Commentary

The Implementation of the Carbon Offsetting and Reduction Scheme for International Aviation and Its Challenges for Aviation

Abdulrahman Alwosheel and Andres Felipe Guzman
About KAPSARC

KAPSARC is an advisory think tank within global energy economics and sustainability providing advisory services to entities and authorities in the Saudi energy sector to advance Saudi Arabia’s energy sector and inform global policies through evidence-based advice and applied research.

This publication is also available in Arabic.

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Summary

The aviation sector is a fast-growing industry that contributes significantly to greenhouse gas emissions and climate change. To address this issue, the International Civil Aviation Organization (ICAO) set aspirational emissions goals and introduced the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). CORSIA aims to cap carbon emissions from international flights by 2020 through the use of sustainable aviation fuels (SAFs) and other measures. The eligibility criteria for SAFs include a 10% reduction in greenhouse gas emissions compared to fossil fuels and compliance with sustainability criteria. However, challenges remain, such as the limited production capacity and higher cost of SAFs. CORSIA’s implementation is voluntary for participating states in the first phase but will become mandatory in the second phase. Increasing participation, ensuring the integrity of offset credits, and addressing technological and documentation challenges are essential for the successful implementation of CORSIA and the decarbonization of the aviation sector.
Introduction

Globally, the aviation sector is one of the fastest-growing industries. Except for a blip in 2020 owing to COVID-19 pandemic, it has achieved average annual growth of 5% (FAA 2022). Although the sector provides numerous benefits to the global economy, it also contributes significantly to greenhouse gas (GHG) emissions and, thus, to climate change. According to the International Civil Aviation Organization (ICAO) (2022a), the aviation industry generates approximately 2.5% of global carbon emissions. This figure is projected to increase in the coming years, as the aviation sector is expected to continue its trajectory of strong growth. It is likely to match historical trends or even exceed them in some regions.

To address the international aviation sector’s emissions, ICAO set aspirational emissions goals during its 39th Assembly in 2016. ICAO aimed to improve fuel efficiency by 2% annually and keep net carbon emissions at 2020 levels, as established at its 37th Assembly in 2010. It also recognized efforts to explore long-term aspirational goals for international aviation in light of the Paris Agreement’s 2°C and 1.5°C temperature increase goals (ICAO 2018).

ICAO identified four measures to achieve its international goals. First, it sought to purchase new aircraft and retrofit existing aircraft with more fuel-efficient technologies. Second, it planned to invest in the development and deployment of sustainable aviation fuels. Third, it aimed to improve the use of communication, navigation, and surveillance and air transport management to reduce fuel burn. Fourth, ICAO agreed to research and build awareness of low-cost, market-based measures to reduce emissions, such as emission trading, levies, and offsets.

The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) was adopted by the ICAO Council on June 27, 2018. CORSIA aims to reduce the aviation sector’s carbon emissions through the use of sustainable fuels¹ and other measures.² As a global market-based assessment, it seeks to minimize market distortion. It provides a coordinated approach for reducing international aviation’s emissions while respecting the unique situations and individual capacities of ICAO’s member states.³ Additionally, CORSIA complements other measures by offsetting carbon dioxide emissions that cannot be reduced through technological improvements, operational improvements, or sustainable aviation fuels. These offsets reduce emissions elsewhere in the carbon market (ICAO 2022a). ICAO has proposed two implementation phases for CORSIA. The first phase, from 2021 to 2023, is voluntary, and the second phase, from 2024 to 2035, will be mandatory for all participating states (ICAO 2022a).

