IEA Bioenergy
Technology Collaboration Programme

Task 39
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Progress in Commercialisation of Biojet fuels/SAF:

Technologies, potential and challenges

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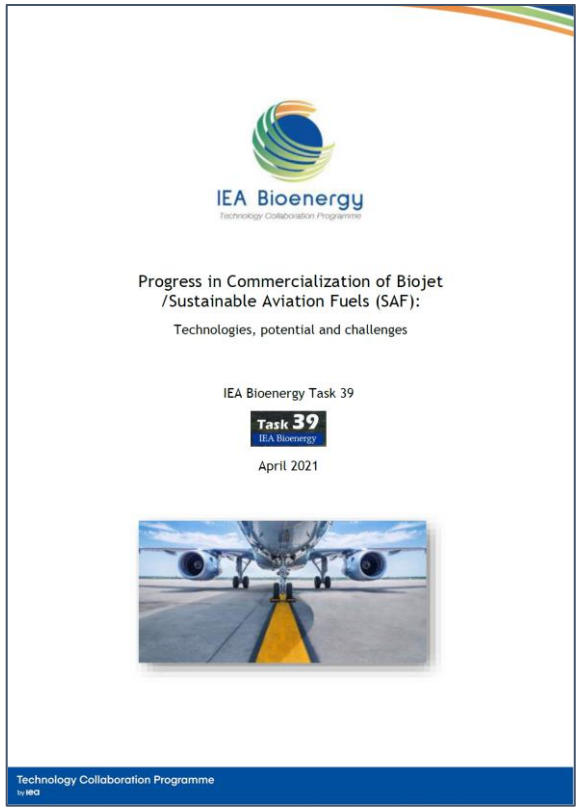
Report published & successful webinar held (~300 attendees)



If you missed the webinar, here is the link to the video and the presentation slides: https://www.ieabioenergy.com/blog/publications/iea-bioenergy-webinar-sustainable-aviation-fuel-biojet-technologies-commercialisation-status-opportunities-and-challenges/

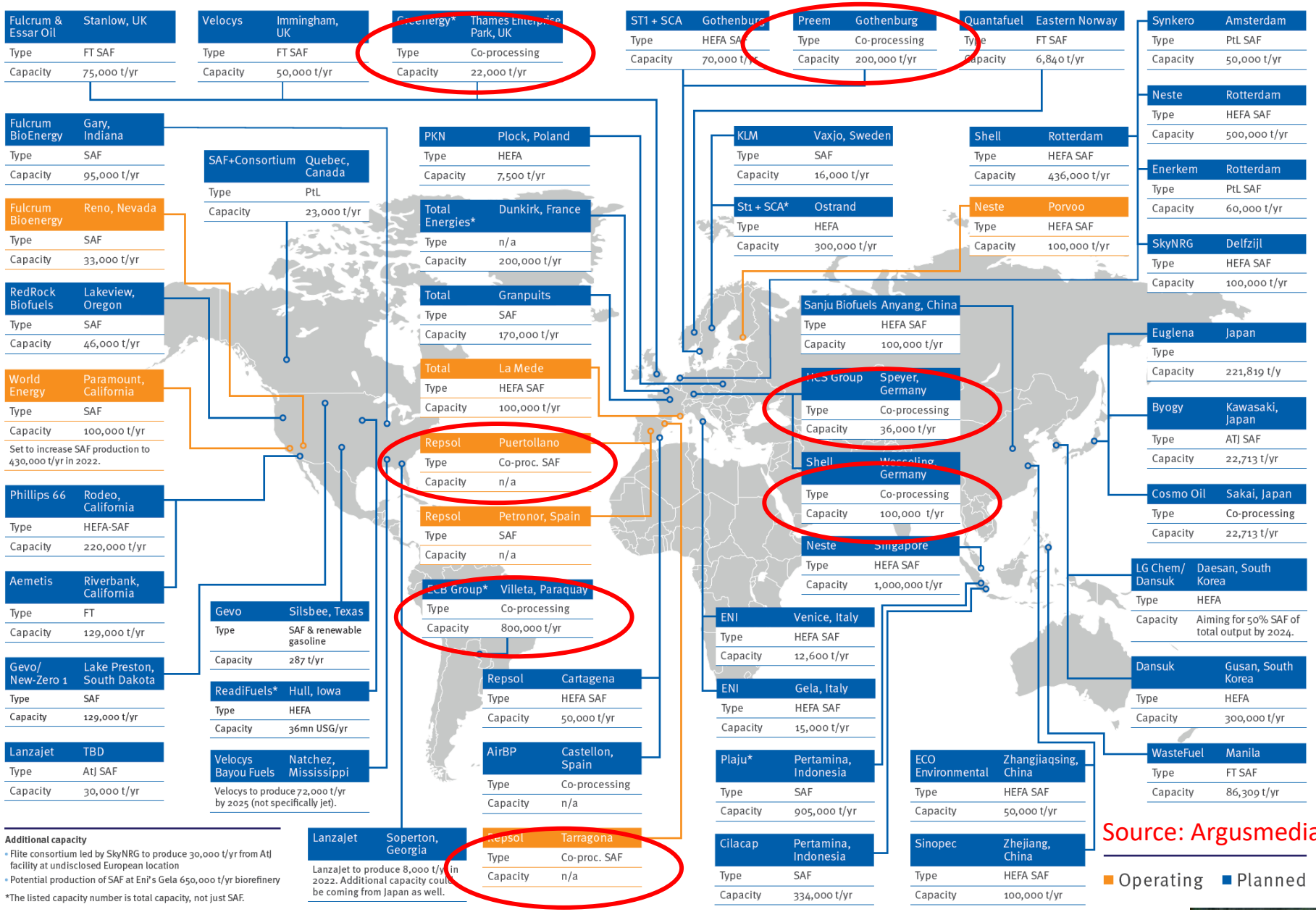
Latest SAF developments and industry announcements

