ENTE NAZIONALE PER L'AVIAZIONE CIVILE

ITALY'S ACTION PLAN

ON CO2 EMISSIONS REDUCTION

EDITION 2021

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Table of Contents

1. INTRODUCTION

Italy has been a member of ICAO since its foundation in 1944 and has always been represented in the Part 1 of the Council due to its longstanding engagement in the International Civil Aviation Regulatory body, its important industrial aeronautical achievements, its strong contribution to the development of safe and sustainable Air Transport. Italy has also participated to the CAEP - Committee for Aviation Environmental Protection, consulting Committee of the ICAO Council - since its constitution in 1983. Today, Italy has its experts inside the CAEP groups and task forces. In particular, they have recently contributed to the most challenging CAEP technical analyses such as the Standards on CO_2 and CORSIA. Actually, they are engaged in the amendments of Annex 16 as regards Aircraft Noise certification plus the Standards on Emissions (CO_2 and Particulate matters) and on the recently issued CORSIA scheme.
Italy is also a member of the European Union and of the European Civil Aviation Conference (ECAC). ECAC is an intergovernmental covering the widest grouping of Member States[1] of any European organization dealing with civil aviation. It is currently composed of 44 Member States, and was created in 1955.

ECAC States share the view that the environmental impacts of the aviation sector must be mitigated, if aviation is to continue to be successful as an important facilitator of economic growth and prosperity, being an urgent need to achieve the ICAO goal of Carbon Neutral Growth from 2020 onwards (CNG2020), and to strive for further emissions reductions. Together, they fully support ICAO's on-going efforts to address the full range of those impacts, including the key strategic challenge posed by climate change, for the sustainable development of international air transport.

All ECAC States, as expressed in the 2016 Bratislava Declaration, support CORSIA effective implementation and have effectively engaged in CORSIA from the start of its pilot phase.

Italy, like all of ECAC's 44 States, is fully committed to and involved in the fight against climate change and works towards a resource-efficient, competitive and sustainable multimodal transport system.

Italy has its experts in ECAC environmental Groups (EAEG - European Aviation Environmental Group and the ENVFORUM) whose activities deal with the environmental objectives foreseen by ICAO CAEP groups and TFs and is in charge of framing the European environmental strategy, taking the appropriate actions, following the provisions outlined by the European legislation and policy.

In this light, Italy recognizes the value of each State preparing and submitting to ICAO an updated State Action Plan for CO_2 emissions reductions as an important step towards the achievement of the global collective goals agreed since the 38th Session of the ICAO Assembly in 2013.

In that context, it is the intention that all ECAC States submit to ICAO an Action

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

plan. This is the action plan of Italy.

Italy strongly supports the ICAO basket of measures as the key means to achieve ICAO's CNG2020 target and shares the view of all ECAC States that a comprehensive approach to reducing aviation CO_2 emissions is necessary, and that this should include:

i. emission reductions at source, including European support to CAEP work,

ii. research and development on emission reductions technologies, including public-private partnerships,

iii. the development and deployment of low-carbon and sustainable alternative aviation fuels, including research and operational initiatives undertaken jointly with stakeholders,

iv. improvement and optimisation of Air Traffic Management and infrastructure use within Europe, in particular through the Single European Sky ATM Research (SESAR), and also beyond European borders through participation in international cooperation initiatives; and

v. Market Based Measures, which allow the sector to continue to grow in a sustainable and efficient manner, recognizing that the measures at (i) to (iv) above cannot, even in aggregate, deliver in time the emissions reductions necessary to meet the global goals.

In Europe, many of the actions which are undertaken within the framework of this comprehensive approach are in practice taken collectively, in Europe, most of them led by the European Union. They are reported in Section 3 of this Action Plan, where the involvement of Italy is described, as well as that of other stakeholders

In Italy a number of actions are undertaken at the national level, including those by stakeholders, in addition to the regional ones. These national actions are reported in Section 4 of this Plan.

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

i. The extent of participation will vary from one State to another, reflecting the priorities and circumstances of each State (economic situation, size of its aviation market, historical and institutional context, such as EU/non EU). The ECAC States are thus involved 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. Acting together, the ECAC States have undertaken measures to reduce the region's emissions through a comprehensive approach. Some of the measures, although implemented by some, but not all of ECAC's 44 States, nonetheless yield emission reduction benefits across the whole of the region (for example research, SAF promotion or ETS).

This National Action Plan was finalized in June 2021.
The section 4.2. related to "National actions for sustainable development of Air Transport" may be subject to further update after that date.

2. CURRENT STATE OF AVIATION IN ITALY

ENAC - the Italian Civil Aviation Authority - was established on 25th July 1997 by the Legislative Decree no. 250/97 as the National Authority.
By the wording of its official Mission, ENAC is committed to regulate, control and oversee the field of civil aviation, by promoting the development of the civil aviation sector, in an environmentally friendly framework.
ENAC is engaged in dealing with the diverse regulatory aspects of air transport system and performs monitoring functions related to the enforcement of the adopted provisions, regulating administrative and economical issues. ENAC is also entrusted to provide traffic rights or related authorizations to Air Transport Services according to bilateral or multilateral agreements in force.
Its core business is doubtless represented by safety and security control.
According to its institutional mandate, ENAC performs, in addition to the issues referred to above:

- preliminary inquiries leading to the entrustment to joint-stock companies of concessions for the total management of airports;
- oversight on free access to the market of handling services in national airports;
- regulating procedures of airport services;
- examination and assessment of land use projects and intervention programmes, as well as investments and airport development;
- evaluation of the conditions for warranting the application of State funded fares on certain city pairs;
- certification of personnel operating in the aeronautical/air navigation field;
- enforcement of recommendations issued by the National Flight Safety Agency.

ENAC HQs are in Rome and Representative Offices are located in the major Italian airports.
ENAC is strongly engaged at national and international level in pushing forward decision making processes for an environmental and territory protection policy. This is carried out with a holistic approach and through attentive assessments aiming at limiting the environment impact on airport areas and reducing aircraft noise and emissions pollution.

2.0 Foreword

In 2020 Italian aviation Market experienced the effects of Covid-19 crisis, as described in paragraph 2.3. For this reason 2019 is taken as a reference for the situation before the pandemic. The effects of the pandemic and a forecast of a recovery scenario are outlined in paragraph 2.3

2.1 Airlines

At the date of Feb 1st, 2020, just before the outburst of the Covid-19 crisis, 12 Italian Air Operators had a valid Air Operator Certificate, issued by ENAC, in accordance with Regulation (EU) 965/2012 for airplanes with more than 19 seats capacity:

- Air Dolomiti S.p.A. Linee Aeree Regionali Europee
- AIR ITALY S.p.A.
- ALBA Servizi Aerotrasporti S.p.A.
- Alitalia CityLiner S.p.A.

- Alitalia Società Aerea Italiana S.p.A.
- Blue Panorama Airlines S.p.A.
- ERNEST S.p.A.
- LEADER S.r.l.
- NEOS S.p.A.
- Poste Air Cargo S.r.l.
- Servizi Aerei S.p.A.
- SIRIO S.p.A.

Two of these operators were not active in January 2021, as an effect of the crisis.

Airlines operating in Italy in 2019

According to EU Regulations, any operator from any EU/EFTA Member State has full right to operate domestic and intra EU/EFTA flights, regardless of the country that issued the AOC. Italy is fully integrated in the European Aviation Market.
Extra-European air transport is regulated by bilateral agreements, both traditional (Italy/Third Countries) and European ones, on the basis of the EU External Aviation Policy. Some of them allow the open-skies template and provide for an exchange of fifth freedom traffic rights.
That said, the traffic share of the major airlines operating in Italy, sorted by the total number of passengers transported in 2019, is displayed in the chart below:

	Domestic and International Traffic		
	Airline	**Country**	**Passengers**
1	Ryanair	Ireland	40.527.373
2	Alitalia Società Aerea Italiana S.p.a.	Italy	21.770.174
3	EasyJet Europe Airline Gmbh	Austria	11.818.020
4	Easyjet UK Ltd	United Kingdom	6.416.675
5	Vueling Airlines	Spain	6.387.056
6	Wizz Air Hungary Ltd	Hungary	5.145.132
7	Deutsche Lufthansa AG	Germany	4.287.437
8	Volotea, S.L.	Spain	3.562.495
9	British Airways	United Kingdom	3.516.364
10	Air France	France	3.077.872
11	Eurowings Gmbh	Germany	2.664.186
12	Air Italy S.p.a.	Italy	2.130.856
13	KLM Royal Dutch Airlines	Netherlands	1.994.151
14	Emirates	United Arab Emirates	1.912.055
15	Turk Hava Yollari (Turkish Airlines Co.)	Turkey	1.689.288
16	Air Dolomiti	Italy	1.630.234
17	Iberia - Lineas Aereas De Espana	Spain	1.609.532
18	Neos S.p.a.	Italy	1.583.398
19	Blue Panorama Airlines Spa	Italy	1.393.020
20	Transportes Aereos Portugueses, E.P.	Portugal	1.284.525

Table 1.1.A: Airlines sorted by the total number of passengers transported in 2019. This includes both domestic and international flights. The source is Enac publication "Dati di Traffico", Edition 2019; data source comes from the airport managing company.

	International Traffic Only		
	Airline	**Country**	**Passengers**
1	Ryanair	Ireland	29.231.007
2	Alitalia Società Aerea Italiana S.p.a.	Italy	9.891.008
3	EasyJet Europe Airline Gmbh	Austria	8.966.308
4	Vueling Airlines	Spain	5.938.221
5	Easyjet UK Ltd	United Kingdom	5.715.926
6	Wizz Air Hungary Ltd	Hungary	5.144.968
7	Deutsche Lufthansa AG	Germany	4.287.247
8	British Airways	United Kingdom	3.516.277
9	Air France	France	3.077.671
10	Eurowings Gmbh	Germany	2.664.186
11	KLM Royal Dutch Airlines	Netherlands	1.994.073
12	Emirates	U.A.E.	1.912.055
13	Turk Hava Yollari (Turkish Airlines Co.)	Turkey	1.689.288
14	Air Dolomiti	Italy	1.610.357
15	Iberia - Lineas Aereas De Espana	Spain	1.609.357
16	Neos S.p.a.	Italy	1.484.801
17	Transportes Aereos Portugueses, E.P.	Portugal	1.284.525
18	Aeroflot - Russian Airlines	Russian Fed.	1.279.864
19	Blue Panorama Airlines Spa	Italy	1.210.641
20	Swiss International Air Lines Ltd	Switzerland	1.147.705

Table 1.1.B: Airlines sorted by number of international passengers transported in 2019

	Domestic Traffic Only		
	Airline	**Country**	**Passengers**
1	Alitalia Società Aerea Italiana S.p.a.	Italy	11.879.166
2	Ryanair	Ireland	11.296.366
3	EasyJet Europe Airline Gmbh	Austria	2.851.712
4	Volotea, S.L.	Spain	2.431.025
5	Air Italy S.p.a.	Italy	1.459.489
6	Easyjet UK Ltd	United Kingdom	700.749
7	Blue Air Aviation S.A.	Romania	524.792
8	Vueling Airlines	Spain	448.835
9	Danish Air Transport A/S	Denmark	207.598
10	Blue Panorama Airlines Spa	Italy	182.379
11	Neos S.p.a.	Italy	98.597
12	Alitalia Cityliner S.p.a.	Italy	46.327
13	Alba Star, S.A.	Spain	34.118
14	Bulgaria Air	Bulgaria	21.873
15	Air Horizont	Malta	20.707
16	Air Dolomiti	Italy	19.877

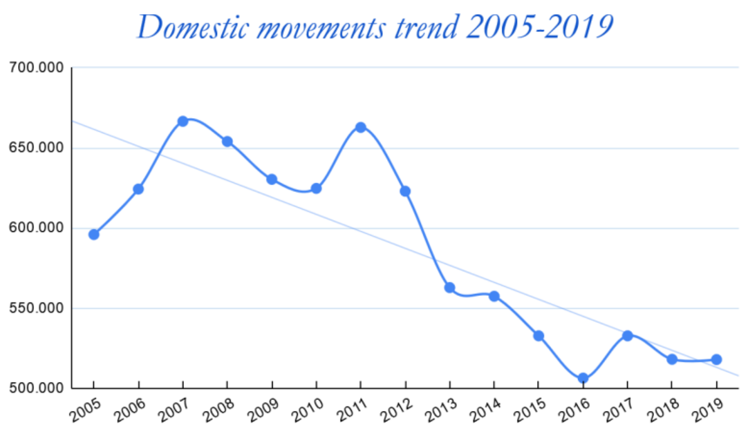
Table 1.1.C: Airlines sorted by number of Domestic passengers transported in 2019

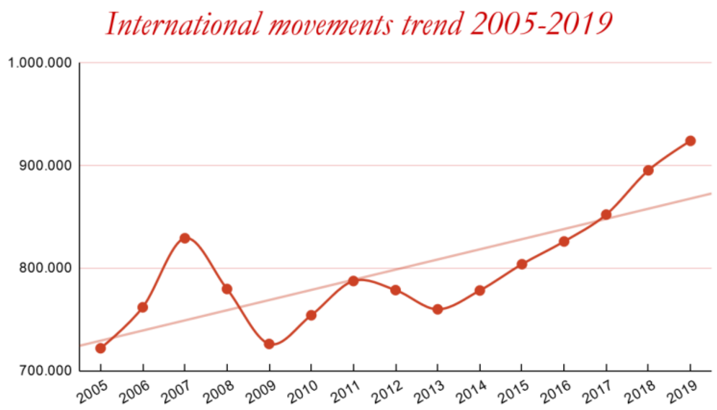
Commercial air carriers - traffic

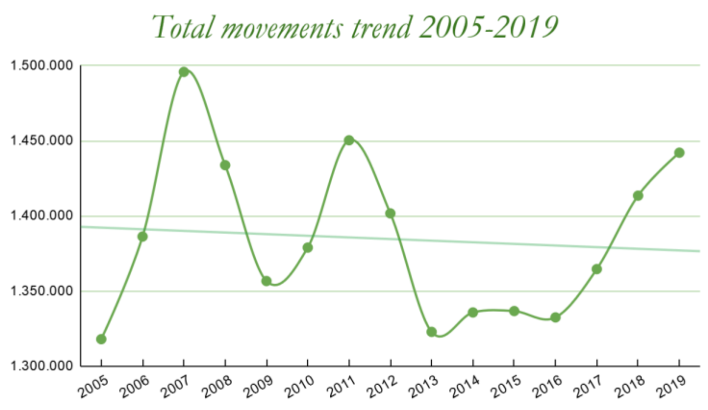
A comparison between the global numbers of movements of 2019 and those of 2015 shows a clear contraction of the domestic traffic, compensated by an increase of the international traffic.
Considering the number of movements of commercial aircraft, 2019 alone was characterized by a small decrease of domestic traffic, and an increase of international traffic, as showed in the charts below.
The number of international movements in 2019 is at its all time high (ATH) of the decade.

Movements (2005-2019)

YEAR	DOMESTIC	Δ%	INTERNATIONAL	Δ%	TOTAL COMMERCIAL	Δ%
2005	595.925	-1,1	721.965	5,9	1.317.890	2,6
2006	624.321	4,8	761.902	5,5	1.386.223	5,2
2007	666.608	6,8	829.257	8,8	1.495.865	7,9
2008	654.006	-1,9	779.777	-6,0	1.433.783	-4,2
2009	630.404	-3,6	726.204	-6,9	1.356.608	-5,4
2010	624.737	-0,9	754.148	3,8	1.378.885	1,6
2011	662.807	6,1	787.535	4,4	1.450.342	5,2
2012	622.979	-6,0	778.684	-1,1	1.401.663	-3,4
2013	562.799	-9,7	759.954	-2,4	1.322.753	-5,6
2014	557.381	-1,0	778.303	2,4	1.335.684	1,0
2015	532.694	-4,4	803.916	3,3	1.336.610	0,1
2016	506.307	-5,0	826.081	2,8	1.332.388	-0,3
2017	512.250	1,2	852.314	3,2	1.364.564	2,4
2018	518.042	1,1	895.424	5,1	1.413.466	3,6
2019	517.891	0,0	924.193	3,2	1.442.084	2,0

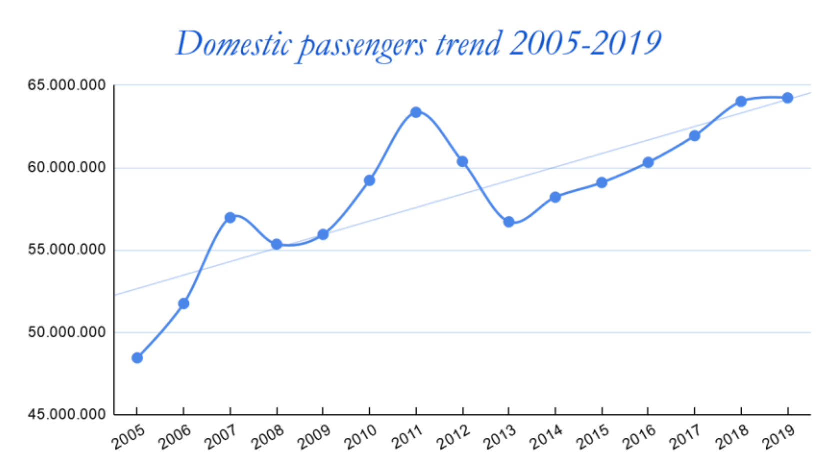


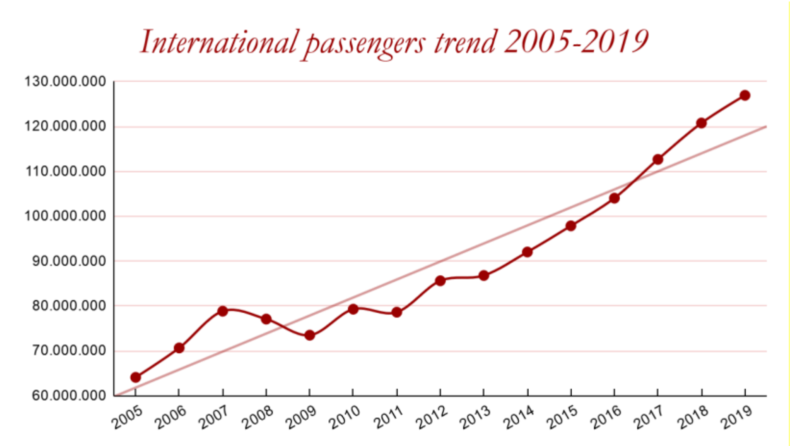




As far as the total traffic of passengers in 2019 registered in Italy was 191,2 millions, of which 126,9 millions international, with origin/destination airports located outside Italy, representing the 66% of the total number. The table below shows a total passenger traffic growth of +22% compared to 2016, with +29% related to international traffic. On the 10 year long period the total increase was +48% (2019 vs 2009), of which more than 50% refers to international traffic. Since 2014 we have observed a positive growth of both domestic and international passengers.

YEAR	DOMESTIC	Δ%	INTERNATIONAL	Δ%	TOTAL COMMERCIAL	Δ%
2005	48.440.901	-0,4	64.095.668	10,6	112.536.569	5,5
2006	51.741.346	6,8	70.657.262	10,2	122.398.608	8,8
2007	56.961.572	10,1	78.847.623	11,6	135.809.195	11,0
2008	55.347.732	-2,8	77.089.380	-2,2	132.437.112	-2,5
2009	55.940.298	1,1	73.501.762	-4,7	129.442.060	-2,3
2010	59.228.056	5,9	79.297.183	7,9	138.525.239	7,0
2011	63.365.984	7,0	78.627.665	-0,8	141.993.649	2,5
2012	60.377.775	-4,7	85.623.008	8,9	146.000.783	2,8
2013	56.704.847	-6,1	86.805.487	1,4	143.510.334	-1,7
2014	58.205.235	2,6	92.037.907	6,0	150.243.142	4,7
2015	59.094.395	1,5	97.870.858	6,3	156.965.253	4,5
2016	60.323.096	2,1	104.045.013	6,3	164.368.109	4,7
2017	61.941.472	2,7	112.686.769	8,3	174.628.241	6,2
2018	64.022.771	3,4	120.788.078	7,2	184.810.849	5,8
2019	64.241.042	0,3	126.965.972	5,1	191.207.014	3,5

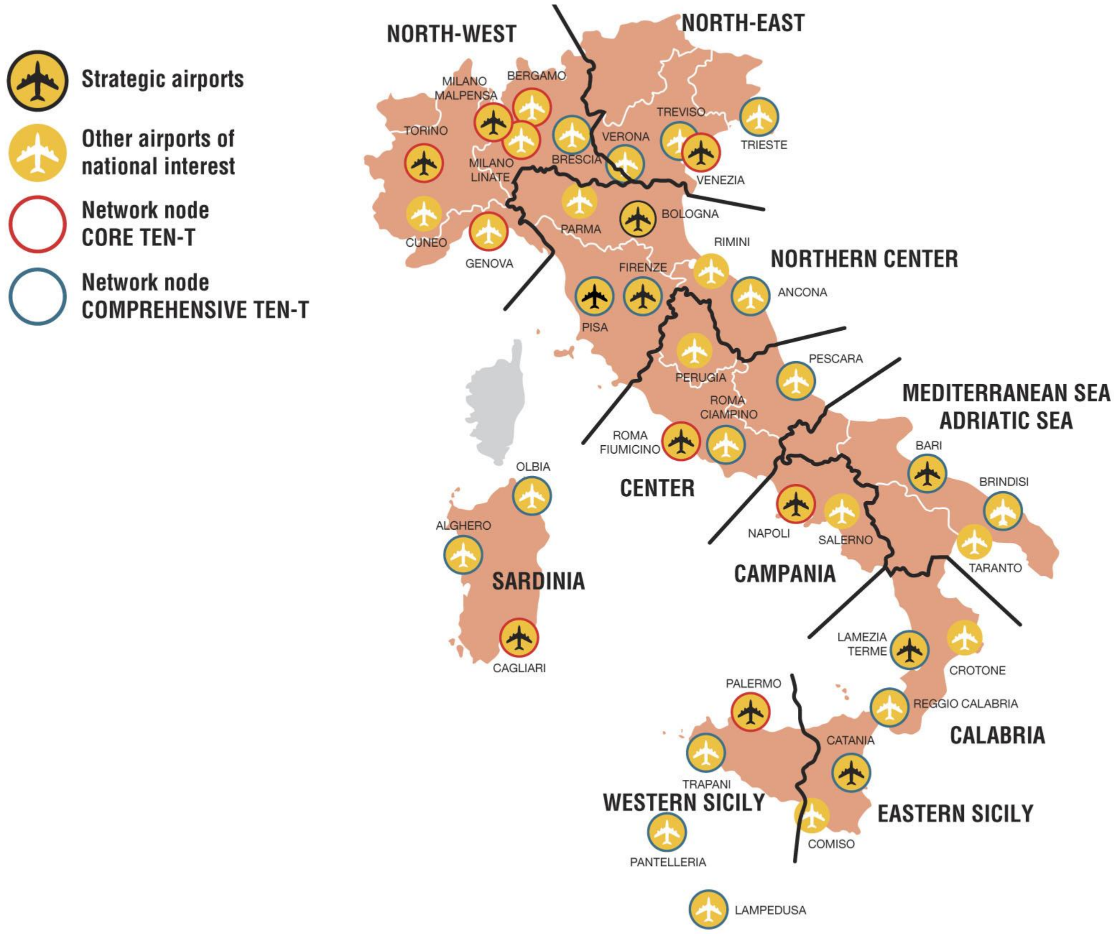




2.2 Airports

Civil airports open to commercial traffic are distributed all over the Italian territory, as illustrated in the map below:

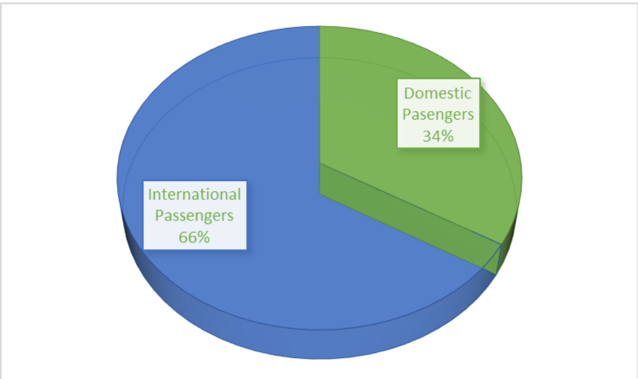
Map of Italian airports open to commercial traffic



The major Italian airport for passenger traffic is Roma Fiumicino, whose traffic volume was higher than 40 million passengers in 2019. Italian airport that registered in 2019 more than 750.000 passengers are listed in the table below:

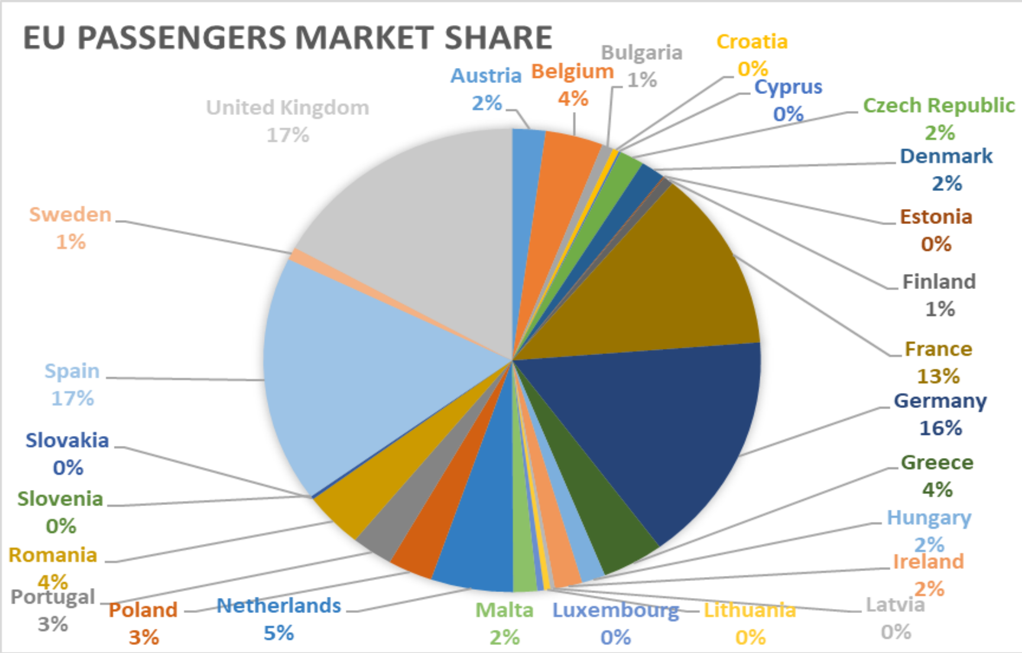
	Airport	Passengers 2019	Domestic Passengers	International Passengers	Share (%)	
					Dom	Int
1	ROMA FIUMICINO	43.354.887	11.051.812	32.303.075	25,5%	74,5%
2	MILANO MALPENSA	28.705.638	5.785.998	22.919.640	20,2%	79,8%
3	BERGAMO	13.792.266	3.479.558	10.312.708	25,2%	74,8%
4	VENEZIA	11.507.301	1.532.577	9.974.724	13,3%	86,7%
5	NAPOLI	10.796.590	3.416.549	7.380.041	31,6%	68,4%
6	CATANIA	10.155.077	6.409.024	3.746.053	63,1%	36,9%
7	BOLOGNA	9.462.808	1.965.539	7.497.269	20,8%	79,2%
8	PALERMO	7.027.567	5.051.799	1.975.768	71,9%	28,1%
9	MILANO LINATE	6.536.914	3.332.406	3.204.508	51,0%	49,0%
10	ROMA CIAMPINO	5.851.821	184.173	5.667.648	3,1%	96,9%
11	BARI	5.363.791	2.921.146	2.442.645	54,5%	45,5%
12	PISA	5.346.624	1.410.395	3.936.229	26,4%	73,6%
13	CAGLIARI	4.760.858	3.374.127	1.386.731	70,9%	29,1%
14	TORINO	3.695.172	1.810.149	1.885.023	49,0%	51,0%
15	VERONA	3.597.869	1.329.842	2.268.027	37,0%	63,0%
16	TREVISO	3.233.483	1.089.319	2.144.164	33,7%	66,3%
17	LAMEZIA	3.117.830	2.320.032	797.798	74,4%	25,6%
18	OLBIA	2.934.290	1.389.297	1.544.993	47,3%	52,7%
19	FIRENZE PERETOLA	2.854.215	378.648	2.475.567	13,3%	86,7%
20	BRINDISI CASALE	2.700.639	1.977.716	722.923	73,2%	26,8%
21	GENOVA SESTRI	1.533.363	750.746	782.617	49,0%	51,0%
22	ALGHERO FERTILIA	1.385.647	982.618	403.029	70,9%	29,1%
23	TRIESTE RONCHI DEI LEGIONARI	779.802	441.856	337.946	56,7%	43,3%

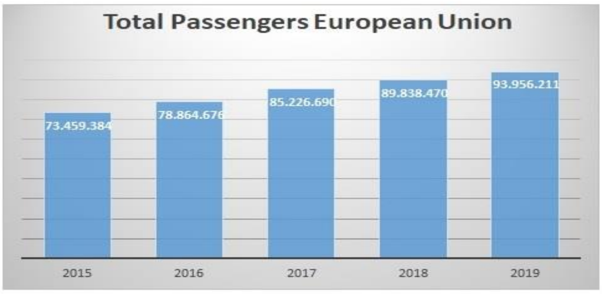
In 2019, the Italian international traffic share reached 66% of the total traffic and registered an additional increase vs. the domestic share, if compared to the previous years.

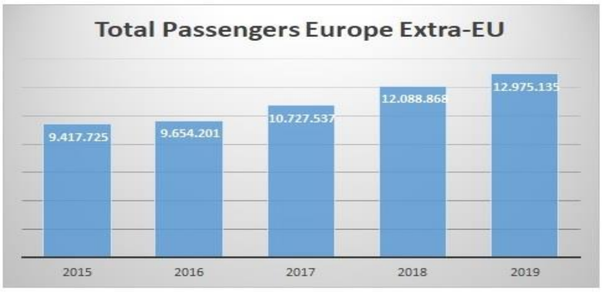


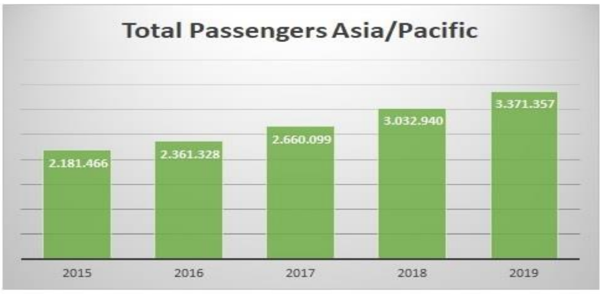
International Domestic Passenger Market Share 2019

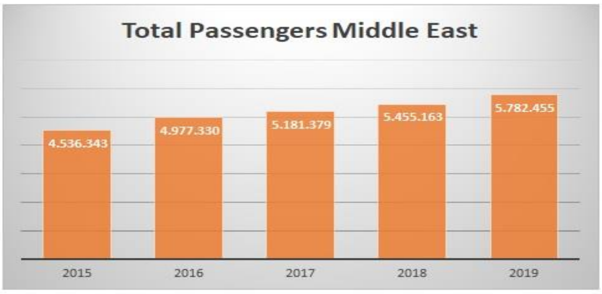
Details on the share of the international passenger traffic by continent are shown in the charts below. EU traffic represents the largest percentage of international traffic with more than 75%. Asia-Oceania and Europe Extra-EU cover around 8%-9% each.

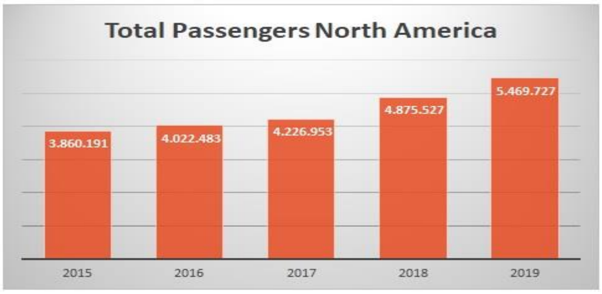

EU PASSENGERS MARKET SHARE
Austria 2%
Belgium 4%
Bulgaria 1%
Croatia 0%
Cyprus 0%
Czech Republic 2%
Denmark 2%
Estonia 0%
Finland 1%
France 13%
Germany 16%
Greece 4%
Hungary 2%
Ireland 2%
Latvia 0%
Lithuania 0%
Luxembourg 0%
Malta 2%
Netherlands 5%
Poland 3%
Portugal 3%
Romania 4%
Slovenia 0%
Slovakia 0%
Spain 17%
Sweden 1%
United Kingdom 17%


Total Passengers European Union
73.459.384
78.864.676
85.226.690
89.838.470
93.956.211
2015
2016
2017
2018
2019

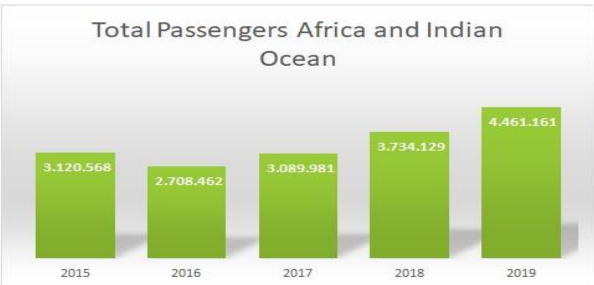

Total Passengers Europe Extra-EU
9.417.725
9.654.201
10.727.537
12.088.868
12.975.135
2015
2016
2017
2018
2019

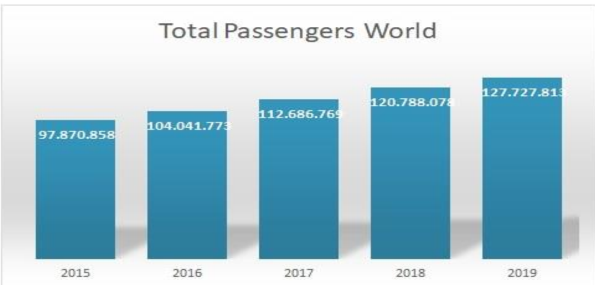

Total Passengers Asia/Pacific
2.181.466
2.361.328
2.660.099
3.032.940
3.371.357
2015
2016
2017
2018
2019


Total Passengers Middle East
4.536.343
4.977.330
5.181.379
5.455.163
5.782.455
2015
2016
2017
2018
2019

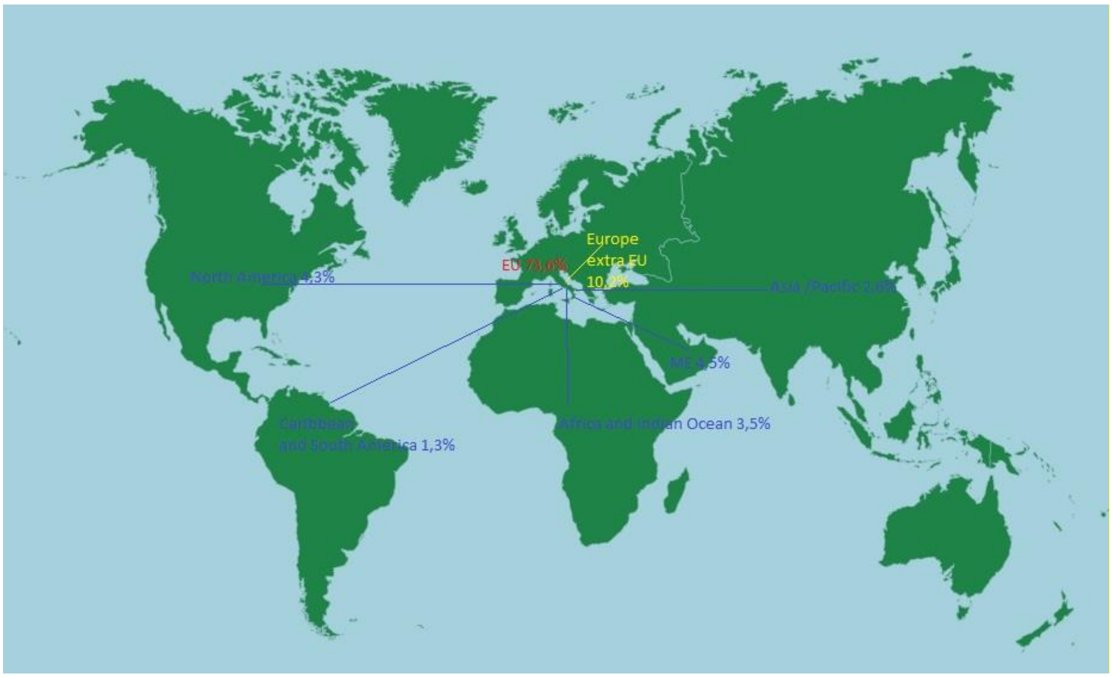

Total Passengers North America
3.860.191
4.022.483
4.226.953
4.875.527
5.469.727
2015
2016
2017
2018
2019


Total Passengers Caribbean and South America
1.295.181
1.453.293
1.574.130
1.762.981
1.711.767
2015
2016
2017
2018
2019


Total Passengers Africa and Indian Ocean
3.120.568
2.708.462
3.089.981
3.734.129
4.461.161
2015
2016
2017
2018
2019


Total Passengers World
97.870.858
104.041.773
112.686.769
120.788.078
127.727.813
2015
2016
2017
2018
2019

The traffic trend from/to Europe, Americas and Asia 2015-2019 is continuously increasing, whereas from/to Africa is recovering, after a decrease in 2015-2016.



