



ICAO CORSIA and Sustainable Aviation Fuels

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CRC Workshop on LCA for transportation fuels
October 3, 2023



Outline

- 1. ICAO Background**
- 2. CORSIA Overview and Technical Details**
- 3. Sustainable Aviation Fuels (SAF) in CORSIA**

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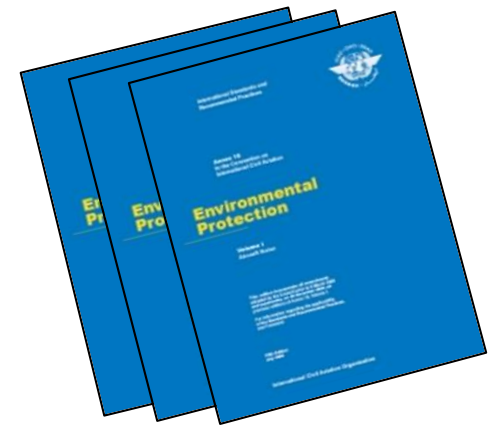
U.N. International Civil Aviation Organization (ICAO)

- ICAO sets standards and recommended practices for civil aircraft to enable our global aviation system
- General Assembly of 193 ICAO Member States
 - Meets every three years (this cycle sets the pace of ICAO work)
 - Assembly approves/endorsees work conducted in the previous three years and sets forth commitments and future work by ICAO
 - Resolution – method by which the Assembly makes policy and commitments
- ICAO Council
 - 36 member states with permanent representatives
 - ICAO Council conducts day-to-day oversight of ICAO work program; meets for two week voting sessions four times per year
- ICAO five Strategic Objectives:
 1. Safety
 2. Air Navigation Capacity and Efficiency
 3. Security & Facilitation
 4. Economic Development of Air Transport
 5. Environmental Protection
- ICAO Committee on Aviation Environmental Protection (CAEP)
 - Standing Committee of the Council to conduct environmental technical work

