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THE INFLUENCE OF AIR TRAFFIC ON CLIMATE CHANGE

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Abstract: *Growth in the aviation sector has brought great benefits, but also an increased impact on the environment. Air transport has a significant impact on climate change, even to the extent that global climate change dictates the limitations of its development and the areas in which aviation needs to adapt its land and flight operations. The main pollutants emitted by aircraft are carbon dioxide (CO2), nitrogen oxides (NOx), sulfur oxides (SOx), non-flammable hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM) and soot. Some of the key ways to mitigate the environmental impact of aviation are the development of new aircraft technologies and the inclusion of advanced design, the development of alternative fuels for use in aviation, the collection of airport taxes related to environmental protection, which encourages airlines to use quieter aircraft with lower emissions. The introduction of operational measures, in the form of changes in operating procedures, have proven to be very effective in reducing emissions. In addition to minimizing the amount of fuel for service and performance of each flight, in addition to the environmental benefits, they also reduce fuel costs. These changes do not require the introduction of new equipment and expensive technologies, but are based on different ways of operating aircrafts that are already in use.*

Keywords: *Air traffic, climante change, emission of CO2, aviation industry*

1. INTRODUCTION

Climate change is considered one of the most serious threats to sustainable environmental development, where we can expect negative impacts on human health, food safety, economic activity, natural resources and physical infrastructure. Scientific evidence suggests that, despite technological improvements and other operational and economic measures to reduce greenhouse gas (GHG) emissions, the climate will continue to change and the potential consequences will be significant. As the impacts of climate change are felt around the world, the need to address the negative effects of climate change, whether mitigating or adapting, is becoming more pronounced.

Climate change can affect aviation and possible areas where aviation needs to adapt its ground and flight operations. Growth in the aviation sector has brought great benefits, but also an increased impact on the environment. One of the key ways to mitigate the environmental impact of aviation is to develop new aircraft technologies and incorporate advanced designs, which are cleaner and quieter. Advanced technologies were developed in the period from 2010 to 2015 and after 2015 they have been integrated into new designs. Investing in new technologies relies on a wider range of expertise and innovative approaches from other sectors, thus creating new opportunities to address the environmental impact of aviation.

The International Civil Aviation Organization (ICAO) has developed a number of standards and recommended practices for mitigating the impact of air traffic on the environment, but is fully aware that even greater efforts are needed. They also recognized the need to consider and adapt, given that the consequences of climate change need to be anticipated and effectively addressed. International efforts to combat climate change, from its inception, have focused primarily on "mitigation" - reducing greenhouse gas emissions to combat climate change. However, in recent years, more attention has been paid to "adaptation" - adapting and dealing with the effects of climate change. While mitigation addresses the causes of climate change, adaptation addresses the consequences. It is obvious that better mitigation, due to its proactive nature, reduces the risks at an early stage and thus reduces the need for adaptation. Similarly, early identification of climate change and anticipation of its impacts will be essential for future adjustments. Anticipating and adapting to these impacts is vital to ensuring that the effects of climate change are reduced. The impact of temperature and precipitation changes could increase the demand for cooling buildings or increase the need for runway drainage. These are, among others, only some potential effects. Restrictions for land and flight operations have already been observed in Europe. These include strong winds, icy rains, heavy rainfall and lightning strikes (mostly in summer) that can endanger buildings, structures and planes. Similarly, in winter there are challenges associated with forecasting and removing snow.

The effects of climate change will be more visible in the lower coastal areas in terms of sea levels and storm activity. Infrastructure such as runways and buildings at some airports could be affected by rising sea levels. According to a preliminary review of the OECD report 5, 64 airports have been identified, which are likely to be affected by the projected sea level rise. Given the risks to major coastal cities, as stated in the IPCC report, floods and stormy activities can negatively affect the movement of planes and passengers. In addition, possible damage to the airport infrastructure should be taken into account. While there are some uncertainties regarding the potential impacts of climate change on aviation operations and related infrastructure, there are clearly challenges that will need to be addressed.

2. THE INFLUENCE OF AIR TRAFFIC ON CLIMATE CHANGE

Direct emissions from aviation account for about 3% of total greenhouse gas emissions and more than 2% of global emissions. The flight from Paris to New York creates approximately the same level of emissions as the average person in the EU, heating his home all year round. Global annual international aviation emissions in 2020 are about 70% higher than in 2005. The International Civil Aviation Organization (ICAO) predicts that in the absence of additional measures, by 2050 aviation emissions could increase by an additional 300%.

The main pollutants emitted by aircraft are carbon dioxide (CO2), nitrogen oxides (NOx), sulfur oxides (SOx), non-flammable hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM) and soot. The two jet aircraft engines shown in Figure 2.1, during a 1-hour flight (a 150-passenger aircraft), consume 850,000 kg of air, which passes through the air inlet to the turbine and compressor and enters the combustion chamber. In the combustion chamber, 2,700 kg of kerosene are burned in 1 hour, from where the combustion products exit through the engine nozzle in the form of 722,700 kg of cold and 130,000 kg of hot air. The hot air at the outlet of the jet contains about 8,500 kg of CO2, 30 kg of nitrogen oxides NOx, 2.5 kg of sulfur dioxide SO2, 2 kg of carbon monoxide, 0.1 kg of PM particles and soot.

