EASA
European Union Aviation Safety Agency

Sustainable Aviation Fuel as Key Value Driver for Sustainability in Aviation

How to become SAF ready? How to make SAF happen?

SAF Training for ACI Africa & AFRAA

23.-25.04.2025, Arusha, Tanzania

Global Gateway

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Day 1 Section 1: Understanding the fundamentals of SAF and decarbonization of aviation

Topic

Sustainable Aviation Fuel as Key Value Driver for Sustainability in Aviation

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CBR Sustainability Partners

Project Manager

Raphaela Spielberg has over 7 years professional experience in the financial field, and 5 years of experience in strategy development and implementation of impact projects and climate technologies and with experience in thematical investment consulting and climate risk management of ESG compliant projects. She is experienced in assessing and developing business cases in the PtX field, analysing global challenges and opportunities, executing the financial modelling and conducting deep-dive research of risk and sensitivity.

Consulting Focus @ CBR Sustainability Partners

- Project management and business planning, e.g., application support for EU funding programs for the demonstration of innovative low-carbon technologies (EU Innovation Fund)
- Sustainability (CSR) and ESG concept development and implementation (strategy, roadmaps, reporting, labels)

Education

- Sustainability & Climate Risk Professional, GARP
- Master in Sustainable Finance, NOVA SBE, Lisbon

Part 1

Introduction to Sustainable Aviation Fuels

Starting with why…

Global CO_2 emissions from aviation exceeded **1 billion tons** in 2019, accounting for **>2%** of total anthropogenic CO_2 emissions.

