U.S. Aviation Climate Action Plan, Sustainable Aviation Fuels, and CORSIA

EPA Workshop on Biofuel Greenhouse Gas Modeling

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Aviation Climate Action Plan

- International Civil Aviation Organization (ICAO) – "State Action Plans"
  - In 2012, ICAO encouraged all countries to prepare and submit action plans detailing national action to reduce greenhouse gas emissions from aviation.
  - Well over 100 countries have submitted plans.
  - U.S. submitted plan to ICAO in 2012 with a subsequent update in 2015
- Sec of Transportation announced the 2021 Plan at the COP meeting

- Climate Action Plan Press Release:
  https://www.faa.gov/newsroom/us-releases-first-ever-comprehensive-aviation-climate-action-plan-achieve-net-zero
- Climate Action Plan Document:
  https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation_Climate_Action_Plan.pdf

U.S. Aviation Climate Goal

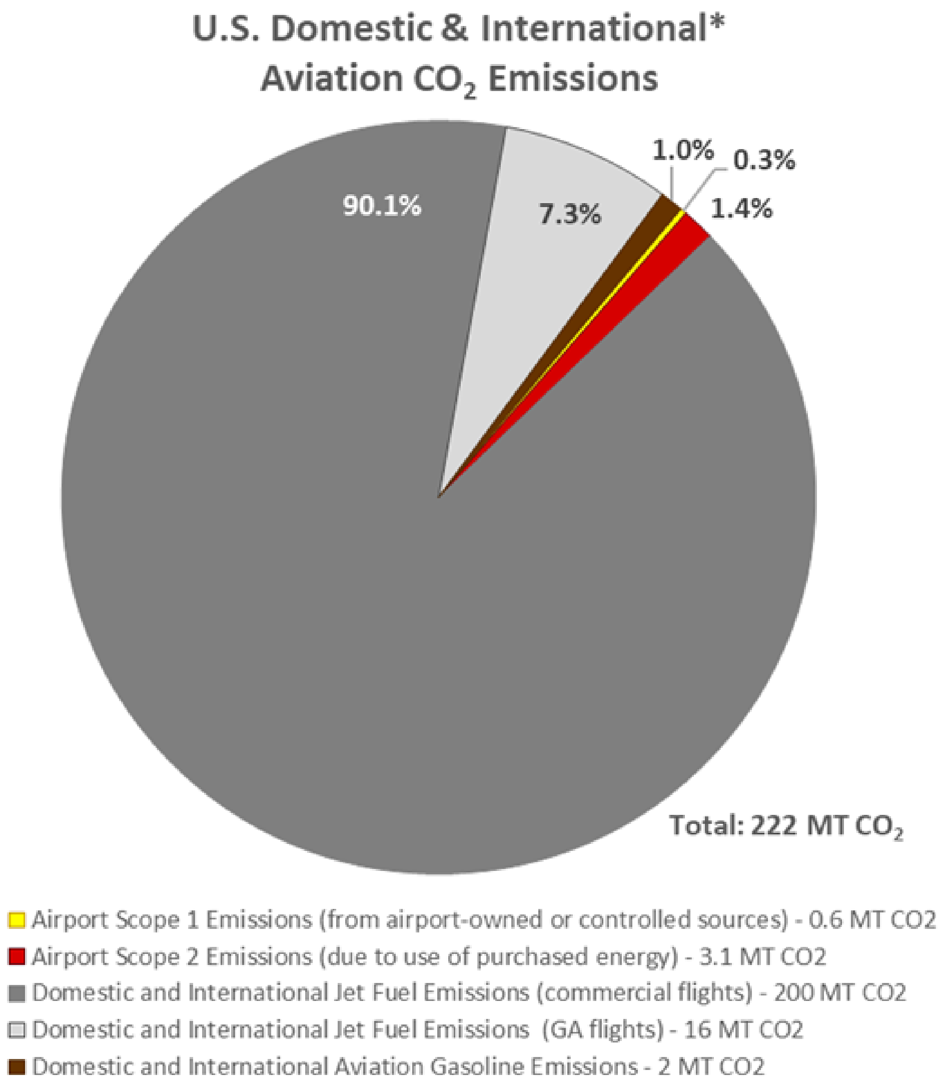
To be effective, a goal should be clear, achievable, and ambitious with specific actions that can be taken to achieve it. The goal outlined below contributes to the broader objective to achieve net-zero GHG emissions economy-wide by 2050.

