SAF market outlook and supporting policies

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

I. Potential policies and coordinated approaches

II. Estimates related to SAF costs, investment needs and production capacity of facilities

III. Market outlook - ICAO Stocktaking and Tracker Tools

I. Potential policies and coordinated approaches

Need for Policies on Aviation Cleaner Energy

- **Cleaner energy production is limited by a number of barriers**
  - Higher costs
  - Limited feedstock and fuel production infrastructure
  - Perceived financial risks
- **In the presence of such barriers, policy intervention is required to develop cleaner energy production.**
  - In general, a supporting policy framework is in place in those states where cleaner energy production has initiated
- **Constraints and opportunities are specific to each State**
  - Specific climates, agricultural systems, available resources, economic factors, political contexts, regulatory structures, etc.

ICAO Guidance on Potential Policies and Coordinated Approaches for the deployment of SAF

- **Developed by CAEP based on studies performed since 2016**
- **A support reference for ICAO States to develop SAF production**
  - Insight on types of policy measures and their impacts
  - Examples of policies used or under preparation
  - Links to additional helpful resources
- **Completes a toolbox of guidance material for ICAO States**
- **Can be used in combination with the ICAO SAF Rules of Thumb**

Publically available on the ICAO website

Guidance document

https://www.icao.int/environmental-protection/Pages/saf_guidance_potential_policies.aspx

SAF rules of thumb

https://www.icao.int/environmental-protection/Pages/SAF_RULESOFTHUMB.aspx

SAF Policy options

Guidance provides details on 28 types of Policy Options, divided into 3 impact areas and 8 categories

Impact area: Stimulating Growth of SAF Supply

1 Government funding for RDD	2 - Targeted incentives and tax relief to expand SAF supply infrastructure	3 - Targeted incentives and tax relief to assist SAF facility operation	4 - Recognition and valorization of SAF environmental benefits
1.1 - Government R&D 1.2 - Government demonstration and deployment	2.1 - Capital grants ; 2.2 - Loan guarantee programs 2.3 - Eligibility of SAF projects for tax advantaged business status ; 2.4 - Accelerated depreciation/'bonus' depreciation 2.5 - Business Investment Tax Credit (ITC) for SAF investments 2.6 - Performance-based tax credit 2.7 – Bonds / Green Bonds	3.1 Blending incentives: Blender's Tax Credit 3.2 – Production incentives: Producer's Tax Credit 3.3 - Excise tax credit for SAF 3.4 - Support for feedstock supply establishment and production	4.1 – Recognize SAF benefits under carbon taxation 4.2 - Recognize SAF benefits under cap and-trade systems 4.3 - Recognize non-carbon SAF benefits: improvements to air quality 4.4 - Recognize non-carbon SAF benefits: reduction in contrails

Impact area: Creating Demand for SAF

5- Creation of SAF mandates	6 - Update existing policies to incorporate SAF	7 – Demonstrate government leadership
5.1 - Mandate renewable energy volume requirements in the fuel supply 5.2 - Mandate reduction in carbon intensity of the fuel supply	6.1: Incorporating SAF into existing national policies 6.2: Incorporating SAF into existing subnational, regional or local policies	7.1 Policy statement to establish direction 7.2: Government commitment to SAF use, carbon neutral air travel

Impact area: Enabling SAF Markets

8 - Market enabling activities
8.1 - Adopt clear and recognized sustainability standards and life cycle GHG emissions methods for certification of feedstock supply and fuel production 8.2 - Support development/recognition of systems for environmental attribute ownership and transfer 8.3 - Support SAF stakeholder initiatives

Policy examples

Financing grant competitions for SAF production (USA, France)

ICAO ENVIRONMENT

IRA SAF and Clean Technology Grant Program

ACT SAF

Support projects to rapidly scale-up domestic SAF production

IRA FAST Grant Program

§40007
$245 million competitive grant program
Specifies consideration criteria and eligible entities
FAST Meeting – Dec. 14

Text - H.R.5376 - 117th Congress (2021-20 of 2022 | Congress.gov | Library of Congr

2. French endeavour for SAF

2- Focus on French endeavour for SAF

Mid-2020 launched **a Call for Expression of Interest** to assess stakeholders' interest and needs

July 2021: calls for proposal to support the development of a French SAF production sector :

- **200 million € for pilot/demonstrator construction or engineering studies**
- Closed in September 2022 – 5 winning projects to date

Concrete application via a mandatory incorporation mandate :

- **January 2022: blending mandate of 1%** implemented
- **Mid-2022 :** launch of a working group to address the **industrialization phase** at government level
- **December 2022 :** study on **PtL fuels potential** in France

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Direction du transport aérien

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SAF blending/use mandates in energy content or CO_2 emissions reductions (EU, Brazil)

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ACT SAF

ReFuelEU Aviation legislative proposal

Design*

Ramp-up: binding minium SAF shares in aviation fuel supplied in the EU:

Total shares in the fuel mix (in %)	2025	2030	2035	2040	2045	2050
Sustainable Aviation Fuels (SAF) target	2	5	20	32	38	63
Synthetic						