Climate impact of example round trip by plane

Frankfurt - **Mombasa**

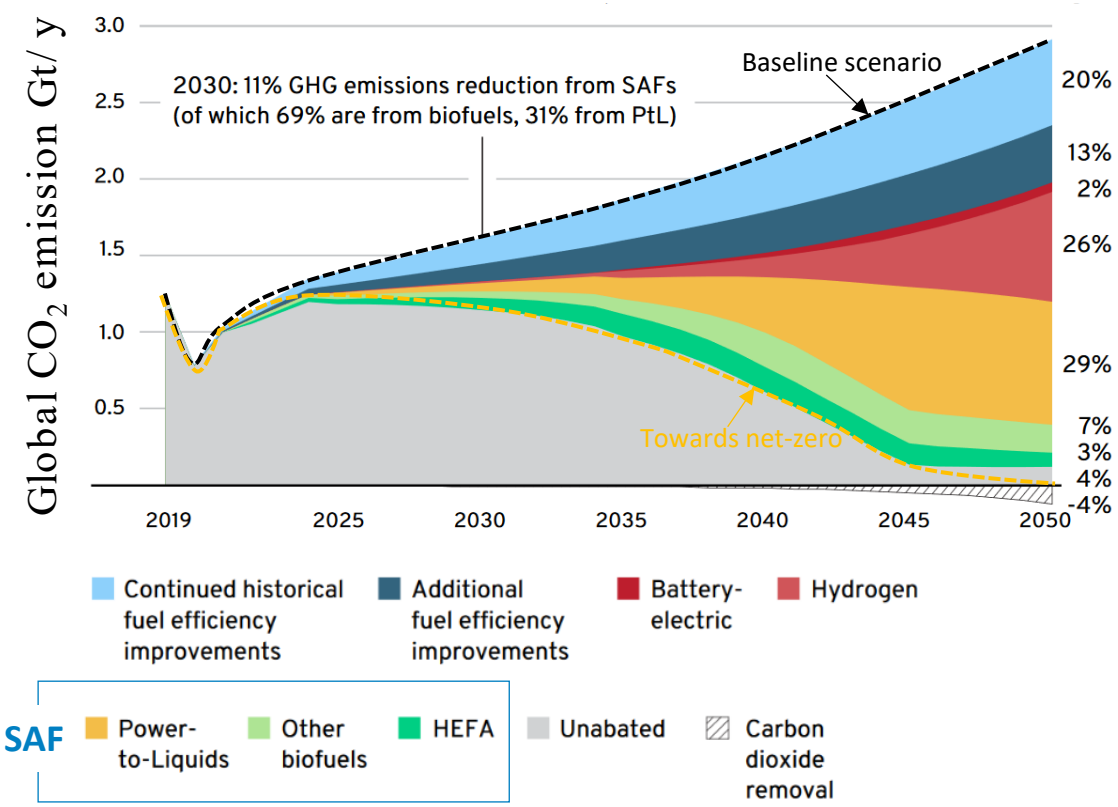
Key figures

Distance:	~ 6700 km * 2 = 13400 km
Jet fuel consumption: (Airbus 330)	~ 55 ton * 2 = 110 ton
CO_2 emission per pax:	**~ 396 kg * 2 = 792 kg**

without non-CO_2-effects (x2)

SAF as substitute for fossil jet kerosene, are critical to decarbonising aviation as hard-to-abate sector.

- **SAF** is a **key contributor** to **reduce CO_2 emissions** in the decades to come **coexisting** with **more disruptive technologies**.



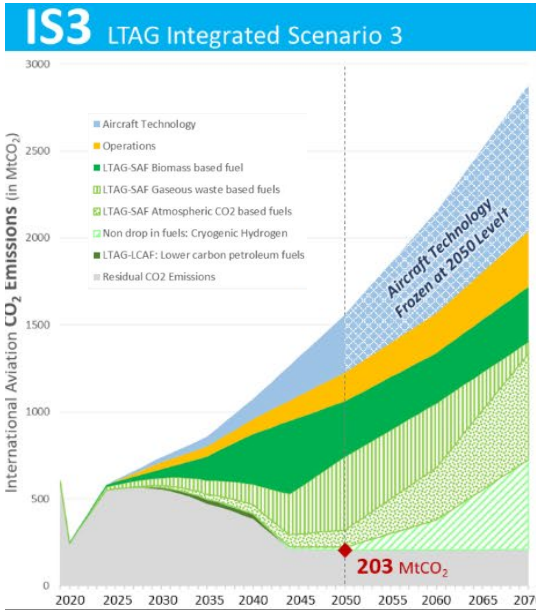
	GHG reduction	Regional flight	Short haul	Medium/ long haul
Batteries	100%	✓		
Hydrogen	100%	✓	✓	
Sustainable aviation fuel (SAF)	70-99%	✓	✓	✓

- Global jet-fuel market in 2022: **~325 million tons**
- **Batteries and hydrogen are limited** to shorter flights
- **SAF** shows an intrinsic advantage by having similar properties to jet-fuel, offering a **drop-in compatibility** with the available fleet technology, and being suitable **for long-distance travel.**
- Different studies predict scenarios for 2050, where SAF global demand could be between **300-500 million tons**.

Source: Mission Possible Partnership, Making net-zero aviation possible - An industry-backed, 1.5°C-aligned transition strategy, here the Optimistic Renewable Electricity scenario, WEF, 2022; CBR, 2025

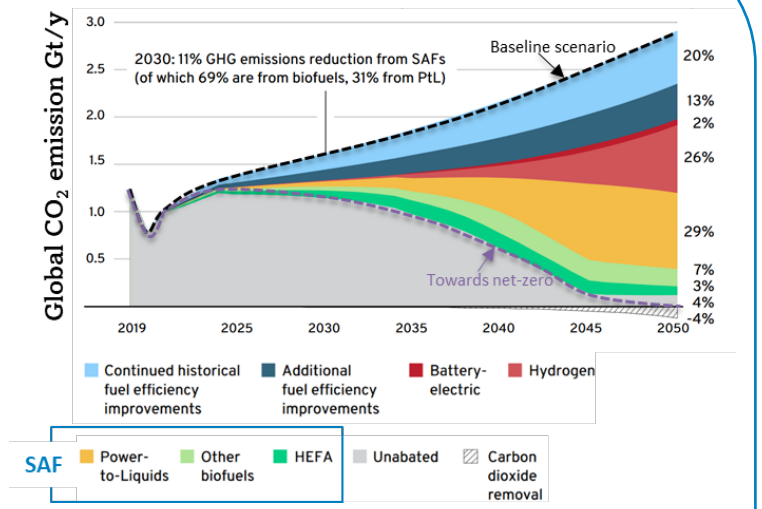
Independent of the various scenarios for emission reduction in the aviation sector, Sustainable Aviation Fuel will be the key contributor