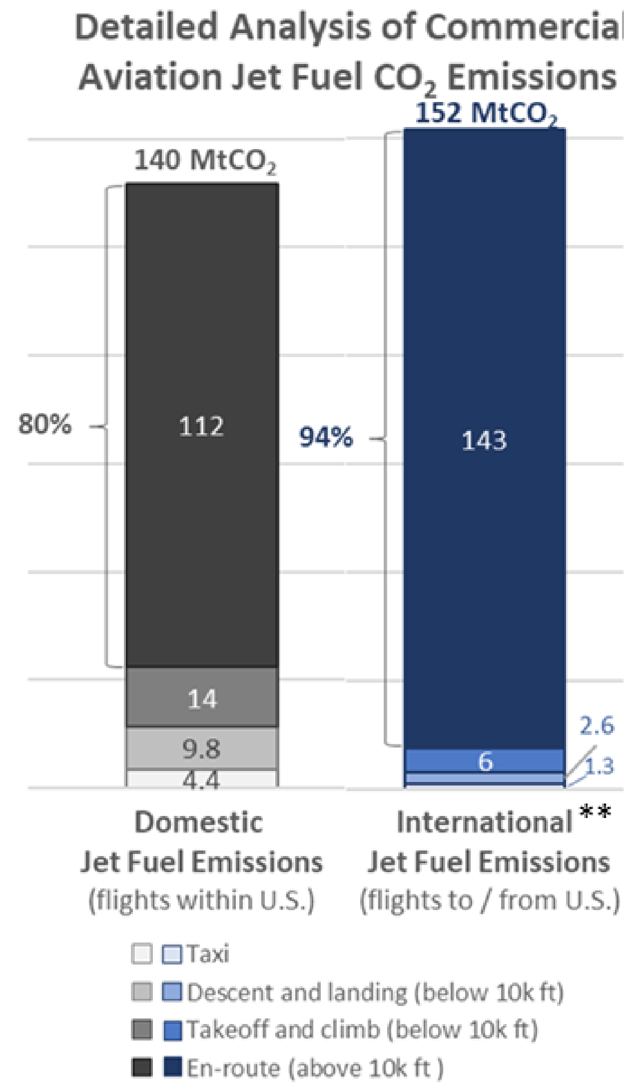
U.S. Aviation Climate Goal:
Net-Zero GHG Emissions* from U.S. Aviation Sector** by 2050

* Aviation GHG emissions include life cycle carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) emissions. Aircraft engines produce negligible amounts of nitrous oxides and methane, so this plan has a focus on aviation combustion CO_2 emissions and well-to-tank life cycle GHG emissions (CO_2, N_2O, and CH_4). The U.S. Aviation 2050 Goal is based on emissions that are measurable and currently monitored. Research is ongoing into the climate impacts of aviation-induced cloudiness and the indirect climate impacts of aviation combustion emissions (see section 7 for details on the climate impacts of aviation non-CO_2 combustion emissions).

** This U.S. aviation goal encompasses CO_2 emissions from (1) domestic aviation (i.e., flights departing and arriving within the United States and its territories) from U.S. and foreign operators, (2) international aviation (i.e., flights between two different ICAO Member States) from U.S. operators, and (3) airports located in the United States.

Analysis of U.S. Aviation CO_2 Emissions in 2019





* CO_2 emissions from (1) domestic aviation (i.e., flights departing and arriving within the United States and its territories) from U.S. and foreign operators and (2) international aviation (i.e., flights between two different ICAO Member States) from U.S. operators (only). Airport scopes 1 and 2 added for this specific analysis (figure).

** International aviation to / from the United States, regardless of the operator of the flights i.e., including both U.S. and foreign operators.