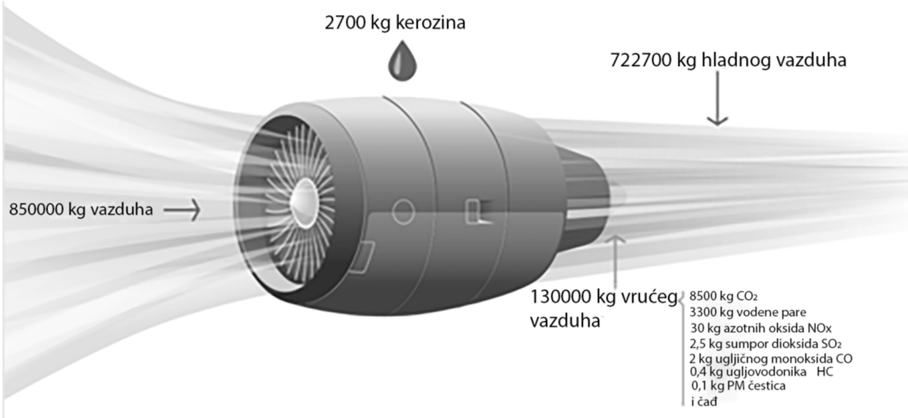


Figure 2.1. Emission of a typical aircraft with two jet engines during a one-hour flight with 150 passengers

2.1 Emission of CO_2

The United Nations Framework Convention on Climate Change states that CO2 emissions from all EU28 and EFTA flights increased from 88 to 171 million tonnes (+ 95%) between 1990 and 2016 (Figure 2.2). CO2 emissions estimated by the IMPACT model reached 163 million tons (Mt) in 2017, which is 16% more than in 2005 and 10% more than in 2014. During the same period, the average fuel combustion per flight kilometer for passenger aircraft, not considering business aviation, decreased by 24%, while in the period from 2014 to 2017 the average rate of reduction of fuel consumption was 2.8%. According to the base traffic forecast and the advanced technological scenario, CO2 emissions are expected to increase by an additional 21% in the future and reach 198 Mt in 2040. The annual purchase of permits under the EU Emissions Trading System (ETS) since 2013 has led to a reduction of 27 Mt net CO2 emissions in 2017 which by 2020 had risen to around 32 Mt [1].

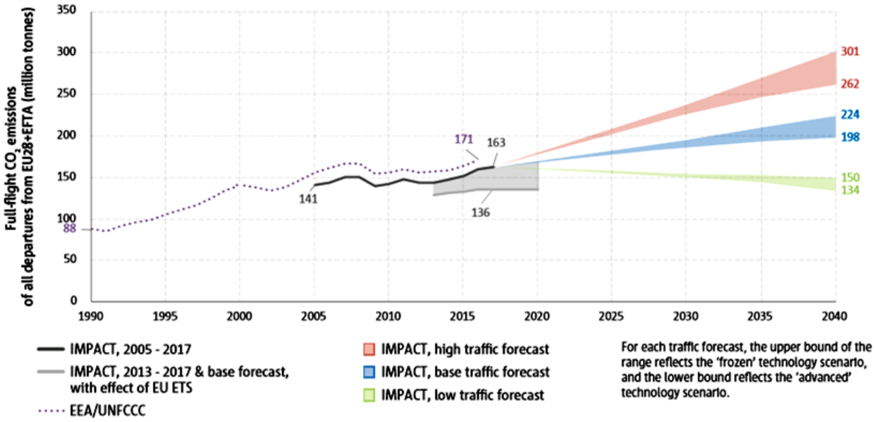


Figure 2.2 Increase in CO2 emissions from 2013 to 2040 [1]

2.2 Emission of NOx

At the 37th session of the ICAO Assembly, the first global trends in environmental protection were presented and approved, which were further developed and repeatedly updated and presented at each session of the Assembly, on the basis of which decisions were made. One part of these updates is ICAO's CAEP / 11 (2019). Global environmental trends involve developing a set of scenarios to assess future trends in fuel combustion and greenhouse gas emissions.

Scenario 1, relating to fuel combustion and CO2 emissions, includes operational improvements necessary to maintain current levels of operational efficiency, but does not include improvements in technology that are greater than those available in aircraft currently in production.

Scenario 2 (low technology) assumed fuel combustion improvements of 0.96% per year for all aircrafts that were part of the fleet in the period from 2010 to 2015, and 0.57% per year for all aircrafts that will be part of the fleet starting from 2015 to 2050, combined with additional operational improvements CAEP / 9 IE of the entire fleet.