LTAG, ICAO



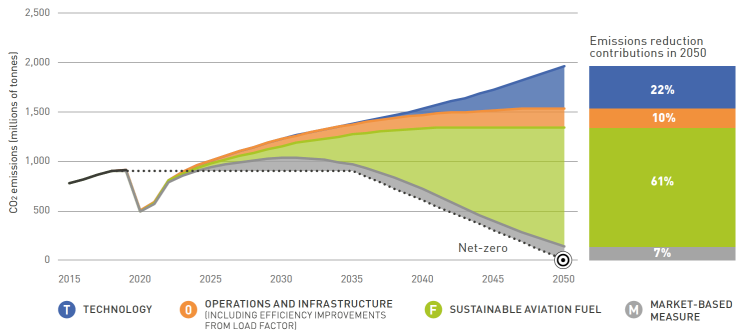
Until 2050 and beyond, **biomass, gaseous** and **atmospheric CO_2 based SAF** will play a **dominant role** in the **CO_2 emission reductions**.

MPP, WEF



Power-to-Liquid based SAF is foreseen as the **major contributor** to a **net-zero aviation sector** by **2050** followed by other biofuels and HEFA.

Waypoint 2050, ATAG

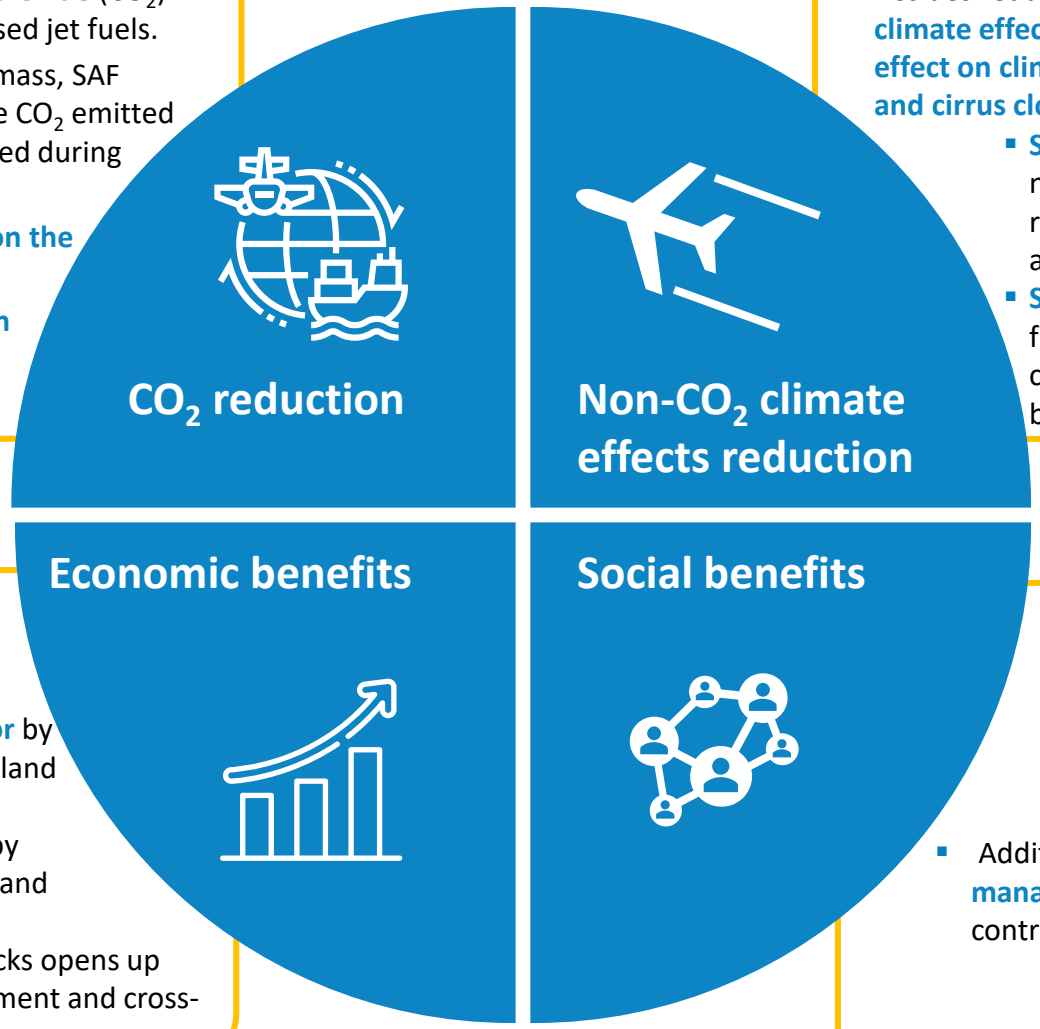


Pathway towards a **net-zero aviation sector** in **2050** mainly enabled by **SAF** with a **contribution** of **61%** with **ramp-up** beginning already in the **current decade**.

Source: Report on the feasibility of a long-term aspirational goal (LTAG) for international civil aviation CO_2 emission reductions/LTAG Integrated Scenario 3; ICAO, 2022; Mission Possible Partnership, Making net-zero aviation possible - An industry-backed, 1.5°C-aligned transition strategy, here the Optimistic Renewable Electricity scenario, WEF, 2022; Waypoint 2050 – An Air Transport Action Group project, ATAG, 2020; CBR, 2023; MPP: Mission Possible Partnership; WEF: World Economic Forum

The multifaceted benefits of Sustainable Aviation Fuels

- **SAF enables significant reductions in carbon dioxide** (CO_2) emissions compared to conventional fossil-based jet fuels.
- By utilizing renewable feedstocks, such as biomass, SAF contributes to a closed carbon cycle where the CO_2 emitted during combustion is offset by the CO_2 absorbed during the feedstock's growth phase.
- The **GHG emission saving intensity depends on the feedstock and the process.**
- SAF is crucial for **aviation industry's transition** toward a low-carbon future and meeting international climate goals.



- Besides reducing CO_2 emissions, **SAF also mitigates non-CO_2 climate effects (which have on average a twofold intense effect on climate warming)**, such as the formation of **contrails and cirrus clouds**, which contribute to global warming.
  - **SAF contains fewer impurities** like sulfur and nitrogen oxides (NOx) than fossil jet fuel, which are responsible for producing aerosols that amplify atmospheric warming.
  - **SAF reduces soot and particulate matter** emissions further lessen the formation of these cloud contrails. SAF plays a critical role in addressing the broader climate impact of aviation.

- The adoption of **SAF stimulates economic growth**, particularly in **local communities** involved in **feedstock production**.
- SAF helps create **jobs in the agricultural sector** by repurposing marginal or otherwise non-viable land for growing feedstock.
- The use of SAF also supports **energy security** by reducing dependence on imported fossil fuels and promoting a diversified energy supply.
- The **integration of waste materials** as feedstocks opens up opportunities for innovation in waste management and cross-sector collaboration.

