet the ICAO 2020 CNG goal. As committed by the 2016 Bratislava Declaration, **Greece supports CORSIA implementation** and voluntarily participates in CORSIA scheme, since 2019 from the start of its implementation.

B.1 Aircraft related technology improvements

B.1.1 Certification of Aircrafts for CO2 Emissions

Greece fully supports ICAO's Committee on Aviation Environmental Protection (CAEP) work on the development and update of aircraft emissions standards, in particular the ICAO Aircraft CO2 Standard adopted by ICAO. Greece along with all European states significantly contributed to its development, notably through the European Aviation Safety Agency (EASA) which is fully committed to its implementation in Europe and the need to review the standard on a regular basis in light of developments in airplane fuel efficiency. All new aircraft joining the European fleet since 2020 have engines that meet the latest CAEP/8 NOX standard Certification of all in-production aircraft types against the ICAO CO2 standard will be required by 1 January 2028, which is leading to an increase in activities within this area.

B.1.2 Greek Operators Fleet modernization

In this section the initiatives of main Greek AOC Holding Aircraft Operators are presented, which showcase significant developments in upgrading their aircraft fleet. These are Aegean Airlines, Olympic Air and Sky Express and their fleet renewal program is presented below.

Aegean Airlines

AEGEAN is committed to the long-term sustainability goals of the aviation industry and is taking an active role to support various initiatives towards achieving net zero by 2050. As part of its sustainability strategy, AEGEAN managed to significantly reduce its CO2 emissions by investing in a large Airbus A320/321neo fleet renewal program. The launch of its SAF program aims at further reducing its environmental footprint, while continuing to expand its network and operations.

More analytically, the Group applies a Sustainable Development Policy, which is incorporated in its Internal Rules of Operations. The Policy sets the framework for managing sustainable development. The Group expects to fully harmonize its operation and be able to deliver on its commitment based on the “Destination 2050 A Route to Net Zero European Aviation” roadmap - as concluded in Paris Conference on Climate Change and the European Green Deal, thus supporting economy's sustained growth.

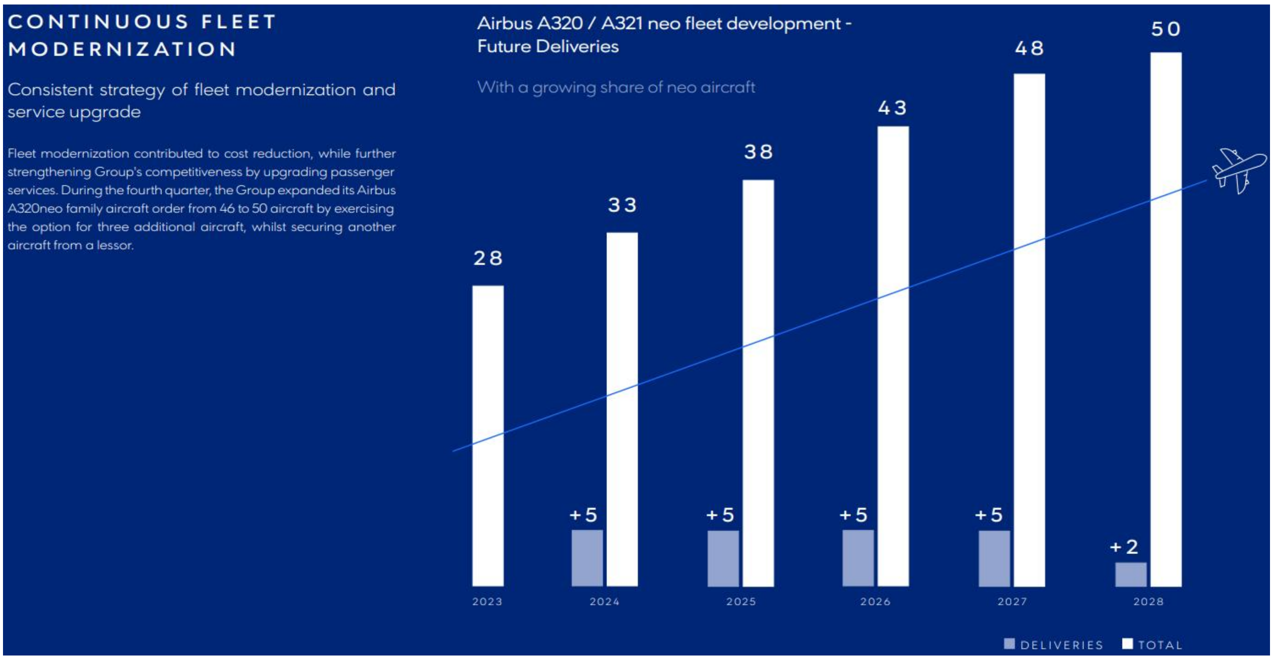
In 2023 Aegean received, 10 new Airbus A320neo, reaching 22 Airbus A320neo in total since the end of 2021. In the context of the continuous fleet renewal AEGEAN proceeded to increase the total order of new A320 neo aircrafts to 50 from 46, i.e. 3 additional aircrafts and 1 additional aircraft from a lessor.

Fleet renewal with new technology engines is expected to be completed by 2028. Pratt & Whitney's new technology GTF engines, which equip the A320 neo family aircraft, contribute to:

- a 16% reduction per flight in terms of fuel consumption and 19-23% less CO2 emissions per passenger seat, compared to previous generation of Airbus aircraft
- a 50% reduction in NOX emissions below the CAEP 6 standard, per passenger seat (compared to previous generation of Airbus aircraft, according to manufacturer data)

The new A320neo family aircraft also reduce their noise footprint by almost 50% compared to previous-generation aircraft (20 EPNdb, according to manufacturer data), with a direct positive impact on passengers, airports and residents of the surrounding areas.

Aegean monitors medium and long-term technological developments and regularly evaluates methods for integrating them into its operational processes. Such developments concern next-generation aircraft, which will use more environmentally friendly fuels, such as hydrogen, electricity and more future-proof, sustainable new-technology aviation fuels, such as synthetic fuels (also referred to as “e-fuels”).



Olympic Air:

In December 2022, an agreement was signed with Olympic Air (subsidiary of Aegean Airlines) involving the future utilization of Building 56, the largest facility of the Technical Base. This development constitutes a significant achievement since the facility has remained idle since 2014, whereas the new tenancy paves the way for Aegean’s investment plan for the development of a major Aircraft Maintenance, Repair and Overhaul (MRO) hangar, as well as a Flight Training Centre at AIA’s premises.
Olympics’ fleet renewal includes less polluting ATR-42/72 aircrafts and the purchase of three new ATR-72s to replace all older and more polluting Bombardier Q400. Olympic's fleet of Dash 8-Q400 turboprop aircraft was completely replaced with ATR72-600 aircraft. These new turboprop aircraft are expected to have 25% lower CO2 footprint compared to the Dash 8-Q400s while feature all the latest improvements of the type, offering a further 3%-5% fuel

savings, and therefore further emissions reductions.

SKY express:

SKY express is operating 33 domestic destinations and 15 international destinations and holds one of the youngest fleets with the smallest environmental footprint in the region and in Greece, both in terms of fuel efficiency and of CO_2 and NOx emissions.
To this direction Sky Express is re-inventing:

- The fleet - with the newest, most fuel-efficient technology and equipment.
- The processes - by introducing new route optimization plans, aircraft weight reduction measures and revised fuel consumption optimization policies.
- The ground operations - by upgrading energy and climate monitoring ground facilities and by consuming renewable-energy-sourced electricity (100%).
- It's industry, by actively engaging with National, European, and international authorities as a leading regional Aircraft Operator.
- The Company, by embedding Environmental, social, and governance (ESG) criteria in strategy and operations.

Concerning fleet expansion & modernization, Sky Express is growing fast, having added over the last three years:

- 8 x new A320neo and 2x A321neo aircraft featuring one of the most advanced and fuel-efficient New Engine Options by CFM International,
- 1 x A320ceo aircraft
- 8 x new ATR 72-600 aircraft, the most efficient turboprops in their category

Even though total annual CO_2 emissions have risen in 2023 compared to 2022, Sky Express CO_2 emissions per Available Seat Kilometer (CO_2 / ASK) have been reduced by 5.3%, proof of the effectiveness of the company's emission reduction operations and fleet efficiency.

Green Fleet means Green Ops' operational procedures. The company also focused on increasing efficiency and reducing fuel consumption and emissions and using state-of-the-art platforms.

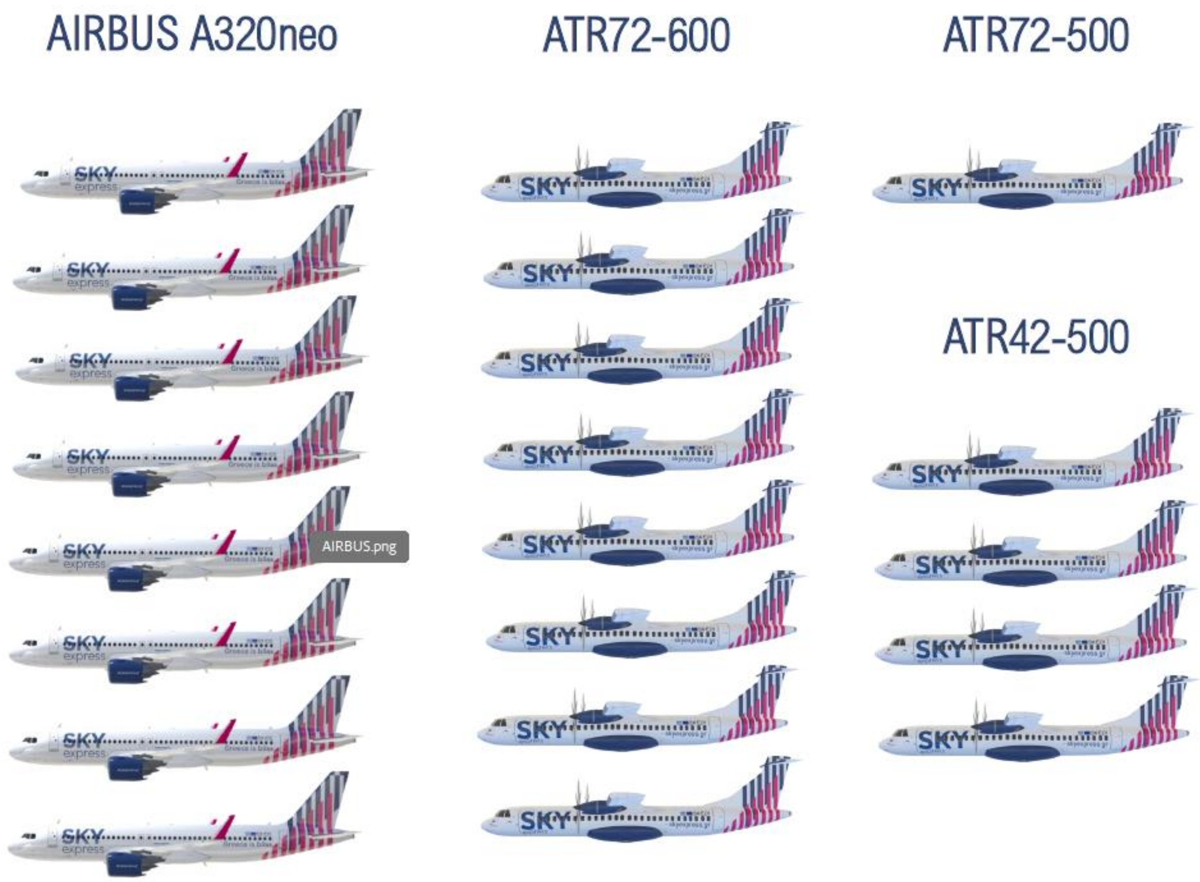


Figure 40: Sky Express Fleet as presented in Environmental Report 2023

Fuel efficiency operational procedures include:

- Optimum take-off configuration
- Optimum take-off thrust
- Minimization of APU usage via preliminary cockpit preparation
- Maximization of GPU usage after landing and at parking
- Air-conditioning setup during taxi
- Single engine taxi-in and taxi–out
- Continuous climb and descent operations
- Route optimization

SKY Express has revised internal processes to ensure efficiency through aircraft weight reductions:

- Gradually removing printed manuals from all flights and substituting them with soft versions
- Replacing old trolleys with new lighter ones on all aircraft
- A320neo and A321neo aircraft equipped with lighter seats
- Algorithmic calculation of potable water per flight
- Gradual replacement of carpets with lighter types.

B.2 Sustainable Aviation Fuels (SAF)

B.2.1 ReFuelEU Aviation Regulation

Since 2020 with the adoption of European Green Deal, Greece actively participates in strategic actions for sustainable and smart mobility, having agreed with the European Commission that all modes of transport have to contribute to the decarbonization of the transport sector in line with the objective of reaching a climate-neutral economy.

The successful implementation of ReFuelEU Aviation Regulation in Greece requires the collaboration of all parties in the supply chain, in particular aviation fuel suppliers, Union airports and airlines. The Regulation lays down harmonized rules on the uptake and supply of Sustainable Aviation Fuels (SAF) and applies to Aircraft Operators, Union Airport managing bodies, and Aviation Fuel Suppliers.

Greece started to implement ReFuelEU Aviation Regulation since 1st January 2024. Aviation fuel suppliers have the obligation to supply the Aircraft operators with increasing shares of SAF and synthetic aviation fuels, blended with conventional aviation fuel, starting with 2% in year 2025, 6% by 2030, up to 70% by 2050, as shown in the Figure below:

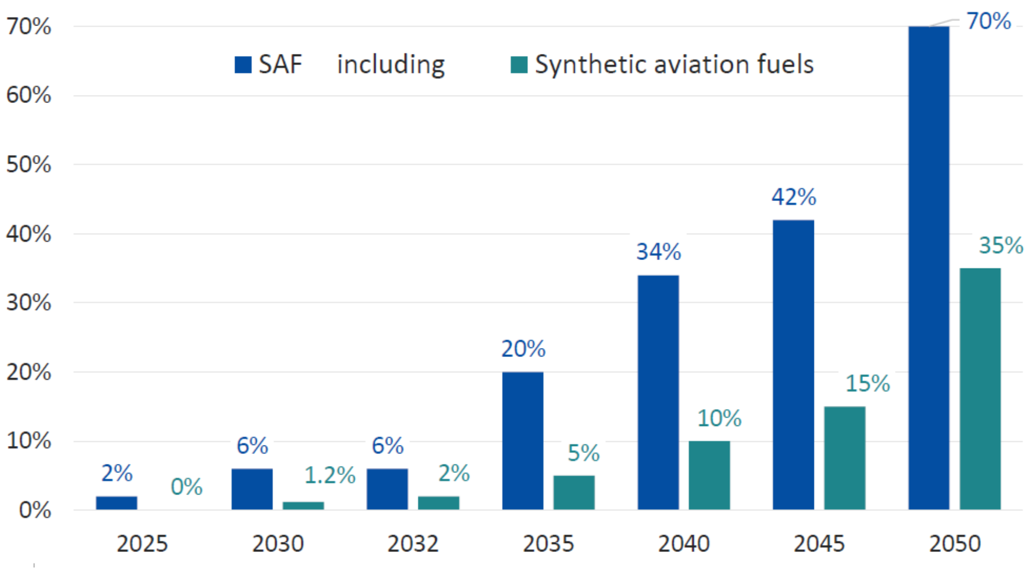


Figure 41: SAF and synthetic fuels percentages by 2050

Hellenic Civil Aviation Authority (HCAA) is working in cooperation with the Department of Alternative Fuels Renewable Energy Sources of Transportation and Alternative Fuels in the Ministry of Environment & Energy. These are the two responsible Competent Authorities for enforcing the application of ReFuelEU Aviation Regulation in Greece.

In Greece, eleven (11) Airports have been designated as Union Airports for reporting year 2024, including Athens & Thessaloniki Airport in the mainland, and nine airports situated in Greek islands such as Crete, Rhodos, Kos, Mykonos, Kerkira, Kefalonia, Zakynthos, and Santorini. These Airports have appropriate establishments to facilitate access to the necessary infrastructure to deliver, store, and refuel aircrafts with SAF. The table below presents the designated as Union Airports in Greece and its ICAO international code.