Eligible
Sustain

* Subject t

ICAO ENVIRONMENT

Public Policy for SAF

ACT SAF

- No blending mandate or tax incentives – limited budget
- Alternative: a mandate of CO_2 emissions reduction (in %) by the use of SAF
  - Applied to airlines (thus not on SAF distribution).
  - Fosters competition for the use of the best technology available and the most efficient SAF

For details – ACT-SAF Series #4 Training –
https://www.icao.int/environmental-protection/Pages/ACT-SAF-Series.aspx

Policy examples

Tax credits on SAF (USA, France)

ICAO ENVIRONMENT — Inflation Reduction Act (IRA) - Production support through 2027 — ACT SAF

IRA Tax Credits

SAF Tax Credit §13203 - 2023-2024
- Achieves 50% lifecycle GHG reduction
- $1.25 with additional up to $1.75 for additional lifecycle emissions reduction

Production Credit §13704 - 2
- Lifecycle GHG <50kg CO2e/MMBTU
- Enhanced value for SAF up to $1.75

Text - H.R.5376 - 117th Congress (2021-2022): In
2022 | Congress.gov | Library of Congress

2. French endeav

2- Focus on French endeavour for SAF

TIRUERT : an existing tax instrument
- Incentive mechanism to encourage the blending of biofuels in diesel and gasoline, and now kerosen
- Set-up via the **budget law** & update annually
- To evolve over the coming years to match our SAF roadmap objectives

Principles
- Separate annual objective per type of fuel (non fungible)
- SAF blending mandate set at **1% since 2022** (in energy)
- Tax level of **168 € / hectolitres** (at present)

Recent development
- Mandate level raised to 1,5% in 2024
- **Upgrade of the biofuel management platform** developed by the French Energy Ministry

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Design of a national SAF roadmap (UAE, Japan)

ICAO ENVIRONMENT — UAE SAF Roadmap — ACT SAF

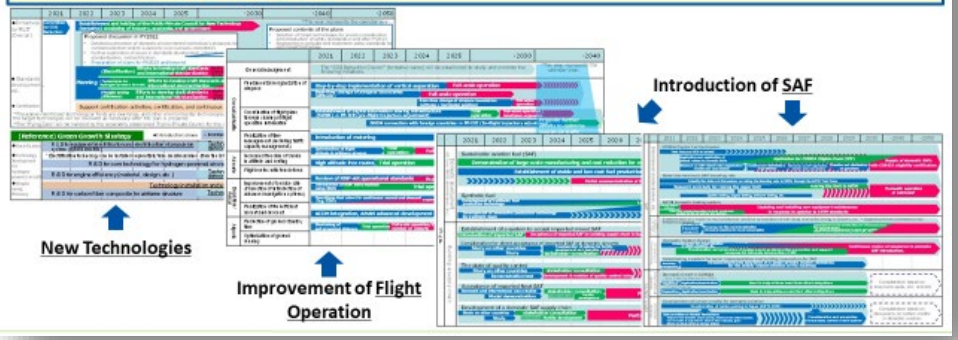
2022-2050: Key strategic points

National Sustainable Aviation Fuel Roadmap of the United Arab Emirates
2022-2050

5 Sustainable Aviation Fuel (SAF) principles are highlighted with the intent to accelerate the decarbonization of the UAE's aviation sector and transform it into a **regional hub for low carbon aviation fuels**

ICAO ENVIRONMENT — SAF Roadmap and Utilization target in 2030 — ACT SAF

- The roadmaps for promoting decarbonization in aircraft operation sector were established in 2021 and are shared among public/private parties in Japan.
- **Two quantitative targets** for decarbonization were established within roadmaps.
  - SAF: *Replacing 10% of the fuel consumption by Japanese airlines with SAF in 2030*
  - **Operational improvement:** *Reducing CO2 emissions by about 10% through future efforts of improvement of flight operations by renovating air navigation services*



For details – ACT-SAF Series #4 Training –
https://www.icao.int/environmental-protection/Pages/ACT-SAF-Series.aspx

Policy examples

Industry engagement (UAE, Japan "Act for Sky", Singapore "Buyers club for SAF")

ICAO ENVIRONMENT — Participants — ACT SAF

The UAE SAF Committee

ICAO ENVIRONMENT — Private Initiative for SAF - Act for Sky - — ACT SAF

- **Establishment of "Act For Sky"**
  On 2 March 2022, a voluntary organisation, "ACT FOR SKY", was launched with JGC HD, Revo INTL', ANA and JAL as lead companies, with the aim of promoting and expanding domestic SAF.
- What is Act For Sky
- Member companies: 24 (as of February 2023)

ICAO ENVIRONMENT — Corporate Buyers' Club for SAF — ACT SAF

- Studying the feasibility and design of a corporate buyers' club to encourage early adopters to take collective action, to aggregate SAF demand and provide stronger demand signals for SAF production and scale-up
  - Tap on business travelers and air cargo users and encourage them to become first movers
  - Potential of collaborating with regional partners to expand the buyers' club to the broader ASEAN region
- As the buyers' club would be the first of its kind in Singapore, need careful assessment of its commercial viability and operating model
- Plan to commence study in second quarter of 2023, which will take around 3 months

