STATE AVIATION
ADMINISTRATION OF UKRAINE

State Aviation Administration of Ukraine

Action plan of Ukraine for reducing aviation CO_2 emissions

Document approved on **5 July 2021**

FOREWORD

Ukraine supports the position to comply a global approach for monitoring and reducing of aviation emissions that includes implementation of the ICAO Resolution A40-18 provisions (Consolidated statement of continuing ICAO policies and practices related to environmental protection – Climate change), encourages States to submit their action plans outlining their respective policies and actions to achieve a global annual average fuel efficiency improvement of 2 per cent until 2020 and an aspirational global fuel efficiency improvement rate of 2 per cent per annum from 2021 to 2050 and keeping the net carbon emissions from 2020 at the same level.

According to the decision of the European Civil Aviation Conference all ECAC Member States, including Ukraine, agreed to provide its National Plan to ICAO and coordinated the format of such plan.

State aviation administration of Ukraine was created the Action Plan with the assistance of aviation industry representatives whose activity may have effect on the final result: airlines, airports, fuel suppliers, air navigation service provider, etc.

The objective of Ukrainian action plan is to calculate and forecast the CO_2 aviation emission and implementation of appropriate measures to reduce and prevent pollution.

STATE AVIATION ADMINISTRATION OF UKRAINE

ACTION PLAN OF UKRAINE

Content

Contact information for Ukraine focal point for the action plan:

Authority name: STATE AVIATION ADMINISTRATION OF UKRAINE

Point of Contact: Ivan Iatsenko

Street Address Peremohy ave, 14

Country: Ukraine

City: Kyiv

Telephone Number: +380443515632

Fax Number: +380443515632

E-mail address: Ivan.Iatsenko@avia.gov.ua

INTRODUCTION

Ukraine is a member of the International Civil Aviation Organization (ICAO) from 09 September 1992, European Civil Aviation Conference (ECAC) from 15 December 1999 and European Organization for the Safety of Air Navigation (EUROCONTROL) from 1 January 2004. ECAC is an intergovernmental organisation covering the widest grouping of Member States[1] of any European organisation dealing with civil aviation. It is currently composed of 44 Member States, and was created in 1955.

Ukraine is also member of the World Trade Organization (WTO) from 2008 year.

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

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

Ukraine recognises the value of each State preparing and submitting to ICAO an updated State Action Plan on emissions reductions, as an important step towards the achievement of the global collective goals agreed at the 37th Session of the ICAO Assembly in 2010.

In that context, all ECAC States submitting to ICAO an Action Plan, regardless of whether or not the 1% de minimis threshold is met, thus going beyond the agreement of ICAO Assembly Resolution A37-19 and reaffirmed by A38-18, A39-2, and A40-18. This is the Action Plan of Ukraine.

Ukraine shares the view of all ECAC States that a comprehensive approach to reducing aviation emissions is necessary, and that this should include:

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

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

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

iv. the optimisation and improvement of Air Traffic Management, and CNS infrastructure within Europe.

v. Applying of global approaches to reduce the negative impact of international aviation to the environment.

In Europe, many of the actions which are undertaken within the framework of this comprehensive approach are in practice taken at a supra-national level, most of them led by the EU. They are reported in Section 1 of this Action Plan, where Ukraine's involvement in them is described, as well as that of stakeholders.

In Ukraine a number of actions are undertaken at the national level, including by stakeholders, in addition to those of a supra-national nature. These national actions are reported in Section 2 of this Plan.

In relation to actions which are taken at a supranational level, it is important to note that:

The extent of participation will vary from one State and another, reflecting the priorities and circumstances of each State (economic situation, size of its aviation market, historical and institutional context, such as EU/ non EU). The ECAC States are thus involved to different degrees and on different timelines in the delivery of

[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

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.

Nonetheless, acting together, the ECAC States have undertaken to reduce the region's emissions through a comprehensive approach which uses each of the pillars of that approach.

STATE AVIATION ADMINISTRATION OF UKRAINE

CURRENT STATE OF AVIATION IN UKRAINE

Structure of aviation sector

President of Ukraine and Cabinet of Ministers of Ukraine shall ensure implementation of the aviation development policy of Ukraine in accordance with the Constitution and Laws of Ukraine.

Civil Aviation Authority and the Ministry of Defense within their powers are entrusted with regulation of Ukraine's airspace.

State Aviation Administration of Ukraine (SAAU) is a Civil Aviation Authority of Ukraine established by the Cabinet of Ministers of Ukraine Edict from 08 October 2014 № 520

State Aviation Administration of Ukraine shall implement the Ukraine's state policy and strategy for aviation development, and it shall exercise regulation of civil aviation in such areas:

- ensuring aviation safety, aviation security, ecological safety, economic and information security;
- creation of conditions for development of aviation activity, air transportation and its servicing, exercising aerial works and flights of general aviation;
- air traffic management and airspace regulation of Ukraine;
- representation of Ukraine in the international civil aviation organizations and in external relations in the field of civil aviation;
- drafting, adoption and implementation of aviation rules;
- certification of aviation entities and facilities;
- issue of licenses for economic activities pertaining to rendering services on transportation of passengers and/or cargo by air as well as authorization of air lines operation and assignment to air carriers;
- continuous supervision and monitoring of the observance of the requirements set by legislation, including aviation rules of Ukraine.

State Aviation Administration of Ukraine is a duly authorized and independent body with regard to ensuring utilization of the airspace of Ukraine by aviation entities of Ukraine and oversight the provision of air navigation services.

For the purpose of aviation safety State Aviation Administration of Ukraine shall cooperate with law-enforcement agencies and other executive bodies.

State Aviation Administration of Ukraine web address: http://www.avia.gov.ua/

The **Ukrainian State Air Traffic Service Enterprise (UkSATSE)** is the main air navigation services provider of Ukraine as well as core for the Integrated Civil-Military Air Traffic Management System of Ukraine (ICMS). The Enterprise is authorized by the Governmental Regulation Body for provision of Air Navigation Services in the ATS airspace of Ukraine and in the part of the high seas of the Black Sea, where the responsibility for the provision of ATS is delegated to Ukraine (hereinafter referred to as ATS airspace of Ukraine) by International Civil Aviation Organization (ICAO). This identifies the mission and main tasks of UkSATSE.

Main tasks:

- Air Traffic Management: Air Traffic Services, Airspace Management and Air Traffic Flow Management in the airspace of Ukraine;
- radio-technical and electrical provision of ATS and flight operation;
- provision of activity and development of the Joint Civil-Military ATM System Units;
- alerting Services and participation in Search and Rescue operations;
- provision of airspace users with Aeronautical Information;
- modernization and development of the Air Navigation System of Ukraine;
- training and refresher training of the UkSATSE experts;
- provision of social development and security of its personnel.

The Ukrainian State Air Traffic Service Enterprise web address: http://uksatse.ua

Participation in International Organisations

1992 - Ukraine became the Full Member State of International Civil Aviation Organisation (ICAO)

1994 - Accession of UkSATSE to International Federation of Air Traffic Controllers' Associations (IFATCA)

1995 - Signature of Bilateral Agreement between Ukraine and Central Route Charges Office (EUROCONTROL)

1997 - Accession of UkSATSE to Air Traffic Control Association (ATCA)

1997 - Introduction of new Flight Information Region (FIR) boundaries over the Black Sea

1998 - UkSATSE became a founder member of Civil Air Navigation Services Organisation (CANSO)

1999 - Ukraine became the Member State of European Civil Aviation Conference (ECAC)

1999 - Ratification of the Agreement between the EBRD and the Government of Ukraine concerning the Ukrainian ANS Modernisation Project by Ukrainian Parliament

1999 - UkSATSE joined International Organisation Information Co-ordinating Council on Air Navigation Charges (IKSANO)

1999 - Conclusion of Agreement between UkSATSE and the EUROCONTROL Central Flow Management Unit (CFMU)

2000 - UkSATSE became the 33rd Member State of International Federation of Air Traffic Safety Electronics Associations (IFATSEA)

2003 - UkSATSE initiates creation of the Regional Air Navigation Services Development Association (RADA)

2004 - Ukraine became the 33rd Member State of EUROCONTROL. Experts of UkSATSE are fully engaged in EUROCONTROL activities

2005 - Contract between SELEX Sistemi Integrati S.p.A. (Italy) and UkSATSE for Supply and Installation of Approach Radars (Dnipropetrovs'k, Kyiv, L'viv, Odesa, Simferopol')

2006 - Ukraine hosted NATO Air Traffic Management Committee (NATMC) Plenary Session

Name	Date of Founding	Date of Entrance
International aviation organisations, where Ukraine is a member		
ICAO	1944	1992
ECAC	1954	1999
EUROCONTROL	1963	2004
International aviation organisations, where UkSATSE is a member		
IFATCA	1961	1994
ATCA	1956	1997
CANSO	1998	1998
IKSANO	1999	1999
IFATSEA	1972	2000

Education

Aviation degree in Ukraine can be obtained in three aviation universities. Kyiv National Aviation University is recognized as a leader of higher aviation education in Ukraine. Kyiv Aviation University cooperates closely with Civil Aviation authorities across the world and even has a special ICAO institute in its structure.

Flight Academy of the National Aviation University in Kropyvnytskyi is famous for pilot training and Kharkiv National University of the Air Force is recognized for preparing best specialists in the fields of space research, aircraft manufacturing and aeronautical engineering. Kharkov University is closely connected to the industry.

National Aviation Policy

Ukraine, with a large power-consuming economy and correspondingly high emissions of greenhouse gases, is committed to the prevention of global climate change.

The primary task of the Government of Ukraine is to create and implement a national policy directed to fulfill the obligations of Ukraine within the framework of the international treaties.

The major legislative document of Ukraine in aviation activity is Air Code of Ukraine in force since 19 May 2011 № 3393–VI which regulates among other questions the question of environmental protection. This chapter include requirements about:

- Maximum acceptable level of aviation noise, air engine emissions established by the Aviation Rules of Ukraine.
- Compensation for damage caused as result of the aviation activity.
- Limitations and prohibitions for civil aircraft if they exceed noise levels established by the Civil Aviation Authority.
- Limitations and prohibitions taking account taking account of measures aimed to reduction of noise levels at the airport and in its vicinity including:
- Technical noise reduction at the source.
- Space zoning of the airport adjacent territory and a proper zone planning.
- Operational measures to reduce aircraft noise and emissions.
- The cost of the measures aimed at reduction and prevention in noise and emissions shall be funded by airport taxes taking account ICAO recommendations.

Other Laws of Ukraine in environmental field:

"About the principles of monitoring, reporting and verification of greenhouse gas emissions", from 12.12.2019, № 377-IX
"About the environmental impact assessment", from 01.12.2020, № 2059- VIII
"About main strategy in state ecological policy of Ukraine for 2030 year", from 28.02.2019 № 2697-VIII
"About atmospheric air protection", from 16.10.2020, № 2707-XII
"About sanitary and epidemiological population welfare", from 14.01.2021, № 4004-XII
"About environmental protection", from 26.06.1991, № 1264-XII

Convention on International Civil Aviation, signed at Chicago on 7 December 1944, hereinafter referred to as the Chicago, ratified by Ukraine on 10 August1992, Ukraine has the obligation to implement and enforce such provisions of Convention, as well as standards set out in annexes.

United Nations Framework Convention on Climate Change, ratified by Verkhovna Rada of Ukraine on 29 October, 1996. The objective of the treaty is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Ukraine corresponds to Annex I countries which have ratified the Protocol have committed to reduce their emission levels of greenhouse gasses to targets that are mainly set below their 1990 levels. They may do this by allocating reduced annual allowances to the major operators within their borders. Ukraine adopted list of regulations concerning prevention of climate change. Among them Law of Ukraine "About atmospheric air protection" from 16.10.1992, № 2708-XII.

Kyoto Protocol to the United Nations Framework Convention on Climate Change, adopted by Ukraine on 04 February, 2004.

Committee on Aviation Environmental Protection. ICAO's current environmental activities are largely undertaken through the Committee on Aviation Environmental Protection (CAEP), which was established by the Council in 1983, superseding the Committee on Alircraft Noise (CAN) and the Committee on Aircraft Engine Emissions (CAEE).

CAEP assists the Council in formulating new policies and adopting new Standards on aircraft noise and aircraft engine emissions.

Ukraine is a member of CAEP and took active part in working groups and steering groups.

