Introduction to SAF

Second Phase of the ICAO Assistance Project with the EU Funding :
"*Capacity Building for CO_2 Mitigation from International Aviation*

3 to 5 April 2023
Harare, Zimbabwe

Bruno Silva
Environment Officer, ICAO

Agenda

1) ICAO action on SAF, and SAF benefits
2) ICAO policies on SAF
3) Definition of SAF, including sustainability criteria and life cycle assessment
4) Developments in the SAF market
5) Conclusions

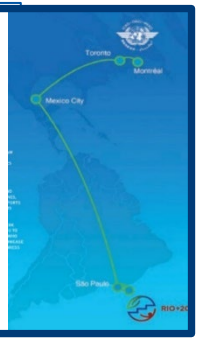
ICAO action on SAF, and SAF benefits

ICAO action on Sustainable Aviation Fuels (SAF)

2009
First ICAO Conference on Aviation and Alternative Fuels (CAAF/1)

2010 – Inclusion of SAF as a measure to reduce CO_2 emissions (ICAO resolution A37-17)

2012 –
Rio + 20 conference – **SAF flight from Montréal to Rio with the ICAO Secretary General**



2013
Creation of the CAEP Alternative Fuels Task Force (AFTF)

2017
Second Conference on Aviation and Alternative Fuels (CAAF/2)
ICAO vision on SAF

2018 – CORSIA adoption (including SAF provisions)

2019 – First ICAO Stocktaking

2020
CORSIA methodologies on sustainability and life cycle analysis

2021
Socio-economic and environmental sustainability criteria

2022 LTAG Agreement
- **SAF has the greatest potential to reduce CO2 emissions**
- **ACT-SAF programme is launched**

ICAO Activities on SAF

ICAO is facilitating SAF development and deployment by:

1) Establishing **Policies, measures and goals**

2) Developing globally-accepted **Standards**, **sustainability criteria,** and **life cycle methodologies for SAF use in CORSIA.**

3) fostering **capacity building and assistance** to ICAO Member States, including through the ACT-SAF programme

4) Outreaching **information and best practices**

Benefits of SAF

A SAF industry can provide multiple benefits

socio-economic benefits – sustainable economic growth and employment

environmental benefits – contribution to climate action

energy security benefits – diversification of energy matrix increases security

Drop-in nature of SAF makes it interchangeable and compatible with conventional aviation fuels

- **SAFs can currently be blended at up to 50% with conventional jet fuel**
- **SAF is handled in the same way as conventional aviation fuels**
- **SAF does not require changes in aircraft or its engines, nor in infrastructure**

ICAO policies on SAF

ICAO Policies on SAF

ICAO has international policies applicable to SAF

CORSIA	2050 ICAO Vision for Sustainable Aviation Fuels	Long term Aspirational goal (LTAG)
• An aeroplane operator can **reduce its CORSIA offsetting requirements** through the use of CORSIA Eligible Fuels (CEF) • Includes international approaches for **sustainability and life cycle assessment** of fuels	Calls for a **significant proportion of SAF use by 2050,** and a **level-playing field with other sectors** **To be reviewed in CAAF/3 (2023)**	Largest aviation CO_2 emissions reductions to come from fuel-related measures LTAG agreement (A41-21) includes aspects related to policy planning, regulatory framework, implementation support, and financing

LTAG Decision

ICAO Long Term Global Aspirational Goal For International Aviation (LTAG)