Defining SAF aspirational targets (Japan 10% SAF by 2030, USA 3 Billion gallons of SAF by 2030)

ICAO ENVIRONMENT — U.S. SAF Grand Challenge — ACT SAF

- Agreement by the Departments of Transportation, Energy and Agriculture
- Achieve 3 b… production… to 35 billio…
- At least a 5… greenhous… convention…
- Multi-agen… to support…

ICAO ENVIRONMENT — Public-Private Councils — ACT SAF

- In Mar21, JCAB established **"Study Group on CO2 Reduction in the Aircraft Operation Sector"** which consists of air-carriers, academic experts etc.
- The study group **established roadmaps for promotion of decarbonisation in aviation operation sector.**
  < Target > Replacing 10% of the fuel consumption by Japanese airlines with SAF in 2030
- Accelerating actions in the roadmaps, JCAB has established **public-private councils**.

Private-Public Councils for promotion of SAF deployment

Purpose
- ✓ Coordination of demand (airlines) and supply (oil companies) to facilitate the development and production of domestic SAF
- ✓ Construction of future supply chain including imported SAF

Key actions
- ✓ Coordinating of demand and supply of SAF
- ✓ Demonstration of imported neat SAF refueling in Japan
- ✓ Assistance of ICAO CEF certification

Member
- ✓ Private sector: Air-carriers, Airport company, Oil company, etc.
- ✓ Public sector: MAFF, METI, MLIT, MOE, NEDO(observer)

Vice-minister of MLIT, Mr. Nakayama at the 1st council

For details – ACT-SAF Series #4 Training –
https://www.icao.int/environmental-protection/Pages/ACT-SAF-Series.aspx

Qualitative metrics for assessing policy effectiveness

1 - Flexibility	2 - Certainty	3 - Financial costs and benefits	4 - Price sensitivity to externalities
Can the policy be easily adjusted given evolving circumstances?	Certainty on timeframe, legal conditions and political decisions increase investor interest.	Policies should be assessed on the its costs benefits they deliver, including social ones.	Higher sensitivity, more unintended consequences. Floor/Ceiling prices can reduce volatility

5 - Ease of implementation	6 - Contribution to SAF deployment and GHG reduction	7 - Unintended consequences	8 - Robustness of policy
Administrative, governance and/or procedural complexity can hinder implementation.	clear criteria on target quantity, sustainability, commercial parameters and timeframe improve results	mechanisms to identify and mitigate unintended consequences (economic, environmental or social)	regulating systems to ensure that policy objectives are achieved and procedures have been followed.

EXAMPLE Marginal abatement cost of CO_2 mitigation

Determining the marginal abatement cost of CO_2 mitigation using SAF

Evaluating the cost of abating 1 ton of CO2 with the use of SAF can be valuable for a policy maker to assess the effectiveness of a specific policy relative to other alternatives (fleet renewal, ATM operations improvement, etc.)

Cost of 1 tonne of conventional kerosene = $600

Cost of 1 tonne of SAF = $1100

Jet fuel combustion CO_2 emissions factor = 3.16

CO_2 emissions reduction factor of this SAF = 80%

Firstly, the amount of CO_2 reduced must be determined which is a function of the amount of SAF used, the jet fuel combustion factor and the SAF emissions reduction factor.

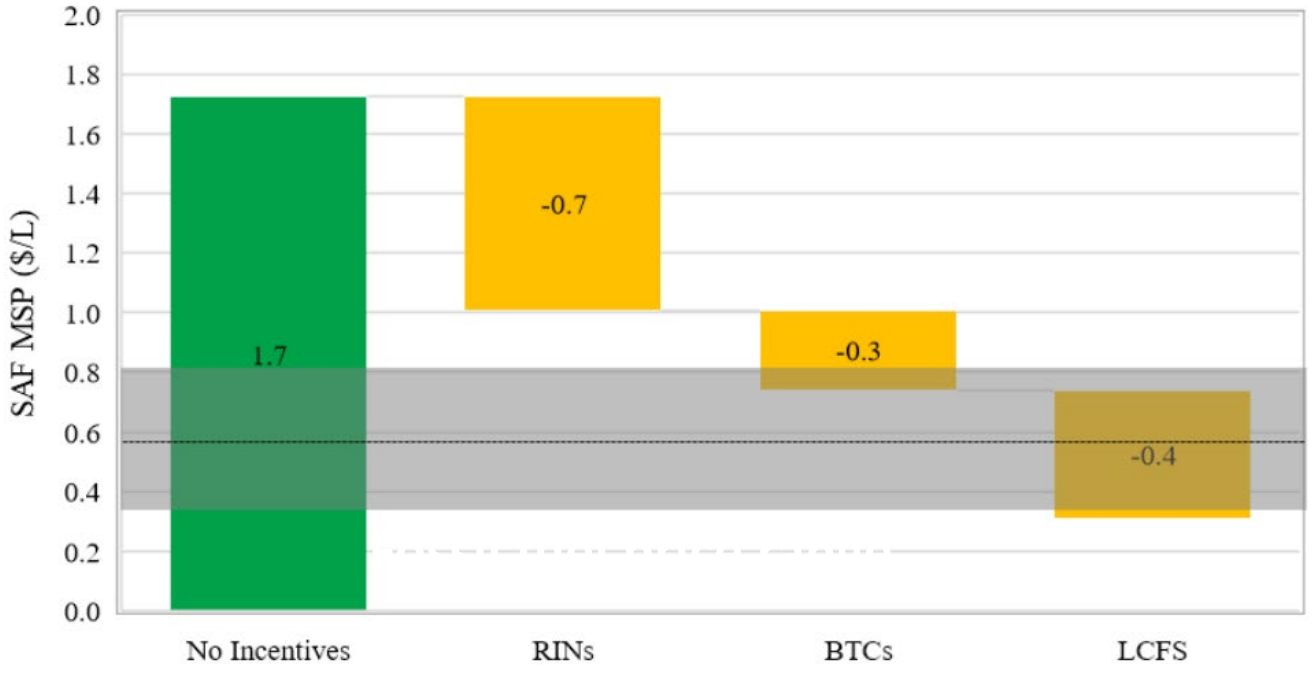
Net CO_2 emissions reduction = 2 tonnes * 3.16 * 80% = 5.06 tonnes CO_2

