Introduction to the ICAO Basket of Measures to Mitigate Climate Change

By ICAO Secretariat

INTRODUCTION TO GLOBAL EMISSIONS

In support of a data-driven decision making process, ICAO, in addition to the evolution of technological developments, is monitoring the evolution of scientific knowledge related to the impacts of aviation on the global climate. Aviation affects the global climate through both CO_2 and non-CO_2 induced effects. The aviation sector accounts for approximately 2% of global anthropogenic CO_2 emissions, including international and domestic aviation. International aviation alone accounts for 1.3% of global anthropogenic CO_2 emissions[1]. While the percentage of CO_2 emissions from global aviation has not significantly changed since 1992, the volume of CO_2 emissions has increased along with the increase in global CO_2 emissions across other sectors.

Other non-CO_2 factors such as ozone, methane, water vapor, or aerosols also affect global warming. Aircraft emit nitrogen oxides (NOx), which form ozone when emitted at cruise altitudes. Aircraft also trigger the formation of condensation trails, or contrails, which are suspected of enhancing the formation of cirrus clouds, which add to the overall global warming effect. These effects are estimated to be about two to four times greater than those of aviation's CO_2 alone[1].

While CO_2 impacts on the climate are well understood, there are important uncertainties regarding some of the non-CO_2 impacts and the underlying physical processes. That is why, since 1997, ICAO has requested scientific bodies to further investigate these impacts in order to develop appropriate measures to address such impacts. This resulted in the publication of the "IPCC Aviation and the Global Atmosphere report" in 1999, which provided the scientific basis for impacts of aviation on the global climate and highlights the state of understanding of the relevant science, aviation technology and socio-economic issues associated with aviation. Twenty years after the publication of this report, these estimates of aviation climate forcing could be enhanced by a new international scientific assessment. In the absence of such a report, in order to update and strengthen the scientific base, the information contained in the IPCC 1999 report is being supplemented by the work carried out by ICAO and the Committee for Aviation Environmental Protection (CAEP).

ICAO'S ASPIRATIONAL GOALS & BASKET OF MEASURES

With a view to minimize the adverse effects of international civil aviation on the global climate, ICAO formulates policies, develops and updates Standards and Recommended Practices (SARPs) on aircraft emissions, and conducts outreach activities. These activities are conducted by the Secretariat and the Committee on Aviation and Environmental Protection (CAEP). In pursuing its activities, ICAO also cooperates with other United Nations bodies and international organizations.

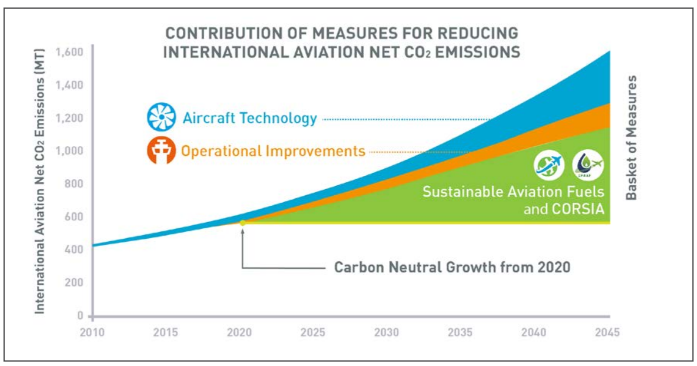
The ICAO Assembly at its 39th Session in 2016 adopted Resolution A39-2: *Consolidated statement of continuing ICAO policies and practices related to environmental protection — Climate change*. It reiterated the two global

1 IPCC 4th Assessment Report, 2007

aspirational goals for the international aviation sector of 2% annual fuel efficiency improvement through 2050 and carbon neutral growth from 2020 onwards, as established at the 37th Assembly in 2010.

To achieve the global aspirational goals and to promote sustainable growth of international aviation, ICAO is pursuing a basket of measures including aircraft technology improvements, operational improvements, sustainable aviation fuels, and market-based measures (CORSIA). ICAO is also exploring long-term global aspirational goals for international aviation, as reiterated by the 39th Session of the ICAO Assembly.

