HELLENIC CIVIL AVIATION AUTHORITY

ICAO Action Plan for International Aviation Greenhouse Gas Emissions Reduction

Greece's Action Plan

September 2018

Contents

SECTION 1 : INTRODUCTION

1.1. Contact Information

Name of the Authority:	**Hellenic Civil Aviation Authority**
Point of contact:	**Georgia Lykou**, *Action Plan Focal Point*[1]
Street address:	**4, Leontos & Eleftherias str., Argyroupolis**
	Postal Code 164 52
City:	**Athens**
Country:	**Greece**
Telephone number:	**+30-2109973364**
Fax number:	**+30-2109680203**
E-mail address:	propeenvdaa@hcaa.gr , prope@hcaa.gr

[1] HCAA, Governor's Letter with ref.: HCAA/GOV//2171/19-07-2012

1.2. Common Introductory Section

a) Greece is a member of the European Union since 1981 and a founding member of the European Civil Aviation Conference (ECAC). ECAC is an intergovernmental organisation covering the widest grouping of Member States[2] of any European organisation dealing with civil aviation. It is currently composed of 44 Member States, and was created in 1955.

b) ECAC States share the view that environmental concerns represent a potential constraint on the future development of the international aviation sector. Together they fully support ICAO's ongoing efforts to address the full range of these concerns, including the key strategic challenge posed by climate change, for the sustainable development of international air transport.

c) Greece, like all of ECAC's forty-four 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.

d) Greece recognises the value of each State preparing and submitting to ICAO an updated State Action Plan for CO_2 emissions reductions as an important step towards the achievement of the global collective goals agreed since the 38th Session of the ICAO Assembly in 2013.

e) In that context, it is the intention that all ECAC States submit to ICAO an Action plan. This is the Action Plan of Greece.

f) Greece shares the view of all ECAC States that a comprehensive approach to reducing aviation 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 low-carbon, sustainable alternative fuels, including research and operational initiatives undertaken jointly with stakeholders,

   iv. improvement and optimisation of Air Traffic Management and infrastructure use within Europe, in particular through the Single European Sky ATM Research (SESAR), and also beyond European borders, through the Atlantic Initiative for the Reduction of Emissions (AIRE) in cooperation with the US FAA, and

   v. Market-based measures, which allow the sector to continue to grow in a sustainable and efficient manner, recognizing that the measures at (i) to (iv) above cannot, even in aggregate, deliver in time the emissions reductions necessary to meet the global goals. This sustainable growth becomes possible through the purchase of carbon units that foster emission reductions in other sectors of the economy, where abatement costs are lower than within the aviation sector.

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

g) In Europe, many of the actions which are undertaken within the framework of this comprehensive approach are in practice taken collectively, throughout Europe, most of them led by the European Union. They are reported in **Section 2** of this Action Plan, where the involvement of Greece is described, as well as that of other stakeholders.

h) In Greece a number of actions are undertaken at the national level, including by stakeholders. These national actions are reported in **Section 3** of this Plan.

i) In relation to European actions, it is important to note that:

  i. The extent of participation will vary from one State and 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 to 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.

  ii. Nonetheless, acting together, the ECAC States have undertaken to reduce the region's emissions through a comprehensive approach which uses each of the pillars of that approach. Some of the component measures, although implemented by some but not all of ECAC's 44 States, nonetheless yield emission reduction benefits across the whole of the region (thus for example research, ETS).

1.3. Current State of Aviation in Greece

Greece is strategically located at the crossroads of Europe, Asia, and Africa. Situated on the southern tip of the Balkan Peninsula, Greece shares land borders with Albania, FYROM and Bulgaria to the north and Turkey to the northeast. Greece has the longest coastline on the Mediterranean Basin (with 13,676 km) in length, featuring a vast number of islands. Most of the Greek islands and many cities of Greece are connected by aviation and marine transportation.

Figure 1: *Map of Greece*

The **Hellenic Civil Aviation Authority (HCAA)** is Civil Service Entity under the Ministry of Infrastructure and Transport. Its mission is the organization, development, and management of the country`s air transport infrastructure, as well as the overall policy formulation in the air transportation sector. HCAA main activities are[3]:

i. Handling and development of air transport inside the country and abroad.
ii. Care for the development of international aviation relations and participation in International Organizations.
iii. Care for the organization of the Hellenic Air Space, the provision of Air Traffic Services (ATS), Communication - Navigation - Surveillance (CNS), Aeronautical information services (AIS) as well as Airspace Management (ASM) and Air Traffic Flow Management (ATFM).
iv. Carrying out and following the application of standards, regulations and requirements for aircraft exploitation and operation.

[3] The current activities of HCAA are described here. However, a new national law (N.4427/2016 along with its implementing rules PD 84/2018 and PD 85/2018 that have been recently established) defines that tasks relevant to regulatory, supervision/ inspection etc. like those depicted in IV,V,(partially the VI) VII,VIII, IX, including those of HANSA, will be fallen into the remit of a new entity named Authority of Civil Aviation. Consequently, in near future, these tasks will not anymore be under jurisdiction of current organization, which will retain the rest of its current activities.

v. Inspection of aircraft and Civil Aviation crew suitability and granting of the relevant certificates and licenses.
vi. Establishment, operation and supervision of the Hellenic airports. Continuous care for development, modernization and environmental protection.
vii. Inspection of Civil Airports and granting of the relevant certificates.
viii. Formulation of air transport legislation.
ix. Care for the general aviation's development and the promotion of air sporting activities.
x. Actions to ensure the inflow of financial resources in return for the services provided to aircraft and passengers, as well as to ensure administrative and financial support for its services.

Greece has established[4] the Hellenic Air Navigation Supervisory Authority (HANSA) to carry out the tasks of Certification of ATM/ANS services, supervision and continued oversight for identification of correct implementation of European regulations related to ATM/ANS services. In this frame and according to Regulation (EU) 390/2013, HANSA is in charge to monitor the effective implementation of ATM/ANS performance plan (apart from its drawing up) which amongst others incorporates the area of environment.

Greek Airports

There are 39 airports in Greece, operating with commercial air traffic and supervised by the Civil Aviation Authority, located all over the country, as presented in the Figure2.

Figure 2: *Commercial Airports in Greece*

Following graphical representation, Table 1 exhibits in detail Greek Commercial Airports, with regional location, ICAO & IATA code, Airport name and operating entity.

4 In accordance with the European Regulations 549/2004 & 550/2004 articles 4 & 2 respectively

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

Table 1: *Greek Commercial Airports*

In table 2, commercial traffic of domestic and international aviation per airport is illustrated for the period January to December 2017.

AIRPORT NAME	JANUARY - DECEMBER 2017							
	COMMERCIAL TRAFFIC				TOTAL FLIGHTS		TOTAL PASSENGERS	
	DOMESTIC		INTERNATIONAL					
	FLIGHTS	PASSENGERS	FLIGHTS	PASSENGERS	2017	2016	2017	2016
	ARR+DEP	ARR+DEP	ARR+DEP	ARR+DEP	ARR+DEP	ARR+DEP	ARR+DEP	ARR+DEP
ATHENS	79.260	7.307.192	108.439	14.357.694	187.699	181.709	21.664.886	19.973.704
THESSALONIKI	22.849	2.420.151	29.914	3.921.861	52.763	48.608	6.342.012	5.687.325
IRAKLEION	11.124	1.137.559	39.813	6.215.008	50.937	47.804	7.352.567	6.742.746
RODOS	8.371	856.076	27.651	4.422.139	36.022	36.164	5.278.215	4.942.386
KERKYRA	3.286	291.344	17.180	2.609.330	20.466	20.754	2.900.674	2.764.559
CHANIA	5.570	831.055	13.447	2.196.989	19.017	19.288	3.028.044	2.953.278
KOS	3.818	228.014	13.300	2.088.188	17.118	15.072	2.316.202	1.901.495
SANTORINI	8.924	1.017.811	6.539	876.706	15.463	14.084	1.894.517	1.685.695
ZAKYNTHOS	2.064	83.088	9.932	1.568.000	11.996	10.596	1.651.088	1.415.712
MYKONOS	4.886	469.286	6.014	693.488	10.900	11.928	1.162.774	999.026
MYTILINI	4.791	329.336	731	90.773	5.522	5.792	420.109	411.285
SAMOS	3.631	153.962	1.724	228.289	5.355	5.186	382.251	346.780
KEFALLONIA	1.506	76.505	3.681	533.487	5.187	4.920	609.992	538.199
CHIOS	4.964	214.089	32	1.568	4.996	4.404	215.657	196.130
AKTIO	1.088	12.942	3.860	538.533	4.948	4.510	551.475	472.870
SKIATHOS	1.131	42.289	2.712	360.698	3.843	3.830	402.987	395.001
KAVALA	1.390	74.793	1.985	257.236	3.375	3.112	332.029	258.239
KARPATHOS	2.068	58.965	1.280	164.034	3.348	4.032	222.999	218.422
KALAMATA	1.122	33.457	2.197	243.268	3.319	2.684	276.725	227.980
PAROS	3.185	159.867	37	2.602	3.222	2.164	162.469	74.288
ALEXANDROUPOLIS	2.365	167.393	34	1.433	2.399	2.832	168.826	161.635
LIMNOS	2.081	67.230	147	17.881	2.228	2.928	85.111	87.232
NAXOS	1.756	56.605	0	0	1.756	1.210	56.605	35.135
MILOS	1.434	48.069	0	0	1.434	1.694	48.069	48.700
IOANNINA	1.354	89.163	54	6.449	1.408	1.460	95.612	97.122
LEROS	1.394	27.543	0	0	1.394	1.380	27.543	25.215
IKARIA	1.259	41.520	0	0	1.259	1.324	41.520	41.239
SITEIA	1.168	19.853	86	11.929	1.254	1.766	31.782	20.903
ARAXOS	32	213	1.212	150.680	1.244	1.042	150.893	127.650
SYROS	928	21.419	0	0	928	736	21.419	17.891
KYTHIRA	834	29.884	50	3.810	884	1.056	33.694	34.493
KALYMNOS	864	11.989	0	0	864	1.164	11.989	18.631
ASTYPALAIA	696	12.490	0	0	696	760	12.490	12.014
SKYROS	661	14.915	19	2.251	680	838	17.166	16.040
KASOS	479	3.039	0	0	479	990	3.039	3.843
KASTELORIZO	418	5.483	0	0	418	492	5.483	6.907
N. ANCHIALOS	16	91	348	30.307	364	318	30.398	22.080
KASTORIA	312	4.866	4	225	316	544	5.091	6.323
KOZANI	298	3.768	0	0	298	378	3.768	4.223
TOTAL	193.377	16.423.314	292.422	41.594.856	485.799	469.553	58.018.170	52.992.396

Table 2: Commercial Traffic of domestic and international aviation per airport for the period January to December 2017.

The largest 10 aerodromes based upon departing and arriving passengers are listed in Fig 3.

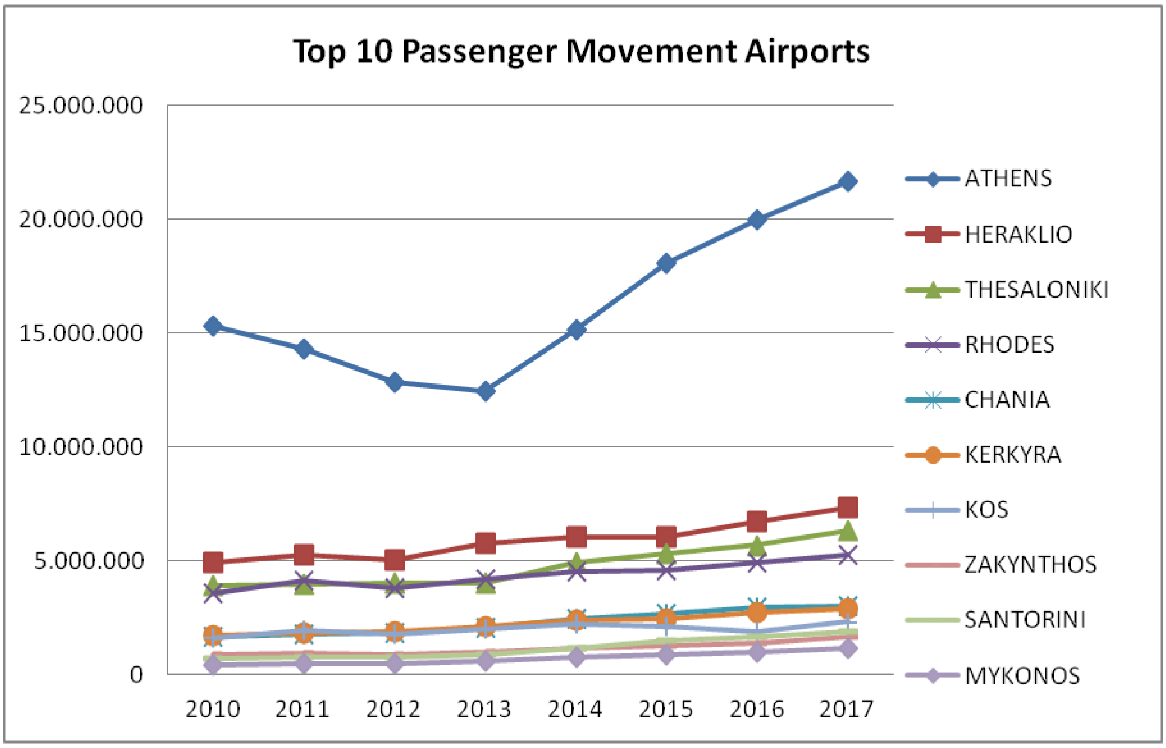


Figure 3: Commercial Airports in Greece

Athens International Airport is the busiest airport in Greece, with 37% SOM of passenger traffic. The 10 top airports (including Athens) keep 92% SOM, while 8% of passenger traffic is attributed to 29 smaller airports of Greece, as seen in Figure 4.

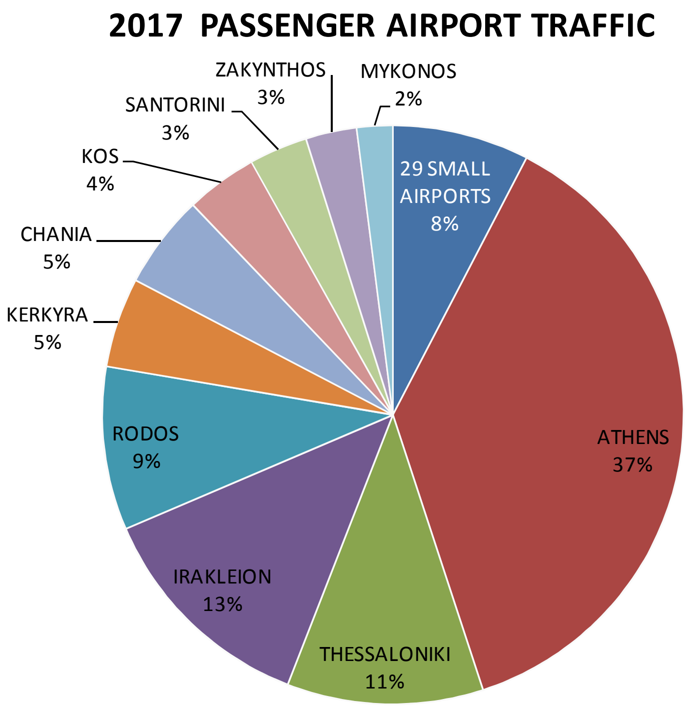


Figure 4: Airport Market Share in Passenger Traffic

Approximately 22 million passengers travelled to/from Athens in 2017, and approximately 7,5 million to/from Iraklion, 6,5 million to/from Thessaloniki and 5,3 million to/ from Rhodes. Total passenger's movements in Greece reached 58 million passengers in 2017, increased by 8,7% versus previous year (53 million in 2016), which was a record of passenger movements during last decade, as illustrated in Figure 5.

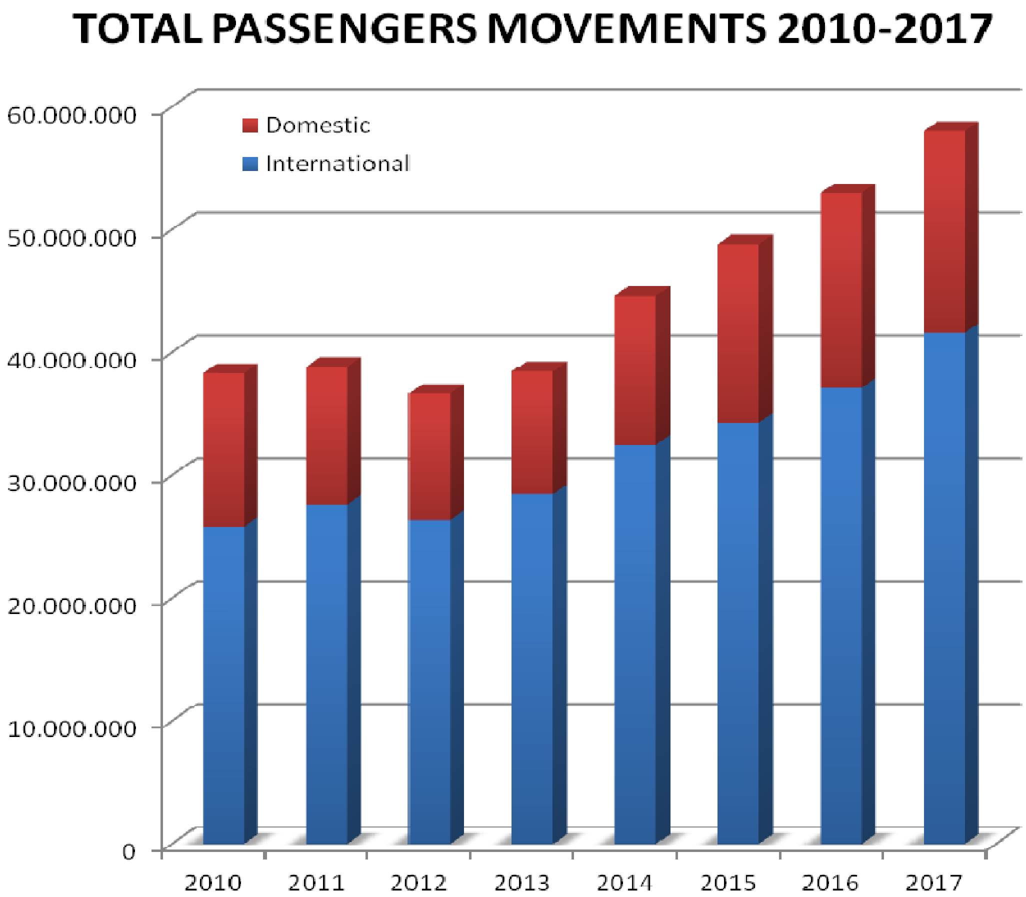


Figure 5: Passenger Movements for period 2010-2017

Air Carriers – Operating Licenses

Operating licenses are categorized according to EC Reg.1008/2008 in two categories:

The first category includes air carriers that cover operations with aircraft of more than ten tonnes maximum take off mass (MTOM) and /or more than 20 seats.

Within this category there currently exist twelve (12) operating licenses granted by Hellenic Civil Aviation Authority.

The second category includes air carriers that cover operations with aircraft of less than 10 tonnes maximum take–off mass (MTOM) and/or less than 20 seats.

Within this category there currently exist nine (9) operating licenses granted by Hellenic Civil Aviation Authority.

Number of Air Carriers	2017
Number of Air Carriers with active operating license	21

Greece has 485 registered aircrafts, which are categorized as illustrated in Table 3 & graphically presented in figure 6.

Category	Quantity
Aircraft over 20 t	119
Aircraft 14 to 20 t	18
Aircraft 5.7 to 14 t	23
Single engine aircraft below 2 t	139
Single engine aircraft 2 to 5.7 t	0
Multi engine aircraft below 2 t	8
Multi engine aircraft 2 to 5.7 t	20
Rotorcraft	89
Gliders	13
Powered Gliders	1
Ultra light aircraft	55
Aircraft in Total:	**485**

Table 3: List of registered aircrafts in HCAA

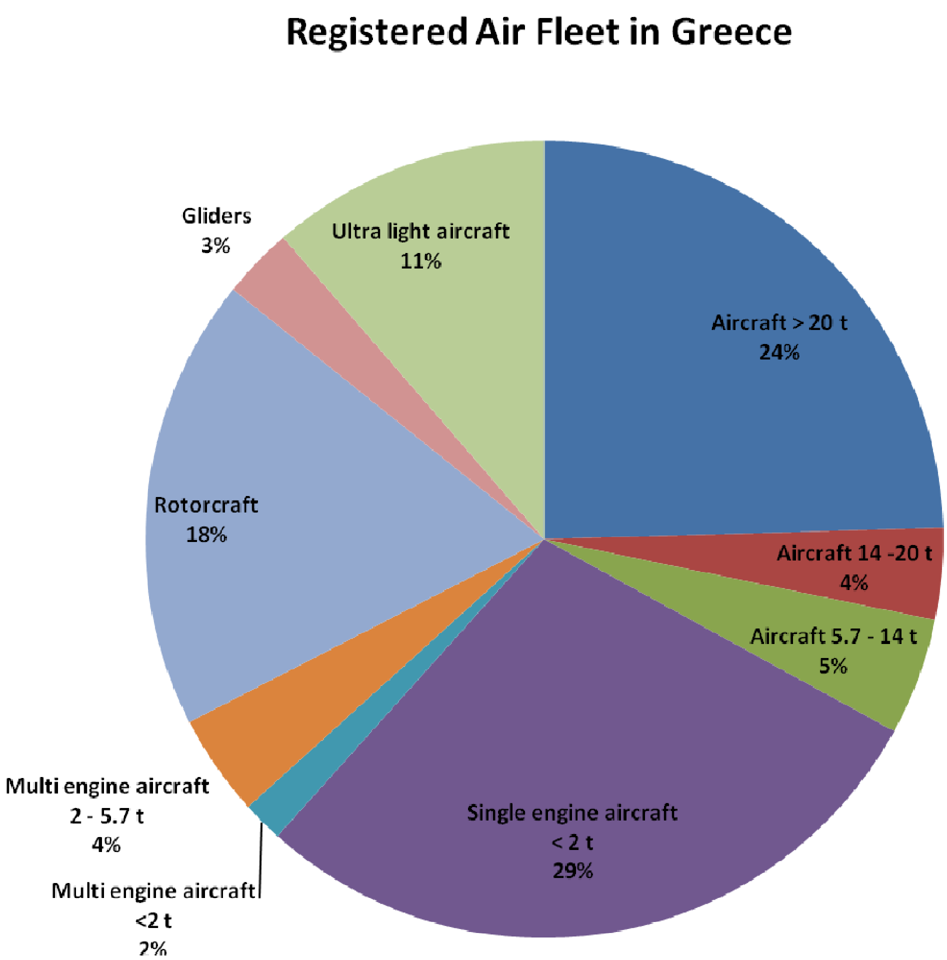


Figure 6: Registered aircrafts in HCAA per Category

1.4. Greece's Greenhouse Gas National Inventory

In response to the emerging evidence that climate change could have a major global impact, the United Nations Framework Convention on Climate Change was adopted on 9 May 1992 and was opened for signature in Rio de Janeiro in June 1992. Greece signed the Convention in Rio and ratified it in 1994 (Law 2205/94).