The cost per tonne of CO_2 reduced is found by calculating the cost difference between SAF and conventional kerosene divided by the amount of CO_2 reduced.

Cost per tonne of CO_2 reduced = 2 tonnes * (1100-600) / 5.06 = $197.78 / tonne

How do policies impact SAF Minimum Selling Price?

The guidance illustrate the effects of policies on the SAF minimum selling price (MSP)



- Example – what is the effect of the combination of 3 measures from the US policy context?
  - RINs – Renewable fuel Standard
  - BTC - Blenders' Tax Credit,
  - LCFS - Low Carbon Fuels Standard
- Thanks to the combined measures, the MSP falls within the range of fossil jet fuel price.

II. Estimates related to SAF costs, investment needs and production capacity of facilities

SAF estimates ("Rules of thumb")

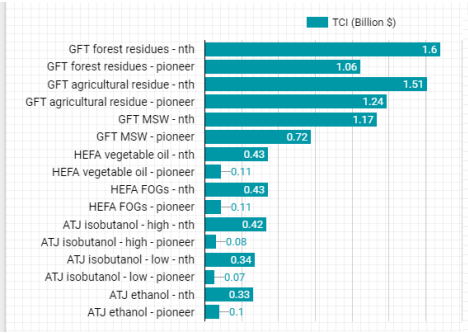
Information on costs and benefits is required to assess policy options

To support such assessment, CAEP developed the ICAO SAF Rules of Thumb

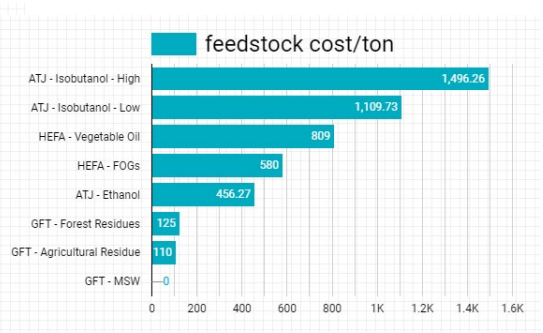
- provides order of magnitude estimations on SAF costs, investment needs and production potential to inform policymakers and project developers
- First Edition (2021)
  - Conversion processes: Fischer Tropsch (FT), Alcohol to jet (ATJ) and hydro-processed esters and fatty acids (HEFA)
  - Multiple feedstocks and two technology maturity levels: "nth" and "pioneer" facilities.

Available at https://www.icao.int/environmental-protection/Pages/SAF_RULESOFTHUMB.aspx

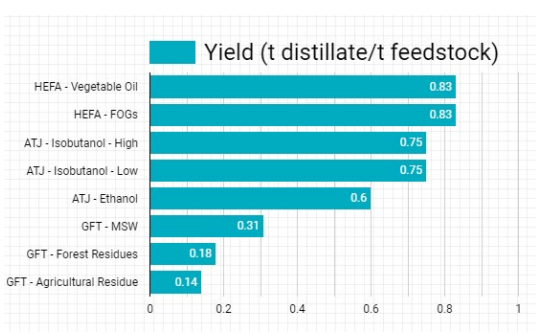
total capital investment (TCI)



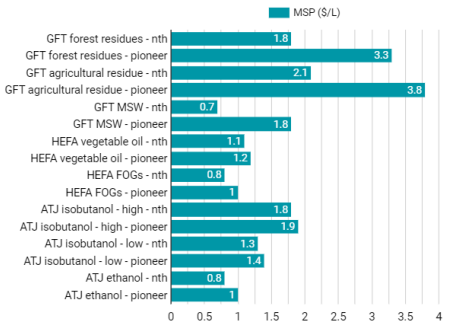
Feedstock costs



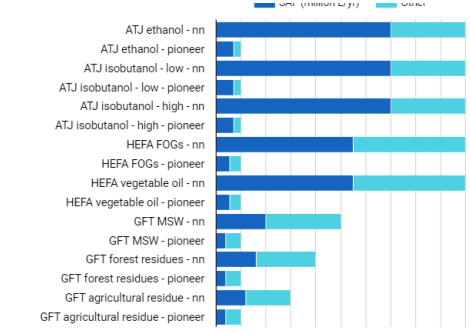
Feedstock Yield



Minimum Selling Price



Refinery capacity



Latest Updates (2023) – inclusion of new pathways: **pyrolysis** with forest residues or agricultural residues; and FT with CO_2 and H_2 as major inputs (**Power to Liquids – PtL**)