Note: The graph shows only the direct traffic from/to Itlay. A significant part of the traffic from/to EU States, Asia and the Rest of the World, is also operated via France, Netherlands, Germany, Uk, Spain, and EAU.

2.2.1 Italy's current airport capacity

The main Italian airports are coordinated.

A coordinated airport is an airport where an air carrier, or any other aircraft operator, needs a slot, in order to land or take off, with the exemption of State flights, emergency landings and humanitarian flights.
The slot is assigned by the Coordinator, according to the capacity of that specific airport.
The airport capacity is the expression, in operational terms, of the whole capacity available for slot allocation at an airport during each coordination period, reflecting all technical, operational and environmental factors that affect the performance of the airport infrastructure and its different sub-systems.

The scheme below (data from Assoclearance website) shows the coordination parameters (capacity availability) of the main Italian airports for the Summer Season 2020:

Year 2020	Runway capacity		Air Terminal Capacity					
			International		Domestic + Schengen		International + Domestic	
Airport	Movements per hour	Number of stands	Arriving pax/h	Departing pax/h	Arriving pax/h	Departing pax/h	Arriving pax/h	Departing pax/h
Bergamo	26	45	1600	2000	3000	2800	3000	3800
Bologna[1]	24	31	1000	1000	2000	2000	3000	3000
Cagliari	12/16	23/25	1200	600	1850	1200	3050	1800
Catania	22	25	89	86	301	305	318	322
Firenze	15	14/16	760	350			2000	1400
Genova	25	36	1250	700	1250	700		
Lamezia Terme	20	19	350	350	600	800		
Lampedusa	4	3					250	250
Milano Linate	18	39					4400	3800[5]
Milano Malpensa	70	132					13800[6]	7700[6]
Napoli	30	25/26	2150		2600		4500	4750
Olbia	14	27	270	270	600	1200		
Palermo	21	25/33	450	400	1450	1050	2000	1950
Pantelleria	4	4					350	350
Pisa [1]	10/14[3]	17	3450[9]		550[8]		4000	4300
Rimini	7	13	492	456	263	265		
Roma Ciampino	10/12[2]	12/17					1400	1400
Roma Fiumicino[7]	90	117/125	4800	6000	9500	9000		
Torino	27	/ [4]					2500	2500
Treviso	8	7/9	350	350			700	700
Venezia	32	45	1800	1630		2780	4400	
Verona	16	20/24	720	720	1500	1600	1500	1600

Note 1 - Scheduled Facilitated Airports

Note 2 - Limitation due to noise impact analysis in progress by ENAC (max 100 movements per day)

Note 3 - on different hours

Note 4 - Aircraft stands of Turin airports are foreseen into four flexible area, arranged for a maximum capacity of 6 wide bodies plus 19 narrow bodies

Note 5 - With maximum 600 extra - Schengen.

Note 6 - Total of terminal 1 and terminal 2 capacities

Note 7 - Runway movement restriction

Note 8 - Domestic only

Note 9 - International + Schengen

2.3 Effects of Covid-19 in 2020

Airport traffic in the first semester of 2020 was characterized by the crisis triggered by the Covid-19 emergency which, starting from March, caused the collapse of the air traffic, both domestic and international

The airport sector was one of the sectors most affected by the crisis and the data of the first semester are also strongly influenced by the lockdown measures mandated by the government to counter the spread of the pandemic.

Small positive signs of recovery began to be registered only in June, at the end of first semester, followed by a more sustained recovery until the end of September.

Then, the outburst of a second wave of the pandemics lead to another decline of the volume of traffic.

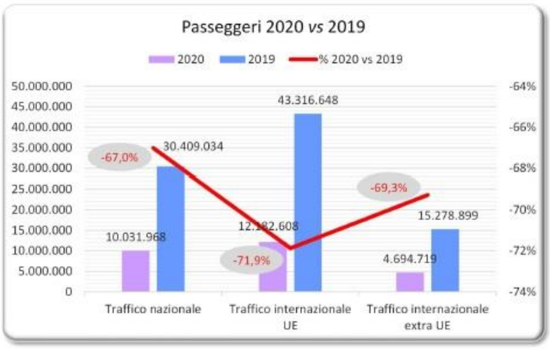
Overall, in national airports open to commercial traffic, scheduled charter in the first half of the year reached 257,233 movements and 26,909,295 passengers, respectively minus 62.3% and minus 69.8% compared to the first semester of 2019. Cargo traffic recorded 368,526 tons, down 28.5% compared to the same period in last year. The cargo segment, even though was also affected by the crisis of the whole system, has undergone a minor decrease as goods have continued to travel, albeit in a more limited manner, and emergency flights have had great influence on some single stopovers. This is the case of Brescia airport which, despite having registered traffic overall passengers in the semester lower by 92% compared to the same period of 2019, it had an increase in the number of movements and cargo, respectively, of + 44% and + 39%.

The following table shows the change of movements, passengers and cargo traffic of the 1st semester 2020, compared to 1st semester of 2019:

I Semestre 2020	Traffico nazionale	Δ% 2020/19	Traffico internazionale UE	Δ% 2020/19	Traffico internazionale extra UE	Δ% 2020/19	Totale traffico internazionale (UE + Extra UE)	Δ% 2020/19	**Totale traffico I semestre**	**Δ% 2020/19**
Movimenti	103.211	-58,6%	116.225	-64,8%	37.797	-63,4%	154.022	-64,5%	257.233	**-62,3%**
Passeggeri	10.031.968	-67,0%	12.182.608	-71,9%	4.694.719	-69,3%	16.877.327	-71,2%	26.909.295	**-69,8%**
Cargo	31.268,9	-17,3%	145.172,6	-7,2%	192.084,0	-40,1%	337.256,7	-29,3%	368.525,6	**-28,5%**

Note: For the sake of the intra EU traffic, the flights to/from UK are still considered intra-EU, considering the transition period of the Brexit until 31st December 2020.

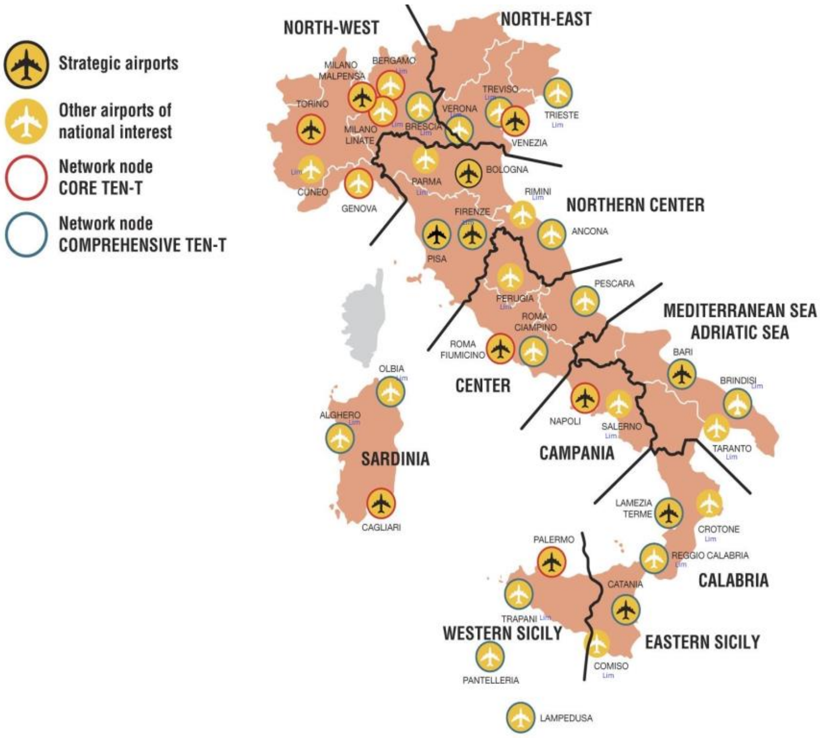
The following charts show the change of passengers and cargo traffic of the 1st semester 2020, compared to 1st semester of 2019, split as domestic, international intra EU, and international outside EU.



Note: For the sake of the intra EU traffic, the flights to/from UK are still considered intra-EU, considering the transition period of the Brexit until 31st December 2020.

In order to contain the spread of the pandemic the Italian Government took the decision to limit the operativity of some airports, as depicted in the following chart*.

*Airports with traffic limitations are indicated with the "Lim" symbol



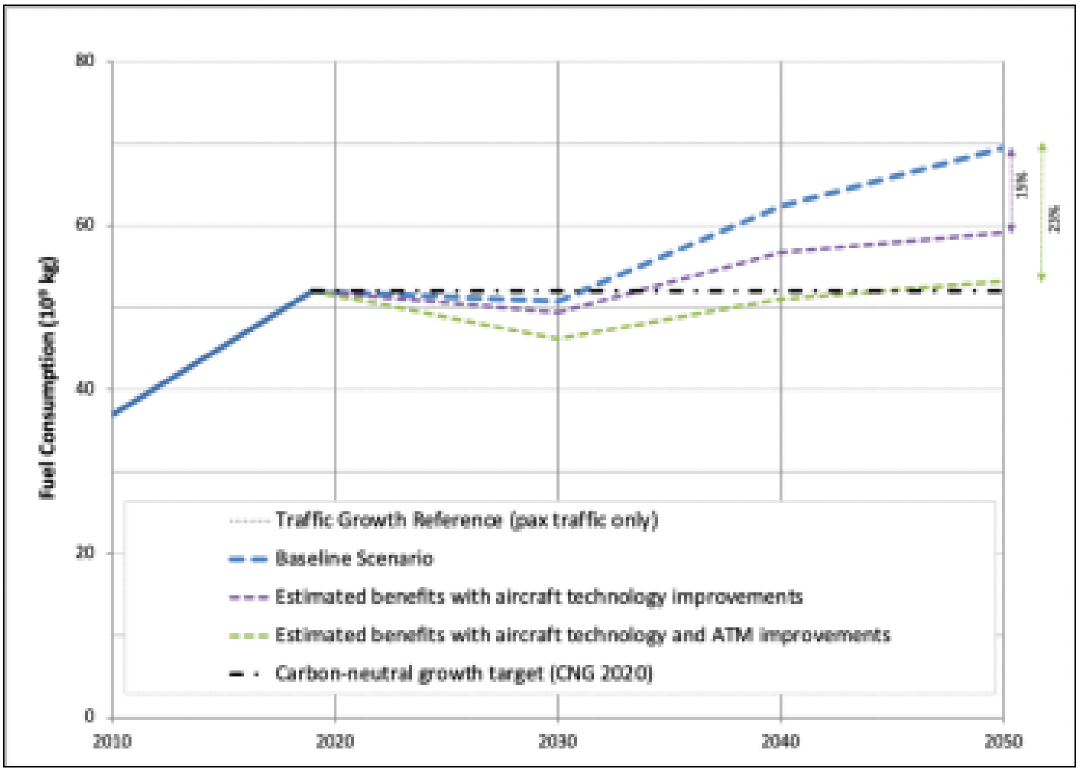
3. EUROPEAN STATES' ACTION PLANS ECAC/EU
common section

3.0 Executive summary

The European section of this action plan presents a summary of the actions taken collectively throughout the 44 States of the European Civil Aviation Conference (ECAC) to reduce CO_2 emissions from the aviation system and which are relevant for each State, and provides an assessment of their benefit against an ECAC baseline. It also provides a description of future measures aimed to provide additional CO_2 savings.

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

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



3.0.1 *Aircraft related technology*

Environmental improvements across the ECAC States are knowledge-led and at the forefront of this is the Clean Sky EU Joint Undertaking that aims to develop and mature breakthrough "clean technologies". The second joint undertaking (Clean Sky 2 – 2014-2024) has the objective to reduce aircraft emissions and noise by 20 to 30% with respect to the latest technologies entering into service in 2014. Under the Horizon Europe programme for research and innovation, the European Commission has proposed the set up of a European Partnership for Clean Aviation (EPCA) which will follow in the footsteps of CleanSky2, recognizing and exploiting the interaction between environmental, social and competitiveness aspects of civil aviation, while maintaining sustainable economic growth. For such technology high end public-private partnerships to be successful, and thus, benefit from this and from future CO_2 action plans, securing the appropriate funding is key.

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

3.0.2 Sustainable Aviation Fuels

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

The European collective SAF measures included in this Action Plan focuses on its CO_2 reductions benefits. Nevertheless SAF has the additional benefit of reducing air pollutant emissions of non-volatile Particulate Matter (nvPM), which can provide important other non-CO_2 benefits on the climate which are not specifically assessed within the scope of this Plan.

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

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

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

3.0.3 Improved Air Traffic Management

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

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

Much of the research to develop these solutions is underway and published results of the many earlier demonstration actions confirm the challenge but give us confidence that the goals will be achieved in the ECAC region with widespread potential to be replicated in other regions.

3.0.4 Market Based Measures (MBMs)

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

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

The 30 European Economic Area (EEA)[2] States in Europe have implemented the EU Emissions Trading System (ETS), including the aviation sector with around 500 aircraft operators participating in the cap-and-trade approach to limit CO_2 emissions. Subject to preserving the environmental integrity and effectiveness it is expected that the EU ETS legislation will continue to be adapted to implement CORSIA.

As a consequence of the linking agreement with Switzerland, from 2020 the EU ETS was extended to all departing flights from the EEA to Switzerland, and Switzerland applies its ETS to all departing flights to EEA airports, ensuring a level playing field on both directions of routes.

In accordance with the EU-UK Trade and Cooperation Agreement reached in December 2020, the EU ETS shall continue to apply to departing flights from the EEA to the UK, while a UK ETS will apply effective carbon pricing on flights departing from the UK to the EEA.

In the period 2013 to 2020, EU ETS has saved an estimated 200 million tonnes of intra European aviation CO_2 emissions.

3.0.5 ECAC Scenarios for Traffic and CO_2 Emissions

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

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

The analysis by EUROCONTROL and EASA have identified the most likely scenario of influences on future traffic and modelled these assumptions out to future years. On the basis of this traffic forecast, fuel consumption and CO_2 emissions of aviation have been estimated for both a theoretical baseline scenario (without any additional mitigation action) and a scenario with estimated benefits from mitigation measures implemented since 2019 or provided benefits beyond 2019 that are presented in this action plan.

Under the baseline assumptions of traffic growth and fleet rollover with 2019 technology, CO_2 emissions would significantly grow in the long-term for flights departing from ECAC airports without mitigation measures. Modelling the impact of improved aircraft technology for the scenario with implemented measures indicates an overall 15% reduction of fuel consumption and CO_2 emissions in 2050 compared to the baseline. Whilst the data to model the benefits of ATM improvements may be less robust, they are nevertheless valuable contributions to reduce emissions further. Overall CO_2 emissions, including the effects of new aircraft types and ATM-related measures, are projected to improve to lead to a 23% reduction in 2050 compared to the baseline.

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

In the common section of this action plan the potential of sustainable aviation fuels and the effects of market-based measures have not been simulated in detail. Notably, CORSIA being a global measure, and not a European measure, the assessments of its benefits were not considered required for the purposes of the State Action Plans. But they should both help reach the ICAO carbon-neutral growth 2020 goal. As further developments in policy and technology are made, further analysis will improve the modelling of future emissions.

3.1 Ecac baseline scenario and estimated benefits of implemented measures

3.1.1 ECAC Baseline Scenario

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

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

The sets of forecasts correspond to projected traffic volumes in a scenario of "Regulation and Growth", while corresponding fuel consumption and CO_2 emissions assume the technology level of the year 2019 (i.e. without considering reductions of emissions by further aircraft related technology improvements, improved ATM and operations, sustainable aviation fuels or market based measures).

Traffic Scenario "Regulation and Growth"

As in all forecasts produced by EUROCONTROL, various scenarios are built with a specific storyline and a mix of characteristics. The aim is to improve the understanding of factors that will influence future traffic growth and the risks that lie ahead. The latest EUROCONTROL long-term forecast10 was published in June 2018 and inspects traffic development in terms of Instrument Flight Rule (IFR) movements to 2040.

In the latter, the scenario called 'Regulation and Growth' is constructed as the 'most likely' or 'baseline' scenario for traffic, most closely following the current trends[3]. 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.

[3] Prior to COVID-19 outbreak.

- More hub-and-spoke or point-to-point **networks** may alter the number of connections and flights needed to travel from origin to destination.
- **Market structure** describes size of aircraft used to satisfy the passenger demand (modelled via the Aircraft Assignment Tool).

Table 1 below presents a summary of the social, economic and air traffic related characteristics of three different scenarios developed by EUROCONTROL. The year 2016 served as the baseline year of the 20-year forecast results[4] (published in 2018 by EUROCONTROL). Historical data for the year 2019 are also shown later for reference.

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

Table 1. *Summary characteristics of EUROCONTROL scenarios.*

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

COVID-19 impact and extension to 2050

Since the start of 2020, COVID-19 has gone from a localised outbreak in China to the most severe global pandemic in a century. No part of European aviation is untouched by the human tragedy or the business crisis. This unprecedented crisis hindered air traffic growth in 2020: flight movements declined by 55% compared to 2019 at ECAC level. It continues to disrupt the traffic growth and patterns in Europe in 2021. In Autumn 2020, EUROCONTROL published a medium-term forecast[5] to 2024, taking into account the impact of the COVID-19 outbreak. The latter is based on three different scenarios depending on how soon an effective vaccine would be made widely available to (air) travellers. Other factors have been included amongst which the economic impact of the crisis or levels of public confidence, to name a few. The Scenario 2: vaccine widely made available for travellers by Summer 2022, considered as the most likely, sees ECAC flights only reaching 92% of their 2019 levels in 2024.

In order to take into account the COVID-19 impact and to extend the horizon to 2050, the following adaptations have been brought to the original long-term forecast10. Considering the most-likely scenarios of the long-term forecast[4] and the medium-term forecasted version of the long-term flight forecast has been derived:

a) Replace the first years (2020-2024) of the long-term forecast[4] horizon by the most recent medium-term forecast[5] to account for COVID impact;

b) Update the rest of the horizon (2025-2040) with assuming the original growth rates of the long-term forecast[4], would remain similar to those calculated pre-COVID-19; and

c) Extrapolate the final years (2040-2050) considering the same average annual growth rates as the one forecasted for 2035-2040 period, but with a 0.9 decay[6].

The method used relies on the calculation of adjustment factors at STATFOR[7] region-pair level and have been applied to the original long-term forecast10. Adjusting the baseline enables to further elaborate the baseline scenario as forecasted future fuel consumption and to 2030, 2040 and 2050, in the absence of action.

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

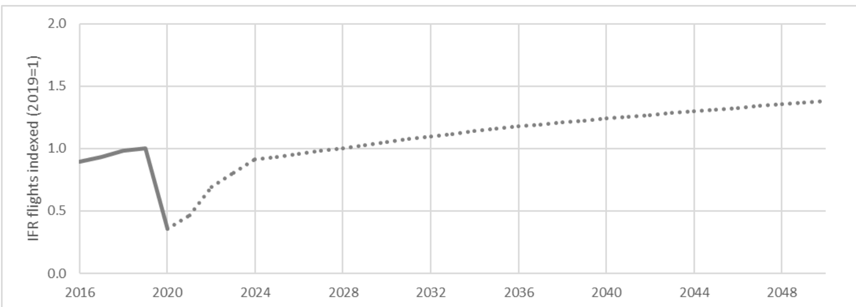

Figure 1. *Updated EUROCONTROL "Regulation and Growth" scenario of the passenger flight forecast for ECAC international departures including the COVID-19 impact in 2020 and the following 4 years.*

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

6 As the number of flights has not been directly forecasted via the system but numerically extrapolated, it does not include any fleet renewal, neither network change (airport pairs) between 2040 and 2050. This factor is aimed at adjusting the extrapolation to capture the gradual maturity of the market.

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

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[8] 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[9]). 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[10] data warehouse used by EUROCONTROL, including the actual flight distance and the cruise altitude by airport pair. These calculations were made for about 99% of the passenger flights (the remaining flights had information missing in the flight plans). Determination of the fuel burn and CO_2 emissions for historical years is built up as the aggregation of fuel burn and emissions for each aircraft of the associated traffic sample characteristics. Fuel burn and CO_2 emission results consider each aircraft's fuel burn in its ground and airborne phases of flight and are obtained by use of the EUROCONTROL IMPACT environmental model, with the aircraft technology level of each year.

Forecast years (until 2050) fuel burn and modelling calculations use the 2019 flight plan characteristics as much as possible, to replicate actual flown distances and cruise levels, by airport pairs and aircraft types. When not possible, this modelling approach uses past years traffics too, and, if needed, the ICAO CAEP forecast modelling. The forecast fuel burn and CO_2 emissions of the baseline scenario for forecast years uses the technology level of 2019.

For each reported year, the revenue per passenger kilometre (RPK) calculations use the number of passengers carried for each airport pair multiplied by the great circle distance between the associated airports and expressed in kilometres. Because of the coverage of the passenger estimation datasets (Scheduled, Low-cost, Non-Scheduled flights, available passenger information, etc.) these results are determined for about 99% of the historical passenger traffic, and 97% of the passenger flight forecasts. From the RPK values, the passenger flights RTK were calculated as the number of tonnes carried by kilometers, assuming that 1 passenger corresponds to 0.1 tonne.
The fuel efficiency represents the amount of fuel burn divided by the RPK for each available airport pair with passenger data, for the passenger traffic only. Here, the RPK and fuel efficiency results corresponds to the aggregation of these values for the whole concerned traffic years.

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

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[8] International departures only. Domestic flights are excluded. A domestic is any flight between two airports in the State, regardless of the operator or which airspaces they enter en-route. Airports located in overseas are attached the State having the sovereignty of the territory. For example, France domestic include flights to Guadeloupe, Martinique, etc.

[9] ICAO Long-Term Traffic Forecasts, Passenger and Cargo, July 2016. Cargo forecasts have not been updated as new ICAO forecast including COVID-19 effects will be made available after the end of June 2021, so those cannot be considered in this action plan common section.

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

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres[11] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[12] FTKT (billion)	Total Revenue Tonne Kilometres[13] RTK (billion)
2010	4.56	1,114	0.198	45.4	156.8
2019	5.95	1,856	0.203	49.0	234.6
2030	5.98	1,993	0.348	63.8	263.1
2040	7.22	2,446	0.450	79.4	324.0
2050	8.07	2,745	0.572	101.6	376.1

Table 2. *Baseline forecast for international traffic departing from ECAC airports*

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Fuel efficiency (kg/RPK[11])	Fuel efficiency (kg/RTK[13])
2010	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280
2030	50.72	160.29	0.0252	0.252
2040	62.38	197.13	0.0252	0.252
2050	69.42	219.35	0.0250	0.250
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

Table 3. *Fuel burn and CO_2 emissions forecast for the baseline scenario*

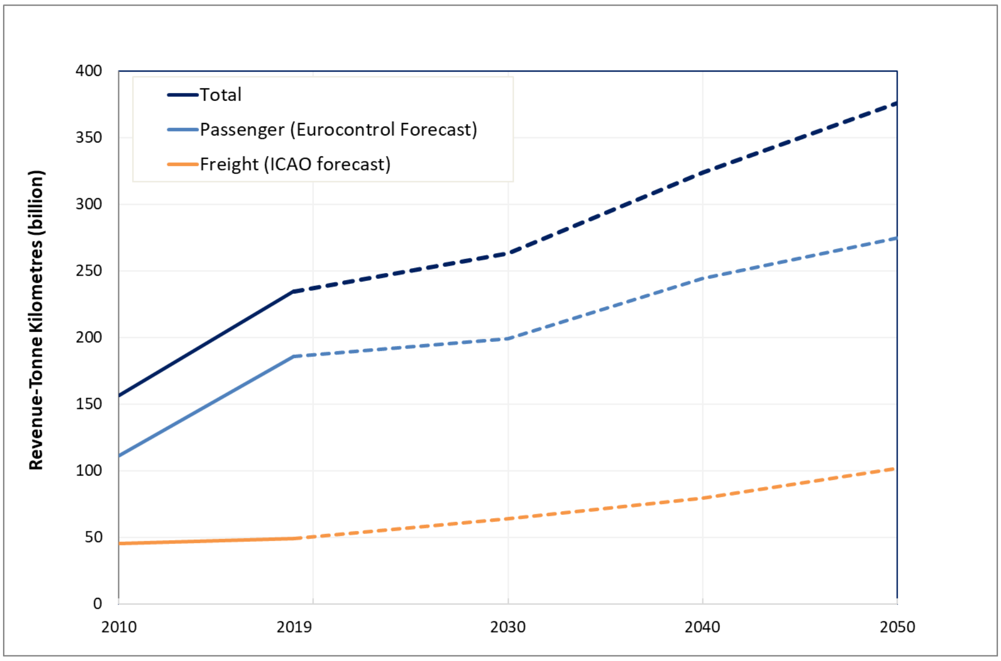

Figure 2. *Forecasted traffic until 2050 (assumed both for the baseline and implemented measures scenarios).*

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

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

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

The impact of the COVID-19 in 2020 is not fully reflected in Figure 2, as this representation is oversimplified through a straight line between 2019 and 2030. The same remark applies for Figure 3 and Figure 4.

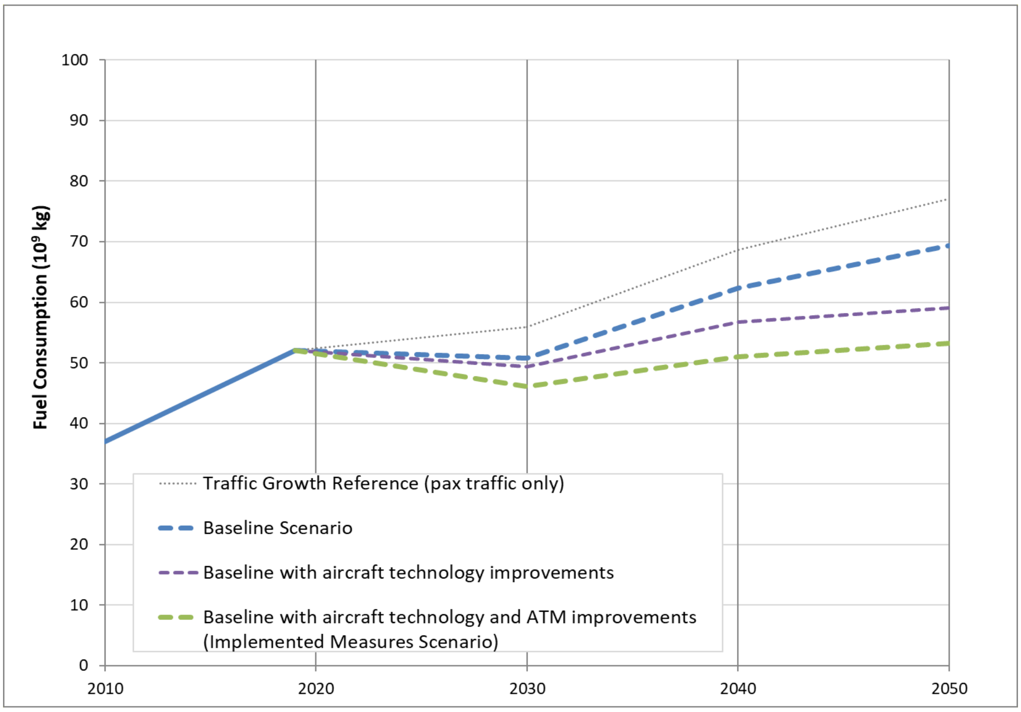

Figure 3. *Fuel consumption forecast for the baseline and implemented measures scenarios (international passenger flights departing from ECAC airports).*

3.1.2 ECAC Scenario with Implemented Measures, Estimated Benefits of Measures

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

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

Effects of **improved aircraft technology** are captured by simulating fleet roll-over and considering the fuel efficiency improvements of new aircraft types of the latest generation (e.g. Airbus A320NEO, Boeing 737MAX, Airbus A350XWB etc.). The simulated future fleet of aircraft has been generated using the Aircraft Assignment Tool[14] (AAT) developed collaboratively by EUROCONTROL, EASA and the European Commission. The retirement process of AAT is performed year by year, allowing the determination of the number of new aircraft required each year. In addition to the fleet rollover, a constant annual improvement of fuel efficiency of 1.16% per annum is assumed for each aircraft type with entry into service from 2020 onwards. This rate of

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

improvement corresponds to the 'Advanced' fuel technology scenario used by CAEP to generate the fuel trends for the Assembly. This technology improvement modelling is applied to the years 2030 and 2040. For the year 2050, as the forecast traffic reuses exactly the fleet of the year 2040, the technological improvement is determined with the extrapolation of the fuel burn ratio between the baseline scenario and the technological improvement scenario results of the years 2030 to 2040.

The effects of **improved ATM efficiency** are captured in the Implemented Measures Scenario on the basis of efficiency analyses from the SESAR project. In SESAR, a value of 5,280 kg of fuel per flight for ECAC (including oceanic region) is used as a baseline[15]. Based on the information provided by the PAGAR 2019 document[16], and compared to a 2012 baseline, the benefits at the end of Wave 1 could be about 3% CO_2/fuel savings achieved by 2025 equivalent to 147.4 kg of fuel/flight. So far, the target for Wave 2 remains at about 7% more CO_2/fuel savings (352.6 kg of fuel) to reach the initial Ambition target of about 10% CO_2/fuel savings (500 kg fuel) per flight by 2035. The 2030 efficiency improvement is calculated by assuming a linear evolution between 2025 and 2035. As beyond 2035, there is no SESAR Ambition yet, it is assumed that the ATM efficiency improvement are reported extensively for years 2040 and 2050.

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

While the effects of **introduction of Sustainable Alternative Fuels (SAF)** where modelled in previous updates on the basis of the European ACARE goals[18], the expected SAF supply objectives for 2020 were not met, and in the current update the SAF benefits have not been modelled as a European common measure in the implemented measures scenario. However, numerous initiatives related to SAF (e.g. ReFuelEU Aviation) are largely described in paragraph 3.2.2 and it is expected that future updates will include an assessment of its benefits as a collective measure.

Effects on aviation's CO_2 emissions of market-based measures including the EU Emissions Trading System (ETS) with the linked Swiss ETS, the UK ETS and the ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) have not been modelled explicitly in the top-down assessment of the implemented measures scenario presented here as, at the time of the submission of this action plan, a legislative proposal for the revision of the EU ETS Directive concerning aviation, is under development to complete the implementation of CORSIA by the EU and to strengthen the ambition level of the EU ETS. CORSIA is not considered a European measure but a global one. It aims for carbon-neutral growth (CNG) of aviation as compared to the average of 2019 and 2020 levels of emissions in participating States, and an indication of a corresponding (hypothetical) target applied to Europe is shown in Figure 4[19], while recalling that this is just a reference level, given that CORSIA was designed to contribute to the CNG 2020 globally and not in individual States or regions.

Tables 4-6 and Figure 4 summarize the results for the scenario with implemented measures. It should be noted that **Table 4** shows direct combustion emissions of CO_2 (assuming 3.16 kg CO_2 per kg fuel). More detailed tabulated results are found in

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

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

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

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

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

Appendix A, including results expressed in equivalent CO_2 emissions on a well-to-wake basis (for comparison purposes of SAF benefits).

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Fuel efficiency (kg/RPK[20])	Fuel efficiency (kg/RTK[17])
2010	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280
2030	46.16	145.86	0.0229	0.229
2040	51.06	161.35	0.0206	0.206
2050	53.18	168.05	0.0192	0.192
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

Table 4. *Fuel burn and CO_2 emissions forecast for the Implemented Measures Scenario (new aircraft technology and ATM improvements only).*

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

Table 5. *Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)*

Year	CO_2 emissions (10^9 kg)			% improvement by Implemented Measures (full scope)
	Baseline Scenario	Implemented Measures Scenario		
		Aircraft techn. improvements only	Aircraft techn. and ATM improvements	
2010	36.95			NA
2019	52.01			NA
2030	50.7	49.4	46.2	-9%
2040	62.4	56.7	51.1	-18%
2050	69.4	59.1	53.2	-23%
For reasons of data availability, results shown in this table do not include cargo/freight traffic. Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.				

Table 6. CO_2 *emissions forecast for the scenarios described in this chapter.*

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

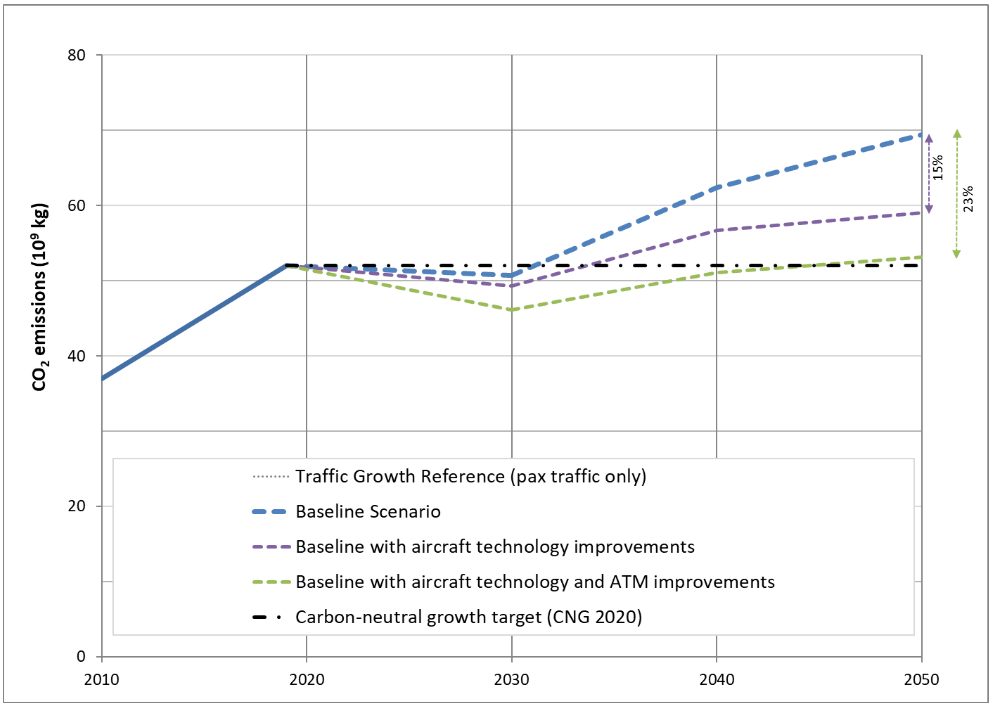

Figure 4*. CO_2 emissions forecast for the baseline and implemented measures scenarios.*

As shown in Figure 4, the impact of improved aircraft technology indicates an overall 15% reduction of fuel consumption and CO_2 emissions in 2050 compared to the baseline scenario. Overall CO_2 emissions, including the effects of new aircraft types and ATM-related measures, are projected to improve to lead to a 23% reduction in 2050 compared to the baseline.

