EASA
European Union Aviation Safety Agency

EU-CORSIA
Africa & Caribbean

CAPACITY BUILDING ON SAF & CORSIA ELIGIBLE FUELS NAMIBIA

SAF Feedstocks

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Contents

Introduction

→ SAF can be produced from a wide variety of renewable feedstocks

→ These can be biological (i.e., relating to living organisms) or non-biological (i.e., not from life or living processes)

→ CORSIA and the EU (EU RED) have differing approaches to the suitability of certain feedstocks under their respective regimes

SAF bio-feedstocks

- There are three main groups of bio-feedstock that can be used to produce SAF
  - SAF made from Oils and Fats
  - SAF made from Sugars
  - SAF made from Lignocellulosic waste

SAF made from Oils and Fats

→ Oil crops (e.g., jatropha, croton nut and castor), animal fats and used cooking oil (UCO) can be processed into triglycerides which is then further processed (to remove oxygen) into fuel

→ Processed through the HEFA – Hydroprocessed Esters and Fatty Acids pathway

SAF made from Sugars

- → Sugars come from sugar crops and cereal starch
- → Mainly processed through fermentation, producing alcohol which is further processed into hydrocarbons and fuel
- → Alcohol to Jet (AtJ) pathway
- → Synthetic Iso-paraffin (SIP), Alcohol to Jet Synthetic Paraffinic Kerosene (ATJ-SPK) and Synthetic Paraffinic Kerosene with Aromatics (ATJ-SKA)

SAF made from Lignocellulosic feedstock

- → Lignocellulose in found in plants and wood and can come from energy crops, agricultural or forestry residues
- → Lignocellulose can be directly converted into hydrocarbons through processes such as Fischer-Tropsch (FT) – Synthetic Paraffinic Kerosene (FT-SPK) or Synthetic Kerosene with Aromatics (FT-SKA)
- → Lignocellulose can also be converted into sugars and processed through the fermentation (AtJ) route

CORSIA

- Food and feed crop feedstocks can be used under CORSIA, but they need default values to be calculated by ICAO beforehand.
- A range of food and feed crops (e.g., rapeseed, palm and corn) as well as non-food and feed crops (e.g., camelina and jatropha) are eligible – published in the *'CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels document'*
- 'New' feedstocks can be put forward for ICAO to consider
- ICAO has a 'positive list' of feedstocks including co-products, by-products, wastes and residues – published in the *'CORSIA Methodology for Calculating Actual Life Cycle Emissions Values'* and online
- This is an 'open list' - materials can be put forward to ICAO for consideration
- ICAO is working on the inclusion of other fuels including synthetic fuels or 'e-SAF'

Example of L_{CEF} from the ICAO Default Values Document

Table 2. CORSIA Default Core LCA Values for CORSIA Eligible Fuels produced with the HEFA Conversion Process

Fuel Feedstock	Pathway Specifications	Default Core LCA Value	Applicability Provisions
Tallow		22.5	This value can be applied to CEF batches produced until 31 December 2029.
Beef Tallow	relevant lifecycle starts with transportation from slaughterhouse to rendering facility	29.7	
Poultry fat	relevant lifecycle starts with transportation from slaughterhouse to rendering facility	33.7	
Lard fat	relevant lifecycle starts with transportation from slaughterhouse to rendering facility	27.8	
Mixed Animal Fats	relevant lifecycle starts with transportation from slaughterhouse to rendering facility	28.6	
Used cooking oil		13.9	
Palm fatty acid distillate		20.7	
Corn oil	Oil from dry mill ethanol plant	17.2	
Soybean oilseed		40.4	
Rapeseed/Canola oilseed		47.4	
Palm fresh fruit bunches	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	
Palm fresh fruit bunches	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	
Brassica carinata oilseed		34.4	
Camelina oilseed		42.0	
Jatropha oilseed	Meal used as fertilizer or electricity input	46.9	
Jatropha oilseed	Meal used as animal feed after detoxification	46.8	
Non-standard coconuts	The default value is valid if the hydrogen used is not produced from coal. If hydrogen is produced from coal, a correction value of 5.17 gCO2e/MJ needs to be added to the core LCA value.	26.9	

