



ICAO EUR/NAT Environment Workshop Hosted by the State Civil Aviation Agency of the Republic of Azerbaijan



ICAO

Aviation and Cleaner Energy

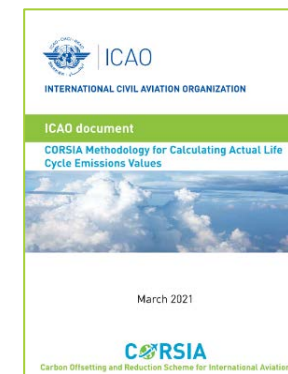
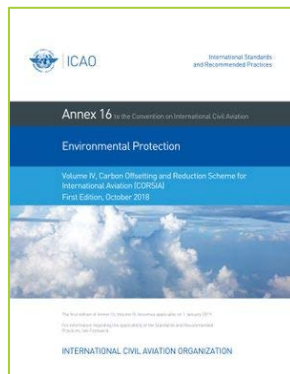


Showcasing aviation's cleaner energy
transition toward SAF scale-up and
ICAO Vision

SAF basic definitions

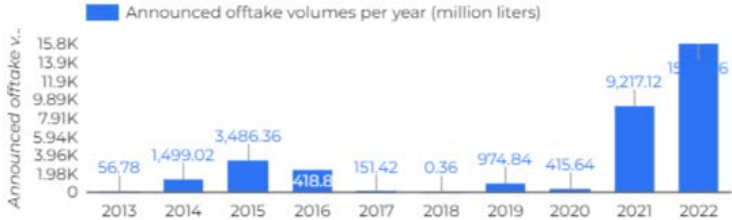
What are Sustainable Aviation Fuels (SAF)?

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

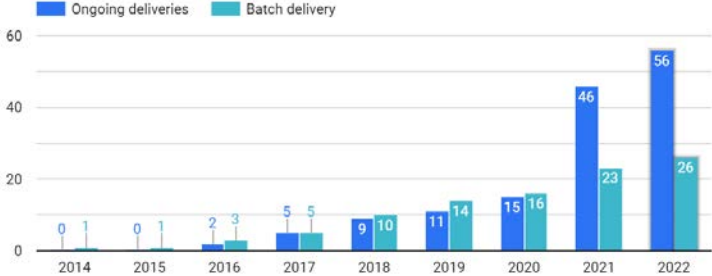


SAF in last Assembly

Offtake agreements 15 million liters/year in 2022

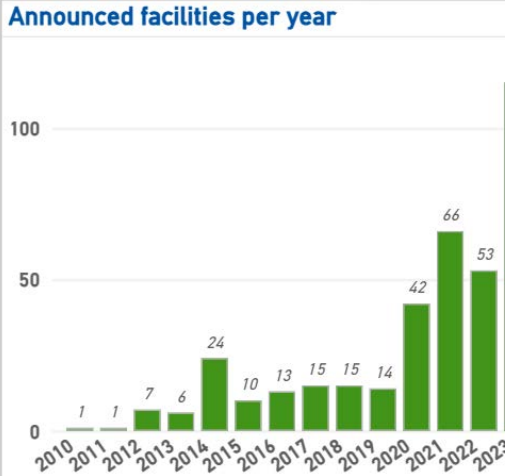
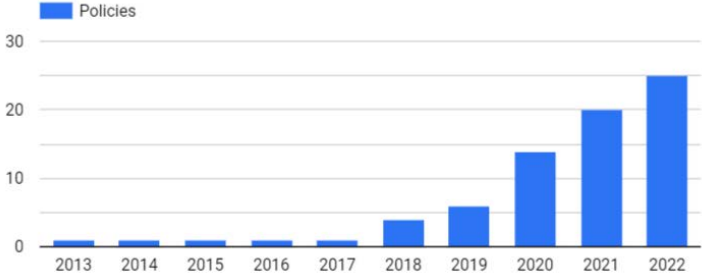


82 Airports distributing SAF



~280 refinery announcements

25 SAF policies



What happened since then?

ICAO Global Framework for SAF, LCAF and other Aviation Cleaner Energies ⁴



- Adopted at the third ICAO Conference on Aviation and Alternative Fuels (CAAF/3) in November 2023
- Collective Vision** to reduce **5% CO₂** by **2030** in international aviation using SAF, LCAF and other aviation cleaner energies
- Requires **~23 million tonnes (Mt)** of cleaner energies use by 2030

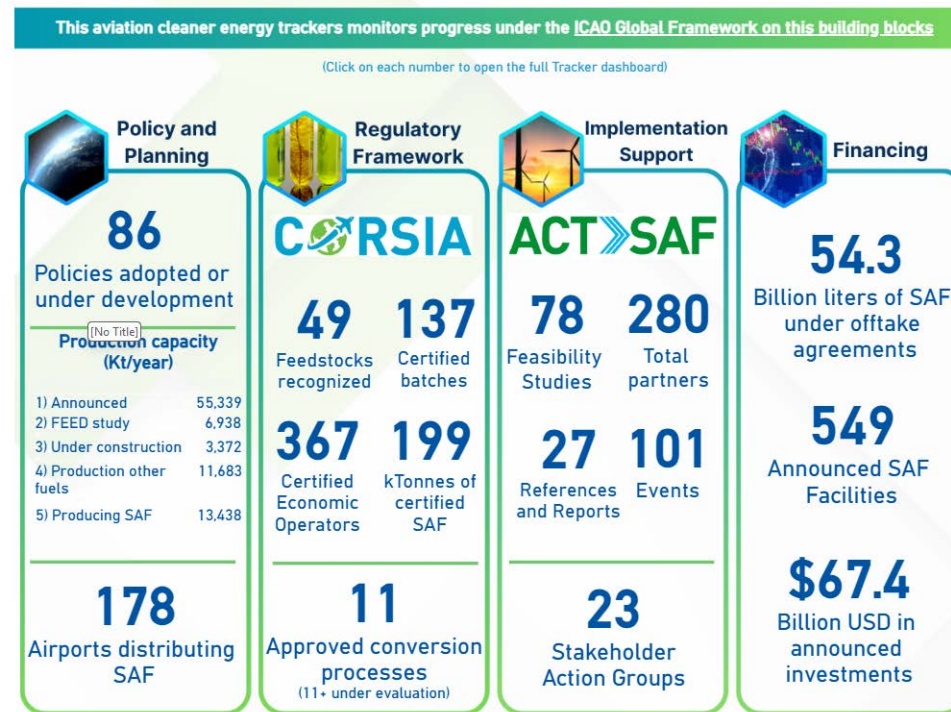
For more details

A42-WP/28 Appendix B



Global Framework is set out through 4 Building Blocks

- ICAO is monitoring progress on these building blocks through the **ICAO Cleaner Energy Tracker**



www.icao.int/SAF



Four Building Blocks to Achieve the Vision & LTAG



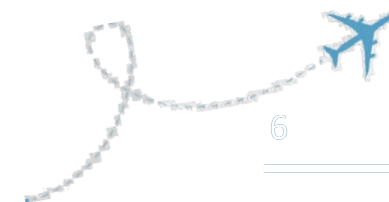
This aviation cleaner energy trackers monitors progress under the ICAO Global Framework on this building blocks