FIGURE 1: ICAO Global Environmental Trends on CO_2 Emissions and Contribution of Measures for Reducing International Aviation Net CO_2 Emissions



AIRCRAFT TECHNOLOGY AND STANDARDS

Advancement in aircraft technology is of great importance to reducing aviation emissions and significant progress has been made over the past 50 years. Today's aircraft are approximately 80 per cent more efficient in use of fuel per passenger kilometre than that in the 1960s. ICAO develops Standards, policies and guidance to ensure that the latest technology is incorporated to new type and in-production aircraft.

Adopted in 2017, the ICAO Aeroplane CO_2 Emissions Standard plays an important role in reducing the sectors fuel burn by ensuring that the latest fuel efficiency technologies are being implemented into the latest aeroplane designs. This Standard will apply to new aircraft type designs from 2020 and to aircraft that are already in production as of 2023.

ICAO recently conducted an Independent Expert Integrated Review of aircraft and engine technologies. This was the first review done in an integrated manner, considering the interdependencies between noise, fuel burn and emissions technologies. Based on this work, new integrated technology goals for engines and aircraft, including noise, emissions and fuel efficiency, were endorsed by ICAO's Committee on Aviation Environmental Protection (CAEP) and approved by the ICAO Council in 2019. More information on this review is provided in Chapter 1.

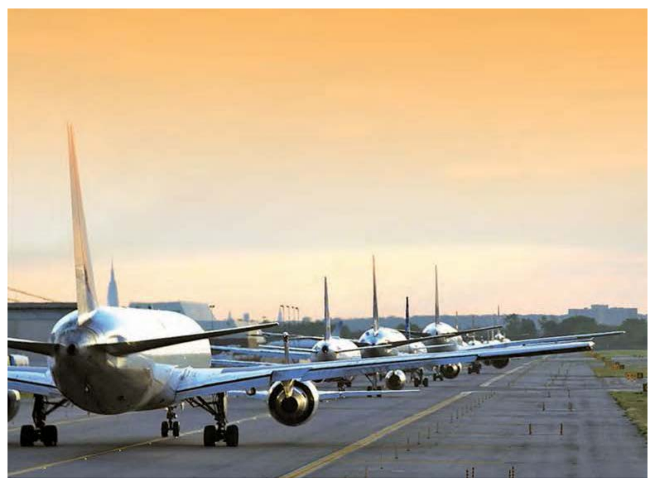
The progress on fuel efficiency improvement is the result of airframe, aero-engine, and aircraft systems manufacturers' continuous drive to develop new and innovative technologies. The utilization of higher By Pass Ratio (BPR) engines, as well as lighter and high temperature materials contribute to increased propulsive efficiency and lower fuel consumption. Reduction in aircraft weight is a key factor in reducing fuel burn. The combination of lighter weight materials and innovative structural technologies result in lower weight airframes. More recent technological developments continue to result in increased use of composite materials in the latest aircraft designs. New aircraft types also incorporate an increasing level of electrical systems and controls that contribute to a low operating weight and help further enhance the operating efficiency of the aircraft. Best practices on aircraft end-of-life such as through aircraft recycling are being developed.

The recent advance in electric or hybrid-electric aircraft technology has generated strong interest in aviation, due to its potential economic and environmental benefits. A number of ongoing projects have been identified globally, ranging from general aviation or recreational aircraft, business and regional aircraft, large commercial aircraft, motor gliders, unmanned aerial vehicles and vertical take-off and landing (VTOL) aircraft (also called electric urban air-taxis). Most of them target an entry-in-service date between 2020 and 2030, and some are already commercially available. ICAO is closely following-up innovative environmentally driven technologies that may impact the environment, including new energy sources for aviation. This will include assessing the consequences for noise and emissions, and maintaining and developing relevant ICAO environmental Standards and guidance. More details on electric aircraft can be found later in this chapter.

