

# **ACTION PLAN ON CO<sub>2</sub> EMISSIONS REDUCTION OF THE SLOVAK REPUBLIC**

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Ministry of Transport and Construction of the Slovak Republic  
General Directorate of Civil Aviation

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**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<sub>2</sub> EMISSIONS REDUCTIONS IN THE DOMESTIC EUROPEAN AIR TRAFFIC. ....62**

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## Article 1 Introduction

1.1. The ICAO Contracting State the Slovak Republic is a member of the European Union<sup>1</sup> (EU), of the Organization for Economic Co-operation and Development<sup>2</sup> (OECD), of the European Organisation for the Safety of Air Navigation (EUROCONTROL) and of the European Civil Aviation Conference (ECAC). ECAC is an intergovernmental organization covering the widest grouping of Member States<sup>3</sup> of any European organization dealing with civil aviation.

It is currently composed of 44 Member States, and was created in 1955.

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

1.3. 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.

1.4. The Slovak Republic, 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.

1.5. The Slovak Republic recognises the value of each State preparing and submitting to ICAO an updated State Action Plan for CO<sub>2</sub> emissions reductions as an important step towards the achievement of the global collective goals agreed since the 38th Session of the ICAO Assembly in 2013.

1.6. In that context, it is the intention that all ECAC States submit to ICAO an Action Plan. This is the Action Plan of the Slovak Republic.

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<sup>1</sup> Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, the Slovak Republic, Slovenia, Spain, Sweden, United Kingdom

<sup>2</sup> Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States

<sup>3</sup> 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, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, The former Yugoslav Republic of Macedonia, Turkey, Ukraine, and the United Kingdom

1.7. The Slovak Republic 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<sub>2</sub> emissions is necessary, and that this should include:

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

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

1.7.3. development and deployment of sustainable aviation fuels, including research and operational initiatives undertaken jointly with stakeholders;

1.7.4. 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

1.7.5. Market Based Measures, which allow the sector to continue to grow in a sustainable and efficient manner, recognizing that the measures at 1.7.1. to 1.7.4. above cannot, even in aggregate, deliver in time the emissions reductions necessary to meet the ICAO 2020 CNG global goal.

1.8. 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 the Slovak Republic is described, as well as that of other stakeholders.

1.9. In the Slovak Republic a number of actions are undertaken at the national level, including those by stakeholders. These national actions are reported in Article 4 of this Plan.

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

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

1.10.2. 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).

## Article 2 Current state of aviation in the Slovak Republic

### 2.1. Historical development of international aviation

The Slovak Republic was founded on 1 January 1993. Its foundation and resulting establishment of the Slovak aviation sector represented a considerable change in the existing managerial, economic and logistic relations. Shortly after the declaration of independence the Slovak Republic became a member of the international organizations ICAO and ECAC.

After the foundation of the Slovak Republic, the contributory organization Air Navigation Services of the Slovak Republic (Riadenie letovej prevádzky Slovenskej republiky) was established with the aim to achieve the required capacity of airspace, its effective configuration and accessibility through the CFMU (Central Flow Management Unit) programme and EATCHIP (European Air Traffic Control Harmonization and Integration Programme).

Since 1 January 2000 the contributory organization Air Navigation Services of the Slovak Republic was transformed to the state enterprise Letové prevádzkové služby Slovenskej republiky (Air Navigation Services). In October 1999 one of at that time most advanced systems for provision of air traffic services EUROCAT E2000 was launched. This system enabled to increase the capacity of the Slovak Republic airspace from 78 to 120 flights per hour.

A part of the historical development of the Slovak aviation sector was the establishment of the Civil Aviation Authority of the Slovak Republic (CAA SR). The activities of CAA SR were then specified by the Resolution of the Minister of Transport, Posts and Telecommunications that entered into force on 1 July 1998.

Since September 2013 the Ministry of Transport and Construction of the Slovak Republic (MoT) started the preparation of the merger of its five regulatory offices and authorities (Telecommunications Office, Postal Regulatory Office, Railway Regulatory Authority, CAA SR and State Navigation Administration). Since 1 January 2014 those authorities and offices were merged into the Regulatory Authority for Electronic Communications and Postal Services and the Transport Authority according to the Act No. 402/2013 Coll. and on amendments to Certain Acts.

Slovak civil aviation infrastructure consists of 27 domestic and international airports. 8 of them are international (Airport Bratislava, Airport Košice, Airport Piešťany, Airport Sliač, Airport Poprad – Tatry, Airport Žilina, Airport Nitra and Airport Prievidza). 6 of the international airports (Airport Bratislava, Airport Košice, Airport Piešťany, Airport Sliač, Airport Poprad – Tatry, Airport Žilina) reported to the Slovak Airport Administration until the end of year 2004. In 2005 these 6 airports were transformed to joint stock companies.

## 2.2. Structure of civil aviation sector

### 2.2.1. Ministry of Transport and Construction of the Slovak Republic

Civil Aviation in the Slovak Republic is under the responsibility of the Ministry of Transport and Construction of the Slovak Republic (MoT).

The regulatory entity under the structure of the MoT in civil aviation is the Directorate General of Civil Aviation. It is (among other functions in civil aviation) responsible for:

- state transport policy in civil aviation;
- representing state in international civil aviation organizations;
- monitoring of state supervision in civil aviation;
- legislation and regulatory process;
- designation of air navigation services providers.

The MoT acts as an economic and market regulator in the civil aviation. In general the MoT is responsible for preparation, transposition and implementation of legal rules.

### 2.2.2. The Ministry of Interior of the Slovak Republic

The Ministry of Interior of the Slovak Republic is responsible for regulation of state aircraft other than military aircraft.

### 2.2.3. Transport Authority

Transport Authority (NSAT) was established by the act No 402/2013 Coll. on Regulatory Authority for Electronic Communications and Postal Services and on Transport Authority and on amendments to certain acts and came into force on 1 January 2014. NSAT is a state administrative body with nationwide competence in the area of railways and other guided transport, civil aviation and inland waterway transport.

Civil Aviation Division of the NSAT ensures the performance of the state administration and state supervision in civil aviation as well as other tasks arising from the Act. 143/1998 Coll. of 2 April 1998 on Civil Aviation (Aviation Act) and on amendments to certain acts, as amended, generally binding regulations, legally binding acts of the European Union and international treaties by which the Slovak Republic is bounded.

Civil Aviation Division performs the function of national supervisory body in the field of certification and preservation of airworthiness and environmental certification of aircraft, certification of design and production, operation of aircraft, professional competence of personnel, training facilities providing air navigation services, airport operations and aviation ground equipment and civil aviation security.

### 2.2.4. Letové prevádzkové služby Slovenskej republiky, štátny podnik - Air Navigation Services Provider

Letové prevádzkové služby Slovenskej republiky, štátny podnik (LPS SR), a state enterprise, has been entrusted for provision of air navigation services under the

Slovak laws since January 1993. LPS SR, state enterprise, is acting as a commercial entity.

The mission of LPS SR is in the following domains:

- Air navigation services,
- Aeronautical Telecommunication Services,
- ATS Infrastructure Operation, Maintenance and Development,
- Aeronautical Information Management, including Aeronautical Information Services,
- Air Traffic Services Safety and Quality,
- Aeronautical search and rescue coordination,
- Administrative and finance.

#### 2.2.5. Airports

The main international airports in the Slovak Republic are:

- Airport Bratislava – Letisko M. R. Štefánika ([www.bts.aero](http://www.bts.aero));
- Airport Košice ([www.airportkosice.sk](http://www.airportkosice.sk));
- Airport Piešťany ([www.airport-piestany.sk](http://www.airport-piestany.sk));
- Airport Sliač ([www.airportsliac.sk](http://www.airportsliac.sk));
- Airport Poprad - Tatry ([www.airport-poprad.sk](http://www.airport-poprad.sk));
- Airport Žilina ([www.letisko.sk](http://www.letisko.sk)).

All of these international airports are for public use and all are joint stock companies. Ownership differs on individual airports and stakeholders are usually municipalities, regional governments and MoT.

Airport Sliač is an international military airport with joint civil aviation operation. The civil part of the operation in Airport Sliač was active till end of year 2020 and was terminated due to the planned reconstruction of the airport infrastructure by January 2021.

#### 2.2.6. Accident and Incident Investigation Body

Technical investigation following accidents and incidents is carried out by Accident and Incident Investigation Board (AAIIB) as an independent part of MoT. This Board performs its functions in compliance with Council Directive 94/56/EC which is transposed into national legislation.

The AAIIB conducts investigations of civil aircraft accidents and serious incidents; upon its decision in specific cases AAIIB also conducts investigations for incidents. In some cases, AAIIB may delegate investigation of incidents and serious occurrences to another body, but remains responsible of it.

The NSAT in co-operation with AAIIB performs the collection, evaluation, process and storing of all information related to accidents, incidents and occurrences, as well as making this information available to the other EU States according to Directive 2003/42/EC, EC Regulation 1321/2007 and EC Regulation 1330/2007. These data and processes are used for safety and investigation purposes.

In case of civil-military accidents/incidents both civil and military investigation authorities have to cooperate.

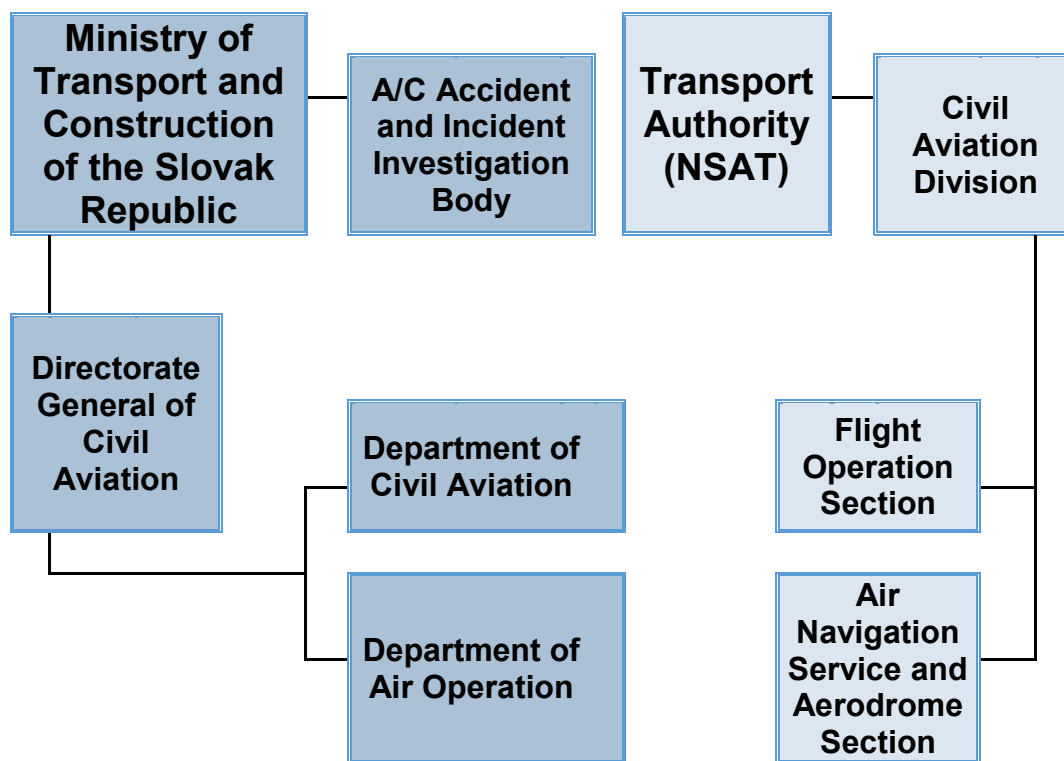


Figure 2.2.0. Regulatory authorities of the Slovak civil aviation sector

### 2.3. Specific geographical or other characteristics that influence the development of international aviation

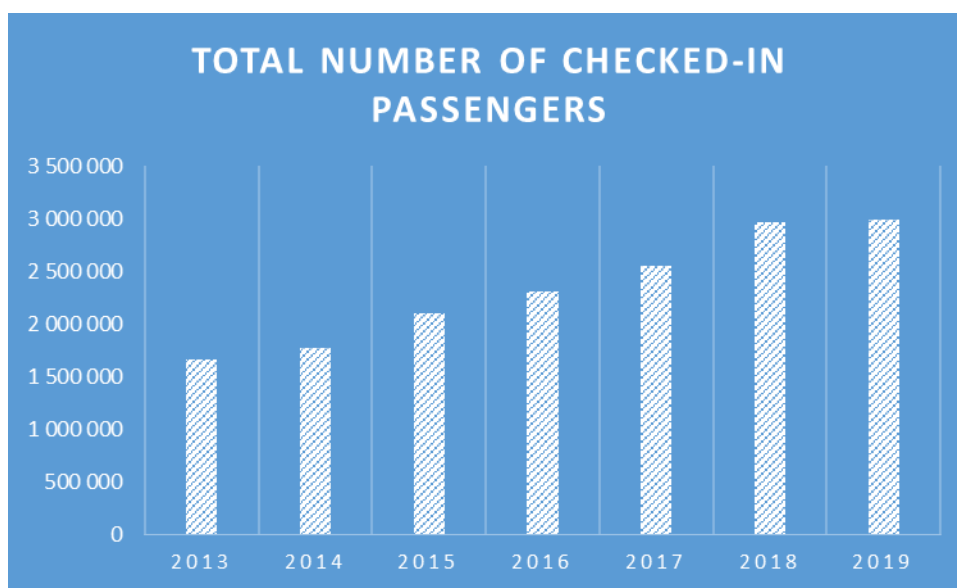
The Slovak Republic is a landlocked central European country. Thanks to its advantageous geographic position it is important for the international air navigation. It closely cooperates with the bodies of the European Union (on the level of Working Parties of the Council and various committees of the Commissions), the European office of ICAO, EASA EUROCONTROL, and ECAC. Air navigation services and provided infrastructure are continuously modernised so that civil aviation can be operated on a safe and economically effective basis.

The Airport Bratislava is the biggest international airport in the Slovak Republic. It is situated near the large international airport in Austria (Vienna Airport 50 km), Hungary (nearest of which is Győr Airport 65 km) and Czech Republic (nearest of which is Airport Brno 130 km).