The Ministry of Environment and Energy (MEE) 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 MEE is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organization, in relation to the implementation of the provisions of the Kyoto Protocol, according to the Law 3017/2002 with which Greece ratified the Kyoto Protocol.

The organizational structure of the National Inventory System with relevant participating entities is:

- The MEE designated as the national entity responsible for the national inventory, which keeps the overall responsibility, but also plays an active role in the inventory planning, preparation and management.
- The National Technical University of Athens (NTUA) / School of Chemical Engineering, which has the technical and scientific responsibility for the compilation of the annual inventory.
- Governmental ministries and agencies through their appointed focal persons, ensure the data provision.

Greece is obligated to prepare and submit an annual national greenhouse gas (GHG) inventory covering anthropogenic emissions by sources and removals by sinks. The National Inventory Report (NIR) contains Greece's annual greenhouse gas emission estimates dating back to 1990.

The GHG emissions analysis by sector for the period 2004 - 2016 is presented in Table 4 (in kt CO2 eq). It is noted that according to the IPCC Guidelines, emissions estimates for international marine and aviation bunkers were not included in the national totals, but are reported separately.

The decreasing trend of emissions in all sectors of energy of the years 2008-2016 is attributed to the use of Renewable Energy Sources (RES), energy efficiency measures, road infrastructure and public transportation improvements, along with the economic recession that the country is facing.

The majority of GHG emissions (52%) in 2016 derived from energy industries, while contribution of transport and manufacturing industries is estimated at 24% and 7% respectively.

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total (without LULUCF)	**109,530.02**	**113,925.11**	**112,464.91**	**114,582.63**	**111,112.53**	**104,340.53**	**97,342.98**	**94,531.70**	**91,417.80**	**81,722.58**	**78,655.82**	**74,962.45**	**71,373.08**
Total (with LULUCF)	**107,045.64**	**110,621.51**	**109,131.01**	**112,760.22**	**108,070.47**	**101,241.57**	**94,270.69**	**91,370.28**	**88,266.58**	**80,112.36**	**78,499.83**	**71,244.44**	**68,015.63**
Energy	**100,509.58**	**104,309.84**	**103,081.26**	**105,297.67**	**102,481.14**	**97,677.64**	**90,725.79**	**89,559.15**	**85,903.15**	**75,823.30**	**72,455.54**	**69,220.33**	**65,355.02**
A. Fuel combustion	100,502.73	104,304.25	103,075.64	105,293.10	102,477.59	97,673.20	90,719.82	89,553.91	85,898.19	75,819.23	72,451.79	69,216.70	65,345.65
1. Energy industries	57,238.34	58,058.17	55,895.54	59,371.47	58,019.05	54,480.47	52,036.60	53,838.38	54,507.26	49,205.02	45,784.63	40,776.46	36,909.61
2. Man. Industry and Construction	8,618.35	10,134.37	10,369.07	9,959.13	9,325.77	7,436.78	6,813.24	4,917.03	5,457.78	5,229.16	5,397.33	5,166.28	5,291.92
3. Transport	21,086.30	21,375.01	22,057.52	22,686.15	21,983.51	24,831.54	22,052.80	19,779.97	16,465.15	16,246.67	16,270.48	16,804.68	17,132.32
4. Other sectors	13,559.75	14,214.11	14,104.93	12,729.20	12,453.05	10,674.72	9,574.70	10,802.99	9,257.07	4,903.11	4,810.77	6,262.95	5,812.76
5. Other	NO,IE	522.59	648.58	547.15	696.21	249.69	242.49	215.53	210.93	235.28	188.58	206.32	199.05
B. Fugitive emissions	6.85	5.59	5.62	4.57	3.55	4.44	5.97	5.24	4.95	4.07	3.75	3.64	9.37
IPPU	**8,983.06**	**9,581.38**	**9,351.32**	**9,248.16**	**8,599.07**	**6,625.53**	**6,580.48**	**4,941.10**	**5,486.18**	**5,869.44**	**6,166.23**	**5,709.71**	**5,981.87**
A. Mineral Industry	7,357.02	7,926.76	7,635.81	7,471.57	6,957.92	5,321.32	4,920.64	3,108.57	3,738.18	4,170.20	4,359.38	3,956.73	4,271.66
B. Chemical Industry	304.52	296.92	313.93	317.94	338.06	453.25	632.88	584.38	502.02	516.91	569.38	495.05	461.93
C. Metal Industry	1,182.25	1,215.54	1,233.61	1,301.47	1,167.74	732.64	909.45	1,137.50	1,139.16	1,072.63	1,124.76	1,143.43	1,135.49
D. Non-energy products from fuels and solvent use	41.86	47.37	72.20	60.48	41.15	27.70	24.15	22.51	21.56	23.54	29.37	30.70	28.99
G. Other product manufacture and use	97.41	94.77	95.78	96.70	94.20	90.62	93.36	88.13	85.27	86.16	83.33	83.81	83.80
LULUCF	**-2,484.38**	**-3,303.60**	**-3,333.90**	**-1,822.42**	**-3,042.06**	**-3,098.96**	**-3,072.29**	**-3,161.42**	**-3,151.22**	**-1,610.22**	**-155.98**	**-3,718.02**	**-3,357.46**
Waste	**1.05**	**1.98**	**2.41**	**3.17**	**3.68**	**12.43**	**6.36**	**5.61**	**3.48**	**3.83**	**10.41**	**8.99**	**9.83**
International transport [1)]	**13,474.19**	**11,815.09**	**12,727.53**	**13,103.79**	**12,862.32**	**11,147.83**	**11,373.02**	**11,652.07**	**9,727.87**	**9,382.76**	**8,878.27**	**8,657.31**	**8,664.95**
Aviation	3,140.94	2,600.48	2,779.42	2,948.31	2,930.90	2,717.91	2,584.15	2,696.04	2,386.98	2,466.45	2,829.92	2,869.09	3,079.15
Marine	10,333.25	9,214.61	9,948.11	10,155.48	9,931.42	8,429.92	8,788.87	8,956.03	7,340.89	6,916.31	6,048.35	5,788.21	5,585.80

Emissions from International transport are not included in national totals.

Table 4: Total CO2 emissions in Greece by sector for period 2004-2016 (Source: NIR Greece /National Inventory Report Available at https://unfccc.int/documents/65722)

The energy data used for the calculation of emissions derived from the national energy balance and the reports of installations under the EU ETS. The Ministry of Transport and the Hellenic Statistical Authority are the main sources of information regarding road transport, while data on civil aviation come from HCAA and Eurocontrol. Internal aviation, road transportation, railways and internal navigation are included in the transport sector. Emissions from international marine and aviation bunkers are not included in national totals, but are calculated and reported separately.

Domestic aviation

GHG emissions from domestic aviation are calculated according to the Tier 2a methodology suggested by the IPCC Guidelines, which is based on the combination of energy consumption data and air traffic data (Landing and Take-off cycles, LTOs). The emission factors used and the distribution of consumption in LTOs and cruise are the suggested CORINAIR values for average fleet. Table 5 illustrates Domestic Aviation emissions per sector (in ktCO2) for the years 2010-2016.

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

Table 5: Domestic Aviation GHG emissions for period 2010-2016 (in kt CO2 eq)

International Aviation

GHG emissions from international aviation are calculated with same IPCCC methodologies as described for domestic aviation. The fuel consumption data used are taken from the national energy balance, as declared by oil trading companies. Finally, the allocation of LTOs between domestic and international aviation was based, up to 2005, on data provided by the Civil Aviation Organisation and EUROCONTROL. Table 6 shows the allocation of LTOs between domestic and international aviation for period 2000-2016.

Year	Domestic LTOs	International LTOs
2000	111.481	102.174
2001	99.765	98.332
2002	85.721	94.421
2003	97.974	99.913
2004	106.108	103.818
2005	100.336	101.246
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	87.392	107.841
2014	91.453	123.532
2015	98.846	129.693
2016	102.039	139.223

Table 6: Allocation of Domestic and International LTOs for period 2000-2016

SECTION 2: ECAC COMMON SECTION MEASURES TAKEN COLLECTIVELY THROUGHOUT EUROPE, INCLUDING THOSE LED BY THE EU

2.1. 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 against a background of increased travel and transport.

For over a century, Europe has led the development of new technology, monitoring its impacts and developing new innovations to better meet societies developing needs and concerns. From the dawn of aviation, governments and industry across the region have invested heavily to understand and mitigate the environmental impacts of aviation, initially focusing on noise, then adding air quality and more recently the emissions affecting the global climate and CO_2 from fuel burn in particular. This is all taking place in a sector ever striving to improve safety and security whilst also reducing operating costs and improving fuel efficiency.

Some of these mitigating actions have domestic beginnings that stretch to international aviation whilst others are part of centralized cross-cutting funding such as through the EU Research Framework programs. The aviation sector has also benefitted from large bespoke programs such as the EU's Single European Sky ATM Research Initiative (SESAR). This has a vision stretching to 2050, which may turn utopian dreams of flight with seamless end-to-end co-ordination, optimized for efficiency, with minimal environmental impacts and complete safety into reality.

The European common section also includes new innovations being tried and tested in a range of demonstration trials to reduce fuel burn and CO_2 emissions at different stages of different flights, airports or routes. These might not be contributing to measured benefits in day-to-day operations yet, but Europe can anticipate a stream of future implementation actions and additional CO_2 savings.

Aircraft related technology

European members have worked together to best support 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 has helped drive the markets demand for technology improvements. Developing what became the 2016 ICAO CO_2 standards for newly built aircraft relied on contributions from many across the ECAC States. Airlines now have confidence that fuel efficient aircraft are future proof which may even have generated orders for manufacturers and demonstrates a virtuous circle that efficiency sells. Solutions and technology improvements have already started to go into service and are helping to support demand for ever more ambitious research.

Environmental improvements across the ECAC States is knowledge lead and at the forefront of this is the Clean Sky EU Joint Technology Initiative (JTI) that aims to develop and mature breakthrough "clean technologies". This activity recognizes and exploits the interaction between environmental, social and competitiveness aspects with sustainable economic growth. Funding and its motivation is critical to research and the public private partnership model of the EU Framework Programs underpins much that will contribute to this and future CO_2 action plans across the ECAC region.

Evaluations of the work so far under the JTI alone estimate aircraft CO_2 reductions of 32% which, aggregated over the future life of those products, amount to 6bn tonnes of CO_2.

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.

Alternative fuels

ECAC States are embracing the introduction of sustainable alternative aviation fuels but recognize the many challenges between the current situation and their widespread availability or use. It has been proven fit for purpose and the distribution system has demonstrated its capacity to handle sustainable alternative fuels. Recent actions have focused on preparing the legal base for recognizing a minimum reduction in greenhouse gas emissions and market share targets for such fuels in the transport sector. The greatest challenge to overcome is economic scalability of the production of sustainable fuel and the future actions of the ECAC states are preparing the building blocks towards that goal. The European Commission has proposed specific measures and sub-quotas to promote innovation and the deployment of more advanced sustainable fuels as well as additional incentives to use such fuels in aviation. Public private partnership in the European Advanced Biofuels Flight-path is also continuing to bring down the commercial barriers. In that framework, Europe is progressing towards a 2 million tonne goal for the consumption of sustainably produced paraffinic biofuels by 2020. Europe has progressed from demonstration flights to sustainable biofuel being made available through the hydrant fuelling infrastructure, but recognizes that continued action will be required to enable a more large-scale introduction.

Improved Air Traffic Management

The European Union's Single European Sky (SES) policy aims to transform Air Traffic Management in Europe, tripling capacity, halving ATM costs with 10 times the safety and 10% less environmental impact. Progress is well underway on the road map to achieve these ambitious goals through commitment and investment in the research and technology. Validated ATM solutions alone are capable of 21% more airspace capacity, 14% more airport capacity, a 40% reduction in accident risk, 2.8% less greenhouse emissions and a 6% reduction in flight cost. Steps 2 and 3 of the overall SES plan for the future will deploy 'Trajectory-based Operation' and 'Performance-based Operations' respectively. Much of the research to develop these solutions is underway and published results of the many earlier demonstration actions confirm the challenge but give us confidence that the goals will be achieved in the ECAC region with widespread potential to be replicated in other regions.

Economic/Market Based Measures (MBMs)

ECAC members have always been strong supporters of a market-based measure scheme for international aviation to incentivize and reward good investment and operational choices, and so welcomed the agreement on the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The 31 EEA states in Europe have already implemented the EU Emissions Trading System (ETS), including the aviation sector with around 500 aircraft operators participating in the cap and trade approach to limit CO_2 emissions. It was the first and is the biggest international system capping greenhouse gas emissions. In the period 2012 to 2018 EU ETS has saved an estimated 100 million tonnes of intra-European aviation CO_2 emissions.

ECAC States, through the Bratislava declaration, have expressed their intention to voluntarily participate in CORSIA from its pilot phase and encourage other States to do likewise and join CORSIA. Subject to preserving the environmental integrity and effectiveness it is expected that the EU ETS legislation will be adapted to implement the CORSIA. A future world with a globally implemented CORSIA aimed at carbon neutral growth of international aviation would significantly reduce emissions.

ECAC Scenarios for Traffic and CO_2 Emissions

Aviation traffic continues to grow, develop and diversify in many ways across the ECAC states. Whilst the focus of available data relates to passenger traffic, similar issues and comparable outcomes might be anticipated for cargo traffic both as belly hold freight or in dedicated freighters. Analysis by EUROCONTROL and EASA has identified the most likely scenario of influences on future traffic and modeled these assumptions out to future years. On the basis of this traffic forecast, fuel consumption and CO_2 emissions of aviation have been estimated for both a theoretical baseline scenario (without any mitigation action) and a scenario with implemented mitigation measures that are presented in this action plan. Results are visualised in figure 7.

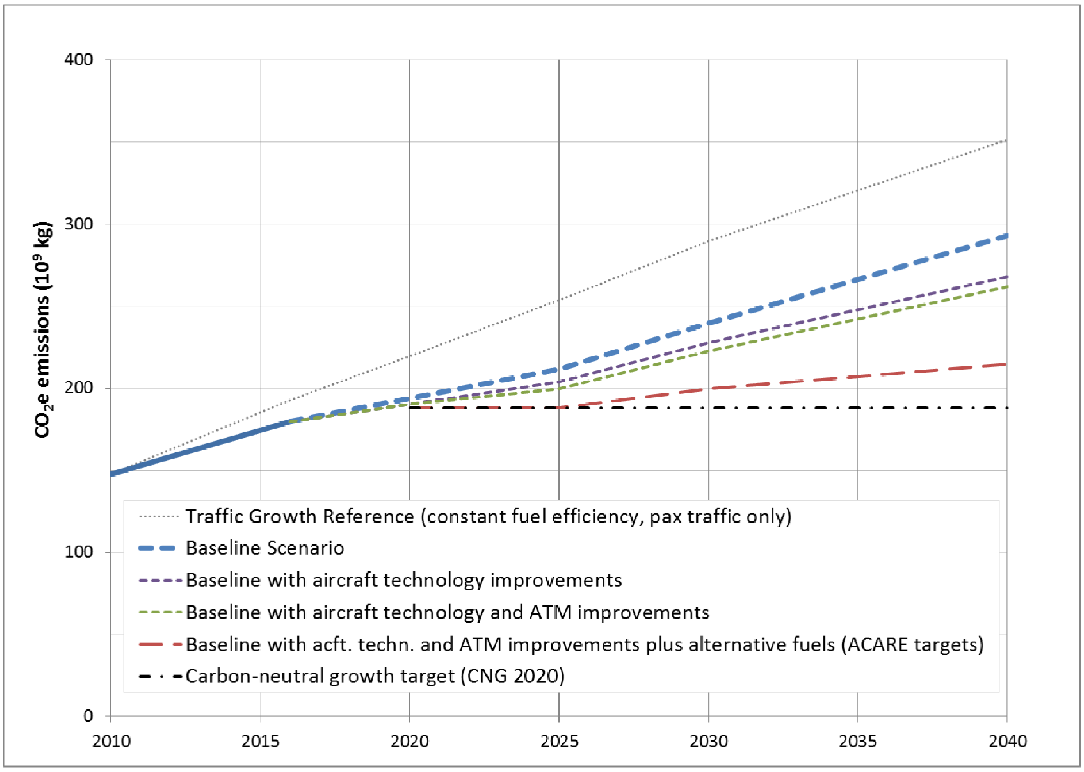


Figure 7 Equivalent CO_2 emissions forecast for the baseline and implemented measures scenarios

Under the baseline assumptions of traffic growth and fleet rollover with 2010 technology, CO_2 emissions would almost double for flights departing ECAC airports. Modeling the impact of improved aircraft technology for the scenario with implemented measures indicates an overall 8.5% reduction of fuel consumption and CO_2 emissions in 2040 compared to the baseline. Whilst the data to model the benefits of ATM improvements and sustainable alternative fuels may be less robust, they are nevertheless valuable contributions to reduce emissions further. Overall fuel efficiency, including the effects of new aircraft types and ATM-related measures, is projected to improve by 24% between 2010 and 2040. The potential of sustainable aviation fuels to reduce CO_2 emissions on a lifecycle basis is reflected in Figure 7. Market-based measures and their effects have not been simulated in detail, but will help reach the goal of carbon-neutral growth. As further developments in policy and technology are made, further analysis will improve the modeling of future emissions.

ECAC BASELINE SCENARIO AND ESTIMATED BENEFITS OF IMPLEMENTED MEASURES

2.2. 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, 2016) and forecasts (for 2020, 2030 and 2040) 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,
- its associated CO_2 emissions.

The sets of forecasts correspond to projected traffic volumes in a scenario of "Regulation and Growth", while corresponding fuel consumption and CO_2 emissions assume the technology level of the year 2010 (i.e. without considering reductions of emissions by further aircraft related technology improvements, improved ATM and operations, alternative fuels or market based measures).

Traffic Scenario "Regulation and Growth"

As in all forecasts produced by EUROCONTROL, various scenarios are built with a specific storyline and a mix of characteristics. The aim is to improve the understanding of factors that will influence future traffic growth and the risks that lie ahead. In the 20 year forecasts published by EUROCONTROL the scenario called 'Regulation and Growth' is constructed as the 'most likely' or 'baseline' scenario for traffic, most closely following the current trends. It considers a moderate economic growth, with some regulation particularly regarding the social and economic demands.

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

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

Table 7 presents a summary of the social, economic and air traffic related characteristics of three different scenarios developed by EUROCONTROL. The year 2016 serves as the baseline year of the 20-year forecast results[5] updated in 2018 by EUROCONTROL and presented here. Historical data for the year 2010 are also shown later for reference.

[5] Challenges of Growth 2018: Flight forecast, EUROCONTROL September 2018 (to be published)

Table 7: Summary characteristics of EUROCONTROL scenarios:

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

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

EUROCONTROL also generates a number of all-cargo flights in its baseline scenario. However, no information about the freight tonnes carried is available. Hence, historical and forecasted cargo traffic have been extracted from another source (ICAO[6]). 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 data warehouse used by EUROCONTROL, including the actual flight distance and the cruise altitude by airport pair. These calculations were made for 98% of the passenger flights; the remaining flights in the flight plans had information missing. 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. 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. While historical traffic data is used for the year 2016, the baseline fuel burn and emissions in 2016 and the forecast years (until 2040) are modeled in a simplified approach on the basis of the historical/forecasted traffic and assume the technology level of the year 2010.

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 8: Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres[7] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[8] FTKT (billion)	Total Revenue Tonne Kilometres[14,9] RTK (billion)
2010	4.6	1,218	0.20	45.4	167.2
2016	5.2	1,601	0.21	45.3	205.4
2020	5.6	1,825	0.25	49.4	231.9
2030	7.0	2,406	0.35	63.8	304.4
2040	8.4	2,919	0.45	79.4	371.2

Table 9: 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	37.98	120.00	0.0310	0.310
2016	46.28	146.26	0.0287	0.287
2020	49.95	157.85	0.0274	0.274
2030	61.75	195.13	0.0256	0.256
2040	75.44	238.38	0.0259	0.259
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

[6] ICAO Long-Term Traffic Forecasts, Passenger and Cargo, July 2016.

[7] Calculated based on 98% of the passenger traffic.