AIR TRAFFIC MANAGEMENT AND OPERATIONS

Optimization of air traffic management and operational procedures is a key element to avoid greenhouse gas emissions from aviation. The Global Air Navigation Plan (GANP) and the Aviation System Block Upgrades (ASBUs) are major initiatives developed by ICAO to that end. The GANP is a strategy to achieve a global interoperable air navigation system, for all users during all phases of flight that meets agreed levels of safety, provides for optimum economic operations, is environmentally sustainable and meets national security requirements. The ASBUs provide a roadmap to assist air navigation service providers in the development of their individual strategic plans and investment decisions. The Committee on Aviation Environmental Protection (CAEP) has estimated that current and planned implementation of ASBU Block 0 and 1 modules by 2025 are likely to provide a total annual global fuel saving in 2025 of between 167 to 307 kg per flight, which corresponds to a reduction of 26.2 to 48.2 Mt of CO_2.

ICAO develops and updates the necessary tools and guidance to assess the environmental benefits associated with air traffic management improvements. Environmental assessment tools such as the ICAO Fuel Savings Estimation Tool (IFSET) have allowed States to successfully assess the environmental benefit of implementing various operational measures. Airports are key stakeholders to improve practices on the ground. Better airport traffic sequencing, allowed by the growing implementation of innovative e-tools, such as Airport Collaborative Decision Making tools, help to improve the overall efficiency of airport operations, especially turn-around and pre-departure sequencing, thus avoiding unnecessary greenhouse gas emissions. Furthermore, ICAO fosters the exchange of information on best practices for Green Airports, covering such subjects as smart buildings, renewable energy, green mobility, climate change resilience, resource and biodiversity protection, community engagement and sustainability reporting, with the aim of sharing and harmonizing best practices amongst airports. Guidance material and tools such as the Eco-Airport Toolkit e-collection are being developed by ICAO to that end.



SUSTAINABLE AVIATION FUELS

Sustainable Aviation Fuels (SAF) have an important role to play in reducing CO_2 emissions from aviation. They are an important element of ICAO's basket of measures to mitigate climate change. Although time will be needed to deploy such fuels at scale, it is encouraging that the technologies for SAF production already exist today: the challenge is to accelerate SAF deployment, reduce its cost, and ensure the environmental integrity of the SAF production.

The growing societal concern with sustainability requires appropriate tools to inform decision making and ICAO is working to ensure that SAF deliver savings in CO_2 emissions. To achieve that, ICAO developed a unified methodology to assess SAF life cycle emissions environmental benefits, based on a life-cycle analysis that takes into account both direct and indirect land use change effects. ICAO also agreed on a set of sustainability criteria for SAF consideration under CORSIA, which require that SAF should achieve a 10% minimum GHG reduction, and that SAF should not be made from biomass obtained from land with high carbon stock (primary forests, wetlands, and peat lands). The ICAO Assembly requested States to recognize existing approaches to assess the sustainability of alternative fuels that should contribute to local social and economic development while avoiding competition with food and water. In that regard, work is ongoing to expand these sustainability criteria which will be subject to ICAO Council approval by the completion of the CORSIA Pilot Phase (end of 2023). More details on the consideration of SAF under CORSIA are provided in Chapter 6.

Since ICAO's first Conference on Aviation and Alternative Fuels (CAAF/1) held in 2009, significant progress has been achieved in the use of SAF. As of May 2019, more than 180,000 commercial flights used a blend of alternative fuel, six conversion processes have been certified for use in aviation, six airports are regularly distributing blended alternative fuel, and a number of sustainable aviation fuel initiatives and projects are ongoing or underway worldwide.