Jet Fuel

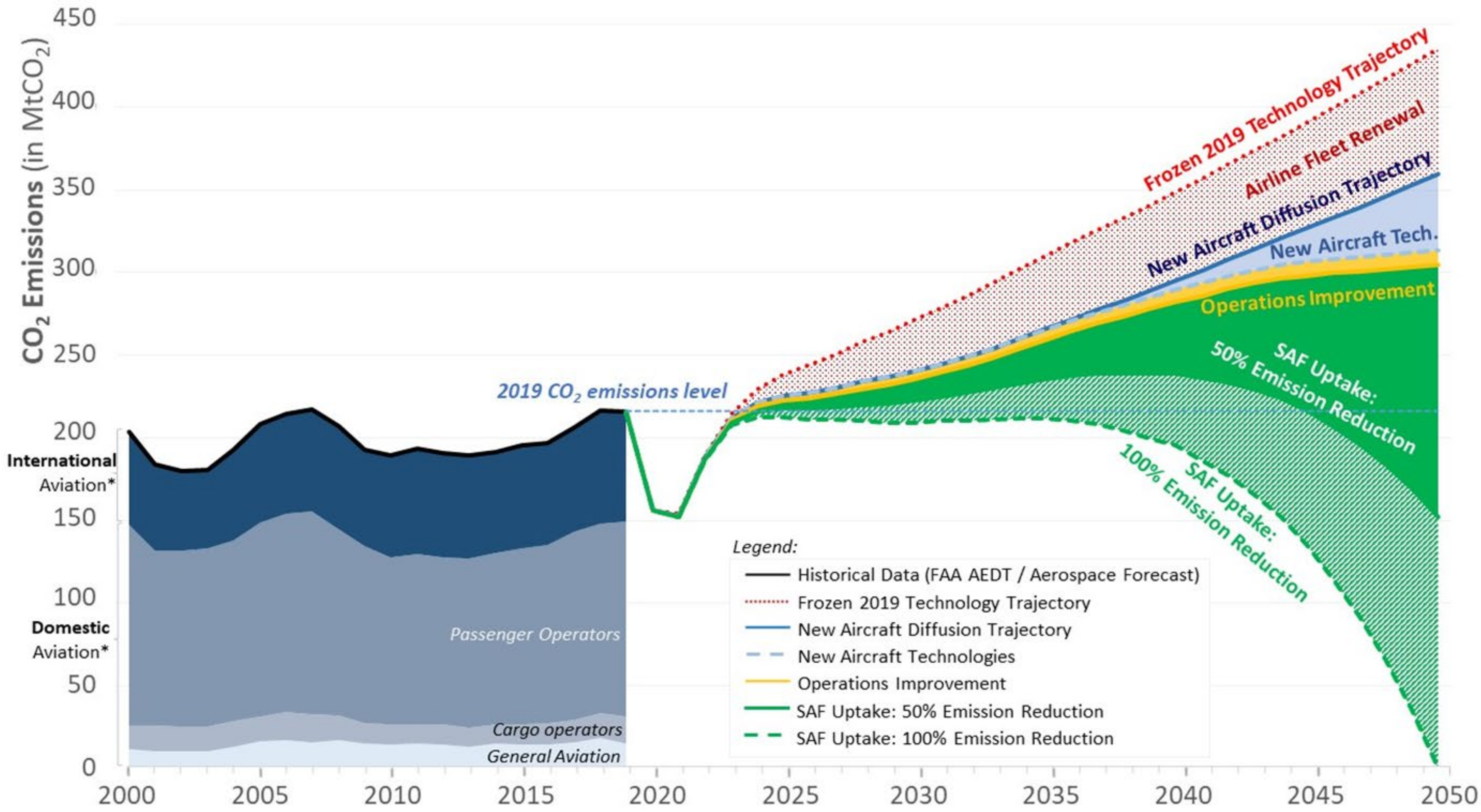
- Jet fuel is a critical component of the safe, reliable, and efficient global air transportation system
- Jet fuel provides a unique combination of properties that enable aircraft to safely carry hundreds of passengers and tons of freight for thousands of miles at high speed
  - Remains a liquid at very low temperatures of flight
  - Does not vaporize at low atmospheric pressures experienced in the upper atmosphere during cruise flight
  - Tolerates relatively high engine temperatures without breaking down and clogging fuel lines
  - Provides considerable energy both in terms of energy per unit mass and per unit volume
- While these properties play a key role in enabling today's aviation system, they also make it a difficult sector to decarbonize because they are hard to replace

Sustainable Aviation Fuels (SAF)

- **SAF are "drop-in" liquid aviation fuels –** same infrastructure, engines & aircraft, but derived from renewable or waste materials.
- Since they are drop-in compatible with the existing fleet, **SAF are hydrocarbon fuels and emit CO_2 when combusted**.
- Extent to which any particular SAF provides a climate benefit depends on the **life cycle GHG emissions**.
- Some types of SAF **reduce emissions that impact air quality** and contribute to **formation of contrails**, which impacts climate change.