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

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

Figure 8: Forecasted traffic until 2040 (assumed both for the baseline and implemented measures scenarios)

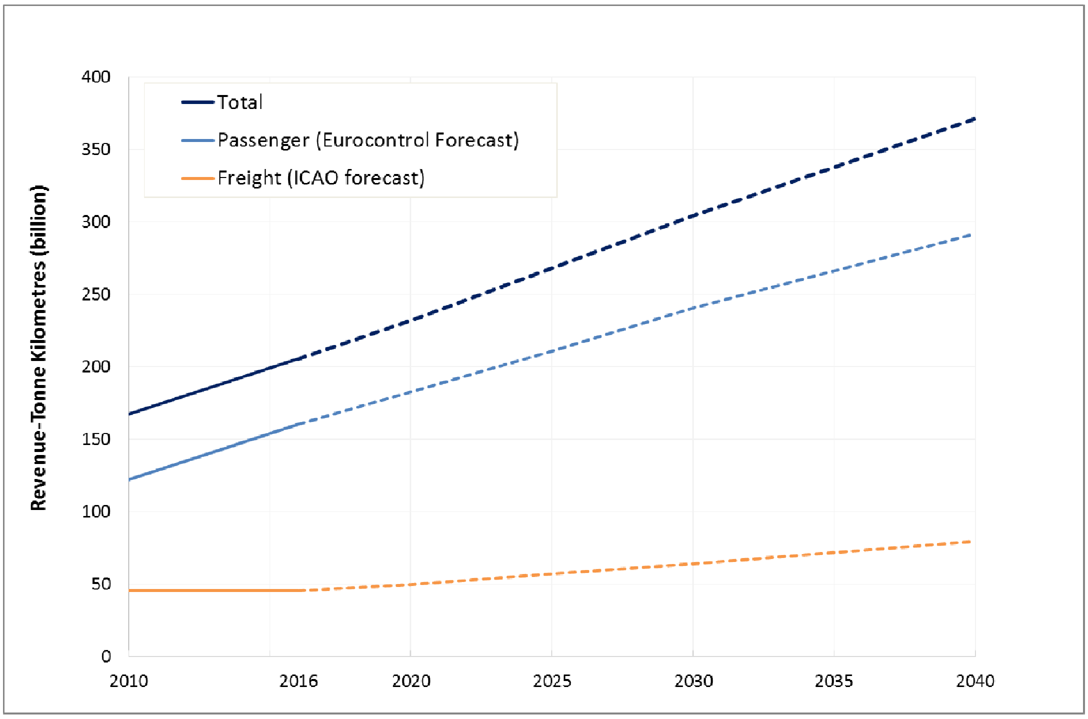
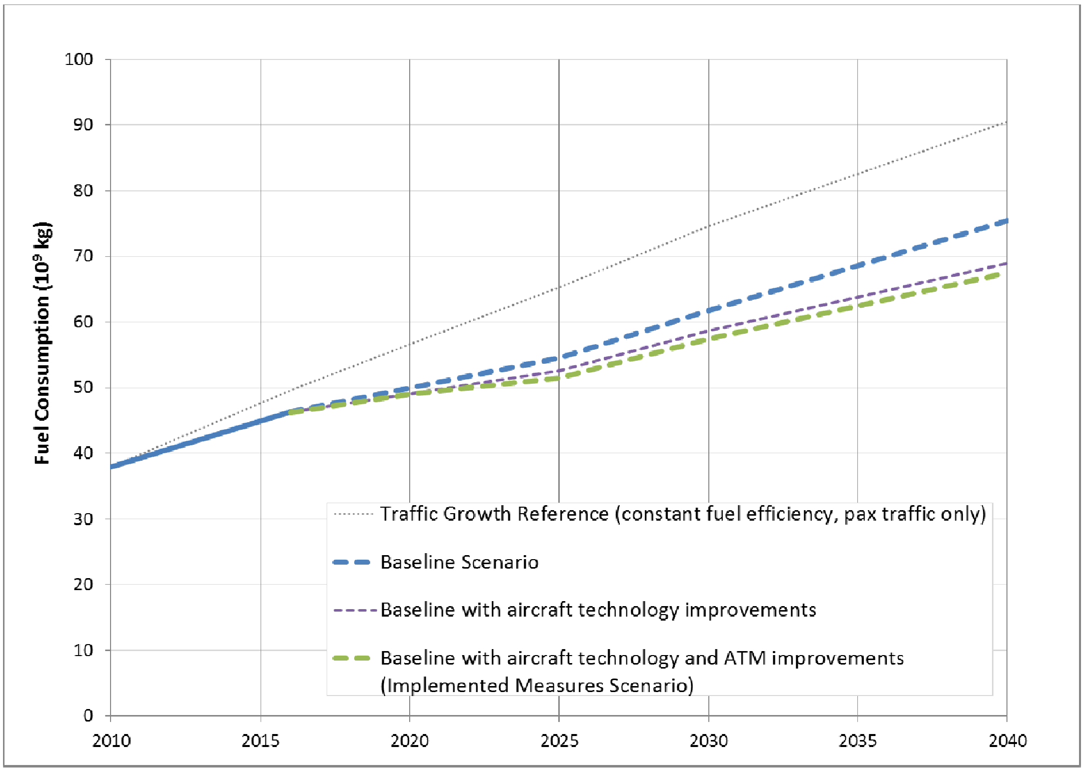


Figure 9: Fuel consumption forecast for the baseline and implemented measures scenarios (international passenger flights departing from ECAC airports)



2.3. ECAC Scenario with Implemented Measures, Estimated Benefits of Measures

In order 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 effects of mitigation actions are presented here, based on modeling 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. EUROCONTROL's 'Regulation and Growth' scenario described earlier. Unlike in the baseline scenario, the effects of aircraft related technology development, improvements in ATM/operations and alternative fuels are considered here for a projection of fuel consumption and CO_2 emissions up to the year 2040.

Effects of **improved aircraft technology** are captured by simulating fleet roll-over and considering the fuel efficiency improvements of new aircraft types of the latest generation (e.g. Airbus A320NEO, Boeing 737MAX, Airbus A350XWB etc.). The simulated future fleet of aircraft has been generated using the Aircraft Assignment Tool (AAT) developed collaboratively by EUROCONTROL, EASA and the European Commission. The retirement process of the Aircraft Assignment Tool is performed year by year, allowing the determination of the amount of new aircraft required each year. In addition to the fleet rollover, a constant annual improvement of fuel efficiency of 0.96% per annum is assumed to aircraft deliveries during the last 10 years of the forecast (2030-2040). This rate of improvement corresponds to the 'medium' fuel technology scenario used by CAEP to generate the fuel trends for the Assembly.

The effects of **improved ATM efficiency** are captured in the Implemented Measures Scenario on the basis of efficiency analyses from the SESAR project. Regarding SESAR effects, baseline deployment improvements of 0.2% in terms of fuel efficiency are assumed to be included in the base year fuel consumption for 2010. This improvement is assumed to rise to 0.3% in 2016 while additional improvements of 2.06% are targeted for the time period from 2025 onwards[10]. Further non-SESAR related fuel savings have been estimated to amount to 1.2% until the year 2010, and are already included in the baseline calculations[11].

Regarding the **introduction of sustainable alternative fuels,** the European ACARE roadmap targets described in section B chapter 2.1 of this document are assumed for the implemented measures case. These targets include an increase of alternative fuel quantities to 2% of aviation's total fuel consumption in the year 2020, rising linearly to 25% in 2035 and 40% in 2050. An average 60% reduction of lifecycle CO_2 emissions compared to crude-oil based JET fuel was assumed for sustainable aviation fuels, which is in line with requirements from Article 17 of the EU's Renewable Energy Directive (Directive 2009/28/EC)[12]. The resulting emission savings are shown in tables below in units of equivalent CO_2 emissions on a well-to-wake basis. Well-to-wake emissions

[10] See SESAR1 D72 "Updated Performance Assessment in 2016" document, November 2016, project B05, project manager: ENAIRE.

[11] See SESAR1 D107 "Updated Step 1 validation targets – aligned with dataset 13", project B.04.01, December 2014, project manager: NATS.

[12] According to article 17 of the EU RED (Directive 2009/28/EC), GHG emission savings of at least 60% are required for biofuels produced in new installations in which production started on or after 1 January 2017.

include all GHG emissions throughout the fuel lifecycle, including emissions from feedstock extraction or cultivation (including land-use change), feedstock processing and transportation, fuel production at conversion facilities as well as distribution and combustion[13].

For simplicity, effects of **market-based measures** including the EU Emissions Trading Scheme (ETS) and ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) on aviation's CO_2 emissions have not been modeled 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[14].

Tables 10-12 and Figures 9-10 summarize the results for the scenario with implemented measures. It should be noted that Table 10 shows direct combustion emissions of CO_2 (assuming 3.16 kg CO_2 per kg fuel), whereas Table 12 and Figure 10 present equivalent CO_2 emissions on a well-to-wake basis. More detailed tabulated results are found in Appendix A.

Table 10: Fuel burn and CO_2 emissions forecast for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	37.98	120.00	0.0310	0.310
2016	46.24	146.11	0.0286	0.286
2020	49.03	154.93	0.0245	0.245
2030	57.38	181.33	0.0242	0.242
2040	67.50	213.30	0.0237	0.237
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

Table 11: Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)

Period	Average annual fuel efficiency improvement (%)
2010-2016	-1.36%
2016-2020	-1.40%
2020-2030	-1.11%
2030-2040	-0.21%

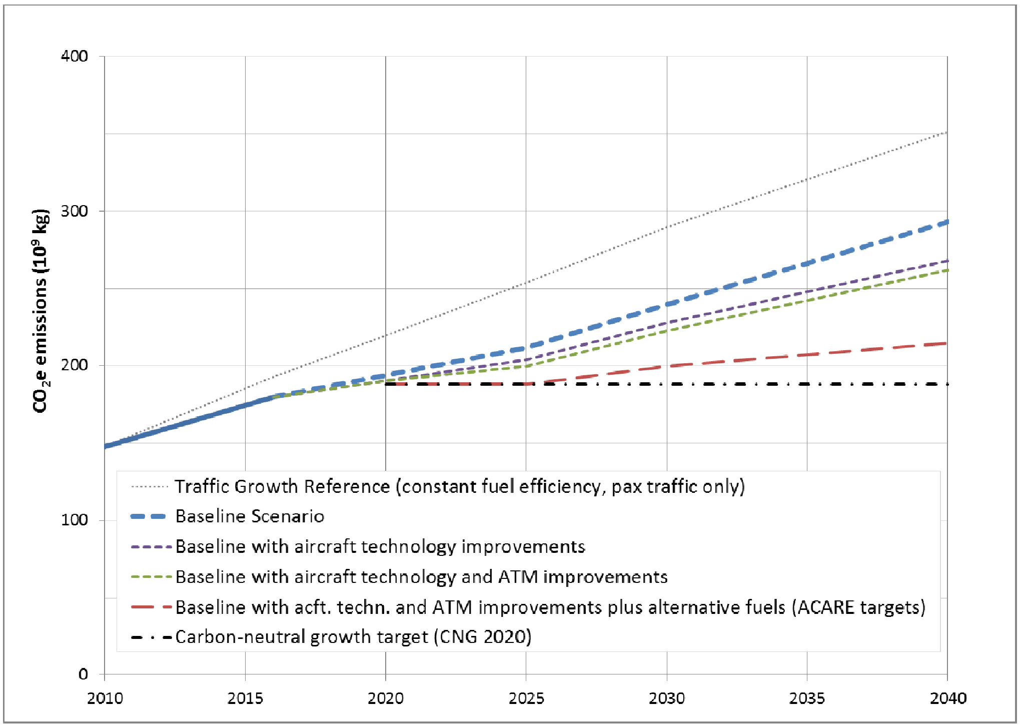
[13] Well-to-wake CO_2e emissions of fossil-based JET fuel are calculated by assuming an emission index of 3.88 kg CO_2e per kg fuel (see DIN e.V., "Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)", German version EN 16258:2012),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

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

Table 12: Equivalent (well-to-wake) CO_2e emissions forecasts for the scenarios described in this chapter

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	Acft. techn. and ATM improvements + alternative fuels	
2010	147.3				NA
2016	179.6	*179.6*	*179.4*	179.4	-0.1%
2020	193.8	*190.4*	*190.2*	187.9	-3.0%
2030	239.6	*227.6*	*222.6*	199.5	-16.7%
2040	292.7	*267.7*	*261.9*	214.8	-26.6%
For reasons of data availability, results shown in this table do not include cargo/freight traffic. Note that fuel consumption is assumed to be unaffected by the use of alternative fuels.					

Figure 10: Equivalent (well-to-wake) CO_2 emissions forecast for the baseline and implemented measures scenarios



As shown in Figures 9-10 consumption and CO_2 emissions in 2040 compared to the baseline scenario. Whilst the data to model the benefits of ATM improvements and sustainable alternative fuels shown in Figure 10 may be less robust, they are nevertheless valuable contributions to reduce emissions further. Overall fuel efficiency, including the effects of new aircraft types and ATM-related measures, is projected to improve by 24% between 2010 and 2040.

Under the currently assumed aircraft and ATM improvement scenarios, the rate of fuel efficiency improvement is expected to slow down progressively until 2040. Aircraft technology and ATM improvements alone will not be sufficient to meet the post-2020 carbon neutral growth objective of aviation, nor will the use of alternative fuels even if Europe's ambitious targets for alternative fuels are met. This confirms that additional action, particularly market-based measures, are required to fill the gap.

2.4 Actions Taken Collectively Throughout Europe

2.4. A. AIRCRAFT-RELATED TECHNOLOGY DEVELOPMENT

A.1 Aircraft emissions standards (Europe's contribution to the development of the airplane CO_2 standard in CAEP)

European Member States fully supported the work achieved in ICAO's Committee on Aviation Environmental Protection (CAEP), which resulted in an agreement on the new airplane CO_2 Standard at CAEP/10 meeting in February 2016, applicable to new airplane type designs from 2020 and to airplane type designs that are already in-production in 2023. Europe significantly contributed to this task, notably through the European Aviation Safety Agency (EASA) which co-led the CO_2 Task Group within CAEP's Working Group 3, and which provided extensive technical and analytical support.

The assessment of the benefits provided by this measure in terms of reduction in European emissions is not provided in this action plan. Nonetheless, elements of assessment of the overall contribution of the CO_2 standard towards the global aspirational goals are available in CAEP.

A.2 Research and development

Clean Sky is an EU Joint Technology Initiative (JTI) that aims to develop and mature breakthrough "clean technologies" for air transport globally. By accelerating their deployment, the JTI will contribute to Europe's strategic environmental and social priorities, and simultaneously promote competitiveness and sustainable economic growth.

Joint Technology Initiatives are specific large-scale EU research projects created by the European Commission within the 7th Framework Program (FP7) and continued within the Horizon 2020 Framework Program. Set up as a Public Private Partnership between the European Commission and the European aeronautical industry, Clean Sky pulls together the research and technology resources of the European Union in a coherent program that contributes significantly to the 'greening' of global aviation.

The first Clean Sky program (**Clean Sky 1 -** 2011-2017) has a budget of €1.6 billion, equally shared between the European Commission and the aeronautics industry. It aims to develop environmental friendly technologies impacting all flying-segments of commercial aviation. The objectives are to reduce aircraft CO_2 emissions by 20-40%, NO_x by around 60% and noise by up to 10dB compared to year 2000 aircraft.

What has the current JTI achieved so far?

It is estimated that Clean Sky resulted in a reduction of aviation CO_2 emissions by more than 32% with respect to baseline levels (in 2000), which represents an ***aggregate of up to 6 billion tonnes of CO_2 over the next 35 years***

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

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

Main remaining areas for RTD efforts under Clean Sky 2 are:

- **Large Passenger Aircraft**: demonstration of best technologies to achieve the environmental goals whilst fulfilling future market needs and improving the competitiveness of future products.
- **Regional Aircraft:** demonstrating and validating key technologies that will enable a 90-seat class turboprop aircraft to deliver breakthrough economic and environmental performance and a superior passenger experience.

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

In addition, the **Technology Evaluator** will continue to be upgraded to assess technological progress routinely and evaluate the performance potential of Clean Sky 2 technologies at both vehicle and aggregate levels (airports and air traffic systems). More details on Clean Sky can be found at the following link: http://www.cleansky.eu/

2.4.B. ALTERNATIVE FUELS

B.1 European Advanced Biofuels Flightpath

Within the European Union, Directive 2009/28/EC on the promotion of the use of energy from renewable sources ("the Renewable Energy Directive" – RED) established mandatory targets to be achieved by 2020 for a 20% overall share of renewable energy in the EU and a 10% share for renewable energy in the transport sector. Furthermore, sustainability criteria for biofuels to be counted towards that target were established[15]. Directive 2009/28/EC of the European Parliament and of the Council of 23/04/2009 on the promotion of the use of energy from renewable sources, details in its Article 17 that '*with effect from 1 January 2017, the greenhouse gas emission saving from the use of biofuels and bioliquids taken into account for the purposes referred to in points (a), (b) and (c) of paragraph 1 shall be at least 50 %. From 1 January 2018 that greenhouse gas emission saving shall be at least 60 % for biofuels and bioliquids produced in installations in which production started on or after 1 January 2017*'.

15 Directive 2009/28/EC of the European Parliament and of the Council of 23/04/2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, Article 17 Sustainability criteria for biofuels and bioliquids, at pp. EU Official Journal L140/36-L140/38

In November 30, 2016, the European Commission (EC) presented a proposal to the EU Council and the European Parliament for a recast of the Renewable Energy Directive for 2030.

To promote the deployment and development of low carbon fuels, such as advanced biofuels, it is proposed to introduce after 2020 an obligation requiring fuel suppliers to sell a gradually increasing share of renewable and low-emission fuels, including advanced biofuels and renewable electricity (at least 1.5% in 2021 increasing to at least 6.8% by 2030).

To promote innovation the obligation includes a specific sub-quota for advanced biofuels, increasing from 0.5% in 2021 to at least 3.6% in 2030. Advanced biofuels are defined as biofuels that are based on a list of feedstocks; mostly lignocellulosic material, wastes and residues.

Aviation and marine sectors are explicitly covered in the proposal. In fact, it is proposed that advanced alternative fuels used for aviation and maritime sectors can be counted 1.2 times towards the 6.8% renewable energy mandate. This would provide an additional incentive to develop and deploy alternative fuels in the aviation sector.

In February 2009, the European Commission's Directorate General for Energy and Transport initiated the SWAFEA (Sustainable Ways for Alternative Fuels and Energy for Aviation) study to investigate the feasibility and the impact of the use of alternative fuels in aviation.

The SWAFEA final report was published in July 2011[16]. It provides a comprehensive analysis on the prospects for alternative fuels in aviation, including an integrated analysis of the technical feasibility, environmental sustainability (based on the sustainability criteria of the EU Directive on renewable energy[17]) and economic aspects. It includes a number of recommendations on the steps that should be taken to promote the take-up of sustainable biofuels for aviation in Europe.

In March 2011, the European Commission published a White Paper on transport[18]. In the context of an overall goal of achieving a reduction of at least 60% in greenhouse gas emissions from transport by 2050 with respect to 1990, the White Paper established a goal of low-carbon sustainable fuels in aviation reaching 40% by 2050.

ACARE Roadmap targets regarding share alternative sustainable fuels:

Aviation to use:

- at minimum 2% sustainable alternative fuels in 2020;

- at minimum 25% sustainable alternative fuels in 2035;

- at minimum 40% sustainable alternative fuels in 2050

Source: ACARE Strategic Research and Innovation Agenda, Volume 2

As a first step towards delivering this goal, in June 2011 the European Commission, in close coordination with Airbus, leading European airlines (Lufthansa, Air France/KLM, & British Airways) and key European biofuel producers (Choren Industries, Neste Oil, Biomass Technology Group and UOP), launched the **European Advanced Biofuels Flight-path**. This industry-wide initiative aims to speed up the commercialisation of aviation biofuels in Europe, with the objective of achieving the commercialisation of sustainably produced paraffinic biofuels in the aviation sector by reaching an aggregated 2 million tonnes consumption by 2020.

[16] http://www.icao.int/environmental-protection/GFAAF/Documents/SW_WP9_D.9.1%20Final%20report_released%20July2011.pdf

[17] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

[18] Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, COM (2011) 144 final

This initiative is a shared and voluntary commitment by its members to support and promote the production, storage and distribution of sustainably produced drop-in biofuels for use in aviation. It also targets establishing appropriate financial mechanisms to support the construction of industrial "first of a kind" advanced biofuel production plants. The Biofuels Flight path is explained in a technical paper, which sets out in more detail the challenges and required actions[19]. More specifically, the initiative focuses on the following:

1. Facilitating the development of standards for drop-in biofuels and their certification for use in commercial aircraft,
2. Working together across the full supply chain to further develop worldwide accepted sustainability certification frameworks,
3. Agree biofuel take-off arrangements over a defined period of time and at a reasonable cost,
4. Promote appropriate public and private actions to ensure the market uptake of paraffinic biofuels by the aviation sector,
5. Establish financing structures to facilitate the realization of 2nd Generation biofuel projects,
6. Accelerate targeted research and innovation for advanced biofuel technologies, and especially algae, and
7. Take concrete actions to inform the European citizen of the benefits of replacing kerosene with certified sustainable biofuels.

When the Flightpath 2020 initiative began in 2010, only one production pathway was approved for aviation use; renewable kerosene had only been produced at very small scale and only a handful of test and demonstration flights had been conducted using it. Since then, worldwide technical and operational progress in the industry has been remarkable. Four different pathways for the production of renewable kerosene are now approved and several more are expected to be certified soon. A significant number of flights using renewable kerosene have been conducted, most of them revenue flights carrying passengers. Production has been demonstrated at up to industrial scale for some of the pathways. Distribution of renewable kerosene through an airport hydrant system was also demonstrated in Oslo in 2015.

In 2016 the European commission tendered support and secretariat functions for the Flightpath 2020, which had so far depended on the initiative of the individual members. This €1.5m tender was won by a consortium run by SENASA, which started the work supporting the Flightpath at the end of 2016.