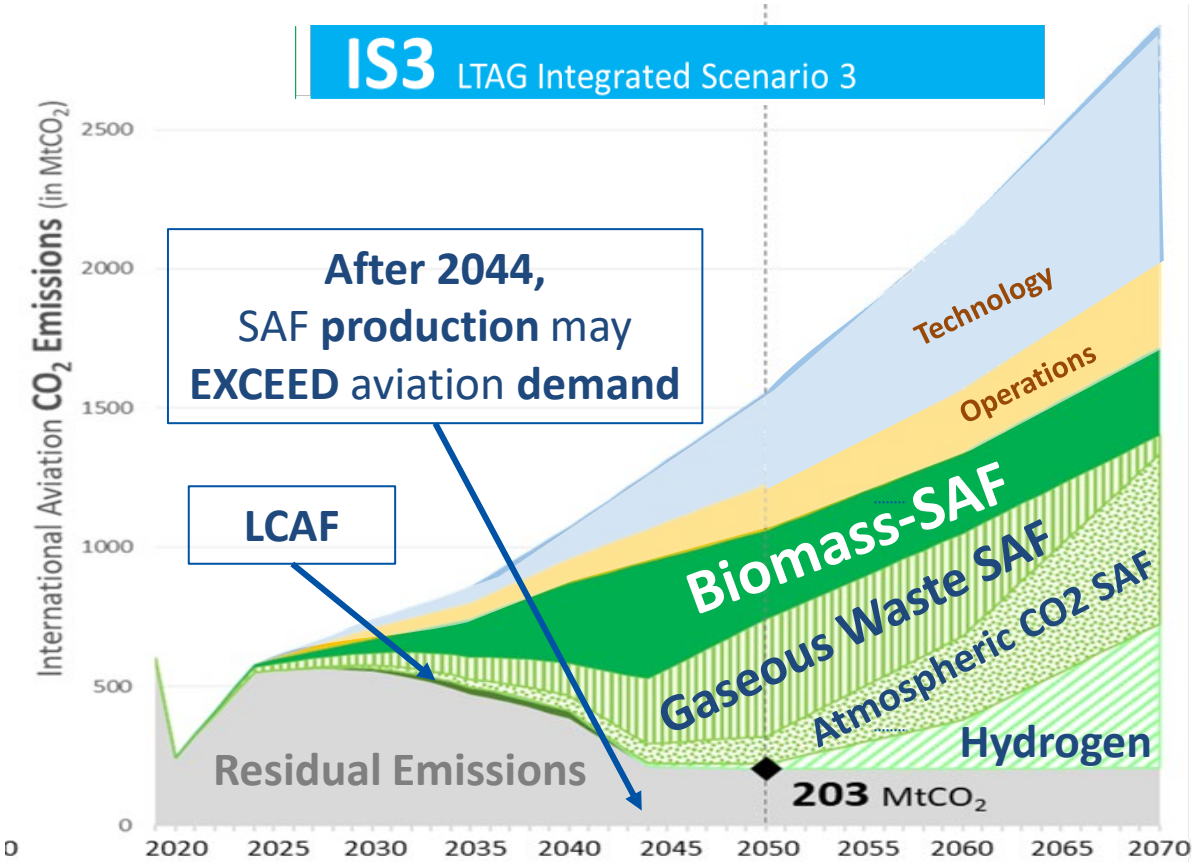
Adopted by ICAO Assembly Resolution A41-21 (2022)

https://www.icao.int/environmental-protection/Documents/Assembly/Resolution_A41-21_Climate_change.pdf

LTAG Report

SAF will play a key role in aviation decarbonization efforts

Financing Needs for SAF and LCAF



2022: 0.15 Billion Liters of SAF being produced

↓

2045: 636 billion liters needed to replace all fossil fuels

↓

By 2050: ca. USD 3,200 billion investment needs

↓

Need for close cooperation with financing institutions

References:
https://www.icao.int/environmental-protection/LTAG/Pages/LTAG-data-spreadsheet.aspx
https://www.iata.org/en/iata-repository/pressroom/fact-sheets/fact-sheet---alternative-fuels/

ICAO 2050 Vision for SAF

adopted at the Second ICAO Conference on Aviation and Alternative Fuels (CAAF/2 - 2017)

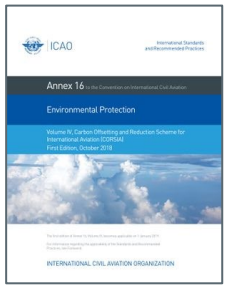
- **Calls on States, industry and other stakeholders to substitute a significant proportion of conventional aviation fuels with sustainable aviation fuels by 2050.**
- **2050 Vision to be revised in 2023 (CAAF/3 Conference)**
- **Stocktaking process supporting these goals – yearly events held since 2019**