- **Viable technologies exist** – seven alternative fuel pathways currently approved for use, and two approved for co-processing with petroleum, more under evaluation for approval
- **Considerable industry support**
- **Critical to international efforts** to address aviation emissions

Longer Term Analysis of Aviation CO_2 Emissions



* Note: Domestic aviation from U.S. and Foreign Carriers. International aviation from U.S. Carriers.

NOTE: Analysis conducted by BlueSky leveraging R&D efforts from the FAA Office of Environment & Energy (AEE) regarding CO_2 emissions contributions from aircraft technology, operational improvements, and SAF

Full Report Contents

https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation_Climate_Action_Plan.pdf

- Introduction
- Climate Goals and Approach
- Aircraft and Engine Technology Development
- Operational Improvements
- Sustainable Aviation Fuels
- International Leadership and Initiatives
- Airport Initiatives
- FAA Leadership on Climate, Sustainability and Resilience
- Non-CO_2 Impacts of Aviation on Climate
- Policy and Measures to Close the Gap

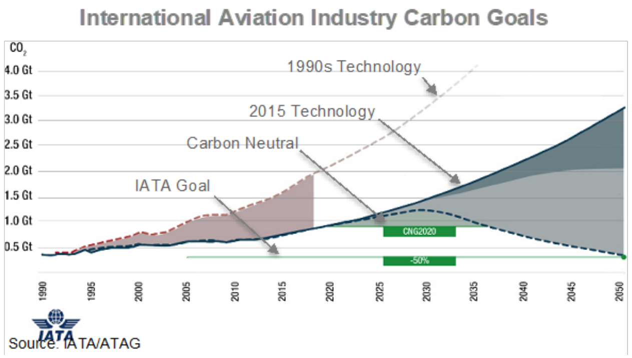
Sustainable Aviation Fuels and CORSIA

CORSIA
CARBON OFFSETTING AND REDUCTION SCHEME FOR INTERNATIONAL AVIATION

International Civil Aviation Organization (ICAO) established CORSIA to help international aviation meet Carbon Neutral Growth goal (relative to a 2019/2020 baseline)

Two means for an aeroplane operator to comply with CORSIA

1. Offsetting with Emissions Units
2. Emissions Reductions from CORSIA Eligible Fuels



Two means of determining life cycle emissions credit

- Default life cycle values provided by ICAO
- Actual life cycle values, certified by a third party, that are computed using a process provided by ICAO

To be eligible for CORSIA, a fuel needs to meet the CORSIA Sustainability Criteria as certified by ICAO Council Approved Sustainability Certification Scheme (SCS)

CORSIA Eligible Fuels – Key Documents

There are a number of ICAO documents that contain information related to CORSIA Implementation