National Airlines network

List of national airlines that include carriers executing regular and charter flights

№	Operator
1.	SKYUP Airline LLC
2.	KRUNK Aviation and Transport Agency LLC
3.	PJSC "UKRAINIAN HELICOPTERS" Airline
4.	MERIDIAN Airlines LLC
5.	ZETAVIA Airline LLC
6.	PJSC "URGA" International Joint Stock Aviation Company
7.	AZUR AIR UKRAINE Airline LLC
8.	SE "ANTONOV"
9.	PJSC "INTERNATIONAL AIRLINES OF UKRAINE"
10.	PJSC "UKRAINE-AEROALIANCE" Airline
11.	SAE "UKRAINE"
12.	MAXIMUS AIRLINES LLC
13.	PJSC "MOTOR SICH"
14.	BRAVO Airlines LLC
15.	KAVOK AIR LLC
17.	PJSC "CONSTANTA AIRLINES"
18.	LLC "YANEIR" LTD
19.	ELERON AVIATION COMPANY LLC
20.	LLC "AIRLINE UKRAINIAN WINGS"
21.	AEROVIZ Airlines LLC
22.	LLC "VULCAN AIR"
23.	JONICA AIRLINE LLC
25.	PJSC "COLUMBUS AIRLINES"
29.	NIKOLAEV-AERO LLC
30.	State Enterprise for Air Traffic Services of Ukraine

31.	Ukrainian Pilot School LLC
32.	Prominterservice Airlines LLC
33.	Rosavia Airlines LLC
34.	V-AVIA LLC
35.	LLC "BREEZE"
37.	LLC JSC "AVIA-SOYUZ"
38.	PJSC "AGROAVIADNIPRO"
39.	CHALLENGE AERO UKRAINE LLC
40.	GLOBAL AIR COMPANY LLC
41.	ZET-AERO Airlines LLC
42.	AIR TAURUS LLC
43.	PE "UNICOM AVIA"
44.	PE "AVIA-STYLE"
45.	YUGAVIA LLC
46.	FENIX AIR LLC
47.	HASCOM LLC
48.	HORIZON AIRLINE LLC
50.	UKRAGROAVIA LLC
51.	YUGAGROAVIA LLC (Kherson)
52.	LLC “B2B”
55.	MERIDIAN Airlines LLC (Kyiv region)
56.	Bees Airline LLC
57.	XENA LLC
58.	DNIPROAVIASERVICE LLC

STATE AVIATION ADMINISTRATION OF UKRAINE

National Airports network of Ukraine

#	AIRPORTS	
1	International airport "Boryspol"	State
2	International airport "Dnipro"	community property
3	International airport "Kyiv" (Zhuliany)	municipal
4	International airport "Ivano-Frankivsk"	community property
5	International airport "Kryvyi Rih"	municipal
6	International airport "Lviv"	State
7	International airport "Zaporizhzhia"	municipal
8	Airport Zhytomyr	community property
9	International airport "Odessa"	municipal
10	International airport "Chernivtsi"	municipal
11	International airport "Rivne"	municipal
12	International airport "Kharkiv"	community property
13	Airport "Sumy"	municipal
14	Airport "Ternopil"	municipal
15	Airport "Vinnytsa" (Havryshivka)	municipal
16	Airport "Cherkasy"	municipal
17	Airport "Poltava"	municipal
18	Airport "Kherson"	municipal
19	Airport "Uzhhorod"	municipal
20	Mykolaiv international airport	municipal

Economic information related to the contribution of international aviation

In recent years there has been a significant reduction in the basic performance of the aviation industry. The main factors that led to the demand decline for air travel and caused consequent breakdown of the current economic situation in general are the next: Joint forces operation in the east of the state, occupation and annexation attempt of the Crimea, safety recommendations from the international organizations and the EU regarding avoidance of that area of Ukraine using alternative airspace routes. Several national airports not working during the year and many airlines have significantly reduced their route network.
During the reporting year, 29 airlines operated on the market of passenger and cargo air transportation, of which 19 carried passenger transport.

Commercial flights of domestic and foreign airlines served 20 Ukrainian airports and airfields.

It should be noted that today, about 98 percent of total passenger traffic and mail traffic are concentrated in 7 leading airports - Boryspil, Kyiv (Zhulyany), Odessa, Lviv, Kharkiv, Dnipro and Zaporizhzhya.

Indicator	Total			By stages of flight					
				international			domestic		
	2019	2020	%	2019	2020	%	2019	2020	%
Commercial flights									
Passengers were transported, thousand people.	13705,7	4797,5	35,0	12547,1	4287,7	34,2	1158,6	509,8	44,0
including regular flights, thousand people.	8267,8	1788,1	21,6	7122,6	1284,6	18,0	1145,2	503,5	44,0
including on non-scheduled flights, thousand people.	5437,9	3009,4	55,3	5424,5	3003,1	55,4	13,4	6,3	47,0
Passenger kilometers, million passenger km	30241,8	10106,9	33,4	29707,4	9843,6	33,1	534,4	263,3	49,3
including on regular flights, million passenger-km	17490,7	3133,8	17,9	16963,3	2874,2	16,9	527,4	259,6	49,2
including on non-scheduled flights, million passenger-km	12751,1	6973,1	54,7	12744,1	6969,4	54,7	7,0	3,7	52,9
% of passenger traffic on scheduled flights	80,8	68,4	84,7	80,9	69,0	85,3	75,9	62,6	82,6
Cargo, tons were transported	88184,1	86345,3	97,9	87653,0	86126,7	98,3	531,1	218,6	41,2
including on scheduled flights, tons	15206,9	4149,8	27,3	14992,1	4107,4	27,4	214,8	42,4	19,7
including on non-scheduled flights, tons	72977,2	82195,5	112,6	72660,9	82019,3	112,9	316,3	176,2	55,7
Transported mail, tons	4393,7	1919,4	43,7	4393,7	1919,4	43,7			
including on scheduled flights, tons	4393,5	1537,0	35,0	4393,5	1537,0	35,0			
including on non-scheduled flights, tons	0,2	382,4		0,2	382,4				
Made ton-kilometers (cargo + mail), thousand tkm	295581,3	316246,2	107,0	295231,1	316079,9	107,1	350,2	166,3	47,5
including on regular flights, thousand tkm	93034,8	18384,5	19,8	92946,2	18365,9	19,8	88,6	18,6	21,0
including on non-scheduled flights, thousand tkm	202546,5	297861,7	147,1	202284,9	297714,0	147,2	261,6	147,7	56,5
Made ton-kilometers (passengers + cargo + mail), thousand km	3061096,3	1256622,8	41,1	3012633,8	1232260,7	40,9	48462,5	24362,1	50,3
including on regular flights, thousand tkm	1683100,5	304839,6	18,1	1635481,2	280950,0	17,2	47619,3	23889,6	50,2
including on non-scheduled flights, thousand tkm	1377995,8	951783,2	69,1	1377152,6	951310,7	69,1	843,2	472,5	56,0
% of commercial load on scheduled flights	66,8	60,0	89,8	66,7	59,9	89,9	70,6	60,3	85,4
Made flights, units	103293,0	45277,0	43,8	86654,0	35346,0	40,8	16639,0	9931,0	59,7
including regular, units	66637,0	20435,0	30,7	51688,0	11846,0	22,9	14949,0	8589,0	57,5
including irregular, units	36656,0	24842,0	67,8	34966,0	23500,0	67,2	1690,0	1342,0	79,4

Raid hours, hours	298509,0	138213,0	46,3	278738,0	125564,0	45,0	19771,0	12649,0	64,0
including on regular flights, hours	171196,0	45321,0	26,5	153855,0	34815,0	22,6	17341,0	10506,0	60,6
including on non-scheduled flights, hours	127313,0	92892,0	73,0	124883,0	90749,0	72,7	2430,0	2143,0	88,2
Send + air arrived. ships, units	201229,0	94014,0	46,7	162669,0	69037,0	42,4	38560,0	24977,0	64,8
including scheduled flights, units	153599,0	58633,0	38,2	124865,0	41686,0	33,4	28734,0	16947,0	59,0
including non-scheduled flights, units	47630,0	35381,0	74,3	37804,0	27351,0	72,3	9826,0	8030,0	81,7
Passenger traffic, thousand people	24334,5	8664,5	35,6	21994,1	7628,9	34,7	2340,4	1035,6	44,2
including regular flights, thousand people.	18833,0	5643,5	30,0	16530,2	4627,2	28,0	2302,8	1016,3	44,1
including on non-scheduled flights, thousand people.	5501,5	3021,0	54,9	5463,9	3001,7	54,9	37,6	19,3	51,3
Mail and cargo flows, tons	60211,7	52243,6	86,8	58431,5	51501,6	88,1	1780,2	742,0	41,7
including on scheduled flights, tons	54124,0	40771,1	75,3	52994,1	40415,8	76,3	1129,9	355,3	31,4
including on non-scheduled flights, tons	6087,7	11472,5	188,5	5437,4	11085,8	203,9	650,3	386,7	59,5

Using the reduction of the negative impact of aviation on the air, namely CO_2 greenhouse gas emissions, Ukraine joins the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) in accordance with the 39th Assembly Resolutions of the International Civil Aviation Organization (ICAO).

Paragraph 5 of Resolutions 39-3 The Assembly of Resolutions shall request the introduction of a global scheme of market measures in the establishment of the International Aviation Carbon Offsetting and Reduction Scheme (CORSIA) to review the annual total CO_2 emissions from international civil aviation.

Specialists of the State Aviation Administration of Ukraine (SAAU) developed the Aviation Rules of Ukraine "Technical requirements and administrative procedures for monitoring emissions of civil aviation services" from 02.08.2019 № 1001. In accordance with which the basic stage of CORSIA implementation is provided monitoring, reporting and verification of CO2 emissions, which provides for the development of Monitoring Plans/Reports on CO2 emissions, their verification and approval by the SAAU. Based on these Reports, the baseline CO2 emissions of Ukrainian operators are monitored and the relevant Report is sent to ICAO.

In Ukraine, 8 Ukrainian aircraft operators (Windrose Aviation, Motor Sich JSC, Maximus Airlines LLC, SkyUp Airlines LLC, Zet-AERO Airline LLC, Azur Air Ukraine Airlines LLC, Ukraine International Airlines, Antonov Company are subject to CORSIA), which from 2019 submit for approval to the SAAU Plans for monitoring emissions of CO2, Emission reports and verification reports (verification is carried out by international verification companies, today there is no national verifier in Ukraine). All CO2 emission information is uploaded to CCR.

In 2021, 8 verified Reports were submitted to the SAAU for approval, and active work is underway to underpin the information to the CCR.

Since 2021, another airline (Bees Airline LLC) has appeared on the Ukrainian aviation services market, which is subject to CORSIA, we are actively cooperating with this airline and in the near future we are waiting for CO2 Emission Monitoring Plans, and then the Report.

To ensure the implementation of the next stages of CORSIA, active work is underway to develop the Law of Ukraine "About the introduction of a system of compensation and reduction of carbon dioxide emissions for international civil aviation."

In order to comply with Art. 10 and Section X of the Air Code of Ukraine, the SAAU shall take measures aimed at implementing and ensuring balanced accounting of flight safety and environmental protection requirements. One of such measures is the introduction of elements of the environmental management system (EMS) in accordance with the international standard DSTU ISO 14001: 2015 in the airports of Ukraine.

In Ukraine, two airports have a valid ISO 14001: 2015 certificate International airport "Boryspol" and Mykolaiv international airport.

Other airports are actively implementing elements of the environmental management system, which make it possible to reduce costs, increase efficiency and reduce anthropogenic pressure on the environment. One of the achievements of this work was the coverage of environmental information for public use, in particular, information about the environmental intentions of enterprises to reduce the negative impact on the environment appeared on the websites of airports.

Supporting the desire of Ukrainian airports to become more progressive and up-to-date, SAAU developed a training course "Fly Green", which will provide access to materials on waste management, green mobility, adaptation to climate change, to familiarize users with energy efficiency issues, etc.

In the future it is planned to place "FlyGreen" training materials on the educational platform (videos, information files, test tasks) and to hold a conference on energy efficiency for industry representatives related to the topic of the "FlyGreen" training course.

CO_2 EMISSIONS INVENTORIES, FORECASTS AND BASELINE CALCULATION

INTERNATIONAL AVIATION CO_2 EMISSIONS INVENTORIES

Ukraine ratified the United Nations Framework Convention on Climate Change on 29 October, 1996 as an Annex I country. One of the commitments of parties to the Convention is to compile national inventories of their emissions sources.

For domestic flights, emissions are considered to be part of the national inventory of the country within which the flights occur. For international flights, inventories are also calculated and reported to UNFCCC under the terminology "emissions from international aviation bunker fuels".

Ukraine also adopted Kyoto Protocol to the United Nations Framework Convention on Climate Change, on 2004.

Due to this, the calculation of the Baseline for Ukraine has been based on the available information on National Inventories reported to UNFCCC, and provided by the Ministry of Ecology and Natural Resources of Ukraine. The methodology used for the calculation of those inventories follows the *IPCC 2006 Guidelines for National Greenhouse Gas Inventories*.