(Click on each number to open the full Tracker dashboard)



- SAF and other aviation cleaner energies must meet the **CORSIA sustainability criteria** (ICAO Annex 16, Volume IV and five supporting ICAO documents)
- **No specific fuel source, pathway, feedstock, or technology is excluded**, provided it meets the **CORSIA sustainability criteria**
- **Harmonized standards to provide regulatory certainty and support investment decisions**

CAAF/3 Global Framework – 4 Building Blocks



1. Policy and Planning

- Global aspirational **Vision** to reduce international aviation CO₂ emissions by **5% by 2030**
- Each State's **special circumstances and respective capabilities**
- **CAAF/4** no later than 2028, with a view to update Vision
- **Collaborative effort** across different stakeholders, and encourage **State policies, action plans and roadmaps**
- Implementation **monitored** and periodically **reviewed**

2. Regulatory Framework

- **CORSIA eligibility framework as accepted basis** for SAF, LCAF and other aviation cleaner energies
- Increase the **number of SCS**, additional fuel production **pathways / life-cycle values**
- Parameters for **fuel accounting methodologies**, leveraging on CORSIA MRV system
- **Study of fuel accounting systems** to determine any possible ICAO role

3. Implementation Support

- **Robust, targeted and tailored** capacity -building and implementation support
- **Building on ACT-CORSIA and ACT-SAF programmes**
- Facilitate **partnerships**, and exchange of best practices
- Develop **policy toolkit/guidance** and support **State Action Plans**
- Support **feasibility studies, pilot projects**, which may facilitate access to investment
- Support **access to technology**

4. Financing

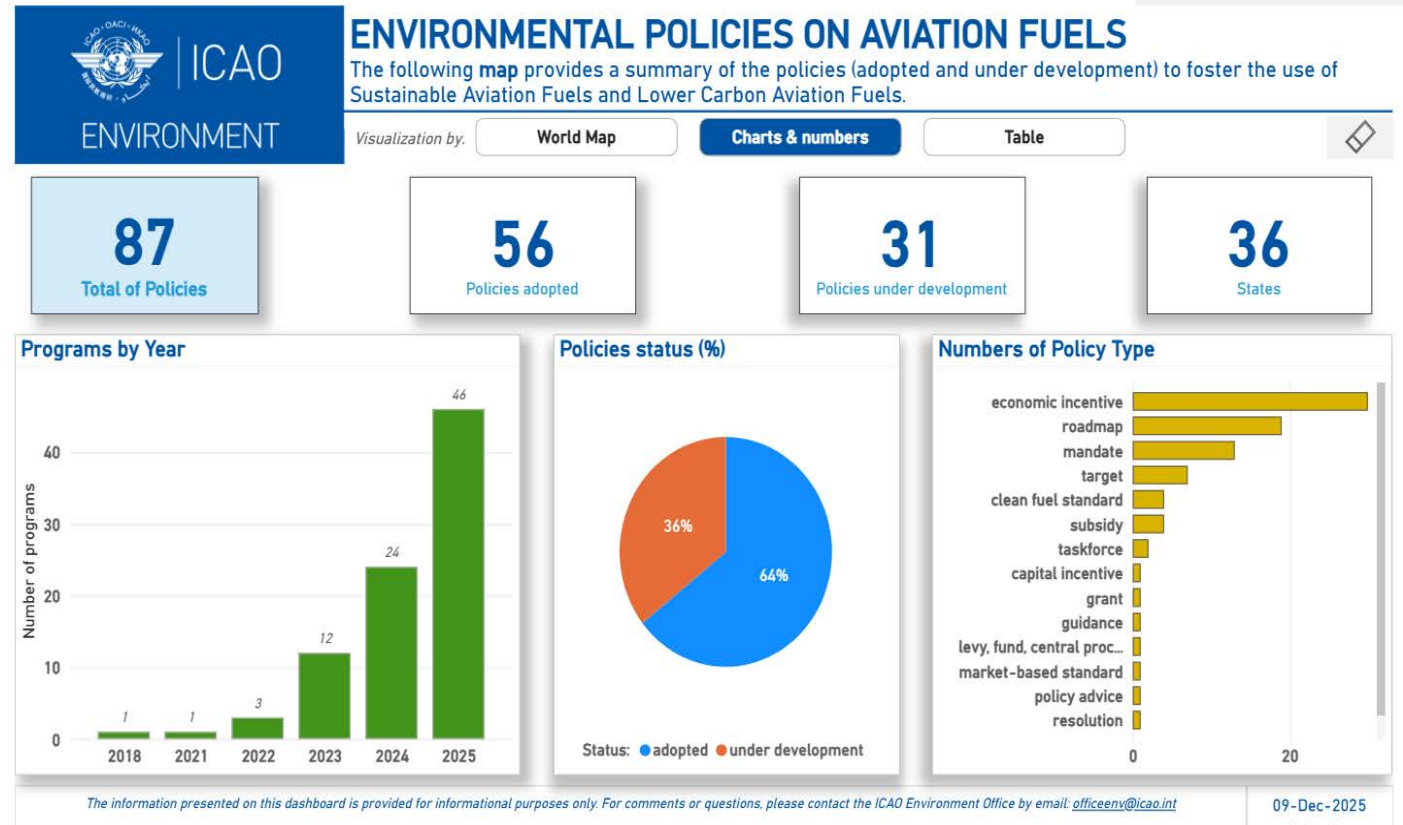
- **Advocacy and outreach** for greater investment in aviation cleaner energy projects, including UN and international financial community
- **Operationalization of ICAO Fininvest Hub** to facilitate better access to public fund / private investment
- Expedite work to **consider the establishment of a climate finance initiative or funding mechanism under ICAO**