Table 23: Eleven Greek Union Airports

Airport Name	ICAO Code
Athens International	LGAV
Iraklion/Nikos Kazantzakis	LGIR
Rodos/Diagoras	LGRP
Thessaloniki/Makedonia	LGTS
Kerkira/Ioannis Kapodistrias	LGKR
Chania/Souda (Mil)	LGSA
Kos/Ippokratis	LGKO
Santorini	LGSR
Zakinthos/D.Solomos	LGZA
Mikonos	LGMK
Kefallinia	LGKF

Aircraft operators, who operate at least 500 commercial flights, when departing from the 11 Greek Union Airports (Table 23), must refuel with the aviation fuel, necessary for the entire flight, avoiding the excessive emissions, related to extra weight, and minimizing the risks of carbon leakage, caused by fuel tankering practices.

The List of aircraft operators, in-scope for this Regulation, includes 5 Aircraft operators, who are supervised by HCAA for their obligations to implement refueling obligations at Union Airports. These are:

- AEGEAN AIRLINES
- BLUE BIRD AIRWAYS
- OLYMPIC AIR
- SKY EXPRESS and
- SWIFTAIR HELLAS

The yearly quantity of aviation fuel uplifted by a given aircraft operator at a given Union airport shall be at least 90 % of the yearly aviation fuel required. The current Aircraft operators have reporting obligations starting in 2024, while the number of Aircraft operators is expected to increase next year, due to the significant air traffic increase that happened last year.
Finally, the implementation of ReFuelEU Aviation leads to the development of the production of sustainable aviation fuel (SAF) of biological or non-biological origin. Projects are already being developed by the Greek refineries and there is expected to be a financial contribution from EU funds or national funds as far as possible.

B.2.2 ACT SAF Initiative

Sustainable Aviation Fuels SAF development is a global commitment for sustainable aviation development. HCAA has informed ICAO for GREECE's engagement for Long-Term Global Aspirational Goal and active participation in Capacity-building and Training for Sustainable Aviation Fuels.

Since 2022, Hellenic Civil Aviation Authority (HCAA) actively participated in SAF working Group, established by Athens International Airport. This SAF Working Group aims to promote the use of SAF at the Airport with representatives from all stakeholders including, the Ministry of Environment and Energy, Hellenic Aviation Service Provider (HASP), IATA, the Airport's airlines, Aviation fuel suppliers, and the Airport's fuel tank farm operator OFC.

Regular meetings of the working group took place through web meetings, with very fruitful discussions and views exchanged among all stakeholders. Regulatory issues in Greek Fuel Market are examined in parallel with operational and fueling opportunities for Greek Aviation, the financial and other challenges associated with the take-up of Sustainable Aviation Fuel development in Greece.

Figure 42: Greek SAF working Group established in 2022

Moreover since 2023, Greece joined ICAO Assistance, Capacity-building and Training for Sustainable Aviation Fuels (ICAO ACT-SAF).

The ICAO ACT-SAF project provides feasibility studies and capacity building activities, with the aim of bringing the States closer to actual SAF production. Greece along with all other participants agreed that accelerating and facilitating the qualifications of new SAF pathways is important for all regions worldwide, in order to produce SAF locally, with the use of Renewable Energy Sources, and to explore financing opportunities to de-risk SAF production at all stages of technology maturity.

As ICAO recognizes that there is significant potential for all States to economically, socially, and environmentally contribute to and benefit from the development, production, and deployment of SAF and other aviation cleaner energies, including new economic streams, and alternative sources for the energy security, Greek Ministry of Environment and Energy is investigating ways to implement SAF initiatives for purposes of aviation and transport section in general.

B.2.3 SAF POLICY AND IMPLEMENTATION IN GREECE

The European collective SAF measures included in this Action Plan focus 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 (SOX) with 100%, compared to fossil jet fuel32.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.

The final updated Greece’s National Energy and Climate Plan (NECP), submitted in 2025, includes a First Period (2025-2030) for Rapid penetration of RES in electricity generation and construction of infrastructure for the electrification of final energy consumption. This period is predicted to rapidly develop RES generation (mainly solar and wind power), i.e. technologies that have already matured and generate electricity at competitive costs vis-à-vis fossil fuels. At the same time, internal electricity transmission and distribution networks are being built and strengthened with a view to speeding up the connection of new RES.

In addition, production of biomethane to replace part of the natural gas (mainly injected into the distribution networks due to the small size of aluminum plants), the production of liquid biofuels for the transport sector with a new phase of advanced biofuels production for aviation sector in Greek refineries has been initiated. Also, the first 2 commercial units producing green hydrogen, mainly for the production of renewable synthetic fuels in refineries (synthetic kerosene, synthetic methanol), are starting during this period.

The use of advanced biofuels (such as bio-SAF and biodiesel, whose production costs are lower than that of synthetic fuels) is foreseen in aviation and shipping due to the obligations set by EU legislation. However, the maritime and aviation sectors are more difficult to decarbonize. Biofuels have an upper limit determined by the availability of the raw material, while electromobility can only be used for short haul.

Synthetic fuels can be separated into carbon and non-carbon originated fuels. The first category includes e.g. synthetic kerosene, synthetic methanol and positive methane/LNG. The origin of carbon can be biological or from CO2 capture of industrial emissions or from air. In the NECP, synthetic carbon fuels are expected to be produced mainly with CO2 captured by industry emissions, and from 2045 and by Direct Air Capture (DAC).

Table 24: Use of advanced biofuels by 2050

Advanced Biofuel (TWh/year)	2022	2030	2035	2040	2045	2050
Land transport (Biodiesel and Bioetha-Nol)	0,0	1,1	1,8	1,6	0,6	0,0
Aviation (Bio-SAF)	0,0	0,8	2,9	4,5	5,9	6,9
Coastal shipping (Bio-LNG)	0,0	0,2	0,3	0,9	1,7	2,2

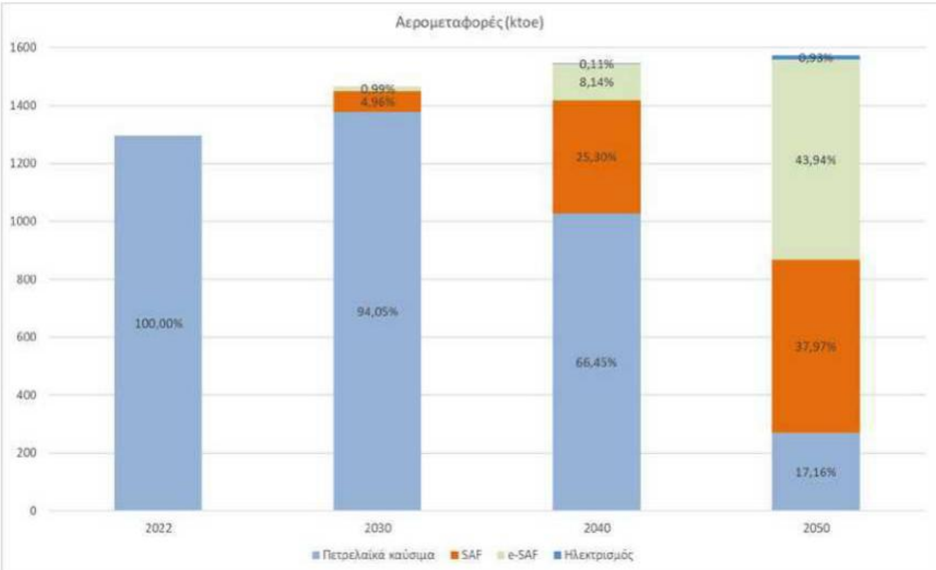


Figure 43: Energy consumption in aviation by type of fuel (ktoe)

Renewable synthetic fuels made from green hydrogen still face significant challenges, mainly production costs and usage technology. An improvement in both areas shall be made by 2040. The NECP assumes that synthetic methanol will be used in shipping, and from 2045 there will be a significant commercial development of synthetic ammonia. For aviation it is considered an extension of synthetic kerosene. These cases will be checked during the periodic reviews of the NECP Emissions of carbon dioxide from the land transport sector are expected to be reduced by 10 % in 2030 compared to 2022 (Figure 44), thus offsetting the expected increase in carbon dioxide emissions from the maritime and aviation sectors due to an increase in activity in these sectors and the resulting increase in consumption. The sharp decrease in energy consumption in the transport sector is expected to occur in the period after 2030, and most importantly from 2035 to 2050, and will be mainly due to the decrease in consumption in land transport, as also found in Figure 43.

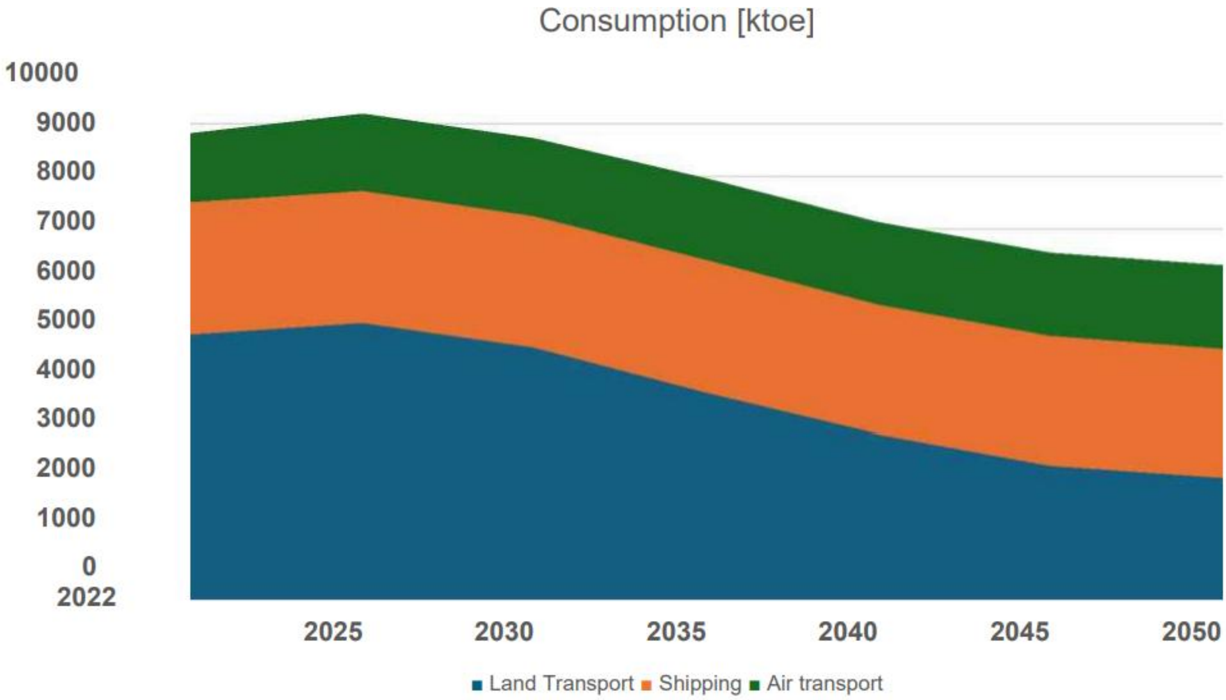


Figure 44: Energy consumption (ktoe) by transport sector, for the period 2022 up to 2050

At the same time, due to the significant penetration of RES and greener transport, which is expected to occur during the same period, the ratio of CO2 emissions to energy consumption (kton CO2/ktoe) will also improve, both for the sector as a whole (average) and for individual clusters, with the land and aviation sectors showing the greatest decline, as shown in Fig. 44.

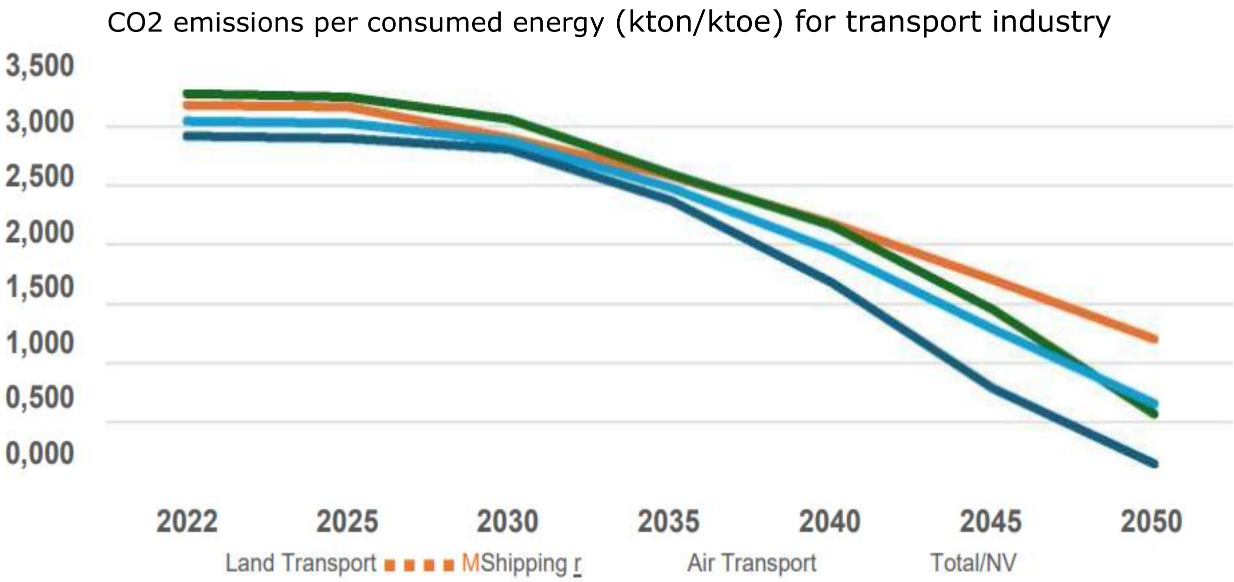


Figure 45: Evolution of CO_2 emissions per unit of energy consumed (kton CO_2/ktoe), average sector and transport sector

Advanced Liquid Biofuels

Advanced biofuels produced by hydrogenation of vegetable oils or other biological fats, such as animal fat, used cooking oil and tall oil (extract from paper industries) are currently not produced in Greece. Technologies for gasification of ligneous residues and synthesis of liquid fuels using hydrogen through the Fischer-Tropsch chemical process that achieves the catalytic conversion of a mixture of CO (produced by gasification) and H2 into liquid fuels (diesel, gasoline, kerosene) (BtL- Biomass-to-Liquids) are also under investigation. One of the liquid fuels that is also considered as a substitute for petrol and can be produced by similar technologies is methanol (biomethanol). According to the projections in the revised NECP, advanced biofuels will account for 4.6 % of transport fuels by 2030 and 13.2 % by 2050. The main restriction is the availability of raw material and the level of production, which, however, has a downward trend. Advanced liquid biofuels will be used in the transport sector. The penetration of the bio-based advanced kerosene (SAF-Sustainable Aviation Fuel) is expected to reach 5 % of the total energy consumption of aeronauts in 2030 and 38 % in 2050.

RFNBO-Renewable Fuels of non-biological Origin

Renewable fuels of non-biological origin are not currently produced and used in Greece. According to the projections in the revised NECP, the diversion of renewable fuels of non-biological origin is expected to reach 0.9 % of transport fuels by 2030 and 30.9 % by 2050. SAF-Sustainable Aviation Fuel penetration is expected to reach 1 % of the total energy consumption of airplanes in 2030 and 44 % in 2050. Refineries are projected to be the spearhead for the production of synthetic fuels and advanced biofuels, although for the latter there is a restriction of the raw material. The production of synthetic fuels is to be made from 'green' hydrogen produced locally, covering the largest share of domestic needs. In particular, it is projected that around 2.7 % of net domestic consumption in 2030 and 20.6 % in 2050 will be due to green hydrogen production needs.

