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ICAO Action Plan on CO_2 Emission Reduction of Switzerland

June 2021

Federal Office of Civil Aviation (FOCA)

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I Introduction

a) The ICAO Contracting State Switzerland is a member of the European free trade association EFTA and of the European Civil Aviation Conference (ECAC). ECAC is an intergovernmental organisation covering the widest grouping of Member States[1] of any European organisation dealing with civil aviation. It is currently composed of 44 Member States, and was created in 1955.

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

c) All ECAC States, in application of their commitment in the 2016 Bratislava Declaration, support CORSIA implementation and have notified ICAO of their decision to voluntarily participate in CORSIA from the start of its pilot phase and have effectively engaged in its implementation.

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

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

f) In that context, it is the intention that all ECAC States submit to ICAO an Action Plan[2]. This is the Action Plan of Switzerland.

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

   i. emission reductions at source, including European support to CAEP work in this matter (standard setting process),

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

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

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

   v. Market Based Measures, which allow the sector to continue to grow in a sustainable and efficient manner, recognizing that the measures at (i) to (iv) above cannot, even in aggregate, deliver in time the emissions reductions necessary to meet the ICAO 2020 CNG global goal.

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

[2] ICAO Assembly Resolution A40-18 also encourages States to submit an annual reporting of international aviation CO2 emissions, which is a task different in nature and purpose to that of action plans, strategic in their nature. Also this requirement is subject to different deadlines for submission and updates as annual updates are expected. For that reason, the reporting to ICAO of international aviation CO2 emissions referred to in paragraphs 10 & 14 of ICAO Resolution A40-18 is not necessarily part of this Action Plan, and may be provided separately, as part of routine provision of data to ICAO, or in future updates of this action plan

h) In Europe, many of the actions which are undertaken within the framework of this comprehensive approach are in practice taken collectively most of them led by the European Union. They are reported in Section 1 of this Action Plan, where the involvement of Switzerland is described, as well as that of other stakeholders.

i) In Switzerland a number of actions are undertaken at the national level, including those by stakeholders. These national actions are reported in Section 2 of this Plan.

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

   i. The extent of participation will vary from one State to another, reflecting the priorities and circumstances of each State (economic situation, size of its aviation market, historical and institutional context, such as EU/ non EU). The ECAC States are thus involved in different degrees and on different timelines in the delivery of these common actions. When an additional State joins a collective action, including at a later stage, this broadens the effect of the measure, thus increasing the European contribution to meeting the global goals.

   ii. Acting together, the ECAC States have undertaken to reduce the region's emissions through a comprehensive approach. Some of the measures, although implemented by some, but not all of ECAC's 44 States, nonetheless yield emission reduction benefits across the whole of the region (for example research, SAF promotion or ETS).

II Current State of Aviation in Switzerland

2.1 Legal basis

The primary aviation legislation of Switzerland is the Federal Aviation Act (LCA.SR 748.0)[3], promulgated by the National Assembly in 1948. The Federal Aviation Act, which has been updated several times, contains general rules which are the basic laws applicable to civil aviation. The last amendment to the Federal Aviation Act came into force on 1th January 2021. On the basis of the Act regulations are implemented in different domains such as infrastructure, airworthiness, air traffic regulations, operating rules, air transport and many more.

A detailed analysis of the primary aviation legislation was published in December 2010 in the final report on the safety oversight audit of the civil aviation system of Switzerland, ICAO Universal Safety Oversight Audit Programme[4].

Recognizing the integrated character of international civil aviation and desiring that intra-European air transport be harmonized, Switzerland ratified the Convention on International Civil Aviation on 6 February 1947 and at the European level an Agreement with the European Community on 21 June 1999 (Ref. 0.748.127.192.68) setting out rules for the Contracting Parties in the field of civil aviation.

In order to fully harmonize the legal system of Switzerland and the EU, the Agreement contains an Annex with all European Community legislation regarding civil aviation to be fully applicable in Switzerland.

Since 1th December 2006 Switzerland participates in the European Aviation Safety Agency (EASA). Switzerland's active role within the EASA system ensures recognition of the Swiss civil aviation sector in the European market. Switzerland has the same rights and obligations as other EASA member states, with the exception of the right to vote in the management board of EASA. Through the bilateral agreement on air transport between Switzerland and the European Union, Switzerland adopts current and future EU legislation on civil aviation safety[5].

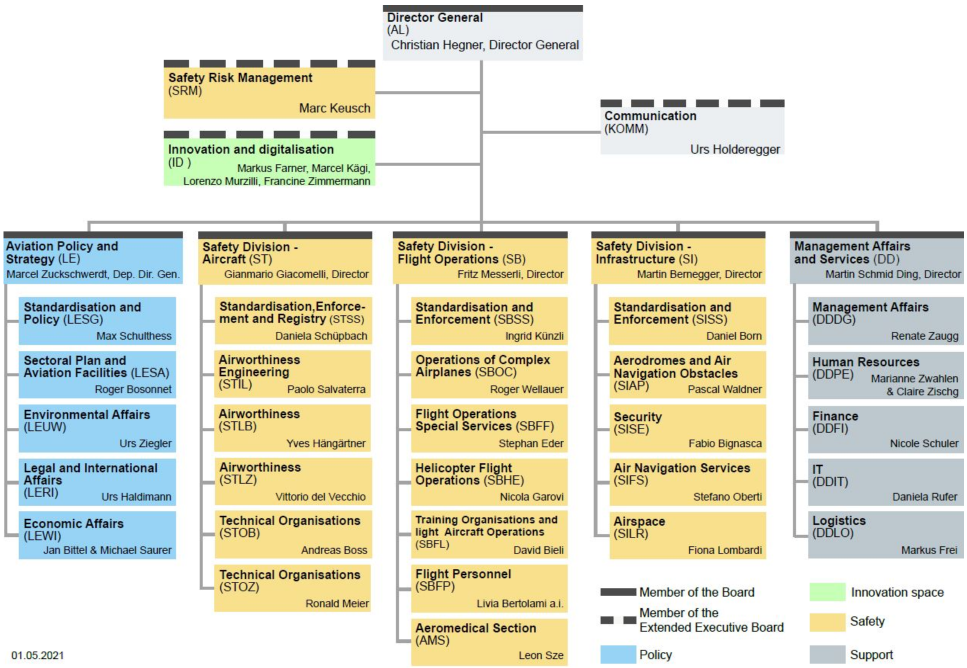

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Figure 2.1.1 Organisation chart FOCA as of June 2021

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3 Federal Aviation Act (SR 748.0) 2021: Bundesgesetz vom 21. Dezember 1948 über die Luftfahrt
4 ICAO Universal Safety Oversight Audit Programme ICAO USOAP 2010: Final Report
5 FOCA website 2021 :EASA

The Federal Office of Civil Aviation (FOCA) is responsible for monitoring the status and development of civil aviation in Switzerland. It is responsible for ensuring that civil aviation in Switzerland has a high safety standard and one that it is in keeping with sustainable development. The FOCA aims to ensure the safe, best possible and environmentally friendly use of the infrastructure, which includes airspace, air traffic control and aerodromes. The Federal Office also supervises aviation companies to which it issues an operating licence based on a technical, operational and financial evaluation.

As far as aviation personnel are concerned, the FOCA ensures that pilots, air traffic controllers and maintenance specialists receive the most comprehensive and up-to-date training or in-service training available. The FOCA inspects the technical requirements with which aircraft, from hot air balloons through gliders to wide-bodied aircraft, need to comply for safe operation.

The FOCA bases itself mainly on internationally agreed standards and practices for its supervisory activities.

In addition to the supervisory function in the four areas mentioned, which comprises a considerable part of its work, the FOCA is responsible for the formulation and implementation of aviation policy decisions. The Federal Office is also involved in various international organisations or collaborates closely with them.

2.2 Aviation Policy in Switzerland

Aviation policy is designed to set the framework for the development of civil aviation in Switzerland. It is oriented around the Federal Council's strategy of sustainability and takes into account the economic, environmental and social dimensions of sustainability. The main aim of aviation policy is to ensure that Switzerland has optimal connections to all Major European and global centres.

The aviation policy report published at the end of 2004[6] marked the first time in fifty years that the Federal Council had conducted a situation appraisal of civil aviation in Switzerland. While this previous report, was prepared in the wake of the Swissair crisis and serious aviation accidents, the new report does not represent a departure from the existing policy, but rather sets out to explain how civil aviation can be further developed against a backdrop of increasing demand for mobility, the appearance of new airlines and the development of new technologies. The Federal Council formally adopted the report on 25 February 2016[7]. In it, the government expresses its desire for the sustainable development of aviation and to strive to ensure the highest safety standards that can be measured amongst the best in Europe.

Based on the superior strategies of the aviation policy the Federal Council defines the guiding principles in the sectors of Aerodromes, Air traffic control, Aviation industry and Education. Those sectors have to be considered as a whole system and are strongly linked. The state has the role of the regulator.

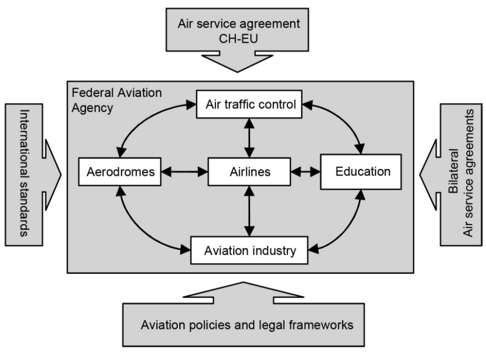

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Figure 2.2.1 Civil Aviation in Switzerland

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6 FOCA 2021: Aviation Policy Report 2004

7 FOCA 2021: Aviation Policy Report 2016

The Sectoral Aviation Infrastructure Plan (SAIP)[8] is the Federal government's planning and coordination instrument for civil aviation. It sets out the purpose, required perimeter, main aspects of use, equipment and general operating conditions for every aerodrome. The SAIP forms the basis for the planning, construction and operation of an aerodrome, in particular for concessions and operating regulations.

2.3 Sustainability

The Swiss Confederation published in 2008 a report on the sustainability of the Swiss civil aviation sector[9]. The report evaluated the Swiss civil aviation system on the basis of three main sustainability dimensions: the economy, the environment and society.

In 2015 an updated assessment of the sustainability of civil aviation in Switzerland[10] was conducted and a short summary of this report is presented in the Action Plan of Switzerland. The impact of the COVID-19 pandemic is not reflected in the report, and therefore the results may not be valid for 2020 and onwards.

With respect to the economic dimension, the trends may largely be regarded as positive. The main challenges concern capacity restrictions at the national airports and maintaining the competitiveness of Switzerland’s civil aviation sector, both of which have an influence on the country’s degree of attractiveness as a small, open economy.

With regard to the environment dimension, despite the fact that improvements have been made in the past few years, deficits continue to exist, primarily relating to noise and impacts on the climate. However, the fact that these environmental impacts have not increased at the same rate as the passenger transport may be regarded as a positive trend. As a consequence of two regulatory amendments in the revised Federal Noise Abatement Ordinance that entered into force on 1 February 2015, there is a tendency for more people to be exposed to aircraft noise in residential zones.

In the social dimension, the assessment is mixed: while the safety and security situation has improved, there are still some deficits regarding public health and the options for residential development in the vicinity of the national airports.

With its 2030 Sustainable Development Strategy[11], the Federal Council is setting out how it intends to implement the 2030 Agenda for Sustainable Development over the next ten years. The strategy defines priorities in those policy areas in which there is a particular need for action and coordination between policy areas at federal level to implement the 2030 Agenda.

For this reason, the Federal Council has identified the three topics of 'sustainable consumption and production', 'climate, energy, biodiversity' and 'equal opportunities' as priority issues, and has set goals for the period up to 2030, as well as strategic domestic and foreign policy guidelines for federal government policy.

The 2030 Sustainable Development Strategy and the associated 2021–2023 Action Plan were adopted by the Federal Council on 23 June 2021. The development of a strategy for the development, promotion and use of sustainable aviation fuels is part of the action plan 2021-2023 mentioned above. In the previous action plan 2016-2019 the ICAO State Action Plan from Switzerland is listed as measure under action area 3 – Energy and climate.

[8] FOCA 2021: Sectoral Aviation Infrastructure Plan (SAIP)
[9] FOCA 2021: Sustainability of the Swiss Civil Aviation 2008
[10] FOCA 2021: Civil Aviation and sustainability, Update 2015
[11] ARE 2021: Sustainable Development Strategy

2.4 Structure of the Civil Aviation Sector

The Swiss civil aerodromes are structured in 6 different categories[12]: national airport (3), regional airport (11), airfield (34; winter airfield 4; 1 water landing site), heliport (22; 2 winter heliport) and mountain landing site (40).

Switzerland has three national airports: Zurich, Geneva and Basel-Mulhouse. They are the principal landing sites for international air traffic and are important for the national and international traffic system in Switzerland. Their function is to achieve optimal connections to all Major European and global centres. Their remaining capacity can be used by any other national or international registered aircraft.

Apart from the national airports, there are 11 regional airports (Bern-Belp, Lugano-Agno, Sion, St. Gallen-Alternrhein, Birrfeld, Bressaucourt, Ecuvillens, Grechen, La Chaux-de-Fons-Les Eplatures, Lausanne-La Blécherette, Samedan). Regional airports are aerodromes with a concession (except St. Gallen-Altenrhein), for public use and they have a customs clearance. The technical standard is higher than at an airfield. The regional airports manly complement the national airports for the scheduled flights. They create direct connections between Switzerland and the foreign country. Besides that they are a regional centre for business, touristic, commercial and training flights.

The airfields are primary for private use and training flights.

Figure 2.4.1 and Figure 2.4.2 are giving an overview of the Swiss national and regional airports.