Building Block 1: Policy and Planning



Policy tracker – encouraging developments in global policy

- **56 policies adopted and 31 under development, including**
 - Mandates and blending targets in **Brazil, European Union, India, Switzerland, Republic of Korea, Türkiye, UK**
 - Various **incentive schemes, e.g. USA Inflation Reduction Act, UK revenue certainty scheme, EU subsidies**
 - Various **sub-national policies** being implemented (e.g. States in India and USA, Provinces in Canada)



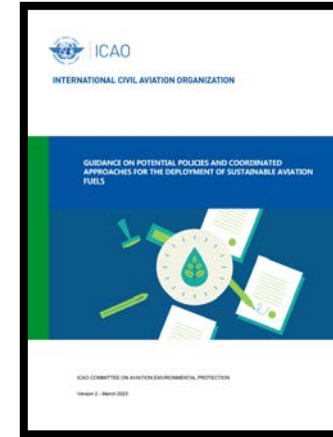
<https://www.icao.int/SAF/saf-policies>

Building Block 1: Policy and Planning

ICAO Toolbox of guidance material for States



- Guidance on SAF policies
- ICAO SAF Rules of Thumb - order of magnitude estimations on SAF costs, investment needs and production potential
- Materials updated since A42 with the latest information

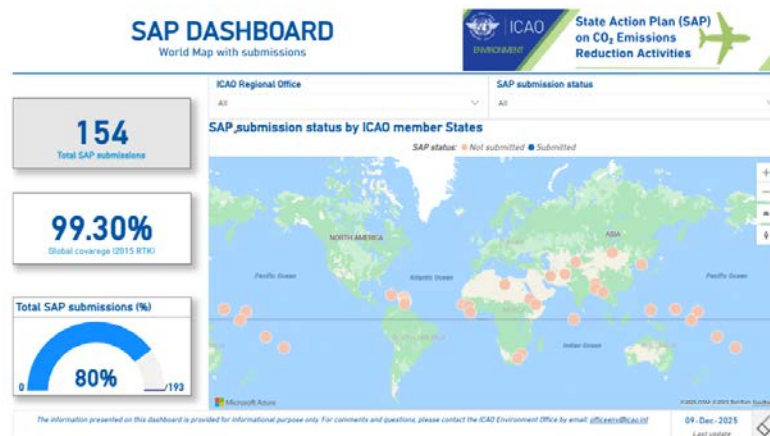


Summary Table 2 - SAF facilities information
Total capital investment (TCI), capital cost, and minimum selling price (MSP) for nth and pioneer facilities for each pathway.

Processing technology	Feedstock	TCI (million \$)		Capital Cost (\$/L total distillate)		MSP (\$/L)	
		n th	pioneer	n th	pioneer	n th	pioneer
FT*	MSW	1428	813	2.9	8.1	0.9	2.1
FT*	forest residues	1618	1088	4.0	10.9	1.7	3.3
FT*	agricultural residues	1509	1297	5.0	12.7	2.0	3.8
ATJ	ethanol**	328	117	0.3	1.2	0.9	1.1
ATJ	ethanol, agricultural residues	581	170	0.6	1.7	2.2	2.5
ATJ	isobutanol-low**	332	94	0.3	0.9	1.3	1.5
ATJ	isobutanol-high**	410	110	0.4	1.1	1.7	1.9
HEFA	FOGs	448	-	0.4	-	0.8	-
HEFA	vegetable oil	450	-	0.5	-	1.0	-
FT	DAC CO ₂ H ₂	3306	-	3.4	-	4.4	-
FT	waste CO ₂ H ₂	3209	-	3.2	-	3.5	-
Pyrolysis***	forest residues	1033	594	2.6	5.9	1.3	2.1
Pyrolysis***	agricultural residues	1084	619	2.7	6.2	1.3	2.2

<https://www.icao.int/SAF/saf-guidance-potential-policies>
<https://www.icao.int/SAF/saf-rules-of-thumb>

ICAO State Action Plans



154 States Submitted action plans, Representing 99.3% of global RTK

Information enable to monitor progress towards LTAG

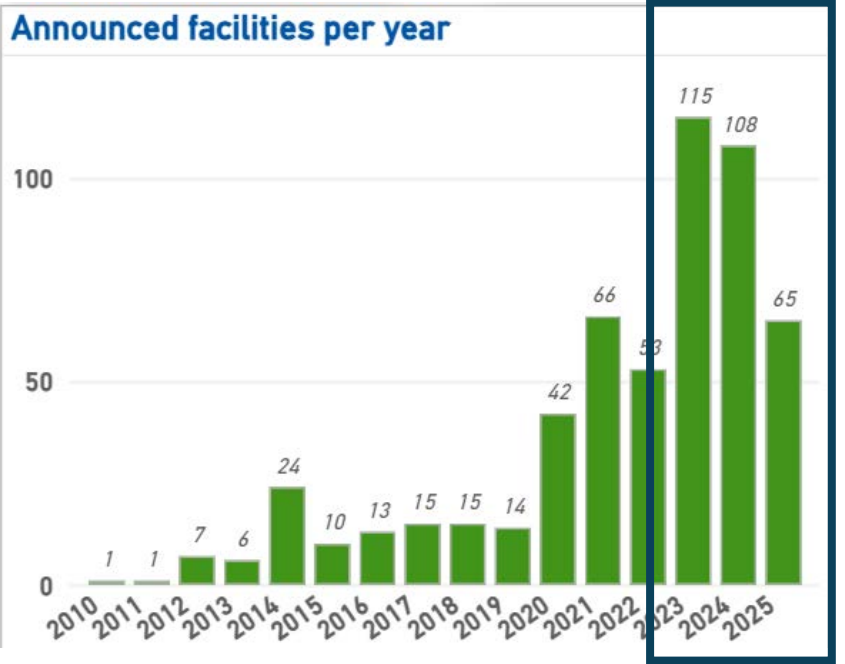
<https://www.icao.int/environmental-protection/state-action-plans-and-assistance>



SAF production facilities

542 Total facilities (announc.)	63 Total of States	369 Total of companies	113 Facilities in service	\$55.2 Total investment (B USD)
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Substantial increase in new facility announcements



542 SAF facilities announced
(88% increase since A41)

262 initial announcements
49 plans in advanced stages
(FEED / under construction)

these could add up to 30MT/year of SAF production capacity

Status	Projected Capacity (kt)	SAF capacity (kt)	Num facilities
0 - cancelled project	6,632	355	30
0 - dormant project	9,411	131	88
1 - Initial Announcement	56,267	26,345	262
2 - Front End Engineering Design (FEED)	6,318	2,765	28
3 - Under construction	3,372	1,822	21
4 - In service - producing other renewable fuels	11,683	0	51
5 - In service - producing SAF	2,773	568	37
6 - Producing CORSIA SAF	10,765	4,385	25
Total	107,221	36,370	542

118 cancelled/dormant projects

What can be done to avoid that?