### 2.3.1. Statistical Data of the Slovak International Airports

| Indicator                     | Total number of checked-in passengers |                 |                 |                 |                 |                 |                 |
|-------------------------------|---------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                               | 2013                                  | 2014            | 2015            | 2016            | 2017            | 2018            | 2019            |
| <b>Airport BRATISLAVA</b>     | 1 373078                              | 1 355625        | 1 564311        | 1 757320        | 1 942069        | 2 292 712       | 2 290 242       |
| <b>Airport KOŠICE</b>         | 237 165                               | 356 750         | 410 449         | 436 696         | 496 708         | 542 026         | 558 064         |
| <b>Airport POPRAD - TATRY</b> | 24 565                                | 31 209          | 85 100          | 84 030          | 80377           | 88 387          | 94249           |
| <b>Airport PIEŠŤANY</b>       | 896                                   | 1 956           | 2 030           | 912             | 1 294           | 768             | 10498           |
| <b>Airport SLIAČ</b>          | 24 165                                | 23 663          | 35 682          | 22 511          | 34 827          | 41 866          | 40624           |
| <b>Airport ŽILINA</b>         | 408                                   | 245             | 888             | 298             | 421             | 523             | 349             |
| <b>TOTAL</b>                  | <b>1 660277</b>                       | <b>1 769448</b> | <b>2 098460</b> | <b>2 301767</b> | <b>2 555696</b> | <b>2 966282</b> | <b>2 994026</b> |

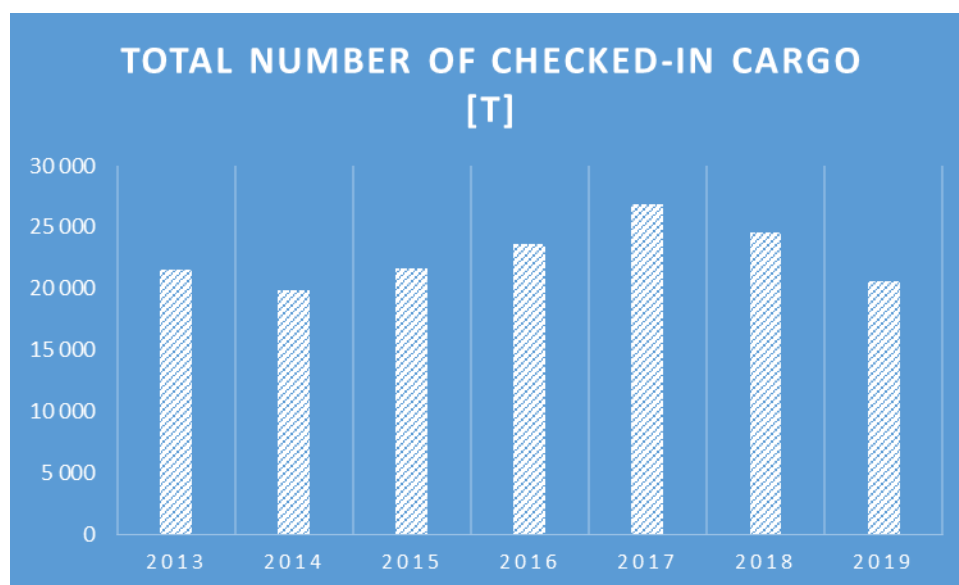
Figure 2.3.1.1. Airport operating outputs – passengers



Graph to figure 2.3.1.1. – total

| Indicator                     | Total number of checked-in cargo [tons] |                  |                  |                  |                  |                  |                  |
|-------------------------------|-----------------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|                               | 2013                                    | 2014             | 2015             | 2016             | 2017             | 2018             | 2019             |
| <b>Airport BRATISLAVA</b>     | 21271,636                               | 19448,169        | 21098,161        | 22895,363        | 26246,065        | 24458,023        | 20449,11         |
| <b>Airport KOŠICE</b>         | 45,419                                  | 82,783           | 251,800          | 88,359           | 106,358          | 82,002           | 59,282           |
| <b>Airport POPRAD - TATRY</b> | 192,960                                 | 68,520           | 42,947           | 5,512            | 0,610            | 0,00             | 0                |
| <b>Airport PIEŠŤANY</b>       | 13,540                                  | 16,200           | 164,311          | 5,706            | 36,517           | 8,680            | 0,487            |
| <b>Airport SLIAČ</b>          | 63,642                                  | 296,000          | 116,501          | 592,200          | 485,286          | 73,922           | 61,643           |
| <b>Airport ŽILINA</b>         | 0,285                                   | 2,852            | 1,252            | 1,200            | 0,526            | 0,001            | 0                |
| <b>TOTAL</b>                  | <b>21587,482</b>                        | <b>19914,524</b> | <b>21674,927</b> | <b>23588,340</b> | <b>26875,362</b> | <b>24622,628</b> | <b>20570,522</b> |

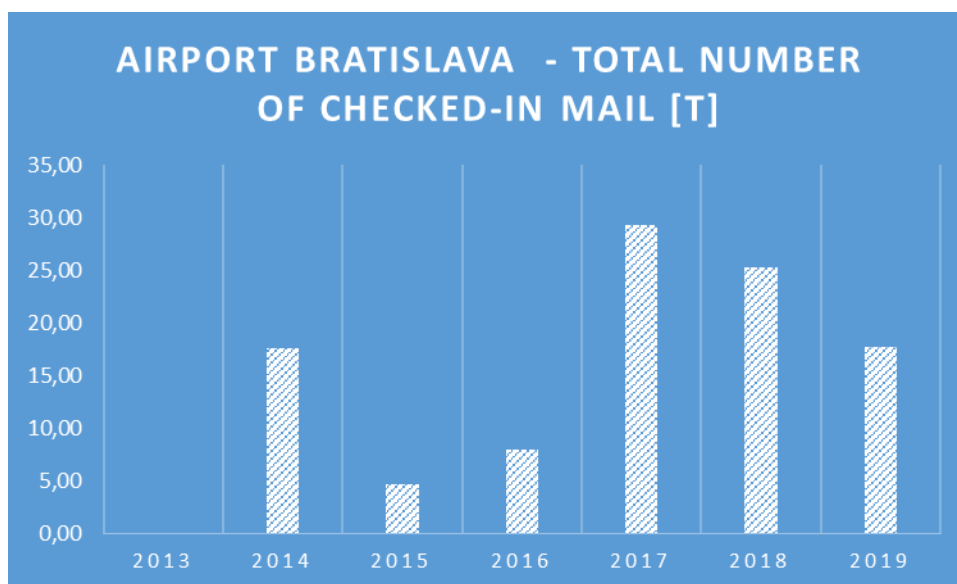
Figure 2.3.1.2. Airport operating outputs – cargo



Graph to figure 2.3.1.2. – total

| Indicator                     | Total number of checked-in mail [tons] |        |       |       |        |        |        |
|-------------------------------|----------------------------------------|--------|-------|-------|--------|--------|--------|
|                               | 2013                                   | 2014   | 2015  | 2016  | 2017   | 2018   | 2019   |
| <b>Airport<br/>BRATISLAVA</b> | 0,08                                   | 17,590 | 4,650 | 7,930 | 29,296 | 25,222 | 17,713 |

Figure 2.3.1.3. Airport operating outputs – mail



Graph to figure 2.3.1.3. – total

## 2.4. Education, including scientific and technical research institutions focusing on aviation-related issues

### 2.4.1. University of Žilina

The Air Transport Department at the University of Žilina (ATD) is a centre for education, research, and training in civil aviation. ATD provides accredited study programmes in a three - tier course structure of university education – Bc., Ing (equivalent to MSc.) and doctorate degrees. On a commercial basis, the ATD also provides initial Air Traffic Controller training and aircraft pilot training up to the CPL/IR/MEP (A) level and theory up to the frozen ATPL level.

ATD is also the base of the National Civil Aviation Security Training Centre of the Slovak Republic. The Centre runs basic aviation security courses in line with the EU regulations for all categories of personnel in aviation. Courses are designed to enhance personnel's academic knowledge and technical skills in handling a variety of potentially critical situations. These courses are certified by the CAA of the Slovak Republic.

The core areas of research and consulting activities of the ATD include:

- Airport capacity and operational assessments
- Civil aviation security
- Meteorology and weather hazards
- Airline operations and economics

- Human Factors
- Safety of general aviation
- Air Traffic Management

#### 2.4.2. Technical university of Košice

Starting with the Academic year of 2005/2006, the Faculty of Aeronautics has adopted a three-level system of education within the accredited 3-year bachelor degree programs (Level I), subsequently followed by a 2-year Master degree study (Level II) and a 3 to 5-year Doctoral degree study program (Level III). In accordance with the basic mission of the Faculty of Aeronautics - to provide, organize and ensure higher level education, life-time education as well as facilitate creative academic research in the fields of aeronautics, aviation equipment, aerospace and related issues - the accredited study programs are focused on the areas such as air traffic control and management (with pilots and ATC-staff included), aviation mechanical engineering, electrical engineering and avionics, aircraft design, aviation equipment repair and operations.

Academic departments:

- Aerodynamics and Simulations
- Air Traffic Management
- Flight Training
- Aviation Technical Studies
- Aviation Engineering
- Avionics

#### 2.4.3. The Transport Research Institute

The Transport Research Institute (TRI), in its 50-year history, has fulfilled important national economic assignments related to national transport policy making and implementation. Wide know-how integrates the TRI activities into the scientific and research basis of the Slovak Republic, which is one of the most important priorities of the TRI's long-term strategy.

TRI scientific and research activities cover all modes of transport, in particular, in the field of engineering and technology, operation, economy, legislation, management and organization, informatics and automation, ecology, power system, transport infrastructure safety and quality, transport services and tourism management transport policy, certification and testing in transport.

#### 2.4.4. Aircraft Repair Company Trenčín JSC

Aircraft Repair Company Trenčín JSC is a well - established aircraft repair and manufacturing company, the only one of its kind in Slovakia not only with regard to the number of repaired military and civil aircraft and other aviation equipment but also in terms of types and versions of repaired and upgraded aircraft and helicopters. Company, headquartered in Trenčín, has risen from the historical basis of one of Slovak Republic's oldest repair companies with almost 60 years of tradition and possession of extensive know-how about repairs of aircraft, airport ground vehicles and equipment, and air defense equipment. As of 1 January 1993 the official founder is the Ministry of Defense of the Slovak Republic. The former state-run company has been transformed as of 1 February 2006 into a joint-stock company with 100% state ownership. The government is currently looking for a strategic partner.

#### 2.5. Effects of past efforts to bring about changes in the international aviation sector of the Slovak Republic

Since the foundation of the Slovak Republic in 1993 the international aviation in the country has made a noticeable progress. The Slovak Republic gradually became a member of several international civil aviation organisations: ICAO, ECAC, EASA and EUROCONTROL.

An important step in the development of civil aviation of our country was the accession of the Slovak Republic to the European Union in 2004. Since then we have actively participated in making transport policy in the area of aviation.

The legislation of the Slovak Republic in the area of civil aviation is sufficiently open and liberal and supports carriers and airports in providing safe and quality services on the air transport market.

### Article 3

#### ECAC/EU Common Section

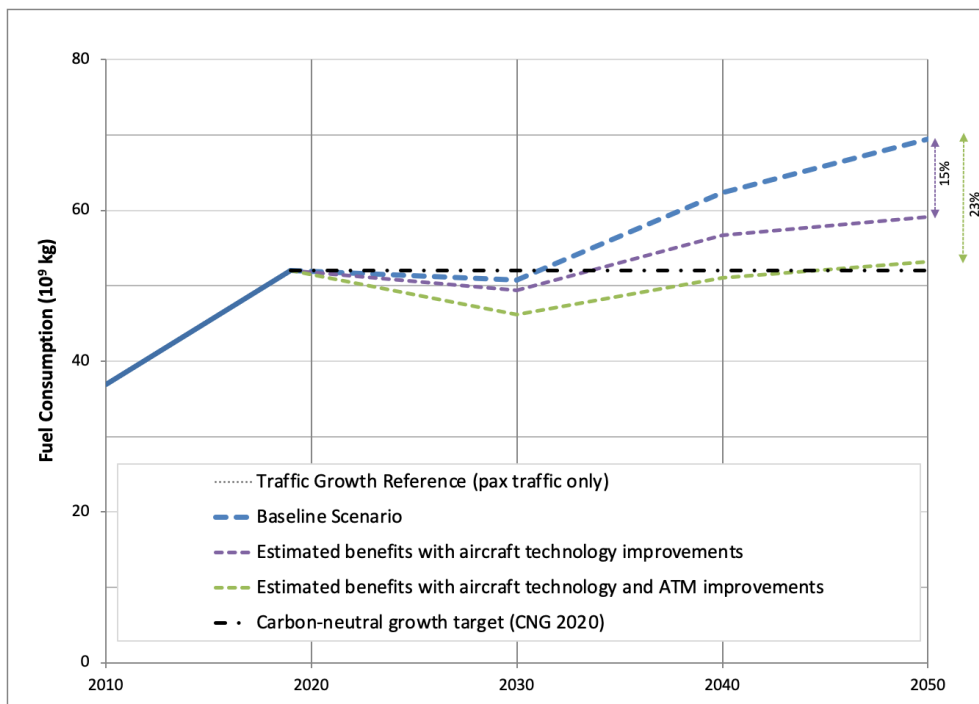
#### ECAC Baseline Scenario and Estimated Benefits Of Implemented Measures

#### **Executive summary**

The European section of this action plan presents a summary of the actions taken collectively throughout the 44 States of the European Civil Aviation Conference (ECAC) to reduce CO<sub>2</sub> emissions from the aviation system and which are relevant for each State, and provides an assessment of their benefit against an ECAC baseline. It also provides a description of future measures aimed to provide additional CO<sub>2</sub> savings.

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

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



### Aircraft related technology

European members have actively contributed to support progress in the ICAO Committee on Aviation Environmental Protection (CAEP). This contribution of resources, analytical capability and co-leadership has facilitated leaps in global certification standards that have helped drive the markets demand for technology improvements. Europe is now fully committed on the implementation of the 2017 ICAO CO<sub>2</sub> standard for newly built aircraft and on the need to review it on a regular basis in light of developments in aeroplane fuel efficiency.

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

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

## **Sustainable Aviation Fuels (SAF)**

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

The European collective SAF measures included in this Action Plan focuses on its CO<sub>2</sub> reductions benefits. Nevertheless SAF has the additional benefit of reducing air pollutant emissions of non-volatile Particulate Matter (nvPM), which can provide important other non-CO<sub>2</sub> benefits on the climate which are not specifically assessed within the scope of this Plan.

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

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

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

## **Improved Air Traffic Management**

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

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

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

## **Market Based Measures (MBMs)**

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

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

The 30 European Economic Area (EEA)<sup>4</sup> States in Europe have implemented the EU Emissions Trading System (ETS), including the aviation sector with around 500 aircraft operators participating in the cap-and-trade approach to limit CO<sub>2</sub> emissions. Subject to preserving the environmental integrity and effectiveness it is expected that the EU ETS legislation will continue to be adapted to implement CORSIA.

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

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

In the period 2013 to 2020, EU ETS has saved an estimated 200 million tonnes of intra-European aviation CO<sub>2</sub> emissions.

### **ECAC Scenarios for Traffic and CO<sub>2</sub> Emissions**

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

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

The analysis by EUROCONTROL and EASA have identified the most likely scenario of influences on future traffic and modelled these assumptions out to future years. On the basis of this traffic forecast, fuel consumption and CO<sub>2</sub> emissions of aviation have been estimated for both a theoretical baseline scenario (without any additional mitigation action) and a scenario with estimated benefits from mitigation measures implemented since 2019 or provided benefits beyond 2019 that are presented in this action plan.

Under the baseline assumptions of traffic growth and fleet rollover with 2019 technology, CO<sub>2</sub> emissions would significantly grow in the long-term for flights departing from ECAC airports without mitigation measures. Modelling the impact of improved aircraft technology for the scenario with implemented measures indicates an overall 15% reduction of fuel consumption and CO<sub>2</sub> emissions in 2050 compared to the baseline. Whilst the data to model the benefits of ATM improvements may be less robust, they are nevertheless valuable contributions to reduce emissions further. Overall CO<sub>2</sub> 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.

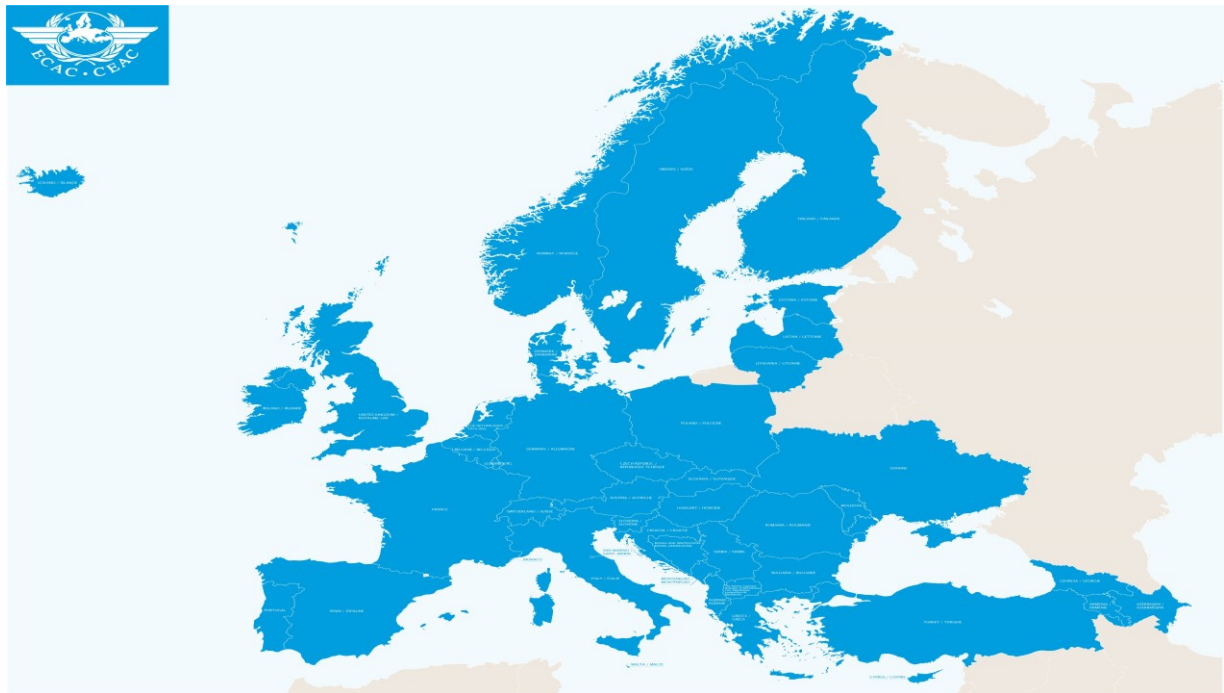
In the common section of this action plan the potential of sustainable aviation fuels and the effects of market-based measures have not been simulated in detail. Notably, CORSIA being

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<sup>4</sup> The EEA includes EU countries and also Iceland, Liechtenstein and Norway.

a global measure, and not a European measure, the assessments of its benefits were not considered required for the purposes of the State Action Plans. But they should both help reach the ICAO carbon-neutral growth 2020 goal. As further developments in policy and technology are made, further analysis will improve the modelling of future emissions.