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

3.2 Actions taken collectively throughout Europe

3.2.1 Technology and Standard

3.2.1.1 Aircraft emissions standards

European Member States fully support ICAO's Committee on Aviation Environmental Protection (CAEP) work on the development and update of aircraft emissions standards, in particular to the **ICAO Aircraft CO_2 Standard** adopted by ICAO in 2017. Europe significantly contributed to its development, notably through the European Aviation Safety Agency (EASA). It is fully committed to its implementation in Europe and the need to review the standard on a regular basis in light of developments in aeroplane fuel efficiency. EASA has supported the process to integrate this standard into European legislation (2018/1139) with an applicability date of 1 January 2020 for new aeroplane types.

ASSESSMENT

This is a European contribution to a global measure (CO_2 standard). Its contribution to the global aspirational goals are available in CAEP.

3.2.1.2 Research and development: Clean Sky and the European Partnership for Clean Aviation

Clean Sky

Clean Sky[21] is an EU Joint Undertaking that aims to develop and mature breakthrough "clean technologies" for air transport globally. Joint Undertakings are Public Private Partnership set up by the European Union on the EU research programmes. By accelerating their deployment, the Joint Undertaking will contribute to Europe's strategic environmental and social priorities, and simultaneously promote competitiveness and sustainable economic growth. The first Clean Sky Joint Undertaking (**Clean Sky 1** - 2011-2017) had a budget of €1.6 billion, equally shared between the European Commission and the aeronautics industry. It aimed to develop environmental-friendly technologies impacting all flying-segments of commercial aviation. The objectives were to reduce aircraft CO_2 emissions by 20-40%, NOx by around 60% and noise by up to 10dB compared to year 2000 aircraft.

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

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

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

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

21 http://www.cleansky.eu/

needs of a future generation of aircraft in terms of maturation, demonstration and Innovation.

- **Small Air Transport:** demonstrating the advantages of applying key technologies on small aircraft demonstrators to revitalise an important segment of the aeronautics sector that can bring new key mobility solutions.
- **Eco-Design:** coordinating research geared towards high eco-compliance in air vehicles over their product life and heightening the stewardship with intelligent Re-use, Recycling and advanced services.

In addition, the **Technology Evaluator**[22] will continue to be upgraded to assess technological progress routinely and evaluate the performance potential of Clean Sky 2 technologies at both vehicle and aggregate levels (airports and air traffic systems).

Disruptive aircraft technological innovations: European Partnership for Clean Aviation

With the Horizon 2020 programme coming to a close in 2020, the Commission has adopted a proposal to set up a new Joint Undertaking under the Horizon Europe programme (2021-2027). The **European Partnership for Clean Aviation (EPCA)**[23] will follow in the footsteps of CleanSky2. The EU contribution proposed is again € 1.7 billion. The stakeholder community has already formulated a Strategic Research and Innovation Agenda (SRIA), which is intended to serve as a basis of the partnership once established. Subject to the final provisions of the partnership and the EU budget allocation, industry stakeholders have proposed a commitment of €3 billion from the private side.

General objectives of EPCA:

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

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

Specific objectives:

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

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

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

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

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

ASSESSMENT:

The quantitative assessment of the technology improvement scenario from 2020 to 2050 has been calculated by EUROCONTROL and EASA and it is included in ch. 3.1 above (ECAC Baseline Scenario and Estimated Benefits of Implemented Measures) and in Appendix A.

Table 7 Fuel consumption and CO_2 emissions of international passenger traffic departing from ECAC airports, with aircraft technology improvements after 2019 included:

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Well-to-wake CO_2 emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	36.95	116.78	143.38	0.0332	0.332
2019	52.01	164.35	201.80	0.0280	0.280
2030	49.37	156.00	191.54	0.0232	0.232
2040	56.74	179.28	220.13	0.0217	0.217
2050	59.09	186.72	229.26	0.0202	0.202
For reasons of data availability, results shown in this table do not include cargo/freight traffic.					

Table 8 Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology only):

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

3.2.2 Sustainable Aviation Fuels

Sustainable aviation fuels (SAF) including advanced biofuels and synthetic fuels, have the potential to significantly reduce aircraft emissions and ECAC States are embracing their large-scale introduction in line with the 2050 ICAO Vision.

The European collective SAF measures included in this Action Plan focuses on its CO_2 reductions benefits. Nevertheless SAF has the additional benefit of reducing air pollutant emissions of non-volatile Particulate Matter (nvPM) with up to 90% and sulphur (SO_X) with 100%, compared to fossil jet fuel[24]. As a result, the large-scale use of SAF can have important other non-CO_2 benefits on the climate which are not specifically assessed within the scope of this Plan.

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

3.2.2.1 ReFuel EU Aviation Initiative

On 15 January 2020, the European Parliament adopted a resolution on the European Green Deal in which it welcomed the upcoming strategy for sustainable and smart mobility and agreed with the European Commission that all modes of transport will have to contribute to the decarbonisation of the transport sector in line with the objective of reaching a climate-neutral economy. The European Parliament also called for "a clear regulatory roadmap for the decarbonisation of aviation, based on technological solutions, infrastructure, requirements for sustainable alternative fuels and efficient operations, in combination with incentives for a modal shift".

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

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

The EU aviation internal market is a key enabler of connectivity and growth but is also accountable for significant environmental impact. In line with the EU's climate goals to reduce emissions by 55% by 2030 and to achieve carbon neutrality by 2050, the aviation sector needs to decarbonise.
While several policy measures are in place, significant potential for emissions savings could come from the use of SAF, i.e. liquid drop-in fuels replacing fossil kerosene. However, currently only around 0.05% of total aviation fuels used in the EU are sustainable.

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

ASSESSMENT:

A meaningful deployment of SAF in the aviation market will lead to a net decrease of the air transport sector's CO_2 emissions. SAF can achieve as high as 85% or more emissions savings compared to conventional jet fuel, and therefore, if deployed at a large scale, have important potential to help aviation contribute to EU reaching its climate targets.

At the time of the submission of this action plan the legislative proposal under the ReFuelEU Aviation initiative, as well as its supporting impact assessment, were not yet adopted. As a result, the assessment of the benefits provided by this collective European measure in terms of reduction in aviation emissions is expected to be included in a future update of the common section of this action plan.

3.2.2.2 Addressing barriers of SAF penetration into the market

SAF are considered to be a critical element in the basket of measures to mitigate aviation's contribution to climate change in the short-term using the existing global fleet.

However, the use of SAF has remained negligible up to now despite previous policy initiatives such as the European Advanced Biofuels Flightpath, as there are still significant barriers for its large-scale deployment.

The European Aviation Environmental Report (EAER) published in January 2019, identified a lack of information at European level on the supply and use of SAF within Europe. EASA completed two studies in 2019 to address the lack of SAF monitoring in the EU.

Sustainable Aviation Fuel 'Facilitation Initiative'

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

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

The report begins by analysing the status of SAFs in Europe today, including both more established technologies and ones at a lower Technology Readiness Level (TRL). It reviews one of the major solutions to the obstacle of navigating the SAF approval process, namely the US Clearing House run by the University of Dayton Research Institute and funded by the Federal Aviation Administration (FAA). The issue of sustainability is also examined, via an analysis of the role of Sustainability Certification Schemes (SCS) and how they interact with regulatory sustainability requirements, particularly those in the EU's Renewable Energy Directive (RED II) and ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

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

The report is available at EASA's website: 'Sustainable Aviation Fuel 'Facilitation Initiative'.

Sustainable Aviation Fuel 'Monitoring System'

In response to a lack of information at the EU level on the supply and use of SAF within Europe identified by the European Aviation Environmental Report, EASA launched a second study to identify a cost effective, robust data stream to monitor the use and supply of SAF, as well as the associated emissions reductions. This included identifying and recommending performance indicators related to the use of SAF in Europe, as well as the associated aviation CO_2 emissions reductions achieved.

The study followed five steps:

1. Identification of possible performance indicators by reviewing the current 'state of the art' SAF indicators and consultation with key stakeholders.
2. Identification of regulatory reporting requirements, and other possible sources of datasets and information streams in the European context, with the potential to cover the data needs of the proposed performance indicators.
3. Examination of sustainability requirements applicable to SAF, and potential savings in greenhouse gas (GHG) emissions compared to fossil-based fuels.
4. Review of SAF use today and future expectations for SAF use within Europe.
5. Definition of a future monitoring and reporting process on SAF use in Europe and related recommendations to implement it.

The results will be used as a basis for subsequent work to include SAF performance indicators in future EAERs, which will provide insight into the market penetration of SAF over time in order to assess the success of policy measures to incentivize uptake.

The report is available at EASA's website: 'Sustainable Aviation Fuel 'Monitoring System'.

ASSESSMENT:

While these studies are expected to contribute to addressing barriers of SAF penetration into the market, its inclusion is for information purposes and the assessment of its benefits in terms of reduction in aviation emissions is not provided in the present action plan.

3.2.2.3 Standards and requirements for SAF

European Union standards applicable to SAF supply

Within the European Union there are currently applicable standards for renewable energy supply in the transportation sector, which are included in the revised Renewable Energy Directive (RED II) that entered into force in December 2018 (Directive 2018/2001/EU).

It aims at promoting the use of energy from renewable sources, establishing mandatory targets to be achieved by 2030 for a 30% overall share of renewable energy in the EU and a minimum of 14% share for renewable energy in the transport sector, including for aviation but without mandatory SAF supply targets.

Sustainability and life cycle emissions methodologies:

Sustainability criteria and life cycle emissions methodologies have been established for all transport renewable fuels supplied within the EU to be counted towards the targets, which are fully applicable to SAF supply.

These can be found in RED´s[25] Article 17, *Sustainability criteria for biofuels and bioliquids*. Those requirements remain applicable on the revised RED II (Directive (EU) 2018/2001)38, Article 29 *Sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels* paragraphs 2 to 7, although the RED II introduces some new specific criteria for forestry feedstocks.

Transport renewable fuels (thus, including SAF) produced in installations starting operation from 1 January 2021 must achieve 65% GHG emissions savings with respect to a fossil fuel comparator for transportation fuels of 94g CO_2 eq/MJ. In the case of transport renewable fuels of non-biological origin[26], the threshold is raised to 70% GHG emissions savings.

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

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

[25] Directive 2009/28/EC

[26] In the case of renewable fuels of non-biological origin, two types are considered: a) Renewable liquid and gaseous transport fuels of non-biological origin (including categories commonly referred as Power to Liquid - PtL-, Electro-fuels and Synthetic fuels). b) Waste gases, which are under the category of REcycled FUel from NOn-BIOlogical origin (also known as REFUNIOBIO).

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

ICAO standards applicable to SAF supply

Europe is actively contributing to the development of the ICAO CORSIA Standards and Recommended Practices (SARPs), though the ICAO Committee on Aviation and Environmental Protection (CAEP), establishing global Sustainability Requirements applicable to SAF as well as to the CORSIA Methodology for Calculating Actual Life Cycle Emissions Values and to the calculation of CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels; CORSIA standards are applicable to any SAF use to be claimed under CORSIA in order to reduce offsetting obligations by aeroplane operators.

ASSESSMENT:

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

3.2.2.4 Research and Development projects on SAF

European Advanced Biofuels Flightpath

An updated and renewed approach to the 2011 Biofuels FlightPath Initiative[27], was required to further impulse its implementation. As a result, the European Commission launched in 2016 the new Biofuels FlightPath to take into account recent evolutions and to tackle the current barriers identified for the deployment of SAF.

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

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

A number of communications and studies were delivered and are available[28].

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

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[27] In June 2011 the European Commission, in close coordination with Airbus, leading European airlines (Lufthansa, Air France/KLM, & British Airways) and key European biofuel producers (Choren Industries, Neste Oil, Biomass Technology Group and UOP), launched the European Advanced Biofuels Flight-path. This industry-wide initiative aimed to speed up the commercialisation of aviation biofuels in Europe, with an initial objective of achieving the commercialisation of 2 million tonnes of SAF by 2020, target that was not reached due to the commercial challenges of SAF large-scale supply.
https://ec.europa.eu/energy/sites/ener/files/20130911_a_performing_biofuels_supply_chain.pdf

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

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

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

BIO4A[29]: The "*Advanced Sustainable Biofuels for Aviation*» project plan to demonstrate the first large industrial-scale production and use of SAF in Europe obtained from residual lipids such as Used Cooking Oil.
The project will also investigate the supply of sustainable feedstocks produced from drought-resistant crops such as Camelina, grown on marginal land in EU Mediterranean areas. By adopting a combination of biochar and other soil amendments, it will be possible to increase the fertility of the soil and its resilience to climate change, while at the same time storing fixed carbon into the soil.
BIO4A will also test the use of SAF across the entire logistic chain at industrial scale and under market conditions, and it will finally assess the environmental and socio-economic sustainability performance of the whole value chain.
Started in May 2018, BIO4A will last until 2022, and it is carried out by a consortium of seven partners from five European countries.

KEROGREEN[30]: *Production of sustainable aircraft grade kerosene from water and air powered by renewable electricity, through the splitting of* CO_2*, syngas formation and Fischer-Tropsch synthesis* (KEROGREEN), is a Research and Innovation Action (RIA) carried out by six partners from four European countries aiming at the development and testing of an innovative conversion route for the production of SAF from water and air powered by renewable electricity.
The new approach and process of KEROGREEN reduces overall CO_2 emission by creating a closed carbon fuel cycle and at the same time creates long-term large-scale energy storage capacity which will strengthen the EU energy security and allow creation of a sustainable transportation sector.
The KEROGREEN project expected duration is from April 2018 to March 2022.

FlexJET[31]: *Sustainable Jet Fuel from Flexible Waste Biomass* (flexJET) is a four-year project targeting diversifying the feedstock for SAF beyond vegetable oils and fats to biocrude oil produced from a wide range of organic waste. This is also one of the first technologies to use green hydrogen from the processed waste feedstock for the downstream refining process thereby maximising greenhouse gas savings.
The project aims at building a demonstration plant for a 12 t/day use of food & market waste and 4000 l/day of Used Cooking Oil (UCO), produce hydrogen for refining through separation from syngas based on Pressure Swing Absorption technology, and finally deliver 1200 tons of SAF (ASTM D7566 Annex 2) for commercial flights to British Airways.
The consortium with 13 partner organisations has brought together some of the leading researchers, industrial technology providers and renewable energy experts from across Europe. The project has a total duration of 48 months from April 2018 to March 2022.

BioSFerA[32]: The *Biofuels production from Syngas Fermentation for Aviation and maritime use* (BioSFerA)project, aims to validate a combined thermochemical - biochemical pathway to develop cost-effective interdisciplinary technology to produce sustainable aviation and maritime fuels. At the end of the project next generation aviation and maritime biofuels, completely derived from second generation biomass, will be produced and validated by industrial partners at pilot scale. The project will undertake

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29 www.bio4a.eu

30 www.kerogreen.eu

31 www.flexjetproject.eu

32 https://biosfera-project.eu

a full value chain evaluation that will result in a final analysis to define a pathway for the market introduction of the project concept. Some crosscutting evaluations carried out on all tested and validated processes will complete the results of the project from an economic, environmental and social point of view.
The project is carried out by a consortium of 11 partners from 6 European countries and its expected duration is from 1 April 2020 to 31 March 2024.

BL2F[33]: The *Black Liquor to Fuel* (BL2F) project will use "Black Liquor" to create a clean, high-quality biofuel. Black liquor is a side-stream of the chemical pulping industry that can be transformed into fuel, reducing waste and providing an alternative to fossil fuels. Launched in April 2020, BL2F will develop a first-of-its-kind Integrated "Hydrothermal Liquefaction" (HTL) process at pulp mills, decreasing carbon emissions during the creation of the fuel intermediate. This will then be further upgraded at oil refineries to bring it closer to the final products and provide a feedstock for marine and aviation fuels. BL2F aims to contribute to a reduction of 83% CO_2 emitted compared to fossil fuels. A large deployment of the processes developed by BL2F, using a variety of biomass, could yield more than 50 billion litres of advanced biofuels by 2050.
The project brings together 12 partners from 8 countries around Europe and its expected duration is from 1 April 2020 till 31 March 2023.

FLITE[34]: The *Fuel via Low Carbon Integrated Technology from Ethanol* (FLITE) consortium proposes to expand the supply of low carbon jet fuel in Europe by designing, building, and demonstrating an innovative ethanol-based Alcohol-to-Jet (ATJ) technology in an ATJ Advanced Production Unit (ATJ-APU). The ATJ-APU will produce jet blend stocks from non-food/non-feed ethanol with over 70% GHG reductions relative to conventional jet. The Project will demonstrate over 1000 hours of operations and production of over 30,000 metric tonnes of Sustainable Aviation Fuel.
The diversity of ethanol sources offers the potential to produce cost competitive SAF, accelerating uptake by commercial airlines and paving the way for implementation.
The project is carried out by a consortium of five partners from six European countries and its expected duration is from 1 December 2020 till 30 November 2024.

TAKE-OFF[35] is an industrially driven project aiming to be a game-changer in the cost-effective production of SAF from CO_2 and hydrogen. The unique TAKE-OFF technology is based on conversion of CO_2 and H2 to SAF via ethylene as intermediate. Its industrial partners will team up with research groups to deliver a highly innovative process which produces SAF at lower costs, higher energy efficiency and higher carbon efficiency to the crude jet fuel product than the current benchmark Fischer-Tropsch process. TAKE-OFF's key industrial players should allow the demonstration of the full technology chain, utilising industrial captured CO_2 and electrolytically produced hydrogen. The demonstration activities will provide valuable data for comprehensive technical and economic and environmental analyses with an outlook on Chemical Factories of the Future.
The project is carried out by a consortium of nine partners from five European countries and its expected duration is from 1 January 2021 till 24 December 2024.

ASSESSMENT:

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

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[33] https://www.bl2f.eu

[34] https://cordis.europa.eu/project/id/857839

[35] https://cordis.europa.eu/project/id/101006799

3.3 Operational improvement

3.3.1 The EU's Single European Sky Initiative and SESAR

3.3.1.1 SESAR Project

SES and SESAR

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

The SESAR (*Single European Sky ATM Research*) programme addresses the technological dimension of the single European sky, aiming in particular to deploy a modern, interoperable and high-performing ATM infrastructure in Europe.

SESAR contributes to the Single Sky's performance targets by defining, validating and deploying innovative technological and operational solutions for managing air traffic in a more efficient manner. SESAR coordinates and concentrates all EU research and development (RTD) activities in ATM.

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

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

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

3.3.1.2 SESAR and the European Green Deal objectives

The European Green Deal launched by the European Commission in December 2019 aims to create the world's first climate-neutral bloc by 2050. This ambitious target calls for deep-rooted change across the aviation sector and places significantly stronger focus on the environmental impact of flying. Multiple technology pathways are required, one of which is the digital transformation of air traffic management, where SESAR innovation comes into play. Over the past ten years the SESAR JU has worked to improve the environmental footprint of air traffic management, from CO_2 and non- CO_2 emissions, to noise and local air quality. The programme is examining every phase of flight and use of the airspace and seeing what technologies can be used to eliminate fuel inefficiencies. It is also investing in synchronised data exchange and operations on the ground and in the air to ensure maximum impact. The ambition is to reduce by 2035 average CO_2 emissions per flight by 0.8-1.6 tonnes, taking into account the entire flight from gate to gate, including the airport.

Results

To date, the SESAR JU has delivered over 90 solutions for implementation, many of which offer direct and indirect benefits for the environment, with more solutions in the pipeline in SESAR 2020. Outlined in the SESAR Solutions Catalogue, these include solutions such as wake turbulence separation (for arrivals and departure), optimised use of runway configuration for multiple runway airports, or even optimised integration of arrival and departure traffic flows for single and multiple runway airports. Looking ahead, it is anticipated that the next generation of SESAR solutions will contribute to a reduction of some 450 kg CO_2 per flight.

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

The **Performance Ambitions for 2035** compared to a **2012 baseline** for Controlled airspace for each key performance area are presented in the figure below, with the ambition for environment, expressed in CO_2 reduction, highlighted by the green dotted rectangle of **Figure 5** below:

Key performance area	SES high-level goals 2005	Key performance indicator	Performance ambition vs. baseline: Baseline value (2012)	Ambition value (2035)	Absolute improvement	Relative improvement
Capacity	Enable 3-fold increase in ATM capacity	**Departure delay**[4], min/dep	9.5 min	6.5-8.5 min	1-3 min	10-30%
		IFR movements at most congested airports[5], million	4 million	4.2-4.4 million	0.2-0.4 million	5-10%
		Network throughput IFR flights[5], million	9.7 million	~15.7 million	~6.0 million	~60%
		Network throughput IFR flight hours[5], million	15.2 million	~26.7 million	~11.5 million	~75%
Cost efficiency	Reduced ATM services unit costs by 50% or more	**Gate-to-gate direct ANS cost per flight**[1] - EUR(2012)	EUR 960	EUR 580-670	EUR 290-380	30-40%
Operational efficiency		**Gate-to-gate fuel burn per flight**[2], kg/flight	5280 kg	4780-5030 kg	250-500 kg	5-10%
		Additional gate-to-gate flight time per flight, min/flight	8.2 min	3.7-4.1 min	4.1-4.5 min	50-55%
		Within the: Gate-to-gate flight time per flight[3], min/flight	(111 min)	(116 min)		
Environment	Enable 10% reduction in the effects flights have on the environment	**Gate-to-gate CO_2 emissions**, tonnes/flight	16.6 tonnes	15-15.8 tonnes	0.8-1.6 tonnes	5-10%
Safety	Improve safety by factor 10	**Accidents with direct ATM contribution**[6], #/year Includes in-flight accidents as well as accidents during surface movement (during taxi and on the runway)	0.7 (long-term average)	no ATM related accidents	0.7	100%
Security		**ATM related security incidents resulting in traffic disruptions**	unknown	no significant disruption due to cyber-security vulnerabilities	unknown	-

1 Unit rate savings will be larger because the average number of Service Units per flight continues to increase.
2 "Additional" means the average flight time extension caused by ATM inefficiencies.
3 Average flight time increases because the number of long-distance flights is forecast to grow faster than the number of short-distance flights.
4 All primary and secondary (reactionary) delay, including ATM and non-ATM causes.
5 Includes all non-segregated unmanned traffic flying IFR, but not the drone traffic flying in airspace below 500 feet or the new entrants flying above FL 600
6 In accordance with the PRR definition: where at least one ATM event or item was judged to be DIRECTLY in the causal chain of events leading to the accident. Without that ATM event, it is considered that the accident would not have happened.

Figure 5: *Performance Ambitions for 2035 for Controlled airspace (Source: European ATM Master Plan 2020 Edition).*

While all SESAR solutions bring added value to ATM performance, some have a higher potential to contribute the performance of the entire European ATM network and require a coordinated and synchronised deployment. To facilitate the deployment of these SESAR solutions, the Commission establishes common projects that mandate the synchronised implementation of selected essential ATM functionalities based on SESAR solutions developed and validated by the SESAR JU.

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

- Optimise the distancing of aircraft during landing and take-off, reducing delays and fuel burn while ensuring the safest flying conditions.
- Allow aircraft to fly their preferred and usually most fuel-efficient trajectory (free route).
- Implement an initial, yet fundamental step towards digitalising communications between aircraft and controllers and between ground stakeholders allowing better planning, predictability, thus less delays and fuel optimisation and passenger experience.

The first common project[36] is planned to be completed by 2027. However, the benefits highlighted in Figure 6 below have been measured where the functionalities have already been implemented.

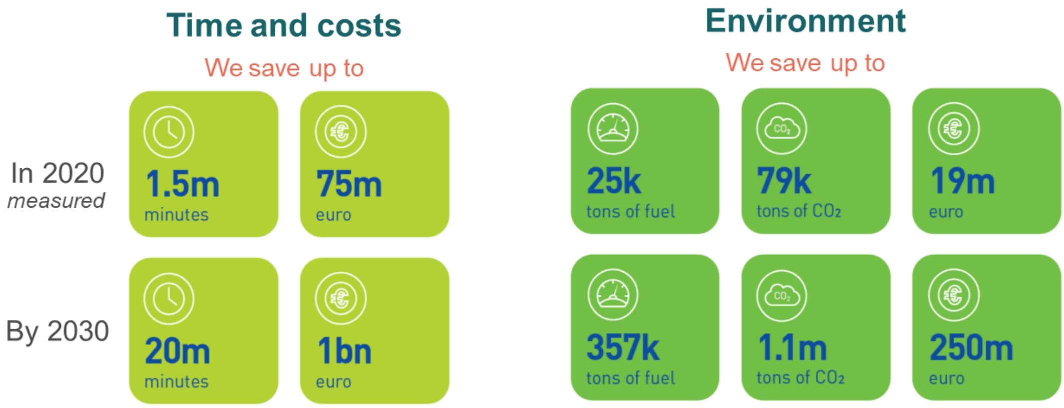

Figure 6: *First results of the first common project implemented.*

SESAR Exploratory Research (V0 to V1)

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

SESAR Industrial Research & Validation Projects (environmental focus)

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

- The initial development by EUROCONTROL of the IMPACT[37] web-based platform which allows noise impact assessments and estimates of fuel burn and resulting emissions to be made from common inputs, thus enabling trade-offs to be conducted. IMPACT has since been continuously maintained and developed by EUROCONTROL, used for ICAO Committee on Aviation Environmental Protection Modelling and Database Group (CAEP) assessments, the conduct of studies in support of the European Aviation Environment Report (EAER) editions 2016 and 2019, and has been adopted by a large range of aviation stakeholders.

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

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

- The initial development/maintenance Open-ALAQS that provides a mean to perform emissions inventory at airports, emissions concentration calculation and dispersion.
- The development of an IMPACT assessment process[38].

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

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

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

A catalogue of SESAR Solutions is available[39] and those addressing environment impacts are identified by the following pictogram:

SESAR2020 Industrial Research and Validation - Environmental Performance Assessment

The systematic assessment of environmental impacts of aviation are at the heart of SESAR Industrial Research and Validation activities since SESAR 1, with a very challenging target on fuel/ CO_2 efficiency of 500kg of fuel savings on average per flight.
SESAR Pj19.04 Content Integration members are monitoring the progress of SESAR Solutions towards this target in a document call Performance Assessment and Gap Analysis Report (PAGAR). The Updated version of PAGAR 2019 provides the following environmental achievements:

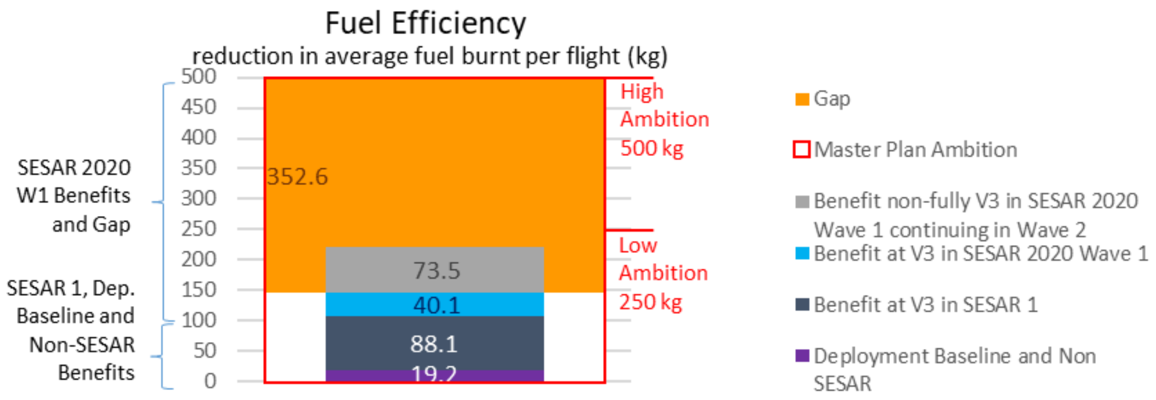

Figure 7: *SESAR fuel efficiency achievement versus gap (Source: Updated version of PAGAR 2019)*

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

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

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

A fuel saving of 40.1 kg per ECAC flight equates to about 0.76% of the 5,280kg of fuel burnt on average by an ECAC flight in 2012 (SESAR baseline). Although this might seem marginal, in 2035, ECAC-wide, it would equate to 1.9 million tonnes of CO_2 saved, equivalent to the CO_2 emitted by 165,000 Paris-Berlin flights; or a city of 258,000 European citizens; or the CO_2 captured by 95 million trees per year.

In SESAR, a value of 5,280 Kg of fuel per flight for the ECAC (including oceanic region) is used as a baseline[40]. Based on the information provided by the PAGAR 2019 document[41], the benefits at the end of Wave 1 could be about 3% CO_2/fuel savings achieved by 2025 equivalent to 147.4kg of fuel/flight. So far, the target for Wave 2 remains at about 7% more CO_2/fuel savings (352.6kg of fuel) to reach the initial Ambition target of about 10% CO_2/fuel savings (500kg fuel) per flight by 2035. Beyond 2035, there is no SESAR Ambition yet. To this could be added the as yet non-estimated benefits of Exploratory Research projects[42].

SESAR AIRE demonstration projects

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

AIRE[43] is the first large-scale environmental initiative bringing together aviation players from both sides of the Atlantic. So far, three AIRE cycles have been successfully completed.

A total of 15 767 flight trials were conducted, involving more than 100 stakeholders, demonstrating savings ranging from 20 to 1 000kg of fuel per flight (or 63 to 3150 kg of CO_2), and improvements in day-to-day operations. Another nine demonstration projects took place from 2012 to 2014, also focusing on the environment, and during 2015/2016 the SESAR JU co-financed fifteen additional large-scale demonstration projects, which were more ambitious in geographic scale and technology.

SESAR 2020 Very Large-Scale Demonstrations (VLDs)

VLDs evaluate SESAR Solutions on a much larger scale and in real operations to prove their applicability and encourage the early take-up of V3 mature solutions.

SESAR JU has recently awarded ALBATROSS[44], a consortium of major European aviation stakeholder groups to demonstrate how the a consortium of major European aviation

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

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

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

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

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

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

Preparing SESAR

Complementing the European ATM Master Plan 2020 and the High-Level Partnership Proposal, the Strategic Research and Innovation Agenda (SRIA) details the research and innovation roadmaps to achieve the Digital European Sky, matching the ambitions of the 'European Green Deal' and the 'Europe fit for the digital age' initiative.
The SRIA[45] identifies inter-alia the need to continue working on "optimum green trajectories", on non-CO_2 impacts of aviation, and the need to accelerate decarbonisation of aviation through operational and business incentivisation.

ASSESSMENT:

The quantitative assessment of the operational and ATM improvement scenario from 2020 to 2050 has been included in the modelled scenarios by EUROCONTROL on the basis of efficiency analyses from the SESAR project indicated in Figure 7 above and it is included in Section A above (ECAC Baseline Scenario and Estimated Benefits of Implemented Measures).

Year	CO_2 emissions (10^9 kg)	
	Baseline Scenario	Implemented Measures Scenario
		ATM improvements
2030	160.29	149.9
2040	197.13	177.4
2050	210.35	197.4
For reasons of data availability, results shown in this table do not include cargo/freight traffic. Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.		

Table 9. *CO_2 emissions forecast for the ATM improvements scenarios.*

3.3.2 Market-Based Measures

3.3.2.1 The Carbon Offsetting and Reduction Scheme for International Aviation

ECAC Member States have always been strong supporters of a market-based measure scheme for international aviation to incentivise and reward good investment and operational choices, and so welcomed the agreement on the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

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

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

The 39th General Assembly of ICAO (2016) reaffirmed the 2013 objective of stabilising CO_2 emissions from international aviation at 2020 levels. In addition, the States adopted the introduction of a global market-based measure, namely the '*Carbon Offsetting and Reduction Scheme for International Aviation*' (CORSIA), to offset and reduce international aviation's CO_2 emissions above average 2019/2020 levels through standard international CO_2 emissions reductions units which would be put into the global market. This major achievement was most welcome by European States which have actively promoted the mitigation of international emissions from aviation at a global level.

Development and update of ICAO CORSIA standards

European Member States have fully supported ICAO's work on the development of Annex 16, Volume IV to the Convention on International Civil Aviation containing the Standards and Recommended Practices (SARPs) for the implementation of CORSIA, which was adopted by the ICAO Council in June 2018.

As a part of the ICAO's Committee on Aviation Environmental Protection (CAEP) work programme for the CAEP/12 cycle, CAEP's Working Group 4 (WG4) is tasked to maintain the Annex 16, Volume IV and related guidance material, and to propose revisions to improve those documents as needed.

Europe is contributing with significant resources to the work of CAEP-WG4 and EASA in particular by providing a WG4 co-Rapporteur, and by co-leading the WG4 task on maintaining the Annex 16, Volume IV and related guidance material.

CORSIA implementation

In application of their commitment in the 2016 "Bratislava Declaration" the 44 ECAC Member States have notified ICAO of their decision to voluntarily participate in CORSIA from the start of the pilot phase in 2021 and have effectively engaged in its implementation. This shows the full commitment of the EU, its Member States and the other Member States of ECAC to counter the expected in-sector growth of total CO_2 emissions from air transport and to achieving overall carbon neutral growth.

On June 2020, the European Council adopted COUNCIL DECISION (EU) 2020/954 on the position to be taken on behalf of the European Union within the International Civil Aviation Organization as regards the notification of voluntary participation in the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) from 1 January 2021 and the option selected for calculating aeroplane operators' offsetting requirements during the 2021-2023 period.

ASSESSMENT:

CORSIA is a global measure which assessment is undertaken globally by ICAO. Thus, the assessment of the benefits provided by CORSIA in terms of reduction in European emissions is not provided in this action plan.

The EU Emissions Trading System and its linkages with other systems (Swiss ETS and UK ETS)

The EU Emissions Trading System (EU ETS) is the cornerstone of the European Union's policy to tackle climate change, and a key tool for reducing greenhouse gas emissions cost-effectively, including from the aviation sector.

The 30 EEA States in Europe have already implemented the EU Emissions Trading System (ETS), including the aviation sector with around 500 aircraft operators participating in the cap-and-trade approach to limit CO_2 emissions. It was the first and is the biggest international system capping greenhouse gas emissions. In the period 2013 to 2020 EU ETS has saved an estimated 200 million tonnes of intra-European aviation CO_2 emissions.