<https://www.icao.int/SAF/SAF-production-facilities>



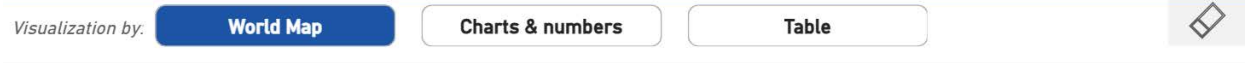


SAF distribution in airports

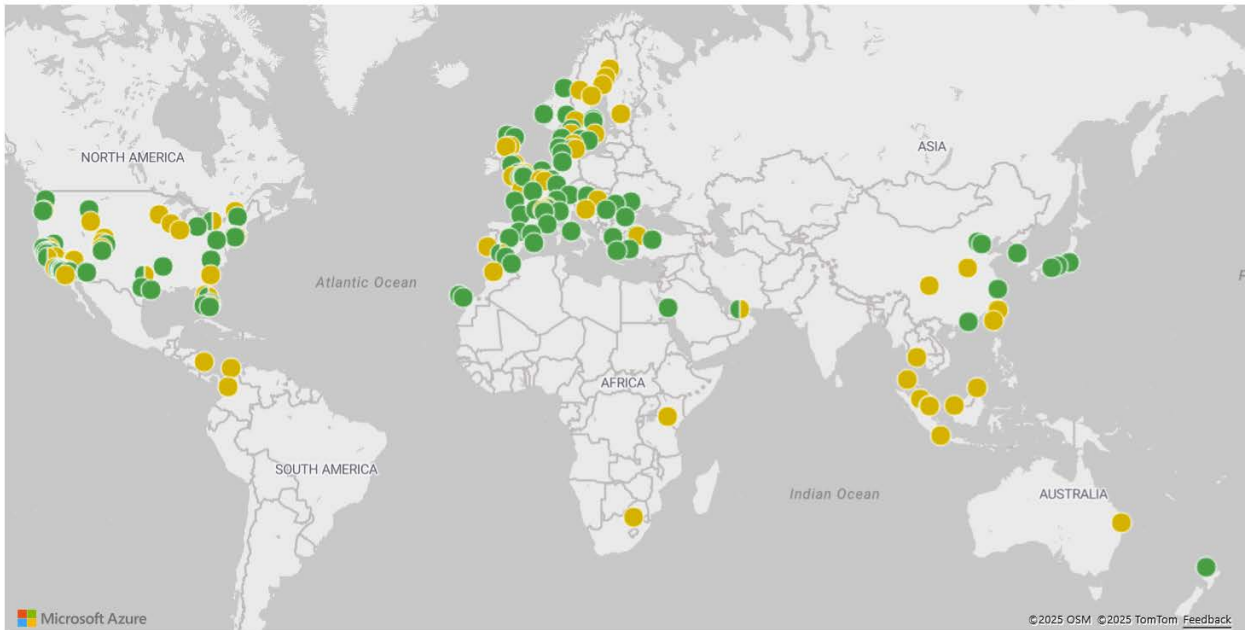


SAF Airports Map

A non-extensive list of airports distributing SAF (regularly or on batches)



Status: ● Batch delivery ● Ongoing deliveries



Airports experience with SAF is expanding

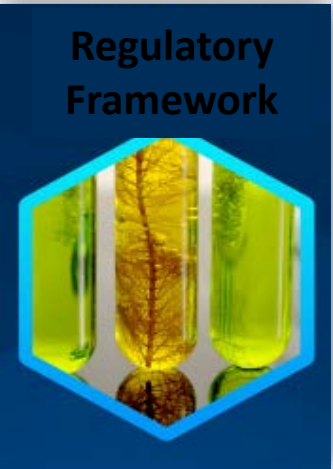
174 airports distributing SAF

- continuous deliveries or batches
- 36 states (all ICAO regions)

113% increase since last Assembly

<https://www.icao.int/environmental-protection/SAF-airports>

CORSIA environmental standards for fuels Recognized as the accepted basis for fuels used in international aviation



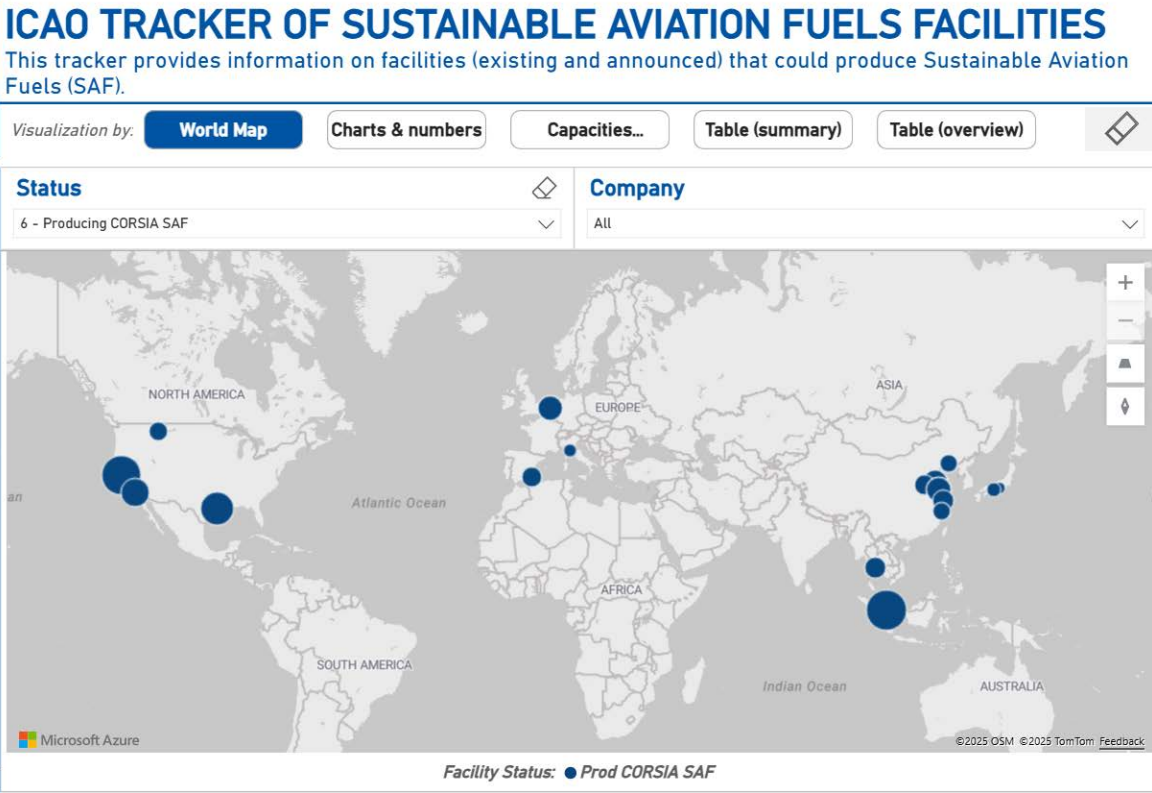
- **Agnostic methodologies**
- **49 types of feedstocks** currently recognized
- Open process for consideration of **new feedstocks**
- **New feedstocks** - beef tallow, poultry fat, lard fat, mixed animals fat, non-standard coconut, wheat starch slurry and cobs
- Monitoring, Reporting, and Verification system (MRV) in place, including a **CORSIA Central Registry**