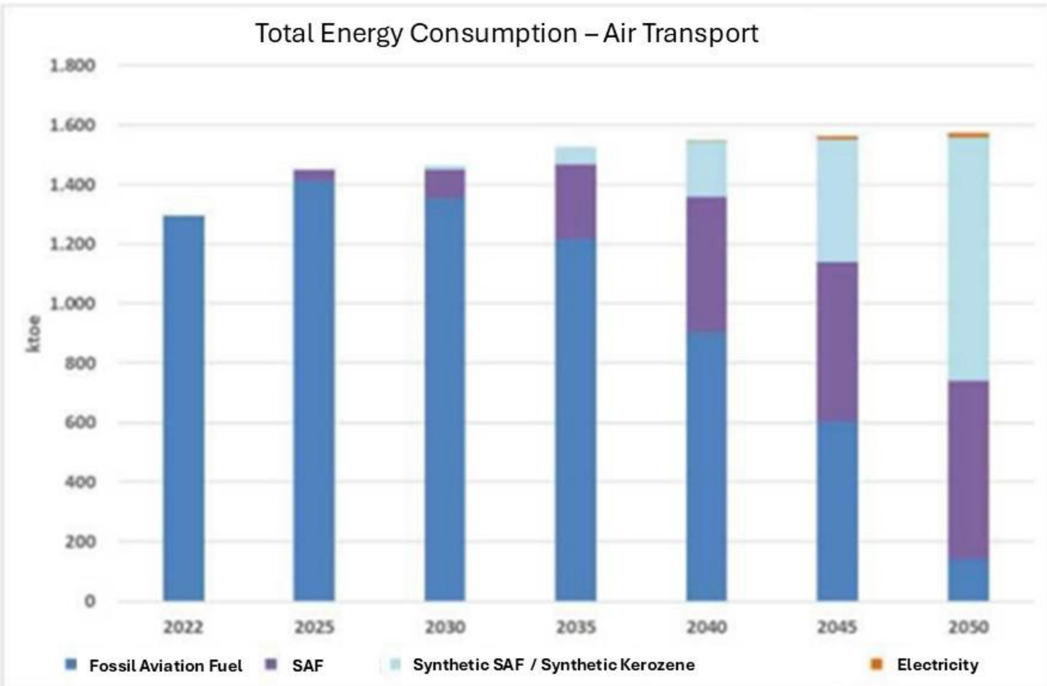


Figure 46: Development of final energy consumption in aviation up to the year 2050

The above trajectory for reducing energy consumption overall in the metropolitan sector, together with the introduction of alternative fuels in all sectors, leading to a reduction in CO2 emissions gradually, starting in 2030 and from 2035 onwards. Table 25 and Figure 47 show the estimated reduction in emissions by sector and overall (Total/NV).

T**able 25:** Estimated CO2 emissions by transport sector, 2022-2050 (IPCC Methodology)

CO2 emissions [kton]							
Year	**2022**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Land Transport	14620	15147	13355	9285	5269	1991	334
Domestic Coastal Shipping	1894	2058	1902	1861	1686	1374	234
Air Transport	4246	4706	4482	3964	3336	2256	890
Total/NV	20760	21912	19740	15110	10291	5622	1458

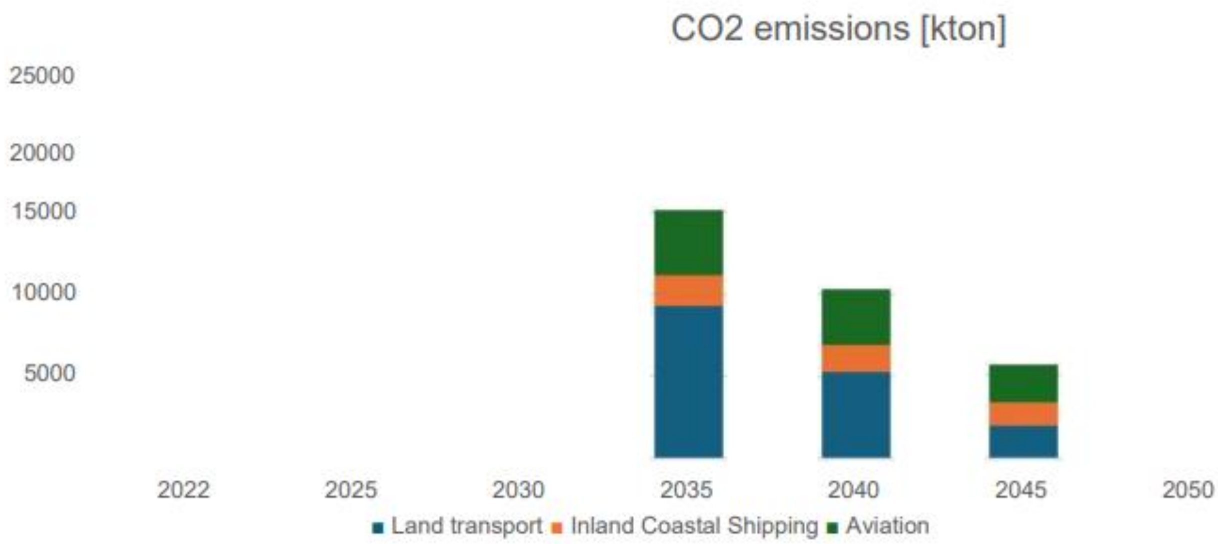


Figure 47: Estimated emissions by transport sector, for the period 2025 - 2050

The expected reduction in emissions can best be reflected in the mission ratio of the corresponding fuel energy consumption (kton/ktoe) shown in Table 25. As the use of alternative fuels in aviation and shipping will start in the coming years, this indicator is expected to decrease by more than 8 % in aviation and almost 7 % in Shipping by 2030 compared to 2022.

Finally, revenues from the auctioning of emission allowances from the Emissions Trading System in the stationery, aviation and maritime sectors (ETS 1) as well as the extension to the buildings and transport sectors (ETS 2) are expected to significantly enhance support for the above actions to achieve the energy transition for the period 2025-2030. In particular, Directive 2003/87, as amended by EU Directive 2023/959 establishing a system for emissions trading within the Union, provides for timely and harmonized requirements for the use by Member States of revenues from auctioning of emissions from the stationary installations, aviation and maritime sectors (ETS 1). One of the key aspects is the provision that to make sure that money from pollutant pricing will lead to investments in the green transition, Member States must use 100 % of the revenues from the sales of allowances for climate and energy purposes.

Greece is one of the Member States that consistently allocates 100 % of its ETS revenues for climate and energy purposes. The main sectors financed through revenues from the auctioning of emission allowances in Greece have remained stable in recent years.

These areas concern:

- energy (RES, energy saving, promotion of electromobility)
- ecosystem management/adaptation to climate change
- skills development and support for just development transition in regions affected by lignite-fired
- support to companies at risk of carbon leakage as well as - the administration of the ETS

Total revenues from the auctioning of ETS 1 allowances are estimated at EUR 6.9 billion with an emission price of EUR 80/tCO2eq on average over the whole period 2025-2030.

B.2.4 Greek Air Operators - SAF implementation Actions

AEGEAN acts in time and decisively against the challenges of the new era for the aviation industry, by promoting in the coming years the expanded use of SAF in Greece and abroad. Since 2022, the company announced the first ever Sustainable Aviation Fuel (SAF) program and thus became the only carrier in Greece to operate part of its domestic and international network using a SAF blend. AEGEAN joined forces with longtime partner HELLENIC PETROLEUM, one of the leading energy groups in South-East Europe, for the supply of SAF blend on flights departing from its Thessaloniki Airport "Makedonia" hub. Flights from Athens International Airport are expected to follow soon.

This strategic initiative for supply of SAF in Greece was welcomed by the Greek government, as it enables Greece to make an effective contribution to all international efforts that target to make air transport more sustainable. It is also the first step for airlines and airports to align in a proactive manner with the upcoming European Union SAF targets by 2025.

The study of AEGEAN's Sustainable Aviation Fuels program started in 2019, and in July 2021 the first flight with a mix of conventional and sustainable aviation fuels (SAF) took place, during the delivery of a new A321neo aircraft at the AIRBUS factory in Hamburg. Additionally, in 2022 as part of its collaboration with HelleniQ Energy Group and Athens International Airport (AIA), AEGEAN carried out the first refueling with SAF at AIA, confirming its capability to refuel its aircraft with SAF in Athens as well.
HEFA-type SAFs are produced from 100% renewable waste and raw material residue, such as

used cooking oil and animal fats. They reduce CO_2 emissions by an average of 80% compared to conventional aviation fuels. In 2022, AEGEAN underwent a SAF Readiness Assessment and received a high readiness rating from IATA. Despite the inability to produce sufficient quantities of SAFs, the lack of storage and distribution infrastructure and especially their increased cost compared to conventional fuels that are hurdles to their wider use, AEGEAN is taking a decisive stance vis a vis the challenges and continues to work with other parties in the transportation value chain for wider SAF adoption both in Greece and abroad.

B.3 Operational Improvements

The Hellenic Aviation Service Provider (HASP) is a Public Organization under the Ministry of Infrastructure and Transport, directed by its Governor and Deputy Governors. HASP is the Hellenic Air Navigation Service Provider and the Operator of 24 Hellenic Civil Airports.
HASP is subject to all national and EU legislation as well as International Conventions regarding civil aviation. Especially on environmental matters, HASP is following and contributing to the work of the European Commission, the International Civil Aviation Organization and the European Civil Aviation Conference (ECAC) as member of the European Aviation and Environment Group (EAEG).
HASP is strongly collaborating with the Hellenic Ministry of Environment and Energy, the Hellenic Civil Aviation Authority, the Athens International Airport and Fraport Greece on implementing environmental legislation.
HASP recognizes the importance of strict adherence to all applicable national and European legal requirements and is fully committed to address the climate change impacts of its operations through technical and operational measures.

B.3.1 BLUE MED FAB Environmental Performance

The Single European Sky Service Provision Regulation 2004/550/EC requires Member States to 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.

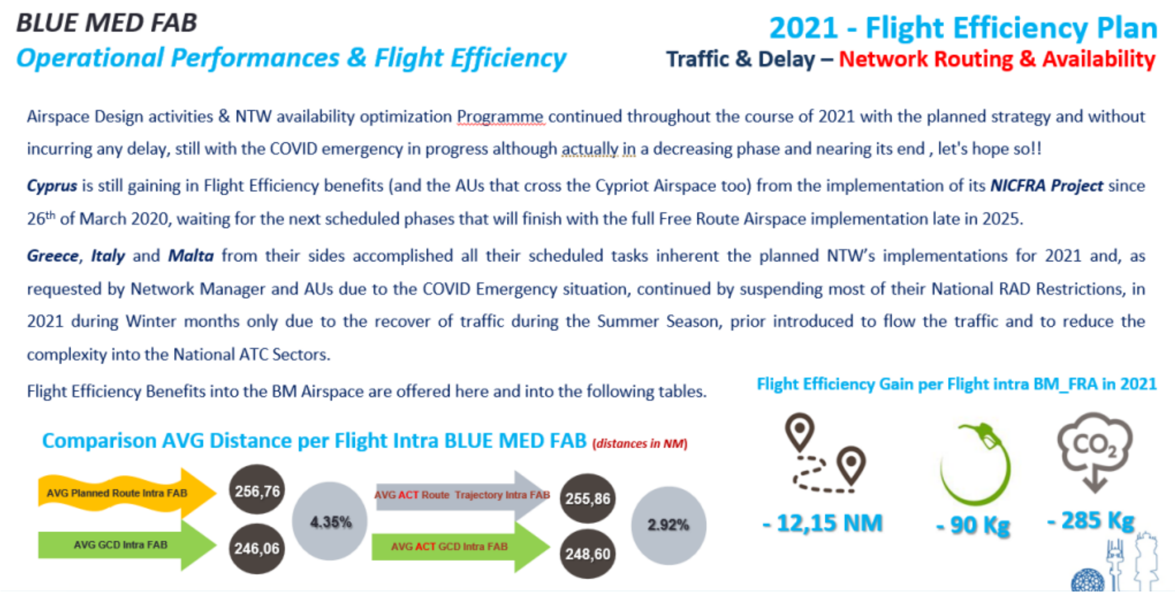
Greece is a Member of the BLUE MED FAB together with Italy, Cyprus, Malta. BLUE MED FAB is the European south-eastern FAB representing the natural European gate dedicated to air traffic flows coming from Africa and the Middle East, namely among the regions with the prospective fastest growing trend in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

Since 2014/2015, a Task Force, composed of Flight efficiency's experts from each Member State, defined a methodology for collecting information, processing and evaluating the implementations introduced to optimize the Network and the Airspace availability and make it more efficient. Such methodology is based on the post analysis of the flight plans of Airspace Users (AUs) that have benefited from the implementations both in terms of flight efficiency and in terms of lower fuel consumption, with consequent environmental benefits thanks to lower CO_2 emissions in the atmosphere.

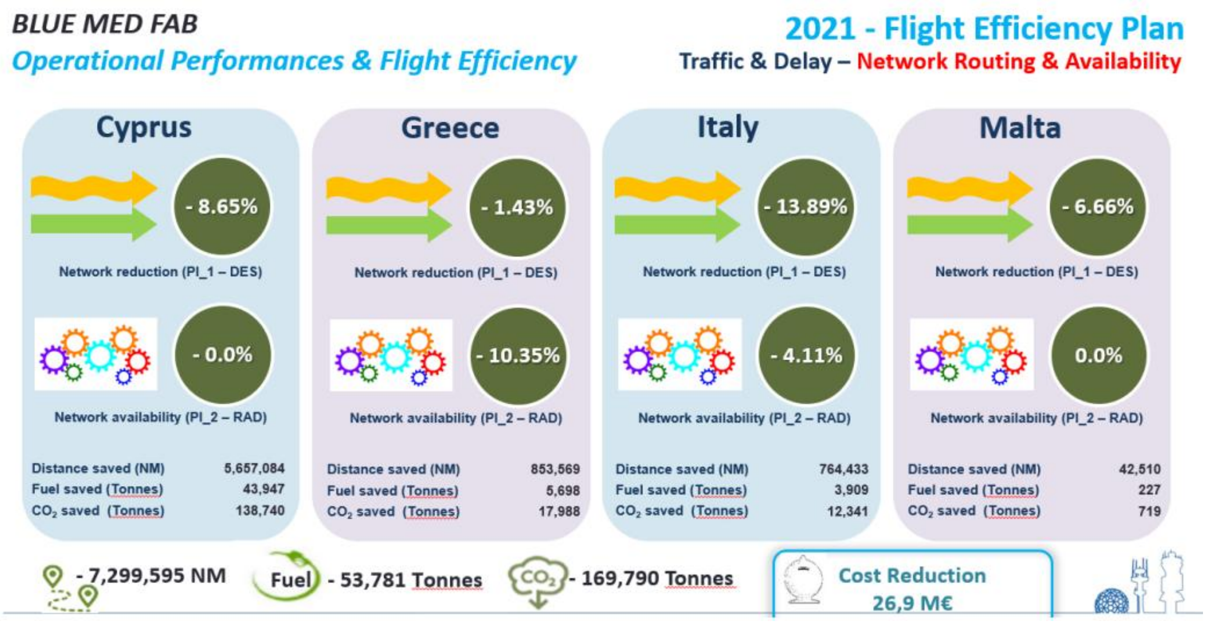
The BLUE MED FAB is in its Implementation Phase, a coordinated deployment initiative in which operational and technical improvements are being delivered through a solid Implementation Programme, which is at the same time a summary and a plan of all the activities deployed or to be undertaken by the BLUE MED working groups and task forces. This is bringing benefit to the Airspace Users in terms of enhanced efficiency, reduced delays and costs and lower environmental impact.

The BLUE MED Annual Report presents, among other information, benefits, in terms of Flight Efficiency, which were accounted within the EnRoute domain, thanks to the optimization both in the Route Network and in the Airspace Availability for the 4 Member States.

BLUE MED Annual Report highlights the improvements that the Aus have perceived in terms of optimization of their planning activities for the trajectories selected within the Airspaces of the 4 BLUE MED States, and specifically: a reduction of the planned distance of approximately 12 NM per flight compared to 2020, a reduction of approximately 90 kg of fuel per aircraft, and approximately 285 kg of lower CO2 emissions into the atmosphere.



Another value important to underline is the constant shortening of flights' distance of City Pairs settled by the AUs with respect to their planning, for optimal management of aircraft trajectories by the ATCOs and the optimization of the EnRoute Network with significant reduction of airspace constraints.



B.3.2 Performance Scheme and Environment KPI

Greece, as Member State of EU and consequently under the European Union Regulatory regime, is obliged to implement the Regulation (EU) 2019/317 (Performance and Charging regulation) in the realms of the Single European Sky.

The performance and charging schemes should enhance the performance of air navigation services through a gate-to-gate approach covering both *en route* and terminal air navigation services. They should foster long-term improvements in the performance of air navigation services, as reflected in the European ATM Master Plan, while having due regard to the overriding safety objectives. The performance scheme should contribute to the reduction of greenhouse gas emissions from aviation and should allow optimum use of airspace, taking into account air traffic flows in the European airspace.

According to the Performance Scheme, key performance indicators (KPIs) should be defined in the key performance areas of safety, environment, capacity and cost-efficiency. These key performance indicators should be used for the purpose of setting achievable, sustainable, realistic and time-bound performance targets at Union level, national level or functional airspace block level. The key performance indicators should cover both en route and terminal air navigation services, as well as network functions, in order to improve the overall performance of the network.