As Ukraine has established this systematic way to estimate, report and verify GHG emissions, those procedures will be used to ensure that the estimation, reporting and verification of CO_2 emissions in its action plan is undertaken in accordance with the ICAO Guidance on States Action Plans Appendix E recommendations.

CO_2 EMISSIONS INVENTORIES METHODOLOGY (UNFCCC)

Emissions estimation was conducted separately for aircraft with jet and turboprop engines, which use jet fuel, and equipped with piston engines, which use aviation kerosene.

For aircraft emissions estimation equipped with jet and turboprop engines, was used method of calculation of aircraft emissions has been produced in accordance with the detailed methodology EMEP/CORINAIR, which correspond to the Tier 2b.

Separation of aircraft emissions

Emissions from domestic aviation include all emissions from aircraft flights, departure and arrival airports of which located on the territory of Ukraine. Emissions from international aviation include emissions from the flights where departure airports are located in the territory of Ukraine, and the destination airport - outside Ukraine.

Calculation of aircraft emissions

It was used data based on departures of aircrafts from airports situated on the territory of Ukraine. Data about flight include next information according to each flight:

- date and time of flight;
- depart and destination points;
- air company;
- aircraft code by ICAO.

Assessment of aircraft emissions was making in 2 steps: preliminary data processing and aircraft emissions calculation.

Fuel consumption:

Fuel consumption cycle per LTO cycle taken according to the methodology EMEP / CORINAIR, and fuel consumption at cruise was calculated according to the flight length.

The length of the flight was defined as orthodromic distance between departure and destination points, taking into account the deflection coefficient of the actual flight path and orthodromic. Deflection coefficient was taken as 1.095.

For recalculation of jet fuel consumption from mass units into energy units, as shown in the methodology EMEP / CORINAIR, it used low-value calorific capacity equal to 44.59 MJ / kg.

TRAFFIC FORECASTS

Annual IFR Movements and 2011-2021 average annual growth.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	AAGR 2021/ 2014
H	-	-	-	-	135	133	147	163	178	194	211	-5,5%
B	453	466	494	312	132	128	138	149	160	171	183	-7,4%
L	-	-	-	-	130	122	128	136	144	151	158	-9,2%

Annual growth rates and 2011-2021 average annual growth.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	AAGR 2021/ 2014
H	-	-	-	-	-57%	-1,6%	11,0 %	10%	9,4 %	9,2 %	8,3 %	-5,5%
B	5,5%	2,9 %	6,0 %	-37%	-58%	-3,5%	8,0 %	8,2 %	7,3 %	7,2 %	6,5 %	-7,4%
L	-	-	-	-	-5,8%	-5,8%	5%	6,2 %	5,4 %	5,3 %	4.7 %	-9,2%

BASELINE CALCULATION AND EXPECTED RESULTS

The State Aviation Administration of Ukraine has decided to calculate a Baseline as a suitable element of its action plan, to estimate the levels of fuel consumption, CO_2 emissions, and air traffic (expressed in RTK) that can be expected in the time horizons of 2020 and 2025. Such "*business as usual*" scenario will be used as the reference to estimate the expected results once the measures identified on the Action Plan are implemented and will represent the projected fuel consumption and CO_2 emissions willing to reach as results.

To calculate the baseline for the evaluation of the Action Plan measures, it has been estimated an average year growth of air traffic (RTK) of 5,3% from 2010-2020 and 4,5% from 2020 to 2025 taken from the EUROCONTROL forecasts included in the previous paragraph.

Please, note that the Ukraine baseline calculation is for information purposes and comparison with the estimated benefits of measures implemented at national level. Ukraine is also considered in the ECAC baseline and its scenarios, as presented below.

Methodological approach

The baseline calculation is based on the extrapolation of past trend data in order to determine future levels of fuel consumption and traffic, and through the calculation of a *Fuel Efficiency Metric*, following the recommendations of the *ICAO Guidance Material for the Development of States Action Plans*.

Historic data sources:

Historic data from fuel consumption have been taken from the official National Emissions Inventory, as described above.

Historic Traffic data expressed in RTK have been taken from the ICAO database provided through the APER Website.

Fuel efficiency metric:

Following the ICAO Guidance, the fuel efficiency metric expresses the rate of efficiency improvement over time, and its calculation is based on the following metric:

Fuel efficiency = Volume of fuel/RTK (1)

This metric is an indicator of the efficiency of fuel usage (in liters) per tonne of revenue load carried (passengers, freight and mail).

METHOD 3 OF ICAO GUIDANCE

Following ICAO Guidance Method 3, the baseline for Ukraine has been calculated as follows:

1. Getting fuel consumption data (volume of fuel) and traffic (RTK) for the latest available years.
2. Determining the RTK future scenarios by considering EUROCONTROL Ukrainian forecasts.

3. Determining the projected volume of fuel for the 2010-2025 scenarios, assuming the same growth rate as for the RTK as follows:

Volume of fuel year n+1 = Volume of fuel year n x (1 + RTK growth)

Such methodology is equivalent to apply the following formula:

Volume of fuel $_{\text{year n+1}}$= efficiency factor $_{\text{year n}}$* RTK $_{\text{year n+1}}$

To estimate CO_2 emissions expressed in Kg from fuel consumption expressed in L, a **0'8 Kg/L** density has been considered.

Then the expected results will be estimated though subtracting the fuel gains due to additional measures to the projected fuel consumption.

On the following tables, the baseline calculation results for both international and total fuel and CO_2 emissions are presented.

ICAO GUIDANCE METHOD 3 BASELINE CALCULATION FOR UKRAINE:

INTERNATIONAL FUEL CONSUMPTION (L) AND EMISSIONS (Kg CO_2)

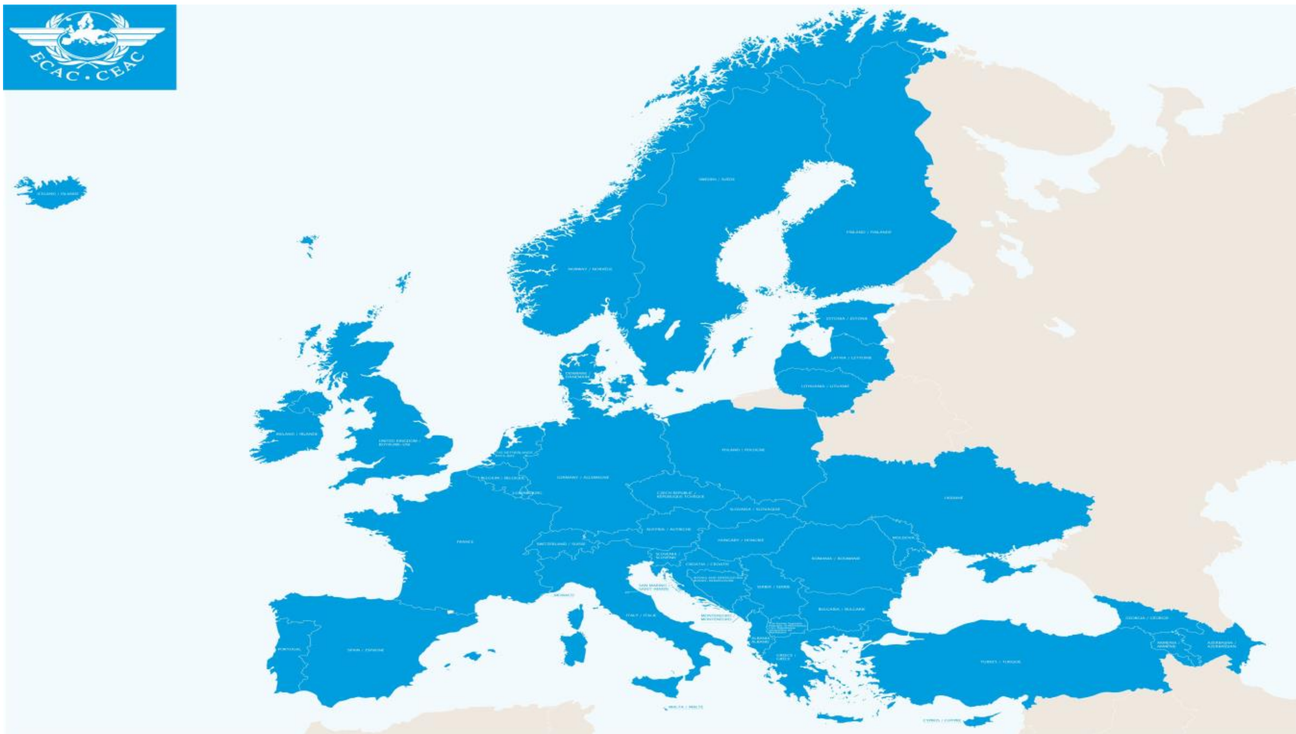
		INTERNATIONAL			
TRAFFIC FORECAST	**YEAR**	**l Fuel**	**RTK**	**Efficiency factor**	**Kg CO_2**
	1990	937589480,98			2367983857,79
	1991	809579320,41			2044680322,48
	1992	681569159,83			1721376787,17
	1993	553558999,26			1398073251,86
	1994	425548838,69			1074769716,55
	1995	297538678,12			751466181,24
	1996	169528517,54			428162645,93
	1997	164471246,66			415389960,17
	1998	157070458,28			396698466,96
	1999	143894984,92			363422380,92
	2000	142596898,65	169711000,00	0,84023	360143923,36
	2001	143233302,30	179197000,00	0,79931	361751229,74
	2002	161260007,82	176824000,00	0,91198	407279628,43
	2003	188277627,95	266708000,00	0,70593	475515556,44
	2004	228262656,79	538749000,00	0,42369	576502080,68
	2005	252620569,70	772859000,00	0,32687	638020629,86
	2006	298103052,02	894011000,00	0,33344	752891568,71
	2007	338146812,07	1078059000,00	0,61920	854026424,99
	2008	369670574,77	1203276000,00	0,58585	933643104,50
	2009	324352159,57	1268003000,00	0,60690	819186534,93

5,30%	2010	353259388,59	659 728 283,00	0,53546	892191911,81
	2011	314163830,28	941 321 646,00	0,33375	793452169,75
	2012	289971227,70	1 002 460 838,00	**0,28926**	732351332,68
	2013	204044379,25	705 402 743,00		515334484,23
	2014	200167509,75	692 000 000,00		505543062,64
-58,00%	2015	84070354,10	290 640 000,00		212328086,31
-3,50%	2016	81127891,70	280 467 600,00		204896603,29
8,00%	2017	87618123,04	302 905 008,00		221288331,55
8,20%	2018	94802809,13	327 743 218,66		239433974,74
7,30%	2019	101723414,20	351 668 473,62		256912654,89
7,20%	2020	109047500,02	376 988 603,72		275410366,05
6,50%	2021	116135587,52	401 492 862,96		293312039,84
5,10%	2022	122058502,48	421 968 998,97		308270953,87
	2023	128283486,11	443 489 417,92		323992772,52
	2024	134825943,90	466 107 378,23		340516403,92
	2025	141702067,04	489 878 854,52		357882740,52

TOTAL FUEL CONSUMPTION (L) AND EMISSIONS (Kg CO_2)

	TOTAL				
TRAFFIC FORECAST	**YEAR**	**l Fuel**	**RTK**	**Efficiency factor**	**Kg CO_2**
	1990	1.253.570.808,76			3.166.018.435
	1991	1.051.050.179,16			2.654.532.332
	1992	864.639.226,18			2.183.732.830
	1993	691.682.537,23			1.746.913.416
	1994	529.707.437,40			1.337.829.104
	1995	376.684.391,49			951.354.099
	1996	227.934.945,64			575.672.499
	1997	210.781.075,04			532.348.683
	1998	202.749.280,48			512.063.583
	1999	186.582.480,61			471.232.713
	2000	182.631.282,99	184.586.000,00	0,98941	461.253.568
	2001	183.681.857,73	195.209.000,00	0,94095	463.906.900
	2002	208.457.269,78	190.424.000,00	1,09470	526.479.681
	2003	251.053.205,65	288.817.000,00	0,86925	634.059.976
	2004	301.762.175,29	588.180.000,00	0,51304	762.130.550
	2005	322.528.267,45	827.229.360,00	0,38989	814.577.392
	2006	376.429.744,44	935.686.000,00	0,40230	950.710.963

