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Committee on Aviation Environmental Protection (CAEP) – Topic 1

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* This paper reflects the author's personal views and cannot be considered as the views of ICAO.

Case:

Developing Sustainable Aviation Fuels (SAF) and Cleaner Energies for Aviation Decarbonization

1. Introduction

The decarbonization of aviation is one of the most pressing challenges facing the global transport sector. In the aviation sector's journey toward net-zero carbon emissions by 2050, Sustainable Aviation Fuels (SAF) are expected to have the largest contribution to aviation CO_2 emissions reductions, alongside other cleaner energies This case explores the evolution of international policies on SAF and cleaner energies for aviation, ICAO's framework, and the key challenges associated with scaling up these solutions while preserving global connectivity and fair competition.

2. Historical Background

Environmental protection has been part of ICAO's mandate since the 1970s, with climate change emerging as a central issue, as scientific evidence linking aviation emissions to global warming became more robust.

A major milestone was the adoption in 2016 of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), the first global market-based measure for any sector, which incentivizes the use of SAF and defines sustainability criteria for SAF and Low Carbon Aviation Fuels (LCAF). In 2022, ICAO agreed on a global Long Term Aspirational Goal (LTAG) for international aviation to achieve net-zero carbon emissions by 2050 in support of the Paris Agreement temperature goals.

In 2023, ICAO reaffirmed and strengthened its commitment to SAF through the Third ICAO Conference on Aviation and Alternative Fuels (CAAF/3) and the adoption of a Global Framework for SAF, LCAF and other Aviation Cleaner Energies encompassing policy and planning, regulatory framework, implementation support and financing.

Airports are also working toward their Long-Term Carbon Goal (LTCG) of achieving net-zero carbon emissions by 2050. Their decarbonization pathways rely heavily on cleaner energy solutions, including the deployment of renewable energy electrification of ground operations, and, over the long term, infrastructure readiness for hydrogen and electric aircraft.

The role of ICAO in aviation's decarbonization and in the development of SAF and cleaner energies has been crucial to ensure a harmonized and coordinated effort in line with the *No Country Left Behind* approach.

3. Contemporary Relevance of SAF and Cleaner Energies Challenges

Despite strong political commitments under the CAAF/3 Framework, and although SAF production has doubled annually since 2023, current volumes remain far below the levels projected in decarbonization scenarios, and significant barriers persist. Key challenges include:

- **Cost and Financing Challenges:**
  - SAF production and associated infrastructure require significant upfront capital investments.
  - SAF prices remain two to five times higher than conventional jet fuel.
  - Limited access to financing for SAF projects, particularly in developing States.
  - Airports face significant upfront investment costs for cleaner energy deployment, electrification, and long-term infrastructure readiness.
  - Uncertainty over long-term policy signals increases investment risk.
  - Revenue certainty mechanisms (e.g. offtake agreements, contracts for difference) remain underdeveloped in many regions.
- **Availability, Feedstock and Regional Imbalances:**
  - SAF production remains low and is concentrated in a few regions.
  - Limited availability of sustainable feedstocks and competition with other sectors (e.g. road transport, maritime).
  - Risk of supply chain bottlenecks and sustainability concerns (e.g. land use change, food security impacts).
  - Need to decarbonize national grids and develop sufficient, reliable production of renewable energy to answer aviation and airport needs.
  - Need for increased support and financing to deploy capacities in developing countries.
- **Policy Fragmentation and Fair Competition:**
  - Lack of policies in certain regions on SAF and cleaner energies.
  - Risk of market distortion and competitive disadvantages for airlines and airports operating in regions without support mechanisms.
  - Lack of harmonized sustainability criteria and certification frameworks.
  - Uncertainty regarding alignment between global frameworks and regional measures.
- **Infrastructure and System Integration**
  - Long-term infrastructure planning uncertainty for hydrogen and electric aircraft.
  - Integration challenges between airports, energy suppliers, airlines, and grid operators.
  - Land-use and space constraints at airports for renewable energy deployment.
- **Capacity and Knowledge Gaps:**
  - Limited technical expertise knowledge and capacity related to SAF development and deployment.
  - Regulatory and institutional capacity gaps, especially in developing States.
  - Need for workforce training across the aviation and energy sectors.