It operates in 30 countries: the 27 EU Member States, Iceland, Liechtenstein and Norway. The EU ETS currently covers half of the EU's CO_2 emissions, encompassing those from around 11 000 power stations and industrial plants in 30 countries, and, under its current scope, around 500 commercial and non-commercial aircraft operators that fly between airports in the European Economic Area (EEA). The EU ETS Directive was revised in line with the European Council Conclusions of October 2014[46] that confirmed that the EU ETS will be the main European instrument to achieve the EU's binding 2030 target of an at least 40%[47], and will be revised to be aligned with the latest Conclusions in December 2020[48], prescribing at least 55% domestic reduction (without using international credits) of greenhouse gases compared to 1990.

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

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

The legislation to include aviation in the EU ETS was adopted in 2008 by the European Parliament and the Council[49].

Following the 2013 ICAO agreement on developing CORSIA, the EU decided[50] to limit the scope of the EU ETS to flights between airports located in the European Economic Area (EEA) for the period 2013-2016, and to carry out a new revision in the light of the outcome of the 2016 ICAO Assembly. The European Commission assessed the outcome of the 39th ICAO Assembly and, in that light, a new Regulation was adopted in 2017[51].

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

[47] 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

[48] 1011-12-20-euco-conclusions-en.pdf (europa.eu)

[49] 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

[50] 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

[51] 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,

The legislation maintains the scope of the EU ETS for aviation limited to intra-EEA flights and sets out the basis for the implementation of CORSIA. It provides for European legislation on the monitoring, reporting and verification rules through a delegated act under the EU ETS Directive of July 2019[52]. It foresees that a further assessment should take place and a report be presented to the European Parliament and to the Council considering how to implement CORSIA in Union law through a revision of the EU ETS Directive. The European Green Deal and 2030 Climate Target Plan clearly set out the Commission's intention to propose to reduce the EU ETS allowances allocated for free to airlines. This work is currently ongoing and is part of the "Fit for 55 package"[53].

The EU legislation foresees that, where a third country takes measures to reduce the climate change impact of flights departing from its airports, the EU will facilitate interaction between the EU scheme and that country's measures and flights arriving from the third country could be excluded from the scope of the EU ETS. This is the case between the EU and Switzerland[54] following the agreement to link their respective emissions trading systems, which entered into force on 1 January 2020.

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

Impact on fuel consumption and/or CO_2 emissions

The EU ETS has delivered around 200 MT of CO_2 emission reductions between 2013 and 2020[55]. While the in-sector aviation emissions for intra-EEA flights kept growing, from 53,5 million tonnes CO_2 in 2013 to 69 million in 2019, the flexibility of the EU ETS, whereby aircraft operators may use any allowances to cover their emissions, meant that the CO_2 impacts from these flights did not lead to overall greater greenhouse gas emissions. Verified emissions from aviation covered by the EU Emissions Trading System (ETS) in 2019 compared to 2018 continued to grow, albeit more modestly, with an increase of 1% compared to the previous year, or around 0.7 million tonnes CO_2 equivalent[56].

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

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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

[52] the European Parliament and of the Council as regards measures adopted by the International Civil Aviation Organisation for the monitoring, reporting and verification of aviation emissions for the purpose of implementing a global market-based measure https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2019.250.01.0010.01.ENG

[53] 2021_commission_work_programme_new_policy_objectives_factsheet_en.pdf (europa.eu)

[54] Commission Delegated Decision (EU) 2020/1071 of 18 May 2020 amending Directive 2003/87/EC of the European Parliament and of the Council, as regards the exclusion of incoming flights from Switzerland from the EU emissions trading system, OJ L 234, 21.7.2020, p. 16.

[55] See the 2019 European aviation environmental report: "Between 2013 and 2020, an estimated net saving of 193.4 Mt CO_2 (twice Belgium's annual emissions) will be achieved by aviation via the EU ETS through funding of emissions reduction in other sectors.", https://www.eurocontrol.int/publication/european-aviation-environmental-report-2019

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

In terms of its contribution towards the ICAO carbon neutral growth goal from 2020, the states implementing the EU ETS have delivered, in "net" terms, the already achieved reduction of around 200 MT of aviation CO_2 emissions will continue to increase in the future under the new legislation. Other emission reduction measures taken, either collectively throughout Europe or by any of the states implementing the EU ETS, will also contribute towards the ICAO global goals. Such measures are likely to moderate the anticipated growth in aviation emissions. measures are likely to moderate the anticipated growth in aviation emissions.

ASSESSMENT:

A quantitative assessment of the EU Emissions Trading System benefits based on the current scope (intra-European flights) is shown in Table 10.

Estimated emissions reductions resulting from the EU-ETS[57]

Year	*Reduction in CO_2 emissions*
2013-2020	*~200 MT[58]*

Table 10: *Summary of estimated EU-ETS emission reductions*

Those benefits illustrate past achievements.

3.3.3 Additional Measures

3.3.3.1 ACI Airport Carbon Accreditation

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

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

58 See the 2019 European aviation environmental report: "Between 2013 and 2020, an estimated net saving of 193.4 Mt CO_2 (twice Belgium's annual emissions) will be achieved by aviation via the EU ETS through funding of emissions reduction in other sectors.", https://www.eurocontrol.int/publication/european-aviation-environmental-report-2019

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

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

In addition to the already existing four accreditation levels, in 2020 two new accreditation levels were introduced: Level 4 and Level 4+. The introduction of those two new levels aims on one hand to align the programme with the objectives of the Paris Agreement and on the other hand to give, especially to airports that have already reached a high level of carbon management maturity, the possibility to continue their improvements[59].

The six steps of the programme are shown in **Figure 8** and are as follows: Level 1 "Mapping", Level 2 "Reduction", Level 3 "Optimisation", Level 3+ "Neutrality", Level 4 "Transformation" and Level 4+ "Transition".

***Figure 8** Six steps of Airport Carbon Accreditation*

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

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

have already achieved accreditation at the newly introduced levels: 1 a Level 4 and 4 airports a Level 4+ accreditation.

One of its essential requirements is the verification by external and independent auditors of the data provided by airports. The Administrator of the programme has been collecting CO_2 data from participating airports since the programme launch. This has allowed the absolute CO_2 reduction from the participation in the programme to be quantified.

Aggregated data are included in the Airport Carbon Accreditation Annual Reports thus ensuring transparent and accurate carbon reporting. At Level 2 of the programme and above, airport operators are required to demonstrate CO_2 reductions associated with the activities they control.

The Annual Report, which is published in the fall of each year, typically covers the previous reporting year (i.e., mid-May to mid-May) and presents the programme's evolution and achievements. However, because of the extraordinary conditions faced in 2020 due to COVID-19 pandemic, special provisions are applied to all accredited airports, including the merge of programme years 11 and 12, which implies the extension of accreditation validity by one year. Thus, the current Airport Carbon Accreditation certification period covers the timespan May 2019 to May 2021. For this reason, the last published Report is considered as an Interim Report which addresses only a part of the on-going reporting period (i.e., from 16th May 2019 to 11th December 2020), and as such does not include the usual carbon Key Performance Indicators, but only valuable information regarding key achievements and developments, the most significant global and regional trends, and case studies highlighting the airports' commitment to continued climate action in spite of the current crisis. Therefore, the tables below show carbon performance metrics until the 2018/2019 regular reporting cycle.

For historical reasons European airports remain at the forefront of airport actions to voluntarily mitigate and reduce their impact on climate change. The strong growth momentum is still being maintained as there are 167 airports in the programme. These airports account for 69.7% of European air passenger traffic.

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

Table 11. *Emissions reduction highlights for the European region*

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

Table 12*. Emissions offset for the European region*

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

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

Table 12. *Airport Carbon Accreditation key performance indicators 2018/2019*

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

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

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

ASSESSMENT:

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

3.3.3.2 European industry roadmap to a net zero European aviation: Destination 2050

DESTINATION 2050

The Destination 2050[60] is an initiative and roadmap developed by aviation industry stakeholders (A4E, ACI EUROPE, ASD, CANSO and ERA) showing an ambitious decarbonisation pathway for European aviation.

These European industry organizations commit to work together with all stakeholders and policymakers to achieve the following climate objectives:

- Reaching net zero CO_2 emissions by 2050 from all flights within and departing from the European Economic Area, Switzerland and the UK. This means that by 2050, emissions from these flights will be reduced as much as possible, with any residual emissions being removed from the atmosphere through negative emissions, achieved through natural carbon sinks (e.g., forests) or dedicated technologies (carbon capture and storage). For intra-EU flights, net zero in 2050 might be achieved with close to no market-based measures..
- Reducing net CO_2 emissions from all flights within and departing from the European Economic Area, Switzerland and the UK by 45% by 2030 compared to the baseline[61]. In 2030, net CO_2 emissions from intra-EU flights would be reduced by 55% compared to 1990 levels.
- Assessing the feasibility of making 2019 the peak year for absolute CO_2 emissions from flights within and departing from the European Economic Area, Switzerland and UK.

With the Destination 2050 roadmap and through these commitments, the European aviation sector contributes to the Paris Agreement, recognising the urgency of pursuing the goal of limiting global warming to 1.5°C.

By doing so, the European aviation sector is also effectively contributing to the collective European Green Deal and EU's climate neutrality objectives.

This roadmap is complementary to the WayPoint 2050 Air Transport Action Group (ATAG) global pathway for the decarbonization of aviation.

ASSESSMENT:

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

3.3.3.3 Environmental Label Programme

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

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60 www.destination2050.eu

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

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

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

While the potential CO_2 emissions reductions generated by such a label were not quantified at this stage, it is proposed to keep the ICAO updated on future developments concerning the European environmental labelling initiative, including on potential CO_2 emissions savings.

ASSESSMENT:

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

3.3.3.4 Multilateral capacity building projects

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

EASA capacity-building partnerships

EASA has been selected as an implementing Agency for several of these initiatives, including the **EU-South East Asia Cooperation on Mitigating Climate Change impact from Civil Aviation** (EU-SEA CCCA), launched in 2019, and a **Capacity Building Project for CO_2 Emissions Mitigation in the African and Caribbean Region**, launched in 2020.

The overall objective of these projects[62] is to enhance the partnership between the EU and partner States in the areas of civil aviation environmental protection and climate change, and to achieve long-lasting results that go beyond the duration of the projects. The specific objectives of the two projects are to develop or support existing policy dialogues with partner States on mitigating GHG emissions from civil aviation, to contribute to the CORSIA readiness process of partner States, as well as to implement CORSIA in line with the agreed international schedule, including considerations of joining the voluntary offsetting phase starting in 2021 or at the earliest time possible. On top of the CORSIA-related support, these projects are assisting the partner States in the development and update of the State Action Plans to reduce CO_2 emissions from civil aviation, as well as providing support in the development of emission data management tools supporting the implementation of State Action Plans and CORSIA.

By January 2021, the EU-SEA CCCA had improved the technical readiness of all the 10 partner States in the region, as well as their aeroplane operators' capabilities to comply

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

with CORSIA requirements. Five States had implemented emission data management solutions to generate CORSIA Emission Reports, and eight States had successfully submitted their 2019 CORSIA CO_2 Emissions Reports to ICAO. 4 CORSIA verification bodies had been accredited in the region with dedicated support to their respective National Accreditation Bodies to finalise the accreditation process.

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

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

ICAO - European Union Assistance Project

The assistance project *Capacity Building on CO_2 mitigation from International Aviation* was launched in 2013 with funding provided by the European Union, while implementation was carried out by ICAO Environment.

Fourteen States from Africa and the Caribbean were selected to participate in this 5-year programme, successfully implemented by ICAO from 2014 to 2019, achieving all expected results and exceeding initial targets.

The first objective of the ICAO-EU project was to create national capacities for the development of action plans. ICAO organized specific training-seminars, directed the establishment of National Action Plan Teams in the selected States, and assisted each civil aviation authority directly in the preparation of their action plans.

By June 2016, the 14 selected States had developed action plans fully compliant with ICAO's guidelines, including robust historical data and a reliable baseline scenario. A total of 218 measures to reduce fuel consumption and CO_2 emissions were proposed in the action plans, including those related to aircraft technology, operational measures, and sustainable aviation fuels.

Four pilot mitigation measures and five feasibility studies were executed with project funding in the beneficiary States. In addition to those, the beneficiary States implemented 90 mitigation measures within the project timeframe, which had been included in their action plans[63].

With the support provided by the ICAO-EU project, ICAO has succeeded in assisting the beneficiary States transform the organizational culture towards environmental protection in aviation, through the establishment of Environmental Units with dedicated staff in the Civil Aviation Authorities along with the voluntary decision of seven selected States of the project to join the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) from its outset.

The Phase two of this project is currently being implemented by ICAO and EASA. It covers ten African States: Benin, Botswana, Cabo Verde, Comoros, Côte d'Ivoire,

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

Madagascar, Mali, Rwanda, Senegal and Zimbabwe. The project will run between 2020 and 2023.

ASSESSMENT:

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

3.3.3.5 Green Airports research and innovation projects

Under the EU research and innovation actions in support of the European Green Deal and funded by the Horizon 2020 Framework Programme, the European Commission has launched in 2020 the call for tenders: ***Green airports and ports as multimodal hubs for sustainable and smart mobility***.

A clear commitment of the European Green Deal is that "transport should become drastically less polluting", highlighting in particular the urgent need to reduce greenhouse gas emissions (GHG) in aviation and waterborne transport.

In this context, airports play a major role, both as inter-connection points in the transport networks, but also as major multimodal nodes, logistics hubs and commercial sites, linking with other transport modes, hinterland connections and integrated with cities.

As such, green airports as multimodal hubs in the post COVID-19 era for sustainable and smart mobility have a great potential to immediately contribute to start driving the transition towards GHG-neutral aviation, shipping and wider multimodal mobility already by 2025.

The scope of this research program is therefore addressing innovative concepts and solutions for airports and ports, in order to urgently reduce transport GHG emissions and increase their contribution to mitigating climate change.

Expected outcomes:

The projects will perform large-scale demonstrations of green airports, demonstrating low emission energy use (electrification or sustainable aviation fuels) for aircraft, airports, other/connected and automated vehicles accessing or operating at airports (e.g. road vehicles, rolling stock, drones), as well as for public transport and carpooling, with re charging/re-fuelling stations and use of incentives.

They will also put the focus on the development of SAF for its use at airports.

The deadline to receive project proposals was closed in January 2021 and at the time of this action plan update the proposals are under revision. Future action plan updates will provide further information on the benefits of the implementation of this measure.

ASSESSMENT:

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

3.3.4 Supplemental Benefits for Domestic Sectors

Although the benefits of all the European collective measures included in this action plan are focused on international aviation, they are also applicable to domestic aviation (except CORSIA) and thus, will bring supplemental benefits in terms of CO_2 emissions reductions in the domestic European air traffic.

In addition, a number of those measures taken collectively in Europe and contained in this action plan offer as well additional supplemental benefits for domestic sectors beyond CO_2 savings. Those are summarized below.

3.3.4.1 ACI Airport Carbon Accreditation

Airport Carbon Accreditation is referred among the measures contained in this action plan aiming to encourage and enable airports to implement best practice carbon and energy management processes.

While its main objective is supporting airport actions to voluntarily mitigate and reduce their impact on climate change, the programme's main immediate environmental co benefit is the improvement of local air quality linked to the non-CO_2 additional emissions benefits from the reduction of fuel burn that an airport operator can control, guide and influence.

3.3.4.2 ReFuel EU Aviation Initiative

Through the large-scale use of SAF, emissions of other pollutants impacting local air quality and other non- CO_2 effects on the climate can also be reduced, implying important potential supplemental benefits beyond CO_2 emissions reductions.

In addition to the reduction of CO_2 emissions, SAF has the additional benefit of reducing air pollutant emissions around airports when emitted during take-off and landing as emissions of particulate matter (PM) with up to 90% and sulphur (SO_X) with 100%, compared to fossil jet fuel[64].

Preserving the quality of natural resources can be considered an additional benefit of any policy measure aiming to increase the sustainability of aviation by boosting the SAF market while paying particular attention to the overall environmental integrity of the SAF incentivised, as it is the case of the ReFuelEU Initiative.

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

3.3.4.3 SAF Research and development projects

One European research project funded by the Horizon 2020 Research and Innovation program of the EU, is currently assessing, among other objectives, the additional

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

supplemental benefits for domestic sectors of the use of sustainable aviation fuels, beyond its climate benefits.

AVIATOR PROJECT[65]: The project *"Assessing aviation emission Impact on local Air quality at airports: Towards Regulation"* aim to better understand air quality impacts of aviation issues, developing new tools and regulation, and linking with the health community, providing unbiased data to society.

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

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

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

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

3.3.4.4 The EU's Single European Sky Initiative and SESAR

The European Union's Single European Sky (SES) initiative and its SESAR (*Single European Sky ATM Research Programme*) programme are aiming to deploy a modern, interoperable and high-performing ATM infrastructure in Europe, as has been described above in detail in this action plan, among its key operational measures to reduce CO_2 emissions.

But the environmental outcomes of SESAR implementation go far beyond reducing fuel burn, and the key deliverables from the SESAR Programme have also a significant potential to mitigate **non-CO_2 emissions and noise impacts**.

It should be noted that although no targets have yet been set for non-CO_2 emissions (at local or global level) and noise impacts, the ATM Master Plan requires that each SESAR solution with an impact on these environmental aspects assesses them to the extent possible and within available resources.

In this context, for example the EUROCONTROL *Integrated aircraft noise and emissions modelling platform* IMPACT, which delivers noise contour shape files, surface and population counts based on the European Environment Agency population database, estimates of fuel burn and emissions for a wide range of pollutants, and geo-referenced inventories of emissions within the landing and take-off portion, is one of the recommended models for conducting environmental impact assessments in SESAR.

3.3.4.5 Green Airports research and innovation projects

The European Commission's Green Airports research and innovation projects referred in this action plan among the "Other measures" commonly implemented in Europe has key

65 https://aviatorproject.eu

objectives to achieve important supplemental benefits beyond CO_2 emissions reductions, among them:

Circular Economy:

- Developing the built environment (construction/demolition) using more ecologically friendly materials and processes and incorporating these improvements in the procurement processes to sustainably decrease the ecological footprint.
- Promoting the conversion of waste to sustainable fuels.
- Addressing the sustainable evolution of airports, also in the context of circular economy (e.g. activities linked to aircraft decommissioning and collection/sorting of recyclable waste), considering institutional and governance aspects, ownership, regulation, performance indicators and balance of force between regulators, airlines and airport operators.
- Addressing the feasibility of a market-based instrument to prevent/reduce Food Loss and Waste (FLW) and to valorise a business case of transformation of FLW into new bio-based products. This includes FLW measurement and monitoring methodologies and the subsequent mapping of FLW total volume at stake in the considered airport.

Biodiversity:

- Enhancing biodiversity, green land planning and use, as well as circular economy (e.g. repair, reuse and recycling of buildings and waste, in the context of zero-waste concepts).

Non-CO_2 impacts:

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

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APPENDIX A

Detailed results for ECAC Scenarios from Ch. 3.1

1. BASELINE SCENARIO

a) Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres[66] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[67] FTKT (billion)	Total Revenue Tonne Kilometres[68] RTK (billion)
2010	4.56	1,114	0.198	45.4	156.8
2019	5.95	1,856	0.203	49.0	234.6
2030	5.98	1,993	0.348	63.8	263.1
2040	7.22	2,446	0.450	79.4	324.0
2050	8.07	2,745	0.572	101.6	376.1

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

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

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

2. IMPLEMENTED MEASURES SCENARIO:

2A) EFFECTS OF AIRCRAFT TECHNOLOGY IMPROVEMENTS AFTER 2019

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

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

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

a) Fuel consumption and CO_2 emissions of international passenger traffic departing from ECAC airports, with aircraft technology improvements after 2019 included:

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Well-to-wake CO_2e emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	36.95	116.78	143.38	0.0332	0.332
2019	52.01	164.35	201.80	0.0280	0.280
2030	49.37	156.00	191.54	0.0232	0.232
2040	56.74	179.28	220.13	0.0217	0.217
2050	59.09	186.72	229.26	0.0202	0.202
For reasons of data availability, results shown in this table do not include cargo/freight traffic.					

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

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

2B) EFFECTS OF AIRCRAFT TECHNOLOGY AND ATM IMPROVEMENTS AFTER 2019

a) Fuel consumption and CO_2 emissions of international passenger traffic departing from ECAC airports, with aircraft technology and ATM improvements after 2019:

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Well-to-wake CO_2e emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	36.95	116.78	143.38	0.0332	0.332
2019	52.01	164.35	201.80	0.0280	0.280
2030	46.16	145.86	179.09	0.0217	0.217
2040	51.06	161.35	198.12	0.0196	0.196
2050	53.18	168.05	206.33	0.0182	0.182
For reasons of data availability, results shown in this table do not include cargo/freight traffic.					

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

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

c) Equivalent (well-to-wake) CO_2e emissions forecasts for the scenarios described in this common section

Year	Well-to-wake CO_2e emissions (10^9 kg)			% improvement by Implemented Measures (full scope)
	Baseline Scenario	Implemented Measures Scenario		
		Aircraft techn. improvements only	Aircraft techn. and ATM improvements	
2010	143.38			NA
2019	201.80			NA
2030	196.8	191.5	179.1	-9%
2040	242.0	220.1	198.1	-18%
2050	269.3	229.3	206.3	-23%
For reasons of data availability, results shown in this table do not include cargo/freight traffic. Note that fuel consumption is assumed to be unaffected by the use of alternative fuels.				

APPENDIX B

NOTE ON THE METHODS TO ACCOUNT FOR THE CO_2 EMISSIONS ATTRIBUTED TO INTERNATIONAL FLIGHTS

1 Background

The present note addresses recommendations on the methodologies to account the CO_2 emissions, for the guidance on the development of the common European approach for ECAC States to follow, in view of the submission to ICAO of their updated State Action Plans for CO_2 Emissions Reduction (APER).

The ECAC APER guidance shall be established on the basis of the ICAO 9988 Guidance on the Development of States' Action Plans on CO_2 Emissions Reduction Activities document (3rd edition). One of its objectives is to define a common approach for accounting CO_2 emissions of international flights: two different methods are proposed for CO_2 accounting, namely ICAO and IPCC. Because of their intrinsic definitions, it is expected that these two different approaches induce both accounting differences, and practical issues, and furthermore, two ways to target the CO_2 Emissions Reduction Activities, and to define the action plans, de facto.

As the objective of the definition of the common section of the ECAC APER guidance consists into determining a common approach for all the foreseen activities, including CO_2 accounting and monitoring, the ECAC APER Task Group required to assess the details of each methods and to propose recommendations in this present note.

2 Accounting methods

The ICAO Doc 9988 document 3rd edition defines the two CO_2 accounting methods (§3.2):

a) ICAO: each State reports the CO_2 emissions from the international flights operated by aircraft registered in the State (State of Registry).

b) IPCC: each State reports the CO_2 emissions from the international flights departing from all aerodromes located in the State or its territories (State of Origin).

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

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

2.1 Comparisons: flown distance and number of operations

The comparison of the number of operations and flown distance of 2019, aggregated at ECAC or State levels provide a good indication of the possible differences for CO_2 accounting.

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

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

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

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

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

3 Impact on the action plan definitions

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

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

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

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

3.1 IMPACT on the baseline definition (ECAC)

The selection of the ICAO/IPCC method also affects the definition and estimation of the CO_2 emissions of the international flights at the ECAC level.

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

4. NATIONAL MEASURES IN ITALY

4.0 Foreword

The scope of this section is to illustrate the additional measures taken by Italy, to further reduce the emissions of CO_2 as well as to show some peculiarities of the implementation of other actions already taken at supranational level. Even though at the end of this paragraph there is a quantitative estimation of the savings generated by such actions, this shall not be construed as an additional quantity of savings in addition to the European regional baseline, already indicated in the supranational section. Consequently, and also in order to avoid errors of double counting, the figures indicated in this section shall be interpreted only as a mathematical ratio "savings/emissions directly generated by Italian airlines".

4.1 Historic emissions and baseline

Since the first edition of the Action Plan Italy established a panel of stakeholders in order to track over time the amount of $C0_2$ emissions generated by the Airlines that operate in Italy, regardless of the nationality. So originally the panel was meant to fully match the criteria set by IPCC, taking into account the peculiarity (shown in the first section of this Action Plan) that the market share of the Italian Airlines decreased over time, being now less than 50%, and so the contribution to the emissions generated by foreign airlines could not be disregarded.

However, for several reasons, the cooperation with foreign airlines became more and more difficult over time, because of the different set of flights to consider for the emissions to be reported in accordance with the ICAO CORSIA scheme. That would have required each airline to filter and sort the flights, and report a different set of data to each different country where an airline operates.

Most of the traffic of the Italian market (as shown in section 1) is operated by airlines that operate in several countries, mainly for intra European connections. For these reasons the number of foreign airlines participating to the panel decreased over time, and recently could be no longer considered significant.

So the original format was dropped and now the panel only includes the national airlines, the ANSP (ENAV), the Italian Industry and the airport operators.

Currently all the Italian Airlines report to Enac the emission generated by the use of their fleet, and present to the NAA a list of actions with the sake of reducing the emissions, in addition to the results coming from other actions coordinated at supranational level. The ANSP (ENAV), the Industry and the airport operators also present to the NAA a list of actions that contribute to the reduction of the emissions.

This section illustrates some of these actions that were considered worth mentioning. The emissions shown below have been calculated on the basis of the following rationale:

With the aim of quantifying the traffic data under Italian responsibility for the baseline, the following assumptions have been taken into consideration.

Italy is a full member of the EU and, consequently, every EU registered operator is free to operate domestic flights within Italy, as well as international intra-European flights.
As per ICAO definition of "international flight", international intra-European flights are always considered "international" and, therefore, the competent authority, overviewing non-Italian operators, is the National Aviation Authority, that registered such operators.

For this Action Plan, Italy decided to adopt the IPCC methodology to differentiate international and domestic aviation operations: a flight departing from an Italian airport and arriving at another Italian airport is always considered domestic, regardless of the nationality of the air operator.

However there are several different scenarios when counting the CO_2 emissions of the international flights within the IPCC framework:

- If the flight is operated by an Italian airline, its emissions are included in the Italian national baseline of this section, only for the outbound flights. The emissions coming from the inbound flight have not been included in the baseline of this section.
- If the flight is operated by a foreign airline, and connects Italy to the State where the operator is registered, the relevant emissions have not been included in the baseline of this section
- If the flight is operated by a foreign airline and connects Italy to a State other than the one where the operator is registered, the relevant emissions have not been included in the baseline of this section
- If the flight is operated under 5th freedom, only emissions of the outbound flights are considered the relevant emissions have not been included in the baseline of this section

The part of the table that shows the total quantity of emissions (domestic+ international), has been calculated considering all the domestic flights operated by the Italian airlines; domestic flights operated by foreign airlines (mainly registered in other EU countries) have not been considered.

In this latter case, some non-Italian airlines that operate domestic flights in the Italian market, actually reported the quantity of CO_2 emissions to Italy on a voluntary basis, however the set of data was incomplete and could not be included in the table.
The table below shows, in accordance with the above IPCC definition, the international percentage of the passengers transported:

- from Italian airports;
- to Italian airports by Italian airlines only.

It is to keep in mind that:

- Data from airlines transporting less than 100.000 passenger a year have not been considered;
- Italian Cargo airlines have been included.

The table below show the emissions of CO_2 generated by Italian airlines operating in Italy, according to the IPCC definition of international flights. Data have been rounded to facilitate reading.
The table below only refers to the airlines that are under direct control of ENAC, the Italian Civil Aviation Authority:

Year	Total RTKs (tonne-kilometres)	Total fuel (litres)	Total CO_2 emissions (metric tonnes)	International RTKs (tonne-kilometres)	International fuel (litres)	International CO_2 emissions (metric tonnes)
2018	1.899.512.595	721.303.070	1.823.198	1.897.004.449	707.932.517	1.789.488
2019	1.946.704.426	756.377.384	1.912.265	1.943.529.069	741.711.306	1.874.793
2020	366.554.350	199.115.304	504.332	362.360.154	178.876.826	452.124

The data of the RTK are partial and include only the numbers from the airlines that reported such numbers. The values for 2020 include the effects of the Covid pandemic. Also, unlike the previous editions of the action plan, there is no forecast for the future since the model that was used by several airlines could not be considered enough robust.

4.2 National actions for sustainable development of Air Transport

Since Civil Aviation is an essential component of the development of the global economy, all the environmental actions of this edition of the CO_2 emissions reduction plan try to find a balance among the needs of mobility of the population, the industry growth and an environmentally sustainable growth. The emissions reduction must be pursued through the adoption of appropriate technological, operational, infrastructural and economical measures.
To obtain sound results, the measures identified by ICAO must be applied in a coordinated manner by all the stakeholders involved, under the supervision of National Civil Aviation Authorities. This supervision involves an objective complexity due to the multitude of stakeholders and to the difficulty of collecting consistent measurable and complete data, to refer them to a common base year and to test the goal achieved by each proposal within an appropriate timing.
In any case, looking at Italian targets of emissions reduction, it must be underlined that Italy joins the group of the most developed countries in the field of air transport, both in Europe and worldwide, for airport infrastructures, configuration of the airline's fleet and optimization of ATM.
Italy has already made several significant steps toward an environmental sustainable civil aviation, with actions individually taken by aeronautical operators and through an active participation in European programmes.
Even though, in accordance with ICAO Resolutions, National Action Plans should incorporate information on activities that aim at addressing CO_2 emissions only from international aviation, Italy considers the aviation sector as a whole. Therefore, the Italy's Action Plan provides information on measures affecting both domestic and international operations and on emissions deriving from airport and/or ground support equipment operations.
Italy is at the forefront in this field and is in a prime position in fulfilling the expectations for global emissions reduction, since policies and strategies for sustainable development of air transport have been already implemented.

4.2.1 Aircraft technology and Flight operations

Aviation is a small but important contributor to climate change. Aircraft are estimated to contribute for roughly 3,5% of the total radioactive forcing (a measuring unit of climate change) produced by all human activities. This percentage, which excludes the effects of possible changes in cirrus clouds, is expected to grow.
CO_2 emissions from air transport represent roughly 2% of total global CO_2 emissions. Fuel burning is responsible for the GHG increase and, on the other hand, the fuel price is one of the major drivers in the determination of profitability in aviation

industry. The implementation of a fuel efficiency policy has been pushed forward as a consequence of the oil cost growth in the last decade. A consequence of this fuel efficiency policy is the CO_2 emissions reduction. Since 2009 some Italian airlines have been adopting several measures for fuel saving, in order to prevent a more significant downgrade, to avoid a worsening of the global economic crisis, as well as in application of the ETS system.
The basket of selected and implemented measures comprises:

Aircraft Related Technology Development

- From 2009 to 2019 Italian airlines phased out most of their old aircraft (MD80; B737 old generation; B767 etc.) with new and more fuel efficient aircraft. The reduction of fuel consumption can be estimated around 20% compared to consumption of MD80 aircraft and 10% compared to consumption of B737 old generation. In absolute terms, Italian airlines saved every year CO_2 emissions equivalent to about 1000 tonnes per aircraft phased out. After the phase out of the majority of the old aircraft, and with the entrance into their fleet of new aircraft, the average age of the Italian airlines fleet is now quite low;
- Winglets have been installed on some long range aircraft with an estimated fuel saving of about 6% per modified aircraft;
- Engines replacement has been accomplished on long range aircraft with new and more efficient engines;
- Some Italian airlines have already introduced in their long haul fleet the latest models of Boeing 787, resulting in a 20% savings of CO_2 emissions compared to the aircraft model previously operated;
- Some foreign airlines operating in Italy (in the domestic, intra-EU and extra-EU market), introduced the latest models of Boeing 737 Max and Airbus 320 Neo with geared turbofan engines, saving 15% CO_2 emissions compared to the aircraft model previously operated.
- Because of the pandemic almost all the Italian airlines accelerated the phase out of part of the fleet; according to the latest estimates, the remaining national fleet should be at least 30% smaller compared with the pre-covid scenario.

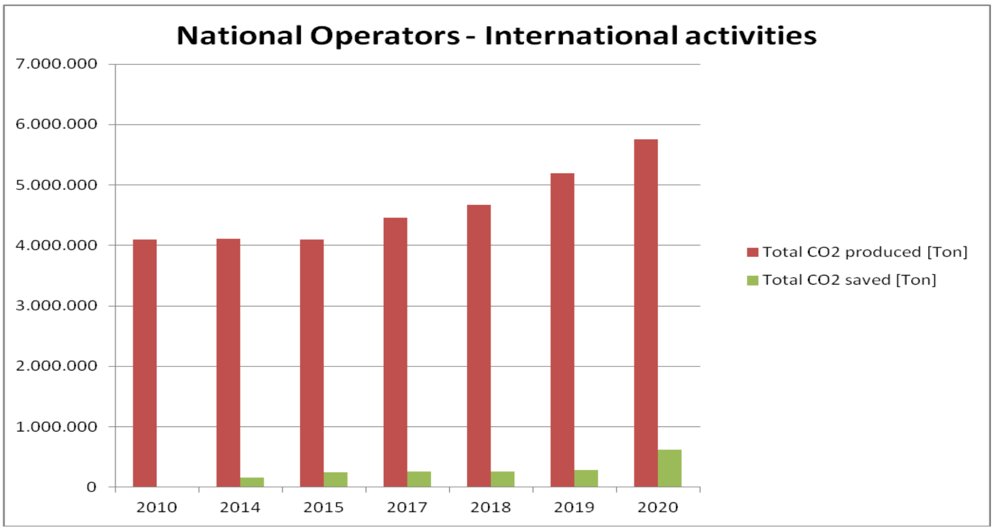
Improvement of Air Traffic Management

- The Actualized Operation Flight Plan has been implemented in order to establish fuel quantity based on actualized updated information en route and on arrival;
- As much extent as possible the En Route Optimization, in coordination with pertinent Air Navigation Service Provider, has been implemented;
- The following more efficient operations procedures have been implemented:
  - Cost Index and Climb Profile Optimization in order to calculate economy climb, cruise and descent speeds based on aircraft performance parameters;
  - Extra fuel Optimization based on Actualized Operation Flight Plan;
  - Estimated Zero Fuel Weight Optimization based on load plan;
  - Final Zero Fuel Weight Calculation Optimization;
  - Single Engine Taxi;
  - Weight Reduction by: Light weight trolleys, less catering equipment, magazine, tires Change, new life vest, paperless cockpit, ULD, coffee makers, entertainment system water load reduction, etc.;
  - Weigh & Balance optimization for best cruise profile;
  - Reduced Flap on Landing;
  - Optimization in APU operation on ground and maximization in the using of the GSE;

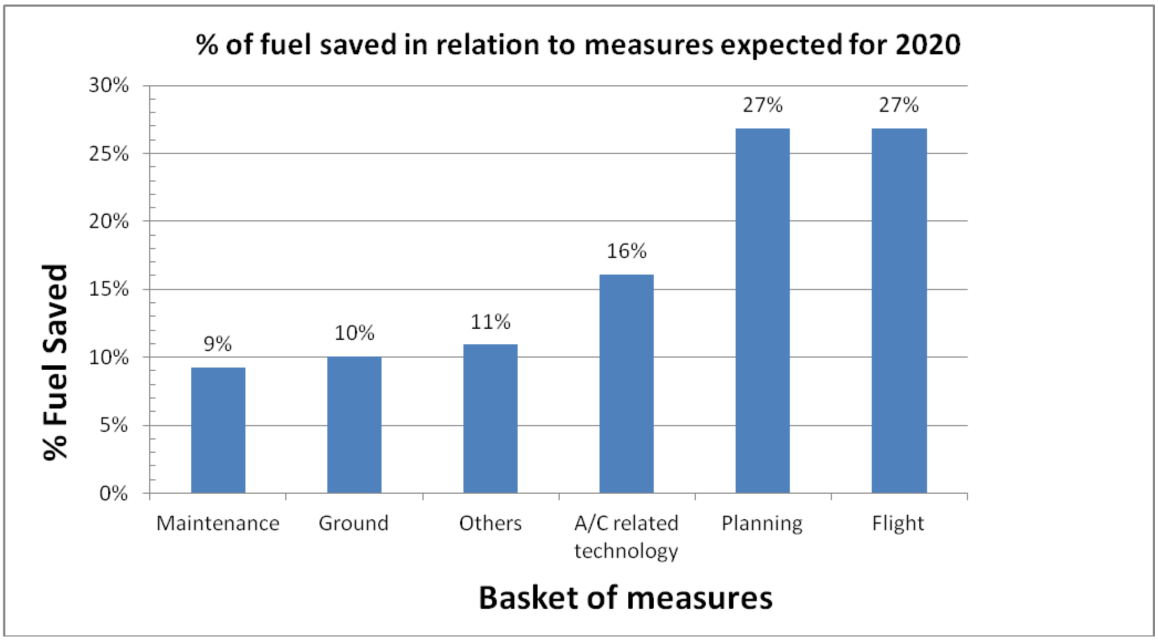
- MEL & CDL reduction in order to resolve malfunction causing air traffic limitation (cruise speed, flight level, etc.);
- Engines Wash in order to restore engine fuel burning efficiency;
- Close in re-fleeting and Fleet Optimization Operation in order to perform the best fleet type assigned to a given flight close to departure to better accommodate the anticipated increase or shortfall in demand.