### 3.1. ECAC Baseline Scenario and Estimated Benefits Of Implemented Measures



#### 3.1.1. ECAC Baseline Scenario

The baseline scenario is intended to serve as a reference scenario for CO<sub>2</sub> 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<sub>2</sub> emissions.

The sets of forecasts correspond to projected traffic volumes in a scenario of “Regulation and Growth”, while corresponding fuel consumption and CO<sub>2</sub> emissions assume the technology level of the year 2019 (i.e. without considering reductions of emissions by further aircraft related technology improvements, improved ATM and operations, sustainable aviation fuels or market based measures).

### Traffic Scenario “Regulation and Growth”

As in all forecasts produced by EUROCONTROL, various scenarios are built with a specific storyline and a mix of characteristics. The aim is to improve the understanding of factors that will influence future traffic growth and the risks that lie ahead. The latest EUROCONTROL long-term forecast<sup>5</sup> 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<sup>6</sup>. It considers a moderate economic growth, with some regulation particularly regarding the social and economic demands.

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

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

**Table 1** below presents a summary of the social, economic and air traffic related characteristics of three different scenarios developed by EUROCONTROL. The year 2016 served as the baseline year of the 20-year forecast results<sup>5</sup> (published in 2018 by EUROCONTROL). Historical data for the year 2019 are also shown later for reference.

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<sup>5</sup> [Challenges of Growth - Annex 1 - Flight Forecast to 2040, EUROCONTROL, September 2018.](#)

<sup>6</sup> Prior to COVID-19 outbreak.

|                                                     | <i>Global Growth</i>                                                            | <i>Regulation and Growth</i>                                                   | <i>Fragmenting World</i>                      |
|-----------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------|
| 2023 traffic growth                                 | High ↗                                                                          | Base →                                                                         | Low ↘                                         |
| <b>Passenger</b>                                    |                                                                                 |                                                                                |                                               |
| Demographics (Population)                           | Ageing<br>UN Medium-fertility variant                                           | Ageing<br>UN Medium-fertility variant                                          | Ageing<br>UN Zero-migration variant           |
| Routes and Destinations                             | Long-haul ↗                                                                     | No Change →                                                                    | Long-haul ↘                                   |
| Open Skies                                          | EU enlargement later<br>+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.           |
| <b>Economic conditions</b>                          |                                                                                 |                                                                                |                                               |
| GDP growth                                          | Stronger ↗                                                                      | Moderate →                                                                     | Weaker ↘↘                                     |
| EU Enlargement                                      | +5 States, Later                                                                | +5 States, Earliest                                                            | +5 States, Latest                             |
| Free Trade                                          | Global, faster                                                                  | Limited, later                                                                 | None                                          |
| <b>Price of travel</b>                              |                                                                                 |                                                                                |                                               |
| Operating cost                                      | Decreasing ↘↘                                                                   | Decreasing ↘                                                                   | No change →                                   |
| Price of CO <sub>2</sub> in Emission Trading Scheme | Moderate                                                                        | Lowest                                                                         | Highest                                       |
| Price of oil/barrel                                 | Low                                                                             | Lowest                                                                         | High                                          |
| Change in other charges                             | Noise: ↗<br>Security: ↘                                                         | Noise: ↗<br>Security: →                                                        | Noise: →<br>Security: ↗                       |
| <b>Structure</b>                                    |                                                                                 |                                                                                |                                               |
| Network                                             | Hubs: Mid-East ↗↗<br>Europe ↘<br>Turkey ↗                                       | Hubs: Mid-East ↗↗<br>Europe & Turkey ↗                                         | No change →                                   |
| Market Structure                                    | Point-to-point: N-Atlantic. ↗↗<br>Industry fleet forecast + STATFOR assumptions | Point-to-point: N-Atlantic. ↗<br>Industry fleet forecast + STATFOR assumptions | Industry fleet forecast + STATFOR assumptions |

**Table 1.** Summary characteristics of EUROCONTROL scenarios.

### 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<sup>7</sup> 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<sup>5</sup>. Considering the most-likely scenarios of the long-term forecast<sup>5</sup> and the medium-term forecasted version of the long-term flight forecast has been derived:

- a) Replace the long-term forecast<sup>5</sup> horizon by the most recent medium-term forecast<sup>7</sup> to account for COVID impact;
- b) Update the rest of the horizon (2025-2040) assuming that the original growth rates of the long-term forecast<sup>5</sup>, would remain similar to those calculated pre-COVID-19; and
- c) Extrapolate the final years (2040-2050) considering the same average annual growth rates as the one forecasted for the 2035-2040 period, but with a 0.9 decay<sup>8</sup>.

The method used relies on the calculation of adjustment factors at STATFOR<sup>9</sup> region-pair level and have been applied to the original long-term forecast<sup>5</sup>. Adjusting the baseline enables to further elaborate the baseline scenario as forecasted future fuel consumption and to 2030, 2040 and 2050, in the absence of action.

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

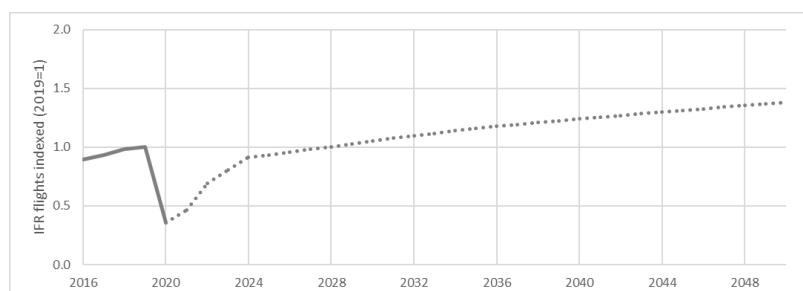
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<sup>7</sup> Five-Year Forecast 2020-2024, IFR Movements, EUROCONTROL, November 2020.

<sup>8</sup> 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.

<sup>9</sup> STATFOR (Statistics and Forecast Service) provides statistics and forecasts on air traffic in Europe and to monitor and analyse the evolution of the Air Transport Industry.

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



#### Further assumptions and results for the baseline scenario

The ECAC baseline scenario was generated by EUROCONTROL for all ECAC States. It covers all commercial international passenger flights departing<sup>10</sup> 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<sup>11</sup>). 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<sup>12</sup> data warehouse used by EUROCONTROL, including the actual flight distance and the cruise altitude by airport pair. These calculations were made for about 99% of the passenger flights (the remaining flights had information missing in the flight plans). Determination of the fuel burn and CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> emissions of the baseline scenario for forecast years uses the technology level of 2019.

<sup>10</sup> 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.

<sup>11</sup> 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.

<sup>12</sup> PRISME is the name of the EUROCONTROL data warehouse hosting the flight plans, fleet and airframe data.

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 kilometers, assuming that 1 passenger corresponds to 0.1 tonne.

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

The following tables and figures show the results for this baseline scenario, which is intended to serve as a reference case by approximating fuel consumption and CO<sub>2</sub> emissions of European aviation in the absence of mitigation actions.

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

| <b>Year</b> | <b>Passenger Traffic (IFR movements)<br/>(million)</b> | <b>Revenue Passenger Kilometres<sup>13</sup> RPK<br/>(billion)</b> | <b>All-Cargo Traffic (IFR movements)<br/>(million)</b> | <b>Freight Tonne Kilometres transported<sup>14</sup> FTKT<br/>(billion)</b> | <b>Total Revenue Tonne Kilometres<sup>15</sup> RTK<br/>(billion)</b> |
|-------------|--------------------------------------------------------|--------------------------------------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------|
| 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                                                                |

<sup>13</sup> Calculated on the basis of Great Circle Distance (GCD) between airports, for 97% of the passenger traffic for forecast years.

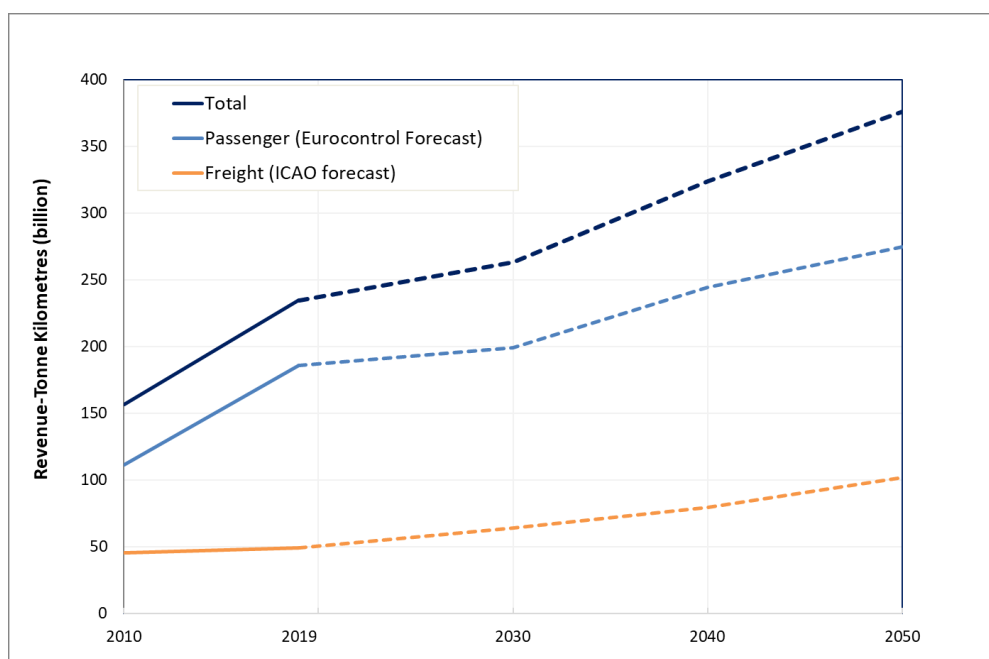
<sup>14</sup> Includes passenger and freight transport (on all-cargo and passenger flights).

<sup>15</sup> A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).

**Table 3.** Fuel burn and CO<sub>2</sub> emissions forecast for the baseline scenario

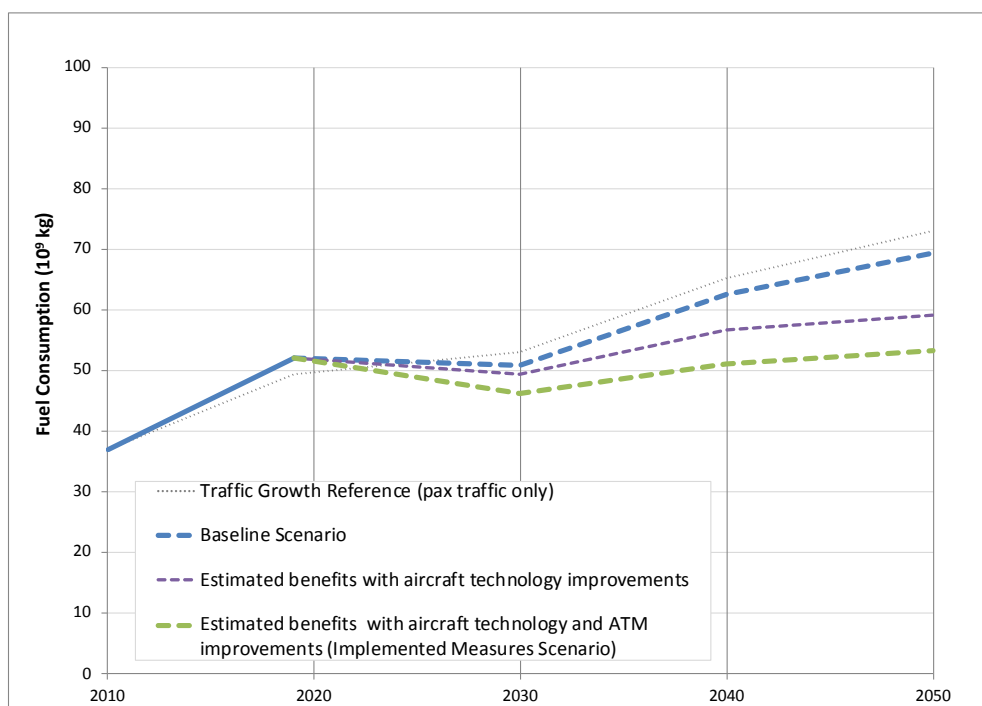
| Year                                                                                                       | Fuel Consumption (10 <sup>9</sup> kg) | CO <sub>2</sub> emissions (10 <sup>9</sup> kg) | Fuel efficiency (kg/RPK <sup>13</sup> ) | Fuel efficiency (kg/RTK <sup>15</sup> ) |
|------------------------------------------------------------------------------------------------------------|---------------------------------------|------------------------------------------------|-----------------------------------------|-----------------------------------------|
| 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                                   |
| <i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i> |                                       |                                                |                                         |                                         |

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



The impact of the COVID-19 in 2020 is not fully reflected in Figure 3.1.1.4, as this representation is oversimplified through a straight line between 2019 and 2030. The same remark applies for Figure 3 and Figure 4.

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



### 3.1.2. ECAC Scenario with Implemented Measures: Estimated Benefits

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

For reasons of simplicity, the scenario with implemented measures is based on the same traffic volumes as the baseline case, i.e. updated EUROCONTROL's 'Regulation and Growth' scenario described earlier. Unlike in the baseline scenario, the effects of aircraft related technology development and improvements in ATM/operations are considered here for a projection of fuel consumption and CO<sub>2</sub> 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<sup>16</sup> (AAT) developed collaboratively by EUROCONTROL, EASA and the European Commission. The retirement process of AAT is performed year by year, allowing the determination of the number of new aircraft required each year. In addition to the fleet rollover, a constant annual improvement of 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

<sup>16</sup> <https://www.easa.europa.eu/domains/environment/impact-assessment-tools>

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<sup>17</sup>. Based on the information provided by the PAGAR 2019 document<sup>18</sup>, and compared to a 2012 baseline, the benefits at the end of Wave 1 could be about 3% CO<sub>2</sub>/fuel savings achieved by 2025 equivalent to 147.4 kg of fuel/flight. So far, the target for Wave 2 remains at about 7% more CO<sub>2</sub>/fuel savings (352.6 kg of fuel) to reach the initial Ambition target of about 10% CO<sub>2</sub>/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<sup>19</sup> 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<sup>20</sup>, 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 Article 4 chapter 4.2.1 and it is expected that future updates will include an assessment of its benefits as a collective measure.

Effects on aviation's CO<sub>2</sub> 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<sup>21</sup>, while recalling that this is just a reference level, given that CORSIA was designed to contribute to the CNG 2020 globally and not in individual States or regions.

Tables 4-6 and Figure 4 summarise the results for the scenario with implemented measures. It should be noted that **Table 4** show direct combustion emissions of CO<sub>2</sub> (assuming 3.16 kg CO<sub>2</sub> per kg fuel). More detailed tabulated results are found in Appendix A, including results

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<sup>17</sup> See SESAR ATM Master Plan – Edition 2020 ([www.atmmasterplan.eu](http://www.atmmasterplan.eu)) - eATM.

<sup>18</sup> See SESAR Performance Assessment Gap Analysis Report (PAGAR) updated version of 2019 v00.01.04, 31-03-2021.

<sup>19</sup> See SESAR Exploratory Research projects - <https://www.sesarju.eu/exploratoryresearch>

<sup>20</sup> <https://www.acare4europe.org/sria/flightpath-2050-goals/protecting-environment-and-energy-supply-0>

<sup>21</sup> 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).

expressed in equivalent CO<sub>2</sub> emissions on a well-to-wake basis (for comparison purposes of SAF benefits).