Civil aerodromes: overview 2019

	Foundation Year	Longest runway Metres	Paved runways (concrete/asphalt) Number	Instrument Flight Rules (IFR) Procedures (yes/no)
Total airports and airfields with paved runways			**33**	
Total national airports			6	
Zurich	1948	3 700	3	yes
Geneva	1922	3 900	1	yes
Basel-Mulhouse	1946	3 900	2	yes
Total regional airports			11	
Bern-Belp	1929	1 730	1	yes
Lugano-Agno	1947	1 350	1	yes
Sion	1935	2 000	1	yes
St. Gallen-Altenrhein	1926	1 500	1	yes
Birrfeld	1937	725	1	no
Bressaucourt	2011	800	1	no
Ecuvillens	1953	800	1	no
Grenchen	1931	1 000	1	yes
La Chaux-de-Fonds-Les Eplatures	1912	1 130	1	yes
Lausanne-La Blécherette	1910	875	1	no
Samedan	1937	1 800	1	no
Total airfields with paved runways			16	

Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL) © FSO 2020

Figure 2.4.1 Swiss Aerodromes: Overview 2019

[12] FOCA 2021: Sectoral Aviation Infrastructure Plan (SAIP)

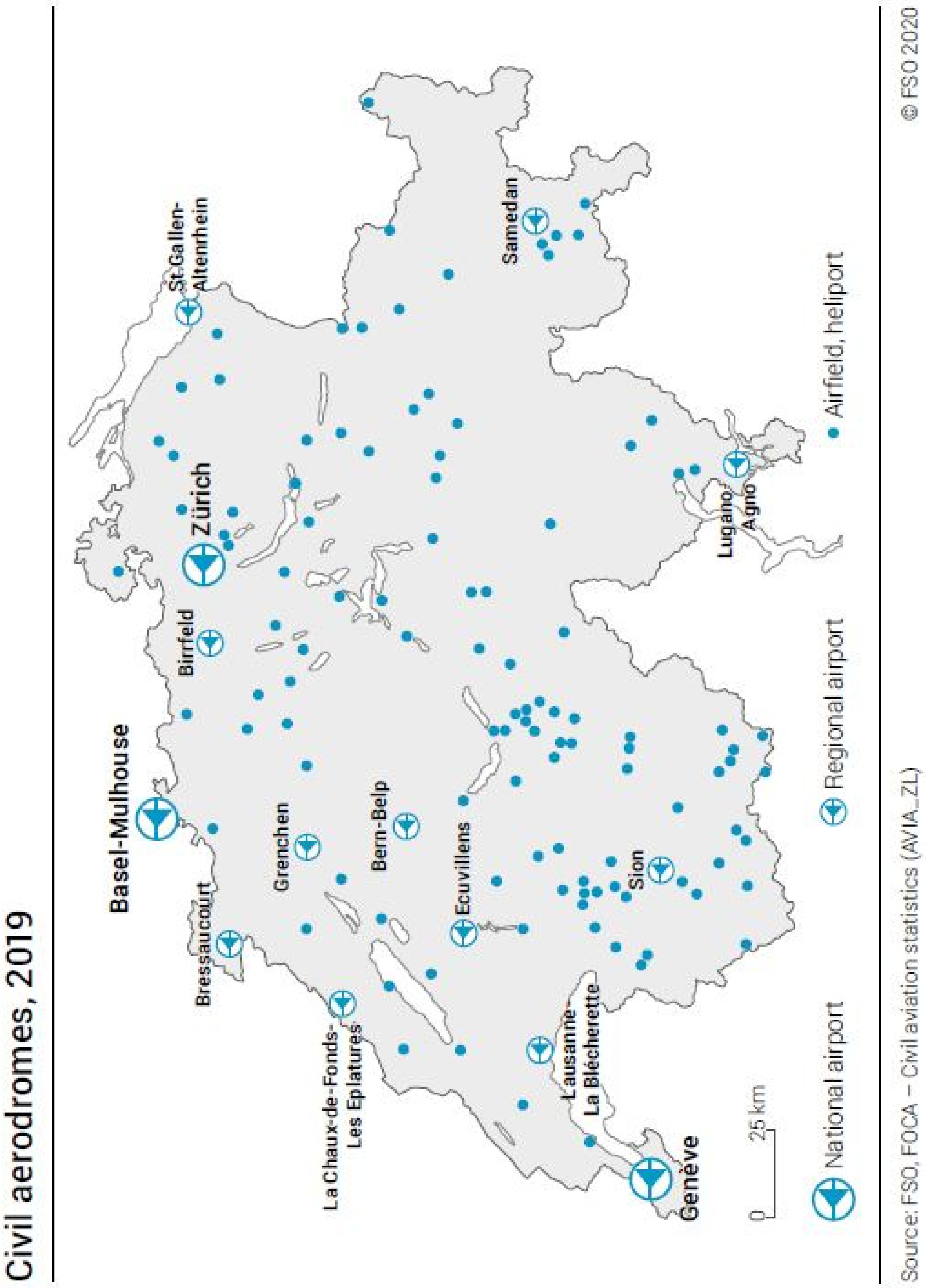
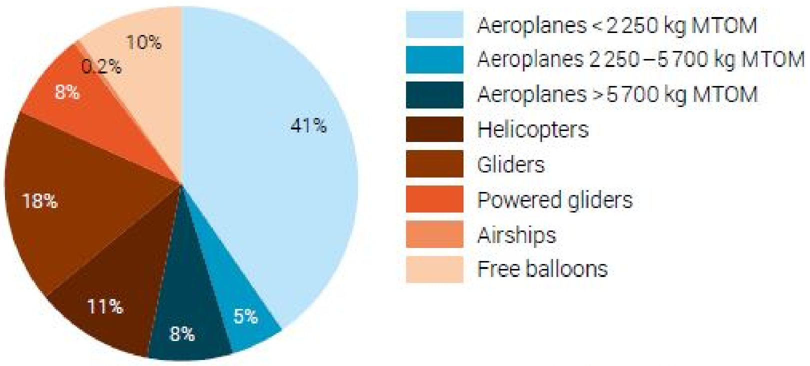


Figure 2.4.2 Civil Aviation 2020; National and regional airports

2.5 Swiss Aircraft Register

The Swiss Aircraft Registry shows all records of Swiss registered aircraft. It contains detailed information regarding owner and holder, type of aircraft, its year of construction, serial number and Maximum take-off Mass. The registry is managed by FOCA and published on the website of FOCA[13].

Registered aircraft, 2019



Total: 3 211 aircraft

MTOM = Maximum Take Off Mass

Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL) © FSO 2020

Registered aircraft

	2000	2005	2010	2015	2018	2019
Total aircraft	**4 048**	**3 841**	**3 705**	**3 494**	**3 284**	**3 211**
Total aeroplanes	2 014	1 892	1 913	1 850	1 773	1 730
< 2 250 kg MTOM	1 572	1 502	1 413	1 397	1 349	1 324
2 250–5 700 kg MTOM	157	149	197	169	162	146
> 5 700 kg MTOM	285	241	303	284	262	260
Helicopters	254	285	327	326	335	345
Gliders	1 024	949	824	696	599	579
Powered gliders	246	254	251	253	245	241
Airships	6	9	9	11	9	8
Free balloons	504	452	381	358	323	308

MTOM = Maximum Take Off Mass

Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL) © FSO 2020

Figure 2.5.1 Swiss Aircraft Register 2019, Aircrafts

2.6 Operations

A pilot, whether of aeroplanes, sailplanes, helicopters or balloons, has to complete a clearly defined training. This includes theory lessons as well as practical training on the aircraft concerned. The training is completed with an examination. After basic training, pilots can undergo further training to become an instructor, commercial pilot or airline pilot. Licences are issued according to EASA and thus ICAO regulations[14].

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[13] FOCA 2021: Swiss Aircraft Registry

[14] FOCA 2021: Flight Training, Legislation and Directives

Aviation operators are required to hold an Air Operator Certificate (AOC), and as a rule also have to possess an operating license in order to fly in Switzerland. The practices are based on the recommendations of ICAO and EASA.

The Swiss civil and military airspace is managed by Skyguide[15], which performs its services under a legal mandate issued by the Swiss Confederation and the FOCA. This mandate requires Skyguide to ensure the safe, fluid and cost-effective management of air traffic in Swiss airspace and in the adjacent airspace of neighbouring countries that has been delegated to its control. Skyguide's legally-prescribed duties and tasks entail providing civil and military air navigation services, aeronautical information and telecommunications services and the technical services required to install, operate and maintain the associated air navigation systems and facilities.

Skyguide has its head office in Geneva and maintains further operations in Alpnach, Bern-Belp, Buochs, Dübendorf, Emmen, Grenchen, Locarno, Lugano Agno, Meiringen, Payerne, St. Gallen-Altenrhein, Sion and Zurich. Furthermore, Skyguide ensure the maintenance of 240 installations throughout the country.

Skyguide is an active member of Functional Airspace Block Europe Central (FABEC) and works closely with ICAO, Eurocontrol and CANSO.

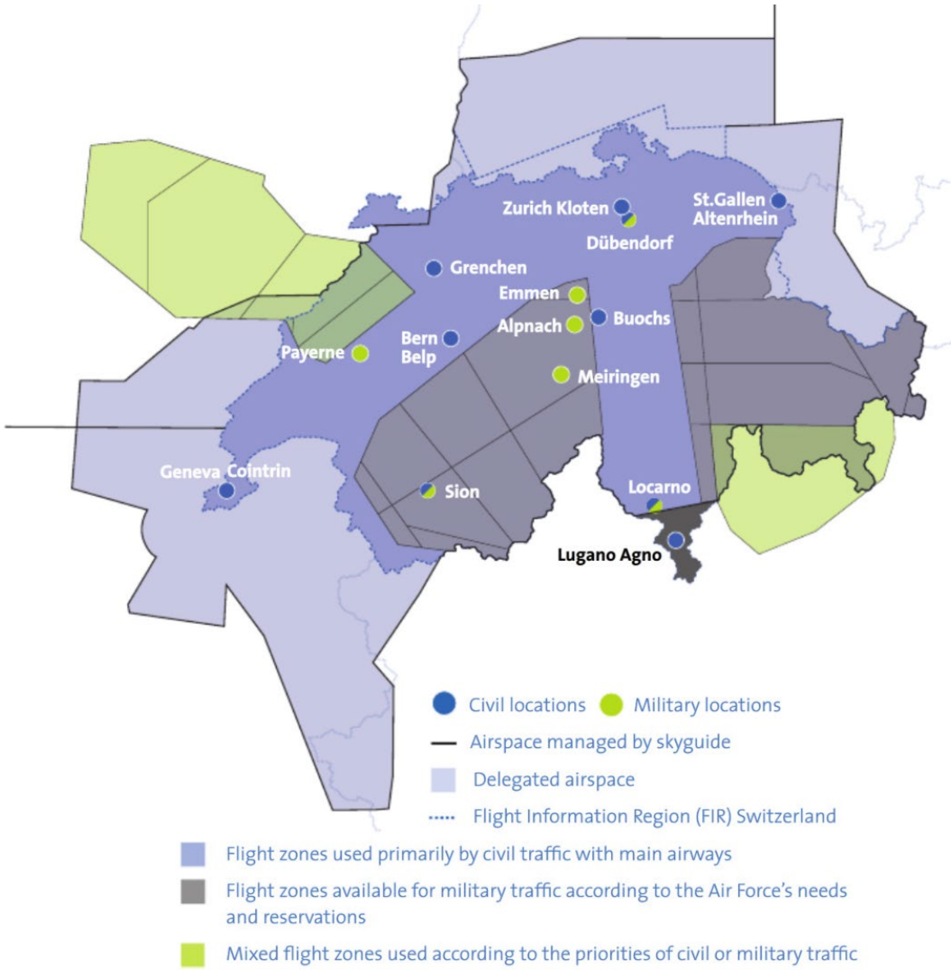


Figure 2.6.1 Skyguide's airspace, Annual Report 2019

[15] Skyguide 2021: www.skyguide.ch

Similar to the register of aircraft published by FOCA, the Federal Office of Statistics publishes yearly an overview of Swiss aviation companies.

Swiss aviation companies

	2000	2005	2010	2015	2018	2019
Total companies	**420**	**355**	**322**	**299**	**267**	**252**
Companies with scheduled traffic	5	5	9	9	5	5
Other companies with commercial traffic	172	109	81	66	38	38
Maintenance companies	94	87	90	84	83	80
Flying schools	149	154	142	140	141	

Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL)

Flight personnel

Licence holders

	2000	2005	2010	2015	2018	2019
Private pilots	6 792	5 928	5 581	4 872	4 536	4 422
Commercial pilots	1 421	1 000	952	1 050	1 062	1 096
Airline transport pilots	2 223	2 086	2 266	2 571	2 437	2 508
Multi-Crew pilots	0	0	46	87	27	22
Helicopter pilots[1]	1 036	1 082	1 168	1 043	1 060	1 072
Glider pilots	3 145	2 764	2 617	1 715	1 717	1 761
Free balloon pilots	449	428	340	255	227	211
Validations[2]	420	38	8	11	8	7
Flight engineers	14	8	2	2	0	0
Radio navigators	30	27	10	4	5	3

1 including Air Transport Pilot Licence ATPL (H)
2 recognition of foreign licences (Validation)

Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL)

Figure 2.6.2 Swiss Aircraft Register 2019, Swiss Companies, Flying Personnel (Licences)

2.7 Traffic Performance

The number of scheduled and charter traffic movements is delivered monthly by the airport authority to FOCA. This information facilitates the organisation of airport operations in the areas of safety, dispatching and passenger information. The information is also used to calculate airport landing fees.

Figure 2.7.1 shows the movements of scheduled and charter traffic at the three national airports and at four regional airports until 2019. The share of scheduled and charter traffic operating through the regional airports (Bern-Belp, Lugano-Agno, Sion and St. Gallen-Altenrhein) is around 1 %. Just over 50% of all scheduled and charter departures and landings are at Zurich airport.

The curve of total scheduled and charter traffic shown in Figure 2.7.1 has a clear peak in 2000. From 1995 to 2000 the aircraft movements grew every year by about 5 to 7 %. After the year 2000, the civil aviation sector experienced a major crisis, which caused a continuous decrease in movements and, from 2004, a stagnation at a level of around 400 000 movements per year. From 2010 until 2019, there is a light increase in movements. The massive decrease of movements in 2020 due to the COVID-19 pandemic situation is not reflected in the following figures.