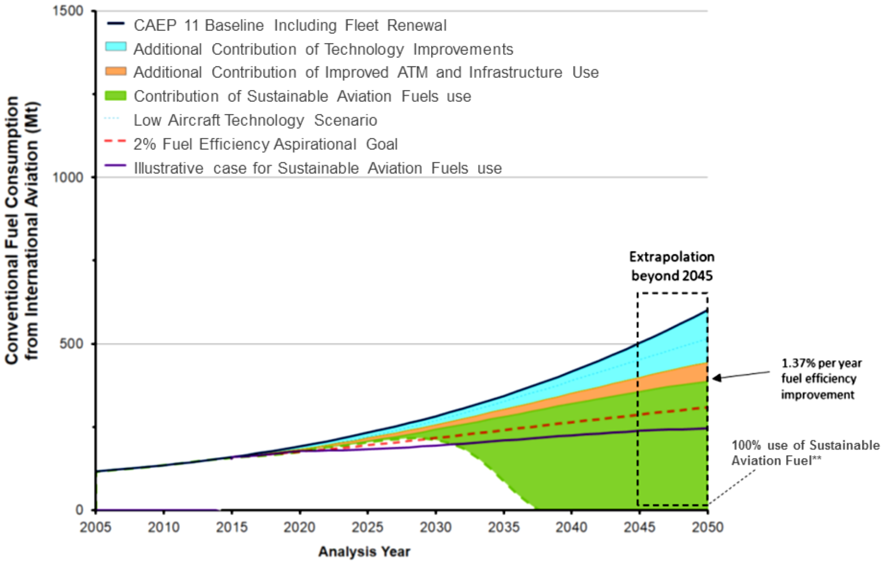
Scenarios 3, 4 and 5 (moderate, advanced and optimistic technology) assume improvements in fuel combustion by 0.96%, 1.16% and 1.5% per year for all aircrafts entering the fleet in the period from 2010 to 2050, combined with recent operational initiatives, such as e.g. initiatives planned in NektGen and SESAR, and additional operational improvements for the entire CAEP / 9 IE fleet.

Scenario 1 for NOx emissions, does not take into account new aircraft technologies and supports basic operational efficiencies sufficient to meet projected air traffic demand. Scenarios 2 and 3 assume moderate and advanced improvements in aircraft technology and the achievement of 50% and 100% of the CAEP / 7 IE NOx targets by 2036 with no further improvements thereafter, combined with operational improvements to the CAEP / 9 fleet. [1].

2.3 Aviation fuels

International civil aviation, as shown in Figure 2.3, consumed about 160 megatons (Mt) of fuel in 2015. By 2045, compared to the expected 3.3-fold increase in international air traffic, fuel consumption is projected to increase by 2.2 to 3.1 times compared to 2015, depending on the technology and ATM scenario. Long-term fuel consumption in international aviation is lower by about 25% compared to previous trends, which were presented at the 39th session of the ICAO Assembly. This smaller projection of fuel consumption can be attributed to a combination of more efficient aircrafts entering the fleet, as well as a reduction in projected long-term traffic demand. The calculated long-term fuel efficiency of 1.37% includes combined improvements related to engine technology and performance. The individual contributions of new technologies and optimization of operations are 0.98% and 0.39%, respectively [2].

The introduction of sustainable alternative fuels for aviation helps to address not only environmental but also economic and safety issues. Currently, the availability of qualified alternative fuels for aviation is very limited. However, it has been shown that sustainable alternative fuels for use in global aviation can be produced from a wide range of raw materials, suggesting that many regions are possible production sites, so there is a significant commitment from countries and industry groups to develop, implement and use sustainable alternative fuels for reduction of aviation emissions. The use of alternative fuels can enable reduced CO_2 emissions compared to conventional aviation fuels.



- The case illustrated would require the high availability of raw materials for bioenergy, the production of which is significantly stimulated by prices or other policy mechanisms;

- 100% replacement with sustainable aviation fuel would require a complete transition of aviation from oil refineries to sustainable aviation fuel production and significant expansion of the agricultural sector, which will require significant policy support.

Figure 2.3 - Conventional fuel consumption in international aviation, from 2005 to 2050, including the potential use of sustainable aviation fuels [2]

There are significant uncertainties in predicting the contribution of sustainable aviation fuels in the future. A number of short-term scenarios, analyzed by the AFTF, show that up to 2.6% of fuel consumption could potentially be reached by using sustainable aviation fuels by 2025. This analysis also considers the long-term availability of sustainable aviation fuels, revealing that by 2050 it would be possible to meet 100% of international demand for sustainable aviation fuel, corresponding to a 63% reduction in emissions. However, this level of fuel production can only be achieved through extremely large capital investments in sustainable aviation fuel infrastructure and significant political support. The effect of such expansion in the use of sustainable aviation fuels on net CO2 emissions from international aviation is shown in Figure 2.4.