Regarding the **environment KPI**, it measures the average horizontal *en route* flight efficiency of the actual trajectory and is the result of the comparison between the length of the en route part of the actual trajectory derived from surveillance data and the achieved distance, summed over IFR flights within or traversing the local airspace. There are also indicators for monitoring environmental performant such as the average horizontal *en route* flight efficiency of the last filed flight plan trajectory, the average horizontal *en route* flight efficiency of the shortest constrained trajectory, the additional time in the taxi-out phase, the additional time in terminal airspace, the share of arrivals applying Continuous Descent Operation (CDO), the effective use of reserved or segregated local airspace, the rate of planning via available local airspace structures and the rate of using available local airspace structures.

For the current reference period, RP3, which covers the years 2020-2024, Greece has developed and applies a national AOC. Effort was made for assignment of achievable, realistic and time corresponding targets, being consistent with European Wide Targets, aiming at effectively steering the sustainable performance of air navigation services.

According to available information, for the main KPI and up to the year 2023, Greece has the following results:

Table 26: main key performance indicators for Greece up to the year 2023

Greece	2020	2021	2022	2023
Targets as shown in performance plan	1,94%	2,00%	1,92%	1,92%
Actual values	2,51%	2,54%	2,33%	2,26%
Difference	0,57%	0,54%	0,41%	0,34%

Main reasons that affected performance in this key performance area in 2023 were:

1) Activation of military areas, 2) Adverse weather phenomena during the summer season, and 3) High levels of traffic. It should be noted that, in November 2023, HASP implemented FRA H24. New 5LNC points GAVDO, IPTES, KUGGI were also implemented, improving flight planning. Regarding CO2 emissions[176] in Greece in relation to traffic, the following diagrams show the evolution throughout the years:

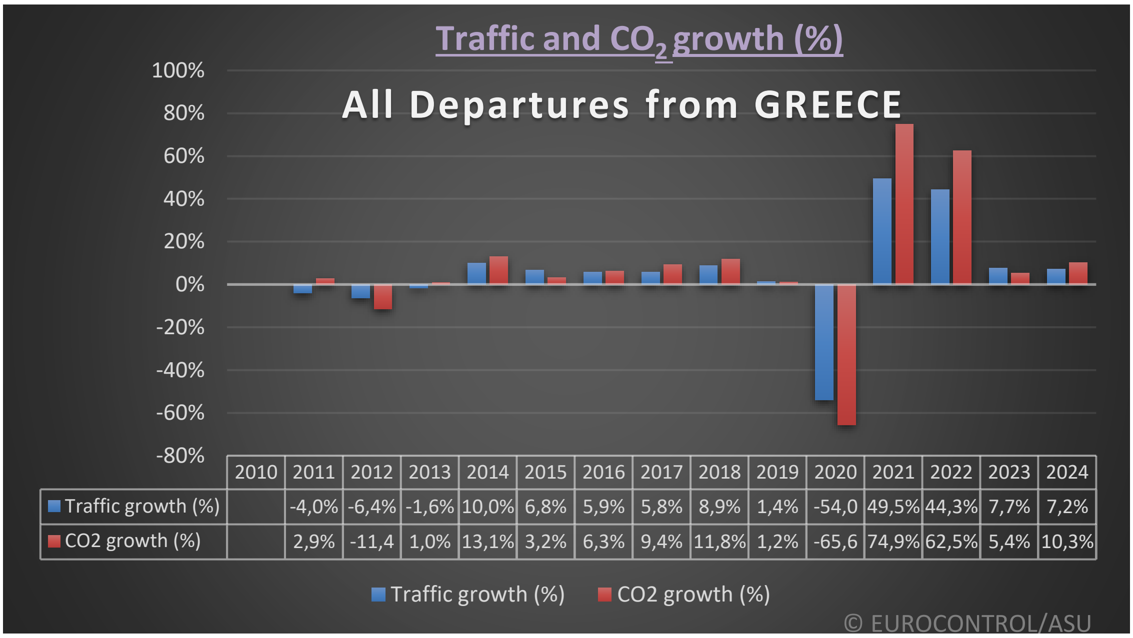


Figure 48: CO2 emissions evolution throughout the years in relation to air traffic

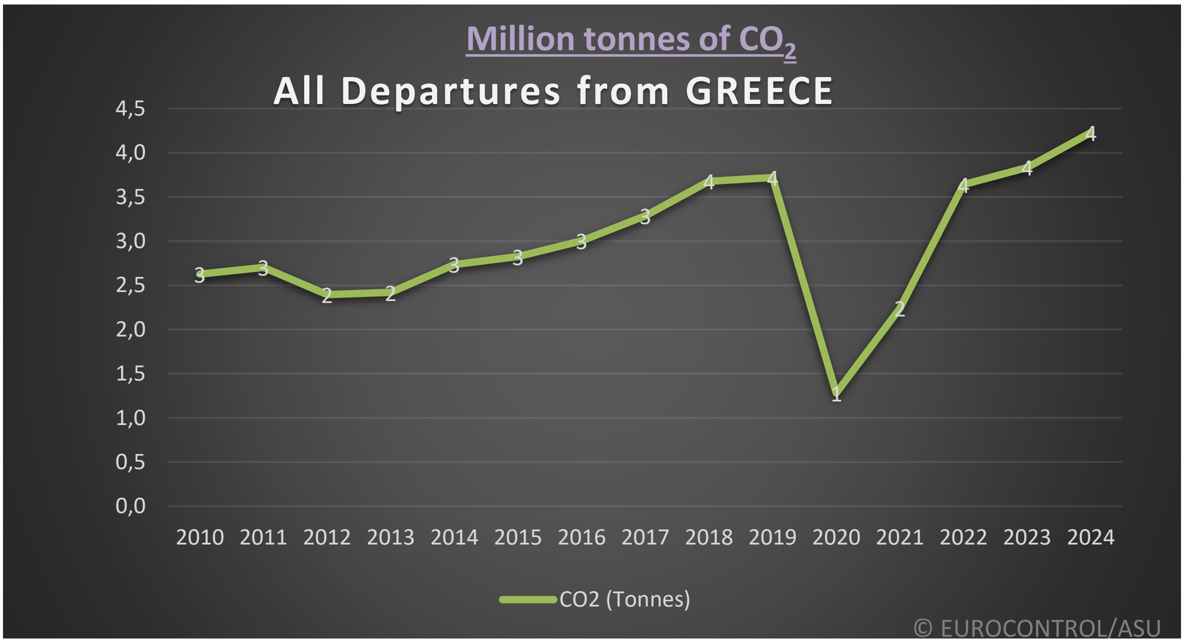


Figure 49: CO2 emissions evolution for the period 2010 - 2024

176 The **total CO_2 emissions** for all departures from each State were calculated for all Aircraft Operators based on all **departing** IFR **flights** as billed by the EUROCONTROL Route Charges Office, **aircraft type** and **actual flown distance** full trajectory from origin to destination.

B.3.3 PBN Implementation Plan

There is a revised Performance-Based Navigation (PBN) Implementation Plan of HASP for all Greek airports. According to this Plan:

- HASP will provide the design of PBN Procedures, via its FPD certified Provider, at seven (7) eligible aerodromes at the end of 2025;
- For Athens International Airport, PBN procedures have been published on 24th of January 2024 according to the provisions of EE 2018/1048;
- for new Iraklion airport, the project has a completion deadline in 2027; and
- for the rest thirty-one aerodromes (31) there is an official Request for Tender which is going to be materialized by the end of 2025. The project is expected to be finalized by the end of 2027.

Moreover, there is another project running for Athens Terminal Maneuvering Area (TMA) Redesign & new PBN procedures – the ATHENIAN Project. This project aims to ensure and accelerate the PBN implementation in Athens, under the frame of a greater airspace re-design, benefiting from the operational improvements derived from new airspace concepts, in terms of flight efficiency, reduced environmental impact and sustainable operations. The project aims to develop a complete PBN Airspace concept for "Athinai" airspace and integrally re-design the TMA procedures. The objective is to optimize the TMA airspace and operations for increased flight efficiency, capacity, reduced noise footprint and cost efficiency with tangible benefits. TMA airspace optimization refers to an integral airspace re-design to increase efficiency, optimize noise footprint and/or reduce radar vectoring operations.

The first phase of the project was completed with the issuance of a total of 78 new PBN procedures for the existing Terminal Area of El. Venizelos, after they were checked and validated from the air by the Aviation Means Unit of HASP. The second phase of the project, which has started, will be completed in February 2027.

The optimization and resilience of PBN implementation is enhanced by DME (Distance Measuring Equipment) coverage, particularly for major airport TMAs, offering backup navigation capability: and increased operational resilience.

B.3.4 Athens International Airport Operational Improvements

An Advanced Surface Movement Guidance and Control System (A-SMGCS) has been installed at Athens International Airport (LGAV). Final acceptance protocol has been issued in November 2023 and operational procedures are under evaluation. The system is foreseen to be operational by the end of 2025.

The procurement, installation and commissioning of a new DPS/ATM system will enable the Automated Support for Conflict Detection, Resolution Support Information and Conformance Monitoring and implementation of Ground-Based Safety Nets. Technical specifications have already been developed and call for tender is in progress. HASP has become a full PENS user with the signature of CPA and associated amendments. The migration to NewPENS is planned by end of 2025.

The following Objectives related to Network Collaborative Management are completed through the deployment of the available NM systems:

- Enhanced Short-Term ATFM Measures are implemented with the use of NM application. STAM are in operational use from April 2023 (FCM04.2).
- The NM Automated Support tools for Traffic Complexity Assessment and Flight Planning interfaces are in use (FCM06.1).
- The implementation of Interactive Rolling NOP is achieved through the utilization of NM technical platform for collaborative NOP.

RNAV 1 SIDs and STARs will be implemented in ATHINAI/Eleftherios Venizelos (LGAV). The **"ATHENIAN PROJECT**", a big project regarding the design of PBN procedures for the existing TMA of EL. Venizelos, the restructuring of the TMA and the design of PBN procedures for the new TMA is on-going, in close cooperation with DFS, AIA, EUROCONTROL and two main Greek air carriers, AEGEAN and SKY EXPRESS. One SID and STAR per instrument RWY for the existing TMA have been already published. The new restructured ATH TMA and the RNAV 1 procedures for the new TMA will be published by 06/06/2030.

RNP1 procedures (SIDs-STARs) will be implemented to TMAs where procedural approach service is provided. RNP1 procedures have already been developed in LGMK, LGSR and LGKO. The development of all RNP1 procedures in LGKO, LGMK, LGSR, LGIO, LGMT and LGSK is expected to be completed by 31/12/2025.

RNAV SIDs and STARs will be implemented in high-traffic density TMAs of Greece where RADAR APPROACH service is provided, i.e. ATHINAI/ Eleftherios Venizelos (LGAV), THESSALONIKI/Makedonia (LGTS), RODOS/Diagoras (LGRP), KERKIRA/Ioannis Kapodistrias (LGKR), IRAKLION/Nikos Kazantzakis (LGIR) as a main navigation solution. Installation of additional DMEs may be required in order to provide DME/DME and GNSS procedures on the above TMAs.

A National PBN Transition Plan has already been developed in coordination with NM and approved by HCAA (PBN Transition Plan v 2.2 March 2023). The development of RNAV 1 procedures in LGTS TMA is on-going. The development of RNAV 1 procedures is planned for LGRP and LGKR and on - going for LGIR (RNAV approach procedure for LGIR has been published in AIP Greece).

The development of all RNP1 procedures in LGKO, LGMK, LGSR, LGIO, LGMT and LGSK is expected to be completed by 31/12/2024. A call for tender for the design of PBN procedures for 30 Greek airports (including all airports with IREs regulated by (EU) 2018/1048) is ongoing. The plan includes not only the IREs regulated by (EU) 2018/1048, but also airports where PBN Operations will improve the level of safety and are highly desired by the aircraft operators (i.e. LGPA, LGNX etc.). RNP1 (SIDs-STARs) will not be implemented to Athens Venizelos TMA, therefore this Objective is Not Applicable for LGAV.

HASP has already designed and published RNP approaches with all 3 minimas (LPV, LNAV/VNAV, LNAV), in selected four (4) Greek airports (Mitilini-LGMT, Ioannina-LGIO, Thessaloniki-LGTS, and Kos-LGKO A call for tender for the design of PBN procedures for 30 Greek airports (including all airports with IREs regulated by (EU) 2018/1048) is ongoing. The plan also includes airports where PBN Operations will improve the level of safety and are highly desired by the aircraft operators (i.e. LGPA, LGNX etc.).

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 CO2 emissions, with economic and environmental benefits but also helps to unlock capacity.

Within the frame of SESAR Deployment, AIA is implementing two major EU co-funded projects with significant environmental benefits, planned to be completed by 2027, as follows:

1. Deployment of an Extended AOP (Airport Operations Plan) and integration with the NOP (Network Operations Plan), under the "BEACON" - BE Aop & nm CONnected joint project, with another 6 airports, ensuring a single, common and collaboratively agreed rolling plan used by all involved airport stakeholders, reflected at network level.

Main benefits: increase in the predictability, flexibility and efficiency both in airport operations and network level. Better predictability of runway capacity reduces airborne and taxi-out holdings, leading to time and fuel savings.

2. Athens TMA Redesign & Performance Based Navigation (PBN), under the "ATHENIAN" - ATHENs termInal Area redesign & pbN project, as per which, AIA is leading a consortium by partnering with Hellenic Aviation Service Provider (HASP), Aegean Airlines, Sky Express and Eurocontrol. The objective is to ensure and accelerate the PBN implementation in Athens, under the frame of a greater airspace re-design.

Main benefits: operational improvements derived from new airspace concepts, in terms of flight efficiency, reduced environment impact (CO2 & non-CO2) and sustainable operations.

B.3.5 CO_2MPASS Performance Reporting Tool

CO_2MPASS is a CO_2 Performance Reporting Tool that was developed to support policy makers and operational stakeholders, as it is designed to understand areas of operational improvements in European Single Sky Network.

HCAA and Aviation stakeholders use CO_2MPASS reporting tool, as updated on daily basis, and have access to comprehensive data giving insights into fuel burn through each phase of flight (climb, en-route and descend) and each ACC or TMA. Users can quickly determine how their actual performance compares to their planned performance and can take measures to adapt their planning in the future.

Analysing fuel burn through each airspace improves understanding of how flight levels affect fuel consumption. Minimising unnecessary fuel consumption and emissions not only helps airlines save on operational costs but also reduces their carbon footprint. ANSP service provider and Air operators can assess the fuel burn of their flights covering the full trajectories of all intra-NM and international departures/arrivals. This provides additional insight into their planned vs actual fuel burn performance for each phase of flight, listing the ACCs (or TMAs) where they experience the highest fuel burn performance in terms of fuel burn per flight.

ANSPs and Competent Authorities can also have an additional insight into the operators planned vs actual fuel burn performance through each phase of flight, listing the operators that experience the highest fuel burn performance in terms of fuel burn per minute.

The performance screenshots and information provided of three major Aircraft Operators that are supervised under HCAA (Greek AOC) are listed below for the years 2022-2024.

AEGEAN AIRLINE FUEL BURN INTERACTIVE REPORTING

High level visualizations from Compass tool of Aegean Airline (2022-2024) that provide number of flights and fuel burn (kg) per flight and flight phase. Other visuals allow users to analyse results at different aggregations, aircraft category and flow inside Network Manager (NM) area.

Figure 50: High level visualizations from Compass tool of Aegean Airline (2022-2024)

OLYMPIC AIR FUEL BURN INTERACTIVE REPORTING

High level visualizations from Compass tool of Olympic Air (2022-2024) that provide number of flights and fuel burn (kg) per flight and flight phase. Other visuals allow users to analyse results at different aggregations, aircraft category and flow inside Network Manager (NM) area.