The implementation of such measures was planned in phases, the first of which started in 2009 and was completed in 2017.

Recently the aviation sector has been consolidating the results achieved, and additional illustrated in the section dedicated to the ANSP (Enav).
In the next future the replacements of the remaining old aircraft, i.e., are foreseeable. Looking forward to the future, up to 2050, it is not simple to predict the evolution, because several factors could affect this forecast.
The following charts shows the quantification of the effects after the implementation of the selected measures, as well as the expected results that were planned to be achieved by 2020: (even though the Covid pandemic changed the scenario)



In the following picture an estimation of the fuel allocation saved in relation to the implemented measures is showed:



It is important to note how the optimization of flight plan activities and flight procedures and routes plays a relevant role in CO_2 emissions reduction.
It is also important to underline the role of the aircraft related technology on the fuel saving. The obtained result is basically related to the replacement of the MD80 fleet. Now the Italian fleet is relatively young but, looking forward in the future years (2021 to 2050), Italy will have the opportunity to introduce the new aircraft with better fuel efficient system (B737 max; Airbus NEO series, B787 Dreamliner, etc…) with an estimated efficiency of roughly 20%.

4.2.2 Sustainable Aviation Fuels

Aviation has an important role to play in greenhouse gas emissions as well as noise and local air quality issues. The continuous increase of air passenger transport generates an increasing use of hydrocarbon fuel with excessive emission of CO_2 and NOX (greenhouse gases, pollutants and noise). It is well known that commercial aircraft operations impact the atmosphere by the emissions of greenhouse gases and greenhouse gas precursors, and also through the formation of contrails and cirrus clouds.
Efforts in green technologies have to be collected and prospected in three major lines: Air vehicle, Air Transport System and Sustainable Energies.
The introduction of alternative fuels will contribute significantly to creating an effective and sustainable framework for the growing aviation industry. Cultivating energy crops that do not compete with food can open up new agro-economic perspectives; research on promising feedstocks such as algae and the development of advanced biorefinery technologies can also contribute to create economic opportunity for Italy.
From 2020, global aviation should experience CO_2 neutral growth; by 2050, net CO_2 emissions should be reduced by 50% compared to the base year 2005. These goals have been set by the airline members of IATA. Increasing the share of aviation biofuel is essential in order to reach these goals. This is because, unlike other modes of transport, new forms of propulsion such as electric or H_2 systems cannot be realized for aviation in the coming decades.

To realize the transition to a competitive energy system, it is necessary to overcome a number of challenges, such as increasingly scarce resources, growing energy needs and climate change.
Italy is strongly committed, both in the EU and in the world context, in trying to create the conditions for the development of a sustainable aviation biofuels competitive market.
Within the EU Horizon 2020, Italy is the coordinating Country for the following research projects:

Brazil-EU Cooperation for Development of Advanced Lignocellulosic Biofuels

The main objective of BECOOL (EU) and BioVALUE (Brazil) projects is to strengthen EU-Brazil cooperation on advanced lignocellulosic biofuels. Information alignment, knowledge synchronization, and synergistic activities on lignocellulosic biomass production logistics and conversion technologies are key targets of both projects and will bring mutual benefits. Both projects are structured in three main pillars covering in a balanced way the whole range of activities of the biofuels value chain (biomass production, logistics, conversion and exploitation). The BECOOL consortium is composed by 14 partners from universities, research institutes, large industries/SMEs, from 7 EU countries. Together with improved logistics, the establishment of the BECOOL innovative cropping systems will enable to increase biomass feedstock availability by at least 50% without negatively impacting food production, soil quality, and customary land uses. The improvements in gasification process efficiency of new feedstocks will allow to achieve an optimal gas quality from non-conventional sources (e.g. lignocellulosic crops and residues). The use of energy carrier in gasification will allow to overcome a major logistics barriers for low-energy density feedstock, while the valorization of lignin-rich residues will dramatically improve the energy efficiency of the overall value chain. Technological breakthroughs on pre-treatment, hydrolysis and enzymatic saccharification and fermentation steps will increase the competitiveness of biochemical advanced ethanol. The cross-project model benchmarking, carried out between EU and Brazil, will decrease present limitations on growth, logistics and process academic models, making them more reliable, opening opportunities for business, new jobs, reduced land pressure, and enhanced environmental benefits in EU and Brazil.

BIOmethane as SUstainable and Renewable Fuel (BIOSURF)

The objective of BIOSURF is to increase the production and use of biomethane (from animal waste, other waste materials and sustainable biomass), for grid injection and as transport fuel, by removing non-technical barriers and by paving the way towards a European biomethane market.
The main pillars of BIOSURF project are:

- to develop a value chain analysis from production to use depending on the territorial, physical and economic features (specified for different areas, i.e., biofuel for transport, electricity generation, heating & cooling);
- to analyse, compare and promote biomethane registering, labelling, certification and trade practices in Europe, in order to favour cooperation among the different countries and cross border markets on the basis of the partner countries involved;
- to address traceability, environmental criteria and quality standards, so aiming at reducing GHG emissions and indirect land-use change (ILUC); at preserving biodiversity and at assessing the energy and CO_2 balance; at identifying the most prominent drivers for CO_2 emissions along the value chain as an input for future optimization approaches;
- to exchange information and best practices all along Europe concerning biomethane policy, regulations, support schemes and technical standards.

Advanced sustainable BIOfuels for Aviation

Decarbonising and reducing aviation dependence on fossil fuel requires biofuels. BIO4A will produce at least kt of sustainable biojet for its use in aviation at commercial scale for accelerating its deployment within the aviation sector, increasing their attractiveness. BIO4A targets HEFA pathway from wastes, aiming at increasing the Technology Readiness Level for the full value chain. BIO4A aims at demonstrating the full value chain, enabling a production capacity of 2-300 kt/y of biojet in a First Of A Kind new biorefinery in France. The fuel will be distributed using the existing infrastructures and conventional aircraft fuelling systems for commercial flights. Special attention will be directed to the supply of sustainable feedstock, focusing on waste streams. In parallel, long-term R&D work will address marginal land in EU MED (low ILUC biofuels). Relevant environmental (inc. GHG and energy balance), economic and social data (inc. health and safety issues, impacts and benefits) will be assessed against targets. Since the current main barrier to the commercial production of biojet is the price gap, BIO4A will explicitly address performance and cost targets vs. relevant key performance indicators. The final goal is to prove the business case, identifying potential issues of public acceptance, market or regulatory risks and barriers (feedstock, technological, business, process) along the entire value chain, taking advantage of previous projects and proposing potential mitigation solutions. Offtake agreements have been signed with KLM and Airfrance. Additional off-take agreements could also be signed to open the participation to more airlines. Regulatory framework is also limiting today the development of the sector and an additional goal is recommendations to policies makers. The proposal will be defined at EU/National level, involving the major sector stakeholders and opening with a profitable dialogue with Member States and the EC.

Improving Photosynthetic Solar Energy Conversion in Microalgal cultures for the production of Biofuels and High Value Products

Solar Energy is the most abundant renewable energy source available for our planet. Light energy conversion into chemical energy by photosynthetic organisms is indeed the main conversion energy step, which originated high energy containing fossil deposits, now being depleted. By the way, plant or algae biomass may still be used to produce biofuels, as bio-ethanol, bio-diesel and bio-hydrogen. Microalgae exploitation for biofuels production have the considerable advantages of being sustainable and not in competition with food production, since not-arable lands, waste water and industrial gasses can be used for algae cultivation. Considering that only 45% of the sunlight covers the range of wavelengths that can be absorbed and used for photosynthesis, the maximum photosynthetic efficiency achievable in microalgae is 10%. On these bases, a photobioreactor carrying 600 l/m-2 would produce 294 Tons/ha/year of biomass of which 30% to 80%, depending on strain and growth conditions, being oil. However this potential has not been exploited yet, since biomass and biofuels yield on industrial scale obtained up to now were relatively low and with high costs of production. The main limitation encountered for sustained biomass production in microalgae by sunlight conversion is low light use efficiency, reduced from the theoretical value of 10% to 1-3%. This low light use efficiency is mainly due to a combined effect of reduced light penetration to deeper layers in highly pigmented cultures, where light available is almost completely absorbed by the outer layers, and an extremely high (up to 80%) thermal dissipation of the light absorbed. This project aims to investigate the molecular basis for efficient light energy conversion into chemical energy, in order to significantly increase the biomass production in microalgae combining a solid investigation of the principles of light energy conversion with biotechnological engineering of algal strains.

Other projects ongoing in Italy related to Alternative Fuels are:

FREE

The FREE Coordination (Coordination of Renewable Sources and Energy Efficiency) is an Association that currently gathers, as Members, 26 Associations in whole or in part active in these sectors, as well as a wide range of Bodies and Associations that have asked to join as Adherent (without decision-making roles). The FREE Coordination aims at promoting the development of renewables and energy efficiency in the context of an environmentally sustainable social and economic model, the decarbonisation of the economy and the cutting of climate-altering emissions, by launching a more coherent action by the Associations and Entities that are part of it also towards all institutions.

ISAFF

It is a National Forum that gathers Alternative Fuel Stakeholders from Industry, Universities, Fuel Producers, with the goal of promoting Research & Development activities on Biofuels in Italy. Activities are ongoing under the aegis of ENAC.

ENI

The Italian National Energy Company currently produces Biofuel in a fuel plant in Northern Italy (Porto Marghera). The fuel is for automotive use, but the same technology is easily adaptable for aviation purposes.

BIOREFLY

It is a FP7 of the European Commission. The purpose consists of establishing in medium term a bio-kerosene plant in Southern Italy (Puglia region).

Biofuel from Microalgae project

During 2017 ENAC assigned funds to a consortium of Italian Universities (Universities of Rome, Verona and Florence) to develop a research intended to produce aviation biofuel from microalgae. Microalgae appear to be one of the best raw materials for their possible production in Italy, given the essentially sunny climate present on most of the peninsula.

The main problems for the positive outcome of the research project are however represented by the environmental and energy balances. In fact, in order to ensure the economic viability of the biofuel production chain from microalgae, it is necessary to significantly reduce energy consumption along the whole chain; this is one of the main objectives of the research project in question: the research aims firstly at selecting in laboratory high-fat and low-energy strains for oil extraction. The ongoing study is also aimed at identifying the optimal cultivation processes, ensuring high productivity for long periods and for large volumes, also focusing efforts on the water/biomass separation process and on the oil extraction processes, which are particularly high energy consumption processes.

The project is divided into <u>two phases</u>:

- the first phase, (completed in 2018): identification of microorganisms optimized for the different phases of the process and the production of a small quantity of oil
- the second phase (developing now), dedicated to the construction of a pilot plant to produce biofuel in a small-demonstrative scale quantity.

It is due to note that a wide scale usage of biofuels has been up to now strongly limited by:

- Economic burdens: Biojet premiums vs fossil jet fuel prices are unaffordable for airlines and the drop of crude oil price has widen that gap;
- Lack of sustainable feedstock crops, with a stable and a wide range production and without competition with food;
- Limited refining capacity: Italy is the first European country where a traditional refinery was converted in a Green Refinery (ENI's Porto Marghera refinery).

Notwithstanding the above considerations, the medium term outlook for biofuels seems to be optimistic:

- Increase of refining capacity: ENI's Porto Marghera green refinery is expected to raise its production and Gela refinery is also going to be converted into a green refinery;
- Growth of awareness and concrete involvement at policymakers level to support the constitution of an Italian sustainable aviation biofuel supply chain, e.g. encouraging the usage of unused fields for biojet feedstock crops and setting up a system of incentives to make it sustainable for the whole industry.

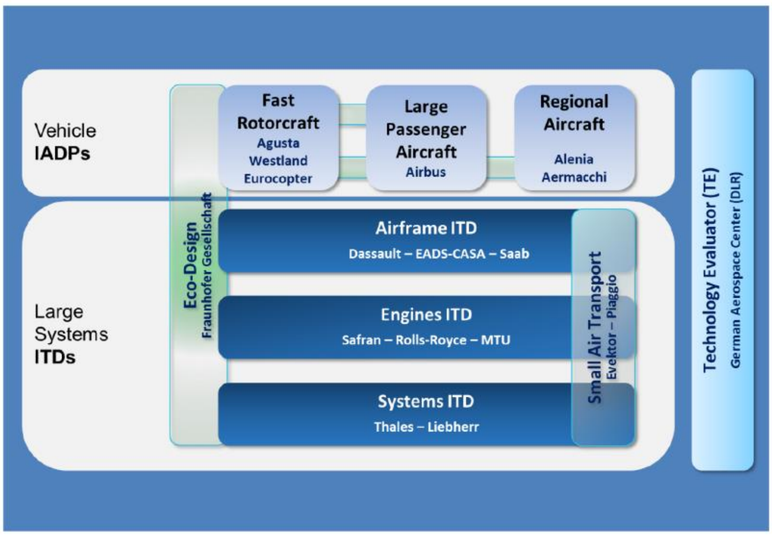
4.2.3 National Research and Development

Industries like Alenia Airmacchi, Leonardo, SelexES, Piaggio, research centers such as CIRA and CNR and several Universities are heavily involved in several programmes related to environmental objectives for CO_2 emissions reduction, to obtain less perceptive noise per operation and to reduce NOx emissions.
The Strategic Research Agenda Italia recognizes the European objectives in the CO_2 reduction programmes. The Strategic Research and Innovation Agenda (SRIA) is the new strategic roadmap for aviation research, development and innovation developed by ACARE that accounts for both the evolution of technology as well as radical changes or 'technology shocks'.
With reference to Clean Sky's environmental objectives and the formulated targets, the assessments performed underlined that Clean Sky is on the right track. In particular, short/medium range commercial aircraft (which is the backbone of the air transport system) will reduce CO_2 emissions up to 30%.

Clean Sky Concept Aircraft	Noise area (take off)	CO_2	NO_X
Low Sweep Biz-Jet (Innovative Empennage)	-68%	-32%	-28%
High Sweep Biz-Jet	-36%	-22%	-26%
TP90 (Regional Turbo-prop)	-48%	-23%	Up to -43%
GTF130 (Regional Jet – Geared Turbo-fan)	-75%	-23%	Up to -46%
Short-Medium Range / CROR Engine	Up to -37%	Up to -30%	N/A
Long Range / 3-shaft Advanced Turbo-fan	Up to -28%	Up to -20%	Up to -21%
Single Engine Light	-47%	-30%	-70%
Twin Engine Light	Up to -53%	-26%	-70%

Clean Sky assessment results

Clean Sky 2, born within H2020 EU Framework for research and innovation, is the natural continuation to the achieved progress in Clean Sky.
In the Clean Sky 2 Programme, Italian industries have been fully involved as per the scheme below:



The regional aircraft are a key element of Clean Sky and Clean Sky 2, providing essential building blocks towards an air transport system that respects the environment. In Clean Sky 2 the Regional Aircraft technologies, aimed at CO_2 reduction of emissions, will be pursued by the synergy between two CS2 platforms namely:

- Airframe ITD, with a relevant Alenia Aermacchi participation, will prepare the building blocks of the critical technologies then integrated and further maturated in the Regional Aircraft IADP such as low weight/high strength primary structure materials, eco-compatible and low weight materials for cabin systems;
- Regional Aircraft IADP, with the Italian leadership of Alenia Aermacchi, will bring the integration of technologies aimed at the reduction of the environmental impact, namely CO_2 reduction for the regional aircraft share, to a further level of complexity and maturity than currently pursued in Clean Sky.

The goal is to integrate and validate, at aircraft level, advanced technologies for regional aircraft useful for the CO_2 emissions reduction as well as to drastically de-risk their integration on future products.
In Clean Sky 2 Alenia Aermacchi will use the following demonstration programmes of the regional IADP to implement the technologies targeting CO_2 reduction:

- A Flying Test-bed using modified existing regional TP a/c for demonstration campaigns of air vehicle technologies such as wing structure with integrated systems, propulsion items, flight dynamics;
- Three Large Integrated Ground Demonstrators - i) full-scale fuselage and cabin including associated systems; ii) flight simulator; iii) iron bird - to fully and completely demonstrate low weight materials for fuselage structures, low weight eco-compatible materials for cabin, mission trajectory solutions and more effective flight controls solutions leading to a CO_2 reduction.

Full-scale demonstrations are essential to validate the insertion of breakthrough technologies on regional aircraft entering into service from 2025. To increase synergies and cross fertilization across the different ITDs and IADPs, some of technologies will be shared with other CS2 ITDs, namely Airframe for the low weight materials, Eco-Design for the low emission material and Systems and Engine ITD for the engine and on-board systems.
The Clean Sky 2 activities are distributed in all Regional Aircraft demonstrators and Airframe ITDs. In the following list a detail of content and technologies considered for application:

- FTB1 - Innovative Wing and Flight Controls (Regional IADP) the wide scope is the integration and flight testing of technologies suitable to regional aircraft applications for a new generation wing and advanced flight control systems. The technologies contributing to CO_2 reduction envisaged to be integrated in this demonstrator are:
  - Smart materials allowing morphing of control surfaces and then drag and CO_2 emissions reduction;
  - Electromechanical actuators applied to primary control surfaces reducing weight and power consumption then again less fuel burnt and lower CO_2 emissions;
  - Movable winglet to improve aerodynamic effectiveness, reduce drag and in turn reduce fuel consumption and CO_2 emission;
  - Control surfaces with a dedicated control for load control in order to reduce weight and in turn fuel burnt and CO_2 emission;
- Full-scale innovative fuselage and passenger cabin (Regional IADP) - the technologies, that will be integrated in the demonstrator, will be:
  - Low weight and eco-compatible material for cabin systems;

- Low weight structural material with SHM feature to reduce weight thus fuel burnt and CO_2 emissions;

- Flight Simulator (Regional IADP) - starting from the Clean Sky GRA Flight Simulator: an advanced Flight Simulator will be set up and used to demonstrate new avionics features allowing a more efficient trajectory for CO_2 reductions;
- Iron Bird (Regional IADP) - Virtual and Physical "Iron Birds" will also be an important part of the Regional A/C Ground Demonstration Programme. It will be used to optimize and validate the systems modification of the Flying Test Bed leading to the weight reduction and to the definition of optimal aircraft trajectory for CO_2 reduction.

The involvement of Leonardo into the Clean Sky programme is related to the "Fast Rotorcraft Technology Demonstrator", based on new NextGenCTR tilt-rotor concept.
The Fast Rotorcraft Technology Demonstrator has the primary objective in obtaining environmental benefits through a new efficient technology which uses the concept of high speed transportation solutions with a minimal infrastructure footprint.
This will be accomplished by means of:

- design, manufacturing and testing of a full scale technology demonstrator;
- analytical form through the technology evaluator efforts which are integral part of the CS2 programme.

The first flight of the technology demonstrator is planned for 2021.
The estimation of CO_2 emissions reduction, based on the application of the Fast Rotorcraft Technology, is still under evaluation. The benefits strongly depend on the final choice of aircraft configuration and on the supporting technological solutions as well as on the possibility of effective insertion within the future airspace and ATM and market requirements.
Alenia Aermacchi and SelexES are involved in the Air Traffic Management within the Single European Sky (SES) initiative and the SESAR programme.

Alenia Aermacchi is basically involved in:

- Taxi phase: the analysis of excess taxi time indicates that at least at the largest and most heavily utilized network hubs, there may be scope to reduce taxi times and hence improve fuel efficiency. In this phase, Alenia is committed in the development of an Airport Navigation Function (ANF) software for providing the capability of taxi routing during the airport surfaces operations as well as the on-ground traffic alerts, managed in cooperation with pilots and ATC controllers that will significantly improve the safety aspects and speed-up the taxi runway procedures reducing the fuel consumption;
- Terminal Maneuvre Area (TMA): the analysis of the Arrival Sequencing and Merging area (ASMA) indicator shows that queue management within the 40Nm radius of arrival airports could contribute to excess fuel burn per flight across the European network. Some Alenia Aermacchi initiatives are in progress in the integration of advanced services enabled by the Ground Based Augmentation System (GBAS), and on new approaches concepts (vertical profile, curved approach & runway approach) integrated in the Flight Management System on board the aircraft that will assist the pilot in the implementation of more efficient approaches to the airport. These functions, that were developed and validated in-flight using the real improved operation procedures, demonstrated the capability to reduce the fuel consumption, as a consequence of a better flight profile, but also due to the reduction of the holding procedures;
- En-route: The analysis of the En-route horizontal flight/fuel efficiency shows excess fuel burn beyond the 40Nm radius of origin/destination airports across the European network. The development of the "Airborne initial 4D for trajectory management", with an important contribution of Alenia Aermacchi,

will allow a continuous synchronization of the aircraft trajectories between air traffic controllers and pilots allowing to fly the most fuel-efficient flight route, optimizing airspace usage.

Selex ES:

- is engaged in providing means for a more efficient Aircraft Navigation System aimed mainly at pursuing the environmental goals promoted by Clean Sky European Project as assessed in the Strategic Research Agendas (SRA1 and SRA2) and confirmed in the Challenge 3 of the Strategic Research and Innovation Agenda (SRIA) and the "Report of the High Level Group on Aviation Research - Flight Path 2050 – Europe's Vision for Aviation";
- is involved in the Work Package 3 - Management of the Trajectory and Mission - dealing with the task of providing the pilot with an aid in the choice of the best trajectory to follow in case of an unexpected (or differently expected) events, in particular weather events, forcing the pilot to change the Reference Flight Plan assessed before the take-off;
- its task in Clean Sky programme is related to the optimization of the path for minimum pollution by means of clear, accurate and timely knowledge of the environmental situation and the provision of a Decision Support System (DSS) identifying, selecting and suggesting the most suitable actions to counteract the change, as a valid help to the pilot for the success of the flight together with the maximum reduction in induced pollution, saving the safety constraints.

Unexpected weather events are one of the major causes of disruptions leading to heavier fuel consumption. In this frame, Selex ES developed two cooperating technologies concerning the improvement of presently available airborne weather radar performances to identify weather situation (Advanced Weather Radar = A-WXR), and the algorithms to optimize flight routes in presence of unforeseen weather – but not only weather – hazardous situations (Trajectory Optimizer, shortly Q-AI = Quasi-Artificial Intelligence, where "Quasi" means that the Optimizer does not replace pilot's skill, but pilot is always the main stakeholder in the decisional loop) and to display the results to the pilot to improve his/her situation awareness and help him/her in decision making process.
To reach this gate the A-WXR and the Q-AI have been integrated in two different flight simulators: the Alenia Aermacchi Green Aircraft Simulator, emulating the ATR72 regional aircraft, and the IDS company's simulator, emulating the A320 aircraft and the ATC.
Preliminary data referred to the cruise phase indicate that a benefit in the CO_2 emissions reduction of about 2% to 5% could be obtained. Such data are derived as a mean from many flight extracted by Flight Aware as well as simulating unexpected weather events on the aircraft route.

SESAR Very Large Demonstration Projects: Free solutions

The Flexible Airspace Management and Free Route is one of the six of the so-called Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan (Commission Implementing Rule (EU) 716/2014), which provides for the implementation (by FL 310+) of Direct Routing operations (by 1 January 2018) and operations Free Routing (by 1 January 2022).
In this context ENAV, Italy's main Air Navigation Service Provider, has decided to follow up the activity carried out in 2013 with the SESAR WE-FREE project, by developing a new project – also thanks to the technical/operational and co-financing opportunities offered by the SESAR JU - called FREE Solutions (Free Route and Environmental Efficient Solutions).
FREE Solutions aims at completing, between 2015 and 2016, a cycle of demonstration flights in operating cross-FAB environment (Blue Med and FABEC specifically) to prove the feasibility and applicability of Direct Routing/Free Routing concepts and the definition of technical and operational requirements essential for

the implementation of the Free Routing. It is carried out in collaboration with a significant group of ANSP and Airspace User. The project was launched under the guidance of ENAV, in September 2014. Just six months after, the first set of demonstration flights was successfully completed. Two weekends have been dedicated to the trials and more than 120 flights were operated by project partner airlines on point-to-point connection between European airports with optimized City-Pairs routes. A first analysis of the data collected during this session confirms and enhances the preliminary expectations: each day 1450Kg of fuel on average were saved, resulting in lower emission CO_2 equal to 4400Kg.
Other demonstration flights are dedicated to the identification of specific Direct Routes and to a Free Route specific Airspace Area (FRA), trans-national and multi-FAB, where users can plan their routes indicating just an entry point, an exit point and a limited (or null) set of intermediate points, freeing themselves from the current network of ATS routes.

4.2.4 New Technologies from Italian Industry

4.2.4.6 Tecnam SpA P-Volt Electric Aircraft

The evolution of electric motors has reached levels beyond which it is difficult to ask for more. The efficiency is the parameter that mostly confirms this concept: a modern electric motor is able to transform up to 98% of the electrical energy received into mechanical energy. It is therefore clear, and now all too much discussed, that the Achilles heel of the development of full-electric aircraft in the years to come will be the capacity of energy storage. This limit slows down the ecological transition since the purchase of a fully electric aircraft, today, would mean condemning the business model of the air carrier to often limited performances but, even more unfortunate, it would mean seeing your asset losing value. as the technology of energy storage systems advances. This consideration (as well as that for which there would certainly be few carriers that nowadays could tolerate operating only one flight a day, lasting a few tens of minutes, and then keep your expensive asset on the apron waiting for the recharging process to be completed, was the pivot around which the definition of the specifications of the new P-VOLT aircraft of Tecnam SpA.

Tecnam, is an historic Italian company world leader in the design, construction and marketing of General and Commercial Aviation aircraft. In order to illustrate the opportunities that the technological concept underlying the electrical aircraft could offer, based on the battery swap principle, i.e. changing the entire battery pack at the end of each section by using a streamlined ground infrastructure, automated and to be developed ad-hoc. The quick battery change technology, introduced more than 10 years ago by Tesla, has never had a real development in the automotive industry since this should bring imply that manufactures should use standardised battery packs, with universal change/share technology, battery exchange systems as well as chassy constraints. Nonetheless, it is clear that the possibility of changing the battery of an electric vehicle in a few minutes at any service station, everywhere, would already constitute an immediate liberation from the constraints of the maximum range of the vehicles. If standardization can be considered a limitation in the automotive sector, in the case of air carriers it could be instead turned into an opportunity: carriers, especially regional ones, operate on a limited number of airports, generally with a limited number of aircraft models. Airlines such as Cape Air in the United States have based their business on a fleet of 70 Cessna 402 aircraft for over 40 years, before renewing it with the introduction of the Tecnam P2012 Traveler, already in service and underpinning the development of the P -VOLT. Cape Air is not the only example: Widerøe, a Norwegian carrier engaged in the connection of the small communities of the peninsula, operates a fleet of 26 Dash 800 on routes that often involve a few minutes of flight. The development of a business model by an energy provider, dedicated to the battery change service, to the procurement of the same, as well as to the maintenance of the charge and, at the end of the operating life considered useful for application on aircraft (between 200 and 400 cycles), when reintroduced on the consumer market, a real driving force can be determined for the growth of the entire Green Aviation sector: the carrier could in fact enter electric aircraft into the fleet, and the value of the aircraft would remain unchanged over time, as it does not actually own also the batteries, but the system would relying on an airport provider that, following each route, offers the battery swap service, thus determining turn- around time levels that are completely comparable, if not lower, to those commonly needed to make a public passenger transport aircraft ready for next flight.

Furthermore, with the development of energy storage systems expected in the coming decades, the carrier will be able to take advantage of the performances implemented without having to bear the costs of updating the batteries. The same battery swap operation that today offers limited flight ranges, will lead in the future to an increase in the supply of routes, leaving the initial value of the aircraft asset unchanged. Also thanks to the strategic partnership with RollsRoyce and Widerøe, Tecnam is firmly convinced that the available technology is ready to initiate, even in the airline sector, an effective, but above all profitable ecological transition and it is for this reason that the search for an provider as a strategic partner for the development in Risk Sharing of logistics and ground infrastructures and related services is considered an essential step towards the objectives outlined by the Green Deal.

4.2.4.7 Leonardo

Leonardo’s Aircraft Division has been engaged for years in initiatives focused on sustainability and on reduction of both direct and indirect GHC emissions and in environmental impact:

- Solutions, architectures and aircraft configurations to reduce fuel and energy consumption covering all phases including the aircraft decommissioning;

- Electrification of board (more/all electric) and propulsion systems, which, in parallel with the evolution of the enabling technologies, allows a significant reduction of fuel and emissions consumption in the field of air transport, contributing to achieve the ICAO ambitious targets;
- New manufacturing processes with low environmental impact: additive manufacturing to reduce production scraps (increase of "buy to fly ratio"); thermoplastic matrix composites and "Out of Autoclave" forming processes; composite material recycling; monitoring and traceability of hazardous substances (REACh, RoHS, Conflict Minerals, etc.).

In the following box the main actions already undertaken by the Aircraft Division or about to start:

MORE EFFICIENT REGIONAL TURBOPROP AIRCRAFT WITH LOW ENVIRONMENTAL IMPACT

In the framework of **Clean Sky 1** programme, carried out in the years 2008-2016, Leonardo achieved important results in terms of environmental impact reduction of regional aircraft with turboprop engine:

- for turboprop aircraft with 90 seats, CO_2 reduction by 25% in comparison with aircraft in service in 2000;
- for turboprop aircraft with 130 seats, CO_2 reduction by 27% in comparison with aircraft in service in 2000;

Such objectives have been achieved by the development, additional studies and architectures, validation by in-flight or on-the-ground demonstrations of advanced technologies applied to materials and structures, advanced aerodynamics, electrification of some aircraft systems along with a more efficient air traffic management system.
The results were confirmed by in-flight demonstrations using a ATR72 and by full scale demonstrations using a flight simulators, which have validated:

- the use of multifunctional structural materials able to reduce structural weight as well as noise in passenger cabin;
- "more electric" aircraft systems to validate advanced system architectures;
- structural configurations of fuselage and wing through innovative composite materials, produced with manufacturing techniques with low energy consumption, which lighten the structure.

In the framework of **Clean Sky 2** programme, started in 2014 in Horizon 2020 and still ongoing, Leonardo has been developing further challenging objectives aimed at reducing turboprop aircraft environmental impact and at making them even more competitive and energetically efficient:

- for turboprop aircraft with 90 seats, CO_2 reduction by 35-40% in comparison with aircraft in service in 2014;
- for turboprop aircraft with 130 seats, CO_2 reduction by 19-25% in comparison with aircraft in service in 2014

Such objectives are pursued through the use of the most advanced technologies applied to materials, structures, aerodynamics and through a further electrification of the aircraft systems. The validation will be achieved by on-the-ground full-scale tests simulating the complexity of the real cases and in-flight tests which will encompass:

- one entire section of fuselage made from a very innovative composite material and using architectural structures aimed at demonstrating the reduced weight, while maintaining the competitiveness of the production process;
- Wing and its innovative control systems (movable winglet and newly designed leading edge) capable of increasing flight efficiency, cutting consumptions and reducing noise produced by aircraft;
- Control and electricity supply systems of aircraft able to allow a further electrification of aircraft at a higher power level.

A NEW AIR TRAFFIC MANAGEMENT SYSTEM

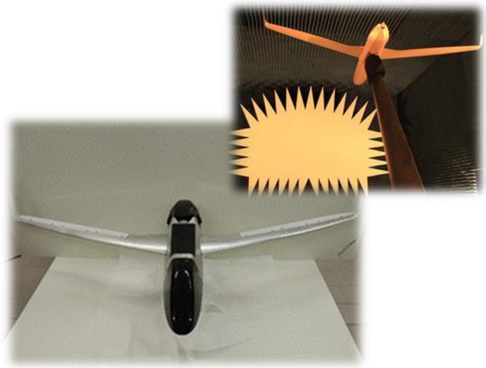
Within **SESAR** programme, Leonardo pursued the emissions reduction by the development and validation of technologies allowing a more efficient use of civil and military aircraft in the framework of the air traffic management system called "Single Sky", currently under definition and development in EU, integrating these technologies in flight simulators and carrying out in-flight demonstrations on ATR72 and C-27J.

During the second phase of SESAR programme, called **SESAR 2020**, started in 2014 in Horizon 2020 EU and still ongoing, Leonardo has been going on with the development of innovative technological solutions for a more efficient integration of civil and military aircraft in the new air traffic management system, by carrying out demonstrations using manned and unmanned flight simulators.

HYBRID/ELECTRIC PROPULSION AIRCRAFT

The push towards the hybrid/electric propulsion is fostered by ICAO challenging objectives, aimed at reducing the environmental impact, not achievable by the incremental evolution of the traditional engines.
This approach will represent the first step towards a *revolution of air transport*, especially in short- and medium-haul routes, since this imposes a relevant change in aircraft technical management and an update of airport infrastructures. The following innovative initiatives have been launched by Leonardo's Aircraft Division:

TIVANO – Innovative Technologies for next-generation General Aviation Aircraft



Leonardo coordinated the national research projects "TIVANO" whose aim was to develop new technologies suitable for specific aircraft to be applied to "more electric" systems and hybrid propulsion, for the purpose of improving the efficiency of aircraft systems and propulsion.
Special attention was paid to a new electrical propulsion technology for ground operations – a "green taxi" concept - complementary to the normal propulsion able to reduce noise and air pollution in airport areas. The study further explored also a new "Tail-less" configuration, with a high efficiency wing and high aspect ratio wing, developing new methods of aerodynamic and aero-elastic optimization, to maximize the capacity of persistence, so that the weight of the wing and the emissions of the aircraft will be reduced.
The results will lead to further studies on hybrid/electric propulsion architectures and will include higher/bigger size class aircraft.

PROSIB – Propulsion and hybrid systems for fixed- and rotor-wing aircraft (expected launch in 2018/19)

The aim of the project, headed by Leonardo in the framework of PNR 2015-2020, is to develop specific technologies for both ATR-42 regional aircraft, on which the distributed hybrid/electric propulsion is planned to be introduced by 2035, and VTOL (Vertical Take Off and Landing) rotorcraft per Urban Mobility. Feasibility studies, laboratory tests and key enabling technologies implementation in cooperation with universities, research centres and national SMEs are forseen.