Performed flights using bio-kerosene

IATA: 2000 flights worldwide using bio-kerosene blends performed by 22 airlines between June 2011 and December 2015

Lufthansa: 1 189 Frankfurt-Hamburg flights using 800 tonnes of bio-kerosene (during 6 months period June - December 2011)

KLM: a series of 200 Amsterdam-Paris flights from September 2011 to December 2014, 26 flights New York-Amsterdam in 2013, and 20 flights Amsterdam-Aruba in 2014 using bio-kerosene

Air France: A series of 50 Paris – Toulouse flights evaluating SIP kerosene in 2014/2015

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

Since late 2015, bio kerosene is regularly available as a fuel blend at Oslo airport. Total throughput so far can be approximatively estimated at 2000 tonnes. Attribution to individual flights is no longer possible except on an accounting basis as the fuel is commingled in the normal hydrant fuelling infrastructure of the airport.

Production (EU)

Neste *(Finland): by batches*

- Frankfurt-Hamburg (6 months) 1 189 flights operated by Lufthansa: 800 tonnes of bio-kerosene

- Itaka: €10m EU funding (2012-2015):ca. 1 000 tonnes

Biorefly*: €13.7m EU funding: 2000 tonnes per year– BioChemtex (Italy)*

BSFJ Swedish Biofuels*: €27.8m EU funding (2014-2019)*

B.2 Research and Development projects on alternative fuels in aviation

In the time frame 2011-2016, 3 projects have been funded by the FP7 Research and Innovation program of the EU.

ITAKA: €10m EU funding (2012-2015) with the aim of assessing the potential of a specific crop (camelina) for providing jet fuel. The project aims entailed testing the whole chain from field to fly and assessing the potential beyond the data gathered in lab experiments, gathering experiences on related certification, distribution and economic aspects. For a feedstock, ITAKA targeted European camelina oil and used cooking oil in order to meet a minimum of 60% GHG emissions savings compared to the fossil fuel jetA1.

SOLAR-JET: This project has demonstrated the possibility of producing jet-fuel from CO_2 and water. This was done by coupling a two-step solar thermochemical cycle based on non-stoichiometric ceria redox reactions with the Fischer-Tropsch process. This successful demonstration is further complemented by assessments of the chemical suitability of the solar kerosene, identification of technological gaps, and determination of the technological and economical potentials.

Core-JetFuel: €1.2m EU funding (2013-2017) this action evaluated the research and innovation "landscape" in order to develop and implement a strategy for sharing information, for coordinating initiatives, projects and results and to identify needs in research, standardisation, innovation/deployment and policy measures at European level. Bottlenecks of research and innovation will be identified and, where appropriate, recommendations for the European Commission will be made with respect to the priorities in the funding strategy. The consortium covers the entire alternative fuel production chain in four domains: Feedstock and sustainability; conversion technologies and radical concepts; technical compatibility, certification and deployment; policies, incentives and regulation. CORE-Jet Fuel ensures cooperation with other European, international and national initiatives and with the key stakeholders. The expected benefits are enhanced knowledge amongst decision makers, support for maintaining coherent research policies and the promotion of a better understanding of future investments in aviation fuel research and innovation.

In 2015, the European Commission launched projects under the Horizon 2020 research program with production capacities of the order of several thousand tonnes per year.

In addition, in 2013 the Commission tendered the **HBBA study** (High Biofuel Blends in Aviation). This study analysed in detail the blending behaviour of fossil kerosene with bio kerosene produced by the various pathways either already approved or undergoing the technical approval process. It also analysed the impact of bio kerosene on various types of aircraft fuel seals, plus the effect of different bio-kerosenes on aircraft emissions. The final report on this research was published in early 2017 and is available at:
https://ec.europa.eu/energy/sites/ener/files/documents/final_report_for_publication.pdf

2.4.C. IMPROVED AIR TRAFFIC MANAGEMENT AND INFRASTRUCTURE USE

The EU's Single European Sky Initiative and SESAR

C.1 SESAR Project

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

The initial SES aims with respect to the 2005 performance were to:

- Triple capacity of ATM systems,
- Reduce ATM costs by 50%,
- Increase safety by a factor of 10, and
- Reduce the environmental impact by 10% per flight.

SESAR, the technology pillar of the Single European Sky, contributes to the Single Sky's performance targets by defining, developing, validating and deploying innovative technological and operational solutions for managing air traffic in a more efficient manner.

Guided by the European ATM Master Plan, the SESAR Joint Undertaking (JU) is responsible for defining, developing, validating and delivering technical and operation solutions to modernise Europe's air traffic management system and deliver benefits to Europe and its citizens. The SESAR JU research programme has been split into 2 phases, SESAR 1 (from 2008 to 2016) and SESAR 2020 (starting in 2016). It is delivering solutions in four key areas, namely airport operations, network operations, air traffic services and technology enablers.

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

Concerning the environmental impact, the estimated potential total fuel and CO_2 emission savings per flight are depicted below by flight segment:

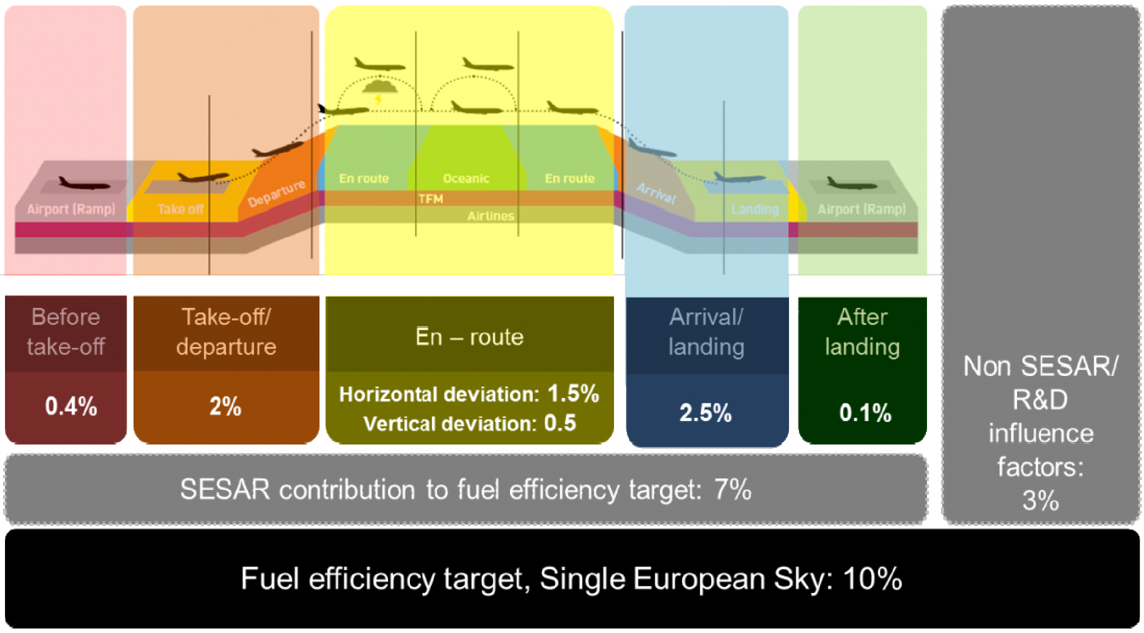

Figure 11*:* SESAR fuel efficiency and contribution to environmental impacts

By the end of SESAR 1, the validation exercises conducted showed that the solutions identified could provide by 2024 (as compared to the 2005 baseline) 2.36% reduction per flight in gate-to-gate greenhouse gas emissions.

C.2 SESAR Research Projects (environmental focus)

During SESAR 1, environmental aspects were mainly addressed under two types of project: Environmental research projects, which were considered as a transversal activity and therefore primarily supported the projects validating the SESAR solutions, and secondly SESAR validation and demonstration projects, which were pre-implementation activities. Environment aspects, in particular fuel efficiency, were also a core objective of approximately 80% of SESAR 1's primary projects.

Environmental Research Projects:

The four Environmental research projects have been completed:

- Project 16.03.01 dealt with the "Development of the Environment validation framework (Models and Tools)");
- Project 16.03.02 addressed the "Development of environmental metrics";
- Project 16.03.03 dealt with the "Development of a framework to establish interdependencies and trade-off with other performance areas";
- Project 16.03.07 considered "Future regulatory scenarios and risks".

In the context of Project 16.03.01, a first version of the IMPACT tool was developed by EUROCONTROL providing SESAR primary projects with the means to conduct fuel efficiency, aircraft emissions and noise assessments, from a web-based platform, using the same aircraft performance assumptions. IMPACT successfully passed the verification and validation process of the ICAO Committee on Aviation Environmental Protection Modelling and Database Group CAEP. Project 16.06.03 also ensured the continuous development/maintenance of other tools covering aircraft greenhouse gas (GHG) assessment (AEM), and local air quality issues (Open-ALAQS). It should be noted that these tools were developed to cover the research and the future deployment phase of SESAR, as well as to support European states and agencies in conducting environmental impact assessments for operational or regulatory purposes.

In the context of Project 16.03.02, a set of metrics for assessing GHG emissions, noise, and airport local air quality were documented. The metrics identified by Project 16.03.02 will be gradually implemented in IMPACT.

Project 16.03.03 produced a comprehensive analysis of the issues related to environmental impact interdependencies and trade-offs.

Project 16.03.07 conducted a review of the then current environmental regulatory measures as applicable to ATM and SESAR deployment, and another report presenting an analysis of environmental regulatory and physical risk scenarios in the form of user guidance. It identifies both those concept of operations and Key Performance Areas which are most likely to be affected by these risks and the future operational solutions that can contribute to mitigating them. It also provides a gap analysis identifying knowledge gaps or uncertainties which require further monitoring, research or analysis.

Project 16.06.03, was the SESAR Environment support and coordination project which ensured the coordination and facilitation of all the Environmental research project activities whilst supporting the SESAR/AIRE/DEMO projects in the application of the material produced by the research projects. In particular, this project delivered an Environment Impact Assessment methodology providing guidance on how to conduct an assessment, which metrics to use, and dos and don'ts for each type of validation exercise with a specific emphasis on flight trials.

The above-mentioned SESAR 1 environmental project deliverables constitute the reference material that SESAR2020 should be using.

SESAR demonstration projects:

In addition to its core activities, the SESAR JU co-financed projects where ATM stakeholders worked collaboratively to perform integrated flight trials and demonstrations of solutions. These aimed to reduce CO_2 emissions for surface, terminal, and oceanic operations and substantially accelerate the pace of change. Between 2009 and 2012, the SESAR JU co-financed a total of 33 "green" projects in collaboration with global partners, under the Atlantic Interoperability Initiative to Reduce Emissions (AIRE).

A total of 15 767 flight trials were conducted under AIRE, involving more than 100 stakeholders, demonstrating savings ranging from 20 to 1 000kg of fuel per flight (or 63 to 3 150 kg of CO_2), and improvements in day-to-day operations. Another nine demonstration projects took place from 2012 to 2014, also focusing on the environment, and during 2015/2016 the SESAR JU co-financed fifteen additional large-scale demonstration projects, which were more ambitious in geographic scale and technology. More information can be found at http://www.sesarju.eu

A key feature leading to the success of AIRE is that it focused strongly on operational and procedural techniques rather than new technologies. AIRE trials used technology that was already in place, but until the relevant AIRE project came along, air traffic controllers and other users hadn't necessarily thought deeply about how to make the best operationally use of that technology. For example, because of the AIRE initiative and the good cooperation between NAV Portugal and FAA, in New York and St Maria oceanic airspace lateral separation optimisation is given for any flight that requests it.

Specific trials were carried for the following improvement areas/solutions as part of the AIRE initiative:

a. Use of GDL/DMAN systems (pre-departure sequencing system / Departure Manager) in Amsterdam, Paris and Zurich,

b. Issue of Target-Off Block time (TOBT), calculation of variable taxiout time and issue of Target-Start-up Arrival Time (TSAT) in Vienna,

c. Continuous Descent Operations (CDOs or CDAs) in Amsterdam, Brussels, Cologne, Madrid, New York, Paris, Prague, Pointe-à-Pitre, Toulouse, and Zurich,

d. CDOs in Stockholm, Gothenburg, Riga, La Palma; Budapest and Palma de Majorca airports using RNP-AR procedures,

e. Lateral and vertical flight profile changes in the NAT taking benefit of the implementation of Automatic Dependent Surveillance-Broadcast (ADS-B) surveillance in the North Atlantic,

f. Calculation of Estimated Times of Arrival (ETA) allowing time based operations in Amsterdam,

g. Precision Area Navigation - Global Navigation Satellite System (PRNAV GNSS) Approaches in Sweden,

h. Free route in Lisbon and Casablanca, over Germany, Belgium, Luxembourg, Netherlands in the EURO-SAM corridor, France, and Italy,

i. Global information sharing and exchange of actual position and updated meteorological data between the ATM system and Airline AOCs for the vertical and lateral optimisation of oceanic flights using a new interface.

The **AIRE 1** campaign (2008-2009) demonstrated, with 1,152 trials performed, that significant savings can already be achieved using existing technology. CO_2 savings per flight ranged from 90kg to 1,250kg and the accumulated savings during the trials were equivalent to 400 tonnes of CO_2. This first set of trials represented not only substantial improvements for the greening of air transport, but generated further motivation and commitment of the teams involved creating momentum to continue to make progress on reducing aviation emissions.

Table 13: Summary of AIRE 1 projects

Domain	Location	Trials performed	CO_2 benefit/flight
Surface	Paris, France	353	190-1 200 kg
Terminal	Paris, France	82	100-1 250 kg
	Stockholm, Sweden	11	450-950 kg
	Madrid, Spain	620	250-800 kg
Oceanic	Santa Maria, Portugal	48	90-650 kg
	Reykjavik, Iceland	48	250-1 050 kg
	Total	**1 152**	

The **AIRE 2** campaign (2010-2011) showed a doubling in demand for projects and a high transition rate from R&D to day-to-day operations. 18 projects involving 40 airlines, airports, ANSPs and industry partners were conducted in which surface, terminal, oceanic and gate-to-gate operations were tackled. 9 416 flight trials took place. Table 14 summarizes AIRE 2 projects operational aims and results.

CDOs were demonstrated in busy and complex TMAs although some operational measures to maintain safety, efficiency, and capacity at an acceptable level had to be developed.

Table 14: Summary of AIRE 2 projects

Project name	Location	Operation	Objective	CO_2 and Noise benefits per flight (kg)	Number of flights
CDM at Vienna Airport	Austria	CDM notably pre-departure sequence	CO_2 & Ground Operational efficiency	54	208
Greener airport operations under adverse conditions	France	CDM notably pre-departure sequence	CO_2 & Ground Operational efficiency	79	1 800
B3	Belgium	CDO in a complex radar vectoring environment	Noise & CO_2	160-315; -2dB (between 10 to 25 Nm from touchdown)	3 094
DoWo - Down Wind Optimisation	France	Green STAR & Green IA in busy TMA	CO_2	158-315	219
REACT-CR	Czech republic	CDO	CO_2	205-302	204
Flight Trials for less CO_2 emission	Germany	Arrival vertical profile	CO_2	110-650	362

during transition from en-route to final approach		optimisation in high density traffic			
RETA-CDA2	Spain	CDO from ToD	CO_2	250-800	210
DORIS	Spain	Oceanic: Flight optimisation with ATC coordination & Data link (ACARS, FANS CPDLC)	CO_2	3 134	110
ONATAP	Portugal	Free and Direct Routes	CO_2	526	999
ENGAGE	UK	Optimisation of cruise altitude and/or Mach number	CO_2	1 310	23
RlongSM (Reduced longitudinal Separation Minima)	UK	Optimisation of cruise altitude profiles	CO_2	441	533
Gate to gate Green Shuttle	France	Optimisation of cruise altitude profile & CDO from ToD	CO_2	788	221
Transatlantic green flight PPTP	France	Optimisation of oceanic trajectory (vertical and lateral) & approach	CO_2	2 090+ 1 050	93
Greener Wave	Switzerland	Optimisation of holding time through 4D slot allocation	CO_2	504	1 700
VINGA	Sweden	CDO from ToD with RNP STAR and RNP AR.	CO_2 & noise	70-285; negligible change to noise contours	189
AIRE Green Connections	Sweden	Optimised arrivals and approaches based on RNP AR & Data link. 4D trajectory exercise	CO_2 & noise	220	25
Trajectory based night time	The Netherlands	CDO with pre-planning	CO_2 + noise	TBC	124
A380 Transatlantic Green Flights	France	Optimisation of taxiing and cruise altitude profile	CO_2	1 200+ 1 900	19
				Total	**9 416**

The AIRE 3 campaign comprised 9 projects (2012-2014) and 5199 trials summarised in table 15.

Table 15: Summary of AIRE 3 projects

Project name	Location	Operation	Number of Trials	Benefits per flight
AMBER	Riga International Airport	Turboprop aircraft to fly tailored Required Navigation Performance – Authorisation Required (RNP-AR) approaches together with Continuous Descent Operations (CDO),	124	230 kg reduction in CO_2 emissions per approach; A reduction in noise impact of 0.6 decibels (dBA).
CANARIAS	La Palma and Lanzarote airports	CCDs and CDOs	8	Area Navigation-Standard Terminal Arrival Route (RNAV STAR) and RNP-AR approaches 34-38 NM and 292-313 kg of fuel for La Palma and 14 NM and 100 kg of fuel for Lanzarote saved.
OPTA-IN	Palma de Mallorca Airport	CDOs	101	Potential reduction of 7-12% in fuel burn and related CO_2 emissions
REACT plus	Budapest Airport	CDOs and CCOs	4 113	102 kg of fuel conserved during each CDO
ENGAGE Phase II	North Atlantic – between Canada & Europe	Optimisation of cruise altitude and/or Mach number	210	200-400 litres of fuel savings; An average of 1-2% of fuel burn
SATISFIED	EUR-SAM Oceanic corridor	Free routing	165	1.58 t CO_2 emissions
SMART	Lisbon flight information region (FIR), New York Oceanic and Santa Maria FIR	Oceanic: Flight optimisation	250	3.13 t CO_2 per flight
WE-FREE	Paris CDG, Venice, Verona, Milano Linate, Pisa, Bologna, Torino, Genoa airports	Free routing	128	693 kg CO_2 for CDG-Roma Fiumicino; 504 kg CO_2 for CDG Milano Linate
MAGGO	Santa Maria FIR and TMA	Several enablers	100	The MAGGO project couldn't be concluded

C.3 SESAR2020 Environmental Performance Assessment

SESAR2020 builds upon the expectations of SESAR1 and of the deployment baseline.
It is estimated that around 50.0m MT of fuel per year will be burned by 2025, ECAC wide, by around 10m flights. The SESAR2020 Fuel Saving Ambition (10%) equate to 500kg per flight or around 1.6 t CO_2 per flight, including:

- SESAR2020 Fuel Saving target for Solutions (6.8%) = 340kg/flight or 1 t CO_2/flight,
- SESAR 1 Fuel Saving performance (1.8%) = 90kg/flight or 283kg of CO_2/flight,
- SESAR Deployment Baseline Fuel Saving performance (0.2%) = 10kg/flight or 31kg of CO_2/flight,
- Non-SESAR ATM improvements (1.2%) = 60kg/flight or 189Kg of CO_2/flight.

It has to be noted that, while the SESAR 1 baseline was 2005, the SESAR2020 baseline is 2012.