Aircraft movements: scheduled and charter traffic

Takeoffs and landings

	2000	2005	2010	2015	2018	2019
Total airports	**537 813**	**418 956**	**416 111**	**460 978**	**471 872**	**469 667**
Total national airports	509 584	404 428	404 921	445 349	462 376	465 030
Zurich	291 044	229 982	227 815	231 095	244 430	243 115
Geneva	118 950	116 545	123 173	146 440	144 721	145 527
Basel-Mulhouse[1]	99 590	57 901	53 933	67 814	73 225	76 388
Total regional airports	28 229	14 528	11 190	15 629	9 496	4 637
Bern-Belp	12 489	4 128	3 486	7 928	4 003	326
Lugano-Agno	12 017	7 741	5 479	5 397	2 753	2 107
Sion	530	80	92	572	508	129
St. Gallen-Altenrhein	3 193	2 579	2 133	1 732	2 232	2 075

[1] Swiss and French traffic

Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL) © FSO 2020

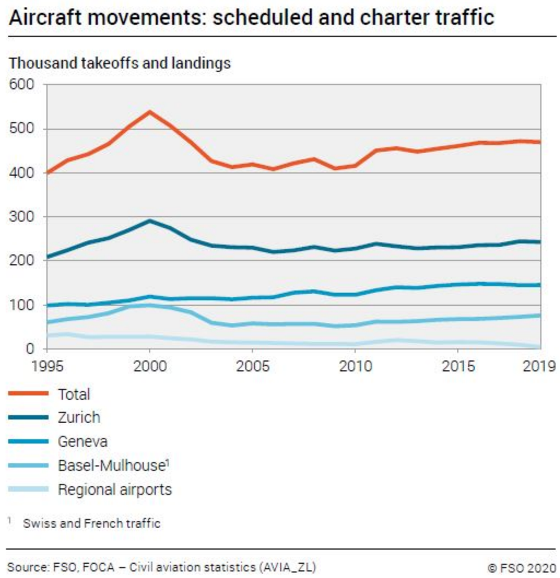


Figure 2.7.1 Scheduled and Charter Traffic; Aircraft Movements 2019

The situation is completely different at the regional airports. Here, growth occurred from 1980 to 1995, after which the level of scheduled and charter traffic is decreasing further. This decrease isn't a COVID-19 effect but due to less airlines operating from regional airports.

As with aircraft movements, the level of passenger movements is reported regularly to FOCA, with the information coming from ticket sales or directly from the airline company.

Figure 2.7.2 shows the total passenger numbers for scheduled and charter traffic. The passenger numbers increased in line with traffic increase until 2000, after which both traffic movements and passenger numbers decreased. After three to four years the market recovered and in 2007 the number of passengers was higher than in 2000. The 'dip' in 2009 was caused by the financial crisis. The effect of global passenger totals drop of more than 60%[16] isn't included in the following figures.

[16] ICAO Newsroom 2021: https://www.icao.int/Newsroom/Pages/2020-passenger-totals-drop-60-percent-as-COVID19-assault-on-international-mobility-continues.aspx

Air passengers: scheduled and charter traffic

Passengers[1] arriving and departing

	2000	2005	2010
Total airports	**34 426 801**	**30 860 051**	**39 009 046**
Zurich	22 450 494	17 877 978	22 854 358
Geneva	7 677 763	9 360 621	11 748 972
Basel-Mulhouse[2]	3 699 194	3 261 762	4 087 931
Bern-Belp	205 314	78 423	85 981
Lugano-Agno	286 507	181 453	159 497
Sion	8 760	4 843	3 912
St. Gallen-Altenrhein	98 769	94 971	68 395
	2015	**2018**	**2019**
Total airports	**49 392 700**	**57 554 795**	**58 561 919**
Zurich	26 251 507	31 069 873	31 478 748
Geneva	15 682 128	17 577 577	17 826 513
Basel-Mulhouse[2]	7 028 970	8 559 352	9 068 206
Bern-Belp	175 024	137 042	22 233
Lugano-Agno	156 435	88 570	56 201
Sion	6 660	8 782	2 381
St. Gallen-Altenrhein	91 976	113 599	107 637

[1] local and transfer passengers
[2] Swiss and French traffic

Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL) © FSO 2020

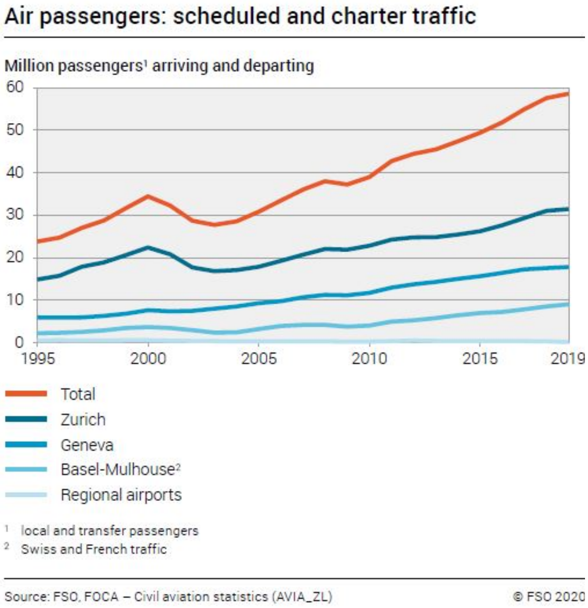


Figure 2.7.2 Total Passengers: Scheduled and Charter Traffic; Number of Passengers to Airport 2019

Dividing the total distance in kilometres travelled in a given period by the number of passengers results in the passenger-kilometres performed. In Figure 2.7.3 the passenger-kilometres for the years 2018 and 2019 and its change in Switzerland are shown.

Transport performance by airport

Incoming and outgoing scheduled and charter traffic

	Scheduled traffic: Passenger-km performed, in millions			Charter traffic: Passenger-km performed, in millions		
	2018	2019	Change	2018	2019	Change
Total	**106 978**	**111 475**	**+4%**	**1 156**	**940**	**–19%**
Zurich	76 426	79 743	+4%	483	379	–22%
Geneva	21 833	22 316	+2%	130	125	–4%
Basel-Mulhouse[1]	8 565	9 335	+9%	496	420	–15%
Bern-Belp	77	7	–91%	42	15	–64%
Lugano-Agno	8	5	–38%	0	0	0%
Sion	2	1	–50%	5	1	–80%
St. Gallen-Altenrhein	67	68	+1%	0	0	0%

[1] Swiss and French traffic

Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL) © FSO 2020

Figure 2.7.3 Passenger-kilometres performed; Scheduled and Charter Traffic 2019

Information from the tickets sold and from the airline companies gives data not only about the number of passengers at airports but also about the passengers' destination and departure point. In Figure 2.7.4 the main destinations of departing passengers for 2019 are shown. Some 77% are travelling from Switzerland to Europe, 10% to Asia, 7% to North America, 4% to Africa, 1.2% to South America and under 2% to Oceania and Central America.

Air passengers by continent of final destination, 2019

Passengers[1] in scheduled and charter traffic

	Europe	Africa	Asia	Oceania
Total airports	**22 920 452**	**1 082 036**	**2 915 945**	**133 794**
Zurich	11 006 945	563 408	2 194 540	114 366
Geneva	7 469 036	377 202	676 317	19 428
Basel-Mulhouse[2]	4 355 576	140 959	43 646	0
Bern-Belp	11 151	0	0	0
Lugano-Agno	22 076	467	1 441	0
Sion	1 204	0	1	0
St. Gallen-Altenrhein	54 464	0	0	0

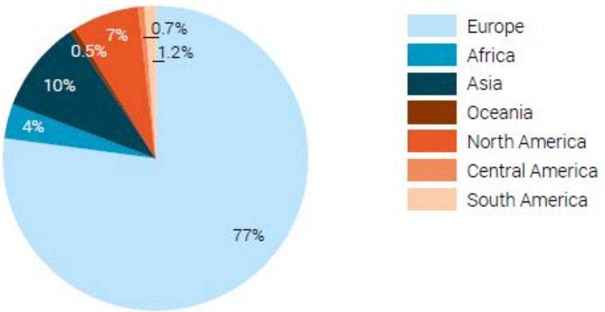
	North America	Central America	South America	Total all continents
Total airports	**2 085 531**	**196 460**	**351 254**	**29 685 472**
Zurich	1 627 617	167 848	280 781	15 955 505
Geneva	449 281	28 357	70 021	9 089 642
Basel-Mulhouse[2]	5 609	0	0	4 54[illegible]
Bern-Belp	0	0	0	1[illegible]
Lugano-Agno	3 024	255	452	27 715
Sion	0	0	0	1 205
St. Gallen-Altenrhein	0	0	0	54 464

[1] local and transfer passengers
[2] Swiss and French traffic

Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL) © FSO 2020

Air passengers by continent of final destination, 2019

Local and transfer passengers in scheduled and charter traffic



Total: 29.7 million passengers

Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL) © FSO 2020

Figure 2.7.4 Destinations of Departing Passengers: Scheduled and Charter Traffic 2019; Passenger traffic flows by continent or destination, 2019

III Historical Emissions and Forecast

3.1 Historical Emissions

Switzerland submits annually the fuel consumption and gaseous emissions under the UNFCCC on GHG emissions and removals[17].

The emissions of civil aviation are modelled by a Tier 3a method developed by FOCA. The Tier 3a method follows standard modelling procedures at the level of single movements based on detailed movement statistics. The primary key for all calculations is the aircraft tail number, which allows calculation at the most precise level, namely on the level of the individual aircraft and engine type. Every aircraft is linked to the FOCA engine-data base containing emission factors for more than 600 individual engines with different power settings. Emissions in the landing and take-off cycle (LTO) are calculated with aircraft category-dependent flight times and corresponding power settings. Cruise emissions are calculated based on the individual aircraft type and the trip distance for every flight.

The movement database from Swiss airports contains departure and destination airport. With this information, all flights from and to Swiss airports are separated into domestic (national) and international flights prior to the emission calculation.

The emission factors used are either country-specific or taken from the ICAO engine emissions databank, from EMEP/CORINAIR databases (EMEP/EEA 2019), Swedish Defence Research Agency (FOI) and Swiss FOCA measurements (precursors). Cruise emission factors are generally calculated from the values of the ICAO engine emissions databank, adjusted to cruise conditions by using the Boeing Fuel Flow Method 2. For N_2O, the IPCC default emission factor is used.

Since 2015, the statistics allowed to assign the individual helicopters to the helicopter companies. All emissions from helicopter flights without using an official airport or an official airfield are considered domestic emissions. These emissions are calculated based on operating time and not on number of movements. This allows a more precise estimation of fuel burn of helicopters.

Also in the year 2015 FOCA included a model to estimate Particulate Matter emissions from aircraft engines (Black Carbon and PM2.5/PM10).

[17] FOEN 2021: Swiss Climate Reporting under the UNFCCC 1990-2019

Fuel consumption and gaseous emissions of civil aviation

Including general aviation

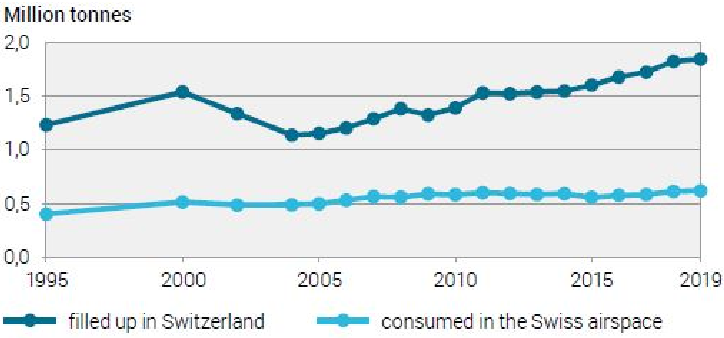
	2000	2010	2018	2019
Fuel consumption, in tonnes				
filled up in Switzerland	1 540 307	1 390 824	1 823 917	1 846 453
consumed in the Swiss airspace	513 678	580 808	612 230	619 179
Gaseous emissions, in tonnes[1]				
CO_2	4 851 967	4 377 758	5 736 147	5 807 021
NO_x	18 470	17 635	28 076	28 368
CO	8 782	6 701	6 511	6 449
HC	905	734	812	810
BC	...	...	34	32
PM	...	...	46	44

[1] International and domestic flights. The calculation is based on the fuel quantity actually filled up in Switzerland.

Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL) © FSO 2020

Fuel consumption of civil aviation

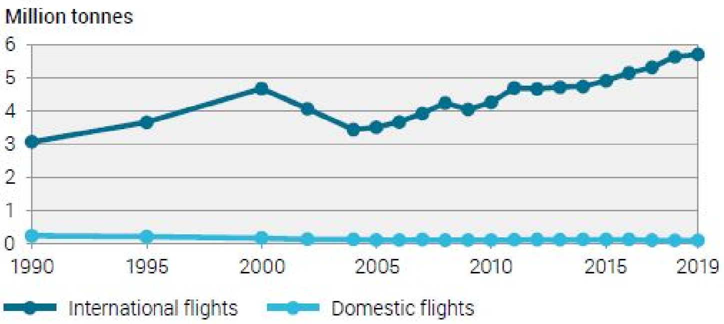
Including general aviation



Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL) © FSO 2020

CO_2 emissions of civil aviation

Including general aviation



Source: FSO, FOCA – Civil aviation statistics (AVIA_ZL) © FSO 2020

Figure 3.1.1 Fuel Consumption and Gaseous Emissions 2019

Activity data are derived from detailed movement statistics. The statistical basis has been extended after 1996, thus the modelling details are not exactly the same for the years 1990-1995 as for the subsequent years. The source for the 1990 and 1995 modelling is the movement statistics, which record information for every movement on airline, number of seats, Swiss airport, arrival/departure, origin / destination, number of passengers, distance. From 1996 onwards, every movement in the FOCA statistics also contains the individual aircraft tail number (aircraft registration). This is the key variable to connect airport data and aircraft data. The statistics may contain more than one million records with individual tail numbers. All annual aircraft movements recorded are split into domestic and international flights.