	2007	422.689.385,69	581 105 187,00	0,72739	1.067.544.313
	2008	452.939.714,20	655 000 000,00	0,69151	1.143.944.542
	2009	381.370.433,69	596 000 000,00	0,63988	963.189.167
5,30%	2010	409 338 031,36	***703 000 000,00***	0,58227	1 033 824 132
	2011	401 418 072,97	***992 000 000,00***	0,40466	1 013 821 485
	2012	376 636 412,20	***1 062 000 000,00***	**0,35465**	951 232 923
	2013	272 015 186,59	***767 000 000,00***		687 001 555
	2014	254 637 423,69	***718 000 000,00***		643 112 277
-58,00%	2015	106 947 717,95	***301 560 000,00***		270 107 156
-3,50%	2016	103 204 547,82	***291 005 400,00***		260 653 406
8,00%	2017	111 460 911,65	***314 285 832,00***		281 505 678
8,20%	2018	120 600 706,40	***340 057 270,22***		304 589 144
7,30%	2019	129 404 557,97	***364 881 450,95***		326 824 152
7,20%	2020	138 721 686,15	***391 152 915,42***		350 355 491
6,50%	2021	147 738 595,74	***416 577 854,92***		373 128 597
5,10%	2022	155 273 264,13	***437 823 325,52***		392 158 156
	2023	163 192 200,60	***460 152 315,12***		412 158 222
	2024	171 515 002,83	***483 620 083,19***		433 178 291
	2025	180 262 267,97	***508 284 707,44***		455 270 384



ECAC BASELINE SCENARIO AND ESTIMATED BENEFITS OF IMPLEMENTED MEASURES

1. ECAC Baseline Scenario

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

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

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

Traffic Scenario "Regulation and Growth"

As in all forecasts produced by EUROCONTROL, various scenarios are built with a specific storyline and a mix of characteristics. The aim is to improve the understanding of factors that will influence future traffic growth and the risks that lie ahead. The latest EUROCONTROL long-term forecast[2] 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 characterising the **passengers** and their travel preferences change patterns in travel demand and travel destinations.
- **Price of tickets** set by the airlines to cover their operating costs influences passengers' travel decisions and their choice of transport.
- More hub-and-spoke or point-to-point **networks** may alter the number of connections and flights needed to travel from origin to destination.
- **Market structure** describes size of aircraft used to satisfy the passenger demand (modelled via the Aircraft Assignment Tool).

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

Table 1. Summary characteristics of EUROCONTROL scenarios.

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

COVID-19 impact and extension to 2050

Since the start of 2020, COVID-19 has gone from a localised outbreak in China to the most severe global pandemic in a century. No part of European aviation is untouched by the human tragedy or the business crisis. This unprecedented crisis hindered air traffic growth in 2020: flight movements declined by 55% compared to 2019 at ECAC level. It continues to disrupt the traffic growth and patterns in Europe in 2021. In Autumn 2020, EUROCONTROL published a medium-term forecast[4] to 2024, taking into account the impact of the COVID-19 outbreak. The latter is based on three different scenarios depending on how soon an effective vaccine would be made widely available to (air) travellers. Other factors have been included amongst which the economic impact of the crisis or levels of public confidence, to name a few. The Scenario 2: vaccine widely made available for travellers by Summer 2022, considered as the most likely, sees ECAC flights only reaching 92% of their 2019 levels in 2024.

In order to take into account the COVID-19 impact and to extend the horizon to 2050, the following adaptations have been brought to the original long-term forecast[2]. Considering the most-likely scenarios of the long-term forecast[2] and the medium-term forecasted version of the long-term flight forecast has been derived:

a) Replace the long-term forecast[2] horizon by the most recent medium-term forecast[4] to account for COVID impact;

b) Update the rest of the horizon (2025-2040) assuming that the original growth rates of the long-term forecast[2], would remain similar to those calculated pre-COVID-19; and

c) Extrapolate the final years (2040-2050) considering the same average annual growth rates as the one forecasted for the 2035-2040 period, but with a 0.9 decay[5].

The method used relies on the calculation of adjustment factors at STATFOR[6] region-pair level and have been applied to the original long-term forecast[2]. 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.

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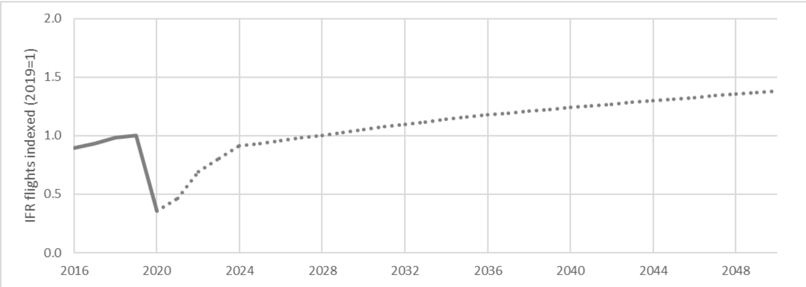
4 Five-Year Forecast 2020-2024, IFR Movements, EUROCONTROL, November 2020.

5 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.

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

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



Further assumptions and results for the baseline scenario

The ECAC baseline scenario was generated by EUROCONTROL for all ECAC States. It covers all commercial international passenger flights departing[7] 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[8]). 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[9] 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

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

[8] 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.

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

between the associated airports and expressed in kilometres. Because of the coverage of the passenger estimation data sets (Scheduled, Low-cost, Non-Scheduled flights, available passenger information, etc.) these results are determined for about 99% of the historical passenger traffic, and 97% of the passenger flight forecasts. From the RPK values, the passenger flights RTK were calculated as the number of tonnes carried by kilometers, assuming that 1 passenger corresponds to 0.1 tonne.

The fuel efficiency represents the amount of fuel burn divided by the RPK for each available airport pair with passenger data, for the passenger traffic only. Here, the RPK and fuel efficiency results corresponds to the aggregation of these values for the whole concerned traffic years.

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

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

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres[10] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[11] FTKT (billion)	Total Revenue Tonne Kilometres[12] RTK (billion)
2010	4.56	1,114	0.198	45.4	156.8
2019	5.95	1,856	0.203	49.0	234.6
2030	5.98	1,993	0.348	63.8	263.1
2040	7.22	2,446	0.450	79.4	324.0
2050	8.07	2,745	0.572	101.6	376.1

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

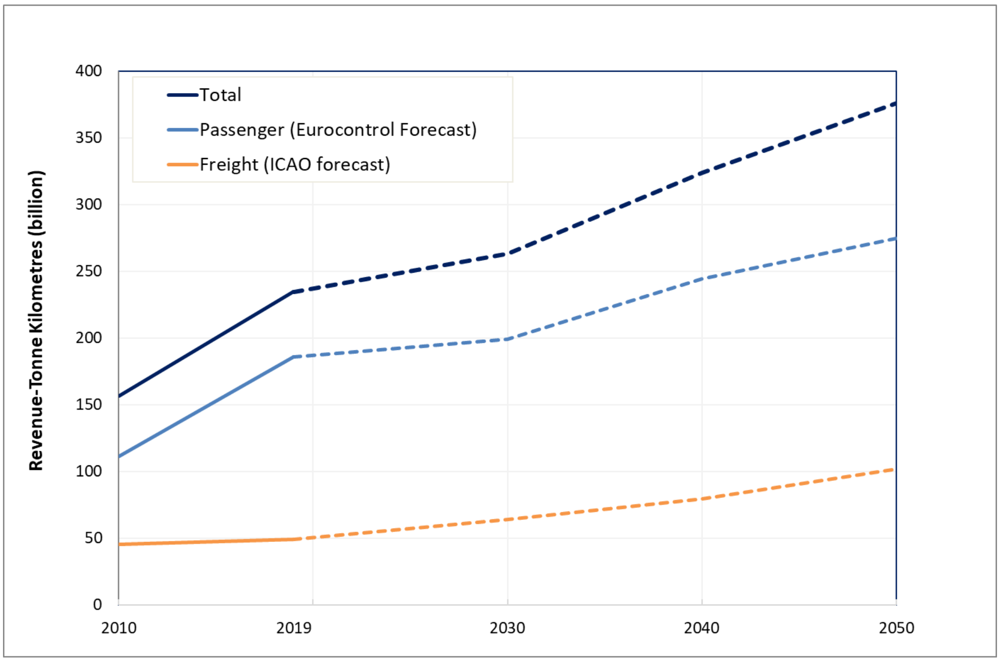
Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Fuel efficiency (kg/RPK[10])	Fuel efficiency (kg/RTK[12])
2010	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280
2030	50.72	160.29	0.0252	0.252
2040	62.38	197.13	0.0252	0.252
2050	69.42	219.35	0.0250	0.250
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

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

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

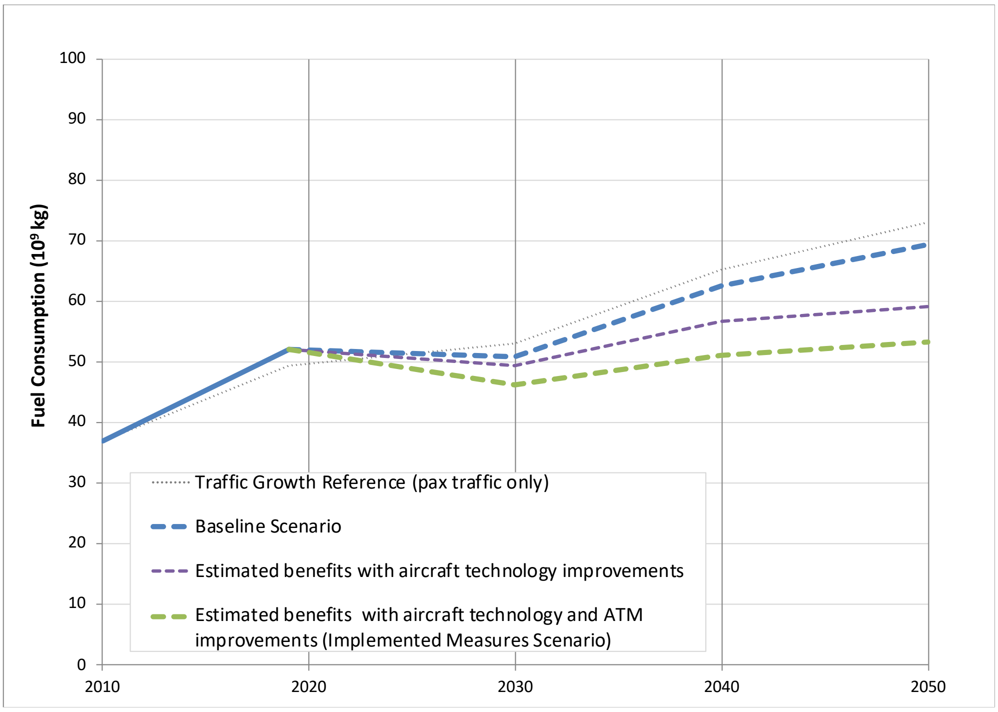
12 A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).

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



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

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



2. ECAC Scenario with Implemented Measures: Estimated Benefits

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

For reasons of simplicity, the scenario with implemented measures is based on the same traffic volumes as the baseline case, i.e. updated EUROCONTROL's 'Regulation and Growth' scenario described earlier. Unlike in the baseline scenario, the effects of aircraft related technology development and improvements in ATM/operations are considered here for a projection of fuel consumption and 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[13] (AAT) developed collaboratively by EUROCONTROL, EASA and the European Commission. The retirement process of AAT is performed year by year, allowing the determination of the number of new aircraft required each year. In addition to the fleet rollover, a constant annual improvement of fuel efficiency of 1.16% per annum is assumed for each aircraft type with entry into service from 2020 onwards. This rate of improvement corresponds to the 'Advanced' fuel technology scenario used by CAEP to generate the fuel trends for the Assembly. This technology improvement modelling is applied to the years 2030 and 2040. For the year 2050, as the forecast traffic reuses exactly the fleet of the year 2040, the technological improvement is determined with the extrapolation of the fuel burn ratio between the baseline scenario and the technological improvement scenario results of the years 2030 to 2040.

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13 https://www.easa.europa.eu/domains/environment/impact-assessment-tools

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[14]. Based on the information provided by the PAGAR 2019 document[15], and compared to a 2012 baseline, the benefits at the end of Wave 1 could be about 3% CO_2/fuel savings achieved by 2025 equivalent to 147.4 kg of fuel/flight. So far, the target for Wave 2 remains at about 7% more CO_2/fuel savings (352.6 kg of fuel) to reach the initial Ambition target of about 10% CO_2/fuel savings (500 kg fuel) per flight by 2035. The 2030 efficiency improvement is calculated by assuming a linear evolution between 2025 and 2035. As beyond 2035, there is no SESAR Ambition yet, it is assumed that the ATM efficiency improvements are reported extensively for years 2040 and 2050.

The as yet un-estimated benefits of Exploratory Research projects[16] are expected to increase the overall future fuel savings.