- SAF contributes to various social benefits, including **job creation and community development**. As SAF production expands, it provides employment opportunities across several sectors, from agriculture to renewable energy and waste management
- Additionally, SAF promotes **more sustainable waste management practices** by utilizing waste as a feedstock, contributing to **circular economy goals.**

NOx: Nitrogen oxides

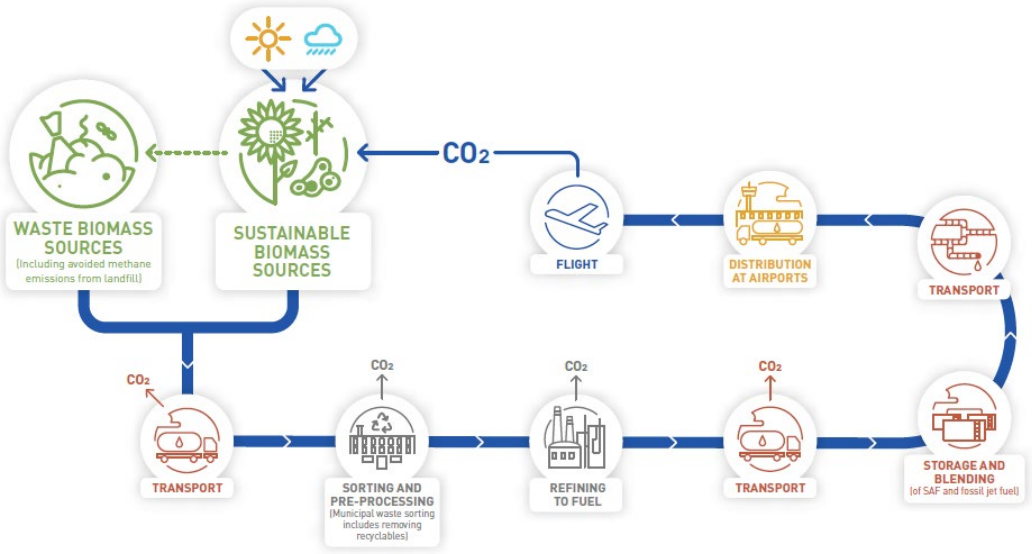
Some definitions on Sustainable Aviation Fuels: CORSIA

CORSIA

Annex 16, Volume IV

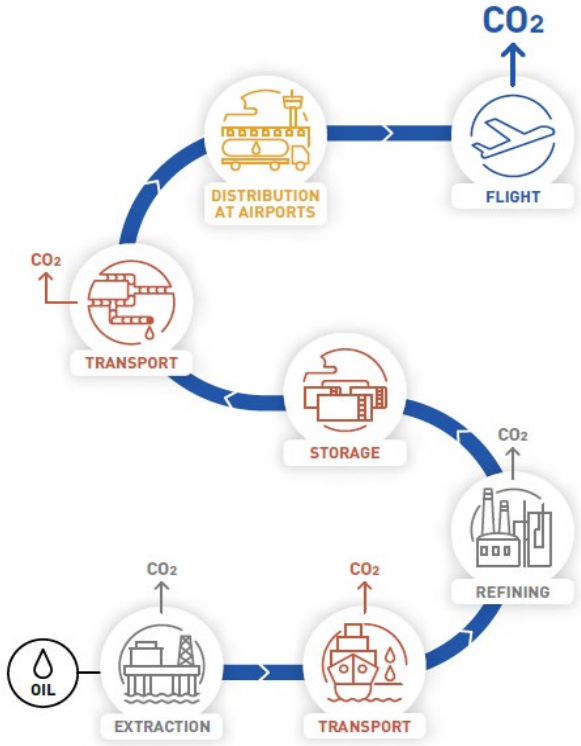
CORSIA sustainable aviation fuel

CORSIA sustainable aviation fuel. A renewable or waste-derived aviation fuel that meets the CORSIA Sustainability Criteria.



CORSIA lower carbon aviation fuel

CORSIA lower carbon aviation fuel. A fossil-based aviation fuel that meets the CORSIA Sustainability Criteria under Volume IV, Annex 16.