Fuel Consumption and Gaseous Emissions of Swiss Civil Aviation

	Traffic	Fuel consumption [t]	Combustion products		Pollutants						
			CO_2 [t]	H_2O [t]	SO_2 [t]	Pb [t]	NOx [t]	VOC [t]	CO [t]	BC [t]	PM [t]
2008	International	1 345 209	4 234 179	1 654 607	1 345	0.5	17 221	662	4 148		
	Domestic	37 627	118 434	46 281	33	3.8	431	127	2 715		
	Total	1 382 835	4 352 613	1 700 887	1 378	4.3	17 653	789	6 863		
2009	International	1 284 598	4 043 401	1 580 056	1 284	0.5	15 761	636	3 979		
	Domestic	39 626	124 726	48 740	35	3.9	478	125	2 707		
	Total	1 324 224	4 168 127	1 628 796	1 319	4.4	16 239	761	6 685		
2010	International	1 351 572	4 254 208	1 662 434	1 351	0.5	17 153	606	4 101		
	Domestic	39 252	123 550	48 280	34	3.9	481	128	2 601		
	Total	1 390 824	4 377 758	1 710 714	1 386	4.3	17 635	734	6 701		
2011	International	1 489 758	4 689 509	1 832 403	1 489	0.5	18 883	685	4 544		
	Domestic	42 047	132 374	51 717	37	4.1	516	126	2 803		
	Total	1 531 805	4 821 884	1 884 120	1 526	4.6	19 399	811	7 347		
2012	International	1 479 702	4 657 856	1 820 034	1 479	0.4	19 061	687	4 546		
	Domestic	43 414	136 678	53 406	39	3.7	534	119	2 550		
	Total	1 523 116	4 794 534	1 873 441	1 518	4.1	19 595	806	7 097		
2013	International	1 497 899	4 710 831	1 842 415	1 498	0.4	19 389	700	4 501		
	Domestic	42 064	132 291	51 739	38	3.5	511	105	2 419		
	Total	1 539 963	4 843 122	1 894 154	1 535	3.8	19 900	805	6 921		
2014	International	1 504 767	4 732 431	1 850 863	1 505	0.4	19 381	694	4 467		
	Domestic	44 462	139 831	54 688	40	3.5	533	113	2 497		
	Total	1 549 228	4 872 262	1 905 551	1 545	4.0	19 913	807	6 964		
2015	International	1 558 639	4 901 856	1 917 125	1 561	0.4	20 730	715	4 664	29	39
	Domestic	43 680	137 373	53 727	41	2.1	498	120	2 145	5	7
	Total	1 602 319	5 039 229	1 970 852	1 602	2.6	21 228	835	6 809	34	47
2016	International	1 634 318	5 139 864	2 010 211	1 637	0.3	23 039	704	4 694	28	39
	Domestic	44 716	140 629	55 000	42	2.0	560	103	1 772	5	7
	Total	1 679 034	5 280 493	2 065 211	1 679	2.3	23 599	807	6 466	33	46
2017	International	1 685 732	5 301 560	2 073 450	1 689	0.3	25 309	690	4 746	29	40
	Domestic	37 985	119 461	46 721	35	2.1	441	105	1 720	4	6
	Total	1 723 717	5 421 021	2 120 172	1 724	2.4	25 751	795	6 466	33	46
2018	International	1 787 356	5 621 163	2 198 448	1 790	0.3	27 665	703	4 828	29	40
	Domestic	36 561	114 984	44 971	34	2.0	412	109	1 683	5	6
	Total	1 823 917	5 736 147	2 243 418	1 825	2.3	28 076	812	6 511	34	46
2019	International	1 810 097	5 692 681	2 226 419	1 813	0.3	27 979	701	4 798	27	38
	Domestic	36 357	114 340	44 719	34	1.9	389	109	1 651	5	6
	Total	1 846 453	5 807 021	2 271 137	1 847	2.2	28 368	810	6 449	32	44

From 2013 on the CO2 emission factor was changed.
Since 2015 particulate matter are modeled. BC means Black Carbon and PM is an approximation to PM2.5/PM10

Figure 3.1.2 Fuel Consumption and Gaseous Emissions of Swiss Civil Aviation 2019

3.2 Forecast

The most recent long-term development forecast for Swiss air traffic was published in 2015 (Intraplan 2015[18]). The results were included in the last update of the State Action Plan of Switzerland in 2018. Due to the unsure extent of impact of COVID-19 pandemic on the future international air traffic, no long-term development forecast for Switzerland was developed until June 2021. Instead a four-year forecast, based on data published by EUROCONTROL Performance Review Unit, is included for illustrative purpose in this action plan. Figure 3.2.1 shows the development of historic IFR movements in green and in different shades of blue three possible scenarios for future traffic.

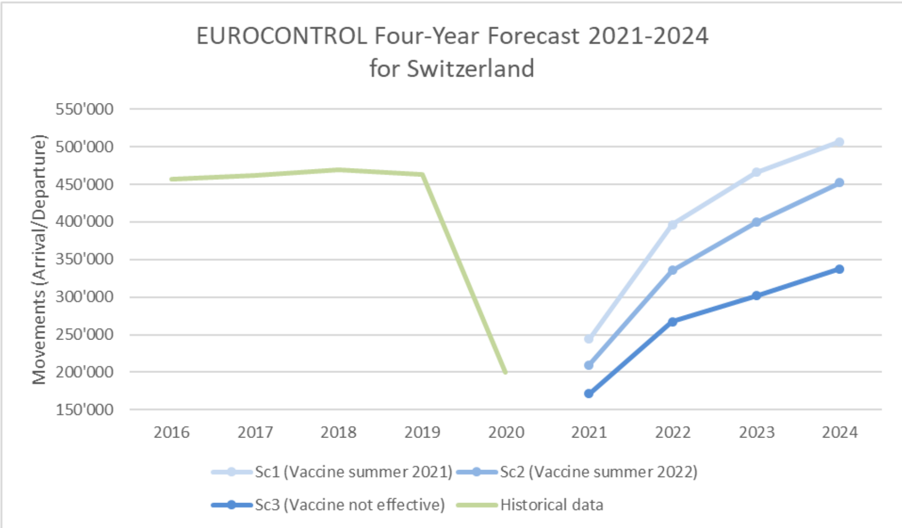


Figure 3.2.1 EUROCONTROL Four-Year Forecast[19]

For more details on the three scenarios see EUROCONTROL traffic forecasts[20]. The four-year forecast is not equal to a baseline scenario used in the context of the State Action Plan Initiative. Switzerland included no national baseline scenario in its action plan, as Switzerland's reference scenario without measures is reflected in the ECAC baseline scenario up to 2050 in section 4.1.

18 FOCA 2021: Entwicklung des Luftverkehrs in der Schweiz bis 2030 – Nachfrageprognose 2015

19 The information does not necessarily reflect the official views or policy of EUROCONTROL, which makes no warranty, either implied or expressed, for the information contained in this document, including its accuracy, completeness or usefulness.

20 https://ansperformance.eu/traffic/statfor/

IV ECAC Baseline Scenario and estimated Benefits of implemented Measures

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).

4.1 ECAC Baseline Scenario

4.1.1 Traffic Scenario “Regulated 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[21] 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[22]. It considers a moderate economic growth, with some regulation particularly regarding the social and economic demands.

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

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

[21] Challenges of Growth - Annex 1 - Flight Forecast to 2040, EUROCONTROL, September 2018.
[22] Prior to COVID-19 outbreak

Figure 4.1.1 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[23] (published in 2018 by EUROCONTROL). Historical data for the year 2019 are also shown later for reference.

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

Figure 4.1.1 Summary characteristics of EUROCONTROL scenarios

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

4.1.2 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[24] 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. Considering the most-likely scenarios of the long-term forecast and the medium-term forecasted version of the long-term flight forecast has been derived:

- Replace the long-term forecast horizon by the most recent medium-term forecast12 to account for COVID impact,
- Update the rest of the horizon (2025-2040) assuming that the original growth rates of the long-term forecast, would remain similar to those calculated pre COVID 19, and
- 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[25].

The method used relies on the calculation of adjustment factors at STATFOR[26] region-pair level and have been applied to the original long-term forecast11. 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 4.1.2 below shows the ECAC scenario of the passenger flight forecasted international departures for both historical (solid line) and future (dashed line) years.

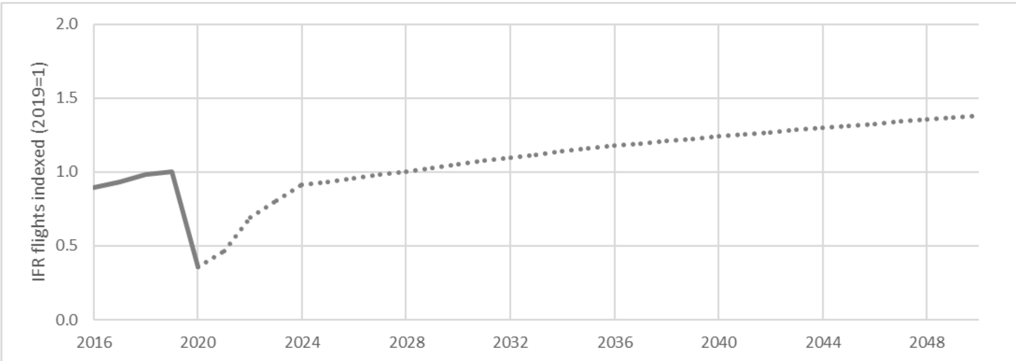


Figure 4.1.2. Updated EUROCONTROL “Regulation and Growth” scenario of the passenger flight forecast for ECAC international departures including the COVID-19 impact in 2020 and the following 4 years.

[24] Five-Year Forecast 2020-2024, IFR Movements, EUROCONTROL, November 2020.

[25] 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.

[26] 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

4.1.3 Further assumptions and results for the baseline scenario

The ECAC baseline scenario was generated by EUROCONTROL for all ECAC States. It covers all commercial international passenger flights departing[27] 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[28]). 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[29] data warehouse used by EUROCONTROL, including the actual flight distance and the cruise altitude by airport pair. These calculations were made for 99% of the passenger flights (the remaining flights had information missing in the flight plans). Determination of the fuel burn and CO_2 emissions for historical years is built up as the aggregation of fuel burn and emissions for each aircraft of the associated traffic sample characteristics. Fuel burn and CO_2 emission results consider each aircraft's fuel burn in its ground and airborne phases of flight and are obtained by use of the EUROCONTROL IMPACT environmental model, with the aircraft technology level of each year.

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

For each reported year, the revenue per passenger kilometre (RPK) calculations use the number of passengers carried for each airport pair multiplied by the great circle distance between the associated airports and expressed in kilometres. Because of the coverage of the passenger estimation 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 kilometres, 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.

[27] 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.

[28] 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.

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

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres[30] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[31] FTKT (billion)	Total Revenue Tonne Kilometres14,[32] 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

Figure 4.1.3 Baseline forecast for international traffic departing from ECAC airports

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

Figure 4.1.4 Fuel burn and CO_2 emissions forecast for the baseline scenario

30 Calculated on the basis of Great Circle Distance (GCD) between airports, for 97% of the passenger traffic for forecast years.
31 Includes passenger and freight transport (on all-cargo and passenger flights).
32 A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).

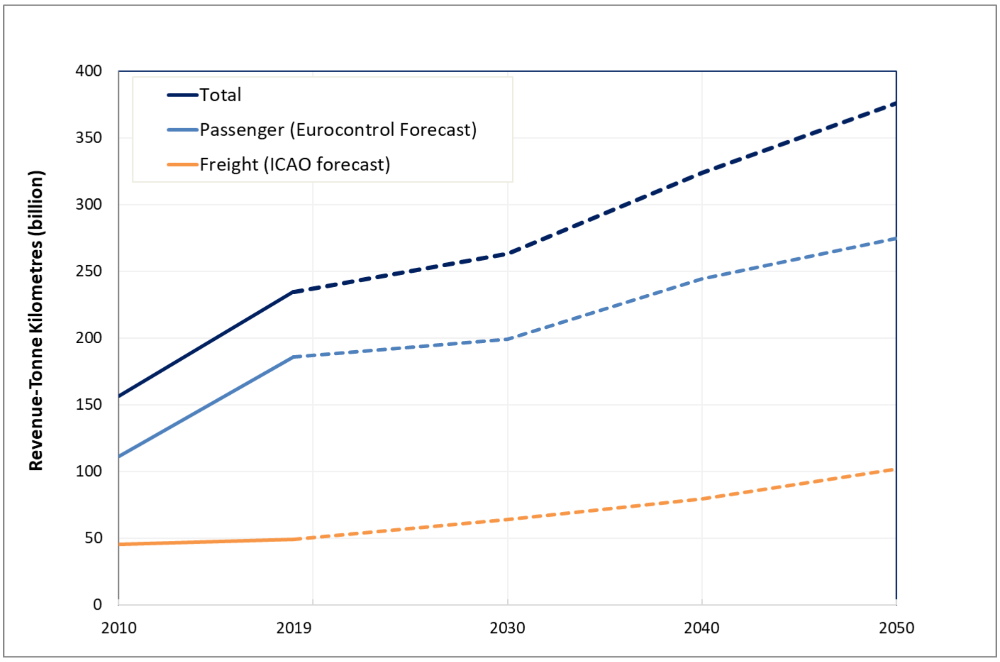


Figure 4.1.5 Forecasted traffic until 2050 (assumed both for the baseline and implemented measures scenarios).

The impact of the COVID-19 in 2020 is not fully reflected in Figure 4.1.5, as this representation is oversimplified through a straight line between 2019 and 2030. The same remark applies for Figure 4.1.6 and Figure 4.

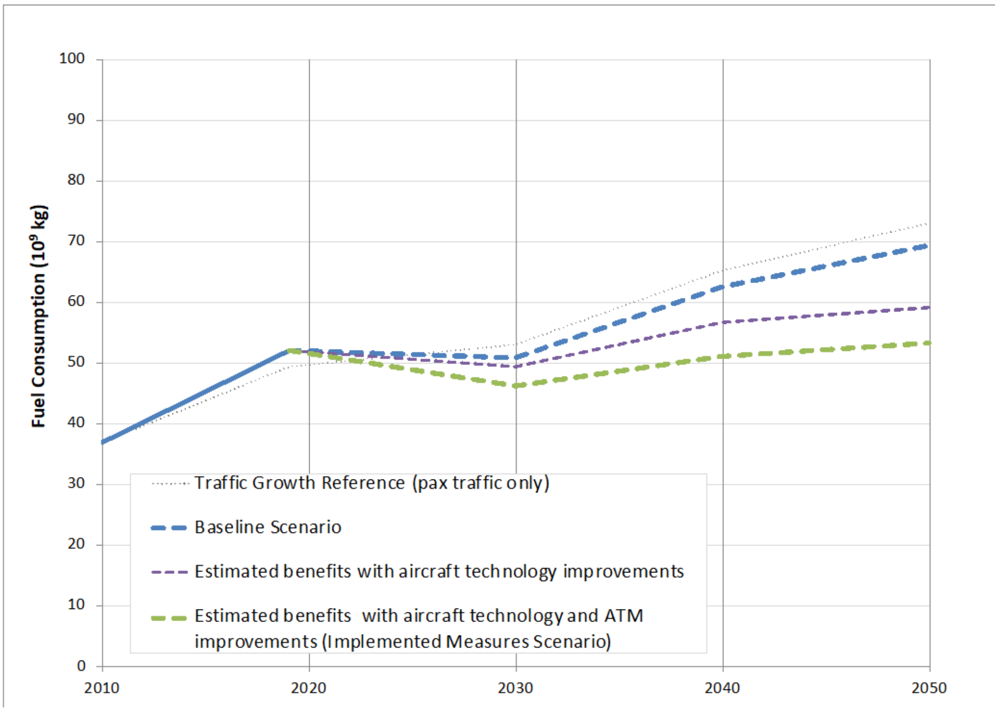


Figure 4.1.6 Fuel consumption forecast for the baseline and implemented measures scenarios (international passenger flights departing from ECAC airports)

4.2 ECAC Scenario with Implemented Measures, Estimated Benefits of Measures

In order to improve fuel efficiency and to reduce future air traffic emissions beyond the projections in the baseline scenario, ECAC States have taken further action. Assumptions for a top-down assessment of effects of mitigation actions are presented here, based on 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[33] (AAT) developed collaboratively by EUROCONTROL, EASA and the European Commission. The retirement process of the ATT is performed year by year, allowing the determination of the number of new aircraft required each year. In addition to the fleet rollover, a constant annual improvement of fuel efficiency of 1.16% per annum is assumed for each aircraft type with entry into service from 2020 onwards. This rate of improvement corresponds to the 'Advanced' fuel technology scenario used by CAEP to generate the fuel trends for the Assembly. This technology improvement modelling is applied to the years 2030 and 2040. For the year 2050, as the forecast traffic reuses exactly the fleet of the year 2040, the technological improvement is determined with the extrapolation of the fuel burn ratio between the baseline scenario and the technological improvement scenario results of the years 2030 to 2040.