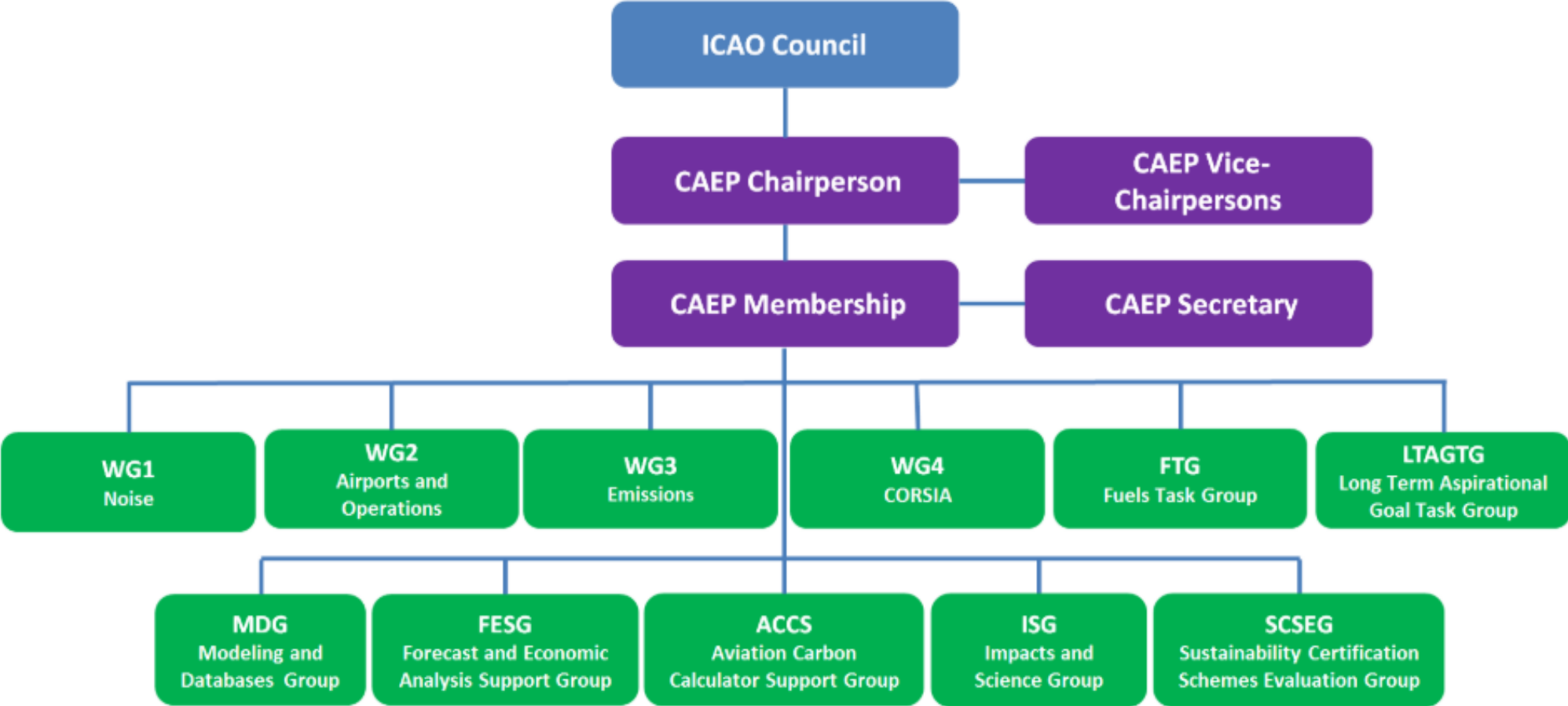


CAEP - Committee on Aviation Environmental Protection

- Standing Committee of the Council to conduct environmental technical work
- Develops environmental Standards and Recommended Practices (SARPs)
- Annex 16 on environment contains four volumes of SARPs: 1. noise, 2. engine emissions, 3. Aeroplane CO2 emissions, and 4. CORSIA
- Composed of 31 Members from all regions of the world and 22 Observers
- Terms of Reference: Assessments and proposals take into account - technical feasibility, economic reasonableness and environmental benefit, interdependencies of measures, developments in other fields, and international and national programs
- Current CAEP/13 (Feb. 2022 through Feb. 2025)
- Work of CAEP is done by many technical groups



CAEP Structure



CAEP Technical Groups for CORSIA and Fuels

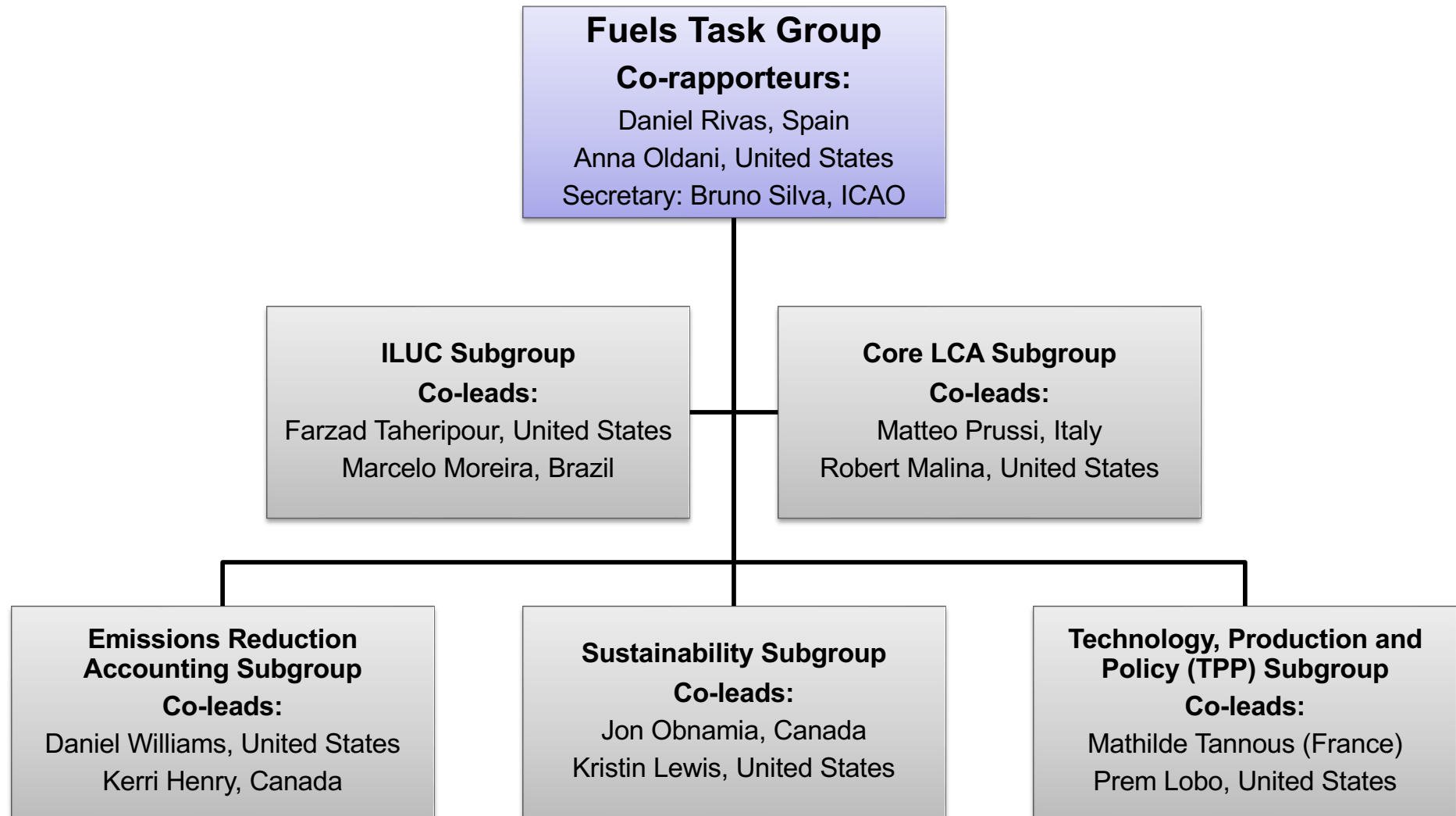
Fuels Task Group (FTG) addresses technical issues related to aviation fuels, including the methodologies for considering CORSIA Sustainable Aviation Fuels and CORSIA Lower Carbon Aviation Fuels under Annex 16, Vol. IV.