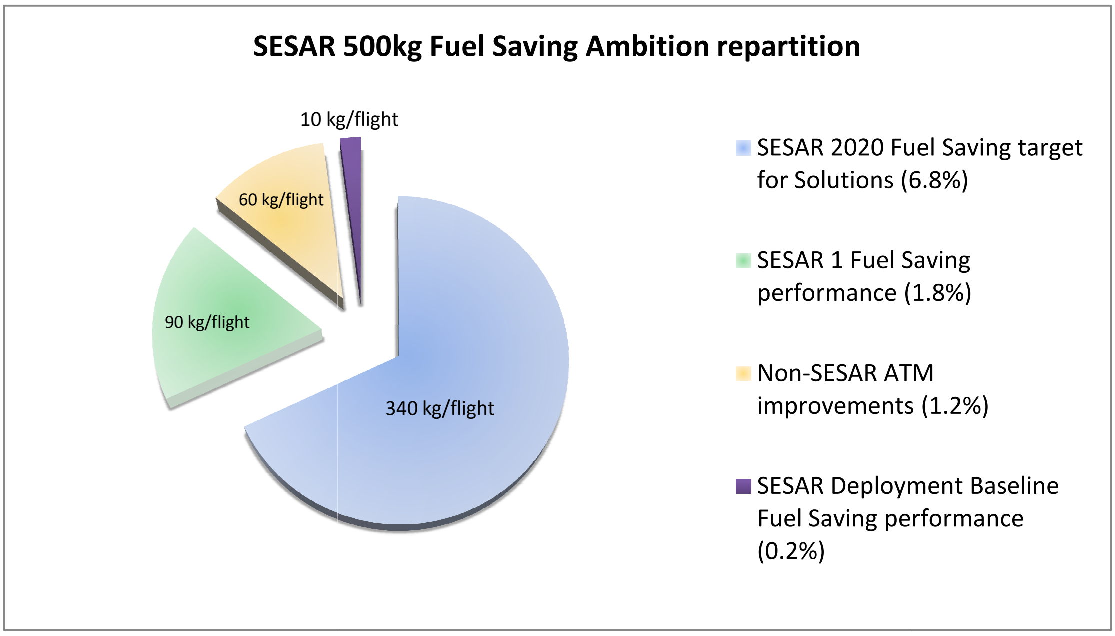

Figure 12: SESAR Fuel Saving Estimations

SESAR2020 has put in place a methodology that should allow a close monitoring of the expected fuel saving performance of each Solution, and of the overall programme. But, at this point of the SESAR2020 programme, it is too early to assess with a good level of confidence the gap between the expected fuel-saving benefit of each SESAR Solution and its demonstrated potential from the results of the validation exercises. However, 30 out of the 85 SESAR2020 Solutions have the potential to generate fuel savings. Table 16 provides the Top 10 Solutions with the biggest expected fuel saving potential:

Table 16: Summary of SESAR2020 projects offering the greatest potential fuel savings

Solution	Short description + Fuel saving rational	Operational environment (OE/ Sub-OEs) benefitting
PJ.07-01 Airspace User Processes for Trajectory Definition	This Solution refers to the development of processes related to the Flight Operation Centre (FOC) aimed at managing and updating the shared business trajectory, and fully integrating FOCs in the ATM Network processes. These processes respond to the need to accommodate individual airspace users' business needs and priorities without compromising the performance of the overall ATM system or the performance of other stakeholders. This will also ensure continuity in the Collaborative Decision Making process throughout the trajectory lifecycle. The benefits will come through anticipation and choice of the optimal route and reduction of vertical inefficiencies, which will reduce costs and fuel burn. No real impact on airport is expected.	Mainly for: Terminal Very High Complexity En-route Very High Complexity Some benefit but much lower for: Terminal High, Medium, Low Complexity En-route High, Medium Complexity
PJ.10-01C Collaborative Control	This Solution refers to coordination by exception rather than coordination by procedure and is facilitated by advanced controller tools, reducing the need for coordination agreements, fewer boundary constraints and the ability to combine sectors into multisector planner teams. The existence of clear procedures for collaborative control reduces the need for coordination and results in a more streamlined method of operation close to a sector boundary. This may bring a reduction in the number of level-offs and, thus, bring a partial improvement in fuel efficiency.	Mainly for: Terminal Very High Complexity En-route Very High Complexity Some benefit but much lower for: Terminal High, Medium, Low Complexity

		En Route High, Medium Complexity
PJ.10-02b Advanced Separation Management	This Solution aims to further improve the quality of services of separation management in the en-route and TMA operational environments by introducing automation mechanisms and integrating additional information (ATC intent, aircraft intent). Controller tools will enable earlier and more precise detection and resolution of conflicts. This will reduce the need for vectoring and enable de-confliction actions to be taken earlier and through the usage of closed clearances. Those will be managed more proactively on-board, and benefit fuel efficiency. Clearances issued by the ATCOs may, in some situations, take into account aircraft derived data related to airline preferences, bringing an improvement in fuel efficiency.	Mainly for: Terminal Very High Complexity En-route Very High Complexity Some benefit but much lower: Terminal High, Medium, Low Complexity En-route High, Medium Complexity
PJ.09-03 Collaborative Network Management Functions	This Solution allows for network management based on transparency, performance targets and agreed control mechanisms. The work enables a real-time visualisation of the evolving Airport Operation Plan (AOP) and Network Operating Plan (NOP) planning environment (such as demand pattern and capacity bottlenecks) to support airspace user and local planning activities. Thanks to this Solution, the increased efficiency of the performance of the system due to more optimised trajectory with airlines preference will result in fuel burn reductions.	Mainly for: En-route Very High Complexity Some benefit but much lower for: Terminal very High, High, Medium Complexity En-route High, Medium Complexity Airport very large, large, medium
PJ.01-02 Use of Arrival and Departure Management Information for Traffic Optimisation within the TMA	This Solution brings near real time traffic management to the TMA, taking advantage of predicted demand information provided by arrival and departure management systems from one or multiple airports. This will allow the identification and resolution of complex interacting traffic flows in the TMA and on the runway, through the use of AMAN and DMAN flow adjustments and ground holdings. Traffic optimisation obtained thanks to this Solution will reduce the need for tactical interventions and will result in more efficient flights, and increased flight efficiency will save fuel.	Mainly for: Terminal Very High Complexity En-route Very High Complexity Some benefit but much lower for: Terminal very High, High, Medium, Low Complexity En-route High, Medium Complexity
PJ2-01 Wake turbulence separation optimization	This Solution refers to the use of downlinked information from aircraft to predict wake vortex and determine appropriate wake-vortex minima dynamically, thereby optimising runway delivery. Wake turbulence separation optimization should reduce airborne delays due to arrival capacity limitations linked to wake separations. For major airports that are today constrained in peak hours, the use of: - optimised wake category scheme or pairwise separations can either be translated into added capacity (as described above) or additional resilience in case of perturbation. - time based separation will reduce the effect of a headwind on the arrival flow rate and thus increase the predictability of the scheduling process. On less constrained airports, significant improvement can also be observed by employing reduced separation applied on a time based separation basis in the specific runway configuration or wind conditions responsible for a large part of the airport delay. This increases the flexibility for Controllers to manage the arrival traffic due to the separation minima reduction. The weather dependant reduction of wake separation, considering the allowable increase of throughput, is expected to be a major mitigation of delay and to provide for an increase in the flexibility for Controllers to manage the arrival traffic due to the reduction in the required wake separations.	Mainly for: Airports and TMAs with High and Medium complexity. • Any runway configuration. • Airports with mainly strong headwinds. • Capacity constrained airports or airports with observed delay.

	The reduction of delay will generate fuel saving.	
PJ.09-02 Integrated local DCB processes	This Solution sees the seamless integration of local network management with extended air traffic control planning and arrival management activities in short-term and execution phases. The work will improve the efficiency of ATM resource management, as well as the effectiveness of complexity resolutions by closing the gap between local network management and extended ATC planning. The increased efficiency of the performance of the system due to more optimised trajectory with airlines preference will result in fuel burn reductions.	Mainly for: Airport Very large Some benefit but much lower for: Terminal very High, High, Medium Complexity En-route very High, High, Medium Complexity Airport large, medium
PJ.01-03 Dynamic and Enhanced Routes and Airspace	This Solution brings together vertical and lateral profile issues in both the en-route and TMA phases of flight, with a view to creating an end-to-end optimised profile and ensuring transition between free route and fixed route airspace. The Solution will be supported by new controller tools and enhanced airborne functionalities. Significant fuel efficiency benefits are expected from Continuous Descent (CDO) / Continuous Climb Operations (CCO) in high density operations. CDO / CCO permit closer correlation of the actual with optimal vertical profile, to take into account the preference of the Airspace User for the most efficient climb / descent profile for the flight. Implementation of enhanced conformance monitoring / alerting by both ground and airborne systems reduce the likelihood of ATCO intervention in the climb / descent, so reducing the potential for tactical level offs.	Mainly for: Terminal Very High Complexity Some benefit but much lower for: Terminal High, Medium Complexity
PJ.02-08 Traffic optimisation on single and multiple runway airports	This Solution refers to a system that enables tower and approach controllers to optimise runway operations arrival and/or departure spacing and make the best use of minimum separations, runway occupancy, runway capacity and airport capacity. Imbalances known more than 3 hours ahead allow to re-planning inbound traffic from the originating airport or reconsider Airport Transit View (ATV) on behalf of airlines reducing delays due to airport constraints up to 20%. Planning runway closures or runway changes in the optimum periods of the day will minimize the time spent re-routing air and ground traffic during the execution phase. Sharing this information with the different actors will provide the NOP with more accurate forecasts for arrival and departure time in order to coordinate the subsequent target times. There should be some fuel gains as a direct consequence of improved predictability, both for departures and arrivals (less variability ==> less patch stretching, holdings ...).	Mainly for: Terminal Very High Complexity • Single and Multiple runways • Preferably Congested large and medium size airports
PJ.08-01 Management of Dynamic Airspace configurations	This Solution refers to the development of the process, procedures and tools related to Dynamic Airspace Configuration (DAC), supporting Dynamic Mobile Areas of Type 1 and Type 2. It consists of the activation of Airspace configurations through an integrated collaborative decision making process, at national, sub-regional and regional levels; a seamless and coordinated approach to airspace configuration, from planning to execution phases, allowing the Network to continuously adapt to demand pattern changes in a free route environment) and ATC sector configurations adapted to dynamic TMA boundaries and both fixed and dynamic elements. This solution increased efficiency enabling optimised flight trajectories and profiles with the end result being reduced fuel burn, noise and CO_2 emissions. Advanced Airspace Management should decrease Airspace Users fuel consumption and reduce flight time. Optimised trajectory and a more direct route as a result of enhanced situation awareness through real airspace status update and seamless civil-military coordination by AFUA application.	Mainly for: En-route Very High Complexity Some benefit but much lower for: En-route High, Medium Complexity

2.4.D. ECONOMIC/MARKET-BASED MEASURES

ECAC members have always been strong supporters of a market-based measure scheme for international aviation to incentivize and reward good investment and operational choices, and so welcomed the agreement on the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The 31 EEA states in Europe have already implemented the EU Emissions Trading System (ETS), including the aviation sector with around 500 aircraft operators participating in the cap and trade approach to limit CO_2 emissions. It was the first and is the biggest international system capping greenhouse gas emissions. In the period 2012 to 2018 EU ETS has saved an estimated 100 million tonnes of intra-European aviation CO_2 emissions.

D.1 The EU Emissions Trading System

The EU Emissions Trading System (EU ETS) is the cornerstone of the European Union's policy to tackle climate change, and a key tool for reducing greenhouse gas emissions cost-effectively, including from the aviation sector. It operates in 31 countries: the 28 EU Member States, Iceland, Liechtenstein and Norway. The EU ETS is the first and so far the biggest international system capping greenhouse gas emissions; it currently covers half of the EU's CO_2 emissions, encompassing those from around 12 000 power stations and industrial plants in 31 countries, and, under its current scope, around 500 commercial and non-commercial aircraft operators that fly between airports in the European Economic Area (EEA). The EU ETS Directive has recently been revised in line with the European Council Conclusions of October 2014[20] that confirmed

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

that the EU ETS will be the main European instrument to achieve the EU's binding 2030 target of an at least 40% domestic reduction of greenhouse gases compared to 1990[21].

The EU ETS began operation in 2005; a series of important changes to the way it works took effect in 2013, strengthening the system. The EU ETS works on the "cap and trade" principle. This means there is a "cap", or limit, on the total amount of certain greenhouse gases that can be emitted by the factories, power plants, other installations and aircraft operators in the system. Within this cap, companies can sell to or buy emission allowances from one another. The limit on allowances available provides certainty that the environmental objective is achieved and gives allowances a market value. For aviation, the cap is calculated based on the average emissions from the years 2004-2006. Aircraft Operators are entitled to free allocation based on an efficiency benchmark, but this might not cover the totality of emissions. The remaining allowances need to be purchased from auctions or from the secondary market. The system allows aircraft operators to use aviation allowances or general (stationary installations) allowances to cover their emissions.

By 30th April each year, companies, including aircraft operators, have to surrender allowances to cover their emissions from the previous calendar year. If a company reduces its emissions, it can keep the spare allowances to cover its future needs or sell them to another company that is short of allowances. The flexibility that trading brings ensures that emissions are cut where it costs least to do so. The number of allowances reduces over time so that total emissions fall.

As regards aviation, legislation to include aviation in the EU ETS was adopted in 2008 by the European Parliament and the Council[22]. The 2006 proposal to include aviation in the EU ETS, in line with the resolution of the 2004 ICAO Assembly deciding not to develop a global measure but to favour the inclusion of aviation in open regional systems, was accompanied by a detailed impact assessment[23]. After careful analysis of the different options, it was concluded that this was the most cost-efficient and environmentally effective option for addressing aviation emissions.

In October 2013, the Assembly of the International Civil Aviation Organisation (ICAO) decided to develop a global market-based mechanism (MBM) for international aviation emissions. Following this agreement the EU decided to limit the scope of the EU ETS to flights between airports located in the European Economic Area (EEA) for the period 2013-2016 (Regulation 421/2014), and to carry out a new revision in the light of the outcome of the 2016 ICAO Assembly. The temporary limitation follows on from the April 2013 'stop the clock' decision[24] adopted to promote progress on global action at the 2013 ICAO Assembly.

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

[22] Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0101

[23] http://ec.europa.eu/clima/policies/transport/aviation/documentation_en.htm

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

The European Commission assessed the outcome of the 39th ICAO Assembly and, in that light, made a new legislative proposal on the scope of the EU ETS. Following the EU legislative process, this Regulation was adopted in December 2017[25].

The legislation maintains the scope of the EU ETS for aviation limited to intra-EEA flights. It foresees that once there is clarity on the nature and content of the legal instruments adopted by ICAO for the implementation of CORSIA, as well as about the intentions of other states regarding its implementation, a further assessment should take place and a report be presented to the European Parliament and to the Council considering how to implement CORSIA in Union law through a revision of the EU ETS Directive. This should be accompanied, where appropriate, by a proposal to the European Parliament and to the Council to revise the EU ETS Directive that is consistent with the Union economy-wide greenhouse gas emission reduction commitment for 2030 with the aim of preserving the environmental integrity and effectiveness of Union climate action.

The Regulation also sets out the basis for the implementation of CORSIA. It provides for European legislation on the monitoring, reporting and verification rules that avoid any distortion of competition for the purpose of implementing CORSIA in European Union law. This will be undertaken through a delegated act under the EU ETS Directive.

The EU ETS has been effectively implemented over recent years on intra-EEA flights, and has ensured a level playing field with a very high level of compliance[26]. It will continue to be a central element of the EU policy to address aviation CO_2 emissions in the coming years.

The complete, consistent, transparent and accurate monitoring, reporting and verification of greenhouse gas emissions remains fundamental for the effective operation of the EU ETS. Aviation operators, verifiers and competent authorities have already gained wide experience with monitoring and reporting; detailed rules are prescribed by Regulations (EU) N°600/2012[27] and 601/2012.[28]

The EU legislation establishes exemptions and simplifications to avoid excessive administrative burden for the smallest operators of aircraft. Since the EU ETS for aviation took effect in 2012 a *de minimis* exemption for commercial operators – with either fewer than 243 flights per period for three consecutive four-month periods or flights with total annual emissions lower than 10 000 tonnes CO_2 per year applies. This means that many aircraft operators from developing countries are exempted from the EU ETS. Indeed, over 90 States have no commercial aircraft operators included in the scope of the EU ETS. In addition, from 2013 flights by non-commercial aircraft operators with total annual emissions lower than 1 000 tonnes CO_2 per year are excluded from the EU ETS. A further administrative simplification applies to small aircraft operators emitting less than 25 000 tonnes of CO_2 per year, who can choose to use the small emitters' tool

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

[26] Report on the functioning of the European carbon market, COM(2017) 693 final, https://ec.europa.eu/commission/sites/beta.../report-functioning-carbon-market_en.pdf

[27] Commission Regulation (EU) No 600/2012 of 21 June 2012 on the verification of greenhouse gas emission reports and tonne-kilometre reports and the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0600&from=EN

[28] Regulation (EU) No 601/2012 of the European Parliament and of the Council of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council, http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32012R0601

rather than independent verification of their emissions. In addition, small emitter aircraft operators can use the simplified reporting procedures under the existing legislation. The recent amendment to extend the intra-EEA scope after 2016 includes a new simplification, allowing aircraft operators emitting less than 3 000 tCO_2 per year on intra-EEA flights to use the small emitters' tool.

The EU legislation foresees that, where a third country takes measures to reduce the climate change impact of flights departing from its airports, the EU will consider options available in order to provide for optimal interaction between the EU scheme and that country's measures. In such a case, flights arriving from the third country could be excluded from the scope of the EU ETS. This will be the case between the EU and Switzerland following the agreement to link their respective emissions trading systems, which was signed on 23rd November 2017. The EU therefore encourages other countries to adopt measures of their own and is ready to engage in bilateral discussions with any country that has done so. The legislation also makes it clear that if there is agreement on global measures, the EU shall consider whether amendments to the EU legislation regarding aviation under the EU ETS are necessary.

Impact on fuel consumption and/or CO2 emissions

The environmental outcome of an emissions trading system is determined by the emissions cap. Aircraft operators are able to use allowances from outside the aviation sector to cover their emissions. The absolute level of CO_2 emissions from the aviation sector itself can exceed the number of allowances allocated to it, as the increase is offset by CO_2 emissions reductions in other sectors of the economy covered by the EU ETS.

With the inclusion of intra-European flights in the EU ETS it has delivered around 100 MT of CO_2 reductions/offsets between 2012 and 2018. The total amount of annual allowances to be issued will be around 38 million, whilst verified CO_2 emissions from aviation activities carried out between aerodromes located in the EEA has fluctuated between 53.5 MT CO_2 in 2013 and 61MT in 2016. This means that the EU ETS is now contributing more than 23 MT CO_2 of emission reductions annually[29], or around 100 MT CO_2 over 2012-2018, partly within the sector (airlines reduce their emissions to avoid paying for additional units) or in other sectors (airlines purchase units from other ETS sectors, which would have to reduce their emissions consistently). While some reductions are likely to be within the aviation sector, encouraged by the EU ETS's economic incentive for limiting emissions or use of aviation biofuels, the majority of reductions are expected to occur in other sectors.

Putting a price on greenhouse gas emissions is important to harness market forces and achieve cost-effective emission reductions. In parallel to providing a carbon price which incentivises emission reductions, the EU ETS also supports the reduction of greenhouse gas emissions through €2.1bn fund for the deployment of innovative renewables and carbon capture and storage. This funding has been raised from the sale of 300 million emission allowances from the New Entrants' Reserve of the third phase of the EU ETS. This includes over €900m for supporting bioenergy projects, including advanced biofuels.

In addition, through Member States' use of EU ETS auction revenue in 2015, over €3.5bn has been reported by them as being used to address climate change. The purposes for which revenues from allowances should be used encompass mitigation of greenhouse gas emissions

[29] Report on the functioning of the European carbon market, COM(2017) 693 final, https://ec.europa.eu/commission/sites/beta.../report-functioning-carbon-market_en.pdf

and adaptation to the inevitable impacts of climate change in the EU and third countries. These will reduce emissions through: low-emission transport; funding research and development, including in particular in the field of aeronautics and air transport; providing contributions to the Global Energy Efficiency and Renewable Energy Fund, and measures to avoid deforestation.
In terms of its contribution towards the ICAO global goals, the states implementing the EU ETS have delivered, in "net" terms, a reduction of around 100 MT of aviation CO_2 emissions over 2012-2018 for the scope that is covered, and this reduction will continue to increase in the future under the new legislation. Other emission reduction measures taken, either collectively throughout Europe or by any of the 31 individual states implementing the EU ETS, will also contribute towards the ICAO global goals. Such measures are likely to moderate the anticipated growth in aviation emissions. The table 17 presents projected benefits of the EU-ETS based on the current scope (intra-European flights).

Table 17: Summary of estimated EU-ETS emission reductions

Estimated emissions reductions resulting from the EU-ETS

Year	*Reduction in CO_2 emissions*
2012-2018	*100 MT*

D.2 The Carbon Offsetting and Reduction Scheme for International Aviation

In October 2016, the Assembly of ICAO confirmed the objective of targeting CO_2-neutral growth as of 2020, and for this purpose to introduce a global market-based measure for compensating CO_2 emissions above that level, namely Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The corresponding resolution is A39-3: Consolidated statement of continuing ICAO policies and practices related to environmental protection – Global Market-based Measure (MBM) scheme.

According to the Assembly Resolution, the average level of CO_2 emissions from international aviation covered by the scheme between 2019 and 2020 represents the basis for carbon neutral growth from 2020, against which emissions in future years are compared. In any year from 2021 when international aviation CO_2 emissions covered by the scheme exceed the average baseline emissions of 2019 and 2020, this difference represents the sector's offsetting requirements for that year.

CORSIA is divided into 3 phases[30]: There is a pilot phase (2021-2023), a first phase (2024-2026) and a second phase (2027-2035). During CORSIA's pilot phase and the first phase, participation from states is voluntary. The second phase applies to all ICAO Member States.

30 Further information on https://www.icao.int/environmental-protection/Pages/market-based-measures.aspx

Figure 13 : CORSIA Implementation Plan (© ICAO)

Exempted are States with individual share of international aviation activities in RTKs, in year 2018 below 0.5 per cent of total RTKs and States that are not part of the list of States that account for 90 per cent of total RTKs when sorted from the highest to the lowest amount of individual RTKs. Additionally Least Developed Countries (LDCs), Small Island Developing States (SIDS) and Landlocked Developing Countries are exempted as well.

CORSIA operates on a route-based approach. The offsetting obligations of CORSIA shall apply to all aircraft operators on the same route between States, both of which are included in the CORSA. Exempted are a) emissions from aircraft operators emitting less than 10 000 tCO_2 emissions from international aviation per year, b) emissions from aircraft whose Maximum Take Off Mass (MTOM) is less than 5 700 kg, and c) emissions from humanitarian, medical and firefighting operations.

According to the “Bratislava Declaration” from September 3rd 2016 the Directors General of Civil Aviation Authorities of the 44 ECAC Member States declared their intention to implement CORSIA from the start of the pilot phase, provided certain conditions were met. This shows the full commitment of the EU, its Member States and the other Member States of ECAC to counter the expected in-sector growth of total CO_2 emissions from air transport and to achieving overall carbon neutral growth.

2.4.E. EU INITIATIVES IN THIRD COUNTRIES

E.1 Multilateral projects

At the end of 2013 the European Commission launched a project with a total budget of €6.5 million under the name "*Capacity building for CO_2 mitigation from international aviation*". The 42-month project, implemented by the ICAO, boosts less developed countries' ability to track, manage and reduce their aviation emissions. In line with the call from the 2013 ICAO Assembly, beneficiary countries will submit meaningful State action plans for reducing aviation emissions. They then and received assistance to establish emissions inventories and pilot new ways of reducing fuel consumption. Through the wide range of activities in these countries, the project contributes to international, regional and national efforts to address growing emissions from international aviation. The beneficiary countries are the following:

Africa: Burkina Faso, Kenya and Economic Community of Central African States (ECCAS) Member States: Angola, Burundi, Cameroon, Central African Republic, Chad, Republic of Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome and Principe.

Caribbean: Dominican Republic and Trinidad and Tobago.

Preceding the ICAO Assembly of October 2016 sealing the decision to create a global MBM scheme, a declaration of intent was signed between Transport Commissioner Violeta Bulc and ICAO Secretary General Dr Fang Liu, announcing their common intention to continue cooperation to address climate change towards the implementation of the ICAO Global Market Based Measures. On adoption of a decision by the ICAO Assembly on a GMBM, the parties intended to jointly examine the most effective mechanisms to upgrade the existing support mechanism and also to continue similar assistance, including cooperation and knowledge sharing with other international organizations, with the aim of starting in 2019.