The effects of improved ATM efficiency are captured in the Implemented Measures Scenario on the basis of efficiency analyses from the SESAR project. In SESAR, a value of 5'280 kg of fuel per flight for ECAC (including oceanic region) is used as a baseline[34]. Based on the information provided by the PAGAR 2019 document[35], and compared to a 2012 baseline, the benefits at the end of Wave 1 could be about 3% CO2/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 CO2/fuel savings (352.6 kg of fuel) to reach the initial Ambition target of about 10% CO2/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[36] 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[37], 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 5.2 and it is expected that future updates will include an assessment of its benefits as a collective measure.

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

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

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

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

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

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 4.2.1[38], 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.

Figure 4.2.1, Figure 4.2.2, Figure 4.2.3 and Figure 4.2.4 summarize the results for the scenario with implemented measures. It should be noted that Figure 4.2.1 shows direct combustion emissions of CO_2 (assuming 3.16 kg CO_2 per kg fuel). More detailed tabulated results are found in Appendix C, including results expressed in equivalent CO_2 emissions on a well-to-wake basis (for comparison purposes of SAF benefits).

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Fuel efficiency (kg/RPK[39])	Fuel efficiency (kg/RTK)
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.				

Figure 4.2.1 Fuel burn and CO_2 emissions forecast for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)

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

Figure 4.2.2 Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)

38 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).

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

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

Figure 4.2.3 CO_2 emissions forecasts for the scenarios described in this chapter

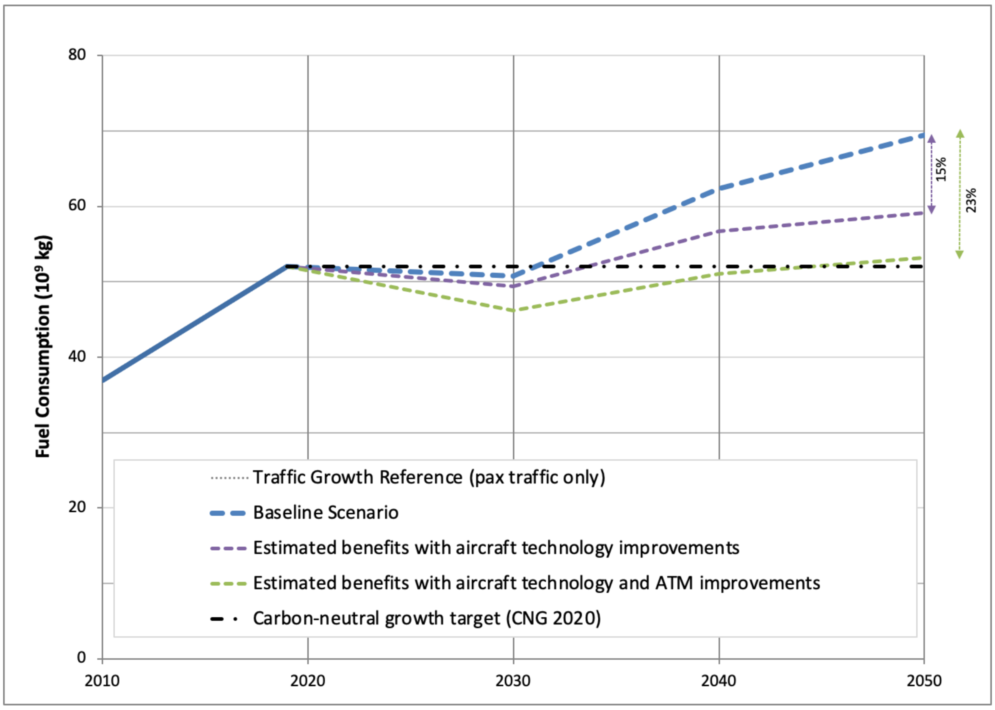

Figure 4.2.4 Fuel consumption forecast for the baseline and implemented measures scenarios

As shown in Figure 4.2.4, 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 Figure 4.2.1, under the currently assumed aircraft 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 slowdown 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.

V Actions taken collectively throughout Europe

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

The Directors General (DGCA) of ECAC agreed on a common language for the section with actions taken collectively throughout Europe[40]. This section includes this common language elaborated by the European Coordination Group APER TG (Action Plan Emission Reduction Task Group). Switzerland was closely involved in the process of writing the common section.

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

Some of these mitigating actions have domestic beginnings that stretch to international aviation whilst others are part of centralised cross-cutting funding such as through the EU Research Framework programmes. The aviation sector has also benefitted from large bespoke programmes such as the EU's Single European Sky ATM Research Initiative (SESAR).

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

The implementation of the measures of the European common section in Switzerland is dependent on political discussions and decisions. However it has to be noted that Switzerland is not a member of the EU and EEA, hence some of the measures are only limited pertinent for Switzerland.

Specific elements of the national contribution of Switzerland to the basket of measures are described in Section VI.

5.1 Technology and Standards

5.1.1 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.

[40] ECAC 2021: EC 9/8.20/6 – 0418 7th June 2021; ICAO States' Action Plans for CO_2 Emissions Reduction - 4th Edition of the ECAC/EU guidelines including a common section to be incorporated into all European action plans

5.1.2 Research and development

Clean Sky[41] 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 by 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 key new mobility solutions.
- Eco-Design: coordinating research geared towards high eco-compliance in air vehicles over their product life and heightening the stewardship with intelligent Re-use, Recycling and advanced services.

In addition, the Clean Sky Technology Evaluator[42] 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).

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)[43] will follow in the footsteps of CleanSky2. The EU contribution proposed is again €1.7 billion. The stakeholder community has already formulated a Strategic

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

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

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

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.

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 4.1 above (ECAC Baseline Scenario and Estimated Benefits of Implemented Measures) and in Appendix C.

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.					

Figure 5.1.1 Fuel consumption and CO_2 emissions of international passenger traffic departing from ECAC airports, with aircraft technology improvements after 2019 included

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

Figure 5.1.2 Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology only)

5.2 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 CO2 reductions benefits. Nevertheless SAF has the additional benefit of reducing air pollutant emissions of non-volatile Particulate Matter (nvPM) with up to 90% and sulphur (SOX) with 100%, compared to fossil jet fuel[44]. As a result, the large-scale use of SAF can have important other non-CO2 benefits on the climate which are not specifically assessed within the scope of this Plan.

5.2.1 ReFuelEU Aviation Initiative

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

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

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

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.

5.2.2 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

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

the European Advanced Biofuels Flightpath, as there are still significant barriers for its large-scale deployment.

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

Sustainable Aviation Fuel 'Facilitation Initiative'

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

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

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

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

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

Sustainable Aviation Fuel 'Monitoring System'

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

The study followed five steps:

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

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

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

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

5.2.3 Standards and requirements for SAF

European Union standards applicable to SAF supply

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

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

Sustainability and life cycle emissions methodologies:

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

These can be found in RED´s[45] 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[46], 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.

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

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[45] Directive 2009/28/EC.

[46] 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 REFUNIO-BIO).

being used or planned to deploy and the methodology used for the life cycle analysis. It is therefore provided for information purposes only and no further assessment of its benefits in terms of reduction in aviation emissions is provided in this action plan common section.

5.2.4 Research and Development projects on SAF

European Advanced Biofuels Flightpath

An updated and renewed approach to the 2011 Biofuels FlightPath Initiative[47], 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[48].

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

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[49]: The "*Advanced Sustainable Biofuels for Aviation»* project plan to demonstrate the first large industrial-scale production and use of SAF in Europe obtained from residual lipids such as Used Cooking Oil.

The project will also investigate the supply of sustainable feedstocks produced from drought-resistant crops such as Camelina, grown on marginal land in EU Mediterranean areas. By adopting a combination of biochar and other soil amendments, it will be possible to increase the fertility of the soil and its resilience to climate change, while at the same time storing fixed carbon into the soil.

BIO4A will also test the use of SAF across the entire logistic chain at industrial scale and under market conditions, and it will finally assess the environmental and socio-economic sustainability performance of the whole value chain.

Started in May 2018, BIO4A will last until 2022, and it is carried out by a consortium of seven partners from five European countries.

KEROGREEN[50]: *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

[47] 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

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

[49] www.bio4a.eu

[50] www.kerogreen.eu

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[51]: *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[52]: The *Biofuels production from Syngas Fermentation for Aviation and maritime use* (BioSFerA) project, aims to validate a combined thermochemical - biochemical pathway to develop cost-effective interdisciplinary technology to produce sustainable aviation and maritime fuels. At the end of the project next generation aviation and maritime biofuels, completely derived from second generation biomass, will be produced and validated by industrial partners at pilot scale. The project will undertake a full value chain evaluation that will result in a final analysis to define a pathway for the market introduction of the project concept. Some crosscutting evaluations carried out on all tested and validated processes will complete the results of the project from an economic, environmental and social point of view.

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

BL2F[53:]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[54]: 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.

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51 www.flexjetproject.eu
52 https://biosfera-project.eu
53 https://www.bl2f.eu
54 https://cordis.europa.eu/project/id/857839

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[55]: 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.

5.3 Operational Improvements

5.3.1 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.

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

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 5.3.1 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 5.3.1 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[56] is planned to be completed by 2027. However, the benefits highlighted in Figure 5.3.21 below have been measured where the functionalities have already been implemented.

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

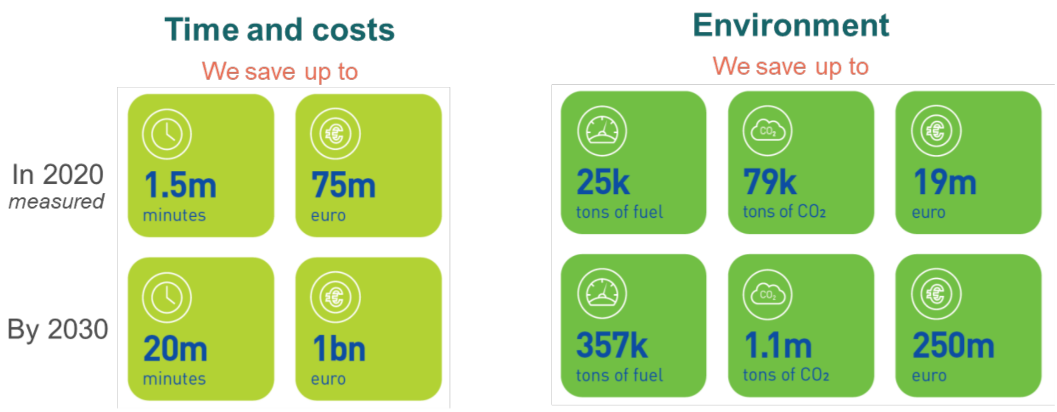

Figure 5.3.2 Performance Ambitions for 2035 for Controlled airspace (Source: European ATM Master Plan 2020 Edition).

SESAR Exploratory Research (V0 to V1)

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

SESAR Industrial Research & Validation Projects (environmental focus)

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

- The initial development by EUROCONTROL of the IMPACT[57] 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[58].

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

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

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

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

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

A catalogue of SESAR Solutions is available[59] and those addressing environment impacts are identified by the following pictogram:

SESAR2020 Industrial Research and Validation - Environmental Performance Assessment

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

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

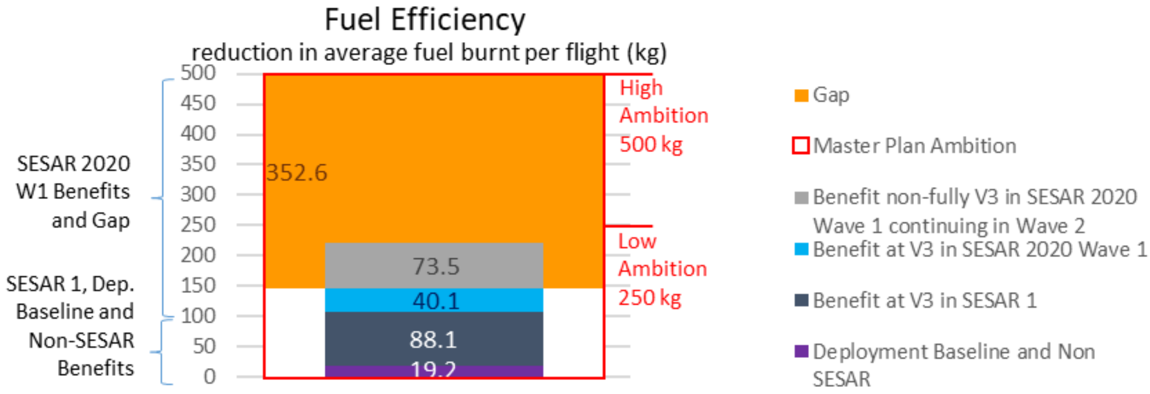

Figure 5.3.3 SESAR fuel efficiency achievement versus gap (Source: Updated version of PAGAR 2019)

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[60]. Based on the information provided by the PAGAR 2019 document[61], 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[62].