While the effects of **introduction of Sustainable Aviation Fuels (SAF)** were modelled in previous updates on the basis of the European ACARE goals[17], the expected SAF supply objectives for 2020 were not met, and in the current update the SAF benefits have not been modelled as a European common measure in the implemented measures scenario. However, numerous initiatives related to SAF (e.g. ReFuelEU Aviation) are largely described in Section B chapter 2 and it is expected that future updates will include an assessment of its benefits as a collective measure.

Effects on aviation's CO_2 emissions of **market-based measures** including the EU Emissions Trading System (ETS) with the linked Swiss ETS, the UK ETS and the ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) have not been modelled in the top-down assessment of the implemented measures scenario presented here as, at the time of the submission of this action plan, a legislative proposal for the revision of the EU ETS Directive concerning aviation, is under development to complete the implementation of CORSIA by the EU and to strengthen the ambition level of the EU ETS. CORSIA is not considered a European measure but a global one. It aims for carbon-neutral growth (CNG) of aviation as compared to the average of 2019 and 2020 levels of emissions in participating States, and an indication of a corresponding (hypothetical) target applied to Europe is shown in Figure 4[18], 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 summarise the results for the scenario with implemented measures. It should be noted that **Table 4** show direct combustion emissions of CO_2 (assuming 3.16 kg CO_2 per kg fuel). More detailed tabulated results are found in Appendix A, including results expressed in equivalent CO_2 emissions on a well-to-wake basis (for comparison purposes of SAF benefits).

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

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

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

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

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

[18] 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).

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Fuel efficiency (kg/RPK[19])	Fuel efficiency (kg/RTK[17])
2010	36.95	116.78	0.0332	0.332
2019	52.01	164.35	0.0280	0.280
2030	46.16	145.86	0.0229	0.229
2040	51.06	161.35	0.0206	0.206
2050	53.18	168.05	0.0192	0.192
2050 vs 2019			*-32%*	
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

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

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

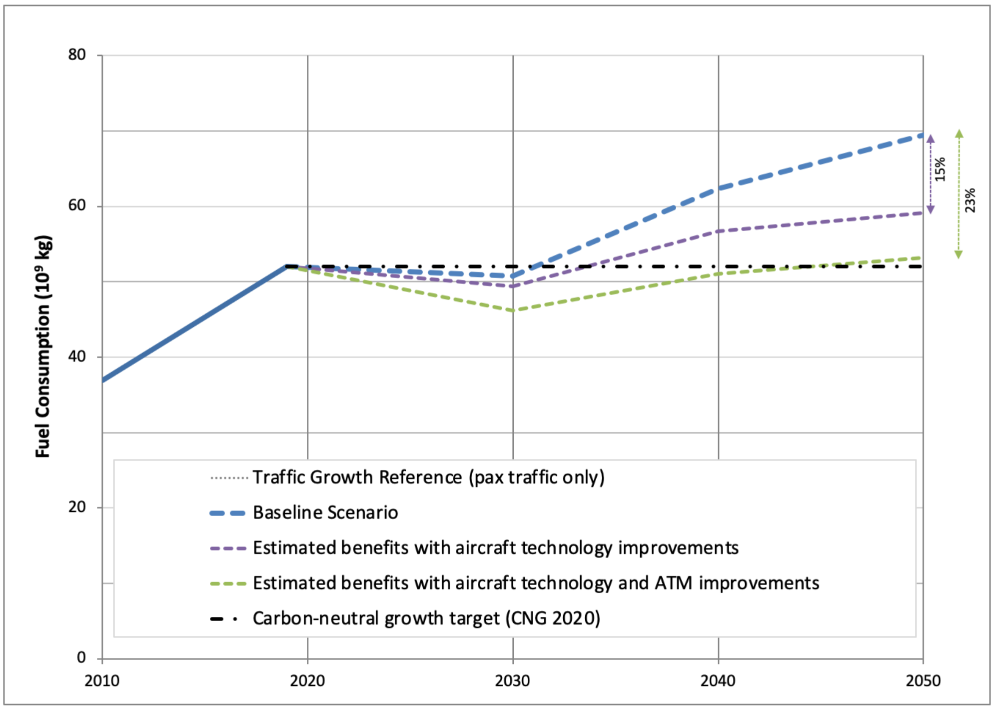
Table 6. CO_2 emissions forecast for the scenarios described in this chapter.

Year	CO_2 emissions (10^9 kg)			% improvement by Implemented Measures (full scope)
	Baseline Scenario	Implemented Measures Scenario		
		Aircraft techn. improvements only	Aircraft techn. and ATM improvements	
2010	116,78			NA
2019	164,35			NA
2030	160,3	156,0	145,9	-9%
2040	197,1	179,3	161,4	-18%
2050	219,4	186,7	168,0	-23%
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

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

Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.

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



As shown in Figure 4, the impact of improved aircraft technology indicates an overall 15% reduction of fuel consumption and 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.

SECTION 1- SUPRA-NATIONAL ACTIONS, INCLUDING THOSE LED BY THE EU

B. ACTIONS TAKEN COLLECTIVELY IN EUROPE

1. **TECHNOLOGY AND STANDARDS**
   - 1.1. Aircraft emissions standards
   - 1.2. Research and development: Clean Sky and the European Partnership for Clean Aviation
2. **SUSTAINABLE AVIATION FUELS (SAF)**
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6. **SUPPLEMENTAL BENEFITS FOR DOMESTIC SECTORS**
   - 6.1. ACI Airport Carbon Accreditation
   - 6.2. ReFuelEU Aviation Initiative
   - 6.3. SAF Research and development projects
   - 6.4. The EU's Single European Sky Initiative and SESAR
   - 6.5. Green Airports research and innovation projects

1. TECHNOLOGY AND STANDARDS

1.1 Aircraft emissions standards

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

ASSESSMENT

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

1.2 Research and development

1.2.1 Clean Sky

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

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

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

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

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

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20 http://www.cleansky.eu/

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

In addition, the **Clean Sky Technology Evaluator**[21] will continue to be upgraded to assess technological progress routinely and evaluate the performance potential of Clean Sky 2 technologies at both vehicle and aggregate levels (airports and air traffic systems).

1.2.1 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)**[22] will follow in the footsteps of CleanSky2. The EU contribution proposed is again €1.7 billion. The stakeholder community has already formulated a Strategic Research and Innovation Agenda (SRIA), which is intended to serve as a basis of the partnership once established. Subject to the final provisions of the partnership and the EU budget allocation, industry stakeholders have proposed a commitment of €3 billion from the private side.

General objectives of EPCA:

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

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

Specific objectives:

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

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

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

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

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

ASSESSMENT

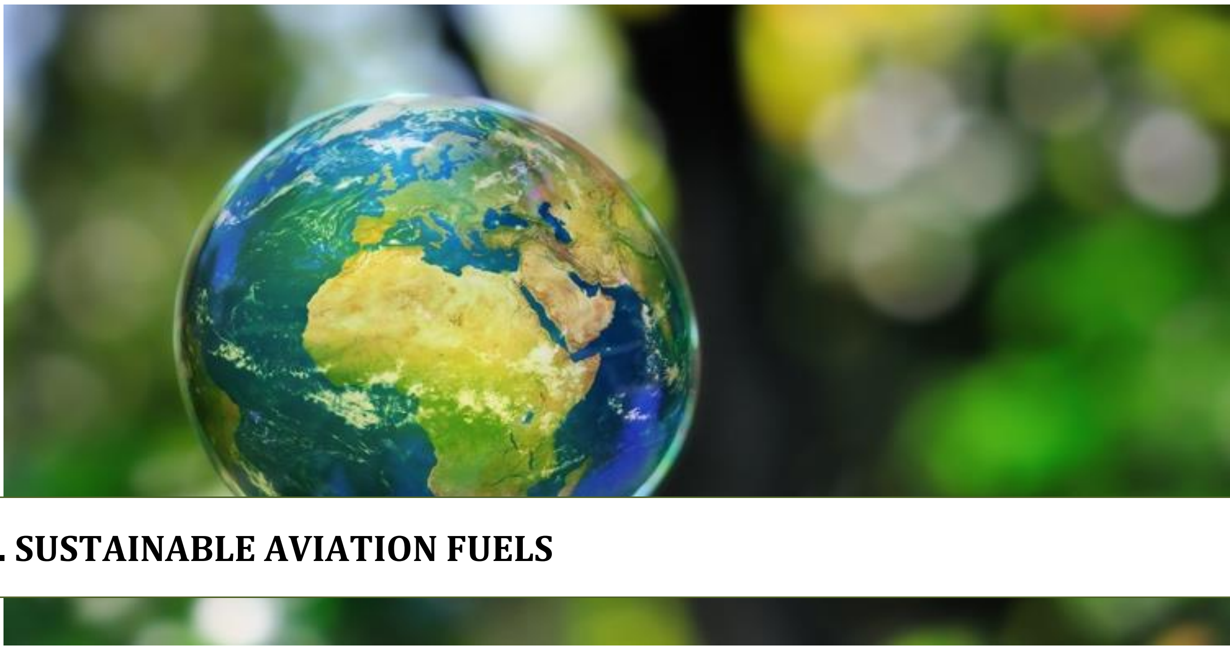
The quantitative assessment of the technology improvement scenario from 2020 to 2050 has been calculated by EUROCONTROL and EASA and it is included in Section A above (ECAC Baseline Scenario and Estimated Benefits of Implemented Measures) and in Appendix A.

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_2e emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	36.95	116.78	143.38	0.0332	0.332
2019	52.01	164.35	201.80	0.0280	0.280
2030	49.37	156.00	191.54	0.0232	0.232
2040	56.74	179.28	220.13	0.0217	0.217
2050	59.09	186.72	229.26	0.0202	0.202
For reasons of data availability, results shown in this table do not include cargo/freight traffic.					

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

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



2. SUSTAINABLE AVIATION FUELS

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

The European collective SAF measures included in this Action Plan focuses on its 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[23]. As a result, the large-scale use of SAF can have important other non-CO_2 benefits on the climate which are not specifically assessed within the scope of this Plan.

2.1 ReFuelEU Aviation Initiative

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

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

This initiative aims to boost the supply and demand for sustainable aviation fuels (SAF) in the EU including not only advanced 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.

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

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

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

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

ASSESSMENT

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

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

2.2 Addressing barriers of SAF penetration into the market

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

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

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

2.2.1 Sustainable Aviation Fuel 'Facilitation Initiative'

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

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

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

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

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

2.2.2. Sustainable Aviation Fuel 'Monitoring System'

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

The study followed five steps:

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

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

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

ASSESSMENT

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

2.3 Standards and requirements for SAF

2.3.1. European Union standards applicable to SAF supply

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

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

Sustainability and life cycle emissions methodologies:

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

These can be found in RED´s[24] Article 17, *Sustainability criteria for biofuels and bioliquids*. Those requirements remain applicable on the revised RED II (Directive (EU) 2018/2001)38, Article 29 *Sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels* paragraphs 2 to 7, although the RED II introduces some new specific criteria for forestry feedstocks.

Transport renewable fuels (thus, including SAF) produced in installations starting operation from 1 January 2021 must achieve 65% GHG emissions savings with respect to a fossil fuel comparator for transportation fuels of 94 g CO_2eq/MJ. In the case of transport renewable fuels of non-biological origin[25], the threshold is raised to 70% GHG emissions savings.

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

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

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

2.3.2. ICAO standards applicable to SAF supply

Europe is actively contributing to the development of the ICAO CORSIA Standards and Recommended Practices (SARPs), 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

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[24] Directive 2009/28/EC.

[25] 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).

of its benefits in terms of reduction in aviation emissions is provided in this action plan common section.

2.4 Research and Development projects on SAF

2.4.1 European Advanced Biofuels Flightpath

An updated and renewed approach to the 2011 Biofuels FlightPath Initiative[26], 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[27].

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

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

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

BIO4A[28]: 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.

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26 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

27 https://www.biofuelsflightpath.eu/ressources

28 www.bio4a.eu

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[29]: *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[30]: *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[31]: The *Biofuels production from Syngas Fermentation for Aviation and maritime use* (BioSFerA)project, aims to validate a combined thermochemical - biochemical pathway to develop cost-effective interdisciplinary technology to produce sustainable aviation and maritime fuels. At the end of the project next generation aviation and maritime biofuels, completely derived from second generation biomass, will be produced and validated by industrial partners at pilot scale. The project will undertake a full value chain evaluation that will result in a final analysis to define a pathway for the market introduction of the project concept. Some crosscutting evaluations carried out on all tested and validated processes will complete the results of the project from an economic, environmental and social point of view.

The project is carried out by a consortium of 11 partners from 6 European countries and its expected duration is from 1 April 2020 to 31 March 2024.