CORSIA Eligibility Framework and Requirements for Sustainability Certification Schemes Third Edition, March 2024	CORSIA Approved Sustainability Certification Schemes* Second Edition, June 2023	CORSIA Sustainability Criteria for CORSIA Eligible Fuels** Third Edition, November 2022	CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels*** Fifth Edition, March 2024	CORSIA Methodology for Calculating Actual Life Cycle Emissions Values Fourth Edition, March 2024

<https://www.icao.int/CORSIA/corsia-eligible-fuels>



Production facilities – CORSIA eligible fuels



CORSIA-certified refineries are getting in service

4.4MT/year
Current production capacity - CORSIA-certified SAF
(25 SAF refineries)

88% of current SAF production capacity is CORSIA compliant
(25 out of 49 operating SAF refineries)

<https://www.icao.int/SAF/SAF-production-facilities>

Sustainability Certification

ICAO-approved “Sustainability Certification Schemes (SCS) are verifying compliance with CORSIA standards

Three approved SCSs as of 2025.

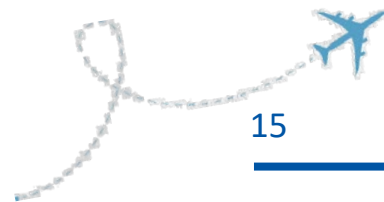


- SCSs currently only approved to certify CORSIA SAF.
- Update September 2025 – ISCC submitted request for approval of LCAF certification scheme – CAEP evaluation is ongoing

Open invitation for SCSs to apply: <https://www.icao.int/CORSIA/corsia-scs-evaluation>



Updates on CORSIA standards



CORSIA environmental standards for fuels

Recognized as the accepted basis for fuels used in international aviation

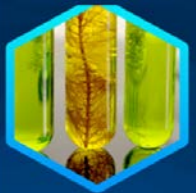
In June/2025, the Council approved updates to the CORSIA standards on fuels

- **Agnostic methodologies**
- **49 types of feedstocks** currently recognized
- Open process for consideration of **new feedstocks**
- **New feedstocks** - beef tallow, poultry fat, lard fat, mixed animals fat, non-standard coconut, wheat starch slurry and cobs
- Monitoring, Reporting, and Verification system (MRV) in place, including a **CORSIA Central Registry**

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ICAO continues to update standards to include the most recent technologies on fuel production





Life Cycle Emission Values of CEF

14 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



Life Cycle Emission Values of CEF with CORSIA as the Globally Harmonized Framework

Default Life Cycle Emissions Value

ICAO document 'CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels' provides default life cycle emissions values for CEFs, as a function of the feedstock, conversion process, and production region of the SAF.

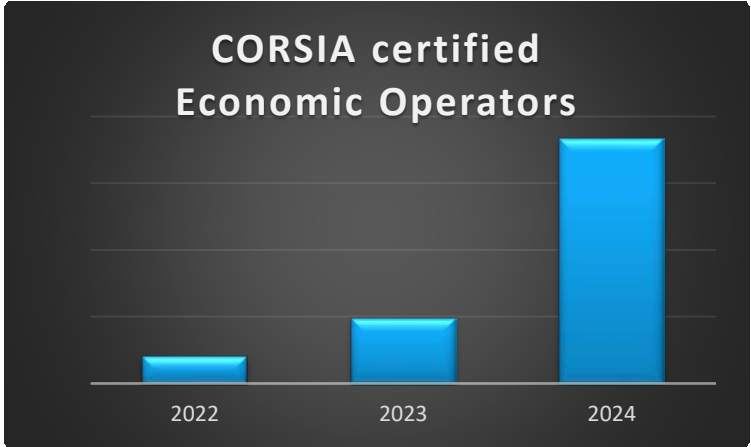


Actual Life Cycle Emissions Value

ICAO document 'CORSIA Methodology for Calculating Actual Life Cycle Emissions Values' provides guidance for fuel producers to determine the actual life cycle emissions values for CEFs and, when supported by robust data, to claim values lower than the default ones.