Working Group 4 (WG4) focuses on CORSIA, including maintenance of Annex 16, Vol. IV

Sustainability Certification Schemes Evaluation Group (SCSEG) evaluates Sustainability Certification Schemes (SCS) in the context of their recognition under CORSIA.

Long-term Global Aspirational Goal Task Group (LTAG-TG) provides technical support in the exploration of the feasibility of a long-term global aspirational goal for international civil aviation CO₂ emissions reductions, including options and roadmaps for their realization.

FTG Structure



Technical Team for FAA on ICAO CAEP Fuels

Greenhouse gas lifecycle analysis (GHG LCA) core values and methods (FTG)

- MIT & University of Hasselt (ASCENT)
- Argonne National Lab (DOE BETO & FAA support)

Induced Land Use Change (ILUC) calculations and methods (FTG)

- Purdue (ASCENT)

Sustainability Criteria Development (FTG & SCSEG)

- Volpe National Transportation Systems Center (FAA support)

Fuel Production Assessment (FTG & LTAG-TG)

- MIT & University of Hasselt (ASCENT)
- Washington State University (ASCENT)
- Volpe Transportation Systems Center (FAA support)

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Timeline of Efforts to Address Aviation's Environmental Challenge

2006: EU Emissions Trading Scheme (ETS) to begin in 2012

2007: ICAO 36th Assembly agreed to explore other options

2010: 37th Assembly - Carbon Neutral Growth 2020 goal

2013: 38th Assembly - development of a Global Market-Based Measure (GMBM)

2016: 39th Assembly - CORSIA framework

2018: CORSIA SARPs Agreed by ICAO Council

2021: CORSIA pilot phase begins (voluntary)

2024: CORSIA first phase begins (voluntary)

2027: CORSIA second phase begin

ICAO “Carbon Offsetting & Reduction Scheme for International Aviation” (CORSIA)

- CORSIA is the only global market-based measure for CO₂ emissions from international aviation
- CORSIA is a Global Carbon Offsetting Scheme
 - Offset increase in CO₂ emissions for international aviation to meet carbon neutral growth goal (relative to 85% of 2019 baseline)*
 - Not a carbon tax or emissions trading scheme
 - Applies to aeroplane operators, international operations only**
 - Offsets required from 2021-2035
 - Pilot phase from 2021-2023
- CORSIA Eligible Fuels (CEF) can be used by an airline to reduce their offsetting requirements

Offsetting, Fuels, and CORSIA

Two options for CORSIA compliance

1. Offsetting with Emissions Units
2. Claiming Emissions Reductions from CEF

Two types of CORSIA Eligible Fuels (CEF)

“CORSIA Sustainable Aviation Fuel”: renewable or waste-derived fuel

“CORSIA Lower Carbon Aviation Fuel”: fossil-based fuel

$$\text{Emissions Reduction} = 3.16 * \left[\sum \text{Net Fuel Mass} * \left(1 - \frac{\text{Life Cycle Emissions}}{89 \text{ g CO}_2/\text{MJ}} \right) \right]$$

CORSIA Eligibility: fuel needs to meet CORSIA Sustainability Criteria as certified by ICAO Council Approved Sustainability Certification Scheme (SCS)

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CORSIA Eligible Fuels – Key Documents



Information related to CORSIA implementation:

Annex 16 Volume IV

See: <https://www.icao.int/environmental-protection/CORSIA/Pages/SARPs-Annex-16-Volume-IV.aspx>

CORSIA Implementation Elements

See: <https://www.icao.int/environmental-protection/CORSIA/Pages/implementation-elements.aspx>

Five ICAO CEF documents

See: <https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx>

ICAO / Environmental Protection / CORSIA / CORSIA Eligible Fuels

ENV Homepage
CORSIA Homepage
CORSIA IMPLEMENTATION
ACT CORSIA

CORSIA Eligible Fuels

This ICAO CORSIA Implementation Element is reflected in five ICAO documents referenced in Annex 16, Volume IV. They are available for download below.