- The aviation sector originally targeted a 50% reduction in emissions by 2050
- At the recent IATA AGM, this was adjusted to net-zero

- 60+ companies committed to 10% SAF by 2030 (EU mandate only 5%)
- Airlines (e.g. United) commit to NOT use Offsetting

- Investments in SAF production increasing – “not enough projects to invest in”

Operating and planned facilities, stand-alone & coprocessing



New US SAF facilities

Location	Company	Facility Type	Feedstock	Capacity (MT/yr)	Operational Year
Paramount, California	World Energy	HEFA-SPK	Agricultural waste fats and oils.	100 - 400,000	2018- 2022
Reno, Nevada (Sierra Biofuels Plant)	Fulcrum	Fischer-Tropsch	MSW	31,646	2021
Soperton, Georgia (Freedom Pines Fuels facility)	LanzaJet	AtJ-SPK	Ethanol made from non-edible agricultural residues such as wheat straw and recycled pollution	7,571	2022
Silsbee, Texas	Gevo	Atj-SPK	Isobutanol		Demo
Lake Preston, South Dakota	Gev0	Atj-SPK	Ag,corn	287	2024
Gary, Indiana	Fulcrum	Fischer-Tropsch	MSW	94,939	2022
Lakeview, Oregon	Red Rock Biofuels	Fischer-Tropsch	Forest waste and residuals (biomass)	46,031	2022
Rodeo, California	Philipps 66	HEFA-SPK	Veg oil, waste fats	221,819	2024
Natchez, Mississippi	Velocys	Fischer-Tropsch	Woody biomass	71,924	2025

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Demand for SAF and SAF policies are driving drop-in biofuel expansion

- These are planned facilities for Lanzajet, all targeting SAF production

2022	**10M GPY**	**Georgia, USA**	**Freedom Pines Fuels**
2024	13M GPY	Central Europe	FLITE (LanzaTech)
2025	30M GPY	UK	Speedbird
	30M GPY	UK	DRAGON (LanzaTech)
	30M GPY	Japan	
	30M GPY	Canada	
	30M+ GPY	North America	
2026+	≥30M GPY	Various	TBA
	30M GPY	UK	AtmosFUEL (LanzaTech)

Price of SAF – challenges and future prospects for price parity

- PRICE considered one of the biggest obstacles to airlines
- HEFA SAF in July about 3-4 x the price of conventional jet (~USD$2,000 - $2,300) (Argusmedia, Greenea)
- Currently, HEFA is priced at $2,900
- Conventional jet fuel 23 June 2021 - USD$615

- Price based on volume, but placing a VALUE on the carbon intensity is critical
- The EU policy mandate is volumetric; the US Blenders Tax Credit rewards low CI

- SAF will potentially always be more expensive although significant cost reductions will take place over time

SAF-specific policies will have the greatest impact on SAF expansion

- **California LCFS includes aviation -** linked to **carbon intensity reduction**
- **US RFS includes SAF**
- Mandates and proposed mandates in Norway, Sweden, Finland