III – SAF market outlook -

ICAO Stocktaking and tracker tools

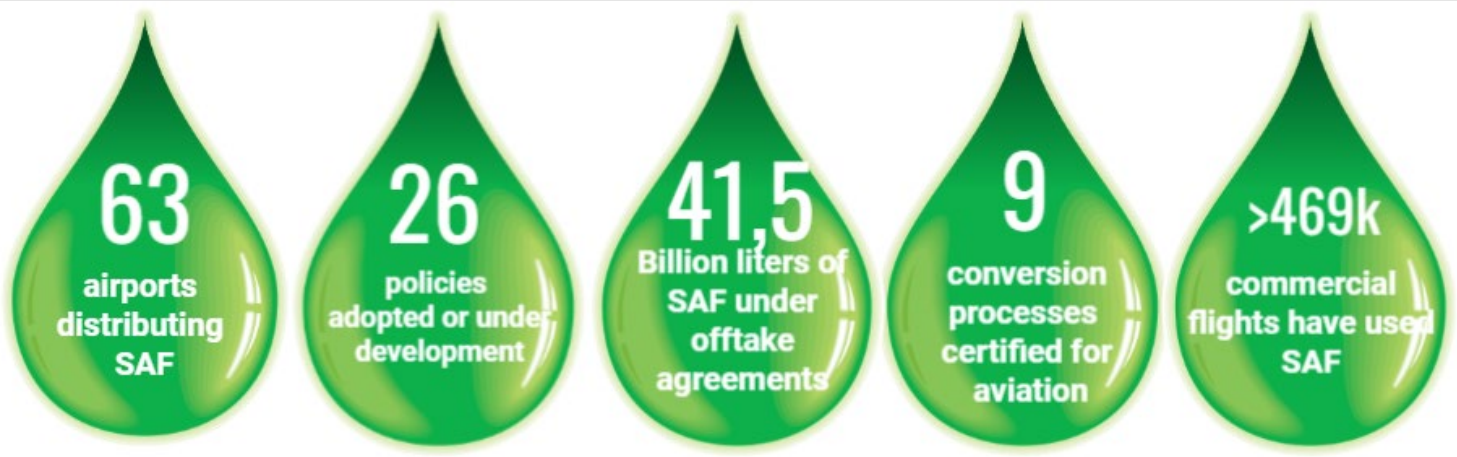
ICAO Environment Stocktaking

ICAO Environment Stocktaking events - element for monitoring progress towards LTAG and support the review the 2050 ICAO Vision for SAF (A41-21 Para 9 and 28 f))

- 2023 Stocktaking to be held from 11-13 July 2023
- Stocktaking is supported by the ICAO Global Coalition for Sustainable Aviation
- Update of the publication “Innovation driving sustainable Aviation”
- Support the update of ICAO tracker tools

SAF tracker tools

- **Updated daily**
- **Transparent: all data available for consultation**



Latest news (click for details)

Search Saisissez une valeur

Filter by State

Date	Link
4 févr. 2023	Praj-Axen pact for sustainable aviation fuel in India
3 févr. 2023	Emirates Operates Test Flight Powered with 100% Sustainable Aviation Fuel
3 févr. 2023	Jet fuel made from wood heads toward production in Japan
2 févr. 2023	VARO and Lufthansa Group deepen partnership for production and supply of SAF
31 janv. 2023	United Airlines' new partnership could power 50,000 flights with sustainable aviation fuel
29 janv. 2023	"World first" solar methanol plant to feed off Port Augusta solar thermal project in Australia
26 janv. 2023	Masdar-led consortium to certify pathway to make SAF from methanol
22 janv. 2023	KLM and Transavia to raise ticket prices to use more sustainable fuel

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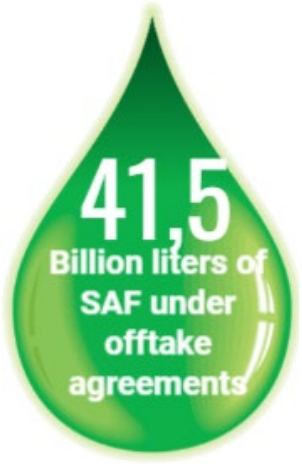
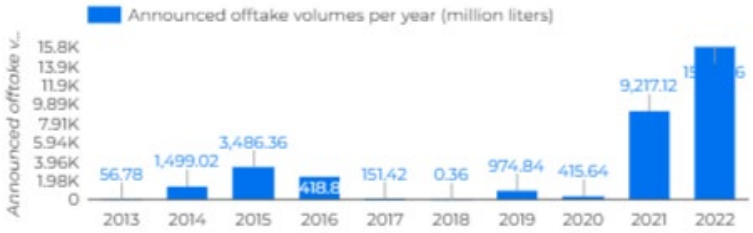
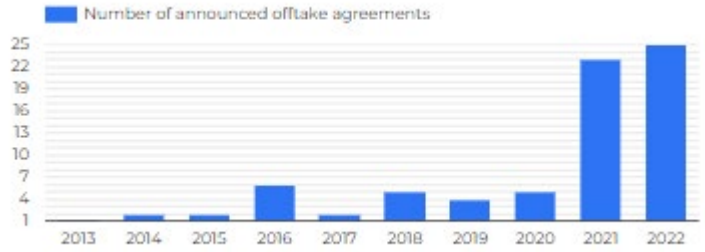
SAF Offtake Agreements tracker