¹ Sustainable fuels include biomass (biofuels), hydrogen, synthetic fuels, power-to-liquid fuel production, and electricity.
² Other measures include carbon offsets and lower-carbon aviation fuel (LCAF).
³ As of 2002, ICAO has 193 member states.
CORSIA’s Importance to the Aviation Sector

CORSIA is an offsetting scheme that aims to cap carbon emissions from international flights by 2020. This scheme requires airlines to purchase carbon credits to offset emissions above the cap. Offset credits can be generated through projects, such as renewable energy and afforestation projects, that reduce GHG emissions. The scheme will initially apply to flights between participating states, including all European Union member states, China, Japan, and the United States. As of January 2023, 115 countries (Figure 1) are participating in this initiative (ICAO 2022c). In other words, 60% of United Nations member states have joined CORSIA. Two countries⁴ that are not United Nations member states have not joined CORSIA.

Figure 2 shows that CORSIA's implementation elements comprise 14 documents divided into five main groups. The first group contains the document "CORSIA States for Chapter 3 State Pairs" (Document 01). The second group includes a document called "ICAO CORSIA CO2 Estimation and Reporting Tool (CERT)" (Document 02). The third group comprises documents describing CORSIA-eligible fuels (Documents 03–07). The fourth group contains documents describing CORSIA-eligible emissions units (Documents 08 and 09). Finally, the fifth group includes documents describing the CORSIA Central Registry (Documents 10–14).

This study explores CORSIA’s proposals for the aviation sector. We consider CORSIA-eligible fuels, their potential impacts on the environment, and the challenges associated with the proposal. The study accounts for the ICAO Council’s approval and release of a third amendment to Document 05 in November 2022 (ICAO 2022b).

⁴ These countries are the Holy See and the state of Palestine.
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**Figure 1.** Countries participating in CORSIA (January 2023).

Source: KAPSARC analysis, based on ICAO data.

**Figure 2.** Elements of CORSIA's implementation.

**Main Groups**

- **Group 1: CORSIA States for Chapter 3 State Pairs**
  - Document 01: CORSIA States for Chapter 3 State Pairs

- **Group 2: ICAO CORSIA CO2 Estimation and Reporting Tool (CERT)**
  - Document 02: ICAO CORSIA CO2 Estimation and Reporting Tool

- **Group 3: CORSIA-eligible fuels**
  - Document 03: CORSIA Eligibility Framework and Requirements for Sustainability Certification Schemes
  - Document 04: CORSIA Approved Sustainability Certification Schemes
  - Document 05: CORSIA Sustainability Criteria for CORSIA Eligible Fuels
  - Document 06: CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels
  - Document 07: CORSIA Methodology for Calculating Actual Life Cycle Emissions Values

- **Group 4: CORSIA-eligible emissions units**
  - Document 08: CORSIA Eligible Emissions Units
  - Document 09: CORSIA Emissions Unit Eligibility Criteria

- **Group 5: CORSIA-central registry (CCR)**
  - Document 10: CORSIA Central Registry: Information and Data for the Implementation of CORSIA
  - Document 11: CORSIA Aeroplane Operator to State Attributions
  - Document 12: CORSIA 2020 Emissions
  - Document 13: CORSIA Annual Sector’s Growth Factor (SGF)
  - Document 14: CORSIA Central Registry (CCR): Information and Data for Transparency

Source: KAPSARC analysis, based on ICAO data.
CORSIA places significant emphasis on the use of sustainable aviation fuels (SAFs) relative to other measures for decarbonizing the aviation industry. ICAO defines an SAF as "any aviation fuel that is produced from sustainable sources, including renewable energy and/or advanced conversion technologies" (ICAO 2022h). CORSIA’s implementation elements widely address its focus on SAFs.

The eligibility framework and requirements for SAFs are outlined in ICAO Document 03. This document provides guidelines for fuel producers and users regarding the eligibility, verification, and recognition criteria for SAFs. According to this document, SAFs must meet several criteria to qualify for CORSIA. First, they must reduce GHG emissions by at least 10% compared to fossil fuels. Second, they must comply with sustainability criteria, including social, environmental, and economic factors. Third, they must be produced from renewable sources or using advanced conversion technologies.