**Table 4.** Fuel burn and CO<sub>2</sub> emissions forecast for the Implemented Measures Scenario (new aircraft technology and ATM improvements only).

| Year                                                                                                | Fuel Consumption (10 <sup>9</sup> kg) | CO <sub>2</sub> emissions (10 <sup>9</sup> kg) | Fuel efficiency (kg/RPK <sup>22</sup> ) | Fuel efficiency (kg/RTK <sup>17</sup> ) |
|-----------------------------------------------------------------------------------------------------|---------------------------------------|------------------------------------------------|-----------------------------------------|-----------------------------------------|
| 2010                                                                                                | 36.95                                 | 116.78                                         | 0.0332                                  | 0.332                                   |
| 2019                                                                                                | 52.01                                 | 164.35                                         | 0.0280                                  | 0.280                                   |
| 2030                                                                                                | 46.16                                 | 145.86                                         | 0.0229                                  | 0.229                                   |
| 2040                                                                                                | 51.06                                 | 161.35                                         | 0.0206                                  | 0.206                                   |
| 2050                                                                                                | 53.18                                 | 168.05                                         | 0.0192                                  | 0.192                                   |
| 2050 vs 2019                                                                                        |                                       |                                                | -32%                                    |                                         |
| For reasons of data availability, results shown in this table do not include cargo/freight traffic. |                                       |                                                |                                         |                                         |

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

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

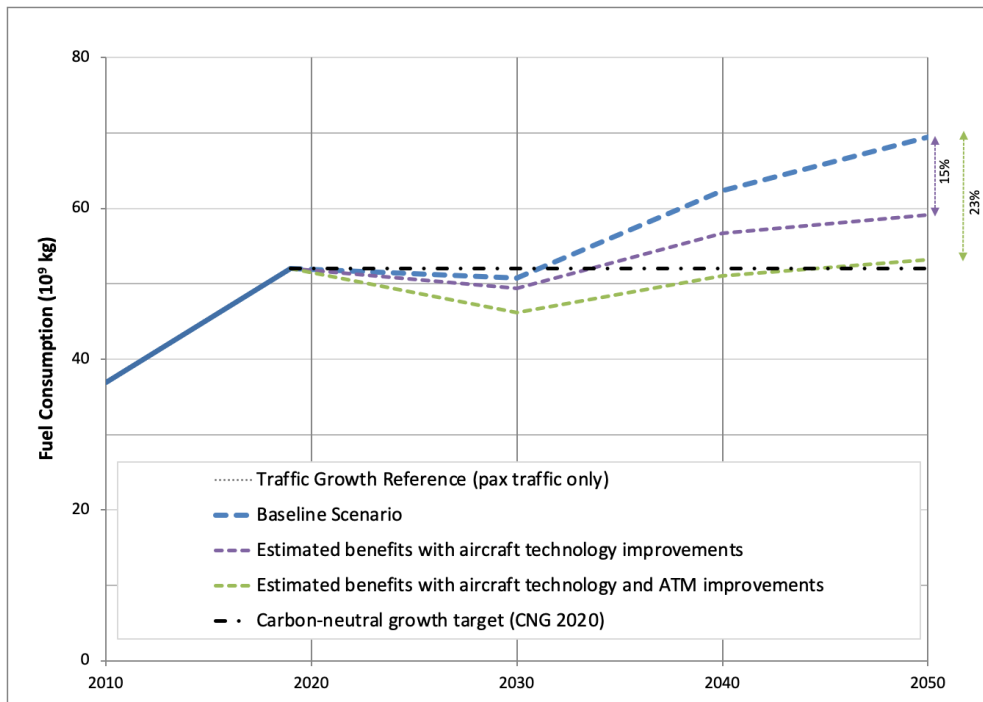
**Table 6.** CO<sub>2</sub> emissions forecast for the scenarios described in this chapter.

| Year | CO <sub>2</sub> emissions (10 <sup>9</sup> kg) |                                         |                                            | % improvement by<br>Implemented<br>Measures (full scope) |
|------|------------------------------------------------|-----------------------------------------|--------------------------------------------|----------------------------------------------------------|
|      | Baseline<br>Scenario                           | Implemented Measures Scenario           |                                            |                                                          |
|      |                                                | Aircraft techn.<br>improvements<br>only | Aircraft techn.<br>and ATM<br>improvements |                                                          |
| 2010 | 116,78                                         |                                         |                                            | NA                                                       |
| 2019 | 164,35                                         |                                         |                                            | NA                                                       |
| 2030 | 160,3                                          | 156,0                                   | 145,9                                      | -9%                                                      |

<sup>22</sup> Calculated on the basis of Great Circle Distance (GCD) between airports, for 97% of the passenger traffic for forecast years.

|                                                                                                            |       |       |       |      |
|------------------------------------------------------------------------------------------------------------|-------|-------|-------|------|
| 2040                                                                                                       | 197,1 | 179,3 | 161,4 | -18% |
| 2050                                                                                                       | 219,4 | 186,7 | 168,0 | -23% |
| <i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i> |       |       |       |      |
| <i>Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.</i>    |       |       |       |      |

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



As shown in Figure 4, the impact of improved aircraft technology indicates an overall 15% reduction of fuel consumption and CO<sub>2</sub> emissions in 2050 compared to the baseline scenario. Overall CO<sub>2</sub> emissions, including the effects of new aircraft types and ATM-related measures, are projected to improve to lead to a 23% reduction in 2050 compared to the baseline.

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

Article 4  
ECAC/EÚ Common Section  
Actions taken collectively in Europe



#### 4.1. TECHNOLOGY AND STANDARDS

##### 4.1.1 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<sub>2</sub> 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<sub>2</sub> standard). Its contribution to the global aspirational goals are available in CAEP.

## 4.1.2 Research and development

### 4.1.2.1 Clean Sky

**Clean Sky**<sup>23</sup> 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<sub>2</sub> emissions by 20-40%, NO<sub>x</sub> by around 60% and noise by up to 10dB compared to year 2000 aircraft.

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

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

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

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

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<sup>23</sup> <http://www.cleansky.eu/>

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

In addition, the **Clean Sky Technology Evaluator**<sup>24</sup> 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).

#### ***4.1.2.2 Disruptive aircraft technological innovations: European Partnership for Clean Aviation***

With the Horizon 2020 programme coming to a close in 2020, the Commission has adopted a proposal to set up a new Joint Undertaking under the Horizon Europe programme (2021-2027). The **European Partnership for Clean Aviation (EPCA)**<sup>25</sup> will follow in the footsteps of CleanSky2. The EU contribution proposed is again €1.7 billion. The stakeholder community has already formulated a Strategic Research and Innovation Agenda (SRIA), which is intended to serve as a basis of the partnership once established. Subject to the final provisions of the partnership and the EU budget allocation, industry stakeholders have proposed a commitment of €3 billion from the private side.

##### General objectives of EPCA:

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

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

##### Specific objectives:

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

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

*(c) To expand and foster integration of the climate-neutral aviation research and innovations value chains, including academia, research organisations, industry, and SMEs,*

<sup>24</sup> <https://www.cleansky.eu/technology-evaluator-te>

<sup>25</sup> <https://clean-aviation.eu/>

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

**Table 7** Fuel consumption and CO<sub>2</sub> emissions of international passenger traffic departing from ECAC airports, with aircraft technology improvements after 2019 included:

| Year                                                                                                       | Fuel Consumption (10 <sup>9</sup> kg) | CO <sub>2</sub> emissions (10 <sup>9</sup> kg) | Well-to-wake CO <sub>2</sub> e emissions (10 <sup>9</sup> 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                    |
| <i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i> |                                       |                                                |                                                               |                          |                          |

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

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



## 4.2. SUSTAINABLE AVIATION FUELS

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

The European collective SAF measures included in this Action Plan focuses on its CO<sub>2</sub> reductions benefits. Nevertheless SAF has the additional benefit of reducing air pollutant emissions of non-volatile Particulate Matter (nvPM) with up to 90% and sulphur (SO<sub>x</sub>) with 100%, compared to fossil jet fuel<sup>26</sup>. As a result, the large-scale use of SAF can have important other non-CO<sub>2</sub> benefits on the climate which are not specifically assessed within the scope of this Plan.

### 4.2.1 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

<sup>26</sup> [ICAO 2016 Environmental Report](#), Chapter 4, Page 162, Figure 4.

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<sub>2</sub> 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.

### 4.2.2 Addressing barriers of SAF penetration into the market

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

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

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

#### 4.2.2.1 Sustainable Aviation Fuel 'Facilitation Initiative'

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

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

The report begins by analysing the status of SAFs in Europe today, including both more established technologies and ones at a lower Technology Readiness Level (TRL). It reviews one of the major solutions to the obstacle of navigating the SAF approval process, namely the US Clearing House run by the University of Dayton Research Institute and funded by the Federal Aviation Administration (FAA). The issue of sustainability is also examined, via an

analysis of the role of Sustainability Certification Schemes (SCS) and how they interact with regulatory sustainability requirements, particularly those in the EU's Renewable Energy Directive (RED II) and ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

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

The report is available at EASA's website: '[Sustainable Aviation Fuel 'Facilitation Initiative'](#)'.

#### 4.2.2.2. Sustainable Aviation Fuel 'Monitoring System'

In response to a lack of information at the EU level on the supply and use of SAF within Europe identified by the [European Aviation Environmental Report](#), EASA launched a second study to identify a cost effective, robust data stream to monitor the use and supply of SAF, as well as the associated emissions reductions. This included identifying and recommending performance indicators related to the use of SAF in Europe, as well as the associated aviation CO<sub>2</sub> 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.

#### 4.2.3 Standards and requirements for SAF

##### 4.2.3.1. European Union standards applicable to SAF supply

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

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

##### *Sustainability and life cycle emissions methodologies:*

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

These can be found in RED's<sup>27</sup> Article 17, *Sustainability criteria for biofuels and bioliquids*. Those requirements remain applicable on the revised RED II (Directive (EU) 2018/2001)<sup>38</sup>, 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<sub>2</sub>eq/MJ. In the case of transport renewable fuels of non-biological origin<sup>28</sup>, 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.

##### 4.2.3.2. ICAO standards applicable to SAF supply

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

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<sup>27</sup> Directive 2009/28/EC.

<sup>28</sup> In the case of renewable fuels of non-biological origin, two types are considered: a) Renewable liquid and gaseous transport fuels of non-biological origin (including categories commonly referred as Power to Liquid - PtL-, Electro-fuels and Synthetic fuels). b) Waste gases, which are under the category of REcycled FUEL from NON-BIOlogical origin (also known as REFUNIOBIO).

Eligible Fuels; CORSIA standards are applicable to any SAF use to be claimed under CORSIA in order to reduce offsetting obligations by aeroplane operators.

## ASSESSMENT

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

### 4.2.4 Research and Development projects on SAF

#### 4.2.4.1 European Advanced Biofuels Flightpath

An updated and renewed approach to the 2011 Biofuels FlightPath Initiative<sup>29</sup>, 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<sup>30</sup>.

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

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

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

**BIO4A<sup>31</sup>**: 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.

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<sup>29</sup> 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](https://ec.europa.eu/energy/sites/ener/files/20130911_a_performing_biofuels_supply_chain.pdf)

<sup>30</sup> <https://www.biofuelsflightpath.eu/ressources>

<sup>31</sup> [www.bio4a.eu](http://www.bio4a.eu)

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<sup>32</sup>:** *Production of sustainable aircraft grade kerosene from water and air powered by renewable electricity, through the splitting of CO<sub>2</sub>, 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<sub>2</sub> emission by creating a closed carbon fuel cycle and at the same time creates long-term large-scale energy storage capacity which will strengthen the EU energy security and allow creation of a sustainable transportation sector.

The KEROGREEN project expected duration is from April 2018 to March 2022.

**FlexJET<sup>33</sup>:** *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<sup>34</sup>:** *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

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<sup>32</sup> [www.kerogreen.eu](http://www.kerogreen.eu)

<sup>33</sup> [www.flexjetproject.eu](http://www.flexjetproject.eu)

<sup>34</sup> <https://biosfera-project.eu>

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**<sup>35</sup>: 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<sub>2</sub> 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**<sup>36</sup>: The *Fuel via Low Carbon Integrated Technology from Ethanol* (FLITE) consortium proposes to expand the supply of low carbon jet fuel in Europe by designing, building, and demonstrating an innovative ethanol-based Alcohol-to-Jet (ATJ) technology in an ATJ Advanced Production Unit (ATJ-APU). The ATJ-APU will produce jet blend stocks from non-food/non-feed ethanol with over 70% GHG reductions relative to conventional jet. The Project will demonstrate over 1000 hours of operations and production of over 30,000 metric tonnes of Sustainable Aviation Fuel.

The diversity of ethanol sources offers the potential to produce cost competitive SAF, accelerating uptake by commercial airlines and paving the way for implementation.

The project is carried out by a consortium of five partners from six European countries and its expected duration is from 1 December 2020 till 30 November 2024.

**TAKE-OFF**<sup>37</sup>: Is an industrially driven project aiming to be a game-changer in the cost-effective production of SAF from CO<sub>2</sub> and hydrogen. The unique TAKE-OFF technology is based on conversion of CO<sub>2</sub> and H<sub>2</sub> 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<sub>2</sub> 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.

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<sup>35</sup> <https://www.bl2f.eu>

<sup>36</sup> <https://cordis.europa.eu/project/id/857839>

<sup>37</sup> <https://cordis.europa.eu/project/id/101006799>

## 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.



### 4.3. OPERATIONAL IMPROVEMENTS

#### 4.3.1 The EU's Single European Sky Initiative and SESAR

##### 4.3.1.1 SESAR Project

###### SES and SESAR

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

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

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

SESAR is fully aligned with the Union's objectives of a sustainable and digitalised mobility and is projected towards their progressive achievement over the next decade. To implement the SESAR project, the Commission has set up with the industry, an innovation cycle

comprising three interrelated phases: definition, development and deployment. These phases are driven by partnerships (SESAR Joint Undertaking and SESAR Deployment Manager) involving all categories of ATM/aviation stakeholders.

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

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

### **SESAR and the European Green Deal objectives**

The European Green Deal launched by the European Commission in December 2019 aims to create the world's first climate-neutral bloc by 2050. This ambitious target calls for deep-rooted change across the aviation sector and places significantly stronger focus on the environmental impact of flying. Multiple technology pathways are required, one of which is the digital transformation of air traffic management, where SESAR innovation comes into play. Over the past ten years the SESAR JU has worked to improve the environmental footprint of air traffic management, from CO<sub>2</sub> and non-CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> reduction, highlighted by the green dotted rectangle of **Figure 5** below:

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

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

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

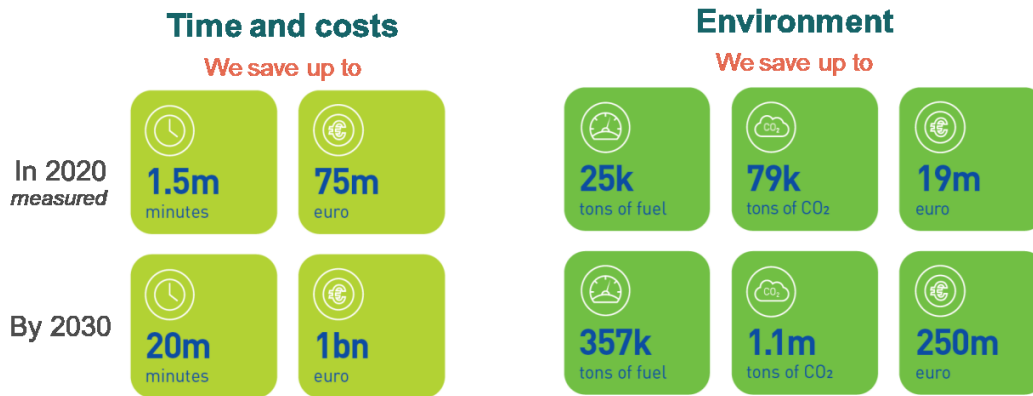
While all SESAR solutions bring added value to ATM performance, some have a higher potential to contribute the performance of the entire European ATM network and require a coordinated and synchronised deployment. To facilitate the deployment of these SESAR solutions, the Commission establishes common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

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

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

The first common project<sup>38</sup> is planned to be completed by 2027. However, the benefits highlighted in **Figure 6** below have been measured where the functionalities have already been implemented.

<sup>38</sup> [https://ec.europa.eu/transport/modes/air/sesar/deployment\\_en](https://ec.europa.eu/transport/modes/air/sesar/deployment_en)



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

#### 4.3.1.2 SESAR Exploratory Research (V0 to V1)

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

#### 4.3.1.3 SESAR Industrial Research & Validation Projects (environmental focus)

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

- The initial development by EUROCONTROL of the IMPACT<sup>39</sup> 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<sup>40</sup>.

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.