- **Latest information on SAF purchase agreements**





ICAO **Tracker of SAF Offtake agreements**

Filter by: Fuel producer | Fuel purchaser

	Date	Fuel producer	Fuel Supplier	Fuel User / Purchaser	total offtake volume (million liters)	Length of offtake agreement (years)	Source
1.	Sep 13, 2022	OMV		Lufthansa Group	999.4	8	https://www.omv.com/en/news/220913-omv-and-luftha...
2.	Sep 8, 2022	DG fuels		Delta	1457.4	7	https://www.rechargenews.com/energy-transition/delta...
3.	Aug 23, 2022	Aemetis		IAG	97.4	7	https://www.canadianbiomassmagazine.ca/aemetis-to-...
4.	Aug 15, 2022	Gevo		Alaska Airlines	700.3	5	https://www.google.com/url?q=https://biofuels-news.co...
5.	Aug 1, 2022	Shell		Lufthansa Group	2248.5	7	https://www.shell.com/business-customers/aviation/ne...
6.	Jul 22, 2022	Gevo		American Airlines	1892.7	5	https://news.aa.com/news/news-details/2022/American-...
7.	Jul 14, 2022	Gevo		Air Lingus	118.7	5	https://www.businesstraveller.com/business-travel/2022...
8.	Jun 28, 2022	Phillips 66		IAG Cargo	1	1	https://www.aviationpros.com/ground-handling/fuel-di...
9.	Jun 21, 2022	Gevo		Finnair	132.5	5	https://www.bakersfield.com/ap/news/finnair-and-gevo...

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Summary per fuel producer

	Fuel producer	Total offtake volume (million liters)	Number of offtake agreements
1.	Gevo	8,887.59	10
2.	Fulcrum	6,719.1	3
3.	Alder Fuels	5,678.12	1
4.	Shell	2,248.53	1
5.	DG fuels	1,457.38	1
6.	Aemetis	1,214.9	8
7.	Dimensional Energy	1,135.62	1
8.	Velocys	1,105.34	2
9.	ECB Group	1,050.08	2
10.	Neste	1,036.41	12
11.	OMV	1,001.32	2
	Grand total	**34,177.01**	**75**

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Summary per fuel purchaser

	Fuel purchaser	Total offtake volume (million liters)	Number of offtake agreements
1.	United Airlines	10,513.98	6
2.	Delta	3,824.4	7
3.	OneWorld	3,785.41	1
4.	Lufthansa Group	3,247.98	2
5.	American Airlines	2,388.59	4
6.	AirBP	2,192.71	2
7.	Cathay Pacific	1,419.53	1
8.	KLM	937.04	4
9.	Southwest Airlines	829	1
10.	DHL Express	798.72	1
11.	Shell	750.08	1
	Grand total	**34,177.01**	**75**