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**	CORSIA Methodology for Calculating Actual Life Cycle Emissions Values

*Sustainability Certification Schemes interested in being evaluated should follow the application process described [here](#).

**The CORSIA Supporting Document "CORSIA Eligible Fuels - Life Cycle Assessment Methodology" provides technical information and describes ICAO processes to manage and maintain the ICAO document "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels", including the process to add new default values to this ICAO document.

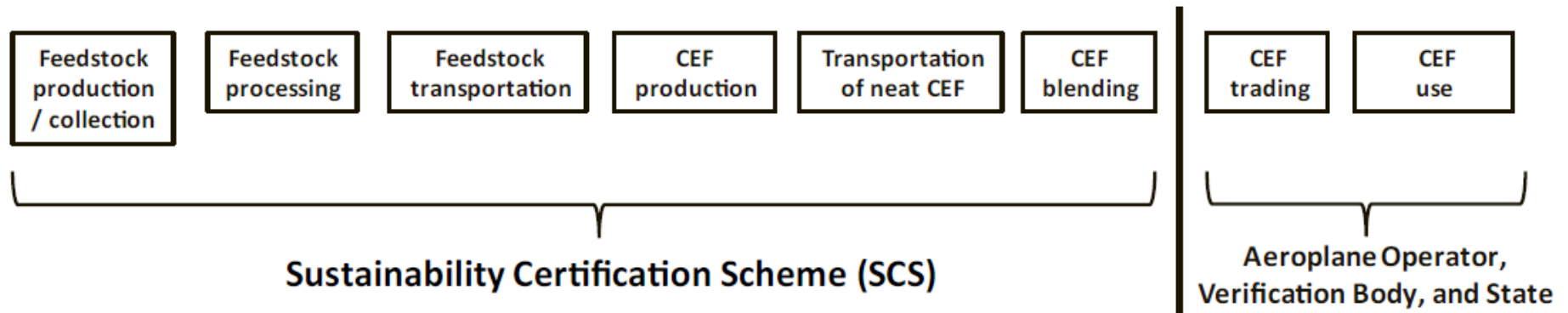
Sustainability Certification Schemes

- CEF producers must be certified by ICAO Sustainability Certification Scheme (SCS)
- SCSs must meet ICAO requirements: "CORSA Eligibility Framework and Requirements for Sustainability Certification Schemes"
- Two SCSs currently approved for CORSIA:
 - International Sustainability and Carbon Certification (ISCC)
 - Roundtable on Sustainable Biomaterials (RSB)
- SCS applications are under ongoing review by SCS Evaluation Group (SCSEG)
- SCSs interested in being approved for CORSIA should apply (link below)



To download document: <https://www.icao.int/environmental-protection/CORSA/Documents/ICAO%20document%2004%20-%20Approved%20SCSs.pdf>

CEF Supply Chain Monitoring, Reporting, and Verification Responsibilities



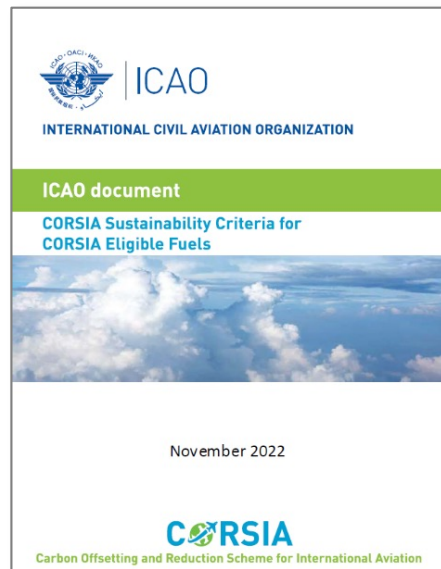
Key Features:

- *The Sustainability Certification Schemes (SCS) certification scope under CORSIA goes up to the CEF blender, although life cycle emissions values go through to the CEF combustion using estimated or default life cycle emissions values for downstream transportation.*
- *Once the CEF is produced and blended, the Aeroplane Operator takes the responsibility of tracking the CEF through the CORSIA Monitoring, Reporting and Verification process. The State to which the Aeroplane Operator is attributed has the prerogative of overseeing the data submitted by the Aeroplane Operator for compliance with CORSIA provisions.*

CORSIA Pilot Phase Sustainability Criteria (until Dec-31-2023) – applies to CEF

ICAO Document

“CORSIA Sustainability Criteria for CORSIA Eligible Fuels”



Theme	Principle	Criteria
1. Greenhouse Gases (GHG)	Principle: CORSIA eligible fuel should generate lower carbon emissions on a life cycle basis.	Criterion 1.1: CORSIA eligible fuel will achieve net greenhouse gas emissions reductions of at least 10% compared to the baseline life cycle emissions values for aviation fuel on a life cycle basis.
2. Carbon stock	Principle: CORSIA eligible fuel should not be made from biomass obtained from land with high carbon stock.	Criterion 2.1: CORSIA eligible fuel will not be made from biomass that is either obtained from land converted after 1 January 2008 that was primary forest, wetlands, or peat lands or contributes to degradation of the carbon stock in primary forests, wetlands, or peat lands as these lands all have high carbon stocks.
		Criterion 2.2: In the event of land use conversion after 1 January 2008, as defined based on the Intergovernmental Panel on Climate Change (IPCC) land categories, direct land use change (DLUC) emissions will be calculated. If DLUC greenhouse gas emissions exceed the default induced land use change (ILUC) value, the DLUC value will replace the default ILUC value.