To verify a fuel’s eligibility to be an SAF, fuel producers and users must undergo a certification process through an approved sustainable certification scheme (SCS). ICAO Document 04 lists the approved SCSs. These certification schemes include the Roundtable on Sustainable Biomaterials, International Sustainability and Carbon Certification, and Sustainable Aviation Fuel Certification.

ICAO Document 05 outlines the sustainability criteria with which eligible fuels must comply in the CORSIA proposal. These criteria cover several environmental, social, and economic factors, including land use change, biodiversity, water use, human rights, labor rights, and economic development. The document says that eligible fuels must not have significant negative impacts on food security, water availability, or biodiversity. As mentioned above, the document sets a threshold of at least a 10% reduction in GHG emissions compared with fossil-based fuels. However, the emission reduction achieved by a fuel may vary depending on the feedstock and production process. Additionally, the document’s third amendment includes sustainability criteria for batches of CORSIA LCAFs produced by certified fuel producers on or after January 1, 2024.

ICAO Document 06 is titled “CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels” (ICAO 2022). The ICAO life cycle assessment default value is based on the associated feedstock, the conversion process (i.e., pathway), the induced land-use change, and pathway specifications. The default life-cycle emissions in Document 06 provide estimates of the GHG emissions associated with different types of feedstocks and production processes. Thus, the document emphasizes that emissions may vary depending on the feedstock and production process.

ICAO Document 07 provides guidelines and a methodology for calculating SAFs’ life-cycle emissions. The methodology considers the specific characteristics of the feedstock and production process. It requires fuel producers to collect and report data on the emissions associated with each stage of the production process, from feedstock production to final distribution.

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5 The second edition of the document was released in June 2022.
6 The first edition of the document was released in November 2020. ICAO (2020) provides more details.
7 The third edition of the document was released in November 2022. ICAO (2022e) provides more details.
8 Eligible fuels include SAFs and LCAFs. LCAFs are fossil-based aviation fuels that meet CORSIA’s sustainability criteria.
9 The fourth edition of the document was released in June 2022. ICAO (2022f) provides more details.
10 The third edition of the document was released in June 2022. ICAO (2022g) provides more details.
Overview of SAF Production

SAFs are derived either from sustainable feedstocks\(^{11}\) to produce biofuels or from synthetic fuels. They include biokerosene, biodiesel, e-kerosene, e-diesel, e-gasoline, hydrogen, bio-liquefied natural gas (LNG), bio-compressed natural gas (CNG), bio-methanol, bio-ammonia, ethanol, e-LNG, e-CNG, e-methanol, and e-ammonia. Some SAFs may be considered drop-in fuels\(^{12}\) that do not require adaptations to the fuel system’s engine. Table 1 shows which SAFs are classified as either drop-in or non-drop-in fuels.

<table>
<thead>
<tr>
<th>FUEL TYPE</th>
<th>FOSSIL-BASED FUELS</th>
<th>BIOFUELS</th>
<th>SYNTHETIC FUELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DROP-IN</td>
<td>Kerosene</td>
<td>Biokerosene</td>
<td>E-kerosene</td>
</tr>
<tr>
<td></td>
<td>Diesel</td>
<td>Biodiesel</td>
<td>E-diesel</td>
</tr>
<tr>
<td></td>
<td>Gasoline</td>
<td></td>
<td>E-gasoline</td>
</tr>
<tr>
<td></td>
<td>Heavy fuel oil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NON-DROP-IN</td>
<td>Hydrogen</td>
<td>Hydrogen</td>
<td>Hydrogen</td>
</tr>
<tr>
<td></td>
<td>LNG</td>
<td>Bio-LNG</td>
<td>E-LNG</td>
</tr>
<tr>
<td></td>
<td>CNG</td>
<td>Bio-CNG</td>
<td>E-CNG</td>
</tr>
<tr>
<td></td>
<td>Methanol</td>
<td>Bio-methanol</td>
<td>E-Methanol</td>
</tr>
<tr>
<td></td>
<td>Ammonia</td>
<td>Bio-ammonia</td>
<td>E-Ammonia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ethanol</td>
<td>Direct power usage</td>
</tr>
</tbody>
</table>

Source: Powering the Future of Logistics with Sustainable Fuels Webinar (DHL 2022).