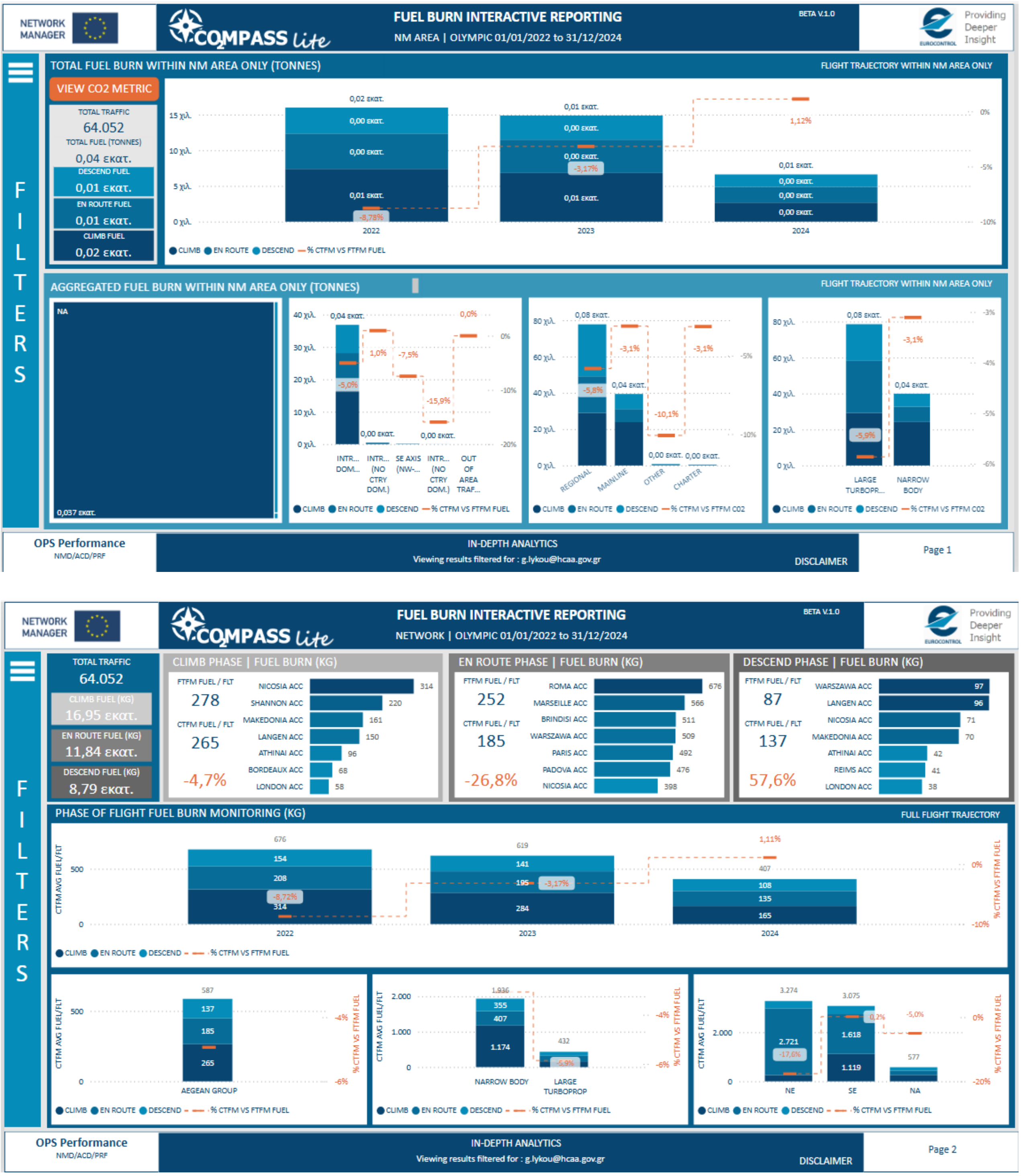


Figure 51: High level visualizations from Compass tool of Olympic Air (2022-2024)

SKY EXPRESS FUEL BURN INTERACTIVE REPORTING

High level visualizations from Compass tool of SKY EXPRESS SA (2022-2024) that provide number of flights and fuel burn (kg) per flight and flight phase. Other visuals allow users to analyse results at different aggregations, aircraft category and flow inside Network Manager (NM) area.

Figure 52: High level visualizations from Compass tool of Sky Express (2022-2024)

B.4. Market-Based Measures

B.4.1 CORSIA

Greece participates in ICAO CORSIA since 2019 from the first pilot period of its implementation. The Aircraft Operators in Greece that subject to CORSIA reporting obligation are presented in the following figures as taken from the CORSIA Central Registry, where HCAA annually updates their contact information and eligibility status.

CORSIA Central Registry

Report Aeroplane Operators Edit > Greece-2023-ARCHIVED

Locked Record

Warning(#1042) : This record is read-only and no changes can be made. Please contact ICAO if the status needs to be changed.

Details | Aeroplane Operators 10 | Aeroplane Operators Data Journal

Actions	Name	ICAO State	Attribution Method	Identifier	Address	City	Postal Code	Country
	AEGEAN AIRLINES	Greece	ICAO Designator	AEE	Building 57, Athens Intern...	Spata	19019	Greece
	AIR MEDITERRANEAN	Greece	ICAO Designator	MAR	140 Vouliagmenis Av.	Glyfada	16674	Greece
	BLUEBIRD AIRWAYS	Greece	ICAO Designator	BBG	Heraklion Int'l Airport , P.O...	Heraklion	71601	Greece
	ELLINAIR S.A.	Greece	ICAO Designator	ELB	14 km Thessaloniki-N.Mic...	Thessaloniki	57001	Greece
	GAINJET AVIATION S.A.	Greece	ICAO Designator	GNJ	Vouliagmenis Av. & 1 The...	Athens	16674	Greece
	MARATHON AIRLINES	Greece	ICAO Designator	MTO	14 Lontou Str.Glyfada	Athens	16675	Greece
	OLYMPIC AIR	Greece	ICAO Designator	OAL	Building 57, Athens Intern...	Spata	19019	Greece
	OLYMPUS AIRWAYS	Greece	ICAO Designator	OLY	12 Megalou Alexandrou st...	Athens	16452	Greece
	PANELLENIC AIRLINES	Greece	ICAO Designator	RJB	S. Kazatzidi & Vosporou 2A	Heraklion	71601	Greece
	SKY EXPRESS S.A.	Greece	ICAO Designator	SEH	Athens Int'l Airport, Buildi...	Spata	19019	Greece

Property of ICAO | Email To: ccr@icao.int

Greece also submits a list to ICAO that contains the accredited verification bodies registered in Greece with their accreditation details, according to Annex16, Vol. IV, Part II, Chapter 2.

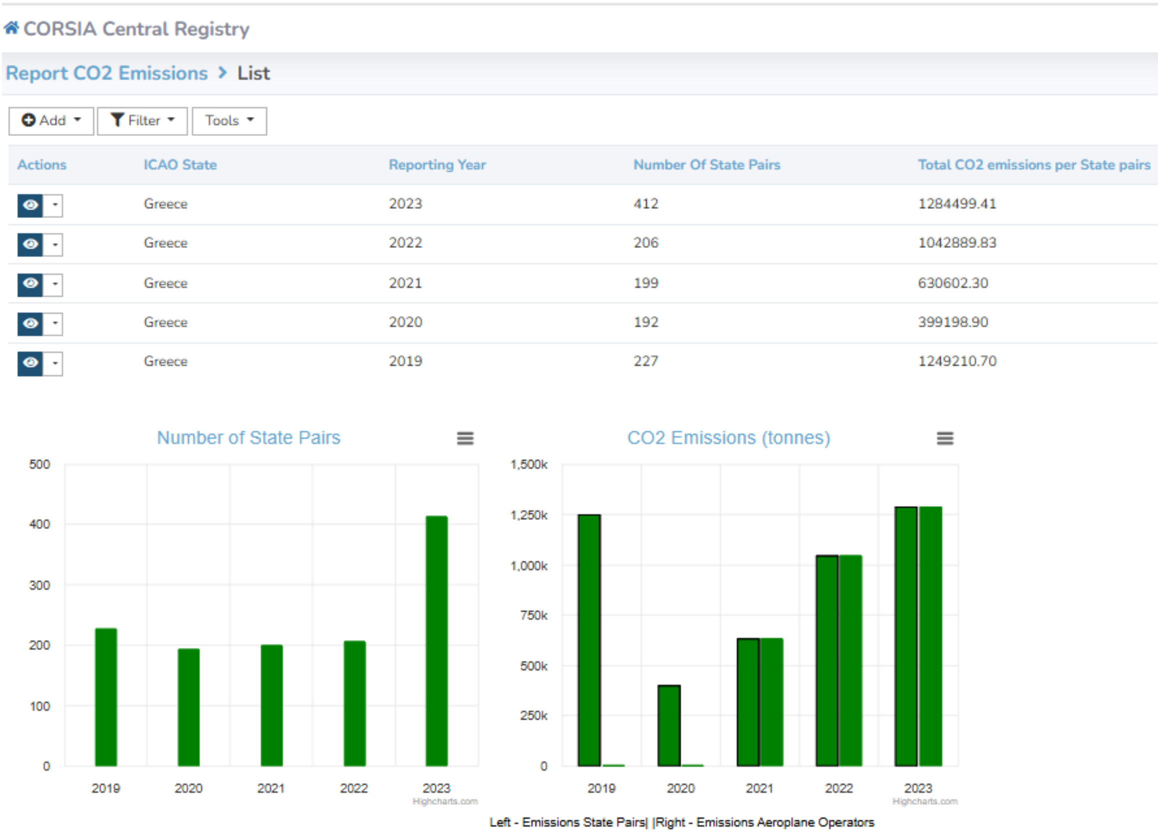
Details | Verification Bodies 3 | Verification Bodies Data Journal

Actions	Name	ICAO State	Accreditation Certificate Number	State of Verification Body Registration	Web Link to Online Certificate
	EMICERT LTD	Greece	874-7	Greece	https://emicert.com/aviation/
	EUROCERT SA	Greece	875-6	Greece	https://old.eurocert.dev.ibserver.gr/cont...
	TÜV AUSTRIA HELLAS Ltd	Greece	876-5	Greece	https://tuvaustriahellas.gr/services/eu-e...

Property of ICAO | Email To: ccr@icao.int

HCAA annually submits a report to ICAO that contains the total annual CO_2 emissions per State pair aggregated for all aeroplane operators attributed to Greece and total annual CO_2 emissions for each aeroplane operator, according to Annex 16, Volume IV, Part II, Chapter 2.

The annual reports of CO_2 Emissions are uploaded to CORSIA Central Registry by HCAA as presented in the screenshot below.



CORSIA Central Registry

Report CO2 Emissions > List

Actions	ICAO State	Reporting Year	Number Of State Pairs	Total CO2 emissions per State pairs
	Greece	2023	412	1284499.41
	Greece	2022	206	1042889.83
	Greece	2021	199	630602.30
	Greece	2020	192	399198.90
	Greece	2019	227	1249210.70

Figure 53: Annual reports of CO2 Emissions as uploaded to CORSIA Central Registry by HCAA

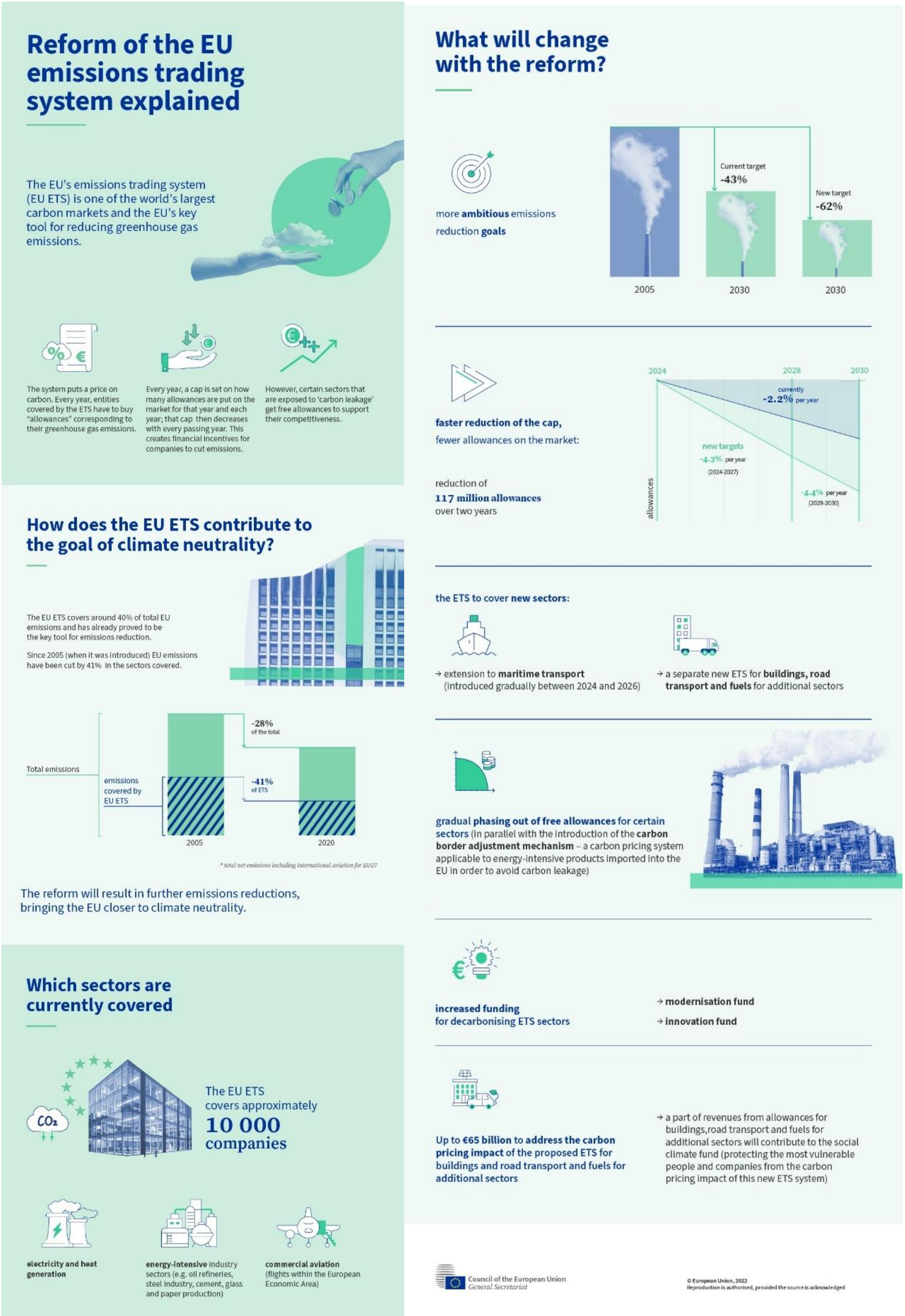
B.4.2. The EU Emissions Trading System

Greece implements the Emissions Trading Scheme (EU ETS) as the main tool of the EU for mitigating the impacts of climate change and reducing greenhouse gas emissions. The reform of the system is a part of the 'Fit for 55' package – a set of proposals to revise and update EU climate, energy and transport legislation, which will contribute to the EU's climate goals of reducing net greenhouse gas emissions by at least 55% by 2030 and reaching climate neutrality by 2050.

Greece applies European rules on an emissions trading system (The ETS Directive 2003/87/EC) and implements appropriately the carbon offsetting scheme (CORSIA) set up by the International Civil Aviation Organization for airlines based in EU and EEA countries.

The revision of the EU ETS in aviation will ensure that the aviation industry contributes to the EU's climate objectives. This includes increasing the auctioning of allowances by phasing out free allowances and applying the strengthened linear reduction factor to aviation.
Additionally, the revision appropriately implements ICAO's CORSIA through the EU ETS Directive. This will be applied to international flights departing from or arriving at airports within the European Economic Area (EEA). For flights within the EEA, only the EU ETS will continue to apply.