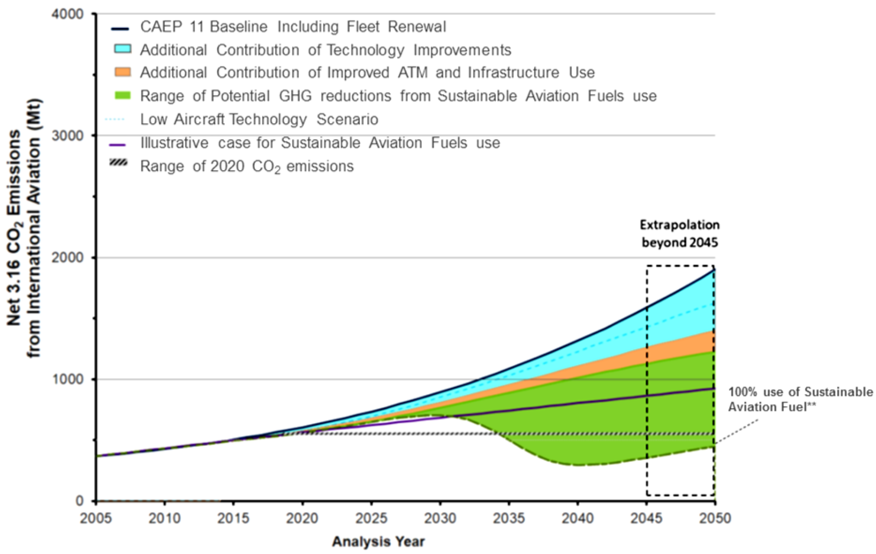


Figure 2.4 - Net CO2 emissions generated by international air traffic, from 2005 to 2050, including the life cycle of sustainable aviation fuels [2]

NOx emission trends during aircraft flight routes have been estimated due to their impact on the global climate. As shown in Figure 2.5, total NOx emissions in international aviation in 2015 were 2.50 Mt. In 2045, the prediction of NOx emissions ranges from 5.53 Mt to 8.16 Mt, which is an increase of 2.2 to 3.3 times compared to 2015, when we take into account that the projected growth of international air traffic has increased by 3 ,3 times [1].

As with fuel consumption, the long-term NOx forecast in international aviation is about 21% lower compared to previous trends. This prediction of lower NOx can be attributed to the combination of aircrafts with lower NOx engines entering the fleet, as well as the reduction in projected long-term traffic demand.

The three main areas for further progress are:

1. Exploration of the feasibility of more ambitious targets for the growth of neutral carbon in the aviation sector and long-term emission reductions, including a global commitment to 2% annual fuel efficiency improvements, by 2050.

2. Developing a framework for market measures (carbon emission trading) in international air transport and

3. Developing measures to assist countries, especially developing countries, in accessing financial resources, technology transfer and capacity building, taking into account the specific needs and circumstances of all member states.

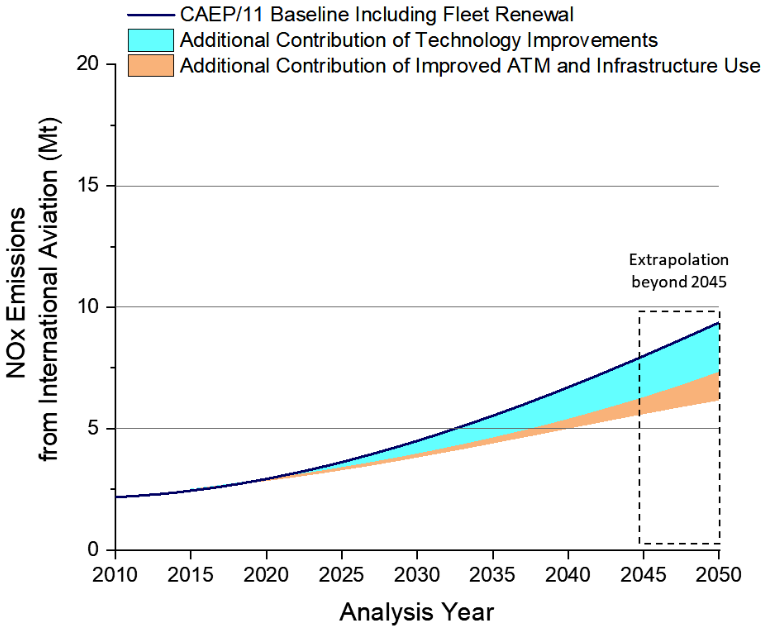


Figure 2.5 - NOx emissions from International Air Traffic flights, for the period 2010-2050 [1]

ICAO has also launched a discussion on the need to address the potential impact of climate change on international air operations and related infrastructure. This must include onshore facilities, airports and fuel depots, as well as unexpected weather changes that may significantly affect air operations. ICAO will continue to manage all issues related to international aviation, including limiting or reducing greenhouse gas emissions. These issues will be addressed within a globally harmonized framework, with all member states and the aviation industry through ICAO.

3. TRADING WITH CARBON EMISSIONS

The EU Emissions Trading System (EU ETS), established in 2005, is a cornerstone of EU climate change policy and its key tool for effectively reducing greenhouse gas emissions. It is the first major carbon market in the world. The EU ETS works on the principle of "restrictions and trade". Within the limits, airlines receive or purchase emission permits, which they can trade with each other as needed. They can also use limited amounts of international loans from emission reduction projects around the world. After each year, the company must cover all its emissions, otherwise large fines are imposed. If a company reduces its emissions, it can keep reserves to cover its future needs or they can sell them to another company that lacks them. In this way, investments in clean technologies with a low carbon content are promoted. CO2 emissions from aviation have been included in the emissions trading system since 2012. According to the EU ETS, all airlines operating in Europe must monitor, report and certify their emissions.

The system has so far contributed to reducing carbon emissions in the aviation sector by more than 17 million tonnes per year, and compliance covers more than 99.5% of emissions.