The "Capacity building for CO_2 mitigation from international aviation" has been of enormous value to the beneficiary countries. A second project has been initiated by the European Commission aimed at assisting a new set of countries on their way to implementing the CORSIA. Further details will be published upon signature of the contract with the different parties.

Additionally, initiatives providing ASEAN Member States with technical assistance on implementing CORSIA have been initiated in 2018 and will possibly be extended further in 2019. The ARISE plus project dedicates an activity under result 3 - *'strengthened national capabilities of individual ASEAN Members States and aligned measures with ICAO SARPs'*. To achieve this, the project will support workshops in 2018 on capacity building and technical assistance, especially for the development or enhancement of actions plans. This will provide a genuine opportunity to pave the way for the effective implementation of further potential assistance and foster States readiness for their first national aviation emission report at the end of 2019.

EASA is also implementing Aviation Partnership Projects (APPs) in China, South Asia and Latin America (including the Caribbean) as well as projects funded by DG NEAR and DG DEVCO in other regions. This can enable the EU to form a holistic view of progress on CORSIA implementation worldwide.

In terms of synergies, the South Asia and South East Asia environmental workshops could engage with key regional stakeholders (ICAO Asia Pacific office, regulatory authorities, airline operators, verification bodies), and thereby assess the level of readiness for CORSIA on wider scale in the Asia Pacific region. This preparatory work would help focus the subsequent FPI CORSIA project and create economies of scale in order to maximize the benefits of the project, which needs to be implemented within an ambitious timescale.

2.4.F. SUPPORT TO VOLUNTARY ACTIONS

F.1 ACI Airport Carbon Accreditation

This is a certification program for carbon management at airports, based on carbon mapping and management standards specifically designed for the airport industry. It was launched in 2009 by ACI EUROPE, the trade association for European airports.

The underlying aim of the program is to encourage and enable airports to implement best practice carbon and energy management processes and to gain public recognition of their achievements. It requires airports to measure their CO_2 emissions in accordance with the World Resources Institute and World Business Council for Sustainable Development GHG Protocol and to get their emissions inventory assured by an independent third party.

This industry-driven initiative was officially endorsed by EUROCONTROL and the European Civil Aviation Conference (ECAC). It is also officially supported by the United Nations Environmental Program (UNEP). The program is overseen by an independent Advisory Board.

At the beginning of this reporting year (May 2016) there were 156 airports in the program. Since then, a further 36 airports have joined and 3 have withdrawn, bringing the total number of airports at the end of this reporting year (May 2017) to 189 covering 38.1 % of global air passenger traffic.

In 2017, for the first time, airports outside Europe achieved the highest accreditation status: 1 airport in North America, 5 in Asia-Pacific and 1 in Africa have been recognized as carbon neutral. European airports doubled their pledge and set the bar at 100 European airports becoming carbon neutral by 2030 from the 34 currently assessed to be carbon neutral.

Airport Carbon Accreditation is a four-step program, from carbon mapping to carbon neutrality. The four steps of certification are: Level 1 "Mapping", Level 2 "Reduction", Level 3 "Optimization", and Level 3+ "Carbon Neutrality".

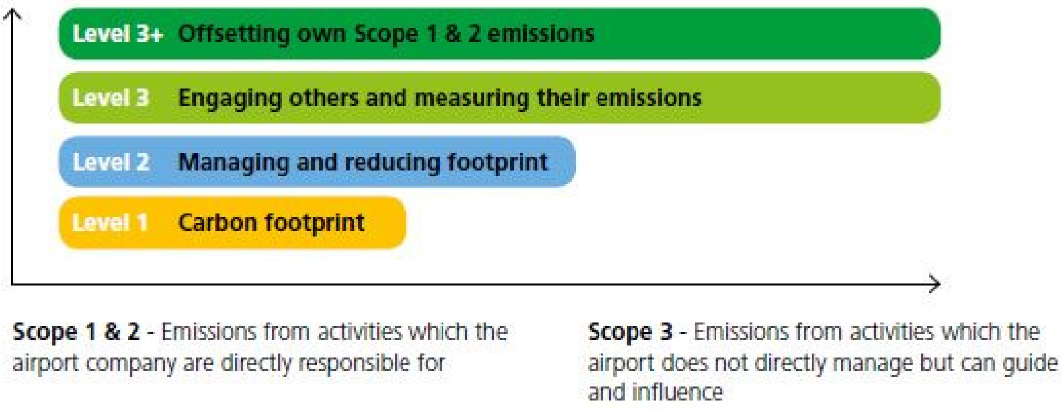


Figure 14: Four steps of Airport Carbon Accreditation

Levels of certification (ACA Annual Report 2016-2017)

One of its essential requirements is the verification by external and independent auditors of the data provided by airports. Aggregated data are included in the *Airport Carbon Accreditation* Annual Report thus ensuring transparent and accurate carbon reporting. At level 2 of the program and above (Reduction, Optimization and Carbon Neutrality), airport operators are required to demonstrate CO_2 reductions associated with the activities they control. For historical reasons European airports remain at the forefront of airport actions to voluntarily mitigate and reduce their impact on climate change. The strong growth momentum was maintained for the reporting year which ended with 116 airports in the program. These airports account for 64.8% of European passenger traffic and 61% of all accredited airports in the program this year.

Anticipated benefits:

The Administrator of the program has been collecting CO_2 data from participating airports over the past five years. This has allowed the absolute CO_2 reduction from the participation in the program to be quantified.

Table 18: Emissions reduction highlights for the European region

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

Table 19: Emissions offset for the European region

	2015-2016	2016-2017
Aggregate emissions offset, Level 3+ (tCO_2)	222	252 218

The table 19 presents the aggregate emissions offset by airports accredited at Level 3+ of the programme. The programme requires airports at Level 3+ to offset their residual Scope 1 & 2 emissions as well as Scope 3 emissions from staff business travel.

Table 20: Summary of Emissions under airports direct control

Variable	2013 -2014		2014-2015	
	Emissions	Number of airports	Emissions	Number of airports
Aggregate carbon footprint for 'year 0'[31] for emissions under airports' direct control (all airports)	22.04 MT CO_2	85	2.09 MT CO_2	92
Carbon footprint per passenger	2.01 kg CO_2		1,89 kg CO_2	
Aggregate reduction in emissions from sources under airports' direct control (Level 2 and above)[32]	87.4 ktonnes CO_2	56	139 ktonnes CO_2	71
Carbon footprint reduction per passenger	0.11 kg CO_2		0.15 kg CO_2	
Total carbon footprint for 'year 0' for emissions sources which an airport may guide or influence (level 3 and above)[33]	12.8 MT CO_2	31	14.0 MT CO_2	36
Aggregate reductions from emissions sources which an airport may guide or influence	224 ktonnes CO_2		551 ktonnes CO_2	
Total emissions offset (Level 3+)	181 ktonnes CO_2	16	294 ktonnes CO_2	20

Its main immediate environmental co-benefit is the improvement of local air quality. Costs for the design, development and implementation of *Airport Carbon Accreditation* have been borne by ACI EUROPE. *Airport Carbon Accreditation* is a non-for-profit initiative, with participation fees set at a level aimed at allowing for the recovery of the aforementioned costs.
The scope of *Airport Carbon Accreditation,* i.e. emissions that an airport operator can control, guide and influence, implies that aircraft emissions in the LTO cycle are also covered. Thus, airlines can benefit from the gains made by more efficient airport operations to see a decrease in their emissions during the LTO cycle. This is consistent with the objective of including aviation in the EU ETS as of 1 January 2012 (Directive 2008/101/EC) and can support the efforts of airlines to reduce these emissions.

[31] 'Year 0' refers to the 12 month period for which an individual airport's carbon footprint refers to, which according to the Airport Carbon Accreditation requirements must have been within 12 months of the application date.

[32] This figure includes increases in CO_2 emissions at airports that have used a relative emissions benchmark in order to demonstrate a reduction.

[33] These emissions sources are those detailed in the guidance document, plus any other sources that an airport may wish to include.

SECTION 3: National Actions in Greece

3.1. REGULATORY MEASURES

Greece as Member State of EU and consequently under the European Union Regulatory regime, is obliged to implement the Regulation (EU) 390/2013 (Performance Regulation), which lays down the measures to improve the overall performance of air navigation services at FAB level.

In accordance with the aforementioned Regulation, Greece has, along with the other Member States of Blue-Med Functional Airspace Block (B.M._FAB), drawn up the Performance Plan for the second reference period (RP2) covering the years 2015-2019.

The Performance Plan has been drawn up in consistency with the requirements set out in the Regulations (EU) 390/2013 and 391/2013 (the common charging scheme Regulation) having incorporated specific and measurable key performance indicators (KPIs), for the key Performance Areas (KPAs) of **Safety, Capacity, Environment and Cost effectiveness.**

Effort was made for assignment of achievable, realistic and time-bound corresponding targets, being consistent with European Wide Targets, aiming at effectively steering the sustainable performance of air navigation services.

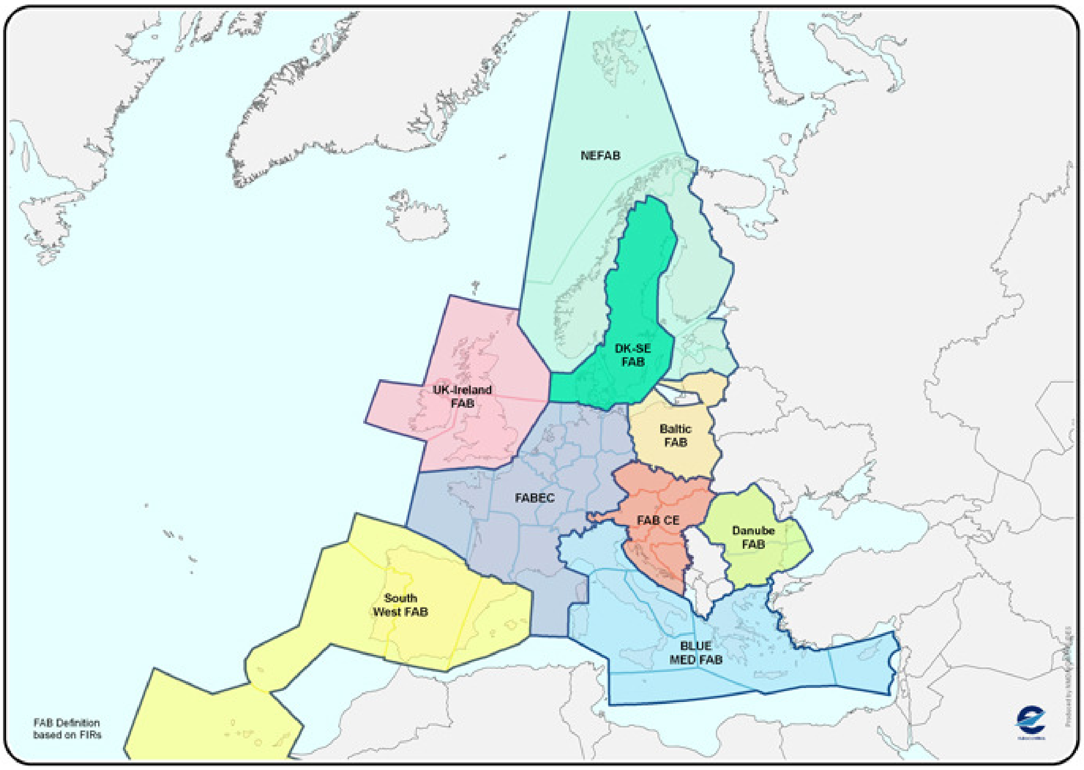


Figure 15: Single European Sky Functional Airspace Blocks (FAB)

BLUE MED FAB Environmental Performance

The Single European Sky regulatory framework, issued in order to obtain a more efficient and flexible management of the airspace, has the implementation of Functional Airspace Blocks (FABs) by the EU Member States.

According to Project 2008-EU-40004, the **BLUE MED FAB** consists:

- Cyprus, **Greece**, Italy and Malta are the Full Members in the ministerial declaration of political support to the definition phase of BLUE MED FAB Project);
- Albania, Egypt and Tunisia are referred to as “Associated Partners” of the BLUE MED FAB Project

The BLUE MED FAB initiative involves a large portion of the Mediterranean airspace and covers all the airspace under the responsibility of Member States and Associated Partners (ICAO EUR region and ICAO AFI region as regards Egypt and Tunisia).

The BLUE MED project in fact, aims to fulfill the new requirements introduced by the SES I and II, creating the necessary conditions for the coordinated management of a large portion of the airspace with the Mediterranean countries bordering the North East Africa and the Middle East. The aim is to harmonize the ATM/ANS systems in use in the states involved, in order to build single system of air traffic management interoperable and also consistent with the results of the research and development SESAR.

The project aims to extend the Single European Sky concept beyond the geographical boundaries of Europe and to achieve a safer, better performing air traffic network for airspace users and the travelling public. The concurrent implementation of described Operational Improvements, particularly with regards to the FAB optimized ATS Route Network and the Free Route introduction, will improve the overall **efficiency**.

BLUE MED FAB - Quantitative Benefits

FAB Improvements Areas	Improvements	Scenarios			Key Improvement Areas					
		2012	2015	2020	Flight Efficiency	Capacity	Cost Effectivenes	Safety	Environmental Sustainability	Human Resources
Airspace management	FAB optimized ATS Route Network	✓	✓	✓	✓	✓	✓		✓	✓
	Free Route Operations	✓	✓	✓	✓	✓			✓	✓
	Sector configuration improvements		✓		✓	✓			✓	✓
	Uniform en route Lateral separation minima (5NM)		✓		✓	✓			✓	
Procedures	Flow management procedure: ATFCM H24	✓			✓	✓	✓	✓	✓	✓

Figure 16: BLUE MED FAB Key Improvement Areas

The following quantitative benefits can be derived from these improvements:

- Reduction of fuel consumption
- Reduction of CO_2 emissions
- Reduction of flight time
- Reduction of NOx emissions
- Increase of capacity

Specifically, with the establishment of BLUE MED FAB a reduction in CO_2 emissions and a reduction in NOx emissions can be achieved in all different BLUE MED FAB scenarios (short, medium e long term), with increasing volumes. In the following table, aviation environmental impact saving (CO_2 and NOx saving) is presented with regards to the different BLUE MED FAB scenarios.

BLUE MED FAB - Yearly Aviation environmental impact saving (CO_2 and NO_X)		
Scenarios	Yearly CO_2 saving [Ton]	Yearly NO_x saving [Ton]
2012	107.899	430.264
2015	176.815	711.619
2015+ Free Route	256.855	1.020.744
2020 + Free Route	346.095	1.414.926

Table 21: BLUE MED FAB Environmental Impact Savings

Key Performance indicator for the Area of environment (KPA)

The Key Performance indicator for the area of Environment is defined on the basis of flight efficiency of the actual trajectory and is the result of *"the comparison between the length of the en route[34] part of the actual trajectory derived from surveillance data and the **achieved distance**[35], summed over all IFR flights within or traversing the B.M_FAB airspace";*

The following tables summarize the list of KPAs for performance plans as well as the definition of "local level" as established in the performance Regulation:

34 '**En route**' refers to the distance flown outside a circle of 40 NM around the airports.

35 "**Achieved distance**' is a function of the position of the entry and exit points of the flight into and out of the B.M._FAB airspace. Achieved distance represents the contribution that these points make to the distance used in the Union- wide indicator. The sum of these distances over all traversed local airspaces equals the distance used in the Union-wide indicator.

KPA	KPIs for Local Target Setting in RP2	Definition of local level
Safety	Effectiveness of Safety Management	FAB level with contribution at national level
	Application of severity classification scheme	FAB level with contribution at national level
	Just Culture	FAB level with contribution at national level
Environment	Horizontal en route flight efficiency	FAB level
Capacity	En route ATFM delay per flight	FAB level with breakdown at most appropriate level
	Terminal and airport ANS ATFM arrival delay per flight	National level with breakdown at airport level
Cost-efficiency	Determined unit cost (DUC) for en route ANS	En route charging zone level and consolidation at FAB level
	Determined unit cost(s) (DUC) for terminal ANS	Terminal charging zone level

KPA	Performance indicators	Level
Safety	Application of automated safety data recording systems	FAB level with contribution at national level
	Level of occurrence reporting	FAB level with contribution at national level
	Trends of separation minima and airspace infringements, runway incursions, and ATM-specific occurrences	FAB level with contribution at national level
Environment	Additional time in the taxi-out phase	National level with breakdown at airport level
	Additional time in terminal airspace	National level with breakdown at airport level
	Effectiveness of booking procedures for flexible use of airspace (FUA),	National level
	Rate of planning of conditional routes (CDRs)	National level
	Effective use of CDRs	National level

Table 22: BLUE MED FAB KPIs

In accordance with the European Commission Implementing Decision 2014/132/EU the average horizontal *en route* flight efficiency has to be of at **least 2,6 % in 2019** for the actual trajectory. Key En Route Flight Efficiency –KEA at **Blue Med_FAB level has been set at 2,45% in 2019,** as proposed by European Network Manager**.**

Following the above, the ATM/ANS providers of Blue-Med_FAB, Member States have made efforts to design as direct as possible en route lines focusing in particular on the exit and entry points at national FIRs and in consistency within the corresponding Flight Information Region of their responsibility, in order to achieve the following values **of Key En Route Flight Efficiency (KEA):**

Environment KPI #1: Horizontal en-route flight efficiency (KEA)

	2015 Value	2016 Value	2017 Value	2018 Value	2019 Target
Union-wide targets	2,96%	2,87%	2,78%	2,69%	2,60%
FAB reference values (NM)	2,78%	2,70%	2,62%	2,54%	2,45%

FAB targets as shown in PP	2,78%	2,70%	2,62%	2,54%	2,45%
FAB actual values	2,80%	3,17%	2,82%		
Difference	0,02%	0,47%	0,20%		

Table 23: Horizontal en-route flight efficiency (KEA)

Although the target of 2.62% has not been achieved during 2017, the remarkable improvement of 0.35% compared to corresponding values of 2016, is mainly owing to FRA implementation at FAB level (to extent FRA is implemented across FAB).

A. En -route performance Indicators (PIs)

For our own performance monitoring and as part of the performance plan, B.M._FAB Member States decided to establish performance indicators (PIs) (although it is an optional request) for the Environment KPA, with the purpose to support the achievement of the Union-wide targets and the resulting targets at FAB level. These performance Indicators are:

- **PI 1 - ER DES - Airspace Design Improvements:** This PI is referred to FAB en route Airspace Design Assessment and evaluates improvements for the Route Network Structure to obtain the measure/value of the B.M._FAB contribution to the Network Manager DES Indicator (Horizontal ER Flight Efficiency on Airspace Design). The PI will contribute to rating (percentage and absolute value) of changes relating to New ER segments established in the FAB Airspace compared with the previous shortest available Routes serving same NTW (i.e.: City Pairs, Traffic Flows, etc).
- **PI 2 - ER RAD - VFE Improvements:** (RAD= Route Availability Document, VFE Vertical Flight Efficiency). This PI is referred to FAB ER Airspace RAD Assessment and evaluates both Vertical and Time Availability improvements on the Route Network Structure, in order to obtain the measure/value of the B.M.FAB contribution to the Network Manager Route Availability Indicator (Vertical ER Flight Efficiency on Airspace Design).
- **PI 3 - ER FPL vs NTW Availability:** This PI is referred to Optimal ER Plannable Trajectory and Available into the B.M._FAB Airspace vs Latest Filed Flight Plan Trajectory Planned by AOs. The benefits of the resulting improvements support the Network Manager KEP Indicator (Horizontal ER Flight Efficiency on Best NTW Availability vs Last Filed Flight Plan Trajectory) to permit to understand how much (measure/value) the AOs have incorporated the improvements in their own planning activity.
- **PI 4 - AOs Flight Plan vs Best NTW Availability**: Through this PI we will compare the Optimal ER Plannable NTW into the BM Airspace vs the Last Filed Flight Plan by AOs, both on Horizontal and on Vertical, in order to evaluate the AOs reactivity in their own Flight Planning Process to intercept the ANSP NTW improvements introduced on the FAB Route Structure (NTW).

B. Terminal Areas and Performance Indicators for Environment Area

- **PI - Additional ASMA time**: The additional ASMA[36] Time (mins) is the difference between the Actual ASMA Transit Time vs the Unimpeded ASMA Transit Time, monitored to obtain the measure/value of Greece contribution to the ASMA PI for the whole B.M._FAB. According to the EU Reg 390/2013, the 4 Member States of B.M.FAB shall monitor the Airports with more than 70.000 movements (or should there be none, the National Airport/s with the highest number of IFR Traffic). Among airports across Greece, the Athens International Airport (LGAV) is falling under the above prerequisite and for the time being, it is the only one where the measurement of Additional ASMA Time will take place.

- **PI - Additional Taxi-Out Time:** Additional Taxi-Out Time (mins) is the difference between the Actual Taxi-Out Time from the Stand to the Departure RWY vs the Unimpeded Taxi-Out Time calculated for each Stand Group to the Departure RWY, monitored to obtain the measure/value of Greece contribution to the Taxi-Out PI for the whole B.M._FAB.

  Regulation (EU) 390/2013, the additional Taxi- Time on the Airports is described as the indicator is the difference between the actual taxi-out time and the unimpeded time based on taxi-out times in low periods of traffic. It is expressed in minutes for taxi per departure for the whole calendar year. The only airport in Greece with more than 70.000 IFR air transport movements per year is the Athens International Airport (LGAV).