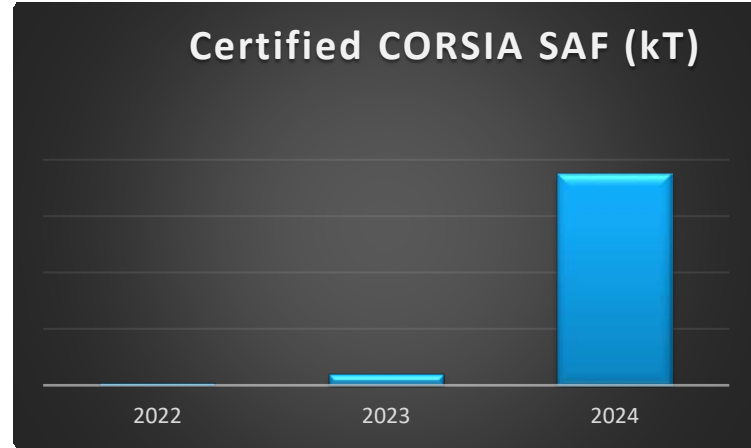
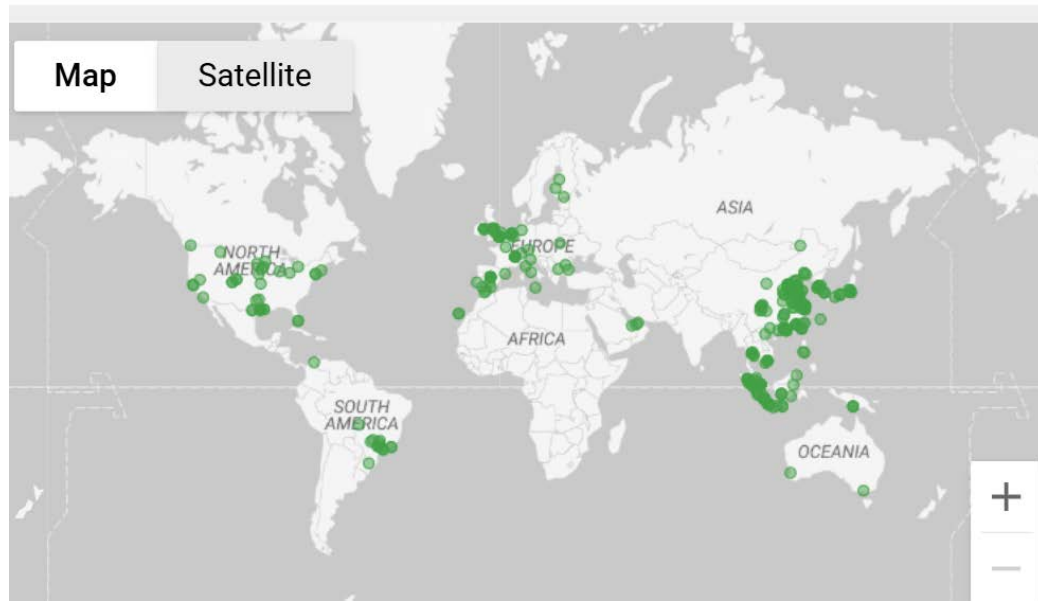


Exponential increase in CORSIA certification



367 economic operators certified (producers of SAF, feedstocks and intermediates, traders, blenders)

CORSIA Certified Economic Operators Map
A NON-EXHAUSTIVE LIST



188kT of CORSIA eligible fuel produced in 2024

(~20% of all SAF produced globally – 1MT)

Dynamic dashboard available to visualize information

<https://www.icao.int/CORSIA/corsia-certified-fuels>

Building Block 3: Implementation Support



- **ICAO Assistance, Capacity-Building, and Training for SAF (ACT-SAF)**

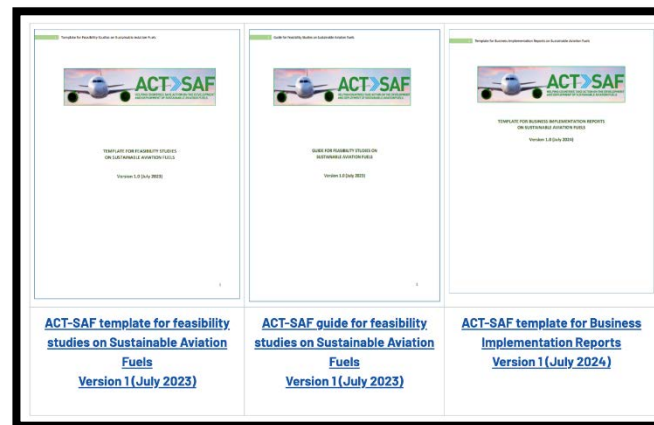
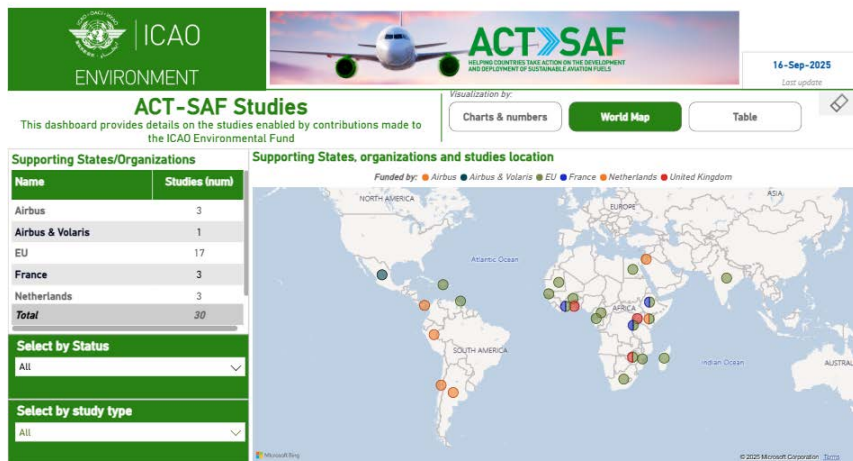
<https://www.icao.int/ACT-SAF>

- The ICAO ACT-SAF programme was launched in 2022 :
 - Provide **tailored support for States**
 - Facilitate **partnerships and cooperation** under ICAO coordination
 - Facilitate **knowledge sharing – 22 training events, ACT-SAF knowledge hub, templates for studies**
 - **9 studies delivered, 21 under development, 25 supported States**



ICAO ACT-SAF Knowledge Hub
 Coordination with ACT-SAF Partners identified that many States need conceptual knowledge on SAF. To help address that, the ACT-SAF Knowledge Hub aims to consolidate all relevant materials and useful references on SAF.

<p>ACT-SAF Series of Training Sessions</p> <p>Comprehensive training on an array of SAF-related topics. All the sessions and their materials are available for viewing and downloading.</p> <table border="1"> <thead> <tr> <th>#</th> <th>Topic</th> <th>link video</th> <th>link presentation</th> </tr> </thead> <tbody> <tr> <td>20</td> <td>2025 Updates on the CORSIA regulatory framework for SAF Part 1 – new CORSIA default LCA values</td> <td>link</td> <td>link</td> </tr> <tr> <td>19</td> <td>Building bankable SAF projects</td> <td>link</td> <td>link</td> </tr> <tr> <td>18</td> <td>Understanding SAF Clearing Houses</td> <td>link</td> <td>link</td> </tr> <tr> <td>17</td> <td>From Vision to Reality - Sweden</td> <td>link</td> <td>link</td> </tr> <tr> <td>16</td> <td>Aviation and Green Taxonomy</td> <td>link</td> <td>link</td> </tr> <tr> <td>15</td> <td>Coprocessing and reworking how to use existing refineries to produce SAF</td> <td>link</td> <td>link</td> </tr> <tr> <td>14</td> <td>Update on 100% SAF testing and recent achievements</td> <td>link</td> <td>link</td> </tr> <tr> <td>13</td> <td>SAF Business Implementation studies and TEA models</td> <td>link</td> <td>link</td> </tr> </tbody> </table>	#	Topic	link video	link presentation	20	2025 Updates on the CORSIA regulatory framework for SAF Part 1 – new CORSIA default LCA values	link	link	19	Building bankable SAF projects	link	link	18	Understanding SAF Clearing Houses	link	link	17	From Vision to Reality - Sweden	link	link	16	Aviation and Green Taxonomy	link	link	15	Coprocessing and reworking how to use existing refineries to produce SAF	link	link	14	Update on 100% SAF testing and recent achievements	link	link	13	SAF Business Implementation studies and TEA models	link	link	<p>SAF Feasibility Studies</p> <p>Studies developed by ICAO and other organisations that aim to evaluate the potential for SAF production at a given State, including feedstock production.</p> <p>Number of Studies: 76</p> <p>SAF events</p> <p>Compilation of events hosted to discuss global challenges and solutions for further developing SAF.</p> <p>Upcoming events: 36 Past events: 59</p> <p>Technical References and Reports</p> <p>Useful materials to facilitate technical understanding on various SAF aspects.</p> <p>Available references: 27</p>
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Building Block 4: Financing