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

[59] https://www.sesarju.eu/news/sesar-solution-catalogue-third-edition-now-out
[60] See SESAR ATM Master Plan – Edition 2020 (www.atmmasterplan.eu) - eATM
[61] See SESAR Performance Assessment Gap Analysis Report (PAGAR) updated version of 2019 v00.01.04, 31-03-2021
[62] See SESAR Exploratory Research projects - https://www.sesarju.eu/exploratoryresearch

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

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

SESAR 2020 Very Large-Scale Demonstrations (VLDs)

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

SESAR JU has recently awarded ALBATROSS[64], 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.

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[65] 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 5.3.3 above and it is included in Section A above (ECAC Baseline Scenario and Estimated Benefits of Implemented Measures).

Year	**CO_2 emissions (10^9 kg)**	
	Baseline Scenario	**Implemented Measures Scenario**
		ATM improvements
2030	160.29	149.9
2040	197.13	177.4
2050	210.35	197.4
For reasons of data availability, results shown in this table do not include cargo/freight traffic.		

Figure 5.3.4 CO_2 emissions forecast for the ATM improvements scenarios.

[63]AIRE – Atlantic Interoperability Initiative to Reduce Emissions
[64] https://www.sesarju.eu/projects/ALBATROSS
[65] https://www.sesarju.eu/node/3697

5.4 Market-Based Measures

5.4.1 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.

Development and update of ICAO CORSIA standards

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

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

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

CORSIA implementation

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

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

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

5.4.2 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[66] 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%[67], and will be revised to be aligned with the latest Conclusions in December 2020[68], prescribing at least 55% domestic reduction (without using international credits) of greenhouse gases compared to 1990.

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

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

The legislation to include aviation in the EU ETS was adopted in 2008 by the European Parliament and the Council[69].

Following the 2013 ICAO agreement on developing CORSIA, the EU decided[70] 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[71].

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,

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

67 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

68 1011-12-20-euco-conclusions-en.pdf (europa.eu)

69 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

70 Decision No. 377/2013/EU derogating temporarily from Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community

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 reporting and verification rules through a delegated act under the EU ETS Directive of July 2019[72]. 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"[73].

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

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

Impact on fuel consumption and/or CO_2 emissions

The EU ETS has delivered around 200 MT of CO_2 emission reductions between 2013 and 2020[75]. 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[76].

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 billion 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.

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[72] 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

[73] 2021_commission_work_programme_new_policy_objectives_factsheet_en.pdf (europa.eu)

[74] 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.

[75] 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

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

ASSESSMENT: A quantitative assessment of the EU Emissions Trading System benefits based on the current scope (intra-European flights) is shown in Figure 5.4.1. Those benefits illustrate past achievements.

Year	*Reduction in CO_2 emissions*
2013-2020	*~200 MT*[77]

Figure 5.4.1 Summary of estimated EU-ETS emission reductions.

5.5 Additional Measures

5.5.1 ACI Airport Carbon Accreditation

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

Figure 5.6.1 Airport Carbon Accreditation

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[78].

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[77] 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

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

The six steps of the programme are shown in Figure 5.6.2 and are as follows: Level 1 "Mapping", Level 2 "Reduction", Level 3 "Optimisation", Level 3+ "Neutrality", Level 4 "Transformation" and Level 4+ "Transition".

Figure 5.6.2 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-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. For historical reasons European airports remain at the forefront of airport actions to voluntarily mitigate and reduce their impact on climate change. The strong growth momentum is still being maintained as there are 167 airports in the programme. These airports account for 69.7% of European air passenger traffic.

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

Figure 5.6.3 Emissions reduction highlights for the European region

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

Figure 5.6.4 Emissions offset for the European region

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

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

Figure 5.6.5 *Airport Carbon Accreditation* key performance indicators 2018/2019

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

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

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

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

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

Figure 5.6.6 *Destination 2050*

The Destination 2050[79] 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[80]. 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

[79] www.destination2050.eu

[80] 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.

pathway for the decarbonisation of aviation.

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

5.5.3 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.

5.5.4 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.

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[81] 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

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

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.

ICAO - European Union Assistance Project

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

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

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

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

Four pilot mitigation measures and five feasibility studies were executed with project funding in the beneficiary States. In addition to those, the beneficiary States implemented 90 mitigation measures within the project timeframe, which had been included in their action plans[82].

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.

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[82] https://www.icao.int/environmental-protection/Documents/ICAO-EU_Project_FinalReport.pdf

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.

5.5.5 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.

5.6 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.

5.6.1 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.

5.6.2 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[83].

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

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

5.6.3 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[84]: 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.

5.6.4 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

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

84 https://aviatorproject.eu

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.

5.6.5 Green Airports research and innovation projects

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

Circular Economy:

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

Biodiversity:

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

Non-CO_2 impacts:

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

VI National Measures

FOCA organised in February 2012 an event for aerodromes, air traffic control and aviation industry stakeholders. The aim of this event was to inform all relevant parties in the Swiss aviation system about the ICAO action plan and to evaluate possible measures to reduce CO_2 emissions undertaken by these stakeholders. For the update of the Swiss Action Plan in 2015, 2018 and 2021 FOCA contacted the relevant stakeholder directly and as the Action Plan was already known as an important instrument to show the effort Swiss stakeholder are undertaking, the submitted national measures were numerous.

Most of those measures are done on a voluntary basis to optimise operations and business in general. If a measure is part of a supra-national measure, the emissions reduction are taken into account at the supra-national level. Nonetheless as the contribution of Swiss stakeholder is essential to the measure, it will be described detailed in the national section.

All these measures are summarised in section VI. Where possible calculations were done of the estimated achievable reduction in CO_2 emissions. It is rather difficult to eliminate double counting. Wherever possible, double counting has been tried to be avoided.

It should also be noted, that most of the estimated achievable reductions are based on 2019 data and the results achieved in 2020 were much lower due to the impact of COVID-19 on international traffic.

6.1 Technology and Standards

6.1.1 Purchase of new aircraft

The substitution of existing engines with more fuel efficient engines reduces mainly the fuel flow and with that the CO_2 emissions of the aircraft of the respective operators. A measure taken by Swiss operators in conjunction with the goal to increase fuel efficiency and hence to reduce their CO_2 emissions is to partly renew their fleet.

SWISS Int. Air Lines replaced its Avro RJ100 short-haul aircraft fleet with the new Airbus A220 from 2016 to 2021. Through new technology (e.g. engines and light construction materials) the new jets consume about 22% less fuel than their predecessors, which results in a net saving of approximately 125’000 tonnes of kerosene. With its state-of-the-art power plant (Pratt & Whitney PW1524G) as well as its system and material technologies, SWISS’s Airbus A220 sets benchmarks in terms of its operating economics and its environmental credentials. Current fleet: 9 A220-100, 21 A220-300. In addition to that SWISS Int. Air Lines complemented its long-haul fleet with 12 Boeing 777-300ER from 2016 to 2020. Through new technology the new jets consume about 20% less fuel per passenger in comparison to A340 operations. Following the commissioning of the two new aircraft, the SWISS long-haul fleet will comprise a total of 12 Boeing 777-300ERs, five Airbus A340-300s and 14 Airbus A330-300s. As from 2020 SWISS Int. Air Lines started to replace its Airbus A320 fleet with A320neos. The Airbus A320neo offers significant environmental performance improvement with substantially less CO_2 emissions and nearly 50% reduction in noise footprint compared to previous generation aircraft. SWISS has chosen the PW1100G Geared Turbofan (GTF) engine to power its Airbus A320neo and A321neo aircraft. Current fleet: 3 A320neo and 2 A321neo.

EasyJet invests in a modern and efficient fleet. All new fleet purchases will be NEO variants.

The introduction of new aircraft with more efficient engines can lead to reductions in CO_2 emission; however the seating capacity will usually be increased as well and the reduction effect will be nullified.

6.1.2 Retrofitting and upgrade improvements on existing aircraft

Airline operators install winglets or sharklets on the wing of their aircraft, which reduces the CO_2 emissions approximately from 2 to 3.4 %.

6.1.3 Adoption of revolutionary new designs in aircraft/engines

EasyJet collaborates on all electric aircraft with Wright Electric and in a strategic partnership with Airbus in their ambition to develop a zero-emissions commercial aircraft by 2035. An estimation of the potential of CO_2 emission reduction is not possible at this investigative stage of the project.

6.2 Sustainable Aviation Fuels

Sustainable Aviation Fuels are the most promising alternative to decisively and sustainably reduce greenhouse gas emissions from aviation. This is stated in the Swiss long-term climate strategy, for which the FOCA was commissioned to draw up a "Strategy for the development, promotion and use of sustainable aviation fuels" as part of the Action Plan 2021-23 of the "Sustainable Development Strategy 2030". In the short term, only SAF produced from biomass are available on the market in significant quantities. A distinction must be made here between biofuels made from waste materials and those produced from purpose-grown biomass. Fuels made from biogenic waste materials are limited by the availability of raw materials, while purpose-grown biomass is limited by its social and environmental impact. The Swiss legislation on the taxation of mineral oils provides for a tax exemption of biofuels used for domestic purposes if these biofuels fulfil certain sustainability related criteria (Biofuels Life Cycle Assessment Ordinance[85]). The current tax relief provisions are limited by law until 31th December 2023.

Zurich Airport has successfully enabled a demonstrator project in early 2020 with the delivery of a biogenic SAF-blend to Zurich Airport. In the context of the World Economic Forum's Annual Meeting, Zurich Airport and an FBO have delivered a 36%-SAF-blend for use in business jets. The reduction achieved by this demonstrator project was 115 t of CO_2 in 2020. Based on the project, Zurich Airport has continued to develop and build the standard-regular import and delivery process for SAF into Switzerland.

However, in the long term, synthetic fuels from renewable sources have the highest potential for CO_2 emission reduction, as their production is not entailing high environmental impacts such as e.g. excessive use of land resources.

6.3 Operational improvements

6.3.1 More efficient use and planning of airport capacities

Working within the SESAR framework, SWISS, Skyguide and Zurich Airport have developed an innovative approach procedure that significantly reduces CO_2 emissions. First started under the name "Greener Wave" [86], and continued as "iStream" [87], the Very Large Scale Demonstration Project xStream started in 2018 and developed further the concept and implemented it on a durable way. Like many other airports around the world, Zurich Airport is closed during the night. The first aircraft to arrive in the morning is permitted to land as of 6.04 a.m. The long-haul flights on approach to Zurich have historically done so on a first come, first served basis, which is the standard, so far uncontested, procedure at airports around the world. The result, however, is often a backlog of flights in the early morning sky over Zurich – which entails unnecessary noise and CO2 emissions. To tackle this problem, SWISS has introduced an alternative approach system coordinated by all partners whereby a specific time slot is assigned for arrival at Zurich Airport. This means that every SWISS aircraft involved in the first wave of arrivals between 6.10 and 6.30 a.m. is assigned a Tactical Time of Arrival (TTA) in the form of a one-minute arrival time window. This new method allows pilots to modify the flight in accordance with operational conditions – by timing their moment of take-off and adjusting the speed of the flight. By flying at a slower speed and scheduling their arrival to avoid being backlogged on arrival and subsequently having to fly a holding pattern ahead of landing, the cockpit crew can reduce CO_2-emissions substantially. xStream also included the short-haul flights by applying Mandatory

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85 SR 641.611.21 DETEC Ordinance on Proof of the Positive Aggregate Environmental Impact of Fuels from Renewable Feedstocks, 15th June 2016

86 SWISS Int. Air Lines 2021: Greener Wave; https://youtu.be/br5bJ-KSi0o

87 SWISS 2016: https://www.swiss.com/corporate/en/media/newsroom/press-releases/media-release-20160930

Cherry Picking (MCP) measures. By further developing the advanced research and calculations done by SWISS, and enhancing the coordination between the stakeholders, xStream further reduced the CO_2 emissions. By also participating to the E-AMAN (Extended Arrival Management) in Zürich, London, Paris and Frankfurt, SWISS contributes to an even better coordination of the flights. Thus a reduction of vectoring and holdings for short-haul flights, improved ETFMS flight profile accuracy and greater adherence of short-haul to the arrival landing sequence can be achieved. Thanks to the new processes, arrival routes during the specific wave are reduced by 30 percent, holdings minimized by 95 percent. xStream reduces approximately 1’800 t of CO_2 per year for the SWISS arrivals in the first wave. This project was honoured with the Overall Excellence in ATM Award (2019) and ATM Awards 2019 in the ‘Environment’ category.

The First Rotation hours Optimisation Trial (FROT) started in 2017 with the following objective: Allowing SWISS to cherry-pick two of its most important arrival flights into Zurich and get them with fixed on-time arrival (against the schedule) into Zurich regulation, to ensure critical passenger connections are made, reduce the workload in the airport and airline operations and consequently avoid reactionary delay on the following departure wave. This will then benefit the entire system, under the condition that no negative impact (through an increase of ATFM delay) should be observed for other carriers. Moreover, it would enhance the stability of the network at Zurich airport and therefore allow better predictability at the hub (for the airport, ATC, other airlines flying to and from Zurich and the entire network). During the trial SWISS committed to keeping the flight plan EOBT aligned with the tactical operational situation by actively updating the flight plans in case of reactionary delay. FROT showed the interdependencies of the network performance between an airline’s hub operations and the impact on the performance of all stakeholders of this hub, by allowing a passenger centric approach in airline decision making. It also proved the need of a multi-criteria based decision making to allow the best decision making at any given time. FROT enables a reduction of CO_2 emissions by avoiding critical flights for operations flying high speed to recover from the delay occurred by ATFM regulation. The estimated CO_2 reduction is about 50 t per year. Due to the pandemic situation the measure is on hold at the moment and a restart is under discussion.

Optimising fuelling places: During the winter season a Swiss company optimises the fuelling places in order to avoid unnecessary flights for refuel (manly for rescue missions).

6.3.2 More efficient ATM planning, ground operations, terminal operations (departure, approach and arrivals), en-route operations, airspace design and usage, aircraft capabilities.

Almost all of the measures concerning airspace are embedded in the wider context of projects such as FABEC and SESAR. Therefore, estimates of CO_2 reduction are calculated on an international level and estimations on a regional level might thus be difficult. Nonetheless examples mostly implemented by Skyguide shall be listed under this chapter, but without an estimation of emissions reduction.

Taxi-time reduction: A Collaborative Decision Making between all airport stakeholders allows an efficiency gain in term of departure sequencing, taxi time and waiting time to access the runway.