<sup>39</sup> <https://www.eurocontrol.int/platform/integrated-aircraft-noise-and-emissions-modelling-platform>

<sup>40</sup> <https://www.sesarju.eu/sites/default/files/documents/transversal/SESAR%202020%20-%20Environment%20Impact%20Assessment%20Guidance.pdf>

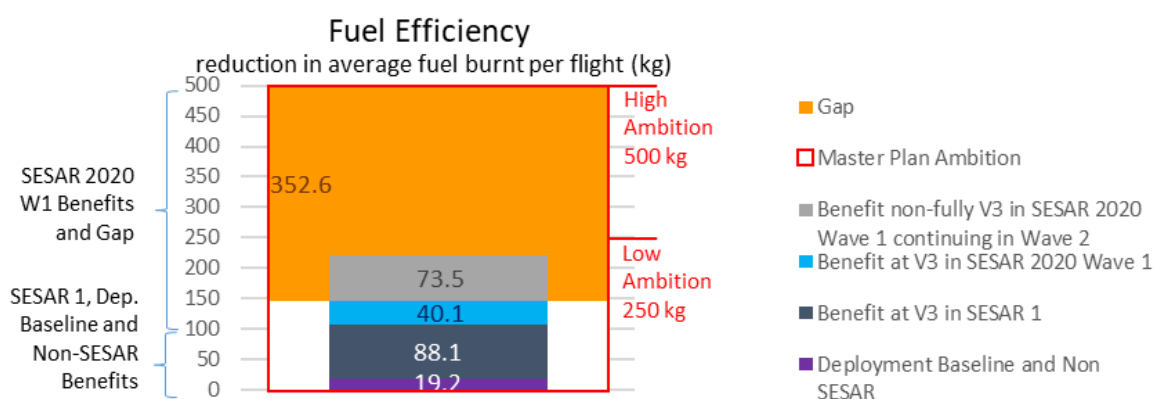
SESAR has a wide range of solutions to improve the efficiency of air traffic management, some of which are specifically designed to improve environmental performance, by reducing noise impact around airports and/or fuel consumption and emissions in all phases of flight. A catalogue of SESAR Solutions is available<sup>41</sup> and those addressing environment impacts are identified by the following pictogram:



#### 4.3.1.4 SESAR2020 Industrial Research and Validation - Environmental Performance Assessment

The systematic assessment of environmental impacts of aviation are at the heart of SESAR Industrial Research and Validation activities since SESAR 1, with a very challenging target on fuel/CO<sub>2</sub> efficiency of 500kg of fuel savings on average per flight.

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



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

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<sub>2</sub> saved, equivalent to the CO<sub>2</sub> emitted by 165,000 Paris-Berlin flights; or a city of 258,000 European citizens; or the CO<sub>2</sub> captured by 95 million trees per year.

<sup>41</sup> <https://www.sesarju.eu/news/sesar-solution-catalogue-third-edition-now-out>

In SESAR, a value of 5,280 Kg of fuel per flight for the ECAC (including oceanic region) is used as a baseline<sup>42</sup>. Based on the information provided by the PAGAR 2019 document<sup>43</sup>, the benefits at the end of Wave 1 could be about 3% CO<sub>2</sub>/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<sub>2</sub>/fuel savings (352.6kg of fuel) to reach the initial Ambition target of about 10% CO<sub>2</sub>/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<sup>44</sup>.

#### 4.3.1.5 SESAR AIRE demonstration projects

In addition to its core activities, the SESAR JU co-financed projects where ATM stakeholders worked collaboratively to perform integrated flight trials and demonstrations of solutions. These aimed to reduce CO<sub>2</sub> emissions for surface, terminal, and oceanic operations and substantially accelerate the pace of change. Between 2009 and 2012, the SESAR JU co-financed a total of 33 “green” projects in collaboration with global partners, under the Atlantic Interoperability Initiative to Reduce Emissions (AIRE).

AIRE<sup>45</sup> 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<sub>2</sub>), 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.

#### 4.3.1.6 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<sup>46</sup>, 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.

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<sup>42</sup> See SESAR ATM Master Plan – Edition 2020 ([www.atmmasterplan.eu](http://www.atmmasterplan.eu)) - eATM

<sup>43</sup> See SESAR Performance Assessment Gap Analysis Report (PAGAR) updated version of 2019 v00.01.04, 31-03-2021

<sup>44</sup> See SESAR Exploratory Research projects - <https://www.sesarju.eu/exploratoryresearch>

<sup>45</sup> [https://ec.europa.eu/transport/modes/air/environment/aire\\_en#:~:text=The%20joint%20initiative%20AIRE%20\(Atlantic,NEXTGEN%20in%20the%20United%20States](https://ec.europa.eu/transport/modes/air/environment/aire_en#:~:text=The%20joint%20initiative%20AIRE%20(Atlantic,NEXTGEN%20in%20the%20United%20States)

<sup>46</sup> <https://www.sesarju.eu/projects/ALBATROSS>

#### 4.3.1.7 Preparing SESAR

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

The SRIA<sup>47</sup> identifies inter-alia the need to continue working on “optimum green trajectories”, on non-CO<sub>2</sub> impacts of aviation, and the need to accelerate decarbonisation of aviation through operational and business incentivisation.

### ASSESSMENT

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

**Table 9.** CO<sub>2</sub> emissions forecast for the ATM improvements scenarios.

| Year                                                                                                       | CO <sub>2</sub> emissions (10 <sup>9</sup> kg) |                               |
|------------------------------------------------------------------------------------------------------------|------------------------------------------------|-------------------------------|
|                                                                                                            | Baseline Scenario                              | Implemented Measures Scenario |
|                                                                                                            |                                                | ATM improvements              |
| 2030                                                                                                       | 160.29                                         | 149.9                         |
| 2040                                                                                                       | 197.13                                         | 177.4                         |
| 2050                                                                                                       | 210.35                                         | 197.4                         |
| <i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i> |                                                |                               |
| <i>Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels.</i>    |                                                |                               |

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<sup>47</sup> <https://www.sesarju.eu/node/3697>



#### 4.4. MARKET-BASED MEASURES



##### 4.4.1 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<sub>2</sub> 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<sub>2</sub> emissions above average 2019/2020 levels through standard international CO<sub>2</sub> emissions reductions units which would be put into the global market. This major achievement was most welcome by European States which have actively promoted the mitigation of international emissions from aviation at a global level.

##### 4.4.1.1 Development and update of ICAO CORSIA standards

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

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

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

#### 4.4.1.2 CORSIA implementation

In application of their commitment in the 2016 “Bratislava Declaration” the 44 ECAC Member States have notified ICAO of their decision to voluntarily participate in CORSIA from the start of the pilot phase in 2021 and have effectively engaged in its implementation. This shows the full commitment of the EU, its Member States and the other Member States of ECAC to counter the expected in-sector growth of total CO<sub>2</sub> emissions from air transport and to achieving overall carbon neutral growth.

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

### ASSESSMENT

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

#### 4.4.2 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<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> 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<sup>48</sup> 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%<sup>49</sup>, and will be revised to be aligned with the latest Conclusions in December 2020<sup>50</sup>, 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

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<sup>48</sup> <http://www.consilium.europa.eu/en/meetings/european-council/2014/10/23-24/>

<sup>49</sup> 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>

<sup>50</sup> [1011-12-20-euco-conclusions-en.pdf \(europa.eu\)](#)

"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<sup>51</sup>.

Following the 2013 ICAO agreement on developing CORSIA, the EU decided<sup>52</sup> 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<sup>53</sup>.

The legislation maintains the scope of the EU ETS for aviation limited to intra-EEA flights and sets out the basis for the implementation of CORSIA. It provides for European legislation on the monitoring, reporting and verification rules through a delegated act under the EU ETS Directive of July 2019<sup>54</sup>. 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"<sup>55</sup>.

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<sup>51</sup> Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0101>

<sup>52</sup> Decision No. 377/2013/EU derogating temporarily from Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, <http://eur-lex.europa.eu/LexUriServLexUriServ.do?uri=CELEX:32013D0377:EN:NOT>

<sup>53</sup> Regulation (EU) 2017/2392 of the European Parliament and of the Council of 13 December 2017 amending Directive 2003/87/EC to continue current limitations of scope for aviation activities and to prepare to implement a global market-based measure from 2021, [http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L\\_.2017.350.01.0007.01.ENG&toc=OJ:L:2017:350:TOC](http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2017.350.01.0007.01.ENG&toc=OJ:L:2017:350:TOC)

<sup>54</sup> Commission Delegated Regulation (EU) 2019/1603 of 18 July 2019 supplementing Directive 2003/87/EC of the European Parliament and of the Council as regards measures adopted by the International Civil Aviation Organisation for the monitoring, reporting and verification of aviation emissions for the purpose of implementing a global market-based measure [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L\\_.2019.250.01.0010.01.ENG](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2019.250.01.0010.01.ENG)

<sup>55</sup> [2021\\_commission\\_work\\_programme\\_new\\_policy\\_objectives\\_factsheet\\_en.pdf \(europa.eu\)](#)

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<sup>56</sup> 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<sub>2</sub> emissions

The EU ETS has delivered around 200 MT of CO<sub>2</sub> emission reductions between 2013 and 2020<sup>57</sup>. While the in-sector aviation emissions for intra-EEA flights kept growing, from 53,5 million tonnes CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> equivalent<sup>58</sup>.

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

In terms of its contribution towards the ICAO carbon neutral growth goal from 2020, the states implementing the EU ETS have delivered, in "net" terms, the already achieved reduction of around 200 MT of aviation CO<sub>2</sub> emissions will continue to increase in the future under the new legislation. Other emission reduction measures taken, either collectively throughout Europe or by any of the states implementing the EU ETS, will also contribute towards the ICAO global goals. Such measures are likely to moderate the anticipated growth in aviation emissions.

## ASSESSMENT

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<sup>56</sup> 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.

<sup>57</sup> See the 2019 European aviation environmental report: "Between 2013 and 2020, an estimated net saving of 193.4 Mt CO<sub>2</sub> (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>

<sup>58</sup> [https://ec.europa.eu/clima/news/carbon-market-report-emissions-eu-ets-stationary-installations-fall-over-9\\_en](https://ec.europa.eu/clima/news/carbon-market-report-emissions-eu-ets-stationary-installations-fall-over-9_en)

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

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

| <i>Estimated emissions reductions resulting from the EU-ETS<sup>59</sup></i> |                                              |
|------------------------------------------------------------------------------|----------------------------------------------|
| <i>Year</i>                                                                  | <i>Reduction in CO<sub>2</sub> emissions</i> |
| <i>2013-2020</i>                                                             | <i>~200 MT<sup>60</sup></i>                  |

Those benefits illustrate past achievements.

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<sup>59</sup> Include aggregated benefits of EU ETS and Swiss ETS for 2020.

<sup>60</sup> See the 2019 European aviation environmental report: "Between 2013 and 2020, an estimated net saving of 193.4 Mt CO<sub>2</sub> (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>



## 4.5. ADDITIONAL MEASURES

### 4.5.1 ACI Airport Carbon Accreditation

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

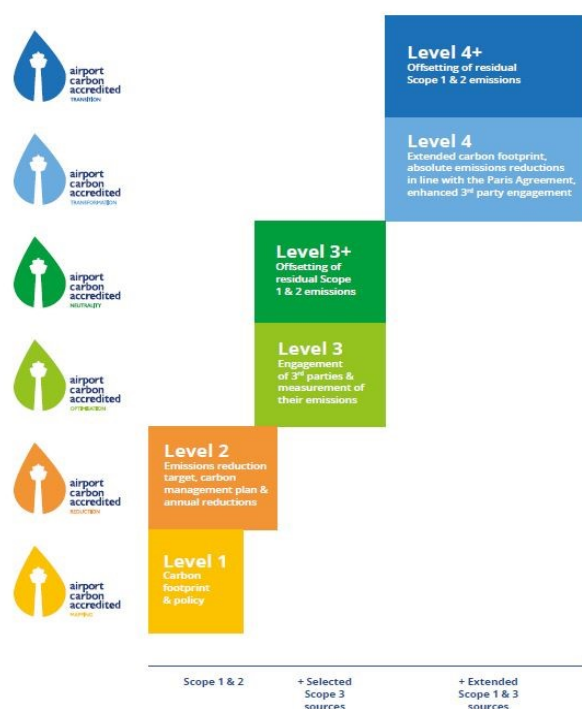
This industry-driven initiative was officially endorsed by EUROCONTROL and the European Civil Aviation Conference (ECAC). The programme is overseen by an independent Advisory Board comprised of many distinguished, independent experts from the fields of aviation and environment, including the European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



The underlying aim of the programme is to encourage and enable airports to implement best practice carbon and energy management processes and to gain public recognition of their achievements. It requires airports to measure their CO<sub>2</sub> 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<sup>61</sup>.

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



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

As of 31 March 2021, there are in total 336 airports in the programme worldwide. They represent 74 countries and 45.9% of global air passenger traffic. 112 reached a Level 1, 96 a Level 2, 63 a Level 3 and 60 a Level 3+ accreditation. Furthermore, five airports have already achieved accreditation at the newly introduced levels: 1 a Level 4 and 4 airports a Level 4+ accreditation.

One of its essential requirements is the verification by external and independent auditors of the data provided by airports. The Administrator of the programme has been collecting CO<sub>2</sub> data from participating airports since the programme launch. This has allowed the absolute CO<sub>2</sub> reduction from the participation in the programme to be quantified.

<sup>61</sup> Interim Report 2019 – 2020, *Airport Carbon Accreditation* 2020

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<sub>2</sub> 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.

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

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

**Table 12:** Emissions offset for the European region

|                                                          | 2015-2016 | 2016-2017 | 2017-2018 | 2018-2019 |
|----------------------------------------------------------|-----------|-----------|-----------|-----------|
| Aggregate emissions offset, Level 3+ (tCO <sub>2</sub> ) | 222339    | 252218    | 321170    | 375146    |

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

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

| Indicator                                                                                       | Unit                   | Time Period (2018/2019) | Absolute change compared to the 3-year rolling average | Change (%) |
|-------------------------------------------------------------------------------------------------|------------------------|-------------------------|--------------------------------------------------------|------------|
| Aggregate scope 1 & 2 emissions from airports at Levels 1-3+                                    | tCO <sub>2</sub>       | 6,520,255               | -322,297                                               | -4.9%      |
| Scope 1 & 2 emissions per passenger from airports at Levels 1-3+                                | kgs of CO <sub>2</sub> | 1.81                    | -0.09                                                  | -4.3%      |
| Scope 1 & 2 emissions per traffic unit from airports at Levels 1-3+                             | kgs of CO <sub>2</sub> | 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 <sub>2e</sub>      | 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 <sub>2</sub>       | 60,253,685              | 6,895,954                                              | 12.9%      |

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

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

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

## ASSESSMENT

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

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



The Destination 2050<sup>62</sup> 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<sub>2</sub> 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<sub>2</sub> emissions from all flights within and departing from the European Economic Area, Switzerland and the UK by 45% by 2030 compared to the baseline<sup>63</sup>. In 2030, net CO<sub>2</sub> 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<sub>2</sub> emissions from flights within and departing from the European Economic Area, Switzerland and UK.

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

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

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

#### **ASSESSMENT**

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

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<sup>62</sup> [www.destination2050.eu](http://www.destination2050.eu)

<sup>63</sup> A hypothetical 'no-action' scenario whereby CO<sub>2</sub> emissions are estimated based on the assumption that aircraft deployed until 2050 have the same fuel efficiency as in 2018.

#### 4.5.3 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<sub>2</sub> emissions and average CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> 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.

#### 4.5.4 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.

##### 4.5.4.1 EASA capacity-building partnerships

EASA has been selected as an implementing Agency for several of these initiatives, including the **EU-South East Asia Cooperation on Mitigating Climate Change impact from Civil Aviation** (EU-SEA CCCA), launched in 2019, and a **Capacity Building Project for CO<sub>2</sub> Emissions Mitigation in the African and Caribbean Region**, launched in 2020.

The overall objective of these projects<sup>64</sup> is to enhance the partnership between the EU and partner States in the areas of civil aviation environmental protection and climate change, and to achieve long-lasting results that go beyond the duration of the projects. The specific objectives of the two projects are to develop or support existing policy dialogues with partner States on mitigating GHG emissions from civil aviation, to contribute to the CORSIA readiness process of partner States, as well as to implement CORSIA in line with the agreed international schedule, including considerations of joining the voluntary offsetting phase starting in 2021 or at the earliest time possible. On top of the CORSIA-related support, these projects are assisting the partner States in the development and update of the State Action Plans to reduce CO<sub>2</sub> 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<sub>2</sub> 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.

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<sup>64</sup> <https://www.easa.europa.eu/domains/international-cooperation/easa-by-country/map#group-easa-extra>

#### 4.5.4.2 ICAO - European Union Assistance Project

The assistance project *Capacity Building on CO<sub>2</sub> 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<sub>2</sub> 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<sup>65</sup>.

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

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

#### ASSESSMENT

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



<sup>65</sup> [https://www.icao.int/environmental-protection/Documents/ICAO-EU\\_Project\\_FinalReport.pdf](https://www.icao.int/environmental-protection/Documents/ICAO-EU_Project_FinalReport.pdf)

#### 4.5.5. 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.

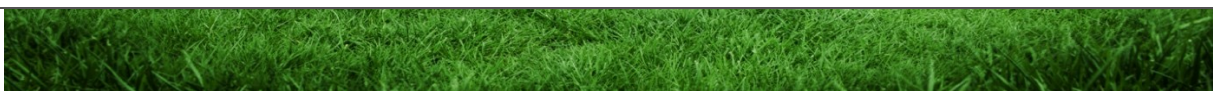
The deadline to receive project proposals was closed in January 2021 and at the time of this action plan update the proposals are under revision. Future action plan updates will provide further information on the benefits of the implementation of this measure.