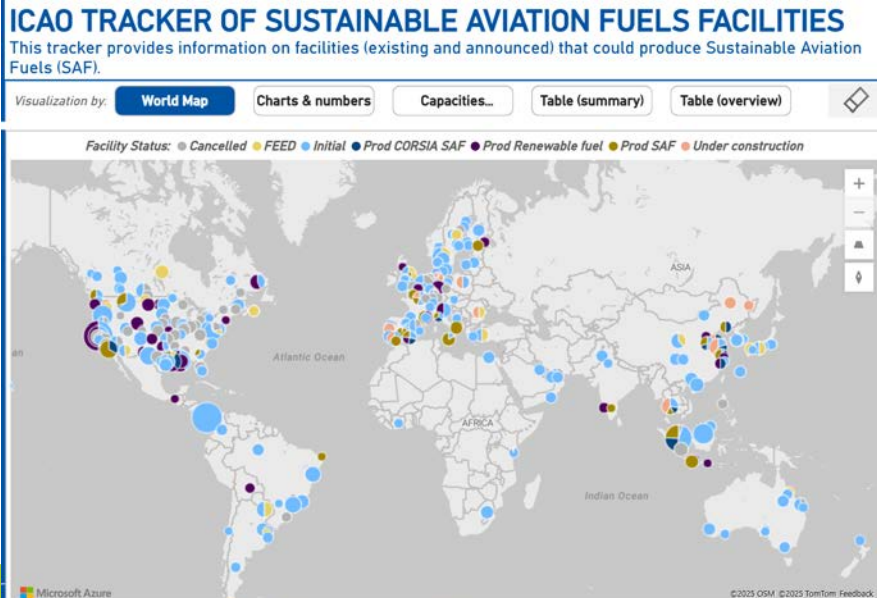
Investments are being announced in SAF development

- **55 Billion dollars** announced on SAF facilities
- 54 billion liters of SAF under offtake agreements (+260% since A41)
- ICAO LTAG will require up to **3.2 trillion USD** in investments - financing needs to accelerate to enable planned SAF facilities
- **ICAO Finvest Hub is now launched** - Facilitate funding for projects contributing to the decarbonization of international aviation



<https://www.icao.int/finvest>

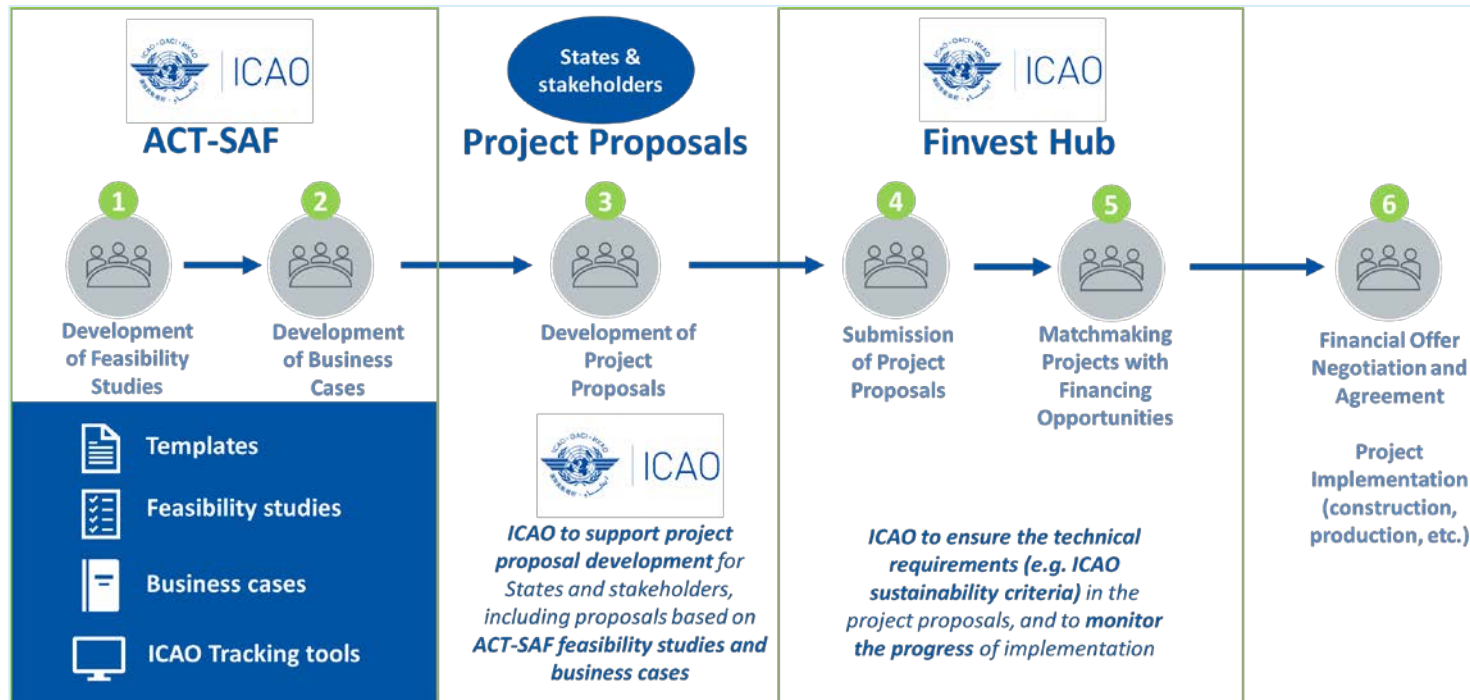
\$55.2
Total investment (B USD)



<https://www.icao.int/SAF/saf-offtake-agreements>

In Summary

- **Aviation clean energy use is taking off**
- **Sector readiness – ICAO’s robust regulatory framework is in place, and kept up to date**
- **Projects and initiatives on clean energy are ramping up exponentially**
- **ICAO ACT-SAF and Fininvest Hub will support development and financing of projects**



For more information
www.icao.int/SAF

Thank You



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SAF specifications

ASTM International defines technical specifications for SAF

- Ensure SAF are safe for use in aircraft
- Specify necessary chemical properties
- 9 conversion processes currently approved for SAF production (ASTM D7566 and D1655)
- Other technical specifications include the UK DEF STAN 91-091, China CTSO-2C701, among others.