Environment PI #1: Additional taxi-out time			**2015 Value**	**2016 Value**	**2017 Value**	**2018 Value**	**2019 Value**
National level	Actual		1,16	1,31	1,89		
Airport level	***LGAV (Athens)***	Actual	1,16	1,31	1,89		

Environment PI #2: Additional time in terminal airspace			2015 Value	2016 Value	2017 Value	2018 Value	2019 Value
National level	Actual		0,82	1,10	0,88		
Airport level	*LGAV (Athens)*	Actual	0,82	1,10	0,88		

Table 24 : Terminal Areas and Performance Indicators

[36] ASMA = Arrival Sequencing and Metering Area. The additional time in the ASMA Terminal Airspace is defined as follows:
- the ASMA is a Traffic Volume with a cylindrical shape with a radius of 40 NMs centered on the Airport Reference Point (ARP);
- the indicator made reference to the Arrival Traffic and take in account the difference between the Actual ASMA Transit Time vs ASMA Unimpeded Time (based on transit time in ASMA in low periods of traffic);
- the indicator is expressed in minutes per arrival for the whole calendar year;
- for each Airport involved (for Greece the Athens International Airport) the Unimpeded ASMA Transit Time Reference Value is established as reference.

C. Performance Plan Monitoring procedure

According to Regulation (EU) 390/2013, article 20.1(a), the National supervisory Authorities of B.M._FAB member States have *"to examine, in relation to all key performance areas, documents and any other material relevant to the establishment of performance plans and targets also to take copies or extracts from such documents; to ask for an oral explanation on site".*

Following the above requirement, the Hellenic Air Navigation Supervisory Authority (HANSA) monitors the performance of HCAA/ANSP (ANSP under its supervision) and reports annually to Commission through Performance Review Body the recorded data.

3.2 IMPROVED AIR TRAFFIC MANAGEMENT & INFRASTRUCTURE

Free Route Airspace implementation within HELLAS UIR

It is still common practice over most of the European Airspace that air transport flights operate along a fixed network of airways/way-points rather than flying directly from a departure airport to the arrival destination. With the availability of current Satellite Navigation, Air Traffic and Network Management systems, soon this will no longer be the case.

In particular, Free Route allows airspace users to freely plan a route between fixed published entry and exit points, with the possibility to route via intermediate (published or unpublished) way points, without reference to the published European route network, subject to airspace availability. Free Route may be deployed both through the use of permanent Directs (DCTs), published within the fixed-route network, and through Free Route Airspace (FRA), where airspace users are free to define and fly via user-defined points and segments not previously published.

Following optimized trajectories, airspace users can sensibly improve the overall flight efficiency and predictability. In turn, reducing the distance flown results in time savings, significant cut in tons of fuel burnt/lower fuel carriage and so in fuel costs, last not least in reduction of gaseous emissions (tons of CO2 and NOX) alleviating the environmental impact.

Focusing on the South-eastern Europe, the BLUEMED FAB partners are implementing the FRA concept according to the agreed BLUEMED FAB Implementation Program, based on gradual steps ranging from the implementation of night DCTs up to more ambitious Free Route scenarios on regional scale. Under this scope, the HCAA/ANSP has recently developed an ambitious project regarding the gradual FRA implementation within Hellas UIR.

The HCAA/ANSP project, aims to implement Free Route operations in Greece through a seamless integration of the two Greek ACCs enabling airspace users to flight-plan their preferred trajectories within the airspace of HELLAS UIR. The deployment will also cover the prerequisites for enabling Free Route operations such as: ATS-route network optimization, including arrival and departure procedures and sector adaptation to accommodate the changes in traffic flows where needed.

The basic implementation elements of the HCAA/ANSP Free Route project are presented in the table below. The Free Route operations over the Mediterranean Basin, will be in full cooperation with the other BLUEMED members.

	Phase I	Phase II	Future Plan
Implementation Timeframe	**11/2015-12/2016**	**01/2017-12/2019**	**01/2020 and beyond**
Airspace	FL355 to FL460	FL355 to FL460	FL355 to FL460
Time Availability	2100-0400 UTC	(a) H24 (b) 2100-0400 UTC	H24
Objectives	Implementation of DRA within HELLAS UIR from specific published entry-to specific published exit points	(a) Enhanced DRA implementation (b) FRA Implementation	Full FRA implementation

Table 25 : Terminal Areas and Performance Indicators

Apart from establishment of DCT routes and Free Route (FRA), PBN procedures are already being applied to Kerkira & Heraklion airports while they are going to be applied into Santorini and Mikonos airports. In addition within Blue GNSS project, RNP approach procedures have been validated during the period August -October 2017, for Mitilini, Thessaloniki, Kos & Ioannina TMAs and the corresponding AIP publication is planned by end 2018. Furthermore, Greece has defined a KPI (Route improvement indicator (RII) as fraction with nominator, total sum of distance route and denominator total sum of initial distance according to Flight Plan. According to the results referred to 42 DCTs within Hellas UIR, the value of RII is 1.54% representing the percentage of shortened routes as well as the corresponding impact on fuels and CO2 etc.

Furthermore, with the new DCTs implementation in Greece and Cyprus, along with the gradual implementation of multiple DCTs connecting City Pairs among airports in the BLUE MED FAB airspace and close to the boundaries lead to 31,24 % reduction in the network, saving 564.500 NM, 3.960 Tones of fuel and 12.500 tones of CO2, over Greek airspace

3.3. AIRCRAFT RELATED TECHNOLOGY

Greek Aircraft Operators initiatives to improve fuel efficiency

Environmental protection is a matter of great importance to Greek Aircraft Operators[37]. Various departments work together efficiently in order to achieve best possible results in environmental management with the goal to annually reduce fuel consumption and improve efficiency. In the following section we present Greek Operators efforts to reduce emissions and update best performance practices and procedures, in order to comply with current environmental management initiatives.

Fleet modernization

For Aegean, its commitment to improve the environmental management is demonstrated by the average fleet age, which is one of the youngest in Europe, as presented in Figure 17.

[37] Aegean Airlines, Astra Airlines, Ellinair, Gainjet, Olympic Air, Sky Express, Swiftair and others

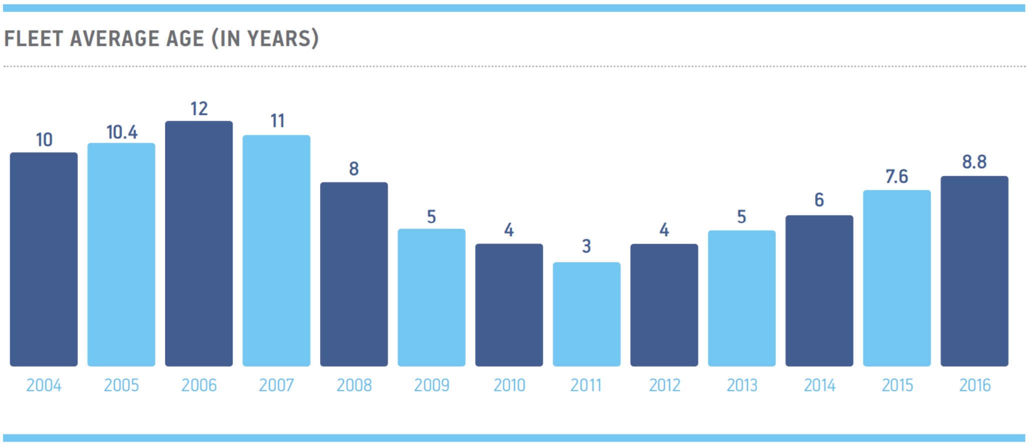


Figure 17 : Aegean's Fleet Average Age

Aegean fleet consists mainly of new generation A320 aircraft equipped with the latest technology engines. As a part of its strategic development, the company invests in evolving technologies by increasing its size of its fleet. The seven new ceo a/c delivered 2015 & 2016 have Sharklets, which on longer routes can provide significant fuel burn savings (up to 4% according Airbus) and all engines are upon production of the SelectTwo model (up to 1% savings in fuel burn vs SelectOne) and also have the Reduced Ground Idle (RGI) option activated which offers additional fuel savings on ground and less Breaks usage. Additionally, Aegean expects the phase out of the A320ceo Family fleet starting end of 2019 / Q1 2020 and until 2024/25 with A320neo and A321neo, ref recent order to Airbus (MOU with Airbus) and ongoing discussions for certain additional direct Operating leases (positions in 2019/20/21).

On the same path other Aircraft Operators like Astra Airlines, Ellinair, Olympic Air, Sky Express are planning to enhance and increase their fleet in the coming years.

Flight Procedures

All aircraft operators have adopted procedures recommended from International Organizations, the aircraft manufacturer and aviation industry always in cooperation with Air Traffic Control in order to improve fuel efficiency and reduce CO_2 emissions. Some of the techniques to improve environmental management are flying techniques during approach, taxiing procedures before takeoff and after landing, careful use of the aircraft's auxiliary power unit while on the ground and takeoff profiles. The fuel savings resulting from the use of these techniques amounts to 350 tn of CO_2 per month.

Annual CO_2 Emission Savings: 350 t CO_2 X 12 = 4200 t CO_2 / year

Route optimization

Most aircraft operators have improved operational performance by acquiring flight planning system software, which contributes significantly to the improvement of environmental management and reduces CO_2 emissions. Moreover, most of the aircraft documentation, essential for pilots and cabin crews, is available in electronic form.

Annual CO_2 Emission Savings: 800 t CO_2 X 12 = 9600 t CO_2 / year

Aircraft Weight Reduction

Aegean Airlines has introduced weight reduction initiatives that result in positive economic and ecological impact:

• By investing in new seats that are lighter and more anatomic. The new seats have been installed to all A320 and A321 aircraft. The result is that around 450 tonnes of CO_2 are conserved every month.

• New lightweight trolleys have been utilized to all aircraft. Consequently, carbon footprint has been reduced by around 50 tonnes of CO_2 every month.

• Optimized quantity of potable water needed for each flight. The environmental impact of this initiative reduces CO_2 emissions by around 40 tonnes every month.

• Reduction in fuel consumption on aircraft due to reduced weight through the elimination of the bulky manuals that are no longer carried on board which corresponds to 15 tonnes of CO_2 per month.

Annual CO_2 Emission Savings: 555 t CO_2 X 12 = 6660 t CO_2 / year

Aircraft Engine Washes

Aegean Airlines Technical department is performing engine pure water washes on a regular basis using an eco-friendly engine wash system. Dust, pollen, sand, salt, chemicals, hydrocarbons and insects pollute an engine over the course of time, thereby reducing its performance. To maintain the same performance, the engine consumes more fuel and its exhaust gases are also hotter. After washing, an engine regains its performance and fuel consumption is reduced. The eco-wash system enables Aegean to perform regularly engine washes without environmental penalties since the water that is used for the engine wash is collected behind the engine and recycled as per the established environmental procedures of the airport.

Noise Reduction

Noise caused by aircraft is one of the leading concerns in the operation of airline companies. Aegean Airlines conforms to the noise specifications of each airport as aircraft are equipped with new generation turbofan engines so that the area around them is not disturbed by passing airplanes. Furthermore, Flight Operations in order to further improve the environmental management of the company has designed takeoff profiles that produce less noise.

Total Greek Operators CO_2 Emission Savings: 20460 t CO_2 / year **or** **2,2 % Annual CO_2 Emission Savings**

3.4. ECONOMIC/MARKET-BASED MEASURES

Aviation in Emissions Trading System (EU ETS)

From 1 January 2012 the EU ETS includes also aviation emissions (according to Directive 2008/101/EC, which amends Directive 2003/87/EC). These aircraft operators have been assigned to an administrating EU Member State.

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

In line with the legislation, the Greek part of the Union Registry is managed by the Office for Greek Greenhouse Gas Emissions Allowances which also serves as a contact point for national and international authorities. The Office for Greek Greenhouse Gas Emissions Allowances is also responsible for the operational management of the registry and provides account holders with the required information and support.

Since the start of 2012 emissions from all flights from, to and within the European Economic Area (EEA) - the 28 EU Member States, plus Iceland, Liechtenstein and Norway - are included in the EU Emissions Trading System (EU ETS). The legislation, adopted in 2008, applies to EU and non-EU airlines alike.

The Commission has updated the list of aircraft operators covered by the EU Emissions Trading System (ETS). This annual update provides information on which Member State regulates a particular operator if it comes under the scope of the EU ETS. Only around 600 aircraft operators are covered by the system in 2013-2016. These are mostly commercial aircraft operators, as all non-commercial aircraft operators emitting less than 1000 tonnes CO_2 have been temporarily exempted by Regulation No. 421/2014.

The allocations of free allowances to these around 600 operators have been published on Member States' websites. Table 26 presents the allocation of free allowances to aircraft operators, as amended to the annual allowances to be allocated for the period 2013- 2016 in Greece.

Aircraft Operator Name	Annual Greenhouse Gas Emissions Allowances		Total Allocation for 2013-2020
	2012 Allocation of Allowances	Allocation of Allowances for 2013-2020	
AEGEAN AIRLINES S.A.	444.592	420.057	3.360.455
ASTRA AIRLINES S.A.	3.876	3.663	29.300
Cassel Invest Limited	14	13	108
CJSC "AEROSVIT AIRLINES"	29.930	28.278	226.227
COSTAIR	15	14	112
First Airways	22	21	168
Jadayel Aviation Ltd	8	7	58
Kenrick Ltd	23	22	178
OXY USA	47	44	354
OLYMPIC AIR	234.373	221.439	1.771.511
JSC "Orenburg Airlines"	29.387	27.765	222.123
S&K Bermuda Ltd	159	150	1.198
SKY EXPRESS S.A.	4.647	4.390	35.123
Universal Air Link Inc	21	20	160
Yamal	7.297	6.895	55.157
GREENLEAF CORPORATION	2	2	14

Table 26 : EU ETS allocations of free allowances in Greece

3.5. ALTERNATIVE FUELS

The Greek legislation for biofuels has adopted the EU Directive 2003/30/EC since 2005 by the Law 3423/2005 “Insertion of biofuels and other alternative fuels in the Greek market”.

The distribution of biodiesel in Greek is implemented through the refineries. There is a specific procedure that defines the biodiesel quantities which every biodiesel company can sell to the refineries. Biodiesel is mixed with diesel and is distributed to the petrol stations and finally to the end users.

The current law imposes the obligatory use of all detaxed biodiesel in the existing refineries (in an up to 7% blend). Detaxed quantities are decided on an annual basis under a quota scheme.

Since 2001 in Athens there are two CNG filling (refueling) stations in Athens for serving the public gas vehicle fleet (manly buses). The geo-information system European Environmental Atlas lists 18 LPG fuelling stations on Greek mainland (10 in the wider Athens region and 5 in the Thessalonica region) as well as two on the Island of Crete. Also one hydrogen refueling station in installed in CRES demonstration wind park.

Biofuels in Greece (biodiesel and bioethanol) are produced from a variety of energy crops, of which the output per acre varies depending on the type of crop and cultivation method used.

In 2015, a new Directive has been approved for the Deployment of Alternative Fuels Infrastructure, which aims to minimize oil dependence for the transport sector and mitigate its environmental impact, ensuring the build-up of alternative fuels infrastructure and the implementation of common technical specifications for this infrastructure in the European Union.

Regarding the use of alternative fuel (biofuel) in aviation,
an interest from Greek Aircraft Operators has been expressed, inasmuch that their use is assured by technology, there is adequate production, and the use is cost effective.

3.6. AIRPORT IMPROVEMENTS:

3.6.1. CONTRIBUTION OF ATHENS INTERNATIONAL AIRPORT

Athens International Airport (AIA) began operation in 2001. It is Greece's busiest airport with 37% of Total Passenger traffic and it serves as the hub and main base of Aegean Airlines, Olympic Air as well as other Greek airlines. The airport is owned by Public/Private consortium and as of 2014, it is the 31st busiest airport in Europe.

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

- Annual Report: https://www.aia.gr/ebooks/annualreport/ar2016/mobile/index.html
- Corporate Responsibility Report: https://www.aia.gr/ebooks/csr/2016/en/mobile/index.html
- Care for the Environment -- an annual publication dedicated entirely to environmental issues) : https://www.aia.gr/company-and-business/the-company/Corporate-Publications/enviroment
- Green Care -- a new annual publication entitled distributed to passengers and visitors

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).

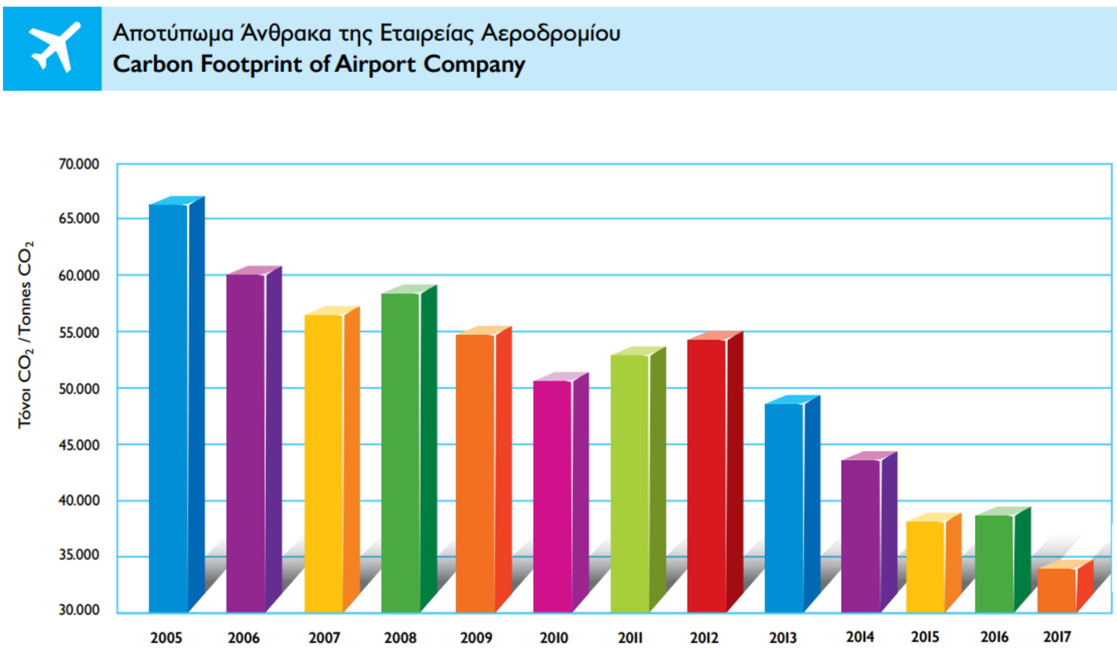


Figure 18: AIA's Historic Performance of Carbon Footprint

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 has organized a number of training sessions with guidance on how to construct carbon footprints, which emission factors to use, etc. Up to now, 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. CO_2 emissions from each activity are calculated using the emission factors provided in the Airport Carbon Accreditation guidance and, in the case of electricity and natural gas, specific emission factors for Greece are calculated and applied. In line with the requirements of the program, AIA's annual CO_2 emissions are verified by an external auditor.

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

And last but not least, in 2017 AIA was certified per the Energy Management Standard ISO 50001 for the operation and maintenance of assets and systems pertaining to its activities. Thus, AIA has become one of the few airports worldwide certified according to ISO 50001. The certification is the capping stone symbolising AIA's dedication to energy efficiency.

AIA's conferences/workshops/training

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

Moreover, a significant effort has been made to increase corporate awareness regarding climate change, specifically through multiple showings of Al Gore's award-winning film An Inconvenient Truth to top level management and staff.

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

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

Regarding Third Parties, AIA works closely with them in order to raise awareness and improve environmental protection and performance across the airport site. This applies not only to the issue of carbon management, but also to other environmental aspects such as proper waste management, recycling, legal compliance, etc. In this framework, there is on-going environmental awareness training to Third Parties which also includes site tours. Since the airport opening, representatives from over 120 companies have attended such training sessions.

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

In 2017, two more workshops were organized:

• One in September on ‘Climate Change Adaptation at the Airport’, in which 52 participants from the airport, the scientific community and the authorities took part. The invited speakers – mainly from the academic and research field – made presentations related to how the climate in Greece and especially in Athens is expected to change over the next 50-100 years and how these changes in climate may affect AIA and its connected infrastructure. The outcome of the workshop will be used in the first Climate Change Adaptation Study planned for 2018.

• One in December on ‘Sustainability’, with the participation of 49 members of the airport community. During the workshop, the first Third Party Environmental Excellence Award was presented to Olympic Fuel Company in recognition of its excellent performance and cooperation with all stakeholders, thus contributing to minimizing the impact of its operations on the environment.

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

Airport improvements

In the context of AIA's Climate Change Corporate Action Plan, which consists of measures to reduce consumption of electricity, natural gas and vehicle fuels (gasoline, diesel, LPG) 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 2017
AIA has managed to reduce its carbon footprint
(Scope 1 & 2) by 47%

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

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

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

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

Figure 19: AIA's 8MWp Photovoltaic Park

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

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

Finally, the average electricity consumption per passenger is annually decreasing as listed in figure 20.