#### **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.



#### 4.6. 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<sub>2</sub> 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<sub>2</sub> savings. Those are summarized below.

##### 4.6.1 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<sub>2</sub> additional emissions benefits from the reduction of fuel burn that an airport operator can control, guide and influence.

##### 4.6.2 ReFuelEU Aviation Initiative

Through the large-scale use of SAF, emissions of other pollutants impacting local air quality and other non-CO<sub>2</sub> effects on the climate can also be reduced, implying important potential supplemental benefits beyond CO<sub>2</sub> emissions reductions.

In addition to the reduction of CO<sub>2</sub> 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<sub>x</sub>) with 100%, compared to fossil jet fuel<sup>66</sup>.

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.

<sup>66</sup> [ICAO 2016 Environmental Report](#), Chapter 4, Page 162, Figure 4.

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

#### 4.6.3 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<sup>67</sup>:** 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, NO<sub>x</sub>, SO<sub>x</sub> 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<sub>x</sub> and SO<sub>x</sub>.

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

#### 4.6.4 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<sub>2</sub> 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<sub>2</sub> emissions and noise impacts**.

It should be noted that although no targets have yet been set for non-CO<sub>2</sub> 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.

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<sup>67</sup> <https://aviatorproject.eu>

#### 4.6.5. 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<sub>2</sub> 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<sub>2</sub> 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.

was terminated due to the planned reconstruction of the airport infrastructure by January 2021.

## Article 5 National Actions in the Slovak Republic

The Slovak Republic as a member state of the European Union takes various actions to meet the climate change goals.

Although the impact of the climate change is contrasting in different regions of the world, its socio-economic and environmental impact always needs an active solution. Necessary political measures have to stem from detailed analysis of the current greenhouse gas emissions in every sector, including aviation sector, emission projections and impact assessment of adopted or planned policy measures.

### 5.1. Airspace optimisation and flight procedures changes

#### Airspace optimisation - Projects/actions completed

On 6 December 2018, the implementation of the FRA flight planning concept was carried out in the Bratislava CTA (controlled area) over FL245. The Bratislava CTA area above FL245 joined the SEEN FRA cross border area applicable daily at 2300 - 0500 (2200 - 0400) UTC. Operators, especially airspace users using "Heavy" category aircraft, could efficiently plan flights in the airspace of 4 states, i.e. over Slovakia, Hungary, Romania, Bulgaria, during 6 hours daily without restrictions resulting from the existence of interstate geographical borders and by minimizing the restrictive measures by ATS providers.

On 28 March 2019, the implementation of FRA concept flight planning within the CTA Bratislava area over FL245 was implemented within the CTA Bratislava boundaries daily at 0500 - 2300 (0400 - 2200) UTC. Despite the increase in traffic complexity caused by the implementation of the FRA concept with the then huge increase in traffic and its density during the daily peaks, ATS level constraints were minimised to maintain the current airspace throughput and to maintain the safety level.

On 6 November 2019, an extension of the period when flights could be scheduled in the SEEN FRA environment was implemented daily between 2000 - 0600 (1900 - 0500) UTC, i.e. 10 hours.

On 28 January 2021, the concept of cross-border FRA, or the SEE FRA initiative, was successfully transformed into H24. Operators are thus allowed to continuously schedule flights under the concept of cross-border FRA through the airspace of 4 States - Slovakia, Hungary, Romania and Bulgaria.

#### Airspace optimisation - Projects/actions scheduled

A follow-up project for further optimisation of flight planning according to the concept of cross-border FRA in Central Europe is to implement this concept between Poland and Slovakia. The cooperation between LPS SR, s.p. and PANSA will culminate in the application of cross-border FRA planning on 24 February 2022.

Concurrently with the above mentioned in point the national ANSP (LPS SR) is actively cooperating with the SEE FRA Initiative partners and MOLDATSA to extend the cross-border FRA concept to the airspace of Moldova with the same effective date.

As a result, mainly thanks to the international cooperation of the national ANSP as of 24 February 2022, airspace users will be able to efficiently plan flights without limits imposed by

national borders across the airspace of 7 Central and South-Eastern European countries covering an area of 1 million km<sup>2</sup>.

Given the seamless experience of cross-border shortening of flights by air traffic controllers at ACC Bratislava and ACC Vienna during COVID-19, it will also be possible from 1 July 2021 to plan predefined direct routes across the Slovak-Austrian border.

At the Functional Airspace Bloc (FAB) level, an Airspace Redesign Task Force - FABCE ATF - was established within FABCE in response to the so-called Airspace Architecture Study, published by SESAR and European Commission. The ultimate goal is for ANSPs in Central and South East Europe to work together to implement a cross-border FRA concept capable of meeting operational requirements in the long term. The plan foresees to restructure the relevant parts of each country's airspace. The cooperation of the 16 States is coordinated by NM EUROCONTROL.

#### Flight procedures changes

On 7 November 2019, RNP 1 departure routes from runways 06 and 24 were implemented at LZZI Airport and on 3 December 2020, RNAV 1 departure routes from runways 09 and 27 were implemented at LZTT.

On the basis of the approved PBN implementation plan in the Slovak Republic:

- RNAV 1 arrival and departure lines at LZIB and LZKZ airports are planned to be implemented in 2021,
- the implementation of RNAV 1 of arrival and departure routes at LZPP airport is planned for 2022.
- The implementation of the PBN concept, especially arrival and departure RNAV routes, will lead to their significant shortening and thus to a reduction in fuel consumption and CO<sub>2</sub> emissions.

#### 5.2. Air traffic control impact on CO<sub>2</sub> emissions reduction

Air Traffic Controllers (ATCOs) of ACC Bratislava perform daily and almost H24 tactical coordination with neighbouring ACC Warszawa, ACC Budapest, ACC Vienna and ACC Prague and issue clearances to fly direct routes through the airspace of 3 States. The constraints to more significantly reduce emission are mostly in form of military activities or, during peak times of the day, air traffic flow management measures necessary in order to maintain maximum sector capacities.

ATCOs at APP and TWR units continuously conduct tactical coordination with adjacent units and issue clearances to fly a direct route.

The national ANSP continuously submits proposals to the military counterparts to redesignate restricted areas for military operations in consideration of the current volume and nature of traffic. The objective is to enable permanent flight path planning with the most efficient trajectory to the international airports in the Bratislava FIR with the on-going military activity.

#### Quantification of the benefits of the implemented initiatives for the reduction of CO<sub>2</sub> emissions

In view of the extraordinary dynamic development, but especially the development of air traffic in the EU area in 2016-2019 and the subsequent sharp decline caused by the pandemic situation COVID-19, it is not feasible to make an objective comparison of the situation before

and after the implementation of the above changes. There are too many factors affecting possible attempts to analyse the benefits within the Bratislava FIR area, which change monthly. The airspace structure is changing not only in the Bratislava FIR but also in neighbouring States and in the Central European area, which has an extremely interactive effect on flight planning, the volume and nature of traffic.

Operators are also changing their preferences in time and space. The impact of low-cost airlines on traffic patterns is very significant - in pursuing their expansion, they are looking for 'city-pairs' that are out of line with the standards of previous periods, while at the same time flexibly cancelling connections if these do not have a positive effect on the airline's economic performance.

Another negative impact on the possible objective quantification is the ever-changing political situation over time, with dramatic consequences for the viability of the flights.

The positive benefit for efficient flight operations based on the filed flight plan principle following the introduction of these changes required by the EU regulation in the airspace structure area (FRA implementation) confirms the permanent pressure of operators to move further in this direction, thus in the end the benefit for flight operations efficiency also means a reduction of CO2 emissions.

### 5.3. Operational and Technical Measures at the International Airports of the Slovak Republic

#### 5.3.1. Operational measures

##### **Airport Košice:**

The airport Košice is committed to protective and conscientious interaction with the environment and pledges to comply with all environmental laws, regulations, binding agreements and official requirements and to minimize continuously the negative ecological impact of its business operations. First and foremost, the airport Košice has set the goal of further reducing its energy consumption, reducing the effects of noise emissions while further reducing airport's CO2 emissions, so that it will become CO2-neutral over the medium term. The Airport Košice has established a comprehensive and systematic energy and environmental management system (EMS – “Green Airport”) and subjects itself to an environmental audit in line with the ISO 14001 standard.

The certificate is valid for three years and is reissued following an external recertification audit. In the interim, annual monitoring audits review the achievement of the set goals and adherence to the defined rules. External monitoring audits took place in 2021. Another recertification audit is planned in 2022. Subsequently, environmental policy, objectives and measures are determined and their progress and the performance of the overall system regularly examined on the basis of specified key performance indicators, annual management reviews and in the context of internal and external audits. Responsibility for the successful implementation of the EMS is with the Management Board and the executives according to the Company line organization.

**Airport Žilina:**

The airport Žilina foresees application of the following principles to reduce its carbon footprint:

1. to adhere as far as possible to the principles of green (electronic) communication
2. to enforce and adhere to energy conservation principles (adherence to maintenance intervals, installation of energy-saving components, minimization of inefficient operating conditions, etc.)
3. to maintain the ratio of green and non-green areas owned by the company at the 2020 level (in case of expansion of built-up areas, carry out replacement tree planting at a ratio of 10m<sup>2</sup> : 1 tree)
4. to maintain the number of trees on company-owned land in 2020. In the event of felling, e.g. for operational reasons, plant replacement trees at a ratio of 1:1
5. in regards to the renewal of the company's technology and equipment - to procure technology and equipment with reduced energy consumption as far as possible, while complying with the current emission standards
6. in regards to purchasing new company equipment and machinery – to procure, as far as possible, equipment and machinery with reduced energy consumption while complying with the emission standards currently in force

**5.3.2. Technical Measures****5.3.2.1. Vehicle fleets and GPUs****Airport Bratislava:**

The fleet of vehicles and technical equipment used for ground handling of aircraft has undergone modernisation in recent years, during which the old ground power units (GPU) have been phased out and replaced by new ones with lower power outputs and more economical diesel-powered power units with 33% lower fuel consumption and with an automatic shutdown function after a specified time without load.

New passenger stairs with electric sliding and adjustment and a fully electric belt for unloading luggage from the aircraft were also purchased.

Based on the operating experience of having loaned few electric vehicles, the fleet of passenger vehicles was renewed by purchasing electric vehicles (five vehicles), and hybrid vehicles (two vehicles). To illustrate, three of the electric vehicles travel an average of 2,000km each per year on short routes in the airport area, which represents a saving of approximately 720 litres of diesel fuel compared to the previously owned diesel vehicles. The other two have an average annual mileage of about 15,000km each, which represents saving additional 3,600 litres of diesel.

The maintenance system for the vehicles, equipment and machinery used for ramp services and the operation and maintenance of the airport's aprons is undergoing a gradual modernisation, where the resulting effect should be to optimise costs and operational repairs and to move towards preventive maintenance, which will ultimately ensure the early identification of inefficiently operated equipment and its timely replacement with more efficient and lower CO<sub>2</sub>-emitting equipment.

In the coming years, further renewal of the fleet is planned, namely purchasing up to 6 new airport buses with lower operating costs, electric propulsion being also considered.

**Airport Košice:**

Airport Košice has started gradual replacement of vehicles by electric ones and using e-bikes and e-motorbikes together with e-charging stations.

**Airport Poprad – Tatry:**

For the operation of Airport Ground Support Equipment (GSE) and other special vehicles, the plan includes the following points and specific solutions:

The airport currently uses diesel forklift trucks for all handling processes related to loading and unloading of baggage as well as cargo.

The handling processes also involves GSE vehicles with a production year of 1980, which certainly do not contribute to the improvement of emissions in air transport. These vehicles provide refuelling of drinking water to the aircraft as well as cleaning of the lavatory bins.

Replacing these vehicles with electric, fuel-efficient and, above all, environmentally friendly ones will certainly help the plan to reduce emissions. The gradual introduction of electric vehicles in the transport system is aimed at the transition to low- and zero-emission forms of transport, a trend that also strategically defined at European Commission level and is part of the so-called “low carbon economy”. Transport is currently responsible for a quarter of greenhouse gas emissions and is the dominant air polluter.

Negotiations are currently underway with a company supplying energy-saving electric trolleys and other equipment related to the aircraft handling process. Specifically, an electric handling trolley has been purchased and has been in service at the airport since 2017. Another is expected to follow in 2022 and phase out older equipment as needed.

**Airport Piešťany:**

Currently all aircraft stairs which are mechanical or battery powered, while majority of the luggage trolleys are also battery-powered. A plan is in place to switch completely all ground services provided for airlines operators to be exclusively battery powered.

**Airport Žilina:**

A programme for fleet modernisation of passenger cars used by the airport company is in place for the period 2021-2025, which consists of the following milestones:

- a. (2021-2022) replacement of 25% of the fleet by electric or hybrid vehicles with reduced emissions;
- b. (2021-2022) replacement of another 25%.
- c. (2025) replacement of another 25%.

An installation of a public vehicle charging station in the public car parking to promote electro-mobility is also considered.

### 5.3.2.2. Lighting systems

**Airport Bratislava:**

In 2019, the airport implemented the replacement of the approach light system at RWY 04-22. The original light temperature sources, halogen bulbs, were replaced with LED technology based light sources. The reduction in electricity consumption after the reconstruction of the approach lighting system is around 50% compared to the original one.

In 2020, the apron lights were widely replaced. The original discharge lamps were replaced by LED-based light source. The electricity savings after the refurbishment are around 50 %

compared to the original technology. In addition, the new technology brings the possibility of light flux control (lower consumption), which was not possible with discharge lamps. A gradual replacement of discharge lamps by LED lamps is planned in the coming years in the Terminals and Airport buildings. At the same time, the installation of solar panels on the terminal roof is being considered.

**Airport Košice:**

Very important is the ongoing project of conversion of conventional lighting to more energy-efficient LED technology. Another focus is the sustainable construction of future buildings and the energy optimization of existing buildings.

**Airport Poprad – Tatry:**

It is planned to replace the lighting in all buildings and also all car park lighting with LED technology (the old car park was lit only by 4 LED floodlights and new car park would be replaced by sodium lamps with LEDs).

By 2025 it is planned to replace the runway lighting with LED technology (in connection with the complete reconstruction of the runway 09/27).

**Airport Piešťany:**

When replacing part of the airport lighting, it is planned to gradually replace the contemporary standard system connected to electrical grid by solar technology and LEDs, which will significantly reduce the cost of electricity consumption and other operating costs.

**Airport Žilina:**

A programme to adapt public lighting systems to use LED technology is in place for the period 2021-2025, which consists of the following milestones:

- a. (2021-2022) adapting 75% of public lighting to use LED technology
- b. (2023-2024) adaptation of remaining 25%
- c. (2025) 100% transition to LED technology, excluding aeronautical equipment

5.3.2.3. Power distribution and heating

**Airport Bratislava:**

Since 2018, a gradual reconstruction of the power distribution system, power substations, has been underway, which also entails the process in which of outdated distribution transformers with high losses would be replaced by transformers with lower losses. The reduction in losses is estimated to be about 10% compared to the original transformers.

**Airport Košice:**

Three photovoltaic power stations installed in 2013 as a substantial part of the “Green Airport” program have delivered positive results from the date of its installation. In 2020, a total of 145 Megawatt hours of electrical energy were produced by this system. For the period 2013 – 2020, 1.114 Megawatt hours of electrical energy were produced. The installation of the photovoltaic systems is one of many other measures in the energy-efficient environmental management at Košice Airport.

**Airport Poprad – Tatry:**

By 2021 it is planned to prepare and building a network for intelligent street lighting (the lights would normally be only 30% lit, when a vehicle or pedestrian approaches, they light up to 80% with a gradual dimming to 100% and then dimming to the original 30%. There is then also a saving on the device itself, as it breaks down later.

By 2023 (project documentation under preparation) insulation of buildings connected with replacement of windows and insulation of roofs is planned (this is to reduce the overall energy consumption of the buildings). Replacement of internal piping in the buildings (hot and cold-water pipes, heating pipes, radiators, waste) is planned at the same period. Another plan (also by 2023) is to purchase new appliances in energy class A+++ (now only A) such as refrigerators, dishwashers, hobs and to replace all old desktop PCs by new ones (ideally laptops).

**Airport Piešťany:**

In 2018, a comprehensive reconstruction of the replacement power supply for the airport's lights systems. The new spare power supply is combined with a battery power supply and the result of this reconstruction was a significant reduction in the consumption of fossil fuels to produce 1Kwh of electricity.