Additionally, several production technologies have been considered for the resulting fuel types. A conversion process is defined as “a form of technology used to convert a feedstock into aviation fuels.” According to Annex 16 Volume IV of ICAO, ASTM International\(^{13}\) has authorized nine conversion processes (i.e., pathways) as of October 2021 (see Table 2).

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\(^{11}\) Sustainable feedstocks include waste, oils, agricultural residues, oil-rich agricultural organisms, and waste carbon-rich gases.

\(^{12}\) Drop-in fuels are completely interchangeable. These fuels can substitute for conventional petroleum-derived hydrocarbons.

\(^{13}\) ASTM International was formerly known as the American Society for Testing and Materials. It is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

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### Table 2. Conversion processes for SAFs.

<table>
<thead>
<tr>
<th>N</th>
<th>ASTM reference</th>
<th>Conversion process</th>
<th>Abbreviation</th>
<th>Possible feedstocks</th>
<th>Blending ratio by volume</th>
<th>Commercialization proposals / projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ASTM D7566 Annex 1</td>
<td>Fischer-Tropsch hydroprocessed synthesized paraffinic kerosene</td>
<td>FT</td>
<td>Coal, natural gas, biomass</td>
<td>50%</td>
<td>Fulcrum, Red Rock Biofuels, SG Preston, Kaidi, Sasol, Shell, Syntroleum</td>
</tr>
<tr>
<td>2</td>
<td>ASTM D7566 Annex 2</td>
<td>Synthesized paraffinic kerosene from hydroprocessed esters and fatty acids</td>
<td>HEFA</td>
<td>Bio-oils, animal fat, recycled oils</td>
<td>50%</td>
<td>World Energy, Honeywell UOP, Neste, Dynamic Fuels, EERC</td>
</tr>
<tr>
<td>3</td>
<td>ASTM D7566 Annex 3</td>
<td>Synthesized iso-paraffins from hydroprocessed fermented sugars</td>
<td>SiP</td>
<td>Biomass used for sugar production</td>
<td>10%</td>
<td>Amyris, Total</td>
</tr>
<tr>
<td>4</td>
<td>ASTM D7566 Annex 4</td>
<td>Synthesized kerosene with aromatics derived by alkylation of light aromatics from non-petroleum sources</td>
<td>FT-SKA</td>
<td>Coal, natural gas, biomass</td>
<td>50%</td>
<td>Sasol</td>
</tr>
<tr>
<td>5</td>
<td>ASTM D7566 Annex 5</td>
<td>Alcohol to jet synthetic paraffinic kerosene</td>
<td>ATJ-SPK</td>
<td>Biomass from ethanol or isobutanol production</td>
<td>50%</td>
<td>Gevo, Cobalt, Honeywell UOP, Lanzatech, Swedish Biofuels, Byogy</td>
</tr>
<tr>
<td>6</td>
<td>ASTM D7566 Annex 6</td>
<td>Catalytic hydrothermolysis jet fuel</td>
<td>CHJ</td>
<td>Triglycerides such as soybean oil, jatropha oil, camelina oil, carinata oil, and tung oil</td>
<td>50%</td>
<td>Applied Research Associates</td>
</tr>
<tr>
<td>7</td>
<td>ASTM D7566 Annex 7</td>
<td>Synthesized paraffinic kerosene from hydrocarbon - hydroprocessed esters and fatty acids</td>
<td>HC-HEFA-SPK</td>
<td>Algae</td>
<td>10%</td>
<td>IHI Corporation</td>
</tr>
<tr>
<td>8</td>
<td>ASTM D1655 Annex A1</td>
<td>Co-hydroprocessing of esters and fatty acids in a conventional petroleum refinery</td>
<td>co-processed HEFA</td>
<td>Fats, oils, and greases co-processed with petroleum</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>ASTM D1655 Annex A1</td>
<td>Co-hydroprocessing of Fischer-Tropsch hydrocarbons in a conventional petroleum refinery</td>
<td>co-processed FT</td>
<td>Fischer-Tropsch hydrocarbons co-processed with petroleum</td>
<td>5%</td>
<td>Fulcrum</td>
</tr>
</tbody>
</table>