To download CORSIA Sustainability Criteria for CORSIA Eligible Fuels document:
<https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO%20document%2005%20-%20Sustainability%20Criteria.pdf>

Expanded CORSIA Sustainability Criteria (post Pilot Phase) – for all CEF except where noted

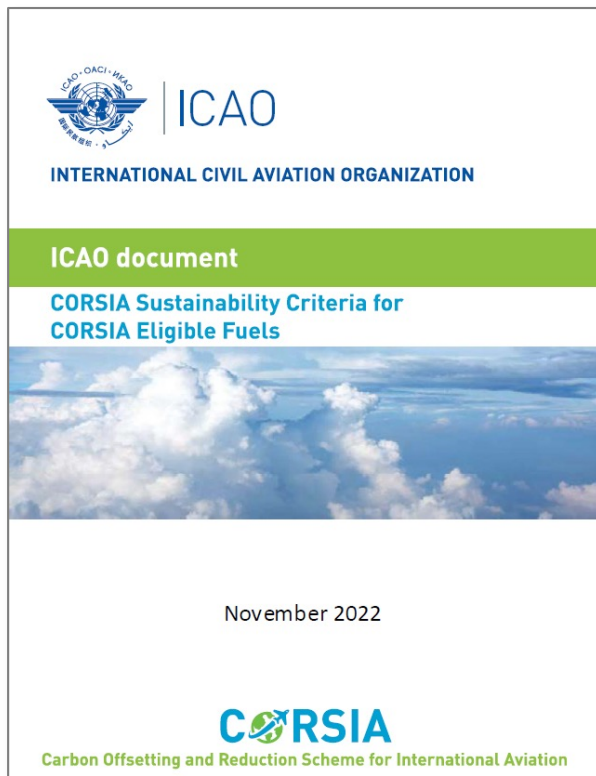
Sustainable =

<p>Environmental</p>	<p>Greenhouse gas (GHGs) (number of criteria: 1) High carbon stocks/land use (2) GHG emissions reduction permanence (1) Water quality (2) Soil quality (1) Air quality (1) Conservation (3) Wastes and chemicals (3) Seismic and vibrational impacts (LCAF only, 2)</p>
<p>Social</p>	<p>Human and labor rights (1) Land use rights and land use (1) Water use rights (1)</p>
<p>Economic</p>	<p>Local and social development (1) Food security (1)</p>

Expanded CORSIA Sustainability Criteria (post Pilot Phase)

ICAO Document

“CORSIA Sustainability Criteria for CORSIA Eligible Fuels”



To download CORSIA Sustainability Criteria for CORSIA Eligible Fuels document:
<https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO%20document%205%20-%20Sustainability%20Criteria.pdf>

	Theme	Principle	Criteria
5. Soil	1. Greenhouse Gases (GHG)	Principle: CORSIA SAF should generate lower carbon emissions on a life cycle basis.	Criterion 1.1: CORSIA SAF will achieve net greenhouse gas emissions reductions of at least 10% compared to the baseline life cycle emissions values for aviation fuel on a life cycle basis.
6. Air	2. Carbon stock	Principle: CORSIA SAF should not be made from biomass obtained from land/aquatic systems with high biogenic carbon stock.	Criterion 2.1: CORSIA SAF will not be made from biomass that is either obtained/extracted from land or aquatic ecosystems converted after 1 January 2008 that was primary forest, wetlands, peat lands, coral reefs, kelp forests, seagrass meadows, estuaries, tidal salt marshes or mangrove forests or contributes to degradation of the carbon stock in primary forests, wetlands, peat lands, coral reefs, kelp forests, seagrass meadows, estuaries, tidal salt marshes or mangrove forests as these systems all have high carbon stocks.
7. Conservation			Criterion 2.2: In the event of land use conversion after 1 January 2008, as defined based on the Intergovernmental Panel on Climate Change (IPCC) land categories, direct land use change (DLUC) emissions will be calculated. If DLUC greenhouse gas emissions exceed the default induced land use change (ILUC) value, the DLUC value will replace the default ILUC value.
8. Waste and Chemicals	3. Greenhouse gas Emissions Reduction Permanence	Principle: Emissions reductions attributed to CORSIA SAF should be permanent.	Criterion 3.1: Operational practices will be implemented to monitor, mitigate and compensate any material incidence of non-permanence resulting from carbon capture and sequestration (CCS) activities.
	4. Water	Principle: Production of CORSIA SAF should maintain or enhance water quality and availability.	Criterion 4.1: Operational practices will be implemented to maintain or enhance water quality. Criterion 4.2: Operational practices will be implemented to use water efficiently and to avoid the depletion of surface or groundwater resources beyond replenishment capacities.
9. Seismic and Vibrational Impacts	Not applicable	Not applicable	implemented to prevent, minimize, and mitigate any damage from unintentional release of fossil resources, fuel products, and/or other chemicals.
			Not applicable