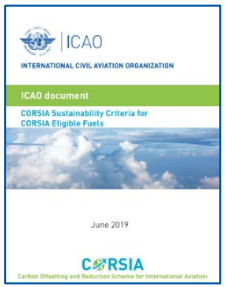
Definition of SAF

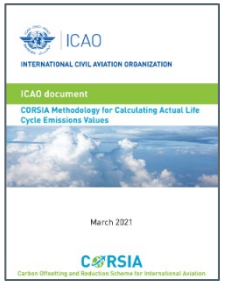
And Sustainability Criteria

What are Sustainable Aviation Fuels (SAF)?

Definition	Which Sustainability Criteria?	What is a waste?
SAF is defined as a *renewable or waste-derived aviation fuel* that meets sustainability criteria. ***reference: Annex 16 Vol IV – CORSIA***	Sustainability Criteria are defined in the ICAO document *"CORSIA Sustainability Criteria for CORSIA Eligible Fuels"*	Waste is a feedstock with inelastic supply and no economic value (e.g. municipal solid waste, used cooking oil, waste gases etc.) ***reference:* ICAO document *"CORSIA Methodology For Calculating Actual Life Cycle Emissions Values"***



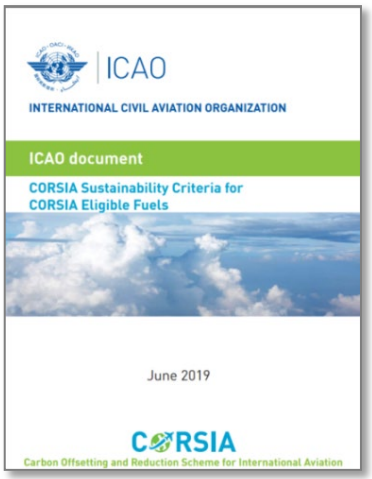




All documents available at https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx

Sustainability

CORSIA sustainability criteria for CORSIA eligible fuels
First global approach to sustainability for an industry sector



Sustainability Themes
1. Greenhouse Gases (GHG)
2. Carbon stock
3. GHG reduction permanence
4. Water
5. Soil
6. Air
7. Conservation
8. Waste and Chemicals
9. Seismic and Vibrational Impacts (Only for LCAF)
10. Human and labour rights
11. Land use rights and land use
12. Water use rights
13. Local and social development
14. Food security

Carbon-reduction themes (CORSIA pilot phase, 2021-2023)

Latest updates (November/2022)

- Environmental and socio-economic Themes for **Lower Carbon Aviation Fuels (LCAF)**
- **New Sustainability Theme on GHG permanence**
- Applicable after CORSIA pilot phase, from 2024

SAF life cycle assessment

Life cycle assessment

CORSIA Sustainability Theme 1 requires lower carbon emissions on a **life cycle basis.**

CORSIA Sustainability Criterion 1.1 requires net greenhouse gas emissions **reductions of at least 10%** compared to a baseline.

These requirements are met based on **a Life cycle assessment of the SAF:**

SAF Life cycle emission value (LSf)
Unit – gCO2e/MJ

=

Core Life cycle assessment (core LCA value)
emissions associated with all steps of SAF production and use