Source: ICAO (2023b)
As of March 2023, fuel producers and consumers (i.e., airline carriers) have made 96 uptake agreements for SAFs totaling 41.6 billion liters of fuel (ICAO 2022h). However, only 26 SAF facilities are in operation across three regions and 14 countries. These facilities have a combined capacity of 10.33 billion liters, as shown in Table 3. North America has seven facilities in service, with five in the United States and two in Canada. They have a total capacity of almost 1,600 million liters. In Europe, 12 facilities are in operation, with a total capacity of 2,500 million liters. Asia has seven facilities with a total capacity of 6,255 million liters. To date, South America, the Middle East, and Africa have no operational SAF facilities. However, seven facilities are under development in these regions: three in South America, two in the Middle East, and two in Africa.

Table 3. SAF facilities in service.

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Region</th>
<th>Entry to service</th>
<th>Feedstock</th>
<th>ASTM</th>
<th>Fuel type</th>
<th>Capacity (million liters/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fulcrum Bioenergy</td>
<td>United States</td>
<td>America</td>
<td>2022</td>
<td>MSW</td>
<td>FT-SPK</td>
<td>Drop-in (e-kerosene)</td>
<td>41.64</td>
</tr>
<tr>
<td>Sinclair Oil</td>
<td>United States</td>
<td>America</td>
<td>2020</td>
<td></td>
<td>FT-SPK</td>
<td>Drop-in (e-kerosene)</td>
<td>359.61</td>
</tr>
<tr>
<td>ARA</td>
<td>United States</td>
<td>America</td>
<td>2014</td>
<td>Fats, oil, greases</td>
<td>CH-SK</td>
<td>Drop-in (e-kerosene)</td>
<td>5.79</td>
</tr>
<tr>
<td>Gevo</td>
<td>United States</td>
<td>America</td>
<td>2013</td>
<td>Sugar</td>
<td>ATJ-SKP</td>
<td>Drop-in (e-kerosene)</td>
<td>0.13</td>
</tr>
<tr>
<td>WorldEnergy</td>
<td>United States</td>
<td>America</td>
<td></td>
<td></td>
<td>Drop-in (e-kerosene)</td>
<td>1158.3</td>
<td></td>
</tr>
<tr>
<td>SAF plus Consortium</td>
<td>Canada</td>
<td></td>
<td>2025</td>
<td>Waste gas</td>
<td>FT-SPK</td>
<td>Drop-in (e-kerosene)</td>
<td>29.9</td>
</tr>
<tr>
<td>Carbon Engineering</td>
<td>Canada</td>
<td>America</td>
<td>2017</td>
<td>Atmospheric carbon dioxide</td>
<td>Not approved</td>
<td>Drop-in (e-kerosene)</td>
<td></td>
</tr>
<tr>
<td>BP</td>
<td>Spain</td>
<td>Europe</td>
<td>2021</td>
<td>Waste</td>
<td>FT-SPK</td>
<td>Drop-in (e-kerosene)</td>
<td>1.23</td>
</tr>
<tr>
<td>Cepsa</td>
<td>Spain</td>
<td>Europe</td>
<td>2022</td>
<td>Lipid caprooessing</td>
<td>Oils and fats</td>
<td>HEFA-SPK</td>
<td>98.4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>France</td>