29 www.kerogreen.eu

30 www.flexjetproject.eu

31 https://biosfera-project.eu

BL2F[32]: 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[33]: 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[34]: Is an industrially driven project aiming to be a game-changer in the cost-effective production of SAF from CO_2 and hydrogen. The unique TAKE-OFF technology is based on conversion of CO_2 and H_2 to SAF via ethylene as intermediate. Its industrial partners will team up with research groups to deliver a highly innovative process which produces SAF at lower costs, higher energy efficiency and higher carbon efficiency to the crude jet fuel product than the current benchmark Fischer-Tropsch process. TAKE-OFF's 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.

32 https://www.bl2f.eu

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

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

3. OPERATIONAL IMPROVEMENTS

3.1 The EU's Single European Sky Initiative and SESAR

3.1.1 SESAR Project

SES and SESAR

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

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

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

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

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

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

SESAR and the European Green Deal objectives

The European Green Deal launched by the European Commission in December 2019 aims to create the world's first climate-neutral bloc by 2050. This ambitious target calls for deep-rooted change across the aviation sector and places significantly stronger focus on the environmental impact of flying. Multiple technology pathways are required, one of which is the digital transformation of air traffic management, where SESAR innovation comes into play. Over the past ten years the SESAR JU has worked to improve the environmental footprint of air traffic management, from 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[35] 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.

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

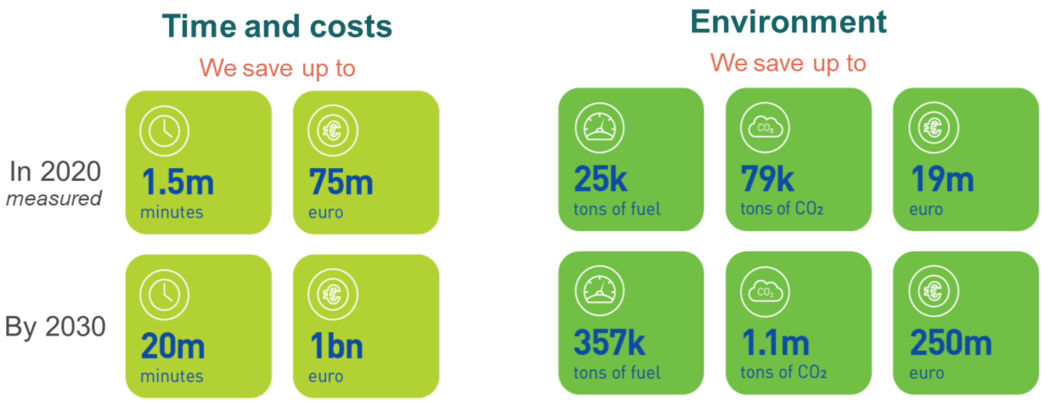

Figure 6: First results of the first common project implemented.

3.1.2 SESAR Exploratory Research (V0 to V1)

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

3.1.3 SESAR Industrial Research & Validation Projects (environmental focus)

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

- The initial development by EUROCONTROL of the IMPACT[36] web-based platform which allows noise impact assessments and estimates of fuel burn and resulting emissions to be made from common inputs, thus enabling trade-offs to be conducted. IMPACT has since been continuously maintained and developed by EUROCONTROL, used for ICAO Committee on Aviation Environmental Protection Modelling and Database Group (CAEP) assessments, the conduct of studies in support of the European Aviation Environment Report (EAER) editions 2016 and 2019, and has been adopted by a large range of aviation stakeholders.
- The initial development/maintenance Open-ALAQS that provides a mean to perform emissions inventory at airports, emissions concentration calculation and dispersion.
- The development of an IMPACT assessment process[37].

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.

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[36] https://www.eurocontrol.int/platform/integrated-aircraft-noise-and-emissions-modelling-platform

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

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

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

A catalogue of SESAR Solutions is availab[illegible]d those addressing environment impacts are identified by the following pictogram:

3.1.4 SESAR2020 Industrial Research and Validation - Environmental Performance Assessment

The systematic assessment of environmental impacts of aviation are at the heart of SESAR Industrial Research and Validation activities since SESAR 1, with a very challenging target on fuel/CO_2 efficiency of 500kg of fuel savings on average per flight.

SESAR Pj19.04 Content Integration members are monitoring the progress of SESAR Solutions towards this target in a document call Performance Assessment and Gap Analysis Report (PAGAR). The Updated version of PAGAR 2019 provides the following environmental achievements:

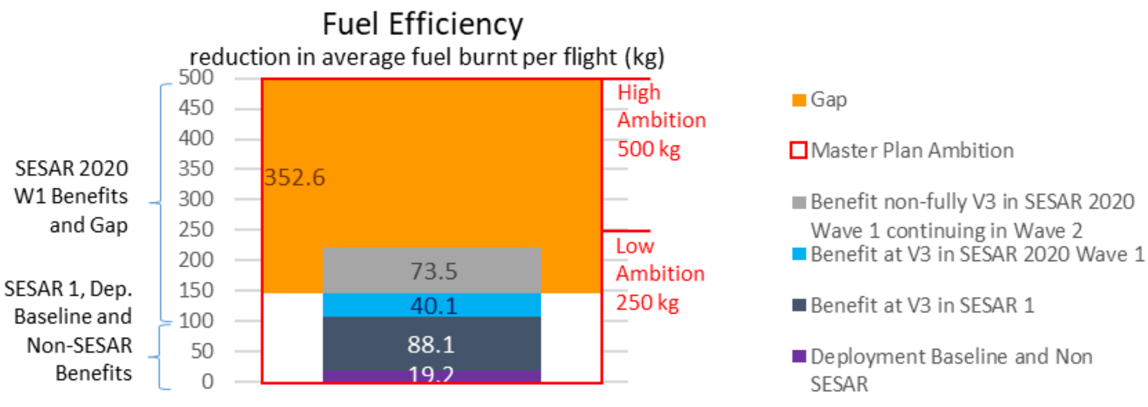

Figure 7: SESAR fuel efficiency achievement versus gap (Source: Updated version of PAGAR 2019)

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38 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 [39]. Based on the information provided by the PAGAR 2019 document[40], 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[41].

3.1.5 SESAR AIRE demonstration projects

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

AIRE[42] is the first large-scale environmental initiative bringing together aviation players from both sides of the Atlantic. So far, three AIRE cycles have been successfully completed.

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

3.1.6 SESAR 2020 Very Large-Scale Demonstrations (VLDs)

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

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

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

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

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

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

3.1.7 Preparing SESAR

Complementing the European ATM Master Plan 2020 and the High-Level Partnership Proposal, the Strategic Research and Innovation Agenda (SRIA) details the research and innovation roadmaps to achieve the Digital European Sky, matching the ambitions of the 'European Green Deal' and the 'Europe fit for the digital age' initiative.

The SRIA[44] 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).

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

Year	CO_2 emissions (10^9 kg)	
	Baseline Scenario	Implemented Measures Scenario
		ATM improvements
2030	160.29	149.9
2040	197.13	177.4
2050	210.35	197.4

43 https://www.sesarju.eu/projects/ALBATROSS

44 https://www.sesarju.eu/node/3697

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

Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.

4. MARKET-BASED MEASURES

4.1 The Carbon Offsetting and Reduction Scheme for International Aviation

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

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

4.1.1 Development and update of ICAO CORSIA standards

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

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

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

4.1.2 CORSIA implementation

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

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

ASSESSMENT

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

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

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

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

It operates in 30 countries: the 27 EU Member States, Iceland, Liechtenstein and Norway. The EU ETS currently covers half of the EU's CO_2 emissions, encompassing those from around 11 000 power stations and industrial plants in 30 countries, and, under its current scope, around 500 commercial and non-commercial aircraft operators that fly between airports in the European Economic Area (EEA). The EU ETS Directive was revised in line with the European Council Conclusions of October 2014[45] 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%[46], and will be revised to be aligned with the latest Conclusions in December 2020[47], 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

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

46 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

47 1011-12-20-euco-conclusions-en.pdf (europa.eu)

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[48].

Following the 2013 ICAO agreement on developing CORSIA, the EU decided[49] 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[50].

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[51]. 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"[52].

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[53] 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

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48 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

49 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

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

51 Commission Delegated Regulation (EU) 2019/1603 of 18 July 2019 supplementing Directive 2003/87/EC of the European Parliament and of the Council as regards measures adopted by the International Civil Aviation Organisation for the monitoring, reporting and verification of aviation emissions for the purpose of implementing a global market-based measure https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2019.250.01.0010.01.ENG

52 2021_commission_work_programme_new_policy_objectives_factsheet_en.pdf (europa.eu)

53 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.

The EU ETS has delivered around 200 MT of CO_2 emission reductions between 2013 and 2020[54]. 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[55].

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

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

ASSESSMENT

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

Table 10: Summary of estimated EU-ETS emission reductions

Estimated emissions reductions resulting from the EU-ETS[56]

Year	*Reduction in CO_2 emissions*
2013-2020	*~200 MT[57]*

Those benefits illustrate past achievements.

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

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

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

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

5. ADDITIONAL MEASURES

5.1 ACI Airport Carbon Accreditation

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

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

The underlying aim of the programme is to encourage and enable airports to implement best practice carbon and energy management processes and to gain public recognition of their achievements. It requires airports to measure their 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[58].

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 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-

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

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

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

Table 11: Emissions reduction highlights for the European region

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Total aggregate scope 1 & 2 reduction (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 12: Emissions offset for the European region

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

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

Table 13: *Airport Carbon Accreditation* key performance indicators 2018/2019

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

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

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

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

ASSESSMENT

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

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

The Destination 2050[59] 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[60]. 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.

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59 www.destination2050.eu

60 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.

ASSESSMENT

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

5.3 Environmental Label Programme

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

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

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

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

ASSESSMENT

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

5.4 Multilateral capacity building projects

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

5.4.1 EASA capacity-building partnerships

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

The overall objective of these projects[61] is to enhance the partnership between the EU and partner States in the areas of civil aviation environmental protection and climate change, and to achieve long-lasting results that go beyond the duration of the projects. The specific objectives of the two projects are to develop or support existing policy dialogues with partner States on mitigating GHG emissions from civil aviation, to contribute to the CORSIA readiness process of partner States, as well as to implement CORSIA in line with the agreed international schedule, including considerations of joining the voluntary offsetting phase starting in 2021 or at the earliest time possible. On top of the CORSIA-related support, these projects are assisting the partner States in the development and update of the State Action Plans to reduce CO2 emissions from civil aviation, as well as providing support in the development of emission data management tools supporting the implementation of State Action Plans and CORSIA.

By January 2021, the EU-SEA CCCA had improved the technical readiness of all the 10 partner States in the region, as well as their aeroplane operators' capabilities to comply with CORSIA requirements. Five States had implemented emission data management solutions to generate CORSIA Emission Reports, and eight States had successfully submitted their 2019 CORSIA 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.

5.4.1 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.

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

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[62].

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

The Phase two of this project is currently being implemented by ICAO and EASA. It covers ten African States: Benin, Botswana, Cabo Verde, Comoros, Côte d'Ivoire, Madagascar, Mali, Rwanda, Senegal and Zimbabwe. The project will run between 2020 and 2023.

ASSESSMENT

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

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

5.5. Green Airports research and innovation projects

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

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

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

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

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

Expected outcomes

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

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

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

ASSESSMENT

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

6. SUPPLEMENTAL BENEFITS FOR DOMESTIC SECTORS

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

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

6.1 ACI Airport Carbon Accreditation

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

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

6.2 ReFuelEU Aviation Initiative

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

In addition to the reduction of CO_2 emissions, SAF has the additional benefit of reducing air pollutant emissions around airports when emitted during take-off and landing as emissions of non-volatile Particulate Matter (nvPM) with up to 90% and sulphur (SO_X) with 100%, compared to fossil jet fuel[63].

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.

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

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

6.3 SAF Research and development projects

One European research project funded by the Horizon 2020 Research and Innovation program of the EU, is currently assessing, among other objectives, the additional supplemental benefits for domestic sectors of the use of sustainable aviation fuels, beyond its climate benefits.

AVIATOR PROJECT[64]: The project "*Assessing aviation emission Impact on local Air quality at airports: Towards Regulation"* aim to better understand air quality impacts of aviation issues, developing new tools and regulation, and linking with the health community, providing unbiased data to society.

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

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

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

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

6.4 The EU's Single European Sky Initiative and SESAR

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

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

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

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

6.5. Green Airports research and innovation projects

The European Commission's Green Airports research and innovation projects referred in this action plan among the "Other measures" commonly implemented in Europe has key objectives to achieve important supplemental benefits beyond CO_2 emissions reductions, among them:

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64 https://aviatorproject.eu

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.

APPENDIX A

DETAILED RESULTS FOR ECAC SCENARIOS FROM SECTION A

1. BASELINE SCENARIO

a) Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres[65] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[66] FTKT (billion)	Total Revenue Tonne Kilometres[67] 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.				