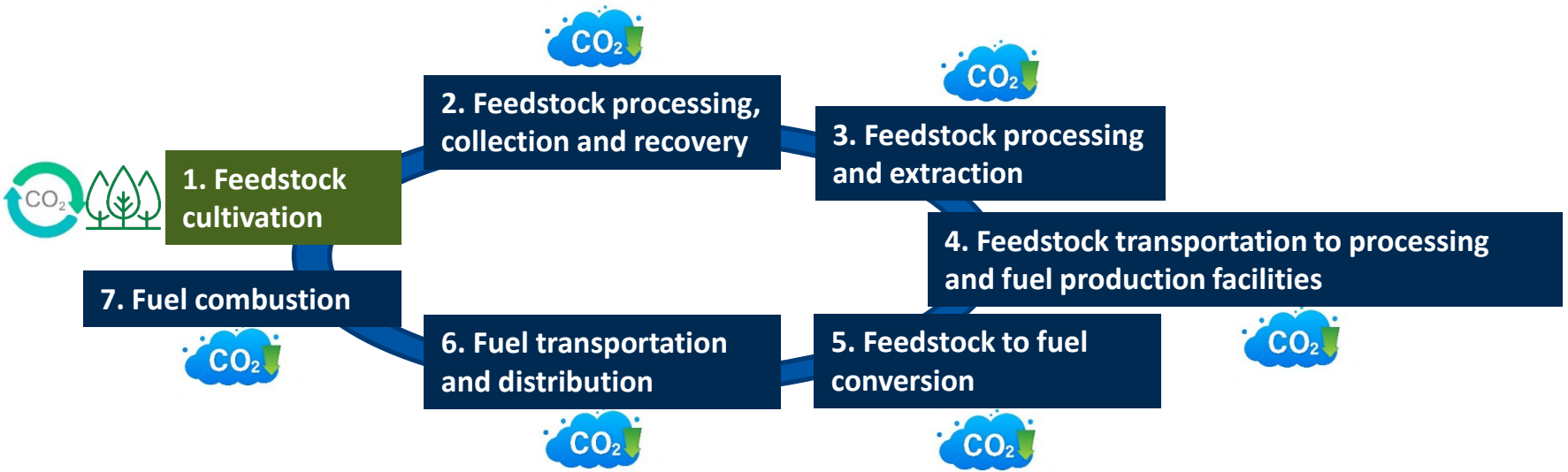
+

Induced Land use Change (ILUC value)
Emissions associated with possible land use change generated by SAF feedstock production

Life cycle assessment

Core Life cycle assessment (core LCA value)

Emissions associated with all steps of SAF production and use



Life cycle assessment

Example: life cycle emissions of sugarcane ethanol ATJ in Brazil

Production step	Associated emissions (gCO2e/MJ)
Feedstock growth	-74
Feedstock cultivation Feedstock processing, collection and recovery Feedstock processing and extraction	16.9
Feedstock transportation to processing and fuel production facilities	1.6
Feedstock to fuel conversion	5.2
Fuel transportation and distribution	0.4
fuel combustion on aircraft engine	74
total (core LCA value)	24.1
Induced Land use Change (ILUC value)	8.7
SAF Life cycle emission value (LSf) = core LCA + ILUC	32.8

63% emission reduction on a life cycle basis
(Compared with Baseline emission value of 89 gCO2e/MJ)

Life cycle assessment

Example: Jatropha-based SAF in India

Production step	Associated emissions (gCO2e/MJ)
Feedstock growth	-74
Feedstock cultivation Feedstock processing, collection and recovery Feedstock processing and extraction	32.7
Feedstock transportation to processing and fuel production facilities	0.8
Feedstock to fuel conversion	12.5
Fuel transportation and distribution	0.4
fuel combustion on aircraft engine	74
total (core LCA value)	46.8
Induced Land use Change (ILUC value) ***(Meal used as animal feed after detoxification)***	-48.1
SAF Life cycle emission value (LSf) = core LCA + ILUC	-1.3

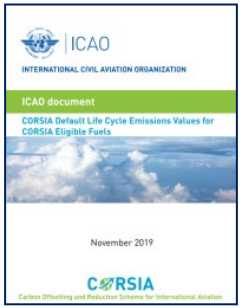
101% emission reduction on a life cycle basis
(Compared with Baseline emission value of 89 gCO2e/MJ)

Life Cycle Assessment

CORSIA allows two options to obtain the life cycle emissions of SAF

DEFAULT Life Cycle Emissions

ICAO document "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels"
Default emission values, as a function of the feedstocks and conversion processes.