OPTIMISATION AND INNOVATIVE CONFIGURATIONS

Leonardo collaborates with European universities and research centers to develop advanced multidisciplinary optimisation techniques for non-conventional aircraft configurations as essential instruments for a further refinement of the analysis on emissions reduction:

AGILE headed by DLR, in the framework Horizon 2020: Leonardo takes part to this project along with many other international organizations with the goal to develop and validate multi objective analysis methodologies.

PARSIFAL in the framework of Horizon 2020: Leonardo is an Advisory Board member together with Airbus, Alitalia and the airport operators "Toscana Aeroporti" and "Milano Aeroporti".

PARSIFAL, headed by Pisa University, studies, with modular approach applied to several classes of aircraft, configurations such as PrandtlPlane, in order to maximize the aerodynamic benefits and to reduce aircraft weight, consumption and emissions with no impact on airports for what concerns the amount of space required and their infrastructure needs. In other words, an airplane with the same wingspan of an A320 or a B737 could have the load capacity of a higher class airplane, such as an Airbus A330 or a Boeing B767, but a fuel consumption of lower class airplane.

INTEGRATED SIMULATION – Simulation as eco-friendly technology

The use of simulation technologies in the activities of development and qualification of platforms and for training purpose, allows Leonardo to decrease the overall number of flight hours with real aircraft and therefore to reduce significantly polluting emissions and costs.
Flight simulators have been continuously improving and updating to reproduce real aircraft behaviours and operative scenarios. This permits to modify training programmes so that up to 50% flight time training can be performed by simutators, reducing flight time training with real aircraft and consequently CO_2 and NOx emissions around airport area.

NEW TECHNOLOGICAL PROCESSES


EP 2 197 643 B1

EUROPEAN PATENT SPECIFICATION

A METHOD FOR RECYCLING SCRAPS OF PREPREG MATERIALS

VERFAHREN ZUM RECYCELN VON ABFALLSTOFFEN VON PREPREG-MATERIALIEN

PROCEDE DE RECYCLAGE DE DECHETS DE MATERIAUX PREIMPREGNES

- **Patent** of a new **method for recycling scraps** of prepregs composite materials in order to reduce the production of brand new materials. The patent will allow a great reduction of CO_2 emissions caused by the production of new prepregs composite materials, including the case where, thanks to the new material, less extreme performance of the original material is required.

  The patent consist of a process that transforms the wastage of continuous fiber prepreg (unidirectional and woven) into a recycled material which is also prepreg, but has broken fibers of sufficient length to maintain high mechanical properties with near-isotropic characteristics. This material can be stratified and hot-formed and polymerized using conventional vacuum-bag technology.
- **Monitoring/traceability of harmful substances** (REACh, RoHS, Conflict Minerals, ecc.) and qualification of alternative eco-friendly processes. Leonardo has always paid particular attention to the characteristics of materials used and accurately monitors them through a specific management tool, in accordance with the legislation on hazardous materials (REACh Management) and considering the direct and especially indirect impacts that these processes have on CO_2 emissions production.
- **Eco-friendly processes**: several processes are under testing and qualifying phase with the aim to avoid the use of harmful substances banned by the recent European Decrees according to the following table:

Existing	Future	Benefits
Chromic Acid Anodizing on Aluminum Alloy	Tartaric Sulphuric Acid Anodizing on Aluminium Alloy	testing stage completed: -20% CO_2 emissions
Chemical Conversion Coating of Aluminium Alloys	Chemical Conversion Coating Chromate Free	testing stages to be completed by 2020
Hard Chromium Plating	Thermal Spray (HVOF)	
Electrolytic Cadmium Plating	Zinc-Nickel Plating	
Vacuum Cadmium on Steel	Ion Vapour Deposition on Steel	
Conversion Coating of Magnesium Alloys	Conversion Coating Chromate Free of Magnesium Alloys (Ardrox 1769)	
Passivation of Corrosion Resistant Steels	Passivation of Corrosion Resistant Steels with Citric Acid	
Wash primer	Wash primer chromate free	
Bonding Primer and Chromated Primer	Bonding Primer and Primer Chromate Free	

4.2.5 Air Traffic Management

4.2.5.1 ENAV S.p.A.

ENAV S.p.A. is the main Italian Air Navigation Service Provider and its first mission is to guarantee the safety of air traffic management and then the punctuality for millions of passengers flying in Italy's skies; in line with its mission - ensuring the safety and punctuality of around 1.8 million controlled flights per year, on an airspace measuring more than 750,000 sq.km., with a peak of 7,300 daily flights managed in July 2019 - ENAV contributes to the growth of national and international air transport based on efficiency and innovation.

Initially transformed into a publicly controlled joint-stock company (1st January 2001), since 26th July 2016 (when shares was publicly listed on market), ENAV has become a joint-stock company, controlled by the Ministry of Economy and Finance (Ministero dell'Economia e delle Finanze - MEF) and supervised by the Ministry of Sustainable Infrastructures and Transport (Ministero Infrastrutture e Mobilità Sostenibili - MIMS). The Italian Economy and Finance Ministry holds 53.28% stake in ENAV.

ENAV mission is to provide Air Navigation Services to assist air traffic in overfly, approach, departure and landings operations from/to 45 main Italian Airports and in Italian FIR/UIR airspace. Thanks to its operational units (Control Towers and Area Control Centers) and its advanced technical facilities, ENAV provides around-the-clock Air Traffic Services ensuring air traffic flow and regularity, with absolute safety.

In addition to the Air Traffic Services Provision, ENAV is designated by Italian State and is certified according to the Single European Sky regulatory framework by National Supervisory Authority, to provide Aeronautical Information Services, Airspace and Instrumental Flight Procedures design, Aeronautical Meteorological Forecasts and Airport Meteorological Observations, other than Flight Validation and Flight-Check activities and to provide, according to the European and/or National regulations, all professional training (i.e., Air Traffic Controllers, Flight Information Service Officers, Meteorologists and Technical Meteorologist, ATS Engineering Personnel, etc.).

ENAV has its legal HQ in Rome and operating facilities throughout the National territory and in addition to ensuring the provision of Air Navigation Services, through its subsidiaries, ENAV Group provides installation, maintenance, continuous monitoring and new technologies development and validation of ATM/CNS/MET systems. ENAV Group consists, in addition to ENAV S.p.A., of Techno Sky, IDS AirNav, D-Flight, ENAV Asia Pacific, ENAV North Atlantic/Aireon and ESSP.

- **Techno Sky** – a subsidiary company that has in charge the ATM, CNS and MET systems and equipment development, implementation and maintenance both for ENAV and for external customers.
- **IDS AirNav** – a subsidiary company that develop Commercial-Off-the-Shelf and its own software and systems which are provided to more than 130 customers, within 5 Continents, ensuring customized and full compliance high-tech solutions aimed to support the transition from Aeronautical Information Services to Aeronautical Information Management, the Airspace Design activities and the Air Traffic Flow Management.
- **D-Flight** - company created by ENAV in partnership with Leonardo and Telespazio to develop the Italian Unmanned Aerial Vehicles (UAV) platform both for the minimum and for the additional set of services/functions requested to play a role in the U-Space Service Provision.

- **ENAV Asia Pacific** - a subsidiary company, based in Kuala Lumpur, which have in charge all ENAV's Group business and commercial activities developed for the Middle East and Asia customers.
- **ENAV NORTH ATLANTIC** - a subsidiary company, based in the United States, to manage the activities related to Aireon (International Consortium made to implement the first global satellite surveillance service for air traffic control and of which ENAV holds 12,5% of shared capital).
- ESSP - the European satellite navigation service, EGNOS, PPP Company of which ENAV holds 16.6% of the stake capital.

ENAV, together with ist subsidiary companies, plays a leading role in key international partnerships and programmes such as the BLUE MED Functional Airspace Block, SESAR Deployment Manager, BLUEGNSS, 4-Flight/Coflight and, through its own acknowledged experts, actively contributes to the work of international institutions and organizations such as ICAO, the European Commission, EUROCONTROL, EASA and EUROCAE as well as the World-Wide Industry Association CANSO (Civil Air Navigation Services Organisation).
Thanks to its long-standing experience in Air Navigation Service Provision and in Aeronautical Consulting, ENAV plays an outstanding role providing operational services and enhanced solutions worldwide and, following its vision, starting from reinforced cooperation and advanced synergy with the Aviation Stakeholders, ENAV priority is to ensure a continuously improvement of the safety and quality of services provided, evaluating the opportunities offered by the technology innovation in order to reach customers, partners and stakeholders needs and finally the wider community benefit.

4.2.6 ENAV's Flight Efficiency Plan

One of ENAV's key objectives is to contribute to lowering the environmental impact related to flight operations. To this regard, in accordance with the relevant international guidelines, ENAV promotes wide-ranging initiatives to decrease the amount of greenhouse gases.
In winter 2008/2009, the Company released its first three-year action plan, which is annually monitored and reviewed. Moreover, ENAV has in place structural initiatives, mainly addressed to airlines, aimed at increasing cooperation and sharing operational suggestions with Airspace Users to elaborate enhanced and tailored operational solutions. The information exchange has followed-up important feedbacks to fine-tune ENAV FEP initiatives.
Since ENAV FEP first publication, thanks to a continuous process of review and improvement of the air navigation system, projects and measures had been set to ensure greater airspace accessibility delivering increased route availability, designing airspace portions and new operational procedures that enabled a more efficient use of terminal areas and approaches by using P-RNAV routes (Precision Area Navigation) and Continuous Descent/Climb Operations.

Under the framework of the National Performance Plan, endorsed by CAA according to Reg. (EU) 390/2013, ENAC monitors ENAV FEP because of its environmental relevance.
The implemented measures have allowed considerable savings in terms of fuel consumption and GHG emissions thus producing their positive effects year after year.

FLIGHT EFFICIENCY PLAN

OUTCOMES 2018-2020

404500 T CO_2 EMISSIONS REDUCTION

- Free Route Airspace Italy (FRA IT) above FL305 implemented in May 2018 (above FL335 implemented in December 2016)
- PBN Implementation Plan Italy/ENAV's PBN Transition Plan
- SID and STAR RNAV1 implementation completed for Airports with APP Radar Services;
- 23 airports with at least 1 RNP APCH IAP
- AIRPORT COLLABORATIVE DECISION MAKING (A-CDM)
- ❖ At Fiumicino, Malpensa, Venezia, Linate and Napoli implemented before May 2018
- ❖ At Bergamo implemented on 1st December 2020

It is worth mentioning the four major projects developed also considering the objective to increase capacity and cost-efficiency performance while maintaining or increasing safety performance and reaching the performance requirements defined by Reg. (EU) 691/2010 subsequent amended and supplemented by the other relevant European regulations and implementing rules currently in force.

Italian Airspace Reorganization

The Italian Airspace Reorganization project was the first comprehensive project that involved all Italian Area Control Centres (ACCs) located in Brindisi, Milan, Padua and Rome, reviewed the preexisting airspace structure and improved the network usability with a flight efficiency-oriented solution. Besides having achieved shorter routes, it mainly enabled improvements in flight profiles, by gradually free up higher flight levels for most domestic city pairs and some cross-border connections. The project was completed in 2013.

Free route Airspace Italy

The Free Route, along with Flexible Airspace Management, is part of the six so-called Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan (Commission Implementing Rule (EU) 716/2014), which provides for the implementation (by FL 310+) of Direct Routing operations (by 1 January 2018) and operations Free Routing (by 1 January 2022). In this context, ENAV decided to follow up the activity carried out with the R&D SESAR related pioneering projects, WE-FREE and FREE Solutions, (Free Route and Environmental Efficient Solutions) which were aimed to demonstrating the feasibility and supporting implementation of a plannable user-preferred route through a wide campaign of live trials, the operational impact assessment with a view to de-risk the implementation of the main concepts addressed towards the deployment phase.
On 8th December 2016, ENAV implemented the **Free Route operations in the Italian airspace** above FL335, and as of May 2018 enlarged the free route Italian airspace offering the capability for optimal trajectories 24/7 above FL305.
Within FRAIT aircraft may freely fly a direct path and an optimal vertical profile between a pair of defined Entry Point and Exit Point, without reference to an ATS Route Network. FRAIT operations are available for overflights as well as for arriving and departing traffic. Ad hoc continuous training sessions and some technological upgrades to the ATC systems have been accomplished to provide ATCOs with tools to manage traffic in Free Route airspace.
Since December 2016 the expectations on FRAIT, in terms of better performance, have been long-established. In three years, from the environmental point of view, the incremental implementation of the FRAIT, along with some adaptations to the below-placed ATS route network have allowed shorter distances with less fuel

consumption and CO_2 emissions: an overall saving of 128 million kg of fuel, with a simultaneous reduction in CO_2 of approximately 400 million kg. In 2020, despite the very heavy impact of the COVID-19 pandemic also on air transport, operations in the Italian free route airspace allowed a reduction of approximately 91 million kg of CO_2.

PBN Implementation Plan Italy and ENAV's PBN Transition Plan

The PBN procedures optimize the use of Airspace, allowing a more efficient design and use of Instrumental Flight Procedures (IFPs) in the Terminal Area, which may support the ATM systems improvement in balancing of the performance levels in the Key Performance Areas of Safety (i.e., reducing the congested airspace management and the related ATCOs task-load) Environment (i.e., reducing flight times and/or enabling CDO/CCO, supporting AUS in fuel consumptions and CO_2 emissions reductions, but also reducing the energy consumption and electro-magnetic emission of the ground navigation equipment), Capacity (i.e., optimizing the traffic flow and ist predictability) and ATM Cost-Effectiveness (i.e., reducing the cost of implementation and maintenance of ground navigation infrastructures).
According to the ICAO Resolution A37-11, in 2012, ENAC and ENAV prepared - with the contribution of the major stakeholders (AM, Alitalia, Agusta-Leonardo, etc.) - and issued the **PBN Implementation Plan Italy**.
Nowadays several major Italian airports are already provided with P-RNAV SIDs/STARs and RNAV APCH procedures. Nonetheless, other new IFPs and optimizations are planned for the next years within the new **ENAV's PBN Transition Plan**, born in 2020 to ensure compliance with EU regulations and to meet passenger demands, without impacting on the safety or capacity of the airspace whilst fulfilling our national environmental commitments.

The airspace strategy and concept, and its associated implementation plan are developed in collaboration with all the involved stakeholders, it follows the high-level principles elaborated by the State and complies with both European and national regulatory requirements, particularly as regards:

- Commission Implementing Regulation (EU) N.1048/2018 (PBN IR) laying down airspace usage requirements and operating procedures concerning performance-based navigation
- Commission Implementing Regulation (EU) N. 716/2014 (PCP IR), on the establishment of the Pilot Common Project (PCP) supporting implementation of the European Air Traffic Management Master Plan, AF#1 Extended Arrival management and PBN in the high-density terminal manoeuvring areas.

ENAV's PBN Transition Plan also complies, of course, with objectives formulated by ICAO in the Global Air Navigation Plan (GANP) and resolution 37-11 and is aligned with the objectives defined in the Italian National Air Space Strategy Implementation Plan.
This first edition focuses on the short - mid timeframes indicated in the PBN IR (period 2020/2024) such as, for example, the implementation of RNP Approach instrument flight procedures and the rationalization of the NDB (Non-Directional Beacon) radio aids to navigation (NAVaids) ground infrastructure.
Updates are planned to consider the evolution of the infrastructure and performance of the satellite navigation system (GNSS), the rate of modernization of aircraft avionics, the internal plans for the rationalization of NAVaids.
ENAV's FEP process then includes the collection and monitoring of the interventions defined to fully deploy Performance Based Navigation.

FLIGHT EFFICIENCY PLAN

2021-2023

- PBN Implementation Plan Italy/ENAV's PBN Transition Plan
- Improvements to RNAV1 network design on going for 3 airports, planned implementation Y2021.
- RNP APCH IAP design on going for planned implementation between 2021 and 2024 in the table below
- Completion of the RNAV network for ATS routes above FL95
- Conditional Route harmonization
- Implementation new CTAs/CTRs and Reorganization CTRs
- AMAN Extended Horizon
- LIRA and LIRF planned implementation winter 2021/2022
- LIMC, LIML and LIME planned implementation spring/summer 2022

EXPECTED CO_2 EMISSIONS REDUCTION (METRIC TONNES)

2021P	2022P	2023P	2024P
95500	146500	164000	176500

NDBs Rationalisation and Decommissioning

The **NDBs Rationalisation and Decommissioning** project is part of ENAV's PBN Transition Plan. The availability of GNSS services enabling the most performing PBN applications and with a greater degree of precision creates an opportunity to rationalize the NDB infrastructure. Moreover, NDBs are conception radio aids obsolete and dated implementation therefore subject to a frequency of failures tends to be higher than other newer navigation systems and for which the maintenance is hampered by the difficulty of finding spare parts. NDBs doesn't enable PBN applications, they can be used as a means for position cross-checking and general situational awareness.

ENAV has decided to implement a plan of disposals of the NDB under its responsibility, to be carried out progressively, in such a way as to inform users with adequate timelines and to prepare any back-ups at the level of procedures and / or routes preserving current level of safety.

Switching off a NavAid involves two main types of direct savings in terms of CO_2: power supply to terrestrial infrastructures and fuel for aircrafts as flight inspections will no longer be required.

The project started with a feasibility study in 2018. The decommissioning road map has been defined by evaluating the operating/design scenario produced by each individual NBD switch off. This progressive plan, currently split into 3 phases, substantiates an operational mitigation linked to the possible impact change on large-scale. The project is expected to complete the switching off by early 2023.

Some NDB facilities will be retained only where no other alternative is available due to constraints in user fleet, financial, terrain or safety limitations.

The full implementation of the PBN flight instrumental procedures on the national territory, both in operating environments characterized by radar surveillance service provision, and in those without in which a procedural air traffic control service is applied, will fully support the decommissioning of NDBs on ENAV's airports.

NDBs Rationalisation and Decommissioning

- 12 NDBs already been shut down, 16 being shut down by 2021 and the remaining by early 2023

Expected Kg CO_2 savings (Kg)

2021P	2022P	2023P	2024P
56700	93000	122800	126300

Airport Collaborative Decision Making (A-CDM)

In cooperation with airport operators and airspace users, ENAV has undertaken the deployment of the **A-CDM** for the Italian main airports. The project is intended to enhance the efficiency of airport operations, by improving the departure sequences and taxi-times (-out and -in).
At the end of December 2020 six Italian airports - Rome Fiumicino, Milan Malpensa, Milan Linate, Venice, Naples and Bergamo- implemented Full A-CDM with data sharing among Air Traffic Control, Airport Operators, Airspace Users and Network Manager Operational Centre.
Air Traffic Controllers skilled in delivering efficient ground operations along with automation represent enabling factors for the reduction of apron and taxiway congestion while still guaranteeing the traffic flows and the airspace users' needs. In a number of other airports, a basic system for automatic data exchange managed by ENAV is available.

Staff Awareness and Training

Ad-hoc ATCO training courses which are more focused on efficiency contribute to further deliver performance improvements. In fact, one of the cornerstones of the Flight Efficiency Plan consist in rising air traffic controllers' awareness since they can give a mighty contribution for fuel savings both to in-flight and on-the-ground operations. The principles of flight efficiency and their environmental implications were planned to be part of all recurrent trainings for ATCOs ever since ENAV first FEP edition.

Appendix RNP APCH Planning from ENAV's PBN Transition Plan v 1.3 December 2020

Airport name	ICAO	RWY end	RWY type	ILS	Cat	LNAV	LNAV/VNAV	LPV
Crotone	LIBC	17	NPI	NO	-	Within 2024	Within 2024	Within 2024
Crotone	LIBC	35	NPI	NO	-	Within 2024	Within 2024	Within 2024
Bari	LIBD	7	PI	YES	I	IS	2021	2021
Bari	LIBD	25	NPI	NO	-	2021	2021	2021
Taranto	LIBG	35	PI	YES	I	2021	2021	2021
Pescara	LIBP	22	PI	YES	I	Within 2024	Within 2024	Within 2024
Brindisi	LIBR	31	PI	YES	I	IS	IS	Within 2024
Brindisi	LIBR	13	NPI	NO	-	IS	IS	2021
Lamezia Terme	LICA	28	PI	YES	I	Within 2024	Within 2024	Within 2024
Lamezia Terme	LICA	10	NPI	NO	-	IS	IS	IS
Lampedusa	LICD	8	NPI	NO	-	IS	IS	IS
Lampedusa	LICD	26	NPI	NO	-	2021	2021	2021
Pantelleria	LICG	26	PI	YES	I	IS	IS	IS
Pantelleria	LICG	8	NPI	NO	-	IS	IS	IS
Pantelleria	LICG	21	NPI	NO	-	IS	IS	IS
Palermo	LICJ	2	NI	-	-	n.f.	n.f.	n.f.
Palermo	LICJ	20	PI	YES	I	IS	n.f.	IS
Palermo	LICJ	25	PI	YES	I	IS	n.f.	IS
Palermo	LICJ	7	NPI	NO	-	IS	n.f.	IS
Reggio Calabria	LICR	15	NPI	NO	-	IS	IS	IS
Reggio Calabria	LICR	33	NPI	NO	-	IS	n.f.	n.f.
Alghero	LIEA	20	PI	YES	I	IS	IS	IS
Alghero	LIEA	2	NPI	NO	-	IS	IS	IS
Olbia	LIEO	5	PI	YES	I	IS	IS	n.f.
Olbia	LIEO	23	PI	YES	I	IS	IS	IS
Milano/Malpensa	LIMC	17L	PI	YES	I	IS	IS	IS
Milano/Malpensa	LIMC	17R	NI	-	-	2021	2021	2021
Milano/Malpensa	LIMC	35L	PI	YES	III	IS	IS	IS
Milano/Malpensa	LIMC	35R	PI	YES	III	IS	IS	IS
Bergamo	LIME	28	PI	YES	III	IS	IS	Within 2024
Bergamo	LIME	10	NPI	NO	-	IS	2021	IS
Bergamo	LIME	12	NI	-	-	n.a.	n.a.	n.a.

Airport name	ICAO	RWY end	RWY type	ILS	Cat	LNAV	LNAV/VNAV	LPV
Bergamo	LIME	30	NI	-	-	n.a.	n.a.	n.a.
Torino	LIMF	36	PI	YES	II	2021	2021	2021
Torino	LIMF	18	NPI	NO	-	TBD	TBD	TBD
Albenga	LIMG	27	NPI	NO	-	Within 2024	Within 2024	Within 2024
Genova	LIMJ	28	PI	YES	I	IS	IS	IS
Milano/Linate	LIML	36	PI	YES	III	IS	IS	IS
Milano/Linate	LIML	18	NPI	NO	-	IS	IS	IS
Milano/Linate	LIML	35	NI	-	-	n.a.	n.a.	n.a.
Parma	LIMP	20	PI	YES	I	IS	IS	IS
Cuneo	LIMZ	21	PI	YES	I	IS	IS	IS
Bolzano	LIPB	1	NPI	NO	-	IS	n.f.	n.f.
Bologna	LIPE	12	PI	YES	III	IS	IS	IS
Bologna	LIPE	30	PI	YES	I	IS	IS	IS
Brescia	LIPO	32	PI	YES	II	Within 2024	Within 2024	Within 2024
Trieste	LIPQ	9	PI	YES	II	2021	2021	2021
Rimini	LIPR	31	PI	YES	I	Within 2024	Within 2024	Within 2024
Rimini	LIPR	13	NPI	NO	-	2021	2021	2021
Verona	LIPX	4	PI	YES	III	IS	IS	Within 2024
Ancona	LIPY	22	PI	YES	I	IS	IS	IS
Venezia	LIPZ	04R	PI	YES	III	IS	Within 2024	IS
Venezia	LIPZ	22L	NPI	NO	-	IS	2021	IS
Venezia	LIPZ	04L	NPI	NO	-	IS	2021	IS
Venezia	LIPZ	22R	NPI	NO	-	IS	IS	IS
Roma/Ciampino	LIRA	15	PI	YES	I	IS	IS	IS
Roma/Ciampino	LIRA	33	NPI	NO	-	TBD	TBD	TBD
Roma/Fiumicino	LIRF	16L	PI	YES	III	IS	IS	IS
Roma/Fiumicino	LIRF	16R	PI	YES	III	IS	IS	IS
Roma/Fiumicino	LIRF	25	PI	YES	I	IS	IS	IS
Roma/Fiumicino	LIRF	34L	PI	YES	I	IS	Within 2024	IS
Roma/Fiumicino	LIRF	34R	PI	YES	I	IS	IS	IS
Roma/Fiumicino	LIRF	7	NPI	NO	-	IS	IS	IS
Salerno	LIRI	5	NPI	NO	-	Within 2024	Within 2024	Within 2024
Napoli	LIRN	6	PI	YES	I	Within 2024	Within 2024	Within 2024
Napoli	LIRN	24	PI	YES	I	IS	IS	Within

Airport name	ICAO	RWY end	RWY type	ILS	Cat	LNAV	LNAV/VNAV	LPV
								2024
Firenze	LIRQ	5	PI	YES	I	IS	IS	IS
Perugia	LIRZ	1	PI	YES	I	Within 2024	Within 2024	Within 2024

Legend: PI = Precision Instrument NPI = Non Precision Instrument NI = Non Instrument IS = In Service n.f. = no feasible n.a. = not applicable

4.2.5.2 ENAV Flight Efficiency Plan

One of ENAV's objectives is to contribute to lowering the environmental impact related to flight operations. To this regard, in accordance with the international guidelines, ENAV promotes wide-ranging initiatives to decrease the amount of greenhouse gases.

In winter 2008/2009, the Company released its first three-year action plan, which is annually monitored and reviewed. Moreover, ENAV has in place structural initiatives, mainly addressed to airlines, aimed at increasing cooperation and sharing operational suggestions with Airspace Users to elaborate operational solutions. The information exchange has followed-up important feedbacks to fine-tune ENAV FEP initiatives.

Since ENAV FEP first publication, thanks to a continuous process of review and improvement of the air navigation system, projects and measures had been set to ensure greater airspace accessibility delivering increased route availability, designing airspace portions and new operational procedures that enabled a more efficient use of terminal areas and approaches by using P-RNAV routes (Precision Area Navigation) and Continuous Descent Operations.

Under the framework of the National Performance Plan endorsed according to Reg. (EU) 390/2013, ENAC monitors ENAV FEP because of its environmental relevance.

The implemented measures have allowed considerable savings in terms of fuel consumption and GHG emissions thus producing their positive effects year after year.

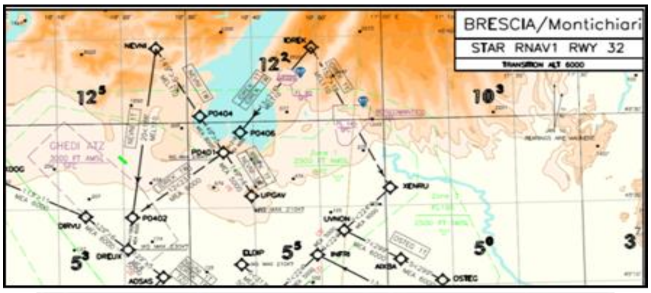
Focusing on the last 5 years implementations, it is worthwhile to mention three major projects which also considered the objective to increase capacity and cost-efficiency performance while maintaining and/or increasing safety performance and reaching the performance requirements defined by

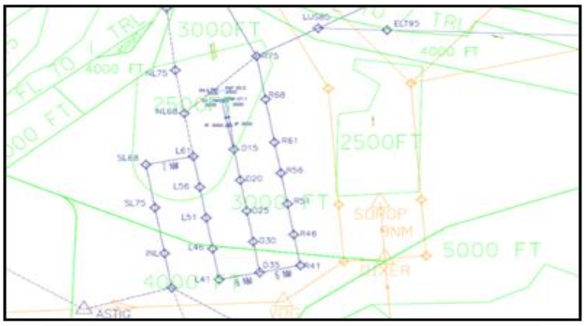
ENAV FEP 10 years' Achievements Timeline

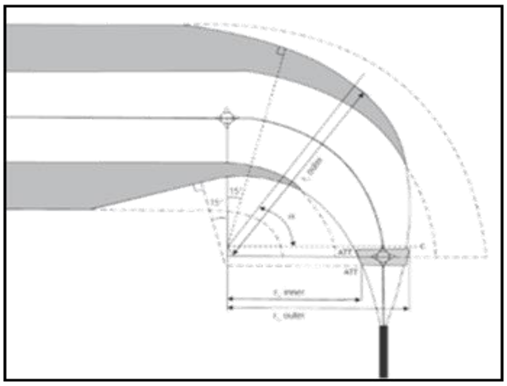
Reg. (EU) 691/2010: the Italian Airspace Reorganization, the Free Route Italy, the PBN Implementation in Italy, and the Airport-Collaborative Decision Making.
The Italian Airspace Reorganization project has involved all Italian Area Control Centres (ACCs), reviewed the preexisting airspace structure and improved the network usability with a flight efficiency-oriented solution. Besides having achieved shorter routes, it has mainly enabled improvements in flight profiles, by gradually free up higher flight levels for most domestic city pairs and some cross-border connections.
The Flexible Airspace Management and Free Route is one of the six of the so-called Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan (Commission Implementing Rule (EU) 716/2014), which provides for the implementation (by FL 310+) of Direct Routing operations (by 1 January 2018) and operations Free Routing (by 1 January 2022).
In this context ENAV decided to follow up the activity carried out in 2013 with the R&D SESAR WE-FREE project, by developing a new project – also thanks to the technical/operational and co-financing opportunities offered by the SESAR JU - named FREE Solutions (Free Route and Environmental Efficient Solutions) and aimed to demonstrating the feasibility and support implementation of a plannable user-preferred route. Through a wide campaign of live trials, the operational impact was assessed with a view to de-risk the implementation of the main concepts addressed towards the deployment phase.
ENAV implemented the **Free Route operations in the Italian airspace (FRAIT)** above FL335, on 8th December 2016, achieving the third phase of a multiannual programme, the **Free Route Italy** project, started in 2013.
Phase 1, in mid-December 2013, enabled the availability of dedicated direct and near direct routings for overflights operating at night and during the weekends in the Italian airspace above FL335 and the extension of the temporal availability of some ATS routes.

Phase 2, in January 2015, lowered the dedicated routing. FRAIT operations offer capability for optimal trajectories 24/7 in the Italian Airspace above FL305 as of 24th May 2018.
Within FRAIT aircraft may freely fly a direct path and an optimal vertical profile between a pair of defined Entry Point and Exit Point, without reference to an ATS Route Network. FRAIT operations are available for overflights as well as for arriving and departing traffic.
Ad hoc continuous training sessions and some technological upgrades to the ATC systems have been accomplished to provide ATCOs with tools to manage traffic in Free Route airspace.
Positive results and feedbacks received from Airspace Users who have benefitted from FRAIT, confirm the fulfillment of their expectations in terms of flight trajectory optimisation.
In **2017** the expectations on FRAIT implementation in terms of environmental performance have been confirmed. FRAIT, along with some adaptations to route availability below FL335 and new IFPs for Firenze, Brindisi and Pescara - that account for about 1% of total performance – have allowed short distances with less fuel consumption and CO_2 Emissions:
Distance reduced = 8,600 mln Km
Fuel saved =30 mln Kg
CO_2 avoided=-95 mln Kg

The PBN procedures optimize the use of Airspace, allowing a more efficient design and use of Instrumental Flight Procedures (IFPs) in the Terminal Area, which often support reduced flight times, fuel consumptions and CO_2 emissions, as well as increasing airspace capacity and optimizing the cost of navigation infrastructure.







According to the ICAO Resolution A37-11 in 2012, ENAC and ENAV prepared - with the contribution of the major stakeholders (AM, Alitalia, Agusta-Leonardo, etc.) - and issued the **PBN Implementation Plan Italy**.

ENAV FEP collects and monitors also the interventions defined to fully deploy Performance Based Navigation which are envisaged in the PBN Implementation Plan Italy.

Nowadays several major Italian airports are provided with P-RNAV SIDs/STARs and RNAV APCH procedures and other new IFPs and optimizations are planned for the next years.

In cooperation with airport operators and airspace users, ENAV has undertaken the deployment of the **A-CDM** (Airport Collaborative Decision Making) for the Italian main airports. The project is intended to enhance the efficiency of airport operations, by improving the departure sequences and taxi-times (-out and -in).

At the end of March 2018 five Italian airports - Rome Fiumicino, Milan Malpensa, Milan Linate, Venice and Naples - implemented Full A-CDM with data sharing among Air Traffic Control, Airport Operators, Airspace Users and Network Manager Operational Centre.

Air Traffic Controllers skilled in delivering efficient ground operations along with automation represent enabling factors for the reduction of apron and taxiway congestion while still guaranteeing the traffic flows and the airspace users' needs. In a number of other airports, a basic system for automatic data exchange managed by ENAV is available.

Ad-hoc ATCO training courses which are more focused on efficiency contribute to further deliver performance improvements. In fact, one of the cornerstones of the Flight Efficiency Plan consist in rising air traffic controllers' awareness since they can give a mighty contribution for fuel savings both to in-flight and on-the-ground operations. The principles of flight efficiency and their environmental implications were planned to be part of all recurrent trainings for ATCOs ever since ENAV first FEP edition.

Below the main achievements and improvements in the Air Space and Traffic Management of the last decade in Italy through the running of Flight Efficiency Plan are displayed.

The following table recaps the main actions achieved since 2008 split over the four lines of action:

ENAV FEP 10 YEARS' ACHIEVEMENT	
EN-ROUTE AIRSPACE DESIGN AND NETWORK AVAILABILITY	▪ FRAIT from FL335 to FL660 ▪ Review of CDR classification following the implementation of military areas with high flexible use, Ionian and Sicilian areas ▪ Route availability maintenance and improvements ▪ Free route in Italy (FRI): first and second phases (2013-2015) ▪ Route realignments, changes in lower/upper limits, or time availability Redesign of the Italian Airspace and ACC Airspace Reorganization (2014) ▪ Improvements in flight profile Italy from/to Tunisia, from/to Spain, from/to France. ▪ Summer season two more hours clear of RAD constraints every day ▪ Reorganization of route network for Milan and Rome U/FIRs ▪ Increase of hourly network availability in winter seasons ▪ Reorganization of route network portion over ALG, BZO, FRZ and Verona ▪ User preferred flight level through raising or removal of level capping for city pairs ▪ Dedicated direct routings, available night-time or H24, improvements from NGT-WE to H24. ▪ Conversion of DCTs into ATS routes and time extension of their availability ▪ Implementation of new routes, extensions, realignments and direct routings in Italian airspace
DESIGN AND USE OF TERMINAL AREAS	▪ Implementation of BRINDISI, MILANO, PADOVA and ROMA CTAs ▪ Withdraw of PADOVA and BRINDISI TMAs ▪ Review of ROMA and MILANO TMAs ▪ Implementations of P-RNAV SIDs/STARs: LIPX, LIRF, LIMZ, LIPZ, LIEO, LIPE, LIPX, LICJ, LIRQ ▪ Publication of an ad-hoc AIC describing the implementation of CDO ▪ New IFPs (STAR or SID or IAP or ICP): LIBC, LIBP, LIPY, LIPO, LIRZ, LIMP, LIMZ, LICA, LIRA, LIRF, LIRQ, LIME, LIMF, LIMZ ▪ Implementation of RNAV APCH for LIEA, LIBR, LIMC, LIRA, LIRF, LIRQ, LIML LIME, LIPE, LIPZ ▪ Reorganization of SIDs for LIRF and LICJ ▪ Review of Initial Climb Procedures and SIDs for LIMP, LIPZ ▪ Reorganization of LICJ, LIPY, LIPE, LIME, and LIRF CTRs and related IFP
AIRPORT OPERATIONS	▪ Optimization and automation of the apron management of LIMC, LIML, LIME, LIMF, LIPE, LIPZ, LIRN, LICJ, LIEA, LIMJ, LIRQ, LIEO, LIBD, LICC and LICA. ▪ Full A-CDM Airports: Roma Fiumicino, Milano Malpensa, Venezia, Milano Linate and Napoli ▪ In several other airports, a basic system for automatic data exchange managed by ENAV is available.
OPERATIONAL STAFF AWARENESS	▪ Around 1000 people - ab initio ATCOs, advanced ATCOs and FISO students - have attended modules on flight efficiency at ENAV's Academy ▪ Managerial dedicated workshops for all ENAV's ATS Units ▪ 44.540 hours on flight efficiency provided to ATCOs during continuous training

The following table recaps the actions planned in Flight Efficiency Plan for the years 2018-2020, split over the four lines of action.