- Energy conservation measures (energy efficient design of plans, increased production efficiencies, improved efficiency monitoring)
- Process gas management (flaring management, venting control, fugitive emissions detection)
- Use of renewable/low carbon electricity, gas and hydrogen.
- Use of carbon capture and storage (CCS)

>10% reduction in lifecycle emissions compared to the aviation fuel baseline

EASA

Source: CORSIA Annex 16, Volume IV

Part 2

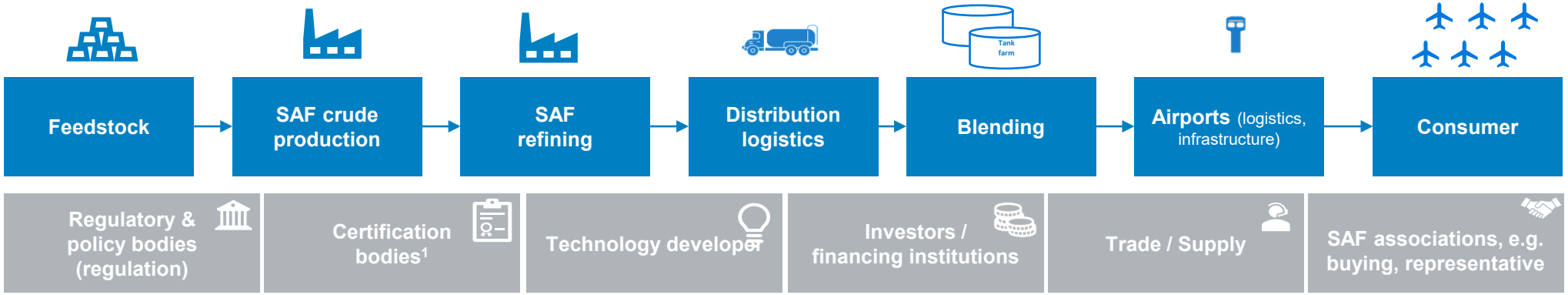
Sustainable Aviation Fuels:

Status, Opportunities & Challenges, Market Dynamics and Major Players

A long way towards net-zero aviation with Sustainable Aviation Fuels as major contributor between opportunities and challenges

- Awareness about the **importance** of **SAF** in the **net-zero target 2050** has increased in the last years.
- The production in **2019** was only **~140 ktons**, up to **~1 mn tons in 2024** (double of the volumes in 2023, yet below the estimated 1.5 mln tonnes).
- Over **490,000 flights** had already used SAF and +**50 airlines** have it **tested** in their **SAF supply chains**.
- However, **SAF production** in **2024** was only around **0.3%** of **total aviation fuel demand** and to reach net zero by 2050, over 3,000 to 6,500 new plants will be needed (annual average CAPEX needed over 30-year period of $128 bln per year).
- Only **one single production technology cannot be the solution** to face the ambitious target, but a strategic combination of them should be adopted and SAF integrated in the supply chain.

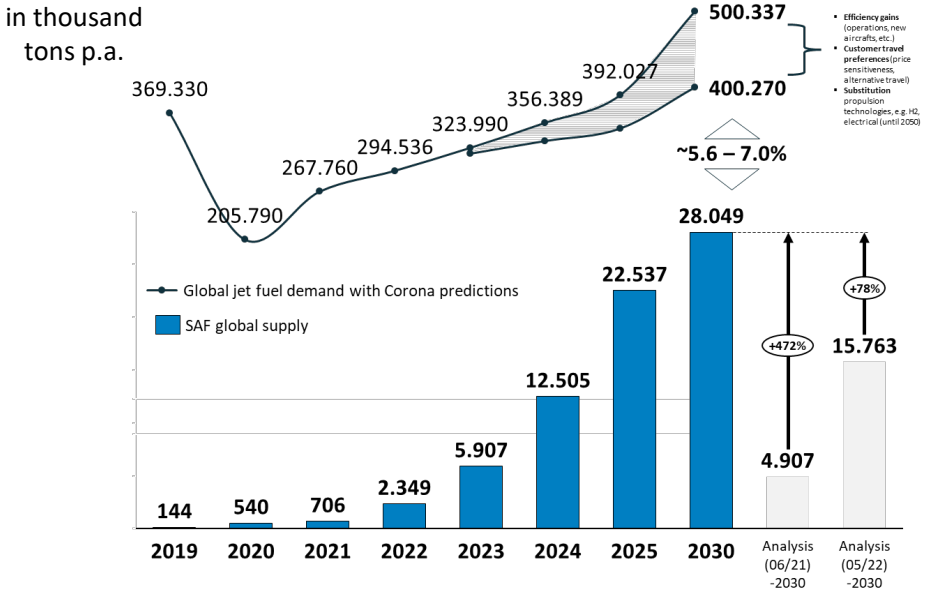
Partnerships along the Value Chain, notably the development of Direct Supply Lines will enable the market players to share risks and overcome the challenges.