For more details
[Conversion processes \(icao.int\)](https://www.icao.int)



All

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Standard Historical Last Updated: Aug 02, 2022

ASTM D7566-21 ⓘ

Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons

Scope

1.1 This specification covers the manufacture of aviation turbine fuel that consists of conventional and synthetic blending components.

1.2 This specification applies only at the point of batch origination, as follows:

SAF – conversion pathways and feedstocks

SAF can be produced from a variety of feedstocks

Oils and fats



Lignocellulose



Sugars



Wastes



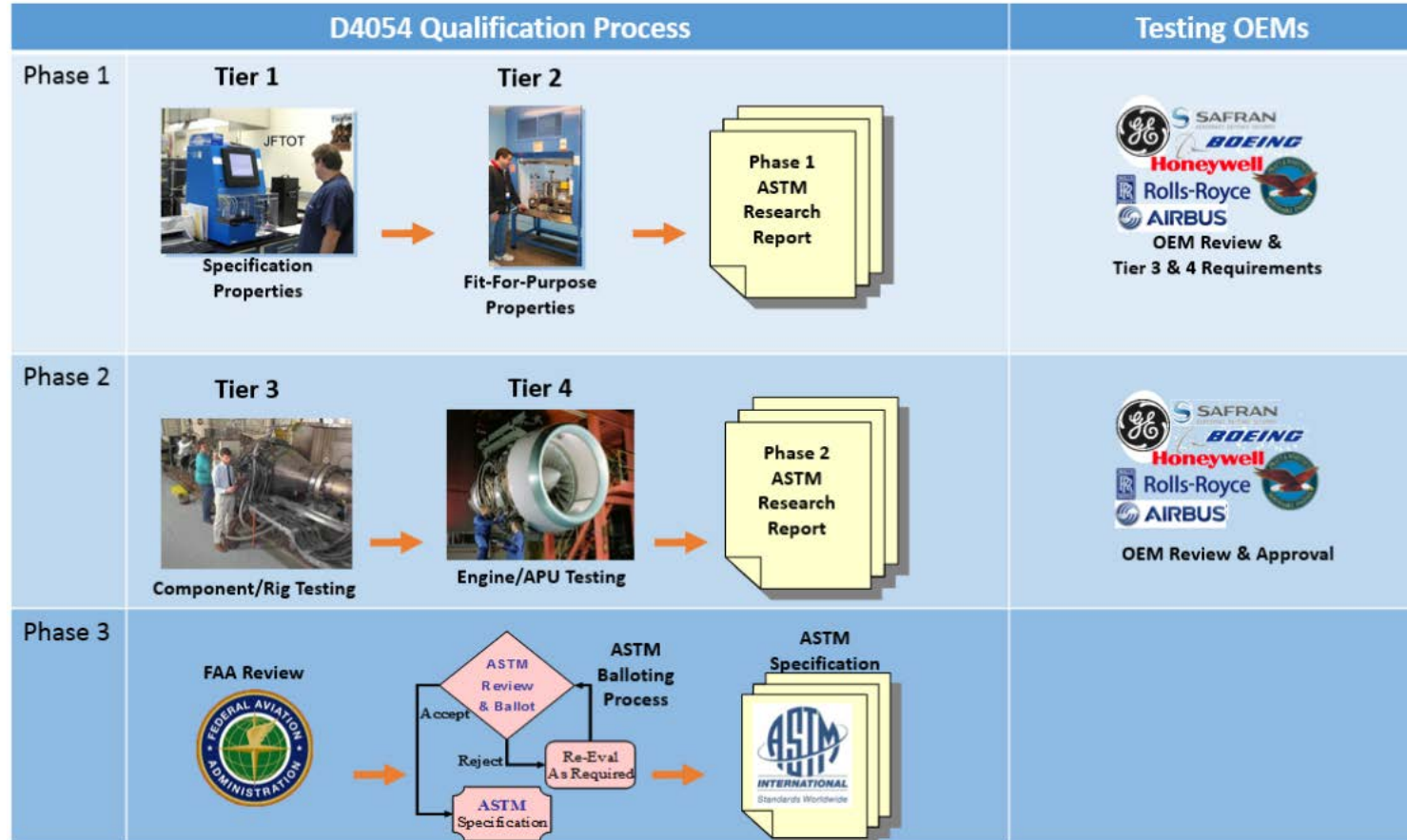
Examples of conversion pathways:

	Synthesized paraffinic kerosene from hydroprocessed esters and fatty acids (HEFA)	Fischer-Tropsch hydroprocessed synthesized paraffinic kerosene (FT)	Alcohol to jet synthetic paraffinic kerosene (ATJ-SPK)
Description	Conversion of oils/fats to hydrocarbons via deoxygenation with hydrogen and cracking	Gasification of carbon containing material to syngas, then converted to SAF through FT synthesis	Sugars (from syngas or cellulosic material) converted to SAF through alcohol intermediate
Blend ratio	50%	50%	50%
Possible feedstock	Animal tallow Used cooking oil	Municipal solid waste Miscanthus	Sugar cane Waste gases
Existing programs	Neste, WorldEnergy, Honeywell UOP, etc.	Fulcrum, Redrock, Sasol, Shell, etc.	Gevo, Lanzatech, Swedish biofuels, etc.

SAF – conversion processes and specifications

ASTM D4054 provides a framework for approval of new SAFs

- guidance on testing and necessary properties
- fast track process for fuel approval



Source: https://www.caafi.org/focus_areas/fuel_qualification.html#streamlining



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Standard Active | Last Updated: Jul 28, 2022

ASTM D4054-22

Standard Practice for Evaluation of New Aviation Turbine Fuels and Fuel Additives

Significance and Use

5.1 This practice is intended to describe the data requirements necessary to support the review of new aviation turbine fuels or additives by ASTM members for the developers or sponsors of these new products.