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Feedstock categories

Primary and co-products

- The main products of a production process
- Significant economic value and elastic supply (i.e., evidence of a link between feedstock price and the feedstock being produced

Molasses

By-products

- Secondary products
- Inelastic supply and economic value

Palm Fatty Acid Distillate
Tallow
Mixed Animal Fats

Wastes

- A substance or object which the holder discards or intends to discard
- This **does not** include raw materials or substances that have been intentionally modified or contaminated
- Inelastic supply and no economic value

Used cooking oil
Municipal solid waste
Waste gases

Residues

- Secondary materials
- Inelastic supply and little economic value
- Include residues from Agriculture, Forestry and Processing

Agriculture
Bagasse/Cobs/Straw
Forestry
Bark/Branches/Tree tops
Processing
Empty palm fruit bunches, sewage sludge, Forestry processing residues

EU (ReFuelEU Aviation)

- → Food and feed crop feedstocks are not eligible under the ReFuelEU Aviation regulation
- → Eligible feedstocks are listed in Annex IX (Parts A and B) of the EU's Renewable Energy Directive (RED)
- → This includes waste and residue feedstocks and in the recent addition (RED III) intermediate crops, if they are cultivated under certain conditions
  - → e.g., Part A: biowaste, straw, animal manure and sewage sludge, bagasse, biomass from specific forestry wastes and residues
  - → e.g., Part B: Used cooking oil and animal fats (certain categories)
- → Eligible Fuels include synthetic aviation fuels or 'e-SAF'
  - → These fuels – also known as Renewable Fuels of Non-Biological Origin (RFNBOs) and include Power-to-Liquid (PtL) fuels are made from renewable sources other than biomass (e.g., wind and solar)
  - → Simply – renewable energy and water are used in an electrolyser to produce hydrogen, which is then synthesised with CO_2 into syngas. This syngas is then further processed into fuel

SAF Pathways (ASTM Approved)

ASTM reference	Conversion process	Abbreviation	Possible Feedstocks	Maximum Blend Ratio	Approval Date
ASTM D7566 Annex A1	**Fischer-Tropsch hydroprocessed synthesized paraffinic kerosene**	**FT**	**Coal, natural gas, biomass**	**50%**	**2009**
ASTM D7566 Annex A2	**Synthesized paraffinic kerosene from hydroprocessed esters and fatty acids**	**HEFA**	**Vegetable oils, animal fats, used cooking oils**	**50%**	**2011**
ASTM D7566 Annex A3	Synthesized iso-paraffins from hydroprocessed fermented sugars	SIP	Biomass used for sugar production	10%	2014
ASTM D7566 Annex A4	**Synthesized kerosene with aromatics derived by alkylation of light aromatics from non-petroleum sources**	**FT-SKA**	**Coal, natural gas, biomass**	**50%**	**2015**
ASTM D7566 Annex A5	**Alcohol to jet synthetic paraffinic kerosene**	**ATJ-SPK**	**Ethanol, isobutanol and isobutene from biomass**	**50%**	**2016**
ASTM D7566 Annex A6	Catalytic hydrothermolysis jet fuel	CHJ	Vegetable oils, animal fats, used cooking oils	50%	2020
ASTM D7566 Annex A7	Synthesized paraffinic kerosene from hydrocarbon - hydroprocessed esters and fatty acids	HC-HEFA-SPK	Algae	10%	2020
ASTM D7566 Annex A8	**Synthetic Paraffinic Kerosene with Aromatics**	**ATJ-SKA**	**C2-C5 alcohols from biomass'**	**50%**	**2023**

Source: adapted from ICAO 2023

Next Session:
SAF Production and Supply


Capacity Building
GHG Emissions
Sustainability
FT-SPK
Drop-in Fuel
RSB
Sustainability Criteria
Certification
PtL
Used Cooking Oil (UCO)
Safety
CAPEX
Life Cycle Emissions
ASTM D1655 DEF Stan 91-091
Co-processing
SAF
HEFA
'neat' SAF
ASTM D4054
ISCC
Environmental
Feedstocks
Alternative
Cost
Municipal Solid Waste
CORSIA Eligible Fuels
ASTM
Sustainability Certification Schemes
Socio-Economic
D7566
Approved ASTM Pathways
AtJ
Risk
CO2
Land use change
Technology
Blending

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