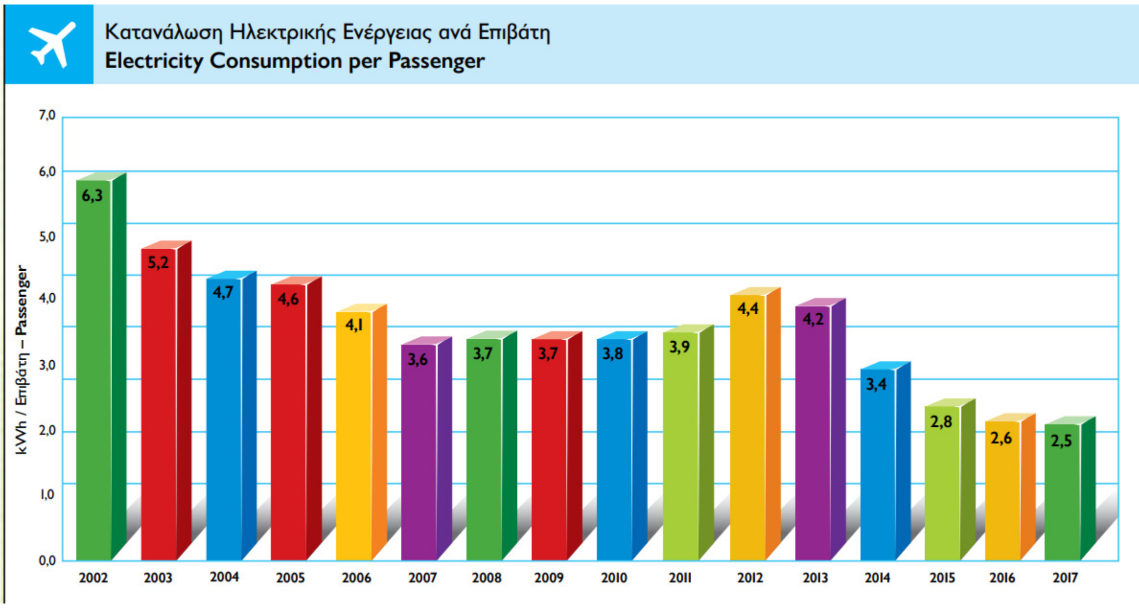


Figure 20: AIA's Annual electricity consumption per passenger

In the framework of AIA's efforts to promote use of cleaner energy sources, in 2017 a meeting was held with Olympic Fuel Company to discuss the possibility of the deployment of sustainable aviation fuel at the airport.

Improved transportation to and from airport

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

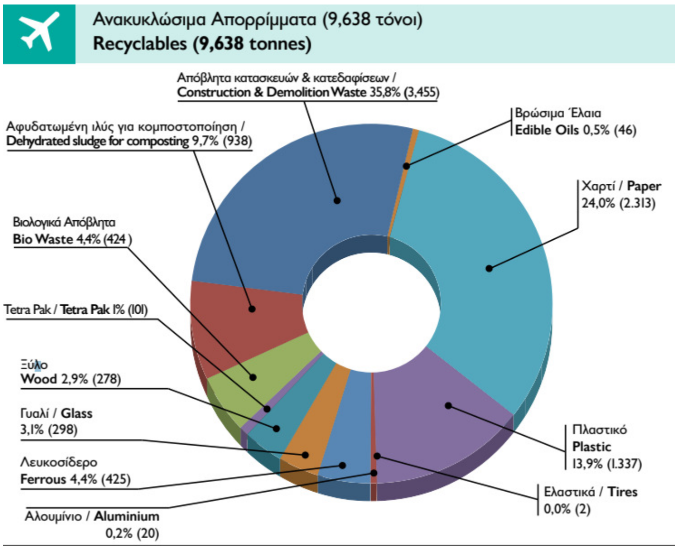
- Collaboration with surface transport organizations to provide special incentives to airport employees that use mass transit
- Special incentives to promote environmentally-friendly means of transport to/from work such as staff coaches, financial incentives for staff that carpool, subsidy of the use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

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.

AIA implements an annual Environmental Plan consisting of Environmental Management Programs with medium- and long-term targets for all environmental aspects. AIA is one of very few airports worldwide that monitors air quality both inside and outside the airport fence. Measures are taken to reduce emissions of air pollutants of concern for local air quality as well as climate change, including a series of successful initiatives to reduce energy and fuel consumption in airport buildings as well as mobile and stationary equipment.

Noise Abatement Procedures have been developed with and are implemented in collaboration with relevant stakeholders. We maintain an active dialogue with local communities 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 our Noise Monitoring System.



AIA established an integrated waste management system based on the "Polluter Pays" principle, with economic incentives for companies that recycle. This combined with awareness, training and other initiatives has helped us increase our recycling rate from 3% in 2001 when the airport opened to 61% in 2017. AIA has increased the recycling rate for all solid non hazardous waste analyzed in a pie chart besides.

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

3.6.2. Contribution of 14 international airports operated by Fraport Greece

Fraport Greece (FG) was created in 2015 and is responsible for maintaining, operating, managing, upgrading and developing 14 regional airports in Greece over a period of 40 years. The operational transfer of the airports to FG took place on April 11th, 2017. The Management of FG has adopted an integrated environmental policy for headquarters and airports, having defined environmental and social protection as one of our main company goals. As a result, energy conservation aspects have already incorporated in the design of the refurbishment, expansion or remodeling works in all of 14 airports.

The main measures that are under implementation (as applicable) are the following:

- Terminal use minimization during winter period by isolating unnecessary parts of the buildings with minimal use.
- Protection of the building against outdoor adverse conditions by enhancing shell insulation specification, solar protection glazing and / or external shading.
- Use of natural light preferred where possible.
- High efficiency chilled and hot water production equipment.
- Adjustable energy consumption to variable load demand (variable flow systems).
- Energy recovery systems in the air-handling units' design and free cooling and night cooling mode concepts.
- Installation of active power harmonic filters.
- Upgrade to low energy consuming lighting fixtures and automated lighting controls.
- Energy Management System in connection for monitoring energy consumption, providing trends and correlation data and introducing effective related controls.
- Energy Balance report as design deliverable that will constitute the baseline for the elaboration of the Energy Management System.

FG Development of Carbon footprint and targets

The traffic forecast for FG airports according to the Master Plan forecasts an average growth rate of passenger traffic at approximately 1.9% per annum while the forecasted Air Traffic Movements (ATM's) show the same tendency. Nevertheless of the increase in the volume of the air traffic FG aims to minimize the increase or even to reduce CO2 emissions caused by the operation of the airports.

FG aims to join Airport Carbon Accreditation scheme as one of its short-term goals (within the next 3 years). The entry point to the scheme recognizes that an airport is quantifying and externally verifying its carbon footprint. FG will calculate the carbon emissions of all 14 airports from sources over which it has control (Scope 1 and 2), including those arising from:

- Stationary sources (scope 1): Boilers, furnaces, burners, engines, firefighting exercises, generators etc.
- Mobile sources (scope 1): automobiles (airside/landside), trucks, employee cars etc.
- Indirect emissions (scope 2): Emissions from purchased electricity.
- Upon completion of Imminent Works and verification of CO2 emissions, FG will develop an action plan for carbon management plan in order to reduce every airport's carbon footprint.

3.7. GREECE BASELINE SCENARIO & EXPECTED RESULTS

Aviation activity and associated fuel use data for years 2013 - 2050 have been requested from Greek Airline Operators and stakeholders, so as to analyse and demonstrate continued progress towards reducing GHG emissions. Air carriers reported domestic and international data, according to ICAO definitions and future projections have been made by Environmental Section of HCAA for Baseline Scenario without any measures taken, as illustrated below in tables 25 & 26:

GREEK OPERATORS BASELINE WITHOUT MEASURES							
Year		Total (Int+Dom) Flight Services			International Flights		
		Fuel Burn (tons)	Traffic RTK (Revenue tonne-kilometre)	CO2 emissions (tons)	Fuel Burn (tons)	Traffic RTK (Revenue tonne-kilometre)	CO2 emissions (tons)
HIstoric Data	2013	333.861	997.759.809	1.055.000	181.962	559.527.479	575.000
	2014	356.013	1.130.191.769	1.125.000	208.861	668.868.769	660.000
	2015	381.741	1.174.713.526	1.224.347	274.206	909.204.280	858.037
	2016	407.913	1.283.501.531	1.284.964	294.420	1.012.496.161	921.577
	2017	415.888	1.392.098.493	1.310.370	303.464	1.100.456.861	950.093
Forecast Data	2020	470.535	1.559.150.312	1.486.890	339.879	1.232.511.684	1.074.019
	2030	611.695	2.026.895.405	1.932.957	441.843	1.602.265.189	1.396.224
	2040	734.034	2.432.274.486	2.319.548	530.212	1.922.718.227	1.675.469
	2050	880.841	2.918.729.383	2.783.458	636.254	2.307.261.872	2.010.563

Table 25 & 26: Baseline Scenario without any measures taken

EFFICIENCY INDEX WITHOUT MEASURES					
Year		Total (Int+Dom) Flights		International Flights	
		Fuel/RTK	CO2 /RTK	Fuel/RTK	CO2 /RTK
HIstoric Data	2013	0,33	1,06	0,33	1,03
	2014	0,32	1,00	0,31	0,99
	2015	0,32	1,04	0,30	0,94
	2016	0,32	1,00	0,29	0,91
	2017	0,30	0,94	0,28	0,86
Forecast Data	2020	0,30	0,95	0,28	0,87
	2030	0,30	0,95	0,28	0,87
	2040	0,30	0,95	0,28	0,87
	2050	0,30	0,95	0,28	0,87

EXPECTED RESULTS OF MEASURES TAKEN

Table 27 illustrates the combined results for Greek air carriers for historic years 2013 to 2017 and Forecast data up to year 2050 when additional efficiency measures are going to be taken, in order to minimize aviation carbon footprint, where RTK (Revenue tonne-kilometre), fuel consumption and its conversion to GHG emissions are expressed in CO_2 emissions.

GREEK OPERATORS IMPLEMENTED MEASURES SCENARIO							
Year		Total (Int+Dom) Flights			International Flights		
		Fuel Burn (tons)	Traffic RTK (Revenue tonne-kilometre)	CO2 emissions (tons)	Fuel Burn (tons)	Traffic RTK (Revenue tonne-kilometre)	CO2 emissions (tons)
Historic Data	2013	333.861	997.759.809	1.055.000	181.962	559.527.479	575.000
	2014	356.013	1.130.191.769	1.125.000	208.861	668.868.769	660.000
	2015	381.741	1.174.713.526	1.224.347	274.206	909.204.280	858.037
	2016	407.913	1.283.501.531	1.284.964	294.420	1.012.496.161	921.577
	2017	415.888	1.392.098.493	1.310.370	303.464	1.100.456.861	950.093
Forecast Data	2020	459.268	1.559.150.312	1.451.286	329.785	1.232.511.684	1.042.119
	2030	564.420	2.026.895.405	1.783.567	399.595	1.602.265.189	1.262.720
	2040	677.304	2.432.274.486	2.140.280	479.514	1.922.718.227	1.515.264
	2050	812.764	2.918.729.383	2.568.336	575.417	2.307.261.872	1.818.317

Table 27: Baseline Scenario with Expected Results

Revenue RTK during 2017 was 1,387 billion in total flights (1,1 billion RTK in International Flights) and presented an increase of 10% related to previous year. CO2 emissions during 2017 was 1,304 million tons (0,95 million tons for International Flights) and presented an increase of only 4% 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.

Efficiency Indexes and ratios in tons of fuel and tons of CO2 per RTK with slightly rounded figures are presented in table 28. For International flights, we can notice the following:

- The fuel consumption rate in International flights was 0,28 tons per RTK in 2017, which is an average annual improvement between 2013 and 2017 of 3%.
- CO2 emissions per RTK during 2017 was 0,86 which exhibits a decrease of 5 % versus previous year performance.

Finally, the comparison Graph of Basic Scenario with already taken measures versus the scenario with additional implemented measures expected to be applied in the future is presented in Figure 21.

EFFICIENCY INDEX WITH IMPLEMENTED MEASURES							
Year		Total Flight Services		International Flights		Domestic Flights	
		Fuel/RTK	CO2 /RTK	Fuel/RTK	CO2 /RTK	Fuel/RTK	CO2 /RTK
HIstoric Data	2013	0,33	1,06	0,33	1,03	0,35	1,10
	2014	0,32	1,00	0,31	0,99	0,32	1,01
	2015	0,32	1,04	0,30	0,94	0,41	1,38
	2016	0,32	1,00	0,29	0,91	0,42	1,34
	2017	0,30	0,94	0,28	0,86	0,39	1,24
Forecast	2020	0,29	0,93	0,27	0,85	0,40	1,25
	2030	0,28	0,88	0,25	0,79	0,39	1,23
	2040	0,28	0,88	0,25	0,79	0,39	1,23
	2050	0,28	0,88	0,25	0,79	0,39	1,23

Table 28: Efficiency Metrics with Expected Results

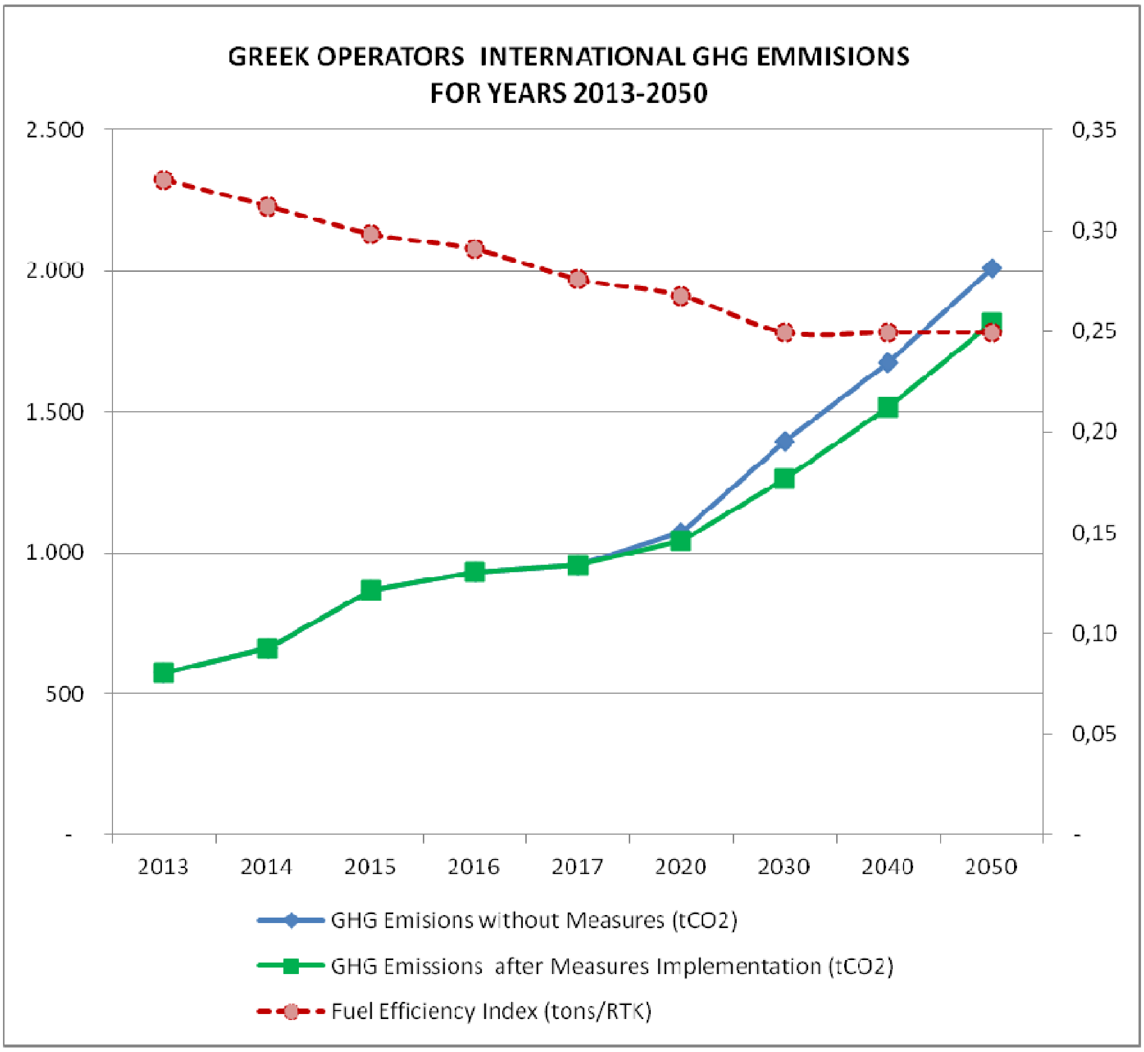


Figure 21: Basic Scenario and Measures Taken Scenario Comparison Graph

SECTION 4: CONCLUSION

The Action Plan provides an overview of the actions undertaken by Greece in order to mitigate climate change and to develop a resource efficient, competitive and sustainable aviation system.

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

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

The National Actions of this Action Plan were updated and finalised on July 2018, and will be considered as subject to updating after that date.

APPENDIX A – DETAILED RESULTS FOR ECAC SCENARIOS FROM SECTION 2

1. BASELINE SCENARIO (technology freeze in 2010)

a) International passenger and cargo traffic departing from ECAC airports

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres[38] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[39] FTKT (billion)	Total Revenue Tonne Kilometres[42, 40] RTK (billion)
2010	4.6	1,218	0.20	45.4	167.2
2016	5.2	1,601	0.21	45.3	205.4
2020	5.6	1,825	0.25	49.4	231.9
2030	7.0	2,406	0.35	63.8	304.4
2040	8.4	2,919	0.45	79.4	371.2

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

b) Fuel consumption and CO_2 emissions of international passenger traffic departing from ECAC airports

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Well-to-wake CO_2e emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	37.98	120.00	147.3	0.0310	0.310
2016	46.28	146.26	179.6	0.0287	0.287
2020	49.95	157.85	193.8	0.0274	0.274
2030	61.75	195.13	239.6	0.0256	0.256
2040	75.44	238.38	292.7	0.0259	0.259
For reasons of data availability, results shown in this table do not include cargo/freight traffic.					

[38] Calculated based on 98% of the passenger traffic for which sufficient data is available.

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

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

2. IMPLEMENTED MEASURES SCENARIO

2A) EFFECTS OF AIRCRAFT TECHNOLOGY IMPROVEMENT AFTER 2010

Fuel consumption and CO_2 emissions of international passenger traffic departing from ECAC airports, with aircraft technology improvements after 2010 included:

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Well-to-wake CO_2e emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	37.98	120.00	147.3	0.0310	0.310
2016	46.28	146.26	179.6	0.0286	0.286
2020	49.08	155.08	190.4	0.0270	0.245
2030	58.65	185.34	227.6	0.0247	0.247
2040	68.99	218.01	267.7	0.0242	0.242
For reasons of data availability, results shown in this table do not include cargo/freight traffic.					

2B) EFFECTS OF AIRCRAFT TECHNOLOGY AND ATM IMPROVEMENTS AFTER 2010

Fuel consumption and CO_2 emissions of international passenger traffic departing from ECAC airports, with aircraft technology and ATM improvements after 2010:

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Well-to-wake CO_2e emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	37.98	120.00	147.3	0.0310	0.310
2016	46.24	146.11	179.4	0.0286	0.286
2020	49.03	154.93	190.2	0.0245	0.245
2030	57.38	181.33	222.6	0.0242	0.242
2040	67.50	213.30	261.9	0.0237	0.237
For reasons of data availability, results shown in this table do not include cargo/freight traffic.					

2C) EFFECTS OF AIRCRAFT TECHNOLOGY AND ATM IMPROVEMENTS AND ALTERNATIVE FUELS

Fuel consumption and CO_2 emissions of international passenger traffic departing from ECAC airports, with aircraft technology and ATM improvements as well as alternative fuel effects included:

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Well-to-wake CO_2e emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	37.98	120.00	147.3	0.0310	0.310
2016	46.24	146.11	179.4	0.0286	0.286
2020	49.03	154.93	187.9	0.0245	0.245
2030	57.38	181.33	199.5	0.0242	0.242
2040	67.50	213.30	214.8	0.0237	0.237
For reasons of data availability, results shown in this table do not include cargo/freight traffic.					
Note that fuel consumption is assumed to be unaffected by the use of alternative fuels.					

LIST OF ABBREVIATIONS

ACARE – Advisory Council for Research and Innovation in Europe
ACARS – Aircraft Communications Addressing and Reporting System
ACA – Airport Carbon Accreditation
ACC – Area Control Centres
ACCAPEG – Aviation and Climate Change Action Plan Expert Group
ACI – Airports Council International
APER TG - Action Plans for Emissions Reduction Task Group of the ECAC/EU Aviation and Environment Working Group (EAEG)
EAER – European Aviation Environmental Report
AEM – Advanced Emission Model
AFTF – Alternative Fuels Task Force (of ICAO CAEP)
AIA – Athens International Airport
AIRE – The Atlantic Interoperability Initiative to Reduce Emissions
ANS – Air Navigation Service
ATC – Air Traffic Control
ATM – Air Traffic Management
BAU – Business as Usual
CAEP – Committee on Aviation Environmental Protection
CCD – Continuous Climb Departures
CDA – Continuous Descent Approach
CDM - Collaborative Decision Making

CDA – Continuous Descent Approach
CDO - Continuous Descent Operations
CNG – Carbon neutral growth
CORSIA - Carbon Offsetting and Reduction Scheme for International Aviation
CPDLC – Controller-Pilot Data Link Communications
EASA – European Aviation Safety Agency
EC – European Commission
ECAC – European Civil Aviation Conference
EEA – European Economic Area
EFTA – European Free Trade Association
EU – European Union
EU ETS – the EU Emissions Trading System
FAB – Functional Airspace Block
FANS – Future Air Navigation System
FP7 - 7^{th} Framework Programme
GHG – Greenhouse Gas
GMBM – Global Market-based Measure
Green STAR – Standard Arrival
Green IA – Initial Approach
HCAA – Hellenic Civil Aviation Authority
HVO – Hydro-treated Vegetable Oil
ICAO – International Civil Aviation Organisation
IFR – Instrumental Flight Rules
IPCC – Intergovernmental Panel on Climate Change
IPR – Intellectual Property Right
JTI – Joint Technology Initiative
LTO cycle – Landing/Take-off Cycle
MBM – Market-based Measure
MT – Million tonnes
OFA - Operational Focus Area
RED – Renewable Energy Directive
RNAV – Area Navigation
RNP AR – Required Navigation Performance Authorization Required
RNP STAR – Required Navigation Performance Standard Arrival
RPAS – Remotely Piloted Aircraft
RPK – Revenue Passenger Kilometre
RTK – Revenue Tonne Kilometre
RTD – Research and Innovation
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
SWAFEA – Sustainable Ways for Alternative Fuels and Energy for Aviation
SWIM – System Wide Information Management
TMA - Terminal Manoeuvring Area
ToD – Top of Descent
UNEP – United Nations Environmental Programme