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

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

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

2. IMPLEMENTED MEASURES SCENARIO

2A) EFFECTS OF AIRCRAFT TECHNOLOGY IMPROVEMENTS AFTER 2019

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

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

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

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

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

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

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

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

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

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

Year	Well-to-wake CO_2e emissions (10^9 kg)			% improvement by Implemented Measures (full scope)
	Baseline Scenario	Implemented Measures Scenario		
		Aircraft techn. improvements only	Aircraft techn. and ATM improvements	
2010	143.38			NA
2019	201.80			NA
2030	196.8	191.5	179.1	-9%
2040	242.0	220.1	198.1	-18%
2050	269.3	229.3	206.3	-23%

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

Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.

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.

LIST OF ABBREVIATIONS

AAT - Aircraft Assignment Tool

ACARE – Advisory Council for Research and Innovation in Europe

ACA – Airport Carbon Accreditation

ACI – Airports Council International

AIRE – The Atlantic Interoperability Initiative to Reduce Emissions

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

ATM – Air Traffic Management

CAEP – Committee on Aviation Environmental Protection

CNG – Carbon neutral growth

CORSIA - Carbon Offsetting and Reduction Scheme for International Aviation

EAER – European Aviation Environmental Report

EASA – European Aviation Safety Agency

EC – European Commission

ECAC – European Civil Aviation Conference

EEA – European Economic Area

EFTA – European Free Trade Association

EU – European Union

EU ETS – the EU Emissions Trading System

GHG – Greenhouse Gas

ICAO – International Civil Aviation Organisation

IFR – Instrumental Flight Rules

IPCC – Intergovernmental Panel on Climate Change

IPR – Intellectual Property Right

JU – Joint Undertaking

MBM – Market-based Measure

MT – Million tonnes

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

RED – Renewable Energy Directive

RPK – Revenue Passenger Kilometre

RTK – Revenue Tonne Kilometre

RTD – Research and Technological Development

SAF – Sustainable Aviation Fuels

SES – Single European Sky

SESAR – Single European Sky ATM Research

SESAR JU – Single European Sky ATM Research Joint Undertaking

SESAR R&D – SESAR Research and Development

SMEs - Small and Medium Enterprises

SECTION 2- NATIONAL ACTIONS IN UKRAINE

The information included in this section provides a description of the implementation of national of measures which are to be considered as Ukraine's contribution to the quantified supranational measures.

1. IMPROVED AIR TRAFFIC MANAGEMENT AND INFRASTRUCTURE USE

Ukraine contributes to the implementation of the European Air Traffic Management (ATM) Master Plan which is the main planning tool for in the airspace of the 44 European Civil Aviation Conference (ECAC) States. It defines the development and deployment priorities needed to deliver the Single European Sky ATM Research (SESAR) the performance ambition for the ECAC area, which is quantified in the ECAC baseline scenarios and expected results.

The main National Stakeholders involved in ATM in Ukraine are the following:

- The Regulator, the State Aviation Administration (SAA);

- Air Navigation Service Provider, UkSATSE;

Their activities are detailed in the following subchapters and their relationships are shown in the diagramme below.

The **Ukrainian State Air Traffic Services Enterprise (UkSATSE)** is undertaken a set of measures for the optimization of the national **Air Navigation System and the Integrated Civil-Military Air Traffic Management System of Ukraine (ICMS)**.

Its main activities include the following:

<u>Implementation of Performance-Based Navigation (PBN):</u>

a) **Introduction of Performance-Based Navigation (PBN)**

PBN is one of the main initiatives of the ICAO Global Air Navigation Plan and is one of the activities in modernization of Ukrainian airspace. Implementation of PBN will contribute to the optimization of the Ukrainian airspace, with a positive effect on fuel efficiency and related CO_2 emissions both in the Terminal areas and en-route airspace.

In order to implement PBN in a harmonized way, Ukraine developed the document named 'Implementation of PBN: Strategy and Roadmap 2013-2025'. This document was approved at the SAA level in 2013 and presented to the community at one of EUR PBN TF regular meetings.

This document distinguishes the following timeline:

short term:	**now – end of 2015;**
medium term:	**2016 – end of 2019;**
long term:	**2023+.**

In complement to the global ICAO intention the following pan-European tasks were assessed and legally approved in Local Single Sky Implementation (LSSIP) Ukraine (formally known as LCIP) document:

- NAV03: Implementation of Precision Area Navigation RNAV (P-RNAV);

- NAV10: Implement Approach Procedures with Vertical Guidance (APV).

By introducing the PBN environment supported by GNSS technology, SAAU wants to facilitate more efficient use of airspace and more flexibility for procedure design, which cooperatively result in improved safety, capacity, predictability, operational efficiency, fuel economy, and environmental effects.

Objectives

The strategic objectives established by SAAU in accordance with ICAO framework for Ukrainian air navigation system up to 2025 are:

- to improve flight safety by recognition of multi-constellation GNSS navigation with a backup ground-based infrastructure;
- to develop a interoperable harmonised CNS/ATM system supported by modern ATM techniques, flow performance metrics and perspective CNS capabilities;
- to improve airports accessibility with GNSS/APV approaches;
- to improve operational efficiency by implementation of CDO, Free Routes and ETA concepts;
- to protect environment by reducing emission, noise pollution over sensitive areas.

More efficient air traffic management on terminal control area (tma):

b) **TMA implementation of PBN**

Based on the global planning by the ICAO Assembly Resolution A37/11 and the regional planning by EUROCONTROL, legally approved in Local Single Sky Implementation (LSSIP) Ukraine (formally known as LCIP), taking into account the high level of PBN equipage of international traffic to/from Ukraine and the relative low PBN equipage of domestic traffic, the following principles were applied for the implementation roadmap for TMA's in Ukraine:

- *At short term perspective RNAV 1 is introduced to facilitate IFR traffic in all TMA's with considerable international traffic with a temporary exemption for GA and domestic air traffic to follow conventional routes.*

- *At medium term perspective RNAV 1 will become mandatory for all IFR traffic in all TMA's serving international flights. Timing will be dependent on operational need and aircraft equipage. Consideration be given to A-RNP introduction in Kyiv TMA. At domestic aerodromes RNAV 1 will be introduced only if there is an operational need.*

- *At long term perspective A-RNP is introduced for all IFR traffic in all TMA's serving international flights. Consideration will be given to A-RNP mandatory in Kyiv TMA. This also implies that mandatory carriage of GNSS is needed. A-RNP mandatory in other TMA's only if there has been shown an operational need and adequate aircraft PBN equipage for minimum 90 % of all traffic.*

Currently RNAV 1 ICAO PBN specification is implemented in following TMAs:	
Kyiv TMA	**AIRAC AMDT 04/12 EFF 31 MAY 2012**
Kharkiv TMA	**AIRAC AMDT 03/12 EFF 03 MAY 2012**
Dnipropetrovs'k TMA	**AIRAC AMDT 05/12 EFF 23 AUG 2012**
L'viv TMA	**AIRAC AMDT 07/12 EFF 13 DEC 2012**
Odesa TMA	**AIRAC AMDT 01/14 EFF 06 FEB 2014**

Detailed planning information is contained in ‘Implementation of PBN: Strategy and Roadmap 2013-2025’, which is publicly available at the SAA’ official web site

c) Continuous Descent Operations

Implementation of Area Navigation, is expected to facilitate the development of Continuous Descent Operations (CDO) procedures in a second phase.

CDO in Kyiv (Boryspil’) Airport was implemented in the end of 2013.

Implementation of CDO in Kyiv (Zhuliany), Odesa, Dnipropetrovs’k, L’viv and

Kharkiv (Osnova) Airports is expected to be done around 2015 – 2016.

Continuous Descent Operations (CDO) describes the optimum way to reduce noise and emissions produced during the approach. The procedure makes full advantage of the onboard Flight Management System by planning an uninterrupted idle decelerating descent to intercept final approach landing. This not only minimizes noise disturbance, it also reduces fuel consumption and emissions during the approach phase.

The procedure requires air traffic control to apply specific, or minimum, speeds to inbound aircraft and to pass adequate ―range from touchdown‖ information to a pilot to ensure he can manage his aircraft‘s vertical profile. Such speed control maximizes runway capacity.

The nature and extent of the benefit from CDO will vary depending on the local situation but would typically include significant reductions in noise, fuel and emissions in the areas prior to the point at which the Instrument Landing System (ILS) is acquired for the approach. This is usually between 10 and 25 nautical miles (18-37 kilometers) from the airport.

Taking into account the facts that the aircraft guidance system needs some time to capture the ILS localizer and glide slope and the aircraft has to be stabilized for landing in a timely manner, it is preferable to intercept the final straight in segment not later than at a height of approximately 2000 ft AAL. The final straight in segment of the CDO includes the avoidance of the application of noise and drag produced by flaps and undercarriage until the latest possible moment.

All of these improvements depend on the provision of accurate real-time data on aircraft position and intent, and improvements in flight data processing systems and CNS systems, particularly data communications. They also depend on new technology in navigation systems performance.

More efficient air traffic management on en-route operations:

d) **RVSM airspace**

Reduced Vertical Separation Minimum (RVSM) is applicable in volume of Ukraine airspace between FL 290 and FL 410 inclusive, except for State aircraft.

e) **Flexible Use of Airspace (civil/military)**

Ukrainian authorities through enhanced civil/military coordination, established a national framework for the flexible use of Airspace (civil/military), ensuring that any airspace segregation is temporary and based on real use for a specified time period according to user requirements.

According to ICAO and EUROCONTROL recommendations, the implementation of the FUA concept has benefits in both civil and military aviation with:

Increased flight economy offered through a reduction in distance, time and fuel;

The establishment of an enhanced Air Traffic Services (ATS) route network and associated sectorisation providing:

- An increase in Air Traffic Control (ATC) capacity;
- A reduction in delays to General Air Traffic;
- More efficient ways to separate Operational and General Air Traffic;
- Enhanced real-time civil/military co-ordination;
- A reduction in airspace segregation needs;

The definition and use of temporary airspace reservation that are more closely in line with military operational requirements and that better respond to specific military requirements.

The implementation of Advanced Airspace Management (LSSIP AOM19) is planned by the end of 2016.

The improved planning process refers to the use of specific procedures allowing Aircraft Operators (AOs) to optimise their flight planning in order to achieve a more efficient utilization of available airspace through more dynamic responses to specific short notice or real-time airspace status changes, requirements and route optimisation at the pre-tactical and/or tactical levels.

Consequently, the implementation of Advanced Airspace Management (LSSIP AOM19) will lead to the next expected environment benefits: aircraft emissions will be reduced through the use of more optimum routes/trajectories.

f) **Free Route Airspace Concept**

Since 05 March 2015 Ukraine has implemented Free Route Airspace (FRAU) Step 1 during the Night Time within 4 current UTAs: (UTA L'viv, UTA Kyiv, UTA Dnipropetrovs'k-North, UTA Odesa-North) from FL275 to FL660.

The implementation of FRAU allows airspace users to reduce flight distances and flight time due

to more available direct flights within FRAU, and as a result to reduce fuel burn and CO_2 emissions.

The development of FRAU Step 2 is discussed, that will include flight operations within defined airspace during H24. That will result in an improved capacity, flexibility and flight efficiency which will generate cost savings for aircraft operators while maintaining safety standards. This Step is quite actual for Ukraine because mainly flight operations are during Day Time.

Calculations in other European Airspaces show that the concept can drive to an average saving of between 1-1,5 % (fuel and flying time).

This section includes information on the basket of possible measures to be taken in Ukraine, according to the capacity of national key agents to implement then.

Flexible use of airspace:

g) **Implementation of scenario 1b of the Airspace of Free Routes of Ukraine (FRAU)**:

According to the plan for the implementation of changes in the ATS system related to the implementation of the airspace of free routes of Ukraine (Stage 1, scenario 1b), the implementation of scenario 1b FRAU is divided into the following phases:

phase 1 - implementation of FRA H24 procedures within the FRA Lviv district. Implemented - December 6, 2018;

phase 2 - implementation of regional FRA H24 procedures within the FRA KIDRO area, which will cover the airspace elements of UTA Kyiv, UTA Dnipro-North and the ATS sector of UTA Dnipro-South DVS. Introduced - May 23, 2019;

phase 3 - implementation of FRA H24 procedures within the FRA Odesa area (within the UTA Odesa-North).