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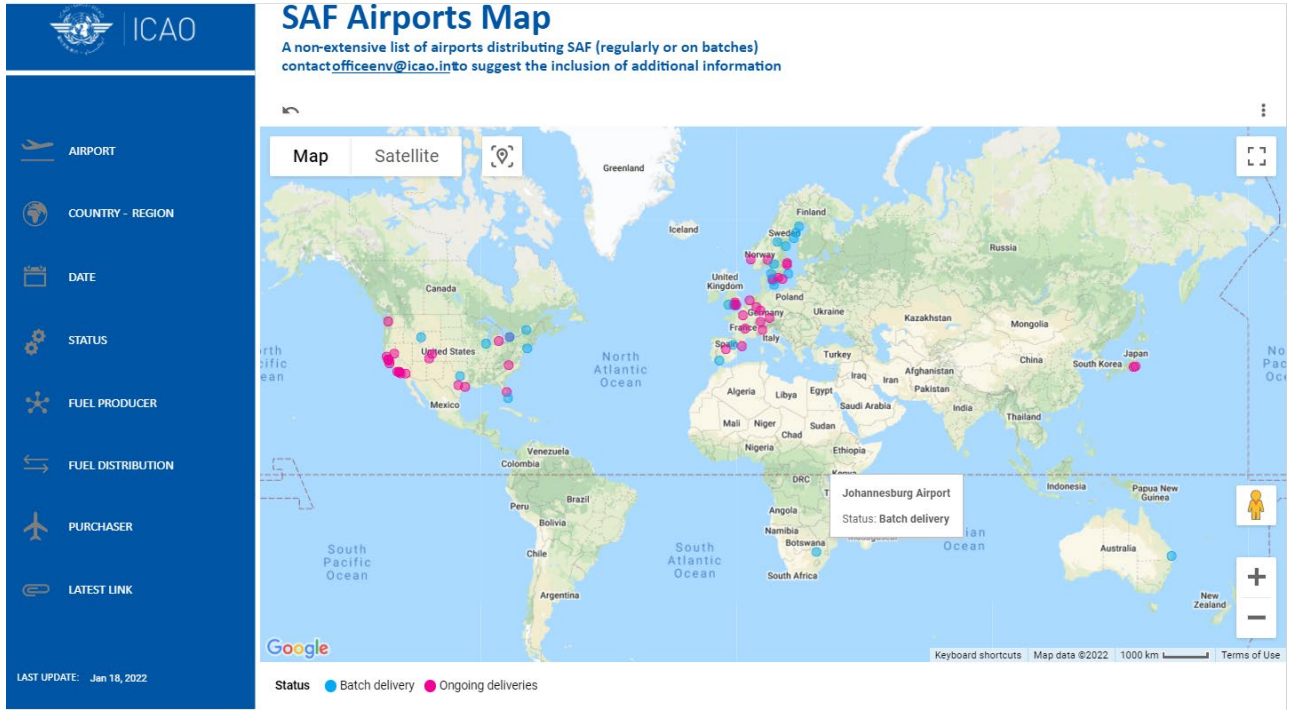
Airports tracker

63 airports distributing SAF

- **Tracker of airports offering Sustainable Aviation Fuels, either continuously or in batches**



	Date	Airport	Status	Source
1.	3 févr. 2023	Dubai Airport	Batch delivery	https://news.gtp.gr...
2.	9 janv. 2023	Toulon Hyères Airport	Ongoing deliveries	https://www.airport...
3.	1 janv. 2023	Brussels Airport	Batch delivery	https://www.aviatio...
4.	31 déc. 2022	Liege Airport	Batch delivery	https://biofuels-ne...
5.	14 déc. 2022	Billund Airport	Ongoing deliveries	https://biofuelscent...
6.	1 déc. 2022	kota kinabalu airport	Batch delivery	https://www.thestar...
7.	25 nov. 2022	Ningbo Lishe International Airport	Ongoing deliveries	https://simpleflying...
8.	24 oct. 2022	Lisbon Airport	Batch delivery	https://www.aviacio...

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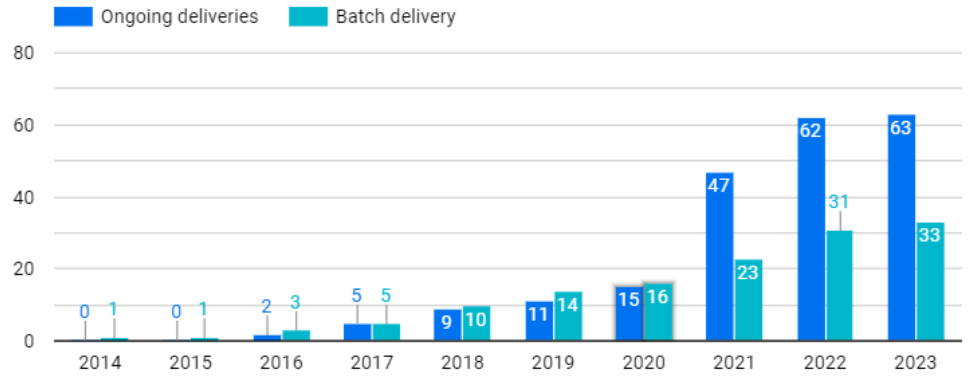
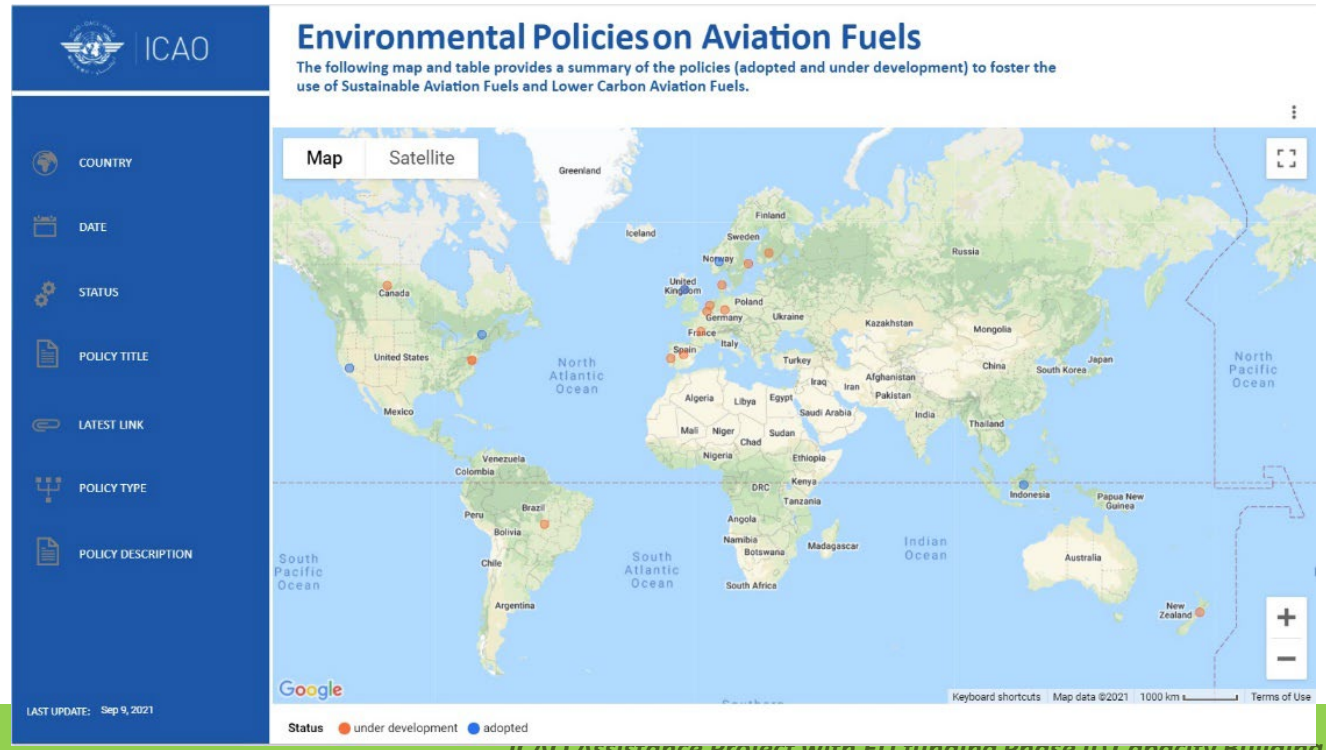
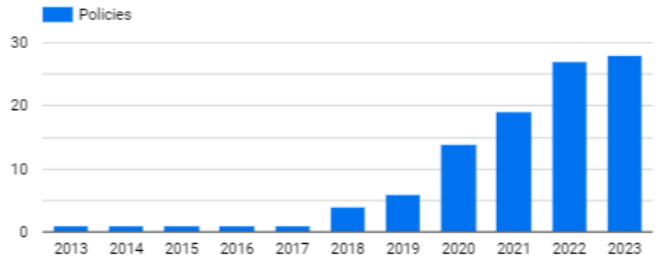