Annex 16 Volume IV

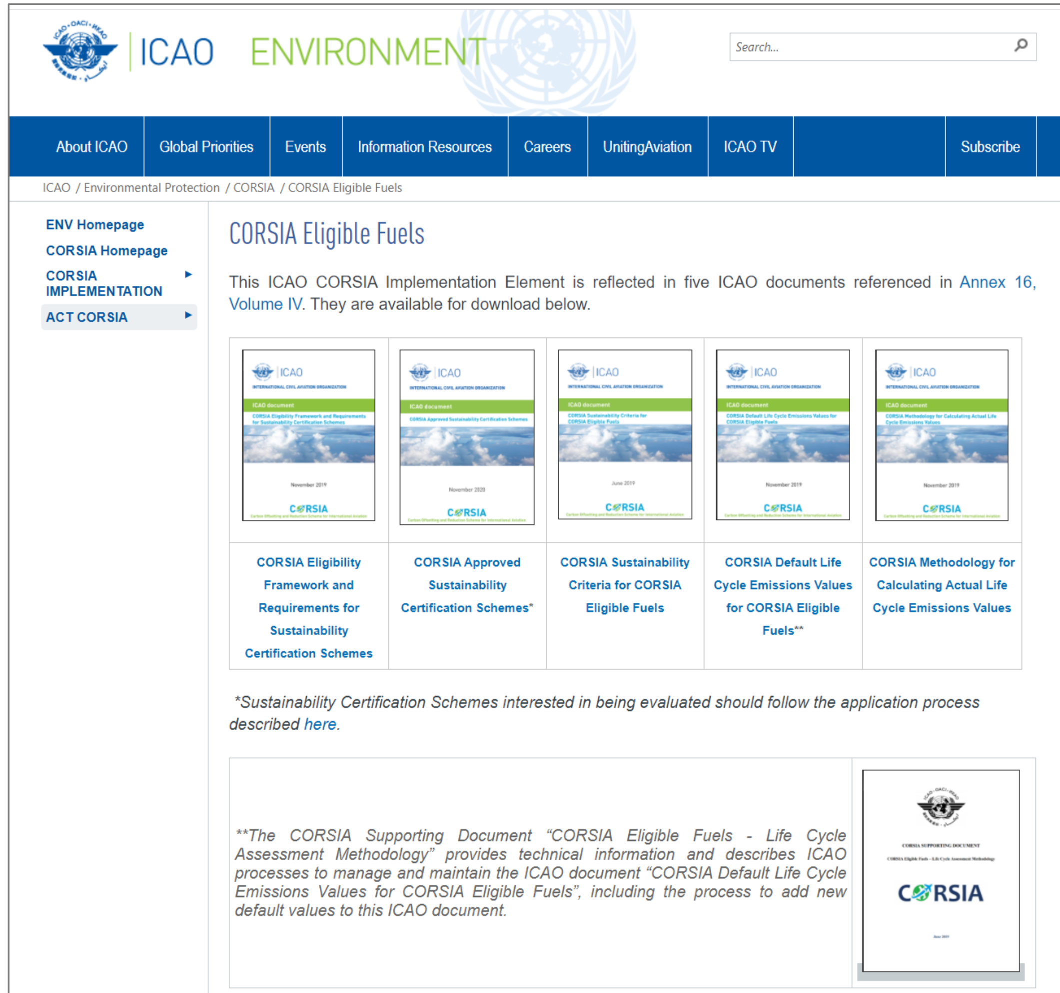
See: https://www.icao.int/environmental-protection/CORSIA/Pages/SARPs-Annex-16-Volume-IV.aspx

CORSIA Implementation Elements

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

Five ICAO documents relate to CORSIA Eligible Fuels

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



Sustainability Certification Schemes

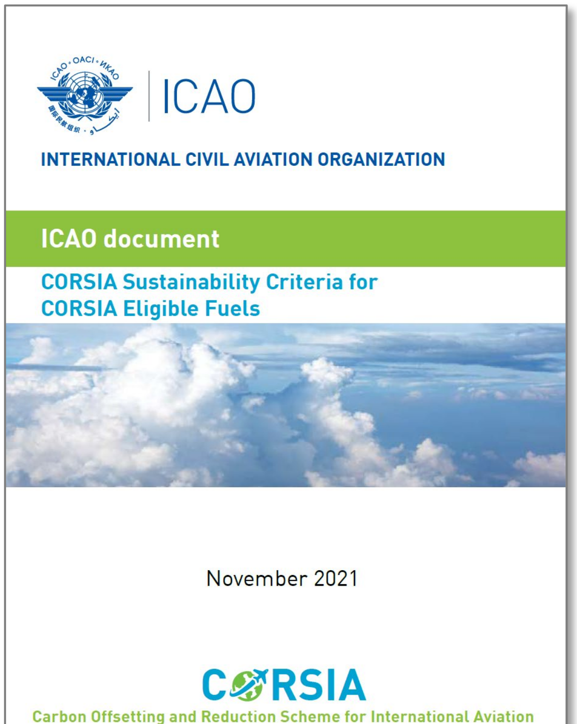
- CORSIA Eligible Fuel need to come from a fuel producer that is certified by an ICAO Council approved Sustainability Certification Scheme (SCS)
- SCSs need to meet requirements of ICAO document entitled "CORSIA Eligibility Framework and Requirements for Sustainability Certification Schemes“
- Two SCSs approved for CORSIA:
  - International Sustainability and Carbon Certification (ISCC)
  - Roundtable on Sustainable Biomaterials (RSB)
- Applications by SCSs being reviewed on an ongoing basis by the SCS Evaluation Group (SCSEG).
- SCSs interested in being considered should complete an application (link below).