ACTUAL Life Cycle Emissions

ICAO document "CORSIA Methodology for Calculating Actual Life Cycle Emissions Values"
Allows calculation of specific emissions values to a given SAF or LCAF

First Global Approach to life cycle assessment

Default life cycle emissions values

Table 1. CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels produced with the Fischer-Tropsch 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	7.7	0.0	7.7
Global	Forestry residues		8.3		8.3
Global	Municipal solid waste (MSW), 0% non-biogenic carbon (NBC)		5.2		5.2
Global	Municipal solid waste (MSW) (NBC given as a percentage of the non-biogenic carbon content)		NBC*170.5 + 5.2		NBC*170.5 + 5.2
USA	Poplar (short-rotation woody crops)		12.2	-5.2	7.0
Global	Poplar (short-rotation woody crops)		12.2	8.6	20.8
USA	Miscanthus (herbaceous energy crops)		10.4	-32.9	-22.5
EU	Miscanthus (herbaceous energy crops)		10.4	-22.0	-11.6
Global	Miscanthus (herbaceous energy crops)		10.4	-12.6	-2.2

For more details, please refer to ICAO document 06 - Default Life Cycle Emissions - June 2022.pdf

Default life cycle emissions values

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	LSr (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
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

For more details, please refer to ICAO document 06 - Default Life Cycle Emissions - June 2022.pdf

Actual life cycle emissions values

ICAO Document "CORSIA Methodology for Calculating Actual Life Cycle Emissions Values" allow for the calculation of specific emissions values to a given CORSIA SAF

- **Document provides further details on the methodology, such as:**
  - Technical report requirements
  - Feedstock categories (wastes, residues, byproducts = zero ILUC),
  - Low land use change risk practices (zero ILUC)
  - Emissions credits

For more details, please refer to ICAO document 07 - Methodology for Actual Life Cycle Emissions - June 2022.pdf

SAF sustainability certification

Sustainability certification

ICAO-approved 'Sustainability Certification Schemes (SCS)' are responsible for

- Ensuring compliance with the sustainability criteria for CORSIA eligible fuels (including CORSIA SAF)
- Ensuring that the life cycle emissions values of the fuel have been applied/calculated correctly
- To date, the International Sustainability and Carbon Certification (ISCC) and Roundtable on Sustainable Biomaterials (RSB) are the two CORSIA approved SCSs