SAF Policies tracker

- **Tracker of Policies adopted or under development to foster SAF development**



Date	State	Policy Title	Policy Description	Status	Source
13 févr. 2023	United States	Invest in Illinois Act	This legislation in Illinois provides a tax credit of $1.50 per gallon for SAF used by aircraft in the state. For the SAF to qualify for the credit, it must reduce carbon emissions by at least 50% throughout its life. The credit applies to all SAF used in Illinois, regardless of where it is produced. However, credits for SAF used before June 1, 2028, must come from renewable sources such as biomass, waste streams, renewable energy, or gaseous carbon oxides. The tax credit will be available until January 1, 2033.	adopted	https://www sustainable-
16 nov. 2022	India		SAF mandate blending under consideration	under development	https://www committed-t
18 oct. 2022	Japan		The Japanese government is seeking public comments on a draft policy to promote decarbonization in the aviation industry. The policy, in part, would require flights to be carbon neutral by 2050 and require airlines to use sustainable aviation fuel (SAF).	under development	https://biom s-draft-policy
3 oct. 2022	China	China Civil Aviation Green Development Policy and Action	Target of 50k tons of SAF use by 2025 SAF performance testing, airworthiness certification, exploration of new paths for its development.	adopted	http://www.c 15425.html
16 août 2022	United States	Inflation Reduction Act (SAF blenders tax credit)	The bill provides a $1.25 per-gallon credit for each gallon of SAF sold as part of a qualified fuel mixture, including that it has a demonstrated lifecycle greenhouse gas (GHG) reduction of at least 50 percent compared to conventional jet fuel. The credit, available for two years beginning January 1, increases up to $1.75 per gallon on a sliding scale based on the percentage of lifecycle GHG emissions reduced beyond 50 percent. Beginning in 2025, SAF would be eligible for credits up to $1.75 per gallon under a new Clean Fuel Production Credit (CFPC). That credit is set to expire at the end of 2027.	adopted	https://www aviation/202
19 juil. 2022	United Kingdom	Jet Zero Strategy	Increasing support for sustainable aviation fuels (SAF), by creating secure and growing UK SAF demand through a SAF mandate that will require at least 10% of jet fuel to be made from sustainable sources by 2030 and kickstarting a domestic	adopted	https://www sets-out-stra free-flying



Summary

- There is a need for effective policies to address a number of challenges on cleaner energies (specific to each State)
- ICAO guidance provides information on various policy options
- Information is also available on CO_2 abatement cost (SAF Rules of Thumb - $ per CO2 reduction) to inform plans/projects and decision-makers.
- ICAO Stocktaking and tracker tools are constantly monitoring the SAF market development