<td>Europe</td>
<td>2019</td>
<td>Waste</td>
<td>FT-SPK</td>
<td>Drop-in (e-kerosene)</td>
<td>624.59</td>
</tr>
<tr>
<td>TOTAL</td>
<td>France</td>
<td>Europe</td>
<td>2021</td>
<td>Straw, forest waste</td>
<td>FT-SPK</td>
<td>Drop-in (e-kerosene)</td>
<td>75.7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>Germany</td>
<td>Europe</td>
<td>2022</td>
<td>Waste</td>
<td>Drop-in (e-kerosene)</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Celtic Renewables Uniled Kingdom</td>
<td>United Kingdom</td>
<td>Europe</td>
<td>2020</td>
<td>Waste</td>
<td>Drop-in (e-kerosene)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Axens/PNN ORLEN</td>
<td>Poland</td>
<td>Europe</td>
<td>2019</td>
<td>Vegetable oil</td>
<td>HEFA-SKP</td>
<td>Drop-in (e-kerosene)</td>
<td>562.5</td>
</tr>
<tr>
<td>OMMV Patrom</td>
<td>Romania</td>
<td>Europe</td>
<td>2024</td>
<td>Forest residues and MSW</td>
<td>HEFA-SKP</td>
<td>Drop-in (e-kerosene)</td>
<td>999.35</td>
</tr>
<tr>
<td>LTU GreenEthils</td>
<td>Sweden</td>
<td>Europe</td>
<td>2020</td>
<td>Wood waste</td>
<td>FT-SPK</td>
<td>Drop-in (e-kerosene)</td>
<td>117.3</td>
</tr>
<tr>
<td>Neste Oil</td>
<td>Finland</td>
<td>Europe</td>
<td>2019</td>
<td>Oils and fats</td>
<td>HEFA-SKP</td>
<td>Drop-in (e-kerosene)</td>
<td>60.6</td>
</tr>
<tr>
<td>Lanzajet</td>
<td>China</td>
<td>Asia</td>
<td>2018</td>
<td>Waste gas</td>
<td>ATJ-SKP</td>
<td>Drop-in (e-kerosene)</td>
<td>41.6</td>
</tr>
<tr>
<td>Lanzajet</td>
<td>China</td>
<td>Asia</td>
<td>2020</td>
<td>Waste cooking oil, fat</td>
<td>HEFA-SKP</td>
<td>Drop-in (e-kerosene)</td>
<td>125</td>
</tr>
<tr>
<td>Euglena / Chevron Lumus</td>
<td>Japan</td>
<td>Asia</td>
<td>2020</td>
<td>HEFA-SKP</td>
<td>Drop-in (e-kerosene)</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Pertamina</td>
<td>Indonesia</td>
<td>Asia</td>
<td>2022</td>
<td>Vegetable oils and fats</td>
<td>HEFA-SKP</td>
<td>Drop-in (e-kerosene)</td>
<td>58</td>
</tr>
<tr>
<td>Pertamina</td>
<td>Indonesia</td>
<td>Asia</td>
<td>2017</td>
<td>Palm oil</td>
<td>HEFA-SKP</td>
<td>Drop-in (e-kerosene)</td>
<td>348</td>
</tr>
<tr>
<td>Neste Oil</td>
<td>Singapore</td>
<td>Asia</td>
<td>2023</td>
<td>Oils and fats</td>
<td>HEFA-SKP</td>
<td>Drop-in (e-kerosene)</td>
<td>56213</td>
</tr>
<tr>
<td>Total capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10330.74</td>
</tr>
</tbody>
</table>

Source: KAPSARC analysis based on ICAO data. 14

Table 3 shows that SAF production is concentrated in a few companies, such as Neste15 and World Energy.16 However, other companies, such as LanzaJet17 and SkyNRG,18 are gaining market share.