Two Methods for CEF Lifecycle Calculations

Default LCA values

- Values developed by international team, approved by ICAO Council, and provided in ICAO Document, “CORISIA Default Life Cycle Emissions Values for CORISIA Eligible Fuels”

Actual LCA values using CORISIA Methodology

- Details in ICAO Document, “CORISIA Methodology for Calculating Actual Life Cycle Emissions Values”
- Airline operator / fuel producer can work with an eligible Sustainability Certification Scheme (SCS) to seek a core LCA value representative of their specific fuel production pathway
- SCS will need to prepare a technical report justifying actual LCA value
- Methodology uses attributional process with energy allocation of emissions among co-products to determine core LCA value
- Methodology provides a means to get an ILUC value of zero or negative ILUC values
- Methodology provides credits for MSW Landfill and Recycling Emissions
- Developing rules wherein additional credits could be considered in the future

CEF Lifecycle Emissions

Induced Land Use Change (ILUC): for fuels not derived from wastes, residues, or by-products



Core LCA

Stage #1: Production at source (feedstock cultivation)

Stage #2: Source conditioning (harvest, collection, recovery)

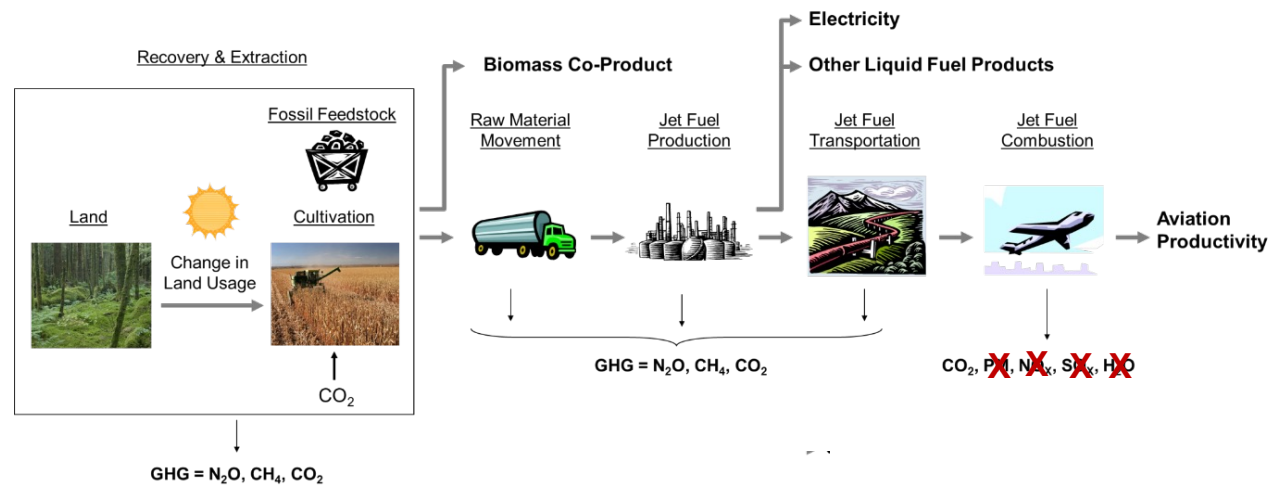
Stage #3: Feedstock processing and extraction

Stage #4: Feedstock transportation to processing and fuel production facilities

Stage #5: Feedstock-to-fuel conversion process

Stage #6: Fuel transportation and distribution to blend point

Stage #7: Fuel combustion in aircraft engine



Lifecycle values calculated by international team:

Default Core LCA Values:

- DOE Argonne National Laboratory
- Massachusetts Institute of Technology
- E.U. Joint Research Centre
- University of Hasselt
- University of Toronto
- Brazilian Bioethanol Science and Technology Laboratory (CTBE)
- Universidade Estadual de Campinas

Default ILUC Values:

- Purdue University (GTAP-Bio)
- International Institute for Applied Systems Analysis (GLOBIOM)

CORSIA Default Lifecycle Values

ICAO Document

“CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels”