FLIGHT EFFICIENCY PLAN FOR THE YEARS 2018-2020

EN-ROUTE AIRSPACE DESIGN AND NETWORK AVAILABILITY	**Plan 2018 – 2020** ▪ Free Route in Italy: ○ FRAIT inferior limit lowering to FL305 (May 2018) ○ FRAIT Integration with FRA ML and FRA GR ▪ Review of CDR classification following the implementation of military areas with high flexible use, Third phase: Sardinia area ▪ Re-Classification military areas above FL335 in AMC manageable and application of AUP/UUP process for Airspace Management ▪ Coordination with FAB Blue Med Partners to improve both intra-FAB and trans-FAB route network; Implementation of intra-FAB BM DCTs for selected routings ▪ Network optimization based on traffic demand and harmonization of new RAD implementations
DESIGN AND USE OF TERMINAL AREAS	**Plan 2018 – 2020** ▪ New P-RNAV SIDs/STARs: LIEA, LICA, LIRA, LIRN, LIMJ, LIBD, LICJ_SID ▪ Improvements on P-RNAV SIDs/STARs: LIEO, LIME, LIPZ [LIPX] ▪ Implementations of RNP Approach procedure: LICJ, LIRN, LIMJ, LIMF, LICR, LIMZ, LIMP, LIPB, LICA, LIEA, LIPY, LIPE, LIBC, LICG, LIBP, LIPR, LIBG, LIMG, LIBD, LICD, LIRZ, LIPO, LIPQ, [LIEO, LIPX, LICC] ▪ New implementations STAR TROMBONI P-RNAV: LICJ, LIMC, LIML, LIMF
AIRPORT OPERATIONS	**Plan 2018 – 2019** ▪ Implementation of A-CDM - Local and Full - with SW support for automatic data exchanging among ATC, AOP, Airlines, NMOC and related operational procedures for Napoli e Bergamo
OPERATIONAL STAFF AWARENESS	**Plan 2018** ▪ Ab initio and advanced ATCO students will follow around 130 hours on flight efficiency. ▪ ATCOs continuation training will include around 4.000 hours focused on flight efficiency

The table below shows a detail of the measures that ENAV is in progress to implement according to FEP Plan Edition 2018, relevant to measures described within the ICAO DOC 9988 Guidance on the Development of States' Action Plans on CO_2 Emissions Reduction Activities:

Doc 9988 Measures	2018	2019	2020	Comments
1 - CDO	Implemented on tactical base			
2 - PBN STAR	LICJ, LIEA, LICA, LIRA	LIRN	LIMJ, LIBD	
	LIEO, LIME	LIPZ		Optimisation
3 - CCO	Implemented on tactical base			
4 - PBN SID	LICJ, LIEA, LICA, LIRA	LIRN	LIMJ, LIBD	
	LIEO, LIME	LIPZ		Optimisation
5 – ACDM (non US version)	LIRN	LIME		
7 - WAKE-RECAT (Departures)	N/A			N/A
8 - WAKE-RECAT (ARRivals)	N/A			N/A
9 - AMAN/(RSEQ)				Extended AMAN LIRF 2019, LIMC 2019
10 - Fully utilize ADS-B surveillance				N/A
11 - Radius to fix PBN procedures				LIMC, LIRF
12 - RNP AR APCH(ARRivals)	LICJ, LIRN, LIMJ, LIMF, LICR, LIMZ, LIMP, LIPB, LICA, LIEA, LIPY, LIPE, LIBC, LICG, LIBP, LIPR, LIBG	LIMG, LIBD, LICD, LIRZ, LIPO	LIPQ	
13 - A-SMGCS Peak - (Departures)	L1 implemented at LIMC; L2 by 2020. L1 implemented at LIML; L2 by 2020 L1 at LIPZ by 2020. L1 implemented at LIRF; L2 by 2020			
14 - A-SMGCS Low Vis -(Departures)				
15 - A-SMGCS Night - (Departures)				

4.2.7 Airports and Infrastructure Use

Environmental management has for decades been an integral part of airport development, addressing issues such as noise and gaseous emissions, water and waste management, and biodiversity.
In recent years, the focus on the environmental impact of the activities of the air transport sector has grown considerably. One of the main challenges undertaken is sustainable growth, able to balance the benefits deriving from the increase of traffic with the environmental repercussions.
Airport operators have undertaken initiatives and measures to proactively and effectively address their impact on climate change reducing CO_2 emissions, and remarkable improvements have been already implemented, both through sustaining investments and developing specific actions at national level and through European certification programmes.
Nowadays several Italian airports are committed to decreasing air pollution and greenhouse gases emissions. Over the years, various measures have been taken to reduce atmospheric pollutants through continuous research and innovation in terms of energy efficiency, the production and use of renewable resources, the implementation of procedures aimed at operational efficiency.
This is witnessed by the certifications achieved and above all by the *Airport Carbon Accreditation* (ACA), as shown in para. 3.2.6.1.
The aim of *Airport Carbon Accreditation* is to encourage and enable airports to implement best practices in carbon management, with the ultimate objective of carbon neutrality. Since November 2020 airports can participate at six progressively stringent levels of accreditation (instead of the previous 4 levels): 1. Mapping; 2. Reduction; 3. Optimisation; 3+. Neutrality; 4 Transformation; and 4+ Transition.

Launched in 2009, *Airport Carbon Accreditation* has become the global standard for carbon management at airports. This programme:

- provides a common framework and guidance for airports to map, reduce and eliminate their CO_2 emissions.
- involves 6 independently verified levels of certification, which are based on internationally recognised methodologies from the World Resource Institute, the WBCSD[69] and ISO 14064 (Greenhouse Gas Accounting).
- is endorsed and supported by the UNFCCC, ICAO, the European Commission and ECAC – which are all members of its Advisory Board.

Airport Carbon Accreditation focuses on CO_2 emissions, which represent the large majority of airport emissions. Airports may include emissions of other greenhouse gases (GHGs) on a voluntary basis, as an example of best practice.
Accreditation provides the opportunity for airports to gain public recognition for their achievements, promotes efficiency improvements, encourages knowledge transfer, raises an airport's profile and credibility, encourages standardization, and increases awareness and specialization.
To date, 167 airports in Europe are certified under Airport Carbon Accreditation, with 52 of them being carbon neutral. Collectively, these airports account for 70% of our continent's air traffic. In 2019, through their participation in *Airport Carbon Accreditation*, Europe's airports delivered a reduction of 158,212 tons of CO_2.

National Context

ENAC asked airport operators for a complete picture of the measures taken under their direct responsibility to reduce CO_2 emissions and the following data represent the Italian "state of play".

[69] World Business Council on Sustainable Development

Airports are committed to becoming cleaner and more efficient. In the middle of a complex web of aircraft movements, technical operations and surface access transport, airports can address the issue of CO_2 emissions in several ways. These include better insulation and energy efficiency (e.g. replacement of building casings, construction of low-consumption energy systems; cogeneration or trigeneration plants; replacement of lighting systems with LEDs; new air conditioning and ventilation systems), switching to green energy sources (e.g. photovoltaic power plants), investment in green mobility (e.g. replacement of vehicles operating in the airside area with electric and/or hybrid vehicles, and adaptation of network infrastructures to install charging points/stations), encouraging employees, passengers and visitors to use public transport, working with airlines and air traffic management to reduce runway taxiing times, implementing green landing processes and much more.

Italian airports fully engaged & leading in carbon management

Italian airports have from the start been closely involved in *Airport Carbon Accreditation*. So far there are 14 accredited airports in Italy, which account for more than 80% of the country's 2019 air passenger traffic.
Of these, 7 airports - representing 57% of the national passenger traffic - are carbon neutral, resulting in Italian airports accounting for 15% of our continent' carbon neutral airports – which is quite remarkable.

Furthermore, it is notable that 2 Italian airports, Rome Ciampino and Rome Fiumicino, have achieved the new highest level of the Airport Carbon Accreditation programme: Level 4+ "Transition", the first in Europe to do so.

The table below provides with details about the Italian airports' involvement in *Airport Carbon Accreditation* with reference to the single levels achieved

ACA Level	Airport Operator	Airport	IATA code
Mapping	So.G.Aer	Cagliari Airport	CAG
Reduction	GES.A.P.	Palermo Airport	PMO
Reduction	Aeroporto Guglielmo Marconi di Bologna	Bologna Airport	BLQ
Reduction	Aeroporto Valerio Catullo di Verona Villafranca	Verona Airport	VRN
Reduction	Geasar	Olbia Costa Smeralda Airport	OLB
Reduction	SAGAT Torino Airport	Torino Airport	TRN
Optimisation	SACBO	Milan Bergamo Airport	BGY
Neutrality	AER TRE	Treviso Airport	TSF
Neutrality	GESAC	Naples Airport	NAP
Neutrality	SAVE	Venice Airport	VCE
Neutrality	SEA Milan Airports	Milan Linate Airport	LIN
Neutrality	SEA Milan Airports	Milan Malpensa Airport	MXP
Transition	Aeroporti di Roma	Rome Ciampino Airport	CIA
Transition	Aeroporti di Roma	Rome Fiumicino Airport	FCO

An industry committed to fossil-free operations by 2050

In addition to the above, 10 Italian airports have since June 2019 been formally committed to achieve Net Zero for CO_2 emissions under their control by 2050 at the latest. This commitment was undertaken through ACI EUROPE and formally undersigned by 215 airports. The 10 airports in Italy which have adhered to the resolution are: Bologna, Milano Bergamo, Milan Linate, Milan Malpensa, Naples, Palermo, Rome Ciampino, Rome Fiumicino, Torino and Venice.

With reference to the CO_2 emissions per passenger in the last three years, at national level it has been estimated a total index as follows:

Year	*2015*	*2016*	*2017*
Average of the total tons of CO_2 emissions per passenger	**0,00166**	**0,00157**	**0,00135**

The data above show how the actions, investments and initiatives developed by the airport operators have had a positive impact in term of CO_2 emissions reduction which have steadily decreased.

The overall initiatives undertaken by Italian airport operators also include airports which are not certified within the ACA programme and which have realized, in any case, initiatives with the aim of reducing CO_2 emissions.

4.2.8 Focus on the major airport operators

4.2.8.1 Aeroporti di Roma (ADR) – Fiumicino and Ciampino Airports

The aviation sector faces the challenge of achieving recovery and growth post the COVID-19 pandemic whilst pursuing its ambition to significantly reduce Greenhouse Gas (GHG) emissions. To pursue this goal, ADR has made commitments and developed programmes to help achieve its target of zero CO_2 emissions by 2030.

As a first step, ADR is committed to monitoring on an annual basis GHG emissions (i.e. Scopes 1, 2 and 3) by ADR, its subsidiaries and other stakeholders in the sector, such as airlines and other companies operating at the ADR airports.
In March 2021, ADR secured the Airport Carbon Accreditation ("ACA") Level 4+ (Transition) certification, the highest level in existence to date. This achievement also makes Rome's airports the first in Europe and among the first in the world to achieve this level of certification as of first quarter of 2021.
Ongoing environmentally-focused construction projects at the airport include two large multi-megawatt photovoltaic plants, electrical and thermal storage systems, and the use of bio methane and low-carbon transport infrastructures. Investments in a network of electric charging stations for airport mobility, which will become cleaner over time, have also been planned.
As part of the European Commission's Horizon 2020 research and innovation program, ADR has participated and won last year in a 12 million euros tender to find solutions that demonstrate how an airport can be designed to operate completely without carbon emissions. In collaboration with Copenhagen airport, the International Air Transport Association (IATA), the University of Parma and 10 other European partners, ADR has joined the "ALIGHT" project to analyse the airport's zero-carbon emission future. The Smart Airport project plans to make Sustainable Aviation Fuels (SAFs) available at participating airports (e.g. biofuel, electricity, hydrogen or e-fuel) all of which are essential for decarbonising aircraft flight.

Typically, airport Scope 3 carbon footprint is mainly driven by its "aircraft" component: take off, landing, approach, climb, and cruise from origin to destination; which account for around 90% of the total Scope 3 emissions.
In this context, ADR is taking initiatives through the establishment of a Stakeholder Engagement Plan to reduce the sources of its Scope 3 emission for which it can only provide guidance and influence:
Contributing to SAFs with full availability for aircraft by 2024, making biofuel available at the airport distribution centre.

ADR successfully implemented the Airport Collaborative Decision Making (A-CDM), an operational procedure which aims to improve air traffic management through better sharing of information amongst all stakeholders. Thanks to its introduction, airlines have been able to save an average of 90 seconds of taxing time (-10%), which resulted in a CO_2 savings for ca. 11,800 tonnes (on an annual basis - 2018 figures).
ADR participates in the SESAR programme (Single European Sky Air Traffic Management Research), which contributes to the targets of the Single European Sky (SES) initiative to reduce the environmental impact of flying through better use of airspace and a sky decarbonisation programme
ADR promotes rail access to Fiumicino airport, in partnership with the national rail operator. ADR has also invested in smart and clean mobility to and from the airport by investing in electric charging stations with clean energy availability and facilitating electric car sharing.
Clean Transportation and Infrastructure for Low Carbon Transport: installation of 500 electric vehicle charging stations by 2025; substitution of the entire vehicle fleet with electric vehicles by 2029, increase of smart and clean mobility to and from the airport by investing in a cycle lane for employees and facilitating electric car sharing.
By installing 500 electric charging stations for electric vehicles by 2025, ADR is committing to reducing landside and airside Scope 3 emissions.

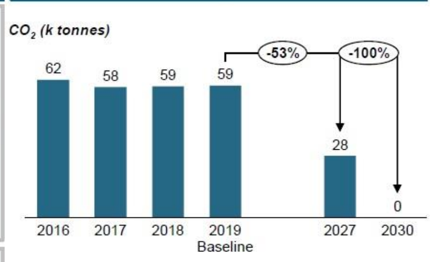
ACA 4+ Main Projects on Scope 3

SCOPE	ACTIONS	IMPACT	OWNER / STAKEHOLDER
Scope 3 - *All other indirect emissions*(1)	Availability for airplanes of SAF (Sustainable Aviation Fuel) by 2024 as committed by EU funded project ALIGHT	Reduction of emissions produced by airplanes during cruise, landing, taxing and take-off	Suppliers (Oil Companies), Re-fuelers, Airlines, ENAC
	Installation into the airport of ca. 500 charging points for electric vehicles by 2025 to improve electric mobility (roughly 100 air side and 400 land side)	Reduction of emissions made by vehicles used by passengers and operators to reach the airport and within the airport	ADR, Passengers, Handlers
	SESAR program projects	Taxi time optimization and airplanes movements optimization to reduce fuel consumption	ADR, ENAV, ENAC, Airlines
	Expansion of airport rail station	Improve public transport share for passengers and employers	Ferrovie dello Stato, Lazio Region, ENAC, ADR
	Working groups with stakeholders to increase use of green energy, green mobility and SAF (Sustainable Aviation Fuels)	Reduction of emissions made by third parties	ADR, Airlines, Tenants, ENAC, ENAV, Handlers, Car sharing, Rent a car, Bus, Taxi

(1) which are a consequence of the activities of the airport but occur from sources not owned and/or controlled by the company (e.g., aircraft movements, vehicles and equipment operated by third parties, off-site waste management, etc.)

4

Decarbonisation data



KPIs	Steps	Action Plan
CO_2 Emission - Scope 1 and 2	(see chart above)	i. Renewable Energies: **multi MW photovoltaic power plants** and procurement of certified green electricity ii. Phase out of the existing methane powered CHP and use of bio methane for boilers from 2029 iii. Installation (on top of the existing thermic storage of 20 MW and 60 MWh) of a **Multi MW electric storage** **iv. Green Buildings with certification**: the LEED "Gold", BREEAM "Very Good", EPBD "A" **v. Electric vehicles fleet**: substitution of the entire fleet **vi. Energy efficiency technologies**
Maintaining ACA Level 4+ Accreditation	***The accreditation is reviewed every 3 years (2024, 2027, etc.)***	**i. Availability of Sustainable Aviation Fuels** by 2024 in line with the ALIGHT EU-funded project ii. Installation into the airport of ca. **500 charging points for electric vehicles** by 2025 iii. Improvement of **rail accessibility** iv. Improvement of **buses accessibility** and link the airport to the regional cycle lines network v. Initiatives within **SESAR program** vi. Actions to **raise awareness on airport's tenants** for the procurement of green certified energy and the use of electric vehicles vii. Raising awareness **initiatives and working group with handlers** for the usage of hybrid/electric vehicles and incentive policies
CO_2 Emission - Scope 3		

ADR First and, to date, Only in Europe to Achieve ACA 4+

AIRPORTS CARBON ACCREDITATION MAP

As at the end of 2020, around 340 airports in the world were certified by the ACA (out of about 18k globally), 167 of which are based in Europe, including all the largest airports

# of European Airports in the Level[1]		Accredited Airports in Europe
1 airport system in Europe (ROME); 3 Globally	**Level 4+** *Transition*	Aeroporti di Roma
None	**Level 4** *Transformation*	
50 (in 16 countries)	**Level 3+** *Neutrality*	Gatwick, London City, Copenhagen, Schiphol, Milan
18 (in 9 countries)	**Level 3** *Optimisation*	Heatrow, Paris-ADP, Vienna, Zurich
40 (in 19 countries)	**Level 2** *Reduction*	Edinburg, Malta, Lisbon, Aberdeen, Bologna, Torino
57 (in 16 countries)	**Level 1** *Mapping*	Stockholm, Istanbul, Luton

In March 2021, Rome airports became the first in Europe to achieve ACA Level 4+ "Transition" (only 3 cities globally)

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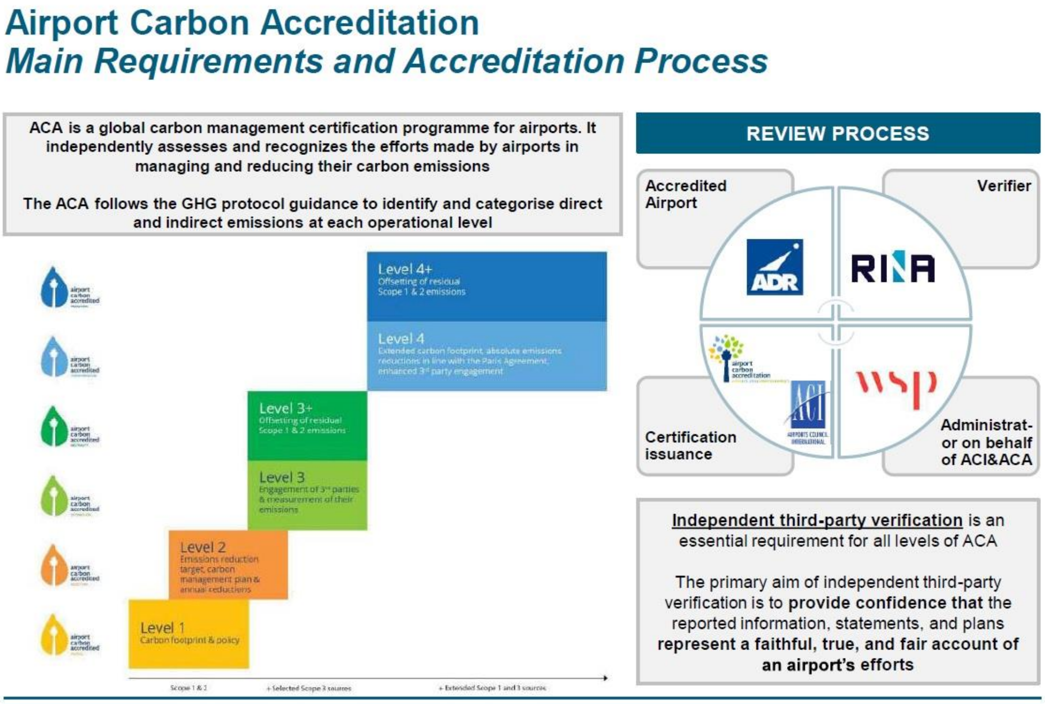
In 2020, Level 4 and 4+ have been added to the ACA to align it with the objectives of the Paris Agreement



Aeroporti di Roma SpA has been committed to quantifying the CO_2 emissions related to the operation of the airport operators and to the activities that gravitate around the Rome airport system since 2011, through the voluntary adhesion to the Airport Carbon Accreditation scheme proposed by ACI Europe.

Aeroporti di Roma joined the scheme in its experimental phase, which involved only European airports, and continued in the certification path that led to the achievement of the Carbon Neutral levels of excellence in both airports (Fiumicino and Ciampino).

The use of the ACA certification at the highest level is integrated with other related management tools that have been implemented by the company for a long time now; in particular, until 2016 practices and procedures of the ACA were integrated in the environmental management system, while in 2017, following the new technical and organisational infrastructure, carbon performance management is included in energy management system procedures in a holistic approach aimed at integrating management systems.

The interventions envisaged by the ACI Europe programme include the reduction of discharges produced by land transport, the increase in renewable energy used and the reduction of energy waste in buildings.

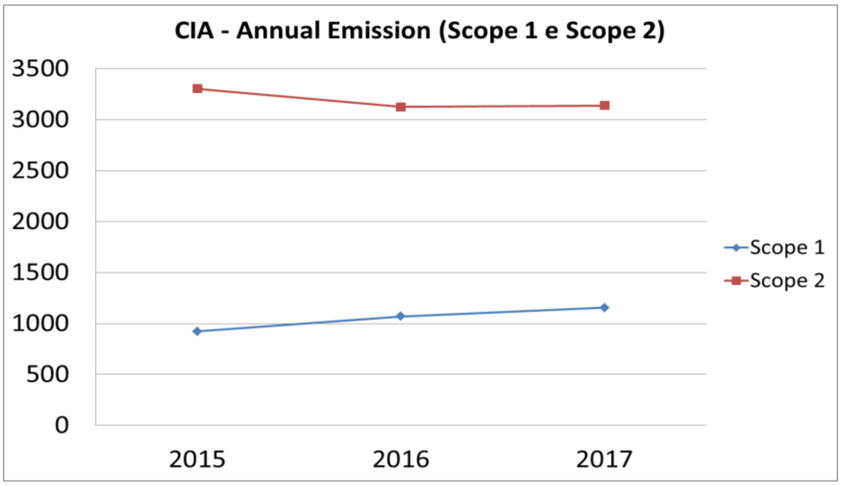
Quantification of emissions

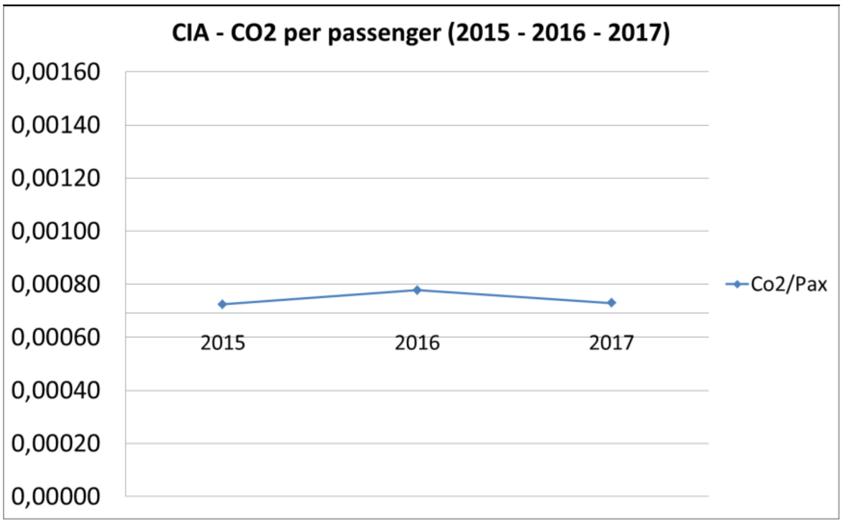
The request for a detailed analysis is aimed at obtaining a picture of the status quo updated to the last three years, in order to identify the actions to be undertaken in the fight against Climate Change, in line with the most recent European policies on the matter and, dynamically and proactively, to meet the challenges of "green communication" in the near future.

The study is conducted annually with the final aim of being used as a management tool within the ISO 50.001 certified SGE, already applied in ADR, and as a primary requirement for accreditation to the Airport Carbon Accreditation scheme, which resumes the methodology for the quantification of greenhouse gases, defined as "Carbon Footprint", defined by the UNI EN ISO 14064: 2012 standard and the guidelines of the GHG Protocol.

Through the use of appropriate indicators, internal and external comparisons are possible both for management and marketing purposes.

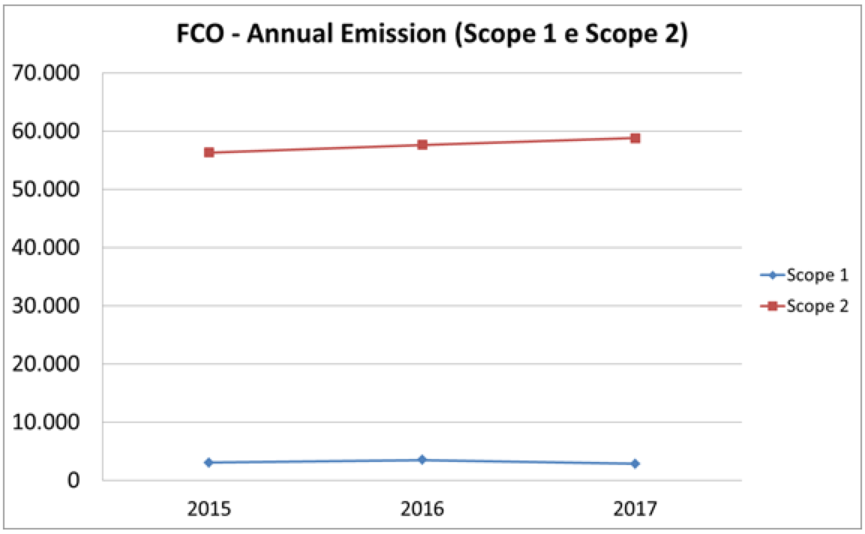
Rome Ciampino Airport - 2015-2017

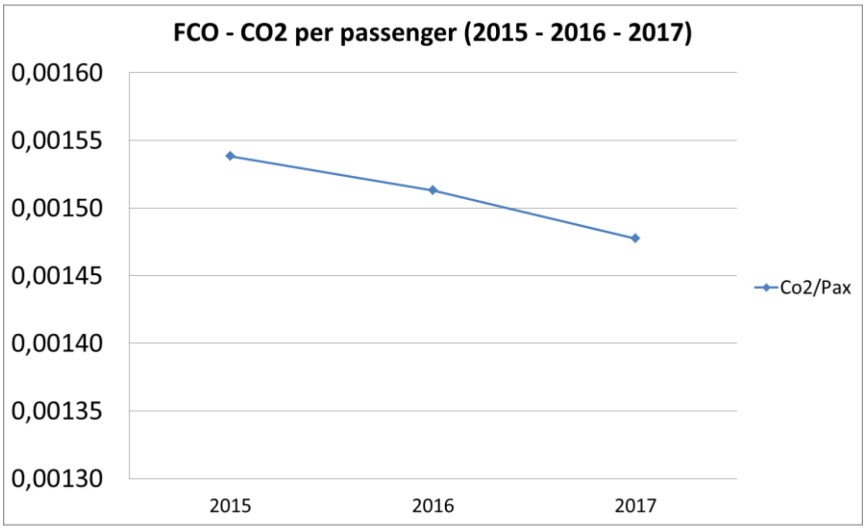




* in Summer 2016 the runway was closed so the passenger number is much lower than in 2015 and 2017.

Rome Fiumicino Airport - 2015-2017





The greatest contribution of the emissions under control of airport operators is given by "Scope 2", i.e. the energy purchased.
Rome Fiumicino and Ciampino airports have been certified ISO 50001 since 2012 and several energy efficiency projects are planned annually.
The continuous decrease in specific consumption is due to a series of energy efficiency measures, investments for the reduction of specific consumption and investments in infrastructure.
Since 2011, the first year of ACA certification, Aeroporti di Roma has constantly improved its carbon performance expressed with the $KgCO_2$/pax indicator related to the directly controlled emissions (Scope 1 + Scope 2).
As for the indirect emissions that cannot be directly controlled, ADR has encouraged the reduction of emissions through a stakeholder engagement plan, in which shared actions are valued, that can lead to an improvement in carbon performance.
Among the initiatives aimed at obtaining a CO_2 emissions reduction in the period 2011-2017, it is important to mention the following:

Directly controlled emissions

- Maintenance actions linked to energy savings which led to a reduction of around 36 GWh (-20%) in electrical energy consumption compared to the natural trend defined as business as usual;
- Use of electricity for Fiumicino, mainly coming from the power station of Fiumicino energy (subsidiary company of ADR), which produces electricity with an emission factor about 10% lower than the emission factor related to the grid (or national energy mix);
- Use of energy efficiency criteria in the design and construction of new infrastructures, C pier and terminal for FCO and general aviation terminal for CIA;
- Installation and use of energy from renewable sources through the installation of photovoltaic, wind and Smart Grid in FCO;
- Training and awareness of employees on energy saving and incentive policy on the use of public transport to reach the airport;
- Use of electric and hybrid cars to partially replace the ADR vehicle park on the air- and landside.

Not directly controlled emissions

- The joint action of ADR and ENAV (Italian Air Navigation Service Provider) led to the implementation of the Airport Collaborative Decision Making (A-CDM) operational procedure aimed at improving air traffic management through a greater exchange of information among all stakeholders (airport operators, handlers, airlines, air traffic controllers, CFMU- Central Flow Management Unit). As for Carbon, the reduction in TAXI time (one of the largest emission sources in absolute terms) and the reduction of the environmental impact of third-party operators were the main stakeholder engagement programmes;

- Improvement of traffic and ease of access to the airport by public transport. Over the years, with the increase in passengers, the construction of specific stalls was necessary for the arrival of buses with municipal, regional and inter-regional origins, both to Fiumicino and Ciampino Airports, which has led to an increase in passengers (and employees) who have chosen to use public transport instead of private car;
- Introduction of free floating carpooling in collaboration with Eni Enjoy and Car2go partners for passenger access to the airport;
- Specific training on energy saving at all the sub-concessionaires who lease commercial areas.

Beyond carbon neutrality: focus on future actions

In the next few years ADR intends to continue to maintain the level of Carbon Neutrality.
However, the process of continuous improvement to achieve the highest levels of certification in the Airport Carbon Accreditation scale will focus on improving the performance of the individual emission sources with regard to their significance.

4.2.8.2 SEA Milan – Malpensa and Linate Airports

The Malpensa and Linate airports are among the top ten in Europe by passenger volume and among the top six by cargo volume, whereas at the national level the Milan airport system is Italy’s second-largest in terms of passenger traffic and number-one in the cargo segment and general aviation.
SEA and the Group companies manage and develop the airports of Milan Malpensa and Milan Linate, guaranteeing services and related activities, such as the landing and take-off of aircrafts, the management of airport security and the development of commercial services for passengers, operators and visitors, through a wide and differentiated offer.

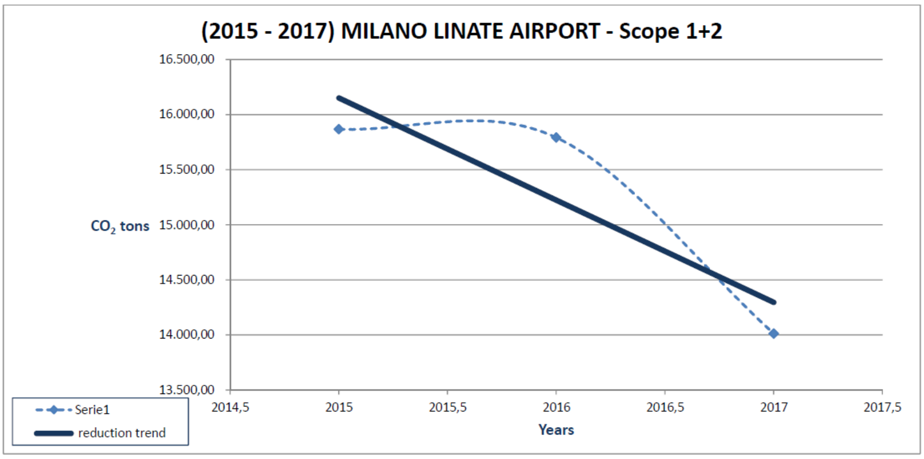
SEA (Società per Azioni Esercizi Aeroportuali) Group manages Milano Malpensa and Milano Linate airports under a 40-year agreement signed by SEA and ENAC in 2001. It is one of the ten biggest airport operators in Europe for goods and passenger traffic, while it is the second-biggest in Italy for the number of passengers handled and the biggest in the country for goods transported.
SEA’s mission is entrenched in the responsibility to provide impetus to this growth in a manner that is sustainable, broadly shared and respectful to all.
Milano Malpensa and Milano Linate make up an airport system that guarantees civilians and economic operators an extensive network of links with Italy, Europe and the rest of the world, thus contributing to the economic and social development of the North of Italy and the country as a whole.
Through SEA Energia (a wholly-owned subsidiary of SEA), the Group owns two co-generation plant, mainly meeting the energy needs of Linate and Malpensa airports, providing electricity, heat and district cooling.
SEA is certified UNI EN ISO 14001, ISO 50001, UNI EN ISO 9001, BS OHSAS 18001. It is also accredited ACI Europe Airport Carbon Accreditation at level “3+ Neutrality” for the reduction of CO_2 emissions.
SEA joined the Programme at the very beginning when it was launched in 2009 by ACI Europe, reaching the level of Optimisation, the first time in Italy, for both Milano Linate and Milano Malpensa airports. In 2010, among the first European airports, it was accredited level 3+ Neutrality, having mapped and reduced its Scope 1 and 2 emissions, comprised Scope 3 emissions, developed a Stakeholder engagement plan as well as offset its residual Scope 1 and 2 emissions for both airports.