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14 ICAO’s SAF facilities map is linked here: https://lookerstudio.google.com/reporting/2532150c-ff4c-4659-9cf3-9e1ea457b8a3/page/p_2sq3qol5nc?s=mGz_sTv1l-c. The table is left blank if information from the source is practically unavailable.
15 Neste has a global presence and provides SAFs to Alaska Airlines, American Airlines, JetBlue, All Nippon Airways, and KLM.
16 World Energy provides SAFs to United Airlines and JetBlue.
17 LanzaJet was founded in 2020. Sunco Energy, a Canadian energy corporation; Mitsui & Co., a Japanese trade and investment firm; British Airways; Shell; and All Nippon Airways support LanzaJet.
18 SkyNRG (i.e., SkyNRG Pacific Northwest, Synkera, and SkyNRG) supplies SAFs to over 40 airlines across all continents. In 2021, SkyNRG announced a partnership with Boeing to scale up SAFs globally, and it is building fully dedicated facilities for producing SAFs.

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Challenges Associated With the CORSIA Proposal

As previously described, the CORSIA proposal has significant implications for the aviation sector. It represents an important step forward in the aviation industry’s efforts to sustainably reduce its environmental impact. By stabilizing carbon dioxide emissions at 2020 levels, CORSIA will help mitigate the aviation sector’s contribution to climate change. The proposal also encourages the development and use of SAFs, which will help reduce the sector’s dependence on fossil fuels.

However, some challenges are associated with CORSIA’s implementation, such as the availability of SAFs. SAF production is still in its infancy, and the current production capacity is insufficient to meet the aviation sector’s demand (ICAO 2022h). As mentioned previously, 96 SAF offtake agreements, totaling 41.6 billion liters, have been signed. This amount of SAF production represents the durations of the agreements, which range from three to 13 years. The corresponding daily SAF production is approximately 0.0715 million barrels per day (Mbb/d). Thus, SAF production accounts for less than 1% of the aviation sector’s total energy demand, which is expected to reach nearly 7.2 Mbb/d on average (Blas 2023). The global SAF facilities listed in Table 3 can supply 25% of all uptake agreements. Thus, production needs to be drastically altered over the next few years to grow at a more aggressive pace. Given the production of existing facilities, thousands of facilities worldwide are needed to support CORSIA’s emissions reduction goals in the near future. As envisaged, these facilities should be developed according to the principle of mitigating severe impacts on the environment by third parties.

The second challenge is the cost of SAFs. SAFs are significantly costlier than conventional jet fuel is, which can increase airline operational costs (ICAO 2022b). SAFs are generally more expensive for several reasons mentioned by the International Air Transport Association (2020). They have lower production volumes than conventional fuels have, they use advanced feedstocks and processing technologies, and the supply chain lacks economies of scale. Additionally, SAFs are derived from various feedstocks, including waste oils, plant oils, and agricultural residues. These feedstocks require additional processing, such as hydrotreatment, to remove impurities and produce fuels that meet aviation fuel standards. These extra steps can increase the cost of SAFs relative to conventional jet fuels (Holladay, Abdullah, and Heyne 2020). The higher costs for SAFs can translate into greater operational costs for airlines, which creates challenges for airlines operating with thin profit margins. To overcome these challenges, some airlines have partnered with biofuel producers to develop new SAF supply chains and improve SAFs’ affordability (Boeing 2023).

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19 The total of 41.6 billion liters is equivalent to 261 Mbb (US oil barrels) for the duration of the agreements.
20 If the agreements require SAF production for 10 years, then the amount of daily production is $261.02/(10*365) = 0.071$ Mbb/d.
The third challenge associated with CORSIA is that it only applies to international flights between states that have volunteered to join. However, more countries are joining the scheme, thereby increasing its coverage and ability to reduce carbon emissions from aviation. As of September 2021, 115 countries, representing over 80% of international aviation activities, have volunteered to participate in CORSIA (ICAO 2022c). Thus, the scheme has expanded significantly since its inception in 2016. Because aviation is a global industry, increasing participation in CORSIA is crucial for achieving the ICAO’s goal of carbon-neutral growth from 2020 onwards. By working together, countries can create a level playing field for airlines. They can ensure that the burden of carbon emission reduction is shared fairly across the industry. Expanding CORSIA’s scope to include domestic flights can also increase the scheme’s coverage and impact. Such an expansion can be achieved through countries’ voluntary participation and through international cooperation and coordination.