Implement Free Route Airspace (FRA) in Upper Sectors: Free Route Airspace (FRA) is a specified airspace within which users may freely plan a route between a defined entry point and a defined exit point, with the possibility to route via intermediate (published or unpublished) waypoints, without reference to the ATS route network, subject to airspace availability. Within this airspace, flights remain subject to air traffic control. The FRA concept brings significant flight efficiency benefits and a choice of user preferred routes to airspace users. As a step to full trajectory-based operations the FRA concept brings increased flight predictability, reduced uncertainty for the Network which in turn can lead to potential capacity increases for ATM which will also benefit the user. Skyguide implemented its first Direct Routes (DCTs) in December 2015, adding up to 50 DCTs in March 2017, and another DCT package in November 2017.

AMAN Extended to en-route airspace: Arrival management (AMAN) extended to en-route airspace extends the AMAN horizon from the 100-120 nautical miles to at least 180-200 nautical miles from the arrival airport. Arrival sequencing may be anticipated during en-route and early descent phases. Air traffic control (ATC) services in the TMAs implementing AMAN operations shall coordinate with air traffic services (ATS) units responsible for adjacent en-route sectors.

Extended Arrival Manager (XMAN): The arrival management of Zurich Airport will be extended to en-route horizon (>200NM). In order to reduce holdings in TMA, pilots are instructed to adjust speed during the cruise phase. The implementation of the XMAN is part of the regulation (EU) 716/2014, making binding this ATM functionality for Switzerland. This project will start in 2019 and end in 2024.

ATFCM (Air Traffic Flow and Capacity Management) Optimisation Tool Environment – AOTE: The efficiency in the European traffic flow depends on the capacities provided by the various ACCs and the airspace availability. With the AOTE, the deployment planning of the air traffic controllers and the sector opening times are coordinated with the expected traffic load per air contorl center (ACC). The improved provision of needs-based capacities also enables the flights to be carried out more efficiently. In this way, more direct routes can be planned and flown at more economical flight altitudes. ATFCM functionality between Geneva and Zürich ACC, analysis of flow according to line of action and adaptation for higher coordinated exit points, for better flight efficiency.

iLVP (low visibility procedures) in Geneva new sensitive area LOC22 catII/III: The new ILS require less wide sensitive protection zones. This means that the minimum distances between the approaches can be reduced from 6 to 5.5 NM in bad weather conditions.

LORD - Leading Optimised Runway Delivery Tool: Support system for air traffic controllers to create the optimal minimum distances between the approaching aircraft. In case of high demand, holding time is reduced.

LARA CIV-MIL airspace management tool: More flexible and precise allocation and deallocation of airspace using smaller increments in time and space give rise to increase in network and flight efficiency. Simultaneous activation and deactivation of airspaces in all equipment (CIV+MIL) enhance this effect. Airspace and Routes can be managed more flexibly and dynamically and allows direct and shorter routes more frequently and allow airlines to plan the route with less fuel.

Nocturne (flight priority): With the knowledge of the priority of a flight and the integration of the priority of these flights into the handling procedure of air traffic controllers or the airport handlers, holdings and high speed flights can be avoided. The identification of the operational priority of a flight is therefore key and a challenge at the same time. Nocturne aims to tackle exactly this challenge by proposing an advanced system based on Operations Research techniques to identify the priority and communicate it to the handling partners and to ATC.

Redesign TMA Zurich: In 2018, the FOCA initiated a redesign of Zurich airspace at the request of FZAG, Skyguide and Swiss. The basic design incorporates the results of the broad-based stakeholder involvement and the current requirements of the Swiss Air Force for the Dübendorf military airfield. It serves as a basis for further work such as safety assessments and for smoothing the CTR and TMA delineations in order to facilitate navigability in VFR traffic[88].

AVISTRAT[89]: In 2016 FOCA started the project AVISTRAT-CH. The aim of this project is to redesign the Swiss airspace in order to reduce risk and gain efficiency. In close collaboration with the Swiss Stakeholders, FOCA developed a vision in 2019, now the project to develop an implementation strategy based on the vision is underway.

6.3.3 Best practices in operations

An airline operator is currently replacing its flight planning system with Sabre FPM. This system applies the latest technology to plan flight operations, therefore significantly reducing carbon emissions. It allows an optimization of the entire flight planning process. This action reduces by its full roll-out in 2017 up to estimated 40 000 t CO_2 per year.

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[88] FOCA 2021: Redesign TMA Zurich

[89] FOCA 2021: AVISRAT-CH

Another new software (SOCRATES) is implemented by a Swiss airline operator in order to collect and analyse fuel relevant data, which origins from different sources. This tool is state-of-the-art software that uses the latest technology in order to spot patterns in fuel usage. Thanks to SOCRATES SWISS continuously develops new pilot tools to further minimize its fuel consumption. Currently this operator is working on a new electronic navigation card displaying historic flight path for specific routes so that pilots know the shortest and most efficient flight route and can actively ask ATC to allocate the specific route. Full implementation will reveal opportunities reducing more than 4000 t CO_2 per year.

The majority of airline operators uses a Cost Index for flight Planning. An airline uses in cases where flight time permits though, a reduced, so called ECON Cost Index (CI). This reduces the overall Mission Costs as well as the trip fuel required. Furthermore, Crews can reduce from Standard to ECON CI inflight when an on-time arrival is still granted. Further research to optimise the speed policy has been made. As an outcome, the simple rule of “only fly high speed when it makes sense” was derived. The simplicity of this approach allowed a further optimisation of flight processes. This measure started in 2013 reduces the CO_2 emissions about 5 500 t per year. In the context of a master thesis SWISS has elaborated a new Cost Index Strategy for its long-haul flight tacking. This new strategy is implemented as a Minimum Viable Product and in operation since 2019 (freeze in 2020 due to the pandemic). The solution takes the needs of the passengers at a specific destination (optimizing connection and ground time) and the needs of our operation (crew, ground time, rotation time) into account. All relevant factors and possibilities are provided to the dispatcher (routes/flight time/fuel Consumption/Cost Index estimation). On the ground of the data provided our dispatchers are able to quickly choose the adequate route and Cost index for each flight. In 2019 SWISS could confirm the CO2 saving estimated during the master thesis. During the full roll-out in 2019 the initiative up to 4 800 t CO_2 per year.

Airline operators are continuously optimizing the interior of their aircraft in terms of weight gain. A weight reduction can be achieved by installing lighter materials such as new seats, lighter freight / baggage containers or lighter on-board equipment. Calculations of CO_2 reduction due to weight gain were carried out by some Swiss operators. As an example they have reduced the numbers of blankets carried along, reduced the weight of the technical flight kits, reduced waste carried on board, and replaced heavy print-out manuals with lighter iPads. These initiatives only lead to small reduction of carbon emissions; however, taken together these initiatives reduce about 1600 t CO_2 emissions.

If applicable, some airline operators reduce thrust and accelerate on lower altitude after take-off. One operator calculated a possible CO_2 reduction of 2 100 t. The procedure is not applied at all airports due to regulatory constraints.

Airline operators encourage their pilots where possible to proceed single-engine taxiing, which reduces an estimated amount of 1600 to 1700 t of CO_2. Another airline operator estimated an additional benefit of 112 t CO_2 per year.

In accordance with official Airbus Green Operating Procedures, some airline operator uses only one Air Conditioning Pack per aircraft during taxi time. This measure reduces an estimated 800 t of CO_2 per year. A calculation by another airline operator resulted an additional saving of approximately 90 t CO_2 emissions.

Further technical and operational measures implemented by airline operators are flap 3 as landing flap setting (saves approximately 40 t CO_2), idle reverse after landing (saves approximately 135 t CO_2), no unnecessary use of APU on ground, defined climb speed range, optimum flight level selection for cruise, reduction of cruise power by 12 % when landing is expected to be ahead of schedule, by air traffic control permitted defined decent angle, vertical speed between 2000 and 25000 ft/min.

GODWIT - Mission Support is a specialised department within SWISS (introduced in Spring 2016) which gives the airborne Crews assistance from the ground. Mission Support continuously tracks the positions of all the aircrafts and has all the relevant operational data at its disposal, such as the latest meteorological data, satellite images, NOTAMs and similar. By providing enhanced inflight steering, SWISS is able to improve the stability and the efficiency of its overall network. The specialist department further allows to save fuel by optimizing the individual flights. Estimated annual CO_2 savings are around 32 000 t.

PLATON is an interactive OPS efficiency briefing tool for pilots that presents historical flight data – on fuel burn, delays, arrival distances, go-arounds and similar – in a dashboard form for any selected city pair. The tool is intended to serve as a decision-making aid in pilots' pre-flight planning, and thus to help provide a sound foundation for efficient flight operations. PLATON is available on the personal devices of all SWISS cockpit crew members (except B777), and provides intuitive access to the aggregated data sets concerned. PLATON reduces about 1 500t CO_2 emissions.

Analysed Contingency Fuel (ACF): In accordance with EASA air ops regulations, air operators are permitted to determine part of the fuel required for their operations (i.e. their contingency fuel) on the basis of historical data and associated statistics. This approach improves flight plan accuracy because, in contrast to the conventional method of adding a fixed fuel amount, it permits route-specific factors to be more effectively considered. It also means that unnecessary contingency fuel need not be carried on certain flights, which in turn permits savings in fuel consumption and reductions in CO_2 emissions. ACF is a stand-alone project which is intended to modify the means of calculating part of the block fuel. As such, it also has a direct influence on required (i.e. minimum) fuel.

OPSD (MVP-basic): With an optimised tail assignment based on the actual fuel bias of the aircraft and the distance of the flights, the fuel consumption of the entire fleet can be reduced significantly. This measure reduces about 2 350 t of CO_2 per year.

Turnaround Energy Efficiency Program: SWISS has successfully optimised Auxiliary Power Unit (APU) usage at Zurich Airport through increased use of Ground Power Units. We are continuously leveraging these insights to outstations (e.g. New York, Miami, etc). Our experts conduct so called KAIZEN workshops on-site with the personnel at the outstations in order to optimize APU- and GPU-usage. This measure leads to an annual CO_2 emission reduction of more than 2 400 t, but is due to the COVID-19 pandemic on hold.

Extra fuel Analysis: Pilots choose the amount of extra fuel that is needed for a trip, based on projected weather conditions and past experience. In order to support their decision making and to optimise the amount extra fuel, we supply pilots with additional information that indicates the amount of fuel that was used in 95% of the cases on this route in the last 12 months. This improve the bases on which pilots may decide on how much extra fuel to take. This measure reduces an estimated 12 800 t CO_2 per annum.

EasyJet implements a number of measures in the category of fleet efficiency: They take measures to reduce level of discretionary fuel, to increase the take up and opportunity of Single Engine Taxi, to increase take up of reduced flaps landing, to increase use of Wind Uplinks in Descent, to ensure optimum use speed selection during climb, to ensure optimum use of APU during turnaround.

For flight planning optimisation easyJet uses the Lido Flight Planning System.

Further easyJet implements "Best Practice" into Standard Operating Procedures and publishes a Flight Efficiencies Handbook for their pilots.

6.3.4 Functional Airspace Block Europe Central (FABEC)

The FABEC Member States (Belgium, Germany, France, Luxembourg, the Netherlands and Switzerland) signed in 2010 the Treaty relating to the establishment of the Functional Airspace Block "Central Europe" (FABEC Treaty)[90]. The FABEC Treaty involves all relevant civil and military authorities and constitutes the basis for establishing specific arrangements in the FABEC framework and for ensuring the development of common FABEC projects with the aim of improving the performance within the relevant airspace. The Treaty is a legal instrument facilitating direct cooperation and coordination among the authorities and Air Navigation Service Providers (ANSP).

FABEC airspace covers 1.7 million km² and handles more than 6 million flights per year – 55% of all European air traffic. FABEC aims at reducing the environmental impact per flight by improving routes, flight profiles and distances flown, in line with the objectives of the Single European Sky Initiative.

90 FABEC 2021: www.fabec.eu

The FABEC States have appointed the Swiss Confederation as FABEC Council presidency for 2021. In that context, FABEC will hold this year its first “Environmental Day”.

The FABEC environmental case includes Airspace Design Projects and Airspace Strategy Projects (i.e. Free Route Airspace).

6.4 Market-Based Measures

6.4.1 Voluntary inclusion of a State in the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

As all other ECAC Member States Switzerland has notified ICAO of its decision to voluntarily participate in CORSIA from the start of the pilot phase in 2021 (according to the “Bratislava Declaration”). In Switzerland five Aircraft Operators are above the threshold of 10'000 tonnes CO_2 emissions per year on international routes (operated by aeroplanes with a MTOM > 5.7 tonnes, Humanitarian, medical and firefighting flights are excluded) and therefore have to monitor and report their CO_2 emissions to FOCA. The Assessment of the contribution of the Swiss Aircraft Operators to CORSIA is not yet possible and will be included in future updates, if possible.

6.4.2 Incorporation of emissions from international aviation into regional or national market-based measures, in accordance with relevant international Standards and instruments

The Swiss ETS: On 23 December 2011 the Swiss parliament passed the CO_2 act[91]. This legal framework allows the Federal Council to define sectors, for example that of civil aviation, which will be included in the Swiss emission trading system (ETS). Switzerland is regarded as a third country and therefore the temporary limitation is applied for 2013-2016, following on from the April 2013 'stop the clock' Decision adopted to promote progress on global action at the 2013 ICAO Assembly.

The agreement on the linking of the ETS of the EU and Switzerland was signed on 27th November 2017, ratified in 2019 and came into force in 2020. Since the entry into force, flights within Switzerland and from Switzerland to the European Economic Area (EEA) are subject to the Swiss ETS[92], while flights from the EEA to Switzerland are subject to the EU ETS.

6.4.3 Emissions charges or modulation of LTO charges, in accordance with relevant international instruments

Aircraft engine emission charges, based on ECAC recommendation 27/4 and Swiss FOCA regulations follow the polluter-pays-principle and are based on the certification LTO emission mass of NO_x on an individual aircraft/engine basis. The charging scheme is revenue neutral, but levies are used to finance measures that reduce emissions from any airport related sources. This measure doesn’t lead to less CO_2 emissions but to better local air quality around airports.

In Geneva Airport three reduction mechanisms are put in place in order to incentive airlines to operate with the most modern aircraft and the best load factor: Landing charges are reduced for airlines operating narrow body aircraft in noise class 5 or wide body in noise class 4 . There is an incremental bonus, for the replacement of older aircraft by newer aircraft and for airlines operating with a load factor of 80% or higher. This measure is not only targeting a reduction of CO_2 emissions but also noise and NO_x reduction.