**Airport Žilina:**

Target is in place for 2021-2022 to reduce emission through the use of renewable energy for water heating in the company's operational buildings. In 2025 installation of 50% of more efficient and environmentally friendly boilers for heating company-owned operational buildings is planned.

#### 5.4. Other measures

**Airport Košice:****Waste**

Unavoidable waste is appropriately sorted and assigned for reuse or recycling, depending on the options available. The airport continues with the development of the waste management programs, which results in cost savings to the airport company. Dangerous wastes are being removed from the airport and this process is monitored regularly.

**Water consumption**

Košice Airport is a consumer of drinking water and a producer of waste water. The protection of surface and ground water is monitored at specific wells, which are located around the perimeter of the airport. All handling areas at the airport are strengthened and drained away through the gravity traps and petroleum product catchers, including runways and taxiways. This water protection process is in accordance with local environmental requirements and it is also monitored regularly.

**Airport Piešťany:**

It is planned to provide some safety and in particular security related activities by drones, in limited and regulated manner, which will increase the efficiency of the activities carried out and, in particular, significantly reduce the consumption of fossil fuels.

## Article 6 Conclusion

This Action Plan was finalized by using the data from 2019 and shall be considered as subject to update the version from 2019.

Appendix A  
Detailed results for ECAC scenarios from Article 3

## 1. BASELINE SCENARIO

### a) Baseline forecast for international traffic departing from ECAC airports

| Year | Passenger Traffic (IFR movements) (million) | Revenue Passenger Kilometres <sup>68</sup> RPK (billion) | All-Cargo Traffic (IFR movements) (million) | Freight Tonne Kilometres transported <sup>69</sup> FTKT (billion) | Total Revenue Tonne Kilometres <sup>70</sup> 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<sub>2</sub> emissions forecast for the baseline scenario

| Year                                                                                                       | Fuel Consumption (10 <sup>9</sup> kg) | CO <sub>2</sub> emissions (10 <sup>9</sup> 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                    |
| <i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i> |                                       |                                                |                          |                          |

<sup>68</sup> Calculated on the basis of Great Circle Distance (GCD) between airports, for 97% of the passenger traffic for forecast years.

<sup>69</sup> Includes passenger and freight transport (on all-cargo and passenger flights).

<sup>70</sup> 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<sub>2</sub> emissions of international passenger traffic departing from ECAC airports, with aircraft technology improvements after 2019 included:

| Year                                                                                                       | Fuel Consumption (10 <sup>9</sup> kg) | CO <sub>2</sub> emissions (10 <sup>9</sup> kg) | Well-to-wake CO <sub>2</sub> e emissions (10 <sup>9</sup> 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                    |
| <i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i> |                                       |                                                |                                                               |                          |                          |

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<sub>2</sub> emissions of international passenger traffic departing from ECAC airports, with aircraft technology and ATM improvements after 2019:

| Year | Fuel Consumption (10 <sup>9</sup> kg) | CO <sub>2</sub> emissions (10 <sup>9</sup> kg) | Well-to-wake CO <sub>2</sub> e emissions (10 <sup>9</sup> 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 |
| <i>For reasons of data availability, results shown in this table do not include cargo/freight traffic.</i> |       |        |        |        |       |

*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<sub>2</sub>e emissions forecasts for the scenarios described in this common section*

| Year                                                                                                                                                                                                    | Well-to-wake CO <sub>2</sub> e emissions (10 <sup>9</sup> kg) |                                         |                                         | % improvement<br>by Implemented<br>Measures (full<br>scope) |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|-----------------------------------------|-----------------------------------------|-------------------------------------------------------------|
|                                                                                                                                                                                                         | Baseline<br>Scenario                                          | Implemented Measures Scenario           |                                         |                                                             |
|                                                                                                                                                                                                         |                                                               | Aircraft techn.<br>improvements<br>only | Aircraft techn. and ATM<br>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.<br>Note that fuel consumption is assumed to be unaffected by the use of sustainable aviation fuels. |                                                               |                                         |                                         |                                                             |

## Appendix B

### Note on the methods to account for the CO<sub>2</sub> emissions attributed to international flights

#### 1. Background

The present note addresses recommendations on the methodologies to account the CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> Emissions Reduction Activities document (3rd edition). One of its objectives is to define a common approach for accounting CO<sub>2</sub> emissions of international flights: two different methods are proposed for CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> accounting methods (§3.2):

- a) ICAO: each State reports the CO<sub>2</sub> emissions from the international flights operated by aircraft registered in the State (State of Registry).
- b) IPCC: each State reports the CO<sub>2</sub> 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                                                                                                                                                                                                                                                          |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Definition</b>      | 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. |
| <b>Use in projects</b> | CORSIA/ETS (partially)                                                                                                                                                                                                                                                                                         | IPCC<br>EAER<br>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<sub>2</sub> 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)<br>% difference number of<br>operations | (ICAO – IPCC)<br>% difference number of flown<br>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<sub>2</sub> 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.

## Appendix C

### List of abbreviations

**AAT** - Aircraft Assignment Tool

**ACARE** – Advisory Council for Research and Innovation in Europe

**ACA** – Airport Carbon Accreditation

**ACI** – Airports Council International

**AIRE** – The Atlantic Interoperability Initiative to Reduce Emissions

**ANS** – Air Navigation Service

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

**ATC** – Air Traffic Control

**ATM** – Air Traffic Management

**CAEP** – Committee on Aviation Environmental Protection

**CNG** – Carbon neutral growth

**CORSIA** - Carbon Offsetting and Reduction Scheme for International Aviation

**EAER** – European Aviation Environmental Report

**EASA** – European Aviation Safety Agency

**EC** – European Commission

**ECAC** – European Civil Aviation Conference

**EEA** – European Economic Area

**EFTA** – European Free Trade Association

**EU** – European Union

**EU ETS** – the EU Emissions Trading System

**FAB** – Functional Airspace Block

**FRA** – Free Route Airspace

**GHG** – Greenhouse Gas

**ICAO** – International Civil Aviation Organisation

**IFR** – Instrumental Flight Rules

**IPCC** – Intergovernmental Panel on Climate Change

**IPR** – Intellectual Property Right

**JU** – Joint Undertaking

**LPS SR** – Letové prevádzkové služby Slovenskej republiky, š.p. (Air Navigation Services Provider)

**LTO cycle** – Landing/Take-off Cycle

**MBM** – Market-based Measure

**MT** – Million tonnes

**NM** – Network manager

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

**RED** – Renewable Energy Directive

**RPK** – Revenue Passenger Kilometre

**RTK** – Revenue Tonne Kilometre

**RTD** – Research and Technological Development

**RWY** - Runway

**SAF** – Sustainable Aviation Fuels

**SEE FRA** – South East Europe Free Route Airspace

**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

# **ACTION PLAN ON CO<sub>2</sub> EMISSIONS REDUCTION OF THE SLOVAK REPUBLIC**

## **REPORT ON CO<sub>2</sub> EMISSIONS AND FUEL CONSUMPTION**

**UPDATE JUNE 2021**

Ministry of Transport and Construction of the Slovak Republic  
General Directorate of Civil Aviation

## Aviation Emissions

### Fuel Consumption

According to the expert assessment of Transport Research Institute, it was determined, that from the total amount of fuel 90% of Jet Kerosene was used on the international flights and 10% on the domestic flights, while 90% of Aviation Gasoline was used on the domestic flights and 10% on the international flights.

The total amount of fuel in liters was converted into TJ in compliance with density a calorific value.

|                                                                                |                                    | 2000   | 2001   | 2002   | 2003   | 2004   | 2005   | 2006    | 2007    | 2008    | 2009    | 2010   | 2011   | 2012   | 2013   | 2014   | 2015   | 2016   | 2017   | 2018   | 2019   |
|--------------------------------------------------------------------------------|------------------------------------|--------|--------|--------|--------|--------|--------|---------|---------|---------|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| CORINAIR based on the fuel consumption at the airports (just domestic flights) | Aviation Gg (CO <sub>2</sub> ekv.) | 2,6728 | 2,5324 | 2,6371 | 3,4145 | 4,4944 | 7,8597 | 10,3040 | 12,4319 | 14,7186 | 10,9569 | 5,1758 | 4,2832 | 3,9537 | 3,4241 | 3,4669 | 3,6874 | 3,5897 | 3,4494 | 2,8784 | 1,8452 |
|                                                                                | z toho CO <sub>2</sub> (Gg)        | 2,6500 | 2,5108 | 2,6146 | 3,3855 | 4,4561 | 7,7927 | 10,2158 | 12,3258 | 14,5935 | 10,8635 | 5,1318 | 4,2469 | 3,9201 | 3,3951 | 3,4374 | 3,6560 | 3,5592 | 3,4200 | 2,8539 | 1,8293 |
|                                                                                | z toho CH <sub>4</sub> (Gg)        | 0,0000 | 0,0000 | 0,0000 | 0,0001 | 0,0001 | 0,0002 | 0,0002  | 0,0002  | 0,0003  | 0,0002  | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0000 |
|                                                                                | z toho N <sub>2</sub> O (Gg)       | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0002 | 0,0003  | 0,0003  | 0,0004  | 0,0003  | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0000 |

Table 1: Aviation Emissions based on the fuel consumption at the airports (domestic flights)

| Year | Aviation Gasoline - national |             |                 |                 |                  |
|------|------------------------------|-------------|-----------------|-----------------|------------------|
|      | Consumption                  | Consumption | CO <sub>2</sub> | CH <sub>4</sub> | N <sub>2</sub> O |
|      | [TJ]                         | [t]         | [t]             | [t]             | [t]              |
| 2000 | 2,56                         | 59,00       | 180,6696        | 0,0017          | 0,0051           |
| 2001 | 2,67                         | 60,97       | 188,6202        | 0,0017          | 0,0053           |
| 2002 | 2,88                         | 66,51       | 203,8802        | 0,0019          | 0,0057           |
| 2003 | 2,79                         | 63,41       | 197,2422        | 0,0018          | 0,0055           |
| 2004 | 2,03                         | 46,05       | 143,2102        | 0,0013          | 0,0040           |
| 2005 | 0,95                         | 21,71       | 67,2344         | 0,0005          | 0,0019           |
| 2006 | 1,36                         | 31,03       | 96,0933         | 0,0008          | 0,0027           |
| 2007 | 1,71                         | 38,98       | 120,6162        | 0,0011          | 0,0034           |
| 2008 | 1,51                         | 34,49       | 106,7001        | 0,0010          | 0,0030           |
| 2009 | 1,26                         | 28,68       | 88,7465         | 0,0008          | 0,0025           |
| 2010 | 1,85                         | 42,26       | 130,6363        | 0,0012          | 0,0037           |
| 2011 | 1,86                         | 42,38       | 131,1908        | 0,0012          | 0,0037           |
| 2012 | 2,44                         | 55,71       | 172,2688        | 0,0015          | 0,0048           |
| 2013 | 1,66                         | 37,79       | 117,4136        | 0,0012          | 0,0033           |
| 2014 | 1,38                         | 31,37       | 97,3655         | 0,0010          | 0,0027           |
| 2015 | 2,11                         | 48,08       | 149,2682        | 0,0015          | 0,0042           |
| 2016 | 1,68                         | 38,17       | 116,6314        | 0,0010          | 0,0033           |
| 2017 | 1,97                         | 44,88       | 138,7831        | 0,0011          | 0,0039           |
| 2018 | 2,32                         | 53,67       | 163,6784        | 0,0011          | 0,0046           |
| 2019 | 1,99                         | 45,96       | 140,1750        | 0,0009          | 0,0039           |

Table 2: Aviation Gasoline - national

| Year | Jet Kerosene - national |             |                 |                 |                  |
|------|-------------------------|-------------|-----------------|-----------------|------------------|
|      | Consumption             | Consumption | CO <sub>2</sub> | CH <sub>4</sub> | N <sub>2</sub> O |
|      | [TJ]                    | [t]         | [t]             | [t]             | [t]              |
| 2000 | 33,94                   | 907,59      | 2 469,3709      | 0,0480          | 0,0671           |
| 2001 | 31,92                   | 740,28      | 2 322,1752      | 0,0452          | 0,0631           |
| 2002 | 33,14                   | 768,52      | 2 410,7620      | 0,0469          | 0,0655           |
| 2003 | 43,83                   | 1 019,07    | 3 188,2221      | 0,0620          | 0,0866           |
| 2004 | 59,29                   | 1 368,98    | 4 312,8915      | 0,0839          | 0,1172           |
| 2005 | 106,19                  | 2 452,51    | 7 725,4203      | 0,1576          | 0,2099           |
| 2006 | 139,11                  | 3 220,78    | 10 119,6913     | 0,2186          | 0,2750           |
| 2007 | 167,77                  | 3 874,57    | 12 205,1694     | 0,2482          | 0,3317           |
| 2008 | 199,14                  | 4 598,89    | 14 486,8430     | 0,2739          | 0,3937           |
| 2009 | 148,11                  | 3 420,49    | 10 774,7998     | 0,2119          | 0,2928           |
| 2010 | 68,75                   | 1 587,65    | 5 001,2084      | 0,0940          | 0,1359           |
| 2011 | 56,57                   | 1 306,56    | 4 115,6757      | 0,0750          | 0,1118           |
| 2012 | 51,52                   | 1 189,80    | 3 747,8740      | 0,0702          | 0,1018           |
| 2013 | 45,05                   | 1 040,52    | 3 277,6523      | 0,0609          | 0,0891           |
| 2014 | 45,91                   | 1 060,32    | 3 340,0049      | 0,0648          | 0,0908           |
| 2015 | 48,20                   | 1 113,25    | 3 506,7310      | 0,0678          | 0,0953           |
| 2016 | 47,32                   | 1 092,89    | 3 442,5935      | 0,0636          | 0,0936           |
| 2017 | 44,99                   | 1 039,00    | 3 281,1839      | 0,0652          | 0,0892           |
| 2018 | 36,89                   | 854,03      | 2 690,1863      | 0,0533          | 0,0731           |
| 2019 | 23,16                   | 536,23      | 1 689,1312      | 0,0392          | 0,0459           |

Table 3: Jet Kerosene - national

| Year | Jet Kerosene - total consumption | Aviation Gasoline - total consumption |
|------|----------------------------------|---------------------------------------|
|      | Consumption                      | Consumption                           |
|      | [I]                              | [I]                                   |
| 2000 | 1 258 800                        | 81 824                                |
| 2001 | 1 026 735                        | 84 558                                |
| 2002 | 1 065 903                        | 92 246                                |
| 2003 | 1 413 413                        | 87 941                                |
| 2004 | 1 898 727                        | 63 867                                |
| 2005 | 3 401 546                        | 30 114                                |
| 2006 | 4 467 105                        | 43 040                                |
| 2007 | 5 373 880                        | 54 071                                |
| 2008 | 6 378 490                        | 47 843                                |
| 2009 | 4 744 095                        | 39 778                                |
| 2010 | 2 202 009                        | 58 607                                |
| 2011 | 1 812 155                        | 58 786                                |
| 2012 | 1 650 210                        | 77 263                                |
| 2013 | 1 443 168                        | 52 407                                |
| 2014 | 1 470 623                        | 43 505                                |
| 2015 | 1 544 033                        | 66 690                                |
| 2016 | 1 515 793                        | 52 943                                |
| 2017 | 1 441 053                        | 62 249                                |
| 2018 | 1 184 504                        | 74 431                                |
| 2019 | 743 734                          | 63 743                                |