In addition to market measures such as the ETS, operational measures such as the modernization and improvement of air traffic management technologies, procedures and systems also contribute to the reduction of emissions from aviation. The legislation, adopted in 2008, is intended to apply to emissions from flights to and from the European Economic Area (EEA), which includes EU Member States, Iceland, Liechtenstein and Norway.

3.1 Global emission compensation scheme

In October 2016, the International Civil Aviation Organization (ICAO) agreed on a Resolution for a global market measure to address CO2 emissions from international air transport starting from 2021. The agreed Resolution sets out the objective and key elements of the global scheme, as well as a plan for its implementation. The International Aviation Carbon Compensation and Reduction Scheme (CORSIA) aims to stabilize CO2 emissions at 2020 level, asking airlines to offset the growth of their emissions after 2020. Airlines will have to monitor emissions on all international routes and compensate emissions from routes included in the scheme, by purchasing eligible emission units generated by projects that reduce emissions in other sectors (eg renewable energy), during the period 2021-2035. Participation in the first phases is voluntary for all countries, but exemptions are provided for those with low aviation activity. All EU countries will join the scheme from the very beginning, and according to the terms of the agreement, a regular review of the scheme will be performed, which should enable continuous improvement and contribution to the goals of the Paris Agreement.

ICAO is constantly working to develop the necessary tools to implement this scheme, in order to make the scheme operational. The efficient and concrete implementation and operationalization of CORSIA will ultimately depend on national measures, which will be developed and implemented at the domestic level. ICAO's program of action in the field of international aviation and climate change includes the following elements:

- Fuel efficiency improvements 2% per year globally, by 2050
- Decision to develop global CO2 standards for aircraft
- Decision on the development of a framework for market measures for international air transport
- Measures to assist developing countries and facilitate access to financial resources, technology transfer and capacity building
- Collection of data on international aviation emissions by ICAO
- Development and submission of ICAO voluntary action plans to countries on emissions and
- Continuation of work on alternative fuels for aviation [3].

4. OBJECTIVES AND ACTIVITIES OF THE AVIATION INDUSTRY IN THE FIELD OF CLIMATE CHANGE

Global associations of aviation industry actors (International Airport Council, Civil Air Navigation Organization, International Air Transport Association and International Coordinating Council of the Aviation Industry Association), under the auspices of the Air Transport Action Group, committed in 2008 to address the impact of aviation on climate change. They have set a number of ambitious targets for mitigating CO2 emissions from air transport:

- Limiting CO2 emissions from aviation by 2020 (neutral carbon growth)
- Reduction of net CO2 emissions from aviation by 50% by 2050 compared to the 2005 level
- Average fuel efficiency improvement of 1.5% per year by 2020 (compared to 2009) [2].

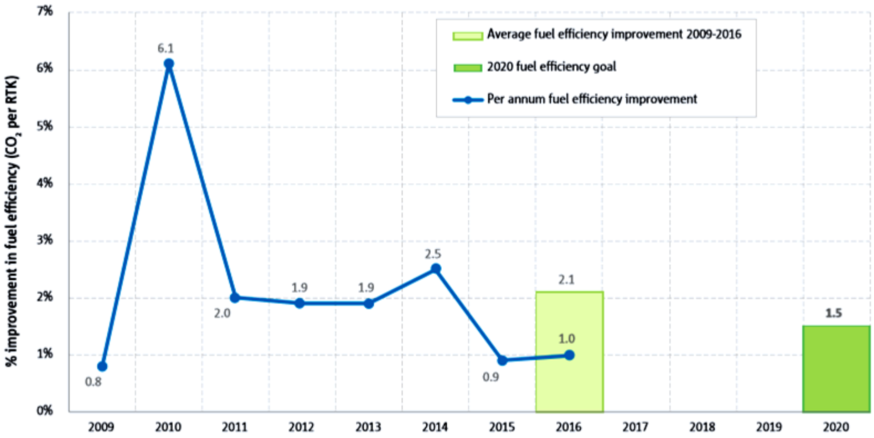


Figure 4.1 Improving fuel efficiency in commercial aviation (Source: IATA)

To achieve these goals, all stakeholders agreed to work closely together to improve technologies, including the use of sustainable low-carbon fuels, more efficient aircraft operation, infrastructure improvements, including modernized air traffic management systems, and the introduction of single measures in the global emission marketplace.

In order to minimize the adverse impacts of international civil aviation on the global climate, ICAO has formulated policy, and developed and updated standards and recommended practices (SARP) for aircraft emissions and conducted field activities. These activities are carried out by the Secretariat and the Committee on Aviation and Environmental Protection (CAEP). In carrying out its activities, ICAO also cooperates with other UN bodies and other international organizations.

At its 39th session in 2016, the ICAO Assembly adopted Resolution A39-2: Consolidated Statement on Continuing ICAO Environmental Policies and Practices - Climate Change. Two global aspirational targets for the international aviation sector have been set: a 2% annual improvement in fuel efficiency by 2050 and a growth in neutral carbon from 2020 onwards, set at the 37th Assembly in 2010.

To achieve global goals and advance the sustainable growth of international aviation, ICAO is implementing a package of measures, which include the improvement of aircraft technology, operational improvements, sustainable aviation fuels and market measures (CORSIA). [3].