The infographic below explains the main changes and ambition of EU ETS revision legislation.



https://www.consilium.europa.eu/en/infographics/fit-for-55-eu-emissions-trading-system/

B.5. Additional measures of Greek Aviation Stakeholders

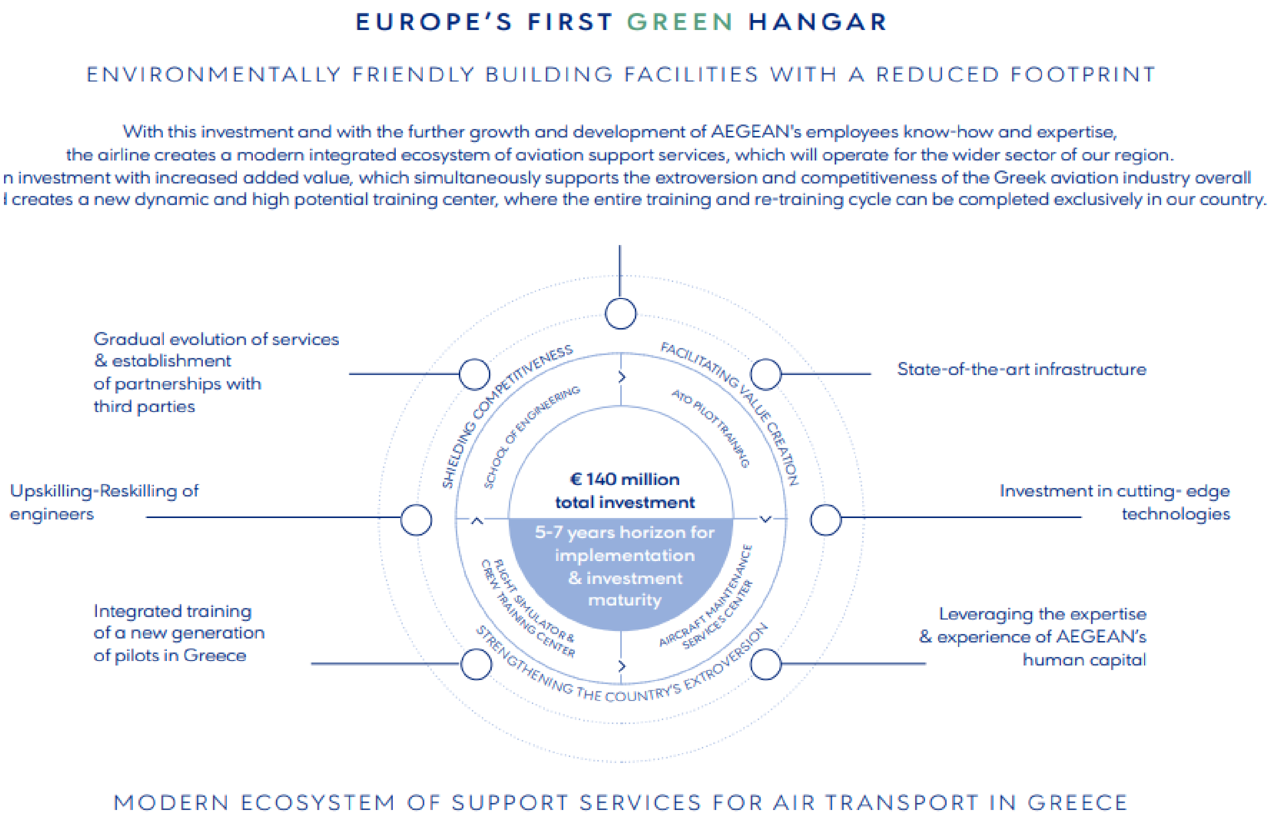
Additional measures to reduce emissions include actions, measures and initiatives taken by Greece's largest airlines and ground handling companies over the last three years.

B.5.1 Greek Air Operators Environmental Initiatives

Aegean Airlines

In 2023, AEGEAN established the first Aircraft Maintenance Services Center and the first Flight Simulator and Crew Training Center in Greece. Both establishments have a significant environmental impact. Specifically, the energy upgrade of the building facilities is planned by installation of 35,000 m^2 of photovoltaic panels, with a capacity of 3MWh, on the roof of the buildings, that aims to cover their energy needs and creating one of the first "green" aircraft maintenance hangars in Europe.

The first aviation ecosystem for flight training and technical support services in Greece. The maintenance repair and overhaul center (MRO), with the development of a technical base of up to 10 bays for various types of aircraft, creates a modern integrated ecosystem of aviation support services with a capacity of 85.000 m2 and it is able to cover the needs of both AEGEAN and third parties. This investment foresees the technological modernization and energy upgrade of the building facilities that will create one of the first "green" hangars in Europe, in one of Europe's "greenest" airports.



Direct and indirect carbon dioxide (CO2) emissions

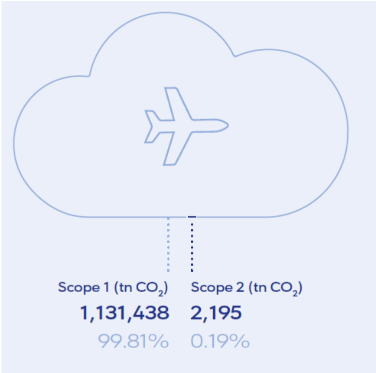
AEGEAN calculates and monitors the direct and indirect emissions produced by its operations. Aviation fuel is the main source of its carbon dioxide emissions, however, every effort to reduce its overall carbon footprint is made.

Scope 1

Direct emissions from fuel consumption arising from:
• the aircraft fleet
• the company vehicles fleet
• gas heating in buildings

Scope 2

Indirect emissions from electricity consumption in buildings



Recognizing the importance of recycling, AEGEAN implements recycling programs in all its operations. AEGEAN has also inaugurated Greece's first Upcycling program, utilizing aviation materials.

In addition to full compliance with legislation, the Company harmonizes with the regulations and guidelines of all airports in which it operates. AEGEAN has designed and implemented a Waste Management System, which includes the separation of waste streams and ensures recycling, reusing or other recovery methods.
The categories of produced waste include municipal solid waste from administrative services and industrial non-hazardous and hazardous waste originating from aircraft maintenance bases. A significant percentage of the Company's total waste arises from its aircraft maintenance technical bases.

Given that a large proportion of the waste is produced by the in-flight service, in 2022 AEGEAN initiated a process to redesign the offered meals as well as their packaging. The company’s new approach to in-flight service design is based unequivocally on quality, while also taking environmental criteria into consideration.

Figure 54: Quantities of hazardous waste (tn) from Aegean's aircraft maintenance technical bases.

Beginning in 2022 and spurred by the law on the banning of single-use plastic products, AEGEAN gradually replaced the plastic cutlery sets used in serving economy class in-flight meals with cutlery made of bamboo. This is only a first step in this direction; AEGEAN has also already decided to replace plastic with paper wrapping and particularly avoid the use and disposal of more than 200,000 packages of plastic cutlery per month

Upcycling

AEGEAN is pioneering an Upcycling programme aimed at making the most of surplus material. The raw materials that are used in this program include clothing and textiles (particularly crew uniforms), old life jackets, worn aircraft carpets and safety belts. It also creates handy new products tailored to the needs of our passengers. All materials, from packaging to the finished product, are environmentally friendly and recyclable. First Aegean collection was centered on life-saving materials, specifically the yellow life jackets found on all our aircraft. They used old life jackets to create accessory bags as well as collars and food dishes for pets. The ultimate goal through this initiative is part of the proceeds to be donated to animal shelters throughout Greece.

• For the second collection, the crew members' old uniforms were reused to create handy products (hair bands, baby bags, etc.), giving company's uniforms a new lease on life.

In 2023, a review and redesign of the recycling program was carried out in all offices, as well as in the technical maintenance area, which indicatively included the supply of new industrial-type bins and recycling systems and new markings. In addition, special bins for the recycling of cigarette butts were placed on the Company's premises.

Sky Express Airlines

SKY express: Fuel consumption & CO_2 emissions

SKY express annual fuel consumption and subsequent CO_2 emissions have grown over the years due to rapid fleet and route expansion. Over the same period, available seats have increased fourfold from 1.48 million to 5.81 million seats.

Aircraft fuel consumption & carbon dioxide emissions

Sky Express total jet fuel consumption and associated CO_2 emissions grew with the expansion of fleet and network. However, fuel efficiency improved as keeps:

1. Modernizing the fleet
2. Introducing Green operational procedures
3. Reducing aircraft's weight
4. Implementing of a new and more efficient refueling policy

- Overall, 2023 saw a 5.3% reduction in the CO_2 per Available Seat Kilometer emissions compared to 2022, proof of the effectiveness of our emission reduction operations and fleet efficiency. (63.2gr CO_2/ASK vs 66.8gr CO_2/ASK)
- Reduced fleet average age by 59% since 2018
- Use of latest fuel efficiency technology to increase aircraft efficiency and reduce fuel consumption
- Gradually replacing printed material in the cockpit with soft-form versions

Noise & local air quality. Go green to breathe clean!

SKY Express' approach to maintaining a young, technologically advanced fleet has ensured continuing reductions in noise levels per aircraft movement. Moreover, the "Green Ops" operations to reduce fuel consumption and carbon emissions also help minimize emissions of local air quality pollutants.

Other measures include:

- Use electric ground equipment
- Switch off aircraft auxiliary power units (APUs) where ground power and pre-conditioned air are available
- Reduced APU usage on aircrafts by 7.4% in 2023 compared to 2022
- Ooptimize ground transportation planning
- Latest generations LEAP 1A engines meet the most stringent noise standards
- A320neo & A321neo aircraft featuring CFM Leap engine operators emit 20% lower CO_2 and up to 50% lower NO_x. (compared to previous-generation engines)

Recycling

SKY express operates recycling bins in all its premises (office spaces and maintenance areas) and disposes of recyclable material responsibly.
There has been an overall increase of the recycled material in 2023 compared to 2022 (9.9%) thanks to the dedication of our employees.

Hazardous waste

SKY Express adheres to the strict waste management procedures stipulated in its ISO 14001:2015 Guidelines. It is committed to the safe disposal, storage and management of hazardous waste in designated areas in and around its buildings.

The overall increase in volume can be explained by the increase in the company's operations.

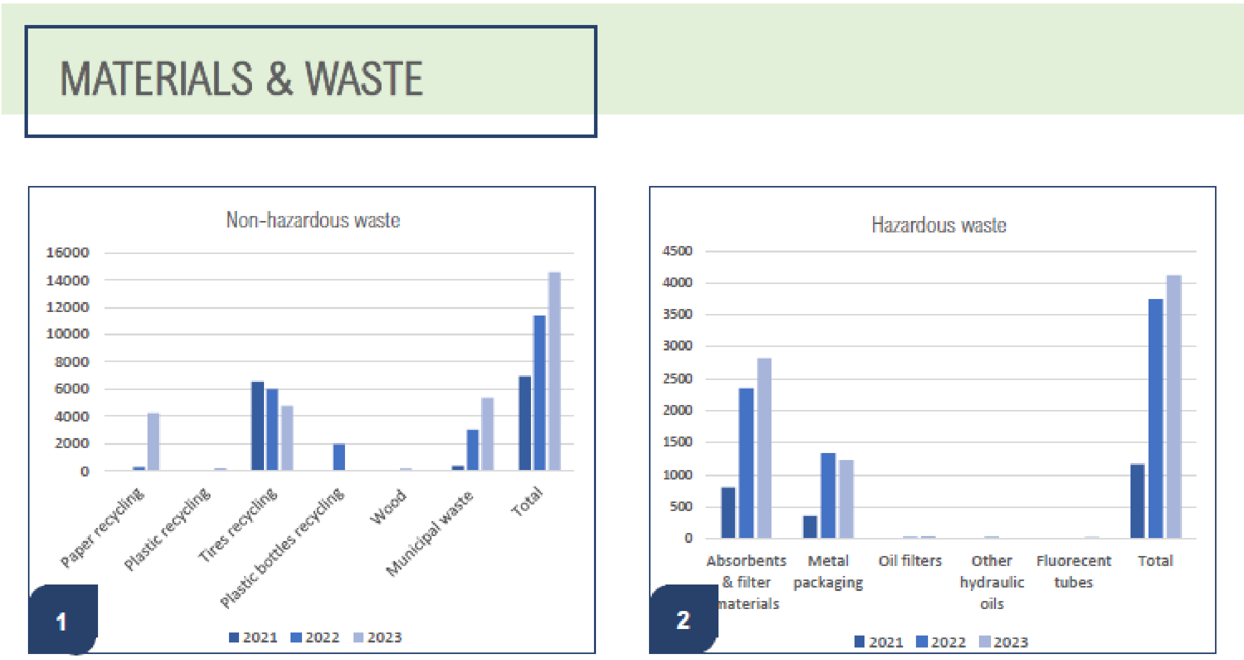


Figure 55: Quantities of non-hazardous and hazardous waste for the period 2021 - 2023

B.5.2 Environmental Management in Greek Airports

B.5.2.1 HASP Environmental Management

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 digitalized, and results are available at the online Environmental Registry.

HASP Environmental Protection Department keeps a database of all previous and valid AETCs and follows all necessary steps in order to issue, renew or amend, where necessary the AETCs under HASP’s control. The Department is also responsible for monitoring the correct implementation of AETCs, by coordinating environmental measurements (where required), waste collection and recycling, energy & water consumption monitoring etc.

The HASP Airport Managers are responsible for adhering to the Airport’s AETC, for preparing an annual Environmental Report and for reporting to the Environmental Protection Department, any issue related to environmental management. HASP Environmental Protection Section is the environmental focal point on Athenian Project (ATHENS TMA Redesign) & PBN) and on Airspace Redesign of the new International Airport in Heraklion.

B.5.2.2 Athens International Airport AIA

Athens International Airport (AIA) has been disclosing its carbon footprint (Scope 1 & 2) in a number of its corporate publications for the past several years, including:

- Annual and Sustainability Report: ASR 2023 (aia.gr)
- Care for the Environment -- an annual publication dedicated entirely to environmental issues: Care for the Environment (Issue 26) (aia.gr)
- Green Care -- an annual publication distributed to passengers and visitors as part of the Green issue of AIA’s 2Board magazine

Table 27: Greenhouse Gas Emissions for the period 2019 – 2023

Greenhouse Gas Emissions

EMISSION SOURCE		GREENHOUSE GAS EMISSIONS				GRI	ATHEX
GREENHOUSE GAS PROTOCOL	AIRPORT CARBON ACCREDITATION (ACA)	2023	2022	2021	2019*		
Scope 1 (tonnes CO_2e)		**5,465**	**4,585**	**3,826**	**4,060**	**305-1a**	**C-E1**
Company facilities	Natural Gas (Boilers)	2,857	3,081	2,520	2,504		
	Heating oil (Boilers)	14	6	138	4		
	Vehicle Fleet	1,510	1,415	1,045	1,428		
	Other Sources	119	83	123	124		
	Wastewater Treatment	108	Information unavailable/incomplete: AIA did not collect such data prior to 2023 as it was not required to do so as per its accreditation level in *Airport Carbon Accreditation*; note: these are AIA's 'Biogenic emissions' (305-1c).				
	Surface De-icing	36	Information unavailable/incomplete: AIA did not collect such data prior to 2023 as it was not required to do so as per its accreditation level in *Airport Carbon Accreditation*.				
	Refrigerant Losses	821	Information unavailable/incomplete: AIA did not collect such data prior to 2023 as it was not required to do so as per its accreditation level in *Airport Carbon Accreditation*.				
Scope 2 (tonnes CO_2e)		**22,568**	**24,923**	**21,938**	**39,086**	**305-2a**	**C-E2**
GHG intensity metrics							
AIA-specific metric (the denominator) chosen to calculate the ratios	Measurement unit: passengers (pax)	28,174,245	22,728,668	12,345,786	25,573,993	305-4	C-E1
Intensity of direct emissions (Scope 1)	tonnes CO_2e/PAX(x1,000)	0.19	0.20	0.31	0.16	305-4	C-E1
Intensity of indirect emissions (Scope 2)	tonnes CO_2e/PAX(x1,000)	0.80	1.10	1.78	1.53	305-4	C-E2
Intensity of Scope 3 emissions	tonnes CO_2e/PAX(x1,000)	84.92	82.44	N/A	N/A	305-4	A-E1
GHG emission intensity ratio for the Company	tonnes CO_2e/PAX(x1,000)	85.91	83.74	2.09[1]	1.69[1]	305-4a	
Total PVP CO_2e savings	tonnes CO_2e	**10,364**	**5,600**	**5,496**	**8,443**		

These publications are available from AIA's corporate website (www.aia.gr) and corporate Intranet (intranet.aia.gr) apart from Green Care which is available in hard copy. 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 Hellenic Ministry of Environment).

In addition, further to AIA's involvement in 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 (www.airportcarbonaccreditation.org), AIA now 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.

In fact, AIA played an instrumental role in helping shape the concept for Airport Carbon Accreditation. 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. CO2 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 CO2 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. 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.

Finally, in 2023 AIA updated its certification to Level 4+ (Transition) of Airport Carbon Accreditation by improving cooperation with Third Parties committed to reduce their emissions, as well as by calculating greenhouse gas emissions from additional sources (both Scope 1 and 3). More specifically, regarding Scope 1, AIA calculated emissions from:

- Wastewater processing from AIA’s Sewage Treatment Plant (STP)
- De-icing substances for surfaces and
- Refrigerant losses from AIA’s HVAC and cooling facilities

Regarding Scope 3, AIA’s greenhouse gas emissions report includes the following sources:

- Landside ground access of PAX, tenants and partners
- Staff commuting & Home office
- Staff business travel
- Fuel for fire training
- Solid waste processing
- Aircraft de-icer
- Cruise emissions (including maintenance and APU)
- Operational vehicles and equipment
- Construction vehicles fuels (services)
- WTT and T&D (fuels and energy)

Furthermore, in 2023, AIA's Energy Management System was successfully re-certified according to the ISO 50001:2018 standard. The new certification is valid until 3/12/2026.

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 2023 AIA has managed to reduce its carbon footprint (Scope 1 & 2) by 60%

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 provision of Fixed Electrical Ground Power and Pre-Conditioned Air
- replacement of older vehicles with more fuel-efficient models, including hybrid and electric 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

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 several 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).