Taking into consideration the due adjusting of the three-year rolling average resulting from the natural evolution of an airport in terms of investments and divestments, from 2009 (when SEA joined the ACA Programme) to 2017, it has been reducing its Scope 1+2+3 emissions of 24.4% for Linate and 39.7% for Malpensa, in absolute terms.
If considering the target expressed in tonnes of CO_2 per equivalent passenger, those reductions accounted for 33.9% for Linate and 54.9% for Malpensa.
Focusing on SEA emissions under Scope 1 and 2, i.e. emissions for which the airport has ownership/control, the last 3 years have been characterized by the following reductions:

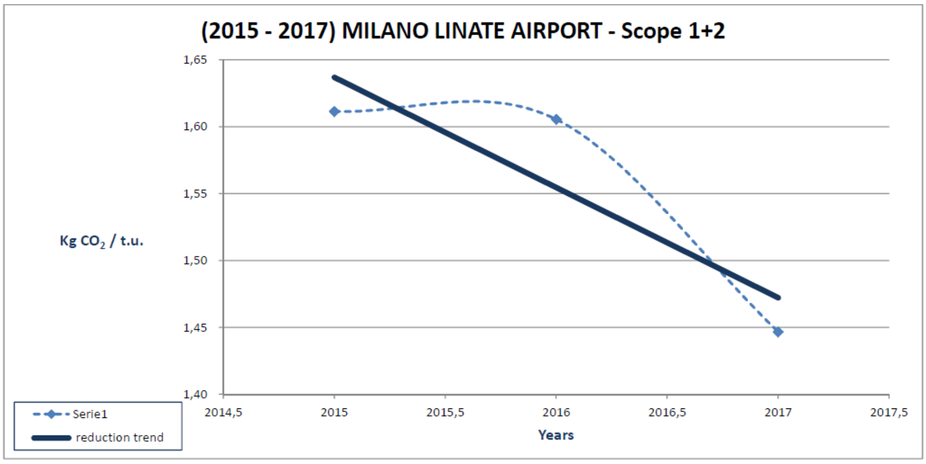
Linate

Linate Airport occupies a total area of approximately 350 hectares in the south-eastern part of the Province of Milan, extending into the municipalities of Peschiera Borromeo, Segrate and Milan. Forlanini Park, one of the major urban parks in Milan, and the Idroscalo lake adjoin the airport.
The airport is dedicated primarily to a frequent flyer type client, on domestic and international routes (these latter both within the European Union and outside).

Reduction in absolute terms: 11.7% tonnes of CO_2



Reduction in Kg of CO_2 per traffic unit: 10,2%

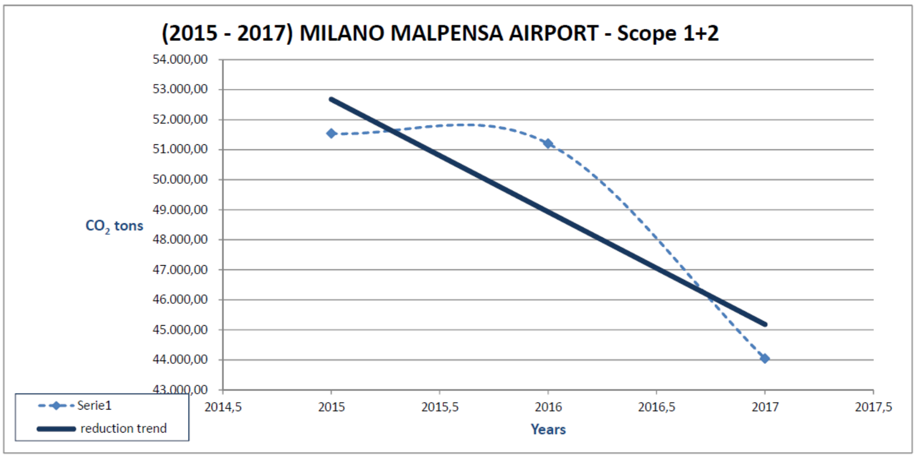


Malpensa

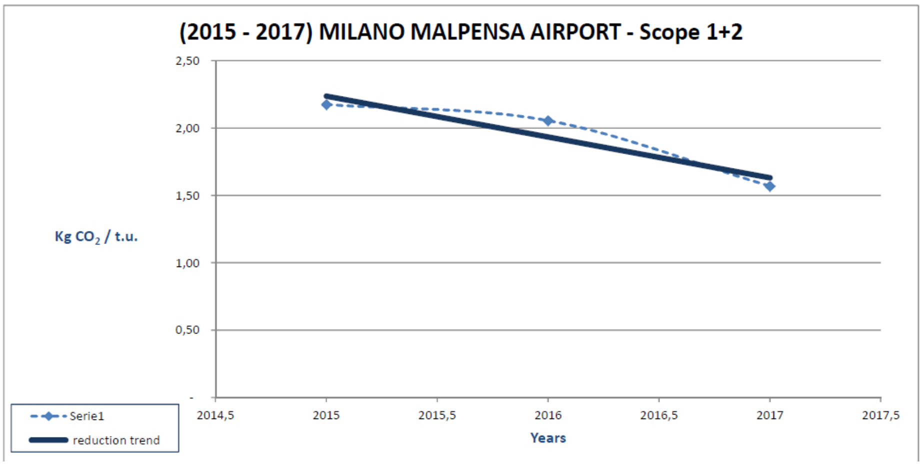
Malpensa Airport is located in the south-west of Varese province, 48km from Milan, with rail connections to the city and a road system, including a motorway, which connects the airport with the major regions of Northern Italy and Switzerland. The airport covers 1,220 hectares within 7 municipalities: Somma Lombardo, Casorate

Sempione, Cardano al Campo, Samarate, Ferno, Lonate Pozzolo and Vizzola Ticino. All airport grounds are within the Lombardy Valle del Ticino Park, the largest regional park in Italy, created in 1974.

Reduction in absolute terms: 14.5% tonnes of CO_2



Reduction in Kg of CO_2 per traffic unit: 27,9%



This reduction in emissions is the result of a series of specific actions, together with a policy commitment to GHG, carbon and energy reduction formally stated from the company top management within SEA integrated Environmental and Energy Management Systems, certified ISO 14001 and 50001, as well as targeted savings measures adopted by the company, including under current institutional arrangements (Contratto di Programma ENAC-SEA).

Just to mention the most relevant ones:

- Optimization of the lightning system through the installation of LED lamps;
- Further optimization of the conditioning power station;
- Further improvement in energy consumptions management, through the implementation of new software and methodologies;
- An increasing use of renewable energy sources.

SEA future actions towards the reduction of CO_2 emissions

SUSTAINABILITY STRATEGY

Integrating key issues of environmental management into SEA development strategies is mandatory to confirm the commitment to reduce the environmental impacts.

SEA environmental and energy policy is inspired by the following principles:

- high compliance with the law;
- continuous improvement of environmental and energy performance;
- raising awareness and involvement of all stakeholders present in the airport system for a responsible commitment aimed at respecting and safeguarding the common heritage represented by the environment in which it operates;
- purchase of products and services based on environmental criteria with particular attention to energy saving, reduction of atmospheric and acoustic emissions and water consumption;
- management of CO_2 emissions, both direct and indirect, through the involvement of stakeholders, as part of the reduction of greenhouse gas emissions established by the Paris Agreement;
- control and monitoring of industrial processes related to energy, atmospheric and acoustic emissions, water cycle and the different phenomena that characterize the interaction with the ecosystem;
- high level of engagement of a wide range of stakeholders.

In the second half of 2019 SEA prepared the document "Environmental Strategy of Milan Airports", which deals with the main environmental aspects: noise, biodiversity, waste management, atmospheric emissions, energy consumption and water resource management.
The state of the art relating to all environmental aspects was defined, as well as the targets to be reached in different time horizons (2025, 2030, 2035 and 2050) to reach "net zero emission".
In this context SEA joined the "NetZero2050" resolution, promoted by ACI Europe in June 2019, which commits its 500 members to reach the "net zero emissions" of CO_2 generated under their control by 2050, or even before.
Since 2009 SEA has joined the Airport Carbon Accreditation initiative, launched by ACI Europe (Airport Council International) to promote a concrete contribution by airports to the fight against climate change. The project involved the activation of a series of actions for the control and reduction of direct and indirect CO_2 emissions by the airport manager, operators, aircraft and all parties working in the airport system.
In 2019 SEA confirmed the European leadership position for both Linate and Malpensa airports, within the "3+ neutrality" group.

CO_2 EMISSIONS REDUCTION PROJECTS

Main projects developed by SEA addressing CO_2 emission reduction:

- adoption and management of UNI EN ISO 14001:2015 e UNI CEI EN ISO 50001:2018 environmental and energy management systems which include a wide range of of energy management measures;
- achievement of ACA3+ certification which attests continuous reduction of CO_2 emissions and allows SEA to be defined "carbon neutral";
- revamping of the electric power station with a new turbine which allows significant fuel and emissions reductions;
- substitution of traditional light bulbs with new technology ones (LED);
- implementation of several 400 HZ GPU system at Malpensa airport to provide parked aircraft with electric power source.

Planned new projects:

- Green transition of vehicle fleet from traditional ones to electric ones. This measure is about cars ad passengers buses;
- Extension of 400 HZ GPU system at Linate airport;
- Installation of wide photovoltaic systems both at Linate and Malpensa airports;
- Completion of substitution of traditional light bulbs with new technology ones (LED);

- Testing of hydrogen production and supply at Malpensa airport;
- Promotion of public/mass transit system for passengers and employees;
- Participation in the construction of a new railroad connecting Malpensa Airport to Milan (T2 – Gallarate connection).

4.2.8.3 Venice Airport (SAVE Spa)

Venice Marco Polo Airport is the unmatched airport of reference in the North-East of Italy and it is the main gateway for long distance access.
SAVE S.p.A., the company managing the airport, is strongly engaged in reducing its levels of pollution, and Venice Airport has achieved "Neutrality 3+" level within the Airport Carbon Accreditation, that requires neutralizing remaining direct carbon emissions by offsetting.
Since achieving complete carbon neutrality is challenging without external help, the ACA certification programme gives the possibility to look for carbon offsetting in the final stage, for example investing in renewable energy facilities which replace those powered by fossil fuels.
In fact, in Marco Polo Airport, since 2016 some of the offsets has came from the project named "Za Hung Hydropower Project" submitted to the Markit Environmental Registry. This project is based on the Voluntary Carbon Standard (VCS), created to ensure the credibility of voluntary compensatory investments. This standard requires projects to meet exact requirements such as the concreteness of the offsetting, their measurability and permanence, independent verifications; the offset quotas are used only once.
Moreover. in 2017 the company decided to support two projects very similar to each other:

- "Jari / Amapà REDD + Project" is registered in the APX VCS Registry and is based on the methodologies used by VCS;
- ii) "Portel-Para REDD Project in Brazil": the planting of trees is associated to each carbon offset.

In January 2015 Venice Airport became a fully implemented A-CDM airport following the connection to the Network Manager Operations Centre and the exchange of live data via DPI messaging and certified its Energy Management System according to UNI CEI EN ISO 50001.
In the same year some initiatives in terms of energy efficiency have been carried out such as:

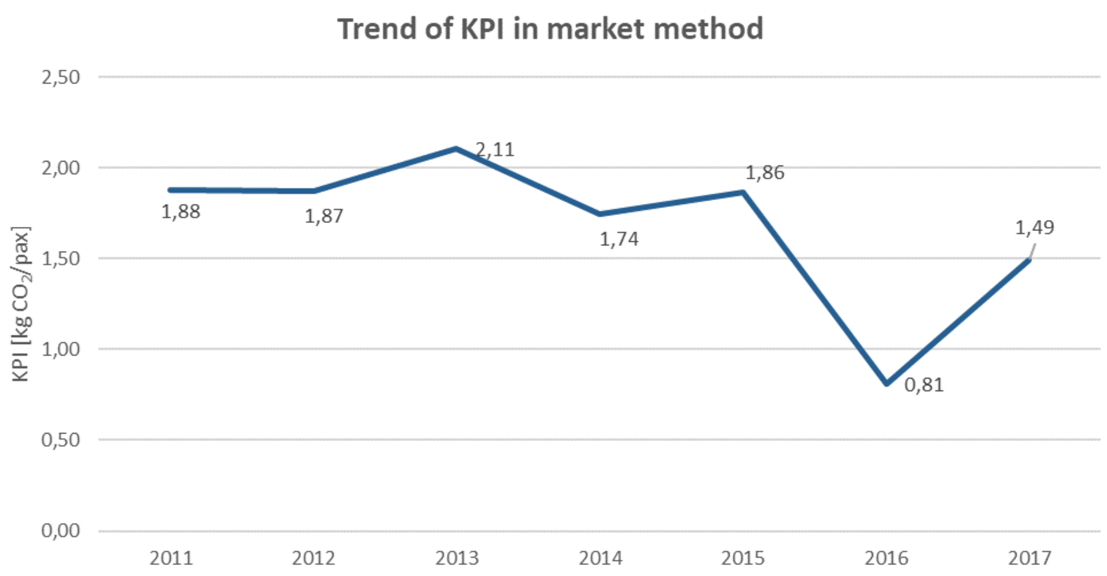
- the installations of air blades on some doors, the substitution of two chillers and the inclusion of a supervisor to switch off the lights in the multistorey car park;
- the replacement of several lamps with LED technology, especially in terminal areas;
- the change of the Baggage Handling Systems engines, saving 339 tons of CO_2 in 2016.

Furthermore, in the last years the airport operator has started to replace the vehicles used in the airport area purchasing eco-friendly cars (currently there are several hybrid and full electric cars) and has installed electric charging stations for electric vehicles available for all airport operators and passengers.It was also incremented the number of stands provided with fixed GPU 400 Hz.
The 2017 electricity, hot and chilled water needs were met in large part with the new trigeneration plant which entered service in February 2017. The plant consists of two internal combustion engines powered by natural gas, each one capable to produce 2 MWe of electric power and 1.9 MWt of thermal power. The engines also can feed two absorption refrigeration units of 1.5 MWf each.
This has also led to an increase in the self-production of electricity (about 65%), but at the same time to an increase in CO_2 emissions because from May 2016 the company has opted to obtain a supply of electricity from 100% renewable sources,

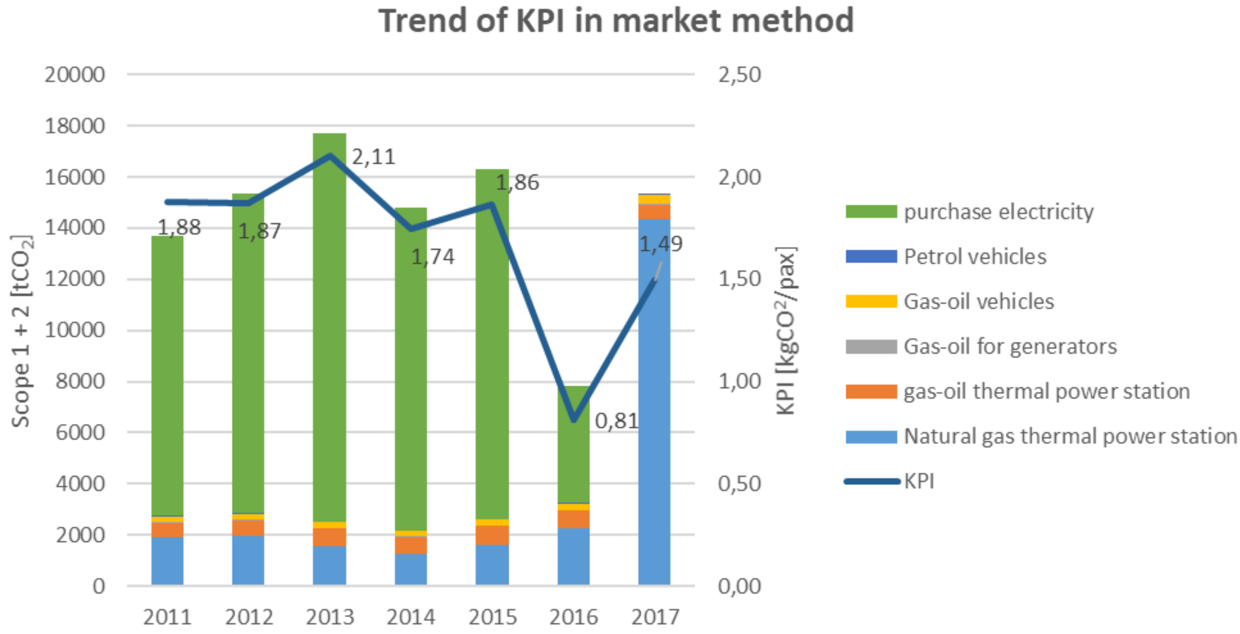
going to neutralize its scope 2 emissions according to Market method described in GHG Protocol Scope 2 Guidance.
However, the airport also owns an emissions inventory and has planned a reduction of CO_2 emissions by 30% below 2011 level by 2030, purpose that is fully achieved through the market method.
Here below a table summarizing CO_2 emissions from 2015 and Venice Airport KPI [$kgCO_2$/pax].

	2015	2016	2017
Scope 1 *[tCO_2]*	2.636	3.246	15.311
Scope 2 *[tCO_2]*	13.671	4.575	0
pax	8.751.028	9.624.748	10.371.380
KPI *[$kgCO_2$/pax]*	1,86	0,81	1,49

Carbon Footprint in the last 3 years



To understand the Venice Airport KPI trend from its base year, the following diagram shows very well the most impact actions taken since 2016 (purchase of 100% renewable electricity) and 2017 (trigeneration plant).



Carbon Footprint from 2011-2017

Further actions for the improvement of air quality are focused on the efficiency of aircraft operations during LTO cycle: it required to minimize the use of reverse and, for all the narrow body aircraft, taxing with a single engine.

In mid-2019 it was decided to adopt a highly innovative project, the Sybil HVAC (Heating Ventilation Air Conditioning) designed by Alperia Bartucci, a leading company in Italy for energy efficiency items, which allows to modulate the actual energy demand and the relative consumptions based on the real number of people present in the terminal affected by heating/air conditioning.
In detail, the intervention involved the design and installation of an Advanced Control System capable of automatically regulating the Air Handling Units (AHUs), which in this first phase are testing the Extra Schengen departures area.
Before the installation of the Advanced Control System, the air conditioning systems were forced to work continuously at high speed to satisfy the conditions of comfort in the event of a high influx of passengers, with consequent high energy consumption even in periods of low crowding.
The new system has overcome the limits of this management through complex algorithms, historically applied in the process industry, capable of acquiring data relating to the precise crowding conditions of the areas concerned and consequently regulating the performance of the machines. In this way the comfort of passengers is guaranteed during periods of maximum crowding but, at the same time, the operation of the engines is reduced in case of low crowding.
After a continuous period of action of the Advanced Control System, the electricity consumption before and after its installation were compared and, under the same exogenous conditions, linked to the external temperature and the influx of passengers, it was calculated an energy saving close to 30%.
This system will be extended to the whole terminal.

VENICE AIRPORT MARCO POLO AIRPORT AFTER RUNWAY UPGRADING

In September 2018, SAVE group started the batch 2 – 2nd section redevelopment and adaptation of works of the flight infrastructure of Venice Marco Polo Airport Tessera. The contract was divided into phases with sectoral closures of the runways and junctions area to allow full aerial operation of the airport.
This intervention envisaged significant infrastructural works for the requalification, implementation and compliance of the flight infrastructures both from a civil and plant engineering point of view in order to align performance with future operating

scenarios planned for the next 20 years and to accommodate the traffic trend that will return to grow as soon as the pandemic due to covid-19 is over, which has drastically reduced the volume of air traffic on all national and international airports.

The layout of the flight infrastructure of the Marco Polo airport in Venice before the start of the redevelopment works

After the various work phases that have seen the redevelopment of various portions of the infrastructure to allow for upgrading and the construction of new connections between the runway area and the apron, the movement of air traffic from the main runway (04R/22L) to the secondary one (04L / 22R) during the last spring 2019 and the suspension for about two months (March-May) of all construction site activities for the emergency due at Covid-19, the air infrastructure finally appears to "take flight" from 1st October 2020.

The interventions of this large two-year contract are essentially consisted of:

- in the upgrading of the current main runways (04R/22L) and secondary one (04L /22R);
- in the extension of the secondary runway on the 22R side to be used as a taxiway but with same characteristics and dimensions in line with the runway;
- in the construction of speed-exits for the runway 04R, of a new central junctions placed on the area where Firefighters and Finance Police department were (between the North apron and the secondary runway);
- a Holding Bay for the 04R header to increase the capacity of the system;
- in the adaptation of the geometry of the airport infrastructure for the operation of long-range aircraft and code F (as Airbus A380);
- in the adaptation of the plant equipment and in the increase of the safety systems of both runways, in particular with regard to AVL (Luminous Visual Aids) and non-raid protection/detection circuits authorized on the runway, in order to be able to manage the future increase in air traffic with increased safety standards, in particular in conditions of low visibility (LVP in CAT IIIB).

THE AIRPORT BEFORE THE START OF THE REDEVELOPMENT WORKS

Before the start of the redevelopment works, the Marco Polo Airport was classified 4E with approval of operations up to 4F, with two runways available usable in both directions placed at a distance between centers of 202 m and totally dependent.
The main runway of 3.300 m long (in addition other 15 m on each shoulder side) and the secondary runway of 2.780 m long (over 7.50 m per side of shoulder) are wide 45 m. A set of taxiway allowed the connection between the two runways and between the secondary runway to North and South aprons of the airport.
The flight activity focused mainly on the use of the main runway located closer to the Venice lagoon.

THE ORGANIZATION OF BUILDING SITE

Before this works, the conservative state of the flooring appeared to a large extent compromise, presenting a degradation of the surfaces with the risk of detachment of the aggregates from the wear layer, to which it is accompanied a widespread state of cracking of the floors.
The last general redevelopment of both runways dates back to 1996 and a partial refurbishment of the wear surface of the main runway dates back to 2013.
To protect airport operations, SAVE S.p.A. has planned the work on several phases with the aim of maintaining unaltered air traffic level and guarantee the same capacity. But how? Optimizing the use of the infrastructure for the entire duration of the construction site.
The sequence was identified in 7 consecutive temporal phases of variable duration appropriately defined on a two-year timeframe starting from September 2018 and with the aim of:

- the deep requalification of the flooring in the central part of the flooring;
- the construction of new cable ducts and poliferae for the plant adaptation of the plants;
- the complete adaptation of the rainwater collection system;
- plant upgrading of movement systems a aircraft land.

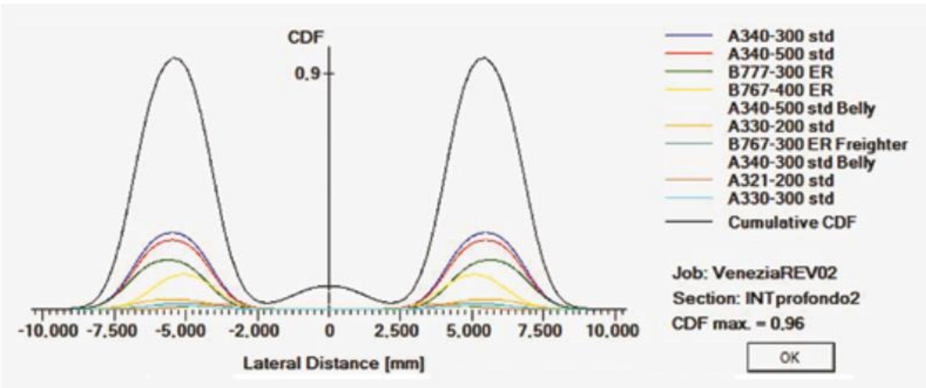
The processes followed one another with cycles 24 hours a day, seven days a week.
However, carrying out the various phases of the construction site over several years represented a great challenge for the complex organization; already during the planning phase of the works, SAVE S.p.A. and the designers have set very stringent requirements to allow to minimize the risk of lengthening the times of the various work phases, which would have irreparably compromised air operations.
In order to ensure what has been described, the set of interventions was evaluated through the definition of two processes indispensable for the purposes of correctly identifying the Safety requirements:

- Change Management with the purposes of safety evaluations deriving from the implementation of the provisions of the construction of the work and therefore for the Interesting Changes the definition of the infrastructures involved; this with the aim of define all the management methods necessary to guarantee that the level of risk associated with the changes was acceptable;
- Temporary Changes with the purposes of safety assessments as regards the compatibility of aeronautical operations and construction site operation, in relation to the daily operations of the airport.
- For the evaluation of the compatibility of the Phases of the works with the operating airport, SAVE carried out risk analyzes defined on two levels:
- Theoretical risk assessment of the project, subjected to evaluation and approval jointly with the Executive Project ENAC, reporting qualitative and quantitative analyzes for the risk assessment associated with the presence of the construction site in the different phase configurations;
- Operational risk assessment, developed weekly with all the different areas of the Manager and the third parties involved in the contract, in order to analyze the singularities of each processing in the operational airport context.

The layout of the infrastructure at the end of the redevelopment works

THE REQUALIFICATION OF THE FLOORING

The redevelopment of the two runways was carried out first through a profound structural renovation of the foundation of the runway package, limited to a central band with an average width of approximately 19 meters and subsequently through the total remaking of the wear layer of the entire infrastructure.
Accurate analysis of the paving of the runways and junctions from the very first draft it was made possible thanks to accurate assessments, which made it possible to define the transversal dispersions of the aircraft trajectories



The transverse dispersion of landing gear trolleys

The definition of the superstructure was obtained downstream a procedural calculation which firstly availed of a sizing method on the analysis of the behavior to fatigue of the superstructure and subsequently on the study of the tension state in the same conditions of instantaneous brake point. In relation to the limited operation of large aircraft (Airbus A380) in the airport it was decided to limit the reconstruction of the flooring with differentiated "stepped" section with thicknesses to scale in reduction towards the shoulders.
The laying of the bituminous conglomerates has always occurred continuously both during the day and at night, so as to never interrupt the paving and eliminating any transversal joint within the various construction site areas. In addition, multiple paving groups were used side by side with the aim of carrying out the joints between the different layers with the "hot on hot" technique.
In addition to the precautions to minimize the joints, the spreads for the various layers of asphalt have been organized in a way to guarantee the misalignment of the longitudinal joints with respect to the distribution of landing gear of aircrafts and, moreover, a shift between the runway axis where there are the AVL system.

ENVIRONMENTAL SUSTAINABILITY

The upgrading of the flight infrastructure has benefited from the key choices initiated since the design phase aimed at minimize the impact of the construction site on the lagoon ecosystem.

Key factors were:

- minimization of the use of virgin materials for the superstructure and on-site stabilization of the substrates;
- the optimization of the phases in relation to the traffic curve expected in the future on the Venice airport;
- maximum attention to the nesting periods of the lagoon fauna in the areas close to the airport grounds;
- reuse, when possible, of soil and rocks;
- presence of surveillance personnel and naturalistic assistance within the construction site areas near the areas naturalistic;
- official communication protocol shared with ARPAV for the management of soil and rocks;
- upgrading of rainwater discharges into the lagoon on head of runways;
- upgrading of systems with LED technology and monitoring of the AVL system with optical fiber for low-level operations visibility (LVP in CAT IIIB);
- careful observance of the provisions contained in the Environmental Monitoring Plan shared with the bodies in charge before the start of work.

The new first rain water treatment plants allow undoubted advantages:

- efficiency of the treatment and filtration system of existing discharges into the lagoon;
- functional simplicity;
- low running / maintenance costs and absence of electro-actuated devices

Final layout

DEVELOPMENT PROJECTS

According to the expected increase of passenger traffic in Venice Airport in the future, its area is affected by various projects aimed at guaranteeing an adequate level of service to passengers.
Below, some project goals:

- use of local materials with characteristics of environmental compatibility and energy efficiency, such as wood for parts of the roof and for the flooring, in continuity with the existing terminal;
- use of the most appropriate systems to achieve the highest environmental and energy sustainability of the building: acoustic and thermal insulation, use of solar panels, enhancement of natural light, reduction of energy consumption, use of drinking water, etc.

Venezia Airport plans to reach Net Zero by 2037 thanks to a series of actions aimed at the progressive reduction of the airport's Carbon Footprint such as the decrease in the use of fossil fuels for all production activities of the energy (use of biomethan for example), the complete replacement of vehicles with full electric vehicles and a development of photovoltaic system plant.

Moreover, this will be possible because of the use of means of transport and forms of sustainable mobility by limiting the construction of new infrastructures but above all the circulation of traditionally powered vehicles, the recovery of primary resources such as water and the reuse/recovery of waste. These are ambitious goals but without the achievement of these, there is no future for airports.
In order to improve the accessibility of the intermodal node, the construction of a rail link line between the "historic" Venice-Trieste line and the Venice airport is planned in the next five years.
The railway line develops on a double track, partly in embankment, partly in viaduct and, for the most substantial section, in a tunnel.
On approaching the station (also underground), the railway line draws a single track "loop". The entire development of the line amounts to about 8 km. The characteristics of the line allow the service both with high-speed trains and with common regional service.

Furthermore, the next construction between the airport and the town of Tessera of a vegetated embankment with relative tree-lined strip arises from the need to intervene on three main aspects:

- Reduce noise pollution
- Reuse of soil and rocks
- Improve social and landscape sustainability

Marco Polo Airport is the first in Italy that will focus on the innovation of the airport infrastructure with the integration of a pneumatic waste transport system within the future expansions of the passenger terminal.
Through this type of technology, the waste produced by all the users present in the terminal will be collected, at established points within the infrastructure, and from there transported through a network of underground pipes to a centralized ecological island that collects all the waste from the various buildings on the site.

This system makes it possible to optimize and make "cleaner" the transport of waste both from the hygienic-sanitary point of view and from the point of view of reducing the use of means for handling and the environmental impact.

4.2.9 Capacity Building, Buddy and other initiatives

In the framework of ICAO Buddy Program initiatives, Italy has initiated in 2018 a partnership with the Republic of Madagascar; both countries will work together to improve their CO_2 emission reduction Action Plans.

Italy also decided to finance the ICAO Capacity Building Programme for CORSIA; ICAO will use these funds to train personnel of Member States needing assistance for the CORSIA programme.
In preparation for CORSIA, Italy also launched a national programme to disseminate information to the air operators involved in CORSIA.

4.2.9.1 Emission Trading System (ETS)

Since January 1 2012, emissions deriving from air transport are included in the EU system of exchange of GHG emissions, named ETS, as regulated by the EU Directive 2003/87/CE.
The provisions related to civil aviation in the ETS, which have been implemented since January 1, 2013 for air carriers administrated by Italy, were endorsed by Legislative Decree n. 30 dated 13 March 2013, as national application of EU Directive 2009/29/CE which superseded Directive 2003/87/CE in order to improve and make more extensive the EU system of exchange of GHG.
Legislative Decree n. 30/2013 entered into force on April 5, 2013 and amended by Legislative Decree n. 47/2020.
As provided for by the Decree, the National Committee for the management of the provisions of Directive 2003/87/CE and for supporting the management of the project activities related to the Kyoto Protocol (ETS Committee) undertakes the function of Competent Authority for the national implementation of the ETS system in air transport as well.
The Committee is composed of representatives of the Ministry of Ecological Transition, the Ministry for the Economic Development, the Ministry of Sustainable Infrastructures and Mobility and ENAC.
The Ministry for Economy and Finance, the Ministry for the European Policies and the Conference for the relations between State and Regions participate in the Committee in a consulting role.
The following table shows the amount of emissions in 2016 and 2017 recorded by air carriers administrated by Italy within the EU ETS (domestic and intra-EEA flights):

Year	*Total number of aircraft operators for which Italy is responsible as administering Member State*	*Total emissions of flights carried out by aircraft operators for which Italy is the administering Member State (t CO_2)*	*Total emissions of domestic flights carried out by aircraft operators for which Italy is the administering Member State (t CO_2)*
2016	20	1.987.546	1.076.437
2017	25	1.906.174	1.050.658

Part of ETS auction proceeds is earmarked for research initiatives to reduce green-house gas emissions in air transport. For this purpose the following projects have been activated:

- Biofuel from microalgae project, intended to the construction of a pilot plant to produce biofuel in a small-demonstrative scale quantity (ENAC);
- Cooperation agreement between Public Administrations and Research and Development Centres for production and use of biofuels in Civil Aviation (Ministry for Environment, Safeguard of Territory and Sea, Italian Air Force, ENEA and CNR);
- Research project for the implementation of a counting system for aircraft CO_2 emissions aimed at estimating the trend of the future emissions (ENAC).

4.2.10 Emissions Reduction Impact of National Measures

The scope of this paragraph is to compare the environmental benefits arising from the national measures, to the quantity of emissions generated by the Italian airlines (international outbound flights only). This has to be construed as a simple comparison of orders of magnitude, and the relevant figures shall not be added to the numbers of the supranational section, since a portion of these saving is already included in the ECAC grand total (in particular the saving generated by the ANSP).
The data of the environmental project were communicated directly by the stakeholders to ENAC; here we present only a selection of the most significant ones capable of generating a significant saving of CO_2 emissions:

Air traffic Management

The implementation of Free Route Airspace, Extended arrival Management, Performance Based Navigation, Airport Collaborative Decision Making, implemented by the Italian National ANSP (ENAV) in 2019 generated 172.000 tons of CO_2 emission reduction. For 2020, because of the reduced amount of traffic, the savings were around 93.500 tons.

Airlines

The Fuel Efficiency Program of Alitalia allowed in 2019 to save 105.000 Tons.
Blue Panorama will install winglets on part of its fleet, and will save around 5.000 Tons a year.

Airport Managers

Airport of Venice and Airport of Palermo installed photovoltaic power generation systems, that allow each to save around 120 Tonnes every year.

Airport of Venice in cooperation with the ANSP upgraded the flight infrastructures, now served by new flight procedures, allowing a CO_2 saving of 4800 Tonnes /year.

This airport Manager is also encouraging the single engine taxing, for a saving of 8900 T/year; minimizing the use of the reverse thrust when landing will allow to save around 4100 T/year.

Airports of Genova and Olbia installed new LED lighting systems, for a saving of 75 T/year.

Airport of Bergamo equipped 12 stands with 400 Herts (saving 470 T/y); also was started the A-CDM procedure, in cooperation with ENAC, for a 2300 T/year

Airport of Napoli, in cooperation with ENAV upgrade the initial climb procedure of Runway 24, for an annual saving of 4600 Tons of CO_2.

Airport of Rome Fiumicino optimized the air conditioning system for a saving of 5800 Tons/year.

The savings generated by all the environmental projects already implemented by these stakeholders (ANSP, airlines, and airport managers) together with other minor projects already can be estimated at approx. 210.000 tons/year.

So, all these measures are equivalent to 12% of the emission generated by the Italian airlines. Of course it shall be noted that the actions of the ANSP and of the Airport Managers affects also the traffic departing from Italy, landing in Italy, or overflying Italy, operated either by Italian or foreign airlines.

The stakeholders presented also some future environmental projects that will be implemented in the cycle 2021-2023.

Among such future projects

Air Traffic Management ANSP (ENAV) planned to be "net zero emissions " by 2022, at least for 80% of the emissions generated by the use of its infrastructures and network.

Leonardo, Avio and CIRA are studying a new concept of climate neutral regional aircraft, that will allow 90% of CO_2 emissions saving, compared to a conventional airplane.

Eni Spa will implement a bio-refinery production line dedicated to the Sustainable Aviation Fuels, that will allow to save around 270.000 Tons of CO_2 /year.

Alitalia, in cooperation with the ANSP (ENAV) presented a plan to optimize the point merge approaching procedure at Fiumicino Airport, for a saving of 1000 Tons/year.

The airline studied also how to optimize the contingency fuel, on the basis of statistics, for a saving ranging from 600 to over 5000 tons/year for its fleet in the 3-year cycle. Alitalia will also encourage the voluntary offsetting of CO_2 by the passengers, for a saving of up to 30.000 Tons/year.

The optimization of the Centre of Gravity of the medium range fleet, will be implemented during the cycle, allowing to save up to 3000 tons/year when fully implemented. Alitalia believes that the above measure, plus other minor ones, will allow to save up to 140.000 Tons/years.

The airport managers presented many projects, including new photovoltaic power generating systems, a railway link system to access the terminals, the reforestation of some areas close to the perimeter of the runways. All these measures could lead to a potential saving of CO_2 emissions, up to 200.000 tons /year, so around another 10% of the emissions generated by the Italian airlines for the international outbound flights.

List of abbreviations

AAT - Aircraft Assignment Tool

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)

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

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

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

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 Technological Development

SAF – Sustainable Aviation Fuels

SES – Single European Sky

SESAR – Single European Sky ATM Research

SESAR JU – Single European Sky ATM Research Joint Undertaking

SESAR R&D – SESAR Research and Development

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

— END —

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