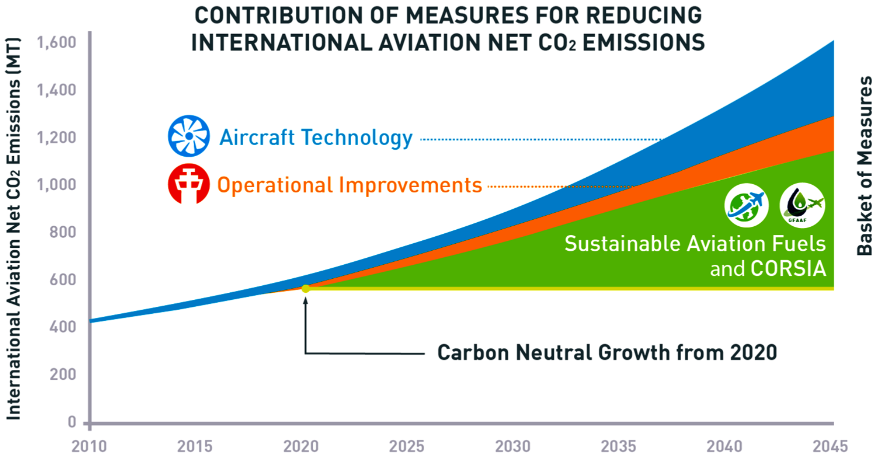


Figure 4.2. ICAO package of measures for the period up to 2045 to reduce CO2 emissions [1]

4.1 Technology and design

In order to ensure, in cooperation with countries, extensive and reasonable research and development of the aviation industry and technology, ICAO regularly sets technological requirements and goals to be achieved. These goals are developed by independent experts, who ensure transparency and involvement of all stakeholders. The latest set of technological targets for CO2 emissions is described in detail in an independent expert assessment and review of technological targets for engines and aircraft (ICAO Doc 10127 - 2019), where ICAO is the first to develop technological targets for noise, local air quality and emissions of CO2 in an integrated way, with full respect for the interdependence between these technologies.

The Clean Sky 2 initiative (2014–2024) is part of the EU Horizon 2020 program, the European Commission and the European aviation industry [4]. It was built on the original Clean Sky 1 program (2008-2017) and contributes to the achievement of the environmental goals "Flightpath 2050", which was determined by the Advisory Council for Aviation Research in Europe. Bringing together the aviation industry, small and medium-sized enterprises, research centers and academia, the Clean Sky 2 Program has been launched, which aims to strengthen European aviation cooperation, global leadership and competitiveness. Clean Sky 2 has a total budget of four billion euros, and contains over 600 unique entities from 27 countries. Clean Sky 1 included technologies and procedures that would reduce CO_2 emissions per mileage by 75%, NOx emissions by 90%, and noise by 65% compared to the capabilities of typical 2000 aircraft. The goals of Clean Sky 2 are to reduce CO_2, NOx and noise emissions by 20 to 30% compared to more modern aircraft that have been in use since 2014. Clean Sky 2 develops innovative, cutting-edge technologies to increase aircraft wing aerodynamics, more advanced and lighter structures, more efficient engines that include hybridization and electrification, advanced control, activation and guidance systems (including increased digitization), completely new aircraft configurations and a more sustainable aircraft life cycle. The scope of the program includes large, regional and passenger aircraft and a rotorcopter [5]. The program aims to accelerate the introduction of new technologies in the time frame 2025-2035. years. By 2050, 75% of the world's fleet now in use will be replaced by aircraft that can apply Clean Sky 2 technologies. Direct economic benefits are estimated at 350 to 400 billion euros, and indirect benefits at 400 billion euros. Ski Sky 2 technology is expected to lead to a potential 4 billion tonne reduction in CO_2 between 2025 and 2050. This is also a reduction to approximately 3 billion tons of CO_2 emissions that Clean Sky 1 was supposed to provide.

The EU is currently working on planning its next multi-year research initiative. Clean Sky 3, which is yet to be defined, will be part of the next EU framework program to start in 2021. Given the crucial role of Clean Sky in enabling cutting-edge innovations that significantly reduce the environmental impact of aviation, Airbus proposes that the next phase program places a special focus on electrification and digitization.

4.3 Environmental taxes

Some airports charge environmental taxes, either separate or integrated into others (eg through landing charges), which encourages airlines to use quieter aircraft with lower emissions. A recent assessment under Directive 2009/12 / EC on airport charges [6], together with an analysis of publicly available information, found that around 60% of the busiest EU28 + EFTA airports have introduced environmental costs. In line with ICAO guidelines, these costs focus on local impacts on noise and air quality (NOx) rather than global impacts on climate change (CO2) and depend on a number of factors, including aircraft and engine type, certified noise and emission levels, and part of the day. The total share of environmental charges in relation to total airport taxes has been growing since 2016, but is still low (approximately 4% for long-haul flights and 1% for short-haul flights). Since airport taxes represent 15-20% of total costs and 4-8% of transportation costs, the assessment report concluded that the question is whether such collection methods affect fleets operating at airports.