The Company inaugurated a 16MWp photovoltaic station for self-consumption in March 2023, which generates approximately 45% of AIA's annual electricity needs. AIA plans to develop an additional 35.5 photovoltaic station with 82 MWh battery energy storage infrastructure in 2025 to produce 100% of the Electricity required for its operations from renewable sources. This will be a significant milestone in AIA's journey towards Net Zero, and the company is committed to achieving this target. In addition to expanding its photovoltaic installations, AIA is also electrifying its vehicle fleet and installing charging infrastructure onsite, replacing diesel and gasoline powered buses and high mileage vehicles. The Company plans to replace natural gas for heating purposes with heat pumps.

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. Up to now, in collaboration with the Public Power Corporation, AIA has installed 55 AC vehicle charging stations and 1 DC quick charger while more than 50 chargers used by 3rd parties have been installed.

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 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. In 2021, the BAS was updated with the electromechanical replacement of its controllers.
- replacement of six (6) of the Main Terminal Building's existing Air-Cooled Chillers with four (4) much more energy efficient Water-Cooled Chillers

In the framework of AIA's efforts to promote use of cleaner energy sources, in . Aegean airlines performed its first pilot flight with SAF from Hamburg to Athens Moreover, AIA has established a SAF Working Group for the promotion of SAF at the airport. All main stakeholders, namely major airlines, Olympic Fuel Company, Hellenic Civil Aviation Authority, Hellenic Service Aviation Provider, Fuel Suppliers, Hellenic Distilleries, etc. participate in the Group, which meets every 8 weeks. AIA is also a member of the ACI SAF Working Group.

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. In 2021 AIA proceeded to the replacement of AIA's Management fleet with electric vehicles with emissions <= 50gr CO_2/Km (BEV and PHEV) and to the installation of required charging infrastructure at relevant locations across the airport site.
- ensuring that the airport maintains its well-developed mass transit infrastructure (Metro, suburban rail, public bus, etc.).

Additional Information regarding AIA's Environmental Performance

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. We regularly monitor 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. The annual Environmental Plan which is implemented is consisting of Environmental Management Programs with medium- and long-term targets for all environmental aspects.

AIA is one of the 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 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 is maintained on noise issues 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 the Noise Monitoring System. An integrated waste management system is established based on the "Polluter Pays" principle, with economic incentives for companies that recycle. This combined with awareness, training and other initiatives has helped to increase recycling rate from 3% in 2001 when the airport opened to 81% in 2023.

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 of operations, especially regarding noise issues (e.g. preferential runway use during the afternoon as well as during exam periods).

Finally, in 2021, AIA joined a consortium of 22 partners in a project entitled STARGATE: SusTainable AiRports, the Green heArT of Europe. The project aims to support the European Green Deal and to reduce carbon emissions from aviation as well as its overall environmental impact. Through STARGATE, AIA will be able to push its ambitious environmental agenda forward, in particular its efforts to decarbonize its operations in relation to its Route 2025 initiative, but also to engage other members of the Airport community towards a more sustainable aviation ecosystem. AIA has focused on the development of Digital Twin for energy efficiency in its infrastructure, electrification of operational vehicles on the airfield, digital solutions for air cargo operations to improve efficiency and to reduce emissions as well as initiatives to increase the use of Sustainable Aviation Fuel (SAF).

B.5.2.3 Fraport Greece: Operator of 14 Hellenic Civil Airports

Environmental Management at 14 regional airports operated by Fraport Greece (2021-2023)

Since 2017, Fraport Greece has been responsible for the upgrade, maintenance, management and operation of 14 regional airports in Greece for a concession period of 40 years. The 14 airports are organized in two Clusters, Cluster A and B.

Figure 56: 14 regional airports in Greece operated by Fraport Greece

Fraport Greece adopted an Environmental & Social (E&S) Management Policy for all business units (Athens headquarters and airports), defining environmental protection and social responsibility as key corporate goals.

This policy is available in the corporate website and has been the basis of Fraport Greece's E&S Management System (ESMS). Energy Use and Climate Protection (emissions and adaptation) have been identified as significant environmental aspects of the ESMS.

Being an ACI member, Fraport Greece has participated in the "Toulouse Declaration" on future sustainability and decarbonization of aviation and committed to the "Destination 2050 Pledge" (2021). Within the context of Fraport Group, Fraport Greece has developed in 2023 and implements a Master Plan Decarbonization (MPD) with the following targets for Scope 1 and 2 emissions (with 2018 as baseline year):

Table 57: Fraport Greece carbon reduction targets

Year	Target
2030	-42,0%
2040	-80,7%
2045	Net Zero

Main categories of the measures included in the MPD are the development of P/V plants, energy optimization at terminals, electrification of vehicles fleet, etc.
Furthermore, the following quantities of SAF were delivered at Thessaloniki airport (SKG) by fuel supplier EKO:

Table 58: SAF quantities delivered at SKG airport

Year	2022	2023
SAF quantity (in MT)	64,40	155,12

Since 2018 (first complete calendar year of its operation) Fraport Greece has been calculating the CO_2 emissions (Scope 1 and 2) of the 14 airports (and Athens headquarters since 2023). In 2019, six (6) airports (Thessaloniki, Rodos, Chania, Samos, Mytilene and Kefallinia) received ACA certification Level 1 (Mapping). In 2023, all 14 airports have been carbon accredited according to ACA Level-1 –Mapping.
In 2022 Fraport Greece updated the initial Climate Change Resilience Study conducted in 2017 in cooperation with the National Observatory of Athens.
Another study for the protection of coastline at SKG airport was conducted by the Coastal Engineering department of Aristotle University of Thessaloniki (AUTH).
Besides the measures to reduce carbon emissions that also affect local air quality, Fraport Greece has established a comprehensive network of air quality and noise permanent stations at certain airports as described below:

Table 28: Fraport Greece permanent monitoring stations

	SKG (Thessaloniki)	CFU (Kerkira)	RHO (Rodos)
Air quality	1	1	1
Noise	4	2	2

Additionally, air quality and noise measurement campaigns as well as modeling are carried out as per each airport's Environmental Terms (E.T.s).

In relation to noise, the SKG Strategic Noise Map was approved by the MoEE in 2023 as well as the Annual Monitoring Program and the Special Study for noise measurements.

Fraport Greece has set up a communication channel for the public via two email accounts (*info@fraport-greece.com* & *environmental@fraport-greece.com*) where complaints (e.g. for noise) or even proposals for improvement can be submitted and processed accordingly.

Monitoring other aspects such as vibrations, electromagnetic radiation, water and soil quality is also performed as required by each airport's E.T.s.

Fraport Greece implements a central Municipal Solid Waste (MSW) management system at all airports following the practice of Separation at Source (SaS) and separate management of seven (7) streams: paper/cardboard, plastic, metal, glass, residual waste, bulky waste and sweeping waste. In the near future, bio-waste is planned to be included.

Fraport Greece cooperates with public or appropriately licensed private companies for waste collection and management. Hazardous waste management campaigns are also conducted annually in cooperation with licensed companies and has established contracts with several alternative management systems for the management of used oils, batteries, tires, WEEE, etc.

All monitoring results are published at the corporate website (Environmental Strategy Fraport Greece (fraport-greece.com)), per airport (Environmental Bulletins) and overall (Annual Environmental Strategy Report).

Fraport Greece will continue organizing similar voluntary activities in the near future. All airports operated by Fraport Greece follow the environmental permitting procedure for any required change and renewal of each airport's environmental license.

In 2022, an extensive modification of all airports E.T.s (with the exception of SKG) took place due the "EASA Compliance Works" project funded by the RRF that aims to improve aviation safety in 13 airports. Technical Environmental Studies for the construction works related to the project, e.g. JSI were also submitted and approved, as required.

E.T.s modification to related to fuel handlers operating at CHQ and JTR took place in 2022 and 2023 respectively.

In 2023 environmental permitting for the installation of PV plants was granted by the MoEE for SKG, CHQ, KVA and ZTH.

For SKG in particular, modification of E.T.s was approved in 2021, followed by a modification and renewal of E.Ts. Decision in 2023.

B.5.3 Ground Handlers Environmental Initiatives

Goldair Handling Action Plan for CO2 emissions reduction

Goldair Handling is the first private ground handling company, which operates in the Greek market since 1999. Aiming to the effective management of all environmental issues and threats to combat climate change, Goldair Handling has adopted and implements an Environmental Management System and is certified with ISO 14001:2015 in the entire network of 26 airports it operates in Greece.

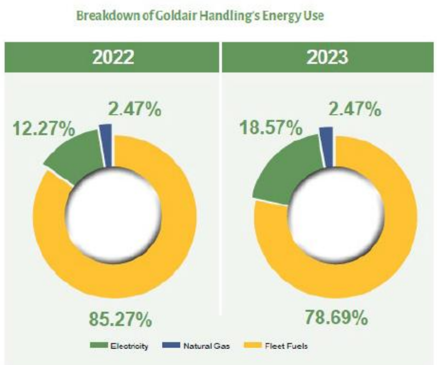
The company conducts 4-year Energy Audit Reports, covering at least 90% of its annual energy consumption. These audits identify energy-saving opportunities and recommend measures to improve energy efficiency. Environmental Performance Indicators (EPIs) and Energy Performance Indicators (EnPIs) are set annually, and an action plan is formulated accordingly.

Moreover, it calculates CO2 emissions, specifically Scope 1 and Scope 2 emissions, each year. These calculations also extend to monitoring fuel consumption per departing flight and energy consumption per square meter of building facilities. For the year 2023, CO2 emissions were 5748,9 tnCO2e, fuel consumption was 260,917 lt per departing flight and average consumption per m2 of building facility was 4873,98. Annual Carbon emissions (in tnCO2e) of 2022 and 2023 per type of consumption, are summed up at the following table:

Table 29: Goldair's Handling Annual Carbon emissions (in tnCO2e) per type of consumption

Carbon Emissions ($tnCO_2e$)	2022	2023	%
Natural Gas	85.68	104.98	22.53%
Diesel - GSE	3,887.96	3,996.62	2.79%
Gasoline - Vehicle Fleet	40.85	85.83	110.13%
Diesel - Vehicle Fleet	360.06	288.41	-19.90%
Scope 1	4,374.54	4,475.84	2.3%
Scope 2	1,133.35	1,273.06	12.3%
Total Emissions	5,507.90	5,748.90	4.4%
Total Emissions Intensity (kg CO_2e/Number of Flights)	47.86	46.01	-3.9%

Since March 2023, Goldair Handling electricity in Athens building facilities have been coming from a Green Energy provider. As a result, 53% of the Goldair Handling in Athens electricity consumption and 32,8% of the total Goldair Handling in Greek network electricity consumption has Guarantees of Wind Turbine Origin for 2023.The company plans to expand the use of green energy wherever available across all its facilities in Greece in the coming years. Additionally, 95 electric vehicle charging points have been installed. The Company has also implemented several upgrades to its facilities to improve energy efficiency. LED light bulbs are used in all building facilities and refrigerators and cooling machines are upgraded and maintained constantly. The company also reports on equipment and installations containing fluorinated gases annually, as well as imports of F-gasses into the EU.



A strategic plan to upgrade Goldair Handling's fleet of cars and Ground Handling Equipment is set. In 2023, the number of electric or hybrid vehicles in GR was increased to 301 (from 199 in 2022), representing 41,6% of the total fleet (compared to 11,2% in 2022). Goldair Handling has its own Ground Handling Equipment workshop department, providing in house maintenance of its equipment on site, thus avoiding fuel and energy consumption due to equipment transportation.

As graphically presented, there is a significant increase of Electrical Energy followed by a reduction of fossil fuel use during the years 2022-2023.

Goldair Handling's sustainable practices were showcased during the Air France Sustainable Flight Challenge 2023, hosted by SkyTeam, where the company received the "Best Collaboration" recognition. Goldair Handling collaboration included among others, the use of eco-friendly Ground Support Equipment and minimization of vehicle movement and energy running time, provision of vegan and local/organic food options and elimination of plastic-packaged snacks in the lounges and the participation to the Climate Fresk Workshop, aiming to raise awareness about climate change and its causes among its employees.

In 2023, 97% of staff received environmental training across the Greek network. Environmental exercises are performed annually in all stations and several voluntary environmental actions take place every year, including waste removal from natural landscape (beaches, rivers, forests), tree planting and offer of ground handling services for transportation of wild animals in need. The Goldair Handling annual plans also include contributions aimed at reducing resource consumption by donating uniforms for reuse, repurposing, or recycling, donating wheelchairs to be converted into mobility aids for pets and donating electronic devices for humanitarian use.

Goldair Handling also evaluates its subcontractors based on environmental criteria, conducts audits on their premises and provides environmental training for their employees. An effort to associate with local suppliers is made where possible, to minimize energy consumption for the transportation of goods, and Public Transport Cards are provided to all personnel to promote less energy consuming ways to commute to work. For example, during 2023, 56,57% of Athens Station personnel commuted to work via public transport.

Regarding other Carbon Emitting activities, the company monitors and inspects waste production and recycling, to investigate implementation of measures for "waste ending to landfills" reduction. During 2023, the percentage of recycled material out of total waste was 21,55% in Athens (19,72% in 2022) and the percentage of recycled materials from outstations in Greece was 17,12%. All hazardous materials deriving from Goldair Handling operations are forwarded to recycling by certified collectors. Starting in 2024, food waste from lounges in Athens will also be recycled into soil fertilizer.

Goldair Handling is advancing its sustainability efforts through digital transformation by developing intranet applications that promote paperless operations. These applications include:

- Electronic recordings for fuel consumption and fleet maintenance
- Waste Management, Environmental Programs and Fire Extinguishers electronic recordings
- Read and sign electronic dissemination of Airline and Goldair Handling notifications (with over 1,886 notifications distributed and acknowledged without using printed paper in 2023)
- Audit Data Base electronic recordings
- Customer Services and Complains-Compliments Data Base electronic recordings
- Personnel Travel and Consumables Requisitions electronic recordings
- E-Training library and electronic training database

For its recent efforts, Goldair Handling was awarded in Energy Mastering Awards 2023 in the category "Reduction / Minimization – Emissions".

The Goldair Handling ESG and Sustainability Report is available in the following link: https://www.goldair-handling.com/sustainable-development/

CONCLUSIONS

6.CONCLUSIONS

The Greek Government, Hellenic Civil Aviation Authority and Aviation Stakeholders are fully committed to address the climate change impacts of commercial aviation and achieve CO2 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 the 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 B of this Action Plan cover the majority of measures taken at state level by State authorities and the Private sector including main aviation stakeholders of air transport industry.

Both Sections A and B were finalized by December 2024 and shall be considered as subject to update after that date.

APPENDIX A

DETAILED RESULTS FOR ECAC SCENARIOS FROM SECTION A

A.1 BASELINE SCENARIO

a) Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movement) (million)	Revenue Passenger Kilometres[177] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported ([178]) FTKT (billion)	Total Revenue Tonne Kilometres[179] RTK (billion)
2010	4.71	1,140	0.198	41.6	155.6
2019	5.88	1,874	0.223	46.9	234.3
2023	5.38	1,793	0.234	49.2	228.5
2030	6.69	2,176	0.262	55.9	273.5
2040	7.69	2,588	0.306	69.0	327.8
2050	8.46	2,928	0.367	86.7	379.5
Note that the traffic scenario shown in the table is assumed for both the baseline and implemented measures scenarios.					

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	38.08	120.34	0.0327	0.327
2019	53.30	168.42	0.0280	0.280
2023	48.41	152.96	0.0268	0.268
2030	54.46	172.10	0.0250	0.250
2040	62.19	196.52	0.0240	0.240
2050	69.79	220.54	0.0238	0.238
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

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

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

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

c) *Average annual fuel efficiency improvement for the Baseline scenario*

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

A.2. IMPLEMENTED MEASURES SCENARIO

2A) EFFECTS OF AIRCRAFT TECHNOLOGY IMPROVEMENTS AFTER 2023

d) Fuel consumption, CO_2, and CO_2 equivalent emissions of international passenger traffic departing from ECAC airports, with aircraft technology improvements after 2023 included. The well-to-wake emissions are determined by assuming 3.88 Kg of CO_2 equivalent emissions for 1 Kg of Jet-A fuel burn[180]:

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

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

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

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

2B) EFFECTS OF AIRCRAFT TECHNOLOGY AND ATM IMPROVEMENTS AFTER 2023

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

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

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

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

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

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

2C) EFFECTS OF AIRCRAFT TECHNOLOGY, ATM IMPROVEMENTS AND SAF AFTER 2023 ON EU27+EFTA INTERNATIONAL DEPARTURES

The Net CO_2 emissions and expected benefits of SAF use are calculated where regional measures are taken (e.g. ReFuelEU Aviation) in the European scenario with measures.

i) Fuel consumption, CO_2, Net CO_2 emissions of international passenger traffic departing from EU27+EFTA airports, with aircraft technology and ATM improvements after 2023 The tank-to-wake Net CO_2 emissions are based on the use of Sustainable Aviation Fuels (ReFuelEU Aviation, 70% decarbonation factor for the synthetic aviation fuels, and 65% for aviation biofuels).