Table 4: Total consumption – Aviation Gasoline and Jet Kerosene

| Aviation Gasoline - national |             |         |             |                   |                 |                 |                  |                            | Jet Kerosene - national |         |             |                   |                 |                 |                  |               |
|------------------------------|-------------|---------|-------------|-------------------|-----------------|-----------------|------------------|----------------------------|-------------------------|---------|-------------|-------------------|-----------------|-----------------|------------------|---------------|
|                              | Consumption | NCV     | Consumption | Consumption       | CO <sub>2</sub> | CH <sub>4</sub> | N <sub>2</sub> O | GHG v CO2<br>ekvivalentoch | Consumption             | NCV     | Consumption | Consumption       | CO <sub>2</sub> | CH <sub>4</sub> | N <sub>2</sub> O | ekvivalentoch |
| Year                         | [TJ]        | [TJ/kt] | [t]         | [m <sup>3</sup> ] | [t]             | [t]             | [t]              | [t]                        | [TJ]                    | [TJ/kt] | [t]         | [m <sup>3</sup> ] | [t]             | [t]             | [t]              | [t]           |
| 2000                         | 2,56        | 43,32   | 59,00       | 81,82             | 180,6696        | 0,0017          | 0,0051           | 182,22                     | 33,94                   | 37,40   | 907,59      | 1 258,80          | 2 469,37        | 0,05            | 0,07             | 2 490,57      |
| 2001                         | 2,67        | 43,76   | 60,97       | 84,56             | 188,6202        | 0,0017          | 0,0053           | 190,24                     | 31,92                   | 43,12   | 740,28      | 1 026,73          | 2 322,18        | 0,05            | 0,06             | 2 342,11      |
| 2002                         | 2,88        | 43,36   | 66,51       | 92,25             | 203,8802        | 0,0019          | 0,0057           | 205,63                     | 33,14                   | 43,12   | 768,52      | 1 065,90          | 2 410,76        | 0,05            | 0,07             | 2 431,46      |
| 2003                         | 2,79        | 44,00   | 63,41       | 87,94             | 197,2422        | 0,0018          | 0,0055           | 198,94                     | 43,83                   | 43,01   | 1 019,07    | 1 413,41          | 3 188,22        | 0,06            | 0,09             | 3 215,59      |
| 2004                         | 2,03        | 43,99   | 46,05       | 63,87             | 143,2102        | 0,0013          | 0,0040           | 144,44                     | 59,29                   | 43,31   | 1 368,98    | 1 898,73          | 4 312,89        | 0,08            | 0,12             | 4 349,91      |
| 2005                         | 0,95        | 43,80   | 21,71       | 30,11             | 67,2344         | 0,0005          | 0,0019           | 67,81                      | 106,19                  | 43,30   | 2 452,51    | 3 401,55          | 7 725,42        | 0,16            | 0,21             | 7 791,92      |
| 2006                         | 1,36        | 43,80   | 31,03       | 43,04             | 96,0933         | 0,0008          | 0,0027           | 96,92                      | 139,11                  | 43,19   | 3 220,78    | 4 467,11          | 10 119,69       | 0,22            | 0,27             | 10 207,11     |
| 2007                         | 1,71        | 43,76   | 38,98       | 54,07             | 120,6162        | 0,0011          | 0,0034           | 121,65                     | 167,77                  | 43,30   | 3 874,57    | 5 373,88          | 12 205,17       | 0,25            | 0,33             | 12 310,21     |
| 2008                         | 1,51        | 43,75   | 34,49       | 47,84             | 106,7001        | 0,0010          | 0,0030           | 107,62                     | 199,14                  | 43,30   | 4 598,89    | 6 378,49          | 14 486,84       | 0,27            | 0,39             | 14 611,00     |
| 2009                         | 1,26        | 43,77   | 28,68       | 39,78             | 88,7465         | 0,0008          | 0,0025           | 89,51                      | 148,11                  | 43,30   | 3 420,49    | 4 744,10          | 10 774,80       | 0,21            | 0,29             | 10 867,35     |
| 2010                         | 1,85        | 43,73   | 42,26       | 58,61             | 130,6363        | 0,0012          | 0,0037           | 131,76                     | 68,75                   | 43,30   | 1 587,65    | 2 202,01          | 5 001,21        | 0,09            | 0,14             | 5 044,06      |
| 2011                         | 1,86        | 43,78   | 42,38       | 58,79             | 131,1908        | 0,0012          | 0,0037           | 132,32                     | 56,57                   | 43,30   | 1 306,56    | 1 812,16          | 4 115,68        | 0,08            | 0,11             | 4 150,88      |
| 2012                         | 2,44        | 43,74   | 55,71       | 77,26             | 172,2688        | 0,0015          | 0,0048           | 173,75                     | 51,52                   | 43,30   | 1 189,80    | 1 650,21          | 3 747,87        | 0,07            | 0,10             | 3 779,98      |
| 2013                         | 1,66        | 43,95   | 37,79       | 52,41             | 117,4136        | 0,0012          | 0,0033           | 118,43                     | 45,05                   | 43,30   | 1 040,52    | 1 443,17          | 3 277,65        | 0,06            | 0,09             | 3 305,72      |
| 2014                         | 1,38        | 43,91   | 31,37       | 43,50             | 97,3655         | 0,0010          | 0,0027           | 98,20                      | 45,91                   | 43,30   | 1 060,32    | 1 470,62          | 3 340,00        | 0,06            | 0,09             | 3 368,67      |
| 2015                         | 2,11        | 43,91   | 48,08       | 66,69             | 149,2682        | 0,0015          | 0,0042           | 150,55                     | 48,20                   | 43,30   | 1 113,25    | 1 544,03          | 3 506,73        | 0,07            | 0,10             | 3 536,82      |
| 2016                         | 1,68        | 43,91   | 38,17       | 52,94             | 116,6314        | 0,0010          | 0,0033           | 117,63                     | 47,32                   | 43,30   | 1 092,89    | 1 515,79          | 3 442,59        | 0,06            | 0,09             | 3 472,06      |
| 2017                         | 1,97        | 43,90   | 44,88       | 62,25             | 138,7831        | 0,0011          | 0,0039           | 139,97                     | 44,99                   | 43,30   | 1 039,00    | 1 441,05          | 3 281,18        | 0,07            | 0,09             | 3 309,39      |
| 2018                         | 2,32        | 43,83   | 53,67       | 74,43             | 163,6784        | 0,0011          | 0,0046           | 165,08                     | 36,89                   | 43,30   | 854,03      | 1 184,50          | 2 690,19        | 0,05            | 0,07             | 2 713,30      |
| 2019                         | 1,99        | 43,83   | 45,96       | 63,74             | 140,1750        | 0,0009          | 0,0039           | 141,37                     | 23,16                   | 43,30   | 536,23      | 743,73            | 1 689,13        | 0,04            | 0,05             | 1 703,79      |

Table 5: Aviation Gasoline, Jet Kerosene (national), consumption

| Aviation Gasoline - international |             |         |             |                   |                 |                 |                  |                                        | Jet Kerosene - international |         |             |                   |                 |                 |                  |                                        |
|-----------------------------------|-------------|---------|-------------|-------------------|-----------------|-----------------|------------------|----------------------------------------|------------------------------|---------|-------------|-------------------|-----------------|-----------------|------------------|----------------------------------------|
|                                   | Consumption | NCV     | Consumption | Consumption       | CO <sub>2</sub> | CH <sub>4</sub> | N <sub>2</sub> O | GHG v CO <sub>2</sub><br>ekvivalentoch | Consumption                  | NCV     | Consumption | Consumption       | CO <sub>2</sub> | CH <sub>4</sub> | N <sub>2</sub> O | GHG v CO <sub>2</sub><br>ekvivalentoch |
| Year                              | [TJ]        | [TJ/kt] | [t]         | [m <sup>3</sup> ] | [t]             | [t]             | [t]              | [t]                                    | [TJ]                         | [TJ/kt] | [t]         | [m <sup>3</sup> ] | [t]             | [t]             | [t]              | [t]                                    |
| 2000                              | 5,96        | 43,32   | 137,66      | 190,92            | 421,5623        | 0,0028          | 0,0118           | 425,16                                 | 644,94                       | 37,40   | 17 244,30   | 21 029,64         | 46 918,05       | 0,45            | 1,27             | 47 309,14                              |
| 2001                              | 6,23        | 43,76   | 142,26      | 197,30            | 440,1138        | 0,0030          | 0,0124           | 443,87                                 | 606,49                       | 43,12   | 14 065,24   | 17 152,73         | 44 121,33       | 0,42            | 1,20             | 44 489,11                              |
| 2002                              | 6,73        | 43,36   | 155,19      | 215,24            | 475,7204        | 0,0032          | 0,0134           | 479,78                                 | 629,63                       | 43,12   | 14 601,81   | 17 807,08         | 45 804,48       | 0,44            | 1,24             | 46 186,29                              |
| 2003                              | 6,51        | 44,00   | 147,95      | 205,20            | 460,2317        | 0,0031          | 0,0129           | 464,16                                 | 832,68                       | 43,01   | 19 362,34   | 23 612,61         | 60 576,22       | 0,58            | 1,65             | 61 081,17                              |
| 2004                              | 4,73        | 43,99   | 107,45      | 149,02            | 334,1571        | 0,0022          | 0,0094           | 337,01                                 | 1 126,42                     | 43,31   | 26 010,66   | 31 720,32         | 81 944,94       | 0,78            | 2,23             | 82 628,01                              |
| 2005                              | 1,93        | 43,80   | 44,18       | 61,27             | 136,7981        | 0,0010          | 0,0038           | 137,97                                 | 1 914,83                     | 43,30   | 44 222,34   | 53 929,69         | 139 300,37      | 1,35            | 3,79             | 140 462,18                             |
| 2006                              | 2,38        | 43,80   | 54,27       | 75,27             | 168,0614        | 0,0011          | 0,0047           | 169,49                                 | 2 281,25                     | 43,19   | 52 819,04   | 64 413,46         | 165 957,28      | 1,68            | 4,51             | 167 343,16                             |
| 2007                              | 2,45        | 43,76   | 56,04       | 77,73             | 173,3966        | 0,0011          | 0,0049           | 174,88                                 | 2 384,58                     | 43,30   | 55 069,88   | 67 158,39         | 173 474,12      | 1,50            | 4,71             | 174 916,30                             |
| 2008                              | 2,93        | 43,75   | 66,91       | 92,80             | 206,9647        | 0,0011          | 0,0058           | 208,72                                 | 2 671,70                     | 43,30   | 61 700,61   | 75 244,65         | 194 361,41      | 1,66            | 5,28             | 195 976,94                             |
| 2009                              | 2,44        | 43,77   | 55,64       | 77,18             | 172,1860        | 0,0008          | 0,0048           | 173,65                                 | 1 965,87                     | 43,30   | 45 400,12   | 55 366,01         | 143 013,70      | 1,39            | 3,89             | 144 206,56                             |
| 2010                              | 2,09        | 43,73   | 47,78       | 66,27             | 147,7090        | 0,0009          | 0,0041           | 148,97                                 | 1 814,71                     | 43,30   | 41 909,14   | 51 108,70         | 132 016,84      | 1,27            | 3,59             | 133 117,63                             |
| 2011                              | 1,90        | 43,78   | 43,49       | 60,32             | 134,6086        | 0,0008          | 0,0038           | 135,75                                 | 1 854,99                     | 43,30   | 42 840,50   | 52 244,51         | 134 947,57      | 1,30            | 3,67             | 136 072,84                             |
| 2012                              | 2,14        | 43,74   | 48,84       | 67,74             | 151,0319        | 0,0012          | 0,0042           | 152,32                                 | 1 650,32                     | 43,30   | 38 113,61   | 46 480,01         | 120 057,87      | 1,18            | 3,26             | 121 059,60                             |
| 2013                              | 1,98        | 43,95   | 45,07       | 62,52             | 140,0640        | 0,0011          | 0,0039           | 141,26                                 | 1 539,95                     | 43,30   | 35 564,65   | 43 371,52         | 112 028,64      | 1,13            | 3,04             | 112 964,07                             |
| 2014                              | 1,56        | 43,91   | 35,61       | 49,39             | 110,5449        | 0,0009          | 0,0031           | 111,49                                 | 1 626,62                     | 43,30   | 37 566,26   | 45 812,51         | 118 333,72      | 1,12            | 3,22             | 119 320,07                             |
| 2015                              | 2,19        | 43,91   | 49,88       | 69,19             | 154,8544        | 0,0013          | 0,0043           | 156,18                                 | 1 982,76                     | 43,30   | 45 791,27   | 55 843,02         | 144 242,52      | 1,33            | 3,92             | 145 443,95                             |
| 2016                              | 3,64        | 43,91   | 82,96       | 115,06            | 253,4758        | 0,0020          | 0,0071           | 255,65                                 | 2 113,08                     | 43,30   | 48 800,87   | 59 513,26         | 153 722,75      | 1,49            | 4,18             | 155 004,95                             |
| 2017                              | 1,80        | 43,90   | 41,10       | 57,00             | 127,0887        | 0,0010          | 0,0036           | 128,18                                 | 2 260,82                     | 43,30   | 52 212,90   | 63 674,27         | 164 889,54      | 1,58            | 4,48             | 166 264,34                             |
| 2018                              | 1,87        | 43,83   | 43,14       | 59,83             | 131,5738        | 0,0010          | 0,0037           | 132,70                                 | 2 527,74                     | 43,30   | 58 526,10   | 71 373,29         | 184 357,20      | 1,78            | 5,01             | 185 894,56                             |
| 2019                              | 1,56        | 43,83   | 35,97       | 49,90             | 109,7215        | 0,0009          | 0,0031           | 110,66                                 | 2 543,38                     | 43,30   | 58 888,11   | 71 814,76         | 185 497,54      | 1,79            | 5,04             | 187 044,58                             |

Table 6: Aviation Gasoline, Jet Kerosene (international), consumption

| Aviation Gasoline - military |             |             |                   |                 |                 |                  |                            | Jet Kerosene - military |             |                   |                 |                 |                  |                            |
|------------------------------|-------------|-------------|-------------------|-----------------|-----------------|------------------|----------------------------|-------------------------|-------------|-------------------|-----------------|-----------------|------------------|----------------------------|
|                              | Consumption | Consumption | Consumption       | CO <sub>2</sub> | CH <sub>4</sub> | N <sub>2</sub> O | GHG v CO2<br>ekvivalentoch | Consumption             | Consumption | Consumption       | CO <sub>2</sub> | CH <sub>4</sub> | N <sub>2</sub> O | GHG v CO2<br>ekvivalentoch |
| Year                         | [TJ]        | [t]         | [m <sup>3</sup> ] | [t]             | [t]             | [t]              | [t]                        | [TJ]                    | [t]         | [m <sup>3</sup> ] | [t]             | [t]             | [t]              | [t]                        |
| 2000                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 230,32                  | 6 158,18    | 7 509,98          | 16 825,03       | 1,87            | 1,34             | 17 269,70                  |
| 2001                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 356,30                  | 8 263,03    | 10 076,87         | 26 028,55       | 2,89            | 2,07             | 26 716,45                  |
| 2002                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 362,03                  | 8 395,92    | 10 238,92         | 26 447,14       | 2,94            | 2,10             | 27 146,10                  |
| 2003                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 216,77                  | 5 040,46    | 6 146,90          | 15 835,21       | 1,76            | 1,26             | 16 253,71                  |
| 2004                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 210,96                  | 4 871,29    | 5 940,60          | 15 410,76       | 1,71            | 1,22             | 15 818,05                  |
| 2005                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 254,83                  | 5 885,31    | 7 177,21          | 18 616,12       | 2,07            | 1,48             | 19 108,12                  |
| 2006                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 254,32                  | 5 888,47    | 7 181,07          | 18 578,81       | 2,06            | 1,47             | 19 069,82                  |
| 2007                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 328,77                  | 7 592,75    | 9 259,45          | 24 017,54       | 2,67            | 1,91             | 24 652,29                  |
| 2008                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 283,78                  | 6 553,59    | 7 992,18          | 20 730,45       | 2,30            | 1,65             | 21 278,32                  |
| 2009                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 210,19                  | 4 854,09    | 5 919,62          | 15 354,57       | 1,71            | 1,22             | 15 760,37                  |
| 2010                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 210,74                  | 4 866,97    | 5 935,33          | 15 395,32       | 1,71            | 1,22             | 15 802,19                  |
| 2011                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 217,30                  | 5 018,43    | 6 120,03          | 15 874,03       | 1,76            | 1,26             | 16 293,56                  |
| 2012                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 195,76                  | 4 520,98    | 5 513,39          | 14 300,53       | 1,59            | 1,13             | 14 678,47                  |
| 2013                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 190,82                  | 4 406,97    | 5 374,35          | 13 939,90       | 1,55            | 1,11             | 14 308,31                  |
| 2014                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 186,01                  | 4 295,80    | 5 238,78          | 13 531,78       | 1,50            | 1,07             | 13 889,43                  |
| 2015                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 232,15                  | 5 361,38    | 6 538,27          | 16 888,40       | 1,88            | 1,34             | 17 334,74                  |
| 2016                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 217,19                  | 5 015,98    | 6 117,05          | 15 800,33       | 1,76            | 1,25             | 16 216,72                  |
| 2017                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 136,85                  | 3 160,53    | 3 854,30          | 9 955,66        | 1,11            | 0,79             | 10 218,77                  |
| 2018                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 169,65                  | 3 917,95    | 4 777,99          | 12 341,56       | 0,98            | 1,37             | 12 774,69                  |
| 2019                         | NO          | NO          | NO                | NO              | NO              | NO               | NO                         | 150,99                  | 3 487,10    | 4 252,56          | 10 984,37       | 0,87            | 1,22             | 11 369,87                  |

Table 7: Aviation Gasoline, Jet Kerosene (military), consumption