ICAO
INTERNATIONAL CIVIL AVIATION ORGANIZATION
ICAO document
CORSIA Approved Sustainability Certification Schemes
November 2020
CORSIA
Carbon Offsetting and Reduction Scheme for International Aviation

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

Sustainability Criteria

Compiled within the ICAO Document "CORSIA Sustainability Criteria for CORSIA Eligible Fuels"



Chapter 2: CORSIA SUSTAINABILITY CRITERIA APPLICABLE FOR BATCHES OF CORSIA SUSTAINABLE AVIATION FUEL PRODUCED BY A CERTIFIED FUEL PRODUCER ON OR AFTER 1 JANUARY 2024

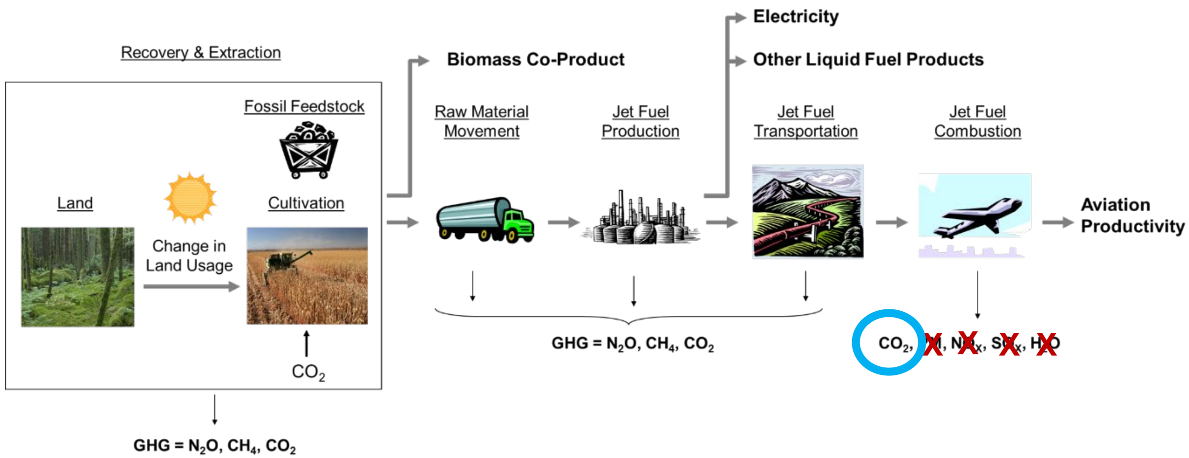
Theme	Principle	Criteria
1. Greenhouse Gases (GHG)	Principle: CORSIA SAF should generate lower carbon emissions on a life cycle basis.	Criterion 1.1: CORSIA SAF will achieve net greenhouse gas emissions reductions of at least 10% compared to the baseline life cycle emissions values for aviation fuel on a life cycle basis.
2. Carbon stock	Principle: CORSIA SAF should not be made from biomass obtained from land with high carbon stock.	Criterion 2.1: CORSIA SAF will not be made from biomass obtained from land converted after 1 January 2008 that was primary forests, wetlands, or peat lands and/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.
3. Water	Principle: Production of CORSIA SAF should maintain or enhance water quality and availability.	Criterion 3.1: Operational practices will be implemented to maintain or enhance water quality.
		Criterion 3.2: Operational practices will be implemented to use water efficiently and to avoid the depletion of surface or groundwater resources beyond replenishment capacities.
4. Soil	Principle: Production of CORSIA SAFs should maintain or enhance soil health.	Criterion 4.1: Agricultural and forestry best management practices for feedstock production or residue collection will be implemented to maintain or enhance soil health, such as physical, chemical and biological conditions.
5. Air	Principle: Production of CORSIA SAF should minimize negative effects on air quality.	Criterion 5.1: Air pollution emissions will be limited.

Theme	Principle	Criteria
6. Conservation		
7. Waste and Chemicals		
8. Human and labour rights		
9. Land use rights and land use		
10. Water use rights		
11. Local and social development	Principle: Production of CORSIA SAF should contribute to social and economic development in regions of poverty.	Criterion 11.1: CORSIA SAF production will strive to, in regions of poverty, improve the socioeconomic conditions of the communities affected by the operation.
12. Food security	Principle: Production of CORSIA SAF should promote food security in food insecure regions.	Criterion 12.1: CORSIA SAF production will, in food insecure regions, strive to enhance the local food security of directly affected stakeholders.