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Tank-to-Wake Net CO_2 emissions (10^9 kg)
2010	27.84	87.97	87.97
2019	38.19	120.69	120.69
2023	34.08	107.71	107.71
2030	36.97	116.84	112.21
2040	35.63	112.60	87.15
2050	32.80	103.63	54.67
For reasons of data availability, results shown in this table do not include cargo/freight traffic.			

APPENDIX B

DETAILED RESULTS FOR GREEK SCENARIO FROM SECTION B

B.1. GREEK BASELINE SCENARIO

The GREEK Baseline Scenario for CO2 emissions of Greek Aircraft Operators has included the Aviation Traffic and performance data for the historic years 2010, 2013, 2016, 2019 - 2023 and forecasts for years 2025, 2030, 2040 and 2050.

Greek scenario analysis includes all commercial International flights performed by Aircraft Operators holding a Greek Air Operator Certificate (AOC) and subject to reporting requirements under EU-ETS & CORSIA. The data reported include number of flights, revenue passenger kilometers (RPK) and revenue tonne-kilometres (RTK), its associated aggregated fuel consumption and its associated CO2 emissions. The reported CO2 emissions include all international flights, which are operated only by aeroplane operators attributed to Greece, as determined in Annex 16, Volume IV.

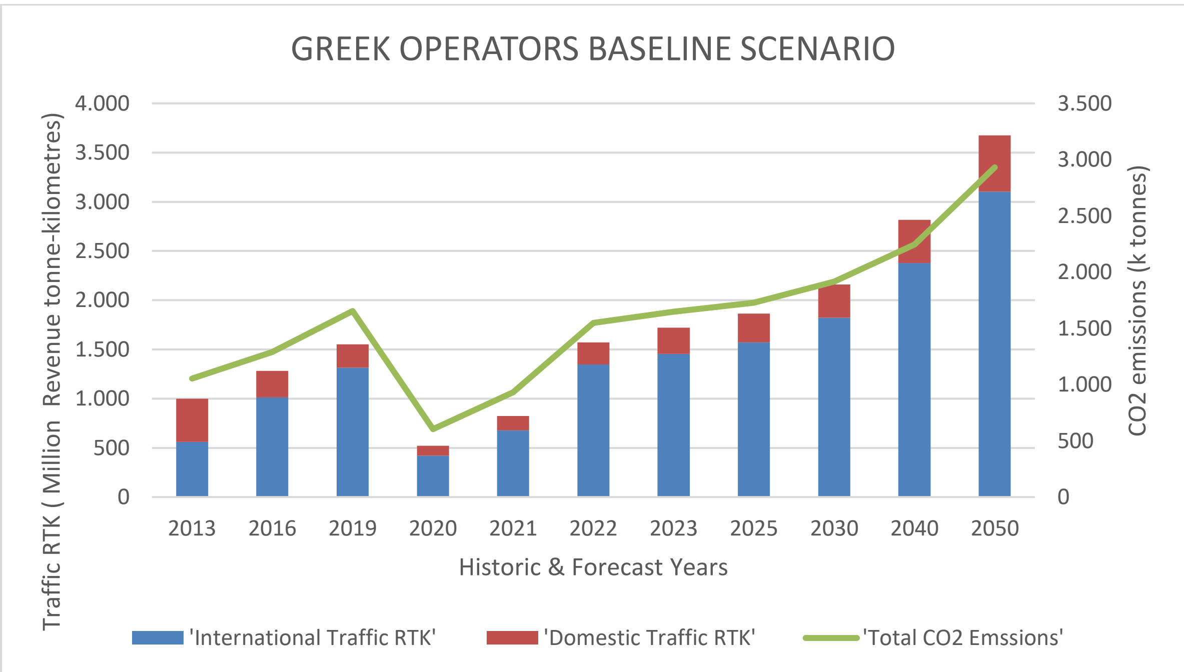
Historical fuel burn and emission calculations are based on EMIS (Environmental Management Information System) database provided by EUROCONTROL and ICAO CORSIA Central Registry (CCR) database, while data for actual flight distance, number of passengers carried, revenue passenger kilometers (RPK) and revenue tonne-kilometres (RTK) were provided by Aircraft Operators and Data by 'Form A' submitted to ICAO on an annual basis.

Forecast years (until 2050) fuel burn and modelling calculations use the same assumptions made in ECAC baseline scenario, as generated by EUROCONTROL for all ECAC States. Although EUROCONTROL generates forecast for all-cargo flights in its baseline scenario, no information about the freight tonnes carried is generated in the Greek Forecast scenario.

The following tables and figures show the results for this baseline scenario, which is intended to serve as a reference case by approximating fuel consumption and CO2 emissions of Greek Aircraft Operators in the absence of mitigation actions after year 2023.

Table 30: Baseline Scenario of Greece without any measures taken

GREEK OPERATORS BASELINE SCENARIO							
Year		International Flights			Total (Int+Dom) Flight Services		
		Fuel Burn (k tonnes)	Traffic RTK (Millions of tonne-kilometres)	CO_2 emissions (k tonnes)	Fuel Burn (k tonnes)	Traffic RTK (Millions of tonne-kilometres)	CO_2 emissions (k tonnes)
HIstoric Data	**2013**	182,0	559,5	575,0	333,9	997,8	1.055,0
	2016	294,4	1.012,5	930,4	407,9	1.283,5	1.289,0
	2019	412,0	1.313,2	1.301,9	523,8	1.551,2	1.655,1
	2020	134,2	421,0	423,9	191,1	522,0	603,9
	2021	208,2	677,0	658,0	294,3	823,0	929,9
	2022	390,0	1.347,0	1.232,4	490,0	1.572,0	1.548,4
	2023	407,6	1.454,3	1.288,1	521,2	1.722,1	1.647,1
Forecast Data	**2025**	440,9	1.572,9	1.393,2	563,8	1.862,7	1.781,5
	2030	511,1	1.823,4	1.615,1	653,5	2.159,3	2.065,2
	2040	666,9	2.379,2	2.107,4	852,7	2.817,4	2.694,6
	2050	870,1	3.104,3	2.749,7	1.112,6	3.676,1	3.515,9



B.2. IMPLEMENTED MEASURES SCENARIO of GREECE

To improve fuel efficiency and to reduce future air traffic emissions beyond the projections GREECE, along with all ECAC States, have taken further actions, as detailed described in Sections A & B of this Action Plan. Assumptions for the effects of mitigation actions are presented here, where all measures to reduce aviation's fuel consumption are taken into consideration.

Table 31: Baseline Scenario of Greece with implemented measures

GREEK OPERATORS IMPLEMENTED MEASURES SCENARIO							
Year		International Flights			Total (Int+Dom) Flights		
		Fuel Burn (k tons)	Traffic RTK (Millions of Revenue tonne-kilometre)	CO2 emissions (k tons)	Fuel Burn (k tons)	Traffic RTK (Millions of Revenue tonne-kilometre)	CO2 emissions (k tons)
HIstoric Data	2013	182,0	559,5	575,0	333,9	997,8	1.055,0
	2016	294,4	1.012,5	930,4	407,9	1.283,5	1.289,0
	2019	412,0	1.313,2	1.301,9	523,8	1.551,2	1.655,1
	2020	134,2	421,0	423,9	191,1	522,0	603,9
	2021	208,2	677,0	658,0	294,3	823,0	929,9
	2022	390,0	1.347,0	1.232,4	490,0	1.572,0	1.548,4
	2023	407,6	1.454,3	1.288,1	521,2	1.722,1	1.647,1
Forecast Data	2025	427,8	1.572,9	1.351,8	547,0	1.862,7	1.728,4
	2030	473,9	1.823,4	1.497,6	606,0	2.159,3	1.914,9
	2040	544,9	2.379,2	1.721,9	711,0	2.817,4	2.246,6
	2050	661,5	3.104,3	2.090,4	927,6	3.676,1	2.931,3

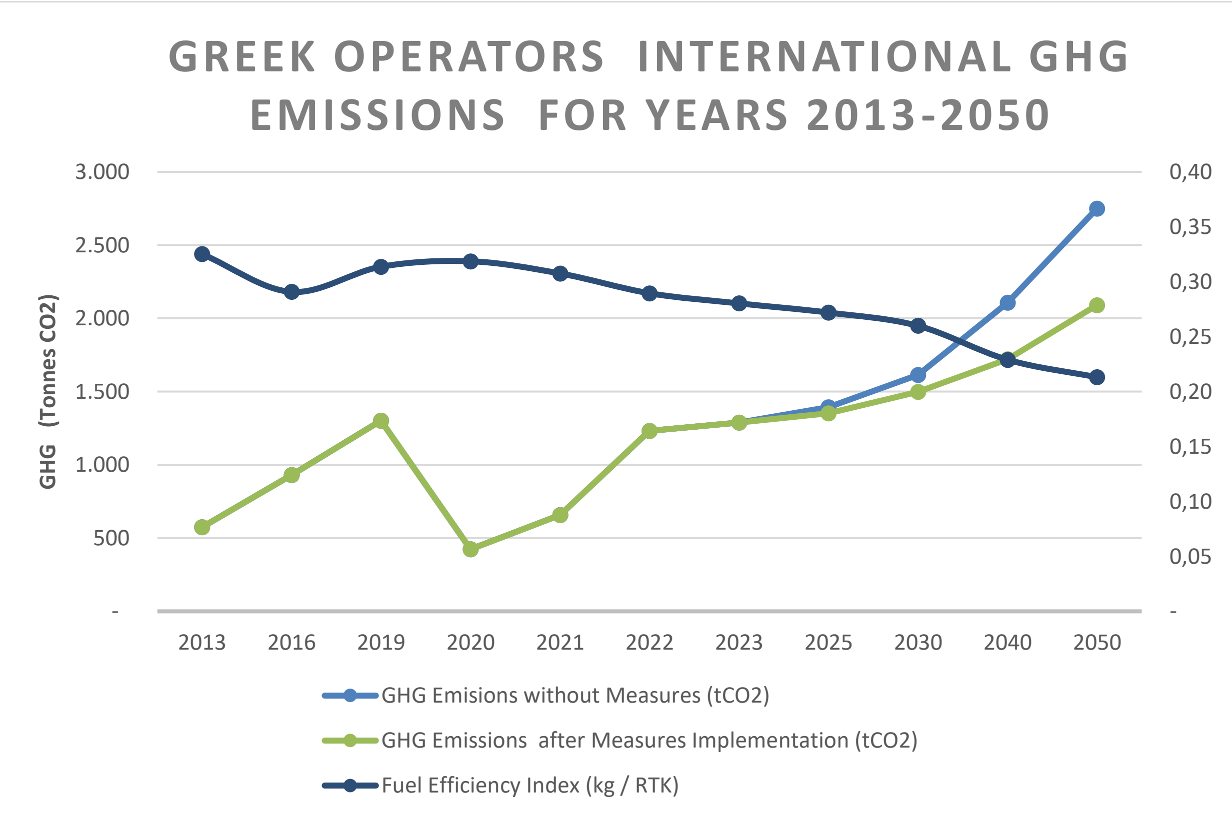
Revenue RTK during 2023 was 1,454 billion in total International Flights and presented an increase of 8% related to previous year and exceeding 2019 pre covid traffic. CO2 emissions during 2023 reached 1,288 million tons for International Flights and presented an increase of only 5% related to previous year. This is the result or continuous improvement in Air Traffic Management and Greek Aircraft Operators initiatives to improve fuel efficiency and carbon footprint.

Fuel Efficiency Indexes from International Flights and GHG Emissions evolution are presented in Table 32. It is noticeable that Fuel Efficiency Index was 0,28 kg/RTK during 2023, which is 3.5% improvement versus previous year. Over the last 10 years of International Aviation activity in Greece, an improvement of 15% of Fuel Efficiency has been achieved, since in 2013 the Fuel Efficiency Index was recorded at 0,33 kg/RTK, as shown in Table 32.

Table 32: Evolution of International Flights Fuel Efficiency (2013-2050)

International Flights GHG Emissions			
Year	GHG Emissions without Measures (tCO2)	GHG Emissions after Measures Implementation (tCO2)	Fuel Efficiency Index (kg / RTK)
2013	575,00	575,00	0,33
2016	930,37	930,37	0,29
2019	1.301,86	1.301,86	0,31
2020	423,92	423,92	0,32
2021	657,99	657,99	0,31
2022	1.232,40	1.232,40	0,29
2023	1.288,12	1.288,12	0,28
2025	1.393,23	**1.351,75**	0,27
2030	1.615,14	**1.497,59**	0,26
2040	2.107,39	**1.721,89**	0,23
2050	2.749,67	**2.090,38**	0,21

The Evolution of GHG Emissions and Fuel Efficiency from International Flights are graphically presented below for the years 2013-2050.



LIST OF ABBREVIATIONS

AAT - Aircraft Assignment Tool

ACARE – Advisory Council for Research and Innovation in Europe

ACA – Airport Carbon Accreditation

ACI – Airports Council International

AFTF - Alternative Fuels Task Force

AFIR Alternative Fuels Infrastructure Regulation (EU)

AIA – Athens International Airport

AIRE – The Atlantic Interoperability Initiative to Reduce Emissions

ANSPs - Air Navigation Service Providers

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

ASK - Available Seat Kilometer

ATAG - Air Transport Action Group

ATC - Air Traffic Control

AtJ - Alcohols to Jet

ATM – Air Traffic Management

AZEA - Alliance for Zero Emission Aviation

CAEP – Committee on Aviation Environmental Protection

CCS - Carbon Capture and Sequestration

CDOs - Continuous Descent Operations

CEF - Connecting Europe Facility

CEF – CORSIA eligible fuels

CNG – Carbon neutral growth

CONOP - Concept of Operation

CORSIA - Carbon Offsetting and Reduction Scheme for International Aviation

DLUC - Direct Land Use Change

DSHC - Direct Sugars to Hydrocarbons

EAER – European Aviation Environmental Report

EASA – European Aviation Safety Agency

EC – European Commission

ECAC – European Civil Aviation Conference

EEA – European Economic Area

EFTA – European Free Trade Association

EIA – Environmental Impact Assessment

EPTS - Environmental Protection Technical Specifications

EPNL Effective Perceived Noise Level or EPNdB

EEA - European Economic Area

EU – European Union

EU ETS – the EU Emissions Trading System

FRA - Free airspace

FOGs - Waste Fats, Oils, Greases from vegetable and animal sources

FTKT - Freight Tonne Kilometres Transported

GA - General Aviation

GCD - Great Circle Distance

GHG – Greenhouse Gas

HEFA - Hydro processed Esters and Fatty Acids

ICAO – International Civil Aviation Organization

IFR – Instrumental Flight Rules

ILUC - Indirect Land Use Change

IPCC – Intergovernmental Panel on Climate Change

IPR – Intellectual Property Right

JTI - Joint Technology Initiative

JU – Joint Undertaking

KPAs - Key Performance Areas

KPIs - Key Performance Indicators

LCA - Lifecycle Analysis

LCAF- Lower Carbon Aviation Fuels

LTAG – Long-Term Aspirational goal for international aviation

MBM – Market-based Measure

MT – Million tonnes

NDC - National Determined Contribution

NM -nautical miles

nvPM non-volatile particulate matter

OEMs - Original Equipment Manufacturers

PBN - Performance Based Navigation

PRA - Price Reporting Agencies

PFAD - Palm Fatty Acid Distillate

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

PtL - Power-to-Liquid

RED – Renewable Energy Directive

RPK – Revenue Passenger Kilometer

RTK – Revenue Tonne Kilometer

RTD – Research and Technological Development

SAF – Sustainable Aviation Fuels

SES – Single European Sky

SESAR – Single European Sky ATM Research

SESAR JU – Single European Sky ATM Research Joint Undertaking

SESAR R&D – SESAR Research and Development

STOL - E-Short Take-Off and Landing

SMEs - Small and Medium Enterprises

TMA - Terminal Maneuvering Areas

ToD - Top-of-Descent

UAS - Unmanned Aircraft Systems – Drones

VCA – VTOL Capable Aircraft

— END —