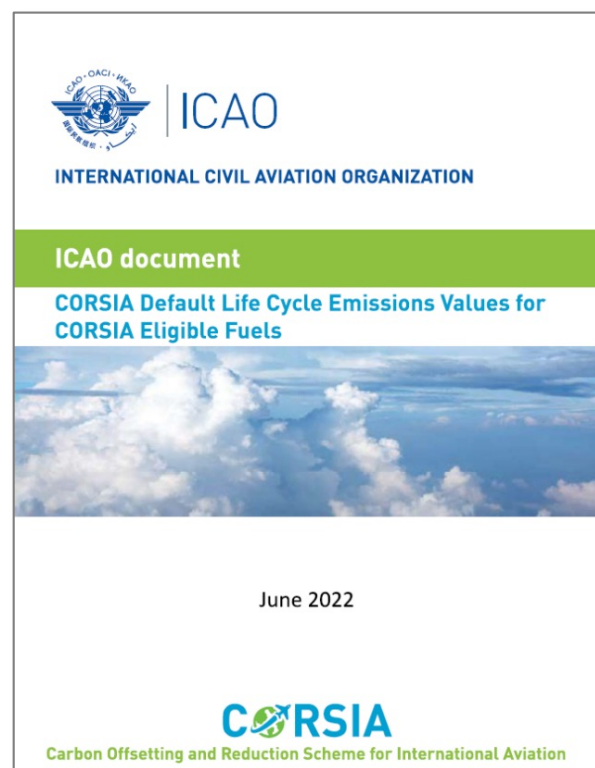


Table 2. CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels produced with the Hydroprocessed Esters and Fatty Acids (HEFA) Fuel Conversion Process

Region	Fuel Feedstock	Pathway Specifications	Core LCA Value	ILUC LCA Value	LS _f (gCO ₂ e/MJ)
Global	Tallow		22.5	0.0	22.5
Global	Used cooking oil		13.9		13.9
Global	Palm fatty acid distillate		20.7		20.7
Global	Corn oil	Oil from dry mill ethanol plant	17.2		17.2
USA	Soybean oil		40.4	24.5	64.9
Brazil	Soybean oil		40.4	27.0	67.4
Global	Soybean oil		40.4	25.8	66.2
EU	Rapeseed oil		47.4	24.1	71.5
Global	Rapeseed oil		47.4	26.0	73.4
Malaysia & Indonesia	Palm oil	At the oil extraction step, at least 85% of the biogas released from the Palm Oil Mill Effluent (POME) treated in anaerobic ponds is captured and oxidized.	37.4	39.1	76.5
Malaysia & Indonesia	Palm oil	At the oil extraction step, less than 85% of the biogas released from the Palm Oil Mill Effluent (POME) treated in anaerobic ponds is captured and oxidized.	60.0	39.1	99.1
Brazil	Brassica carinata oil	Feedstock is grown as a secondary crop that avoids other crops displacement	34.4	-20.4	14.0
USA	Brassica carinata oil	Feedstock is grown as a secondary crop that avoids other crops displacement	34.4	-21.4	13.0
Global	Brassica carinata oil	Feedstock is grown as a secondary crop that avoids other crops displacement	34.4	-12.7	21.7
Global	Camelina oil	Feedstock is grown as a secondary crop that avoids other crops displacement	42.0	-13.4	28.6
India	Jatropha oil	Meal used as fertilizer or electricity input	46.9	-24.8	22.1
India	Jatropha oil	Meal used as animal feed after detoxification	46.8	-48.1	-1.3

To download the Default Life Cycle Emissions Values document, please visit: <https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO%20document%2006%20-%20Default%20Life%20Cycle%20Emissions.pdf>