4. ICAO's Framework for SAF, LCAF and other Aviation Cleaner Energies

Through ICAO's Resolution A42-21 and Global Framework for SAF, LCAF and other Aviation Cleaner Energies, ICAO promotes a basket of measures to address aviation CO_2 emissions, and

offer a comprehensive and coordinated approach across four interdependent Building Blocks: 1) Policy and Planning; 2) Regulatory Framework; 3) Implementation Support; and 4) Financing:

1. **Policy and Planning**
    - Strive to achieve a collective global aspirational Vision to reduce CO2 emissions in international aviation by 5 percent by 2030, compared to zero cleaner energy use.
    - States are encouraged to implement policies.
2. **Regulatory Framework**
    - CORSIA sustainability criteria, sustainability certification, and the methodology for the assessment of life cycle emissions as the accepted basis for the eligibility of SAF, LCAF and other aviation cleaner energies used in international aviation.
3. **Implementation Support**
    - All States should have access to the means to participate across all stages of the development and deployment of SAF, LCAF and other aviation cleaner energies.
    - ICAO ACT-SAF programme capacity-building and implementation support projects.
4. **Financing**
    - Facilitate, in particular for developing countries and States having particular needs, better access to private investment capacities, as well as funding from financial institutions.
    - ICAO Finvest Hub initiative in cooperation with the International Renewable Energy Agency (IRENA).

6. Discussion Points for Students

1. **Scaling SAF production:**
    - How can SAF deployment be accelerated to achieve decarbonization goals and provide new opportunities for developing countries?
    - What combination of policy mandates, incentives, and market-based measures would most effectively scale SAF while preserving fair competition?
    - How can SAF deployment be accelerated without disproportionately increasing ticket prices or reducing air connectivity, especially for remote, small island developing states (SIDS), and developing regions?
    - How to ensure investments flow towards SAF and cleaner energy projects?
    - How can developing countries position themselves within the SAF value chain (feedstock production, refining, export, domestic use)?
    - What is the role of each stakeholder to facilitate the deployment of SAF (governments, airlines, fuel producers, airports, financial institutions, ICAO)?
    - How to engage traditional fuel suppliers?
2. **Strengthening Global Action to Implement SAF and Cleaner Energies**
    - What strategies can ICAO adopt to accelerate the implementation of the CAAF/3 Global Framework?
    - Given the uncertainty of the timeline and scale, how can the aviation sector prepare for hydrogen propulsion and electric aircraft?
    - What is the role of ICAO in this long-term energy transition?
3. **Airports Energy Needs**

- How to integrate airports' electricity needs within national energy strategies?
- How should airports define their energy strategies and their investments?
- How can airports coordinate with energy providers and national authorities to ensure grid capacity and renewable supply?
- How can smaller and regional airports avoid being left behind in the energy transition?
- What are the risks and benefits of airports becoming energy producers?
- In this energy transition, how can ICAO and States support airport infrastructure readiness?

8. Further Reading and Resources

- ICAO Assembly Resolution A42-21 – Climate Change
- ICAO CORSIA Sustainability Criteria for CORSIA Eligible Fuels
- ICAO Global Framework for SAF, LCAF and other Aviation Cleaner Energies
- ICAO 2025 Environmental Report "Skyward Action, Realizing Aviation's Sustainable Future"
- ICAO Eco-Airport Toolkit e-publication, "A focus on the production of renewable energy at the airport site"
- ICAO Eco-Airport Toolkit e-publication, "Cleaner Energies at Airports"
- ATAG, Waypoint 2050 – A Pathway to Net Zero Aviation
- Airports Council International, Long-Term Carbon Goal Study for Airports Report
- ACI-ATI, Integration of Sustainable Aviation Fuels into the Air Transport System
- ACI-ATI, Integration of Hydrogen Aircraft into the Air Transport System: An Airport Operations and Infrastructure Review
- ACI, Sustainable Energy Sources for Aviation: An Airport Perspective
- ACI, Airport Carbon Accreditation
- IATA, Resources on SAF