Implementation of FRA-H24 in FRA Odesa (UTA Odesa-North) (Phase 1, Scenario 1b, Phase 3) allowed to optimize the structure of UTA Odesa-North and FIR Odesa airspace, to provide more flexible use of available airspace, to simplify R & D procedures for ATS, air traffic management, airspace management and civil-military coordination in ATS. For operators, this simplifies flight planning and provides an additional opportunity to reduce fuel consumption, reduce flight time and emissions.

h) **Introduction of advanced flexible use of airspace (A-FUA)**

The development of airspace management is taking place in accordance with EU legislation and is being improved in accordance with the concept of improved flexible use of airspace A-FUA, which will improve the coordination of the needs of civilian and military airspace users and address the following:

- implementation of advanced ASM rules and procedures (Airspace management, airspace management);

- ensuring flight safety during flights of civil and state aircraft (AIR), carrying out other activities on the use of airspace;

- ensuring the need to use the airspace of different categories of users;

- improving the attractiveness of Ukrainian airspace for operators;

- increase in transit air traffic flows;

- increasing the efficiency of flights of aircraft operators and the use of airspace;

- reduction of emissions of harmful substances by reducing the length of flight routes of aircraft;

- improving control over the use of Ukrainian airspace.

Next steps

In order to achieve operational and economic goals, to harmonize the airspace of Ukraine with the European network and simplify the use of airspace by operators, it is planned to implement the following projects:

- further implementation of the regional FRA within the airspace of Ukraine and in cooperation with related providers of AIEs should allow airlines to use more direct and efficient trajectories;

- to improve flight efficiency in the aerodrome area at the busiest aerodromes and in the terminal control areas, new ATS techniques will be introduced using A-CDM (Airport Collaborative Decision Making), AMAN (Arrival management, arrival management system), DMAN (Departure management, system departure management). For incoming air traffic, improved interaction will be introduced between the authorities providing the district air traffic control service and the air traffic control service approach;

- the introduction of A-FUA will improve the coordination of the needs of civilian and military airspace users;

- implementation of CCO procedures (Continuous climb operations) will satisfy the requirements of airlines for optimal altitude schemes both in the route segment and in the terminal airspace;

- improved and joint planning of the airport according to the A-CDM concept for operators will reduce the number of delays on the ground and thus save fuel due to reduced taxiing time.

2. AIRCRAFT RELATED TECHNOLOGY DEVELOPMENT

Research & Development

Ukraine-based Antonov Design Bureau, a scientific and technical complex named after Oleg Konstantinovich (O.K.) Antonov, designs transport, regional, and special purpose aircraft. The bureau is engaged in designing and building new prototype aircraft and modifications of earlier designs, providing their operational support and follow-up engineering work on the aircraft service life extension. Specifically, Antonov offers basic and conversion training of flight and maintenance crews, sends high-skilled specialists to render assistance in mastering the aircraft and training local personnel, provides international air transportation of cargoes including oversized ones on a charter basis, participates in the international co-operation in the field of aircraft and equipment design and manufacture, and develops land transit vehicles. Among its designs are the An-124 and the An-225, the world's largest plane, which can carry things no other aircraft can. The An-124 was originally designed for military use, while the An-225 was designed to carry the space shuttle. These giants have been marketed in the West since the late 1980s. Besides enjoying a corner on the outsized air freight market, Antonov aircraft have made possible previously inconceivable logistical undertakings, and their ability to quickly transport huge pieces of equipment across the world has saved mining, construction, and manufacturing industries from costly downtime.

Fields of commercial activity of Antonov include:

- Aircraft construction and manufacture
- Airfreight services (Antonov Airlines)
- Aircraft maintenance and upgrading
- Aerospace related engineering support
- Operation of the Gostomel airport (Antonov Airport)
- Trolley bus construction and manufacture (a spin-off, using existing technical expertise).
- Air Start project. Satellite launch from the modified version of Ruslan.

The State Aviation Administration of Ukraine has undertaken a consultation process with national stakeholders, to identify the potential basket of measures currently ongoing or planned to be implemented, that could have potential CO_2 emissions reductions in international flights.

Since 2017, there has been a steady trend of increasing air traffic: + 19% - until 2017, + 18% - until 2018, + 11.5% - until 2019. In 2020, due to the spread of COVID-19 coronavirus in Ukraine and other countries, a number of measures have been taken to combat the pandemic (in particular, scheduled air travel has been restricted). As a result, in 2020 there was a drop in air traffic by 59% (Table below).

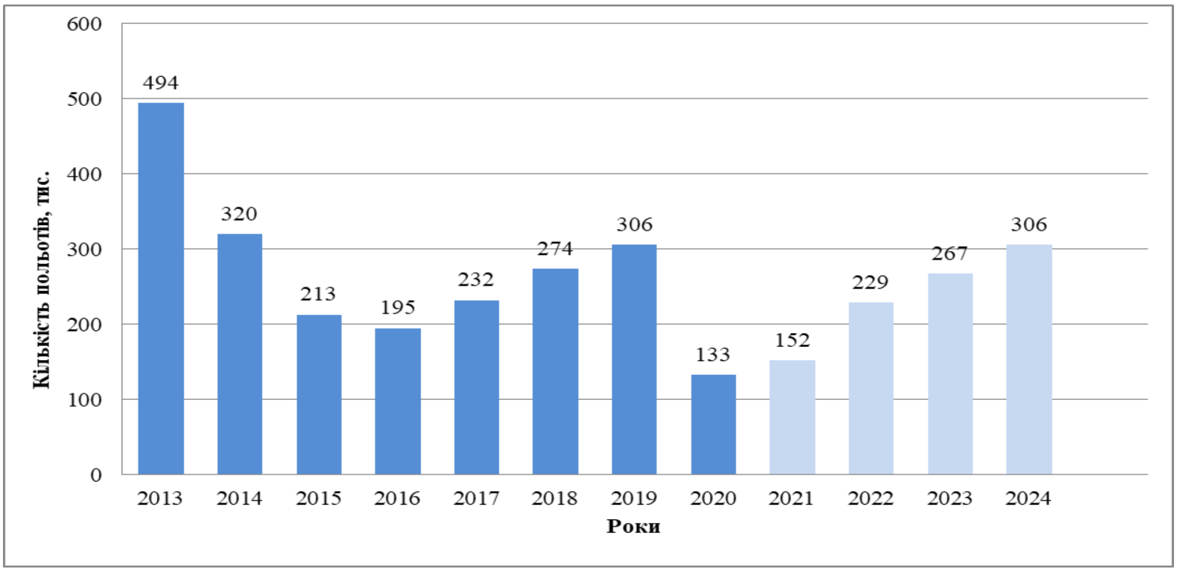
Volumes of air traffic in Ukraine in 2019 - 2020

FIR of Ukraine	**Number of flights**	
	2019	**2020**
FIR Kyiv	184 552	80 192
FIR Dnipro	26 913	17 653
FIR Lviv	167 480	61 726
FIR Odessa	109 834	51 744
A total of	**335 407**	**142 047**

According to Eurocontrol forecasts, air traffic volumes in Ukraine will return to the level of 2019 not earlier than 2024 (Fig. 1).

Eurocontrol forecast data "EUROCONTROL 5-YEAR FORECAST 2020-2024: Detailed Forecasts" were used for air traffic forecast.

Air traffic statistics for 2013 - 2020 and forecast for 2021 - 2024



3. ANALYSIS AND PROPOSALS OF MEASURES IN THE FIELD OF CARBON DIOXIDE REDUCTION, AIRPORTS SECTION

Application of the Automated Building Management System, introduction of new lighting systems	The use of LED technology saves 50% of electricity compared to the use of fluorescent lamps, also reduces the amount of hazardous waste - used fluorescent lamps
Installation and use of service systems at airports (as an example, stationary aerodrome ground power units AXA 2300 Power Coil (type 3GVC-200/260-N) and stationary aerodrome air conditioning units SIAT aircraft (type PCA B.03) integrated into telescopic ladders type APRON DRIVE	Reduction of electricity consumption by 17%
Use of service systems such as mobile converters static APOJET S 400Hz 90kVA on air bridges 2, 2A and in the hangar.	The purpose of the event: - reduction of CO2 emissions; - exclusion of costs for the purchase of fuel
Implementation of the Continuous Climb Operations (CCO) method	
Runway use (during landings): the use of minimum radar intervals at the final stage of approaching the runway provides optimal runway use time and minimizes the probability of the next ACFT entering the second round. Objective: To reduce the time spent on the runway.	Saving aviation kerosene in one operation is close 1000 kg
Purchase of 5 units of electric tractors with replaceable batteries	Reduction of CO2 emissions (2-4%) into the atmosphere by minimizing the use of groundwater with internal combustion engines for ground maintenance
Decommissioned vehicles with diesel engines of Euro1 standard: platform buses "Neoplan -9012" - 6 units, "Neoplan -9022" - 1 unit, "Neoplan - 9122" - 2 units; Decommissioned vehicles that ran on A-76, A-80 gasoline (A-76, A-80 gasoline are not used at the enterprise).	When the fleet was renewed, emissions were reduced from 7 to 15%
Renewal of the trailer fleet; purchased: - GPU - 2 units;	Emissions reduced to 10%

- Tricks - 2 units with environmental emission standards of Euro 5; - marking machines - 1 unit with environmental emission standards Tier4 * (instead of Euro 1); - bitumen-smelting boiler - 1 unit with environmental emission standards Tier4 * (instead of Euro 1). Objective: to reduce greenhouse gas emissions in exhaust gas mixtures from car engines.	
Technical re-equipment of the fuel boiler house: Purpose: to reduce the use of natural gas, as well as heat loss in the production and transfer of thermal energy by replacing steam boilers E-1 / 9G with a steam capacity of 0.9 t. Steam / h for two gas boilers with a capacity of 98 kW each.	Natural gas use decreased by 15-20%
Use of thermal energy produced at installations from non-traditional or renewable energy sources Objective: to reduce the use of natural gas in thermal energy production Purchase of thermal energy produced by KYIV GREEN ENERGY LLC at its own installation from a renewable energy source.	Purchase of 19,000 Gcal / year ensures the exclusion of consumption of 2.5 million m3 of natural gas

ESTIMATED BENEFITS AND CONCLUSION

The State Aviation Administration of Ukraine through the measures included in this Action Plan is willing to contribute achieving ICAO's climate change goals for international aviation, as stated in Assembly Resolution A37-19: A global **annual average fuel efficiency improvement of 2 per cent until 2020** and an aspirational **global fuel efficiency improvement rate of 2 per cent per annum from 2021 to 2050**, calculated on the basis of volume of fuel used per revenue tonne kilometer performed;

The estimated expected benefits in terms of fuel savings and emissions reductions of the basket of measures included in this plan are already estimated among the common ECAC estimated benefits of implemented measures.

Nevertheless, and following ICAO guidance, the following estimation quantifies the contribution of Ukraine to the common ECAC estimated benefits:

AIRCRAFT RELATED TECHNOLOGY DEVELOPMENT:

2 % annual efficiency improvement (accumulated 16%) till 2020 (including RTK efficiency optimization, through adaptation of aircraft fleets to specific airline's needs)

IMPROVED AIR TRAFFIC MANAGEMENT AND INFRASTRUCTURE USE:

5 % accumulated efficiency improvement in 2020

BASKET OF POSSIBLE OPERATIONAL OR ADDITIONAL MEASURES TO BE TAKEN IN UKRAINE, ACCORDING TO THE CAPACITY OF NATIONAL KEY AGENTS:

6 % accumulated efficiency improvement in 2020

EXPECTED RESULTS:

The estimated results in terms of fuel and CO_2 emissions savings are summarized in the following table:

Year	Tot RTK	Int RTK	Tot Fuel (L) after measures	Int Fuel (L) after measures	Tot CO_2 (Kg) after measures	Int CO_2 (Kg) after measures
2012	1062000000,00	1002460838,00	376636412,20	289971227,70	951232922,66	732351332,68
2013	767000000,00	705402743,00	266574882,86	203279212,83	673261524,15	505027794,55
2014	718000000,00	692000000,00	244451926,75	198666253,43	617387786,19	485321340,13
2015	301560000,00	290640000,00	100530854,87	83124562,61	253900727,07	199588401,13
2016	291005400,00	280467600,00	94948184,00	79910973,33	239801133,50	188504875,02
2017	314285832,00	302905008,00	100314820,48	85975283,23	253355110,61	199159498,39
2018	340057270,22	327743218,66	106128621,63	92669745,92	268038446,80	210701897,77
2019	364881450,95	351668473,62	111287919,86	99053174,57	281068770,39	220944883,21
2020	391152915,42	376988603,72	116526216,36	105776075,02	294298612,05	231344707,48
2021	416577854,92	401492862,96	121145648,51	112216011,44	305965449,88	240515872,67
2022	437823325,52	421968998,97	124218611,30	117481308,64	313726524,70	246616763,10
2023	460152315,12	443489417,92	127289916,47	122991792,31	321483413,03	252714362,56
2024	483620083,19	466107378,23	130351402,15	128758776,43	329215501,27	258792466,98
2025	508284707,44	489878854,52	133394078,30	134794091,27	336900084,16	264833227,98