4.4 Operational measures

The term "operations" in the context of aviation is used to describe a wide range of activities, which include the flight of aircraft, the control and supervision of aircraft under the air traffic management system and the implementation of various airport activities. Operations include planning activities before loading and cargoing, throughout the flight, until passengers disembark and cargo is unloaded. Operational measures to reduce emissions provide a double benefit. The first, which is based on minimizing the amount of fuel for servicing and performing each flight, in addition to environmental benefits, also brings a reduction in fuel costs. Another benefit is that operational measures do not require the introduction of new equipment or the introduction of expensive technologies. Changes in operating procedures are based on different aircraft modes already in use [7].

In 2001, the ICAO Assembly asked the Council to promote the use of operational measures as a means of limiting or reducing the impact of aircraft emissions. In February 2004, ICAO published a material with ICAO Guideline 303-AN / 176 on operational options for reducing fuel consumption and reducing emissions. This material includes information on ground and in-flight operations, ground service equipment and engine start-up auxiliaries, and a new instruction manual is being developed as well.

An effective means of reducing fuel consumption and avoiding unnecessary emissions, according to ICAO research, is the early implementation of new communication, navigation, surveillance and air traffic management systems. The results of a preliminary study on the environmental benefits associated with the application of these new systems and the methodologies for their evaluation have been incorporated into the Global Air Navigation Plan for CNS / ATM systems (Doc 9750) [8].

In 2018, ICAO made a global analysis of the efficiency of horizontal flight, for which input data were collected by using ADS-B (Automatic dependent surveillance-broadcast) surveillance technology, in which the aircraft determines its position via satellite navigation and periodically broadcasts it, enabling tracking. ICAO translated this data into a format that could be analyzed and verified. The final results of the HFE for 2017, expressed in efficiency levels (%), are shown in Figure 4.3.

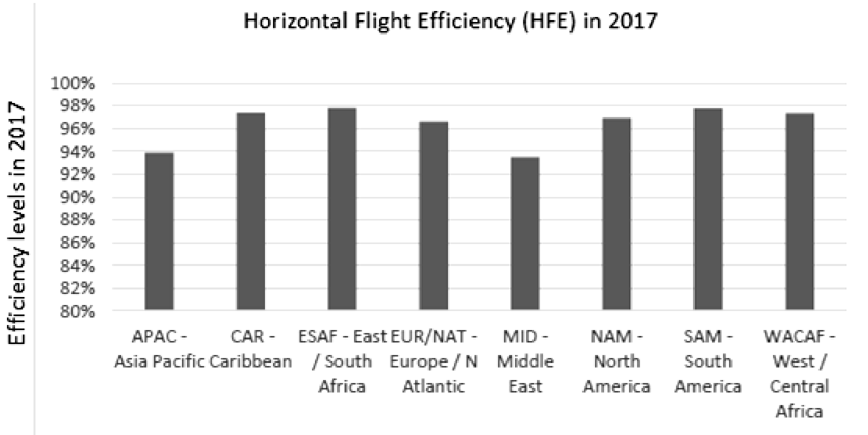


Figure 4.3 Horizontal flight efficiency (HFE) [1]

5. AVIATION STANDARDS RELATED TO CLIMATE CHANGE

In October 2010, at the 37th Assembly (Resolution A37-19), the development of ICAO standards for CO2 emissions was requested. After six years of development, the ICAO Aviation Environmental Protection Committee (CAEP), at its tenth meeting, recommended the Aircraft CO2 Certification Standard for Aircraft. Following its adoption by the ICAO Council, the new Aircraft Certification Standard for CO2 Emissions was published as Annex 16, Volume III - Standard for Aircraft Certification for CO2 Emissions (2017).

The CO2 emission standard places an additional requirement in the design process, which increases the priority of fuel efficiency in the overall design of an aircraft. An important step forward is tackling the growing CO2 emissions from the aviation sector, which will make a significant contribution to the climate change mitigation goals of the UNFCCC Paris Agreement. ICAO is also working on future standards, relating to the amount of particulate matter (PM) and the introduction of the nvPM number (nvPM-non-expirable particles), which are based on emissions from landing and take-off operations. These proposed standards were discussed at CAEP / 11 2019 and are expected to be implemented in the European legislative framework.

This new standard is part of ICAO's "Greenhouse Gas Emission Reduction Package from the airtransportation system" and represents the world's first CO2 technology standard in any sector, with the aim of encouraging more economical technologies in aircraft design. Following the adoption of the standards, EASA has supported the process of their integration into European legislation and has been implementing them since 1 January 2020. [9].

The standard applies to subsonic jet and turboprop aircrafts of a new type (NT) designed until 2020. After 2023, this standard will also apply to aircraft in production (InP), which have been modified and which meet special modification criteria. After 2028, InP aircraft that do not meet the standard will no longer be able to be produced unless the design is modified in accordance with the standard. Figure 5.1 provides an overview of CO2 emission regulatory limits for NT and InP CO2 standards.