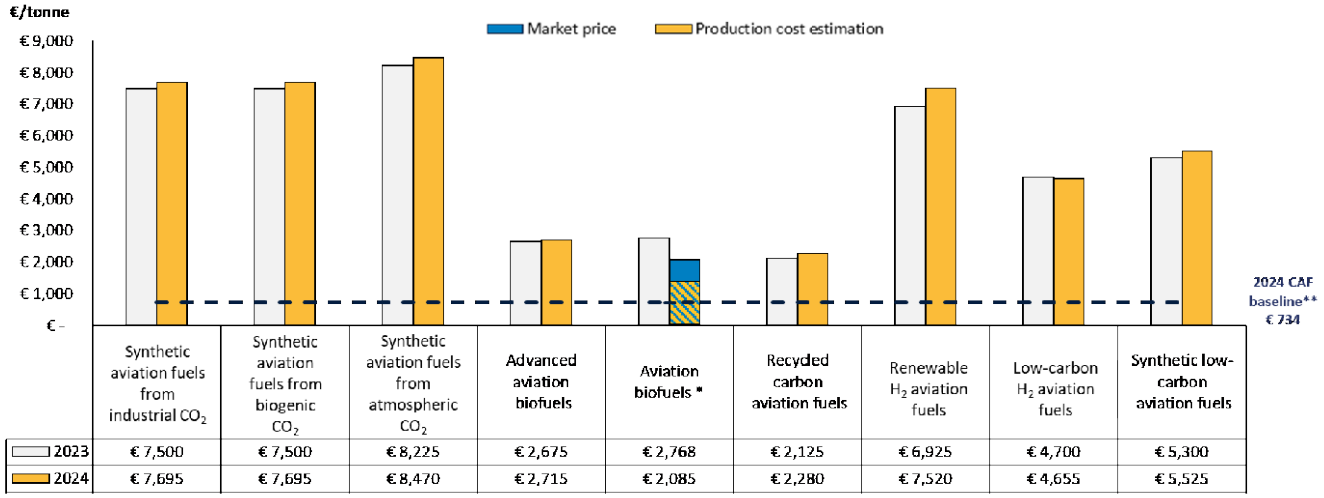
Source: CBR Sustainability Partners, 2023; IATA

The „current“ challenge: SAF availability and affordability

5-7 %



3-10 times



	Synthetic aviation fuels from industrial CO_2	Synthetic aviation fuels from biogenic CO_2	Synthetic aviation fuels from atmospheric CO_2	Advanced aviation biofuels	Aviation biofuels *	Recycled carbon aviation fuels	Renewable H_2 aviation fuels	Low-carbon H_2 aviation fuels	Synthetic low-carbon aviation fuels
2023	€ 7,500	€ 7,500	€ 8,225	€ 2,675	€ 2,768	€ 2,125	€ 6,925	€ 4,700	€ 5,300
2024	€ 7,695	€ 7,695	€ 8,470	€ 2,715	€ 2,085	€ 2,280	€ 7,520	€ 4,655	€ 5,525

The bar with blue and yellow stripes represents the 2024 production cost estimation for aviation biofuels (provided for informational purposes).