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

Life Cycle Emissions for CORSIA Eligible Fuels

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



Core LCA

Stage #1: Production at source (feedstock cultivation)

Stage #2: Conditioning at source (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 the blend point

Stage #7: Fuel combustion in aircraft engine

Life cycle values calculated by international team of experts:

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)

Two Methods for Determining Life Cycle Emissions for CORSIA Eligible Fuels

Two methods to determine life cycle emissions value for CORSIA Eligible Fuels

1. CORSIA default life cycle emissions values
2. CORSIA methodology for calculating actual life cycle emissions values

Default LCA values

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

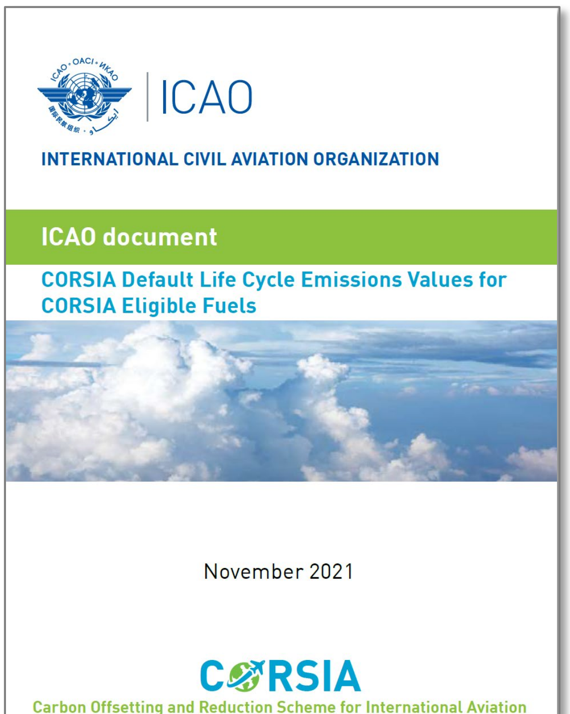
Actual LCA values using CORSIA Methodology

- Details within ICAO Document, "CORSIA 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
- Have rules wherein additional credits could be considered in the future for waste and residue feedstocks

For additional information on CORSIA Eligible Fuels:
https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx

CORSIA Default Life Cycle Emissions Values

Compiled within the ICAO Document "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels"