ISCC
International Sustainability & Carbon Certification

RSB

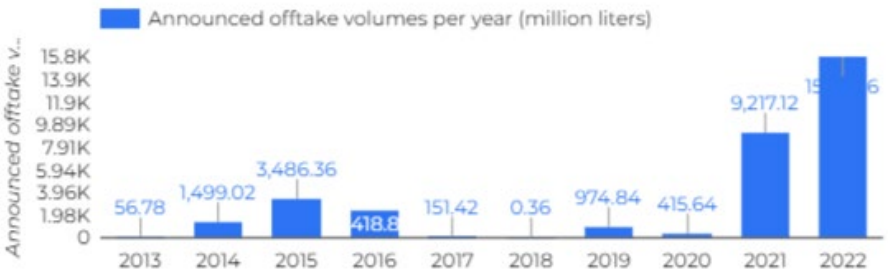
Developments in the SAF market

Developments in the SAF market - demand

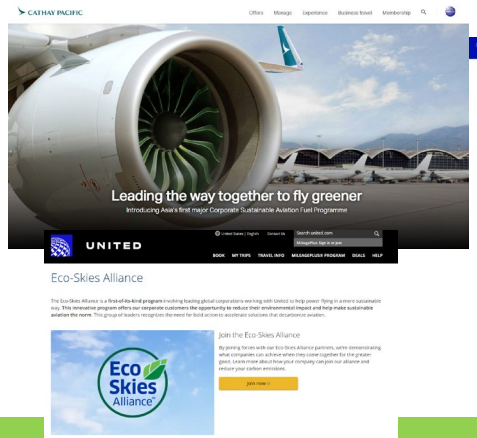
Demand for SAF is growing exponentially

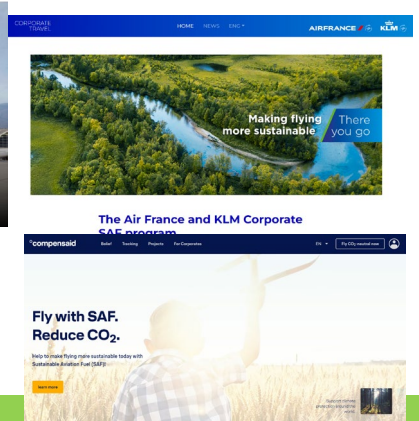
- Airlines signing multi year offtake agreements
- States are implementing supporting policies
- Programmes allow corporates and travelers to purchase SAF

Offtake agreements

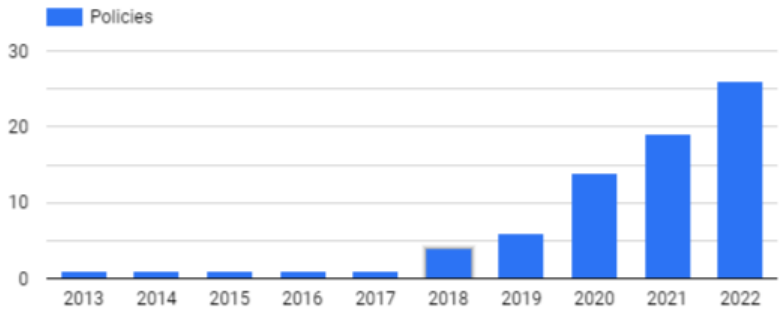


Source: https://www.icao.int/environmental-protection/GFAAF/Pages/Offtake-Agreements.aspx





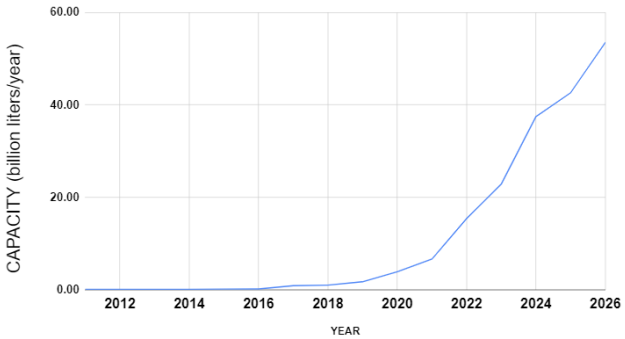
Policies



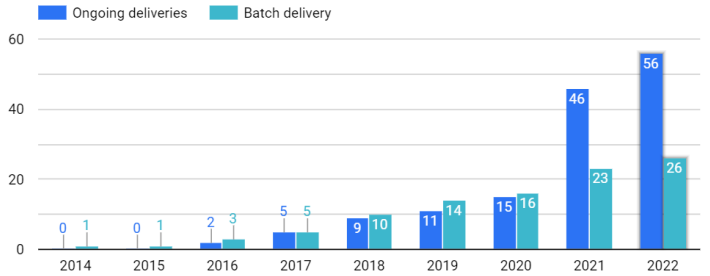
Developments in the SAF market - supply

SAF production volumes and distribution also growing

Announced Production capacity



Airports distributing SAF



ICAO SAF Tracking Tools provide regular updates on SAF market

Conclusions

- **Sustainable Aviation Fuels are a reality – technology, sustainability and life cycle methodologies are ready**
- **Opportunities exist for States in developing this new industry**
- **Leadership from States will be of paramount importance to drive the CO2 reductions from SAF**
- **Important to include SAF related opportunities in the State Action Plan**
- **Challenges remain for further deployment**
  - Further policies are needed to drive cost down and increase volumes
  - Level playing field with ground transportation
  - Harmonized approach

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