*** For reference: The 2023 CAF price was 816 €/tonne.*

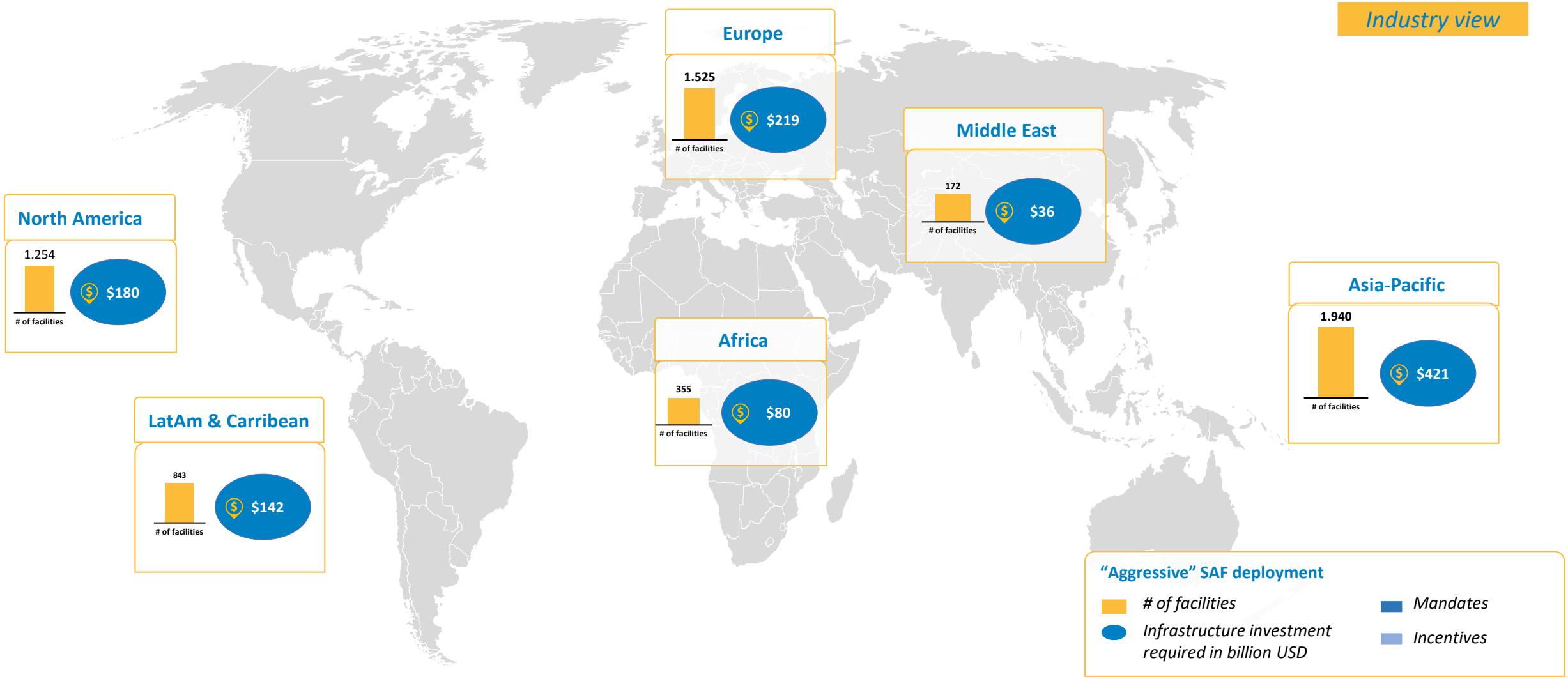
SAF production capacity only **covering ~5.6% up to 7.0% of global demand** in **2030** depending on consumption

SAF more expensive by a **multiple of 3-10 times** with **no price parity** towards **fossil jet fuel** to be expected

Source: EASA 2025; BloombergNEF; Statista; Reuters/FGE ; Corporate announcements by respective companies; IEA; CBR, 2023;
Remarks: Predicted SAF production capacity based on operating plants and announced projects becoming operational until 2030.

Investment of approx. $1 - 1.45 trn will be necessary to build sufficient SAF capacity to achieve the LTAG of ICAO (factor of 1.300).

Industry view



Source: ATAG, Waypoint 2050 report. Assumes small production close to the source of feedstock (consolidation, and smaller number of larger facilities possible).
LTAG: long-term global aspirational goal

Global regulatory landscape is very heterogenous, and schemes