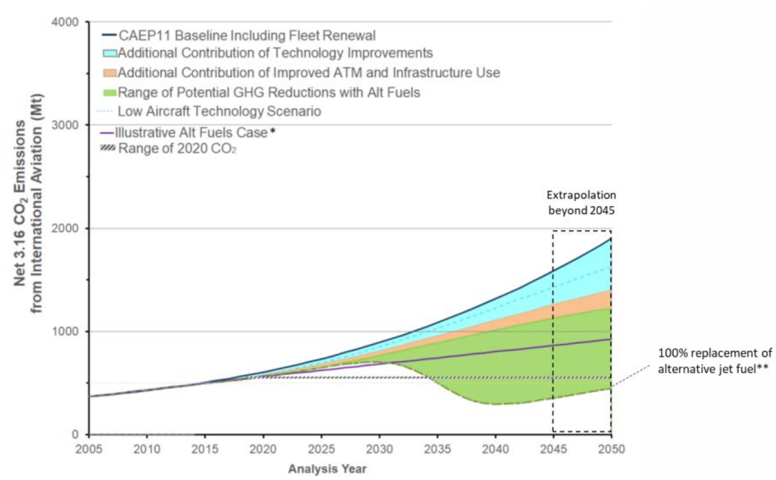
Significant uncertainties exist in predicting the contribution of sustainable aviation fuels in the future. However, a number of near-term scenarios evaluated by ICAO indicate that up to 2% of fuel consumption could potentially consist of SAF by 2025. This level of fuel production could only be achieved with large capital investments in sustainable aviation fuel production infrastructure, and substantial policy support. The effort required to reach these production volumes would have to significantly exceed historical precedent for other alternative fuels, such as ethanol and biodiesel for road transportation. The effect of such an expansion in the use of sustainable aviation fuels on CO_2 emissions from international aviation, without taking into account land use changes, has been assessed for the first time by ICAO (Figure 2 below).

ICAO supports States and stakeholders in their efforts to develop and deploy SAF by: establishing policies and measures that can hasten the use of sustainable aviation fuels; developing robust sustainability criteria and life cycle methodologies; sharing information and best practices including through ICAO's Global Framework for Aviation Alternative Fuels (GFAAF); assisting in the development of SAF feasibility studies; and organizing events for information-sharing and outreach. More details on these initiatives are provided in Chapter 5.

The use of sustainable aviation fuels could be crucial in achieving the carbon neutral growth goal from 2020 for international aviation.

GFAAF

FIGURE 2: Net 3.16 CO_2 Emissions from International Aviation, 2005 to 2050, including Sustainable Aviation Fuels Life Cycle CO_2 Emissions Reductions



Note: Reductions in atmospheric carbon from sustainable aviation fuel use occur from feedstock production and fuel conversion and not from fuel combustion.

However, the amount of current production is relatively small. To promote and regulate its use, incentives are needed through policies and regulatory frameworks, financial support to the production and certification of SAF, and technical and financial assistance at the State level. ICAO is actively working to that end, in collaboration with all relevant stakeholders.

CORSIA

At the 39th Session of the ICAO Assembly, ICAO Member States decided to implement the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), the first global market-based measures scheme in any sector, to address the increase in total CO_2 emissions from international aviation above the 2020 levels (Assembly Resolution A39-3). CORSIA represents a cooperative approach that moves away from a “patchwork” of regulatory initiatives through the implementation of a global scheme that has been developed through global consensus amongst governments, industry and international organizations. It offers a harmonized way to reduce emissions from international aviation thereby ensuring that there is no market distortion, while respecting the specific circumstances of all ICAO States. CORSIA complements the other components in the basket of measures by offsetting the amount of CO_2 emissions that cannot be reduced through the use of technological and operational improvements, and sustainable aviation fuels through the use of high quality emissions units from the global carbon market. It is estimated that between 2021 and 2035, the international aviation sector would have to offset about 2.5 billion tonnes of CO_2 emissions to achieve carbon neutral growth. More information on CORSIA can be found in Chapter 6 of this report.

REFERENCE

ICAO Environmental Protection webpage, https://www.icao.int/environmental-protection/Pages/default.aspx