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%20-%20March%202021.pdf

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

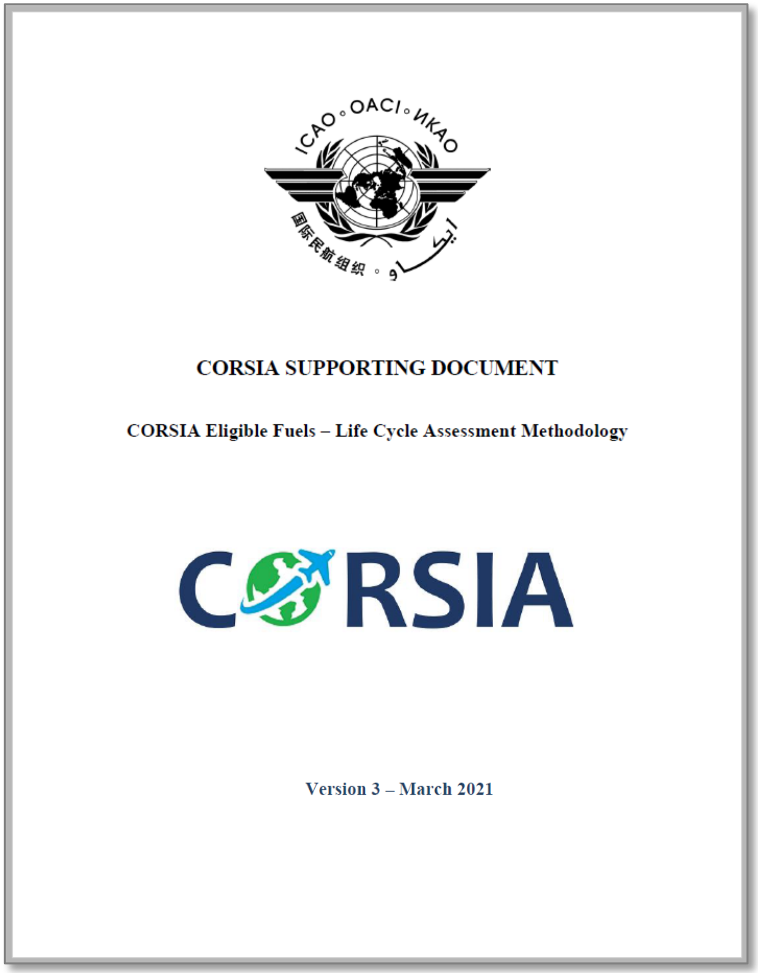
Region	Fuel Feedstock	Pathway Specifications	Core LCA Value	ILUC LCA Value	LS_f (gCO_2e/MJ)
Global	Tallow		22.5	0.0	22.5
Global	Used cooking oil		13.9		13.9
Global	Palm fatty acid distillate		20.7		20.7
Global	Corn oil	Oil from dry mill ethanol plant	17.2		17.2
USA	Soybean oil		40.4	24.5	64.9
Brazil	Soybean oil		40.4	27.0	67.4
EU	Rapeseed oil		47.4	24.1	71.5
Malaysia & Indonesia	Palm oil	At the oil extraction step, at least 85% of the biogas released from the 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 POME treated in anaerobic ponds is captured and oxidized.	60.0	39.1	99.1
Brazil	Brassica carinata	Feedstock is grown as a secondary crop that avoids other crops displacement	34.4	-20.4	14.0
USA	Brassica carinata	Feedstock is grown as a secondary crop that avoids other crops displacement	34.4	-21.4	13.0

Table 3. CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels produced with the Alcohol (isobutanol) to jet (ATJ) Fuel Conversion Process

Region	Fuel Feedstock	Pathway Specifications	Core LCA Value	ILUC LCA Value	LS_f (gCO_2e/MJ)
Global	Agricultural residues	Residue removal does not necessitate additional nutrient replacement on the primary crop.	29.3	0.0	29.3
Global	Forestry residues		23.8		23.8
Brazil	Sugarcane	Standalone or integrated conversion design	24.0	7.3	31.3
USA	Corn grain	Standalone or integrated conversion design	55.8	22.1	77.9
USA	Miscanthus (herbaceous energy crops)		43.4	-54.1	-10.7
EU	Miscanthus (herbaceous energy crops)		43.4	-31.0	12.4
USA	Switchgrass (herbaceous energy crops)		43.4	-14.5	28.9

CORSIA Supporting Document “CORSIA Eligible Fuels - LCA 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”


ICAO • OACI • ИКАО

CORSIA SUPPORTING DOCUMENT

CORSIA Eligible Fuels – Life Cycle Assessment Methodology

CORSIA

Version 3 – March 2021

Adding New Default Life Cycle Values

CORSIA SARP Package contains default life cycle emissions values for a number of fuel pathways.

Adding default life cycle values for a new fuel pathway (Part I of CEF LCA Doc)

- Following criteria need to be met for a pathway to be evaluated as a CORSIA Eligible Fuel:
  - The pathway uses an ASTM certified conversion process or, a conversion process for which the Phase 2 ASTM Research Report has been reviewed and approved by the OEMs.
  - The conversion process has been validated at sufficient scale to establish a basis for facility design and operating parameters at commercial scale
  - There are sufficient data on the conversion process of interest to perform LCA modelling.
  - There are sufficient data on the feedstock of interest to perform LCA modelling.
  - There are sufficient data on the region of interest to perform ILUC modelling, where applicable to the pathway.
- 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 this 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

Closing Observations

- We are taking a holistic approach to address aviation's impact on climate change
- SAF are central to this approach - critical to reducing CO_2 emissions from aviation in near, mid, and long term

- U.S. Government committed to SAF production through the SAF Grand Challenge and are working with industry to scale up production with a near term goal of 3 billion gallons per year by 2030
- Developed CORSIA as a rigorous means to do life cycle accounting

First flight from continuous commercial production of SAF UAL 0708, 10 March 2016, LAX-SFO

Fuel from World Energy - Paramount (HEFA-SPK 30/70 Blend).

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