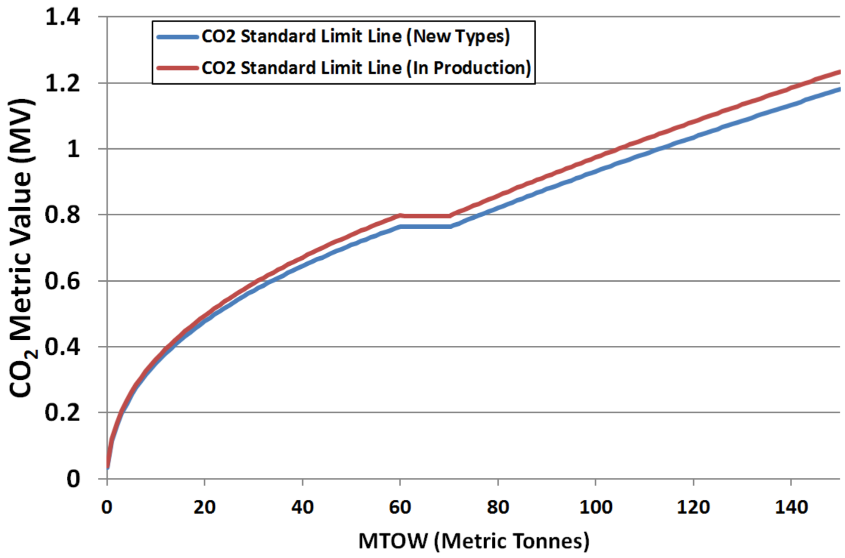


Figure 5.1 - Standard limits for CO_2 [3]

According to this standard, to determine the efficiency of aviation fuel in terms of CO2 emissions, three weighted points are used, representing high, medium and low gross mass aircraft, which are calculated as a function of maximum take-off mass (MTOM), to represent combustion performance. aircraft fuel during the cruise phase. Each of them represents the gross mass of the aircraft in the cruising phase, which lasts the longest during the flight of the aircraft. The goal of using three gross weights on a cruise is to make the fuel combustion performance assessment as relevant as possible.

With some aircraft models, there are cases where changes in the size of the aircraft do not reflect a change in the weight of the aircraft, for example when the aircraft is an extended version of the existing aircraft design. In order to better explain such cases, without mentioning the wide range of aircraft types and the technology they use, an adjustment factor was used to represent the size of the aircraft. This is defined as a reference geometric factor (RGF), and the measure is the size of the aircraft cabin based on the two-dimensional projection of the cabin. This has improved the performance of the CO2 metric system, making it more accurate and better for calculating different types of aircraft designs.

The ICAO standard for CO2 of aircrafts has direct effects on increasing the importance of fuel efficiency in the design process, so that the aircraft not only meets the regulatory limit, but in this respect becomes a relatively well-positioned product.

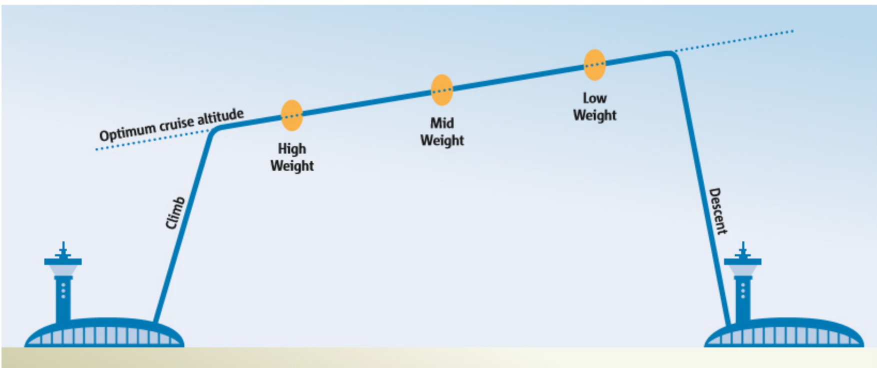


Figure 5.2 Example of measuring points of CO_2 [1]

6. CONCLUSION

In order to reduce the impact of air traffic on climate change, three areas have been identified where opportunities for progress should be sought. These are achieving the goals of neutral carbon growth in the aviation sector and long-term emission reductions through improving fuel efficiency by 2050, developing the EU ETS on the principle of "restriction and trade" and the introduction of environmental taxes in international aviation, as well as optimizing aircraft operation.

Optimization of air operations contributes to reducing the impact of air traffic on the environment while maintaining its safety. With the realization of a global, interoperable ATM system, combined with technological progress, it becomes possible to achieve future goals for reducing the impact of air traffic on the environment.

Sustainable aviation fuels are one element of ICAO's measures to reduce aviation emissions, which also includes technology and standards, operational improvements and the International Aviation Compensation and Carbon Reduction Scheme (CORSIA).

The need for SAF to be developed and implemented in an economically viable, socially and environmentally sound manner was recognized and states were asked to recognize existing approaches to assessing the sustainability of all alternative fuels in general, including those for use in aviation. This achieves a net reduction of greenhouse gas emissions, respect for areas of high importance for biodiversity, conservation and benefits for people from ecosystems, in accordance with international and national regulations and contribution to local social and economic development.

Adaptation to the effects of climate change has been recognized as necessary for an efficient and equitable response to the effects of climate change. Activities and international cooperation on adaptation have been strengthened, and developed countries need to provide adequate, predictable and sustainable financial resources, technology and capacity building to support the implementation of adaptation actions in developing countries.

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