Another challenge associated with CORSIA relates to the integrity of offset credits. CORSIA allows airlines to purchase offset credits from projects that reduce GHG emissions. However, concerns regarding the quality and transparency of these offset projects have been raised. Some projects may not deliver the promised emission reductions, and offset credits may be double-counted. Furthermore, the price of offset credits can be volatile, making it difficult for airlines to plan and reduce their budget emissions.

The above challenges relate to CORSIA’s implementation within the aviation industry. However, CORSIA’s implementation elements, particularly CORSIA-eligible fuels, also highlight difficulties that may impede a smooth transition to a sustainable aviation sector. First, the implementation elements emphasize SAFs, discussing them in greater detail than other measures. These other measures may be helpful in achieving decarbonization targets and goals in this hard-to-abate sector. Second, many of the documents describing implementation elements are amended or have new editions established at different times. The other documents must be updated accordingly to avoid conflicts in their application. For example, the third amendment of Document 05, published on November 28, 2022, includes sustainability criteria for LCAFs. However, the other documents do not include LCAFs in their recommendations.

In conclusion, CORSIA’s implementation elements are crucial to the aviation sector’s decarbonization. However, their documentation is still being developed. Continuous improvements are needed to overcome technological problems or to incorporate new alternative fuel sources, such as LCAFs that meet CORSIA’s sustainability criteria. The decarbonization of the aviation sector is a serious challenge to achieving net-zero carbon emissions by 2050. However, the potential impact of the CORSIA implementation elements is promising because they are progressively including many possibilities.

21 CORSIA-eligible fuels are described in Documents 03 to 07 (“CORSIA Eligibility Framework and Requirements for Sustainability Certification Schemes,” “CORSIA Approved Sustainability Certification Schemes,” “CORSIA Sustainability Criteria for CORSIA Eligible Fuels,” “CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels,” and “CORSIA Methodology for Calculating Actual Life Cycle Emissions Values.”)

22 For example, Document 06, titled “CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels,” was published in June 2022. It mentions the LCAF values of CORSIA-eligible fuels but does not describe the recommended values for LCAFs. Document 04, titled “CORSIA Approved Sustainability Certification Schemes,” was published in November 2022. It does not explicitly describe the validity of the CORSIA-approved SCSs for other editions of the CORSIA sustainability criteria for CORSIA-eligible fuels.
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References


———. 2022c. ICAO Document 01 - CORSIA States for Chapter 3 State Pairs. Montreal: ICAO.

———. 2022d. ICAO Document 03 - Eligibility Framework and Requirements for SCSs. Montreal: ICAO.

———. 2022e. ICAO Document 05 - CORSIA Sustainability Criteria for CORSIA Eligible Fuels. Montreal: ICAO.


About the Project

The KAPSARC Aviation Model project’s objective is to analyze the main drivers of aviation demand and assess energy concerns by considering the current and future use of fossil- and non-fossil-based fuels. Aviation is a key transport mode worldwide. It is essential for connecting the world and generating economic growth in many other related sectors. Therefore, a better understanding of aviation in countries like Saudi Arabia is necessary to illustrate how policy decisions are framed so that they continue to be a catalyst for national development. This project explores current and future aviation and energy demand scenarios to generate policy-relevant insights. The ever-increasing needs related to aviation performance, energy demand, and consumption necessitate the development of better information management tools and methodologies, models, and technologies, which this project aims to provide.