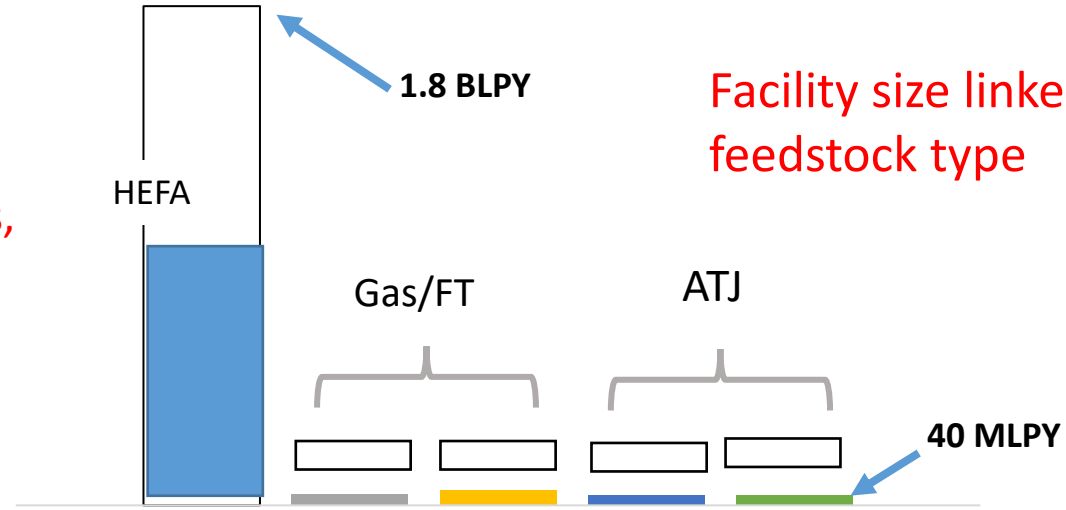
- **ReFuelEU** proposed mandate (volumetric) – 2% in 2025, moving to 5% in 2030, 20% in 2035, 32% in 2040, and 63% in 2050 (dedicated e-kerosene mandate)
- **Sustainable Skies Act** (USA) – proposed blenders tax credit; linked to **carbon intensity reduction**
  - $1.50 per gallon up to $2 per gallon for 100% emission reduction

- Voluntary corporate actions & BUYERS ALLIANCES (Sustainable Aviation Buyers Alliance) could create a strong demand signal (irrespective of national policies) (based on SAF certificates)

Feedstocks for SAF production?

- Feedstock density limits transport distances and size of facility
- For most technologies feedstock must be sourced within a limited radius

Lipid feedstocks can be transported long distances, but not most other feedstocks



Facility size linked to feedstock type

Two reports give completely contradictory conclusions about feedstocks

- World Economic Forum – Clean Skies for Tomorrow (WEF-CST) report –
  - Feedstocks not considered limiting for SAF expansion, but does not take competition for other applications into account
  - Can produce ALL SAF from biobased feedstocks – 648 BL by 2050

- ICF report (part of ATAG Waypoint 2050)
  - Taking competition into account, biobased feedstocks will only be able to deliver about half of required SAF - ~250 BL
  - The rest will need to come from power-to-liquids technology

Availability of lipid feedstocks for HEFA

WEF-CST report

- 40 MT waste lipids,
- 85 MT oilseed-bearing trees
- 70 MT oil cover crops

ICF report

- 27 MT waste lipids available (UCO, tallow)
- HEFA production less than 10% SAF by 2050

Crops such as soy, canola, etc. are all excluded from assessments

- RSB and ISCC have different views
- ISCC believes sustainably certified crops could be used

Technology assessment

- HVO/HEFA facilities mainly producing renewable diesel, but with the right policies, at least 15% of capacity can be shifted to SAF at low cost
- First Gasification/FT facilities are coming online over the next year
- Multiple alcohol-to-jet facilities under construction and planned (Lanzajet, Gevo)
- Pyrolysis/HTL is still under development for SAF production and no ASTM certification yet
- PtL slowly developing, but high production cost

Conclusions

- Commercialization of ALL technologies should be pursued as they can utilize different feedstocks and take advantage of regional differences
- Technical challenges remain, but high price difference with conventional jet fuel remains the biggest obstacle
- HEFA is fully commercial and will continue to be the main technology for the next 10 years at least
- Policies are essential and there is significant development on this front in the EU and USA that will have a major impact on SAF development
- Policies should be linked with carbon intensity of SAF
- SAF development is gaining momentum and there is a high level of optimism in the sector

Future work

- Ongoing monitoring of technology commercialization
- Specific in-depth assessment of PtL for SAF
- Developments in ASTM certification and higher blends (up to 100% SAF)
- Book and claim system
- Sustainability standards and LCA methods under CORSIA (e.g. CCS)
- Non-

Thanks!

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