6.4.4 Accredited offset schemes

SWISS Int. Air Lines offers its customers to offset the CO_2 emissions generated each time they travel by air[93]. SWISS Int. Air Lines and Lufthansa have entered into a partnership with the non-profit foundation myclimate, a Swiss-based charitable foundation, which provides carbon offsetting measures. The airlines work with myclimate to calculate the cost of offsetting the volume of CO_2 emissions that

91 SR 641.71 Federal Act on the Reduction of CO_2 Emissions, 23rd December 2011
92 FOCA 2021: Emissions trading scheme
93 SWISS Int. Air Lines 2021: Compensaid

can be ascribed to each passenger on a flight. This “carbon offset” amount will be invested by myclimate in climate protection projects selected by SWISS Int. Air Lines. The foundation assures that this will save the same amount of CO_2 as was generated by the passenger’s flight.

The Swiss federal administrative authorities are offsetting their CO_2 emissions for business trips by aircraft[94]. 2020 the amount for all departments was 17 800 t CO_2 emissions. In normal times the amount would be double, but due to COVID-19 pandemic situation, business trips by air were significantly less.

As the first airline in Europe easyJet is offsetting the carbon emissions from the fuel used for all its flights since November 2019.

6.5 Additional Measures

6.5.1 Special financing of civil aviation: distribution of funds

In 2009, the Swiss electorate voted in favour of an amendment to Article 86 of the Swiss Federal Constitution which created the basis whereby revenue from aviation fuel tax can be used to support the civil aviation sector[95]. In the past, this revenue had been used in the road transport sector.

The relevant details regarding this form of special financing are regulated in the Federal Act on the use of earmarked oil tax and in the Federal Ordinance on the use of earmarked oil tax for measures in the civil aviation sector.

Special financing is intended to support measures to limit the impacts of civil aviation on the environment, to prevent unlawful acts against civil aviation operations (enhancement of security) and to promote a high standard of technical safety. In order to qualify for special financing, a planned measure must:

- be voluntary, i.e. not based on a legal requirement
- be purposeful and effective
- be designed to take effect throughout Switzerland
- be implemented cost-effectively
- not be realisable without federal government support

The FOCA has implemented four-year programmes in which it prioritises those measures in the areas of environmental protection, security and safety that are to qualify for financial support. As long as there is sufficient available revenue from the aviation fuel tax, the amounts concerned will be paid out in the form of non-repayable financing (i.e. on an à fonds perdu basis). In its examination of applications, the FOCA assesses whether the measure concerned qualifies for financial support and the necessary funding is available, and specifies the maximum amount to be granted.

6.5.2 ACI Airport Carbon Accreditation

Zurich Airport has been accredited in the ACI EUROPE Airport Carbon Accreditation program at Level 3 since 2010, thus demonstrating its engagement in itself but also towards the airport partners. In 2017 Geneva Airport has upgraded its certification to level 3+.

6.5.3 Swiss Long-term climate strategy to 2050

The Federal Council adopted the long-term climate strategy for Switzerland on 27 January 2021 and has approved the submission of the strategy to the UN Climate Change Secretariat. Switzerland has thus fulfilled one of the terms of the Paris Agreement (Art. 4.19), which requires countries to develop long-term climate strategies with a time horizon up to 2050. In line with the scientific evidence, based on the Paris Agreement, in accordance with its 'highest possible ambition' and in view of specific economic and social requirements, Switzerland has set itself the a long-term target also for aviation: International aviation from Switzerland should no longer generate climate-impacting emissions in net terms

[94] www.rumba.admin.ch

[95] FOCA 2021: Special financing of civil aviation; distribution of funds

by 2050 as far as possible. This means: Fossil CO_2 emissions amount to net zero and the other climate impacts decline or are offset with other measures.

6.5.4 Road Map Sustainable Aviation

The Aviation Research Center Switzerland (ARCS) launched the Swiss "Road Map Sustainable Aviation" project in 2020 and prepared a study together with the company Ecoplan. Representatives of SWISS, easyJet, the Swiss Business Aviation Association, the national airports of Zurich, Geneva and Basel, the federal offices FOCA and FOEN as well as the ETH Zurich and the Zurich University of Applied Sciences ZHAW accompanied the study. In the final phase of the project, the group was supplemented by easyJet. The study shows how the Swiss aviation industry can achieve the goals of the Paris Agreement and the Long-term climate strategy to 2050[96].

Based on this study, SWISS, easyJet, the national airports and the Swiss Business Aviation Association have adopted a joint declaration of intent to reduce CO_2 emissions.

6.5.5 Report on measures for the reduction of CO_2 emissions in aviation

The umbrella association AEROSUISSE published in June 2021 a report with an overview of different measures to reduce CO_2 emissions in the aviation sector. The measures include projects from areas of aircraft operations, airport infrastructure, air traffic management and sustainable aviation fuels. The report was developed in a collaboration with experts from airports, air navigation service providers, airlines, business jet operators and research institutes[97].

6.6 Supplemental Benefits for Domestic Sectors

6.6.1 Reduced energy demand and preferred cleaner energy source

The measures that are listed in this part are not directly reducing the CO_2 emissions of international aviation and therefore cannot be added to the total reduction from those measures described above. Nonetheless these measures are directly linked to the aviation sector and they undoubtedly have a positive effect on CO_2 emissions of Switzerland.

Continuous building improvements at the national airport of Zurich and a range of energy savings measures have led to a stabilisation of the airport's energy demand over the past 30 years despite the increase in building area of 50% and traffic growth of 60%. Further improvements in the energy provision have led to a reduction of greenhouse gas emission from the airport's central power plant. An estimated total amount of CO_2 savings is 22 700 t for the period from 1991 to 2020.

Zurich airport currently has 12 photovoltaic-power plants in operation (2020) producing a total of 1.7 GWh/a (2020). Also 3 buildings use their ground underneath as a seasonal energy storage.

Geneva Airport uses 100 % renewable electricity. Moreover, 12 % of the airport's electricity is certified NatureMade Star, the highest level of certification for renewable electricity.

Further Geneva Airport has installed solar panels for electricity and heat production. Currently, almost 12 000 m² of photovoltaic panels are installed, with an annual production of a little more than 1.2 GWh. Genève Aéroport has also made an agreement with the local energy provider to co-develop the installation of solar panels, in order to reach 55 000 m² of photovoltaic panels.

Geneva Airport is studying and taking measures to reduce energy consumption for the heating and cooling of its buildings. Such reduction is obtained by gradually improving the thermal insulation of existing buildings, by the renewal of the technical equipment, and the replacement of the main heating power plant. For example, renovation of the «grand hangar» doors led to more than 1GWh/year thermal energy saving. The goal is to be able to heat and cool all the airport buildings without any fossil fuel around year 2025. This will be achieved mainly by replacing the current main heating fuel-based

[96] Aviation Research Center Switzerland 2021: https://www.arcs.aero/de/node/159
[97] AEROSUISSE 2021: https://www.aerosuisse.ch/de/klima/umwelt-und-luftfahrt.html

boilers by a thermal pump using the Geneva Lac water as a main thermal source. The estimated annually CO_2 savings are from 800 to 4 000 t.

Resourceefficient management of air traffic is an important aspect of Skyguide's mandate. Skyguide is committed to reducing emissions from air transport and its own energy consumption through operational improvements. To this end, Skyguide invests in efficiency measures on the ground and in improved traffic management in the air. And does so with consistently high and, where possible, enhanced safety standards. Therefore Skyguide implements the Exemplary Energy and Climate Initiative[98]. One of the measures is a renewable cooling system: Skyguide aims to be able from 2022 or 2023 onwards to cover all of its of the Geneva site's cooling requirements (2.6 GWh/a) with renewable cooling. Several possible solutions are currently being analysed with regard to their technical and economic feasibility, in particular the coverage of the cooling demand by using the GeniLac cooling network.

SR Technics intends to reduce the CO2 footprint (Scope 1 and 2 GHG Protocol) on a yearly basis by 2.5% based on general guidance by Swiss Federal government. The initiative started in 2019 and will define the baseline for the time horizon until 2030, focusing on the Line Maintenance business and the MRO business for aircraft engines. Spanning over the main contributors, i.e. heating, electricity and fuel combustion (vehicles and stationary), the initiative also aims to introduce and support SAF for engine testing, the biggest contributor of SR Technics. The latter requires the introduction and promotion of SAF by authorities and retailers in Switzerland. The estimated reduction per year is about 200 t of CO_2.Enhanced Ground Support Equipment (GSE) management

Both national airports Zurich and Geneva have aircraft positions with pre-conditioned air (PCA) and electricity (400Hz). In Zurich Airport all terminal stands are equipped with 400Hz and PCA, most open stands are equipped with 400Hz systems. The use of the system is mandatory and is regulated in the AIP ZRH. The use monitored and annual benefit calculations are done. The airport of Zurich estimates a reduction of 42 000 t CO_2 per year from their aircraft stands.
Geneva Airport has equipped 30 aircraft positions with fixed 400 Hz and pre-conditioned air installation. The use of these facilities has been made mandatory at equipped positions. Simultaneously, the use of aircrafts APU is prohibited. In 2017, 5 new aircraft positions has been opened with 400 Hz energy. It is estimated that the use of this systems instead of the APU saves about 32 500 t CO_2 and 64 t of NO_x annually.

6.6.2 Conversion of GSE to cleaner fuels

Geneva Airport has enforced a set of regulations to prevent the use of too old ground support vehicles (gradual phase-out of vehicles and engines older than 20 years (2019), respectively 15 years (2023)). New vehicles should follow the latest EU engine regulation. Starting in 2019, only electric light vehicle will be authorize for new vehicle entering the apron. The use of electric/gas vehicles is encouraged and subsidized. More than 150 electric charging points have been installed on the apron. In 2020, 30 % of the vehicles in operation on the tarmac are electric, hybrid or gas vehicles.

Zurich airport has continuously installed electric charging stations for GSE that is being electrified by the all Ground Handlers. The electric fleet has risen by 25% from 2014 to 2016 and now makes up 30% of all airside registered vehicles and machinery. Zurich Airport’s own electric vehicle fleet is constantly growing, now comprising of 106 vehicles and machinery (2019, equals 25%).

6.6.3 Improved transportation to and from airport

Zurich Airport has constantly improved public transportation access to the airport while at the same time managing all vehicle parking lots at the airport. As of now, approximately 45% of all airport users (passengers, staff, and visitors) are using public transportation. New early bus arrivals for staff working shifts have been introduced. This measure leads to an estimated CO_2 reduction of 250 t per year.

[98] Exemplary Energy and Climate Initative 2021: www.energie-vorbild.admin.ch

Geneva Airport manages an ambitious mobility plan both for the airport's employees and for the passengers, with the goal of reaching 45% of sustainable mobility for both categories. This goal is already reached for the passengers. For the employees, there are incentive measures for the use of public or active transportation. There also are restrictive measures for car parks. Currently, 38 % of employees are using sustainable mobility for commuting. In addition, high level lobbying is pursued to get improvements of the airport public transportation network. The estimate of the associated emissions reduction is about 4 500 t CO_2 per year.

VII Conclusion

Switzerland is fully committed to and involved in the fight against climate change, and works towards a resource-efficient, competitive and sustainable multimodal transport system.

Swiss civil aviation has a high safety standard and at the same time pursues a sustainable development strategy.

The Action Plan provides an overview of past and future actions by Switzerland to reduce the CO_2 emissions of its civil aviation sector on a supranational as well as on a national level.

On the national level FOCA evaluated possible measures to reduce CO_2 emissions in collaboration with stakeholders of aerodromes, air traffic control and aviation industry. Most of those measures are done on a voluntary base and are mostly also targeted at optimising operations and business. The quantification of these measures is only possible with limitations. Nonetheless the results show the willingness and effort of the civil aviation sector to reduce CO_2 emissions.

Switzerland shares the view that environmental concerns represent a potential constraint on the future development of the international aviation sector, and 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.

This Action Plan was finalised on June 2021 and shall be considered as subject to updating after that date.

VIII Appendix

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SWISS Int. Air Lines 2021: Compensaid https://swiss.compensaid.com/

SWISS Int. Air Lines 2021: Greener Wave; https://youtu.be/br5bJ-KSi0o

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C Detailed Results for ECAC Scenarios from Section 4.2

1. BASELINE SCENARIO

a) Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres[99] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[100] FTKT (billion)	Total Revenue Tonne Kilometres[101] 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.				

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

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

101 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.

D 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.

E List of Abbreviations

ATT – Aircraft Assignment Tool

ACARE – Advisory Council for Research and Innovation in Europe

ACARS – Aircraft Communications Addressing and Reporting System

ACA – Airport Carbon Accreditation

ACC – Area Control Centres

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)

EAER – European Aviation Environmental Report

AEM – Advanced Emission Model

AFTF – Alternative Fuels Task Force (of ICAO CAEP)

AIRE – The Atlantic Interoperability Initiative to Reduce Emissions

ANS – Air Navigation Service

ATC – Air Traffic Control

ATM – Air Traffic Management

BAU – Business as Usual

CAEP – Committee on Aviation Environmental Protection

CCD – Continuous Climb Departures

CDA – Continuous Descent Approach

CDM - Collaborative Decision Making

CDA – Continuous Descent Approach

CDO - Continuous Descent Operations

CNG – Carbon neutral growth

CORSIA - Carbon Offsetting and Reduction Scheme for International Aviation

CPDLC – Controller-Pilot Data Link Communications

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

FAB – Functional Airspace Block

FANS – Future Air Navigation System

FP7 - 7th Framework Programme

GHG – Greenhouse Gas

GMBM – Global Market-based Measure

Green STAR – Standard Arrival

Green IA – Initial Approach

HVO – Hydro-treated Vegetable Oil

ICAO – International Civil Aviation Organisation

IFR – Instrumental Flight Rules

IPCC – Intergovernmental Panel on Climate Change

IPR – Intellectual Property Right

JTI – Joint Technology Initiative

JU – Joint Undertaking

LTO cycle – Landing/Take-off Cycle

MBM – Market-based Measure

MT – Million tonnes

OFA - Operational Focus Area

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

RED – Renewable Energy Directive

RNAV – Area Navigation

RNP AR – Required Navigation Performance Authorization Required

RNP STAR – Required Navigation Performance Standard Arrival

RPAS – Remotely Piloted Aircraft

RPK – Revenue Passenger Kilometre

RTK – Revenue Tonne Kilometre

RTD – Research and Innovation

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

SWAFEA – Sustainable Ways for Alternative Fuels and Energy for Aviation

SWIM – System Wide Information Management

TMA - Terminal Manoeuvring Area

ToD – Top of Descent

UNEP – United Nations Environmental Programme