Induced Land Use Change Considerations

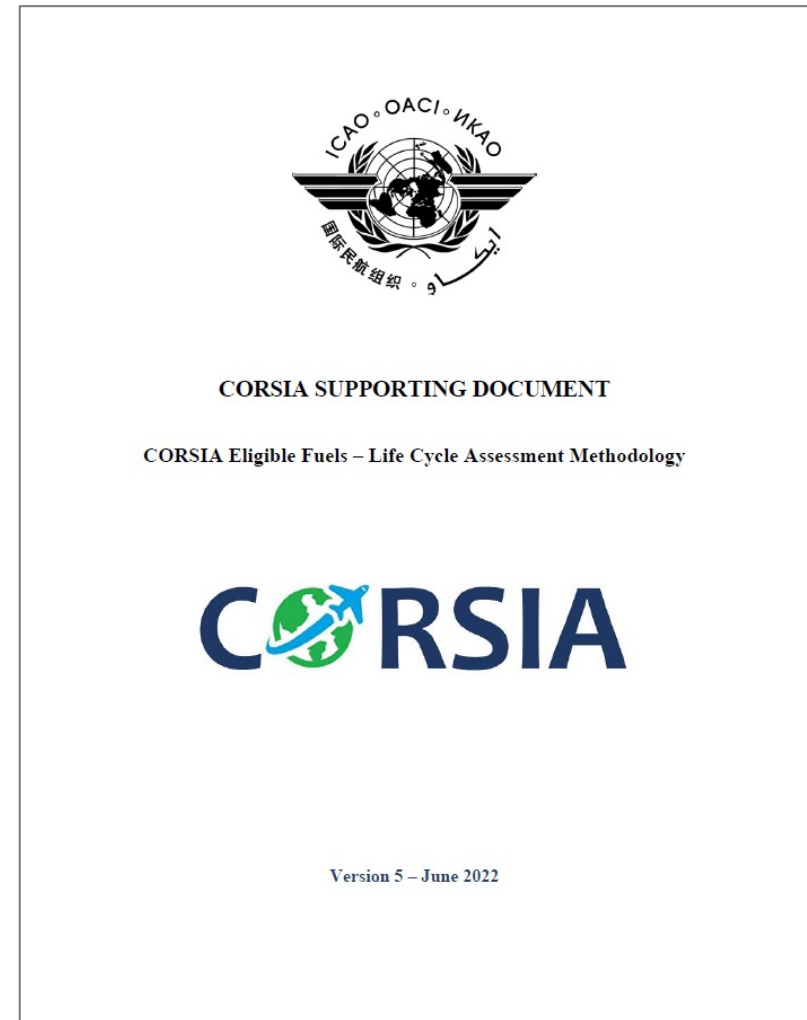
ILUC can be set to zero for feedstocks that:

- Are defined as wastes, residues, and byproducts.
- Have yields per surface unit significantly higher than terrestrial crops (~ one order of magnitude higher) such as some algal feedstocks.
- Are grown using land use change-risk mitigation practices that result in increased yields or that utilize unused land.

Negative ILUC values are allowed during pilot phase and under discussion for subsequent phases.

CEF LCA Methodology Document

Provides technical information and describes ICAO processes to manage and maintain the ICAO document “CORSA Default Life Cycle Emissions Values for CORSA Eligible Fuels”.



Adding New Default Lifecycle Values

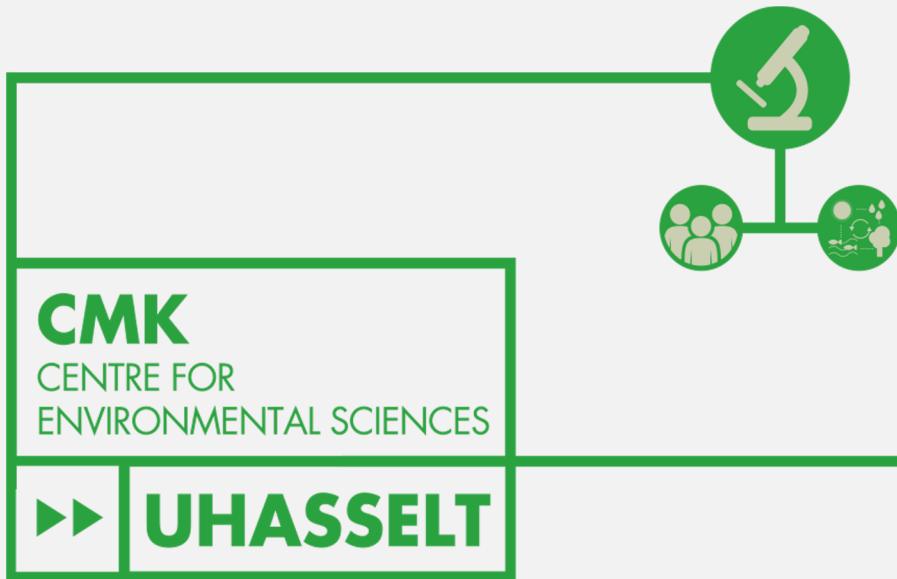
CORSIA SARP Package contains default life cycle emissions values for over 70 fuel pathway and region combinations and is expanding.

Part I of CEF LCA Document

- Criteria for a pathway to be evaluated as a CORSIA Eligible Fuel:
 - **ASTM** Annex or OEM approved Phase 2 ASTM Research Report
 - **Validated** at sufficient scale to establish basis for commercial facility design and operating parameters
 - **Sufficient data**
 - On the conversion process and feedstocks to perform **LCA modelling**
 - On the region of interest to perform **ILUC modelling**, where applicable
- CAEP designees will determine if criteria have been met for adding a new pathway, carry out the calculation of default LCA values for the pathway, and communicate the results in the CORSIA Default Values document.
- Requests for CAEP to consider a conversion process, feedstock, and/or region can be made by ICAO Member States, Observer Organizations, or an approved SCS to the CAEP Secretary in ICAO.

To download the CEF LCA Methodology document, please visit:

https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA%20Supporting%20Document_CORSIA%20Eligible%20Fuels_LCA%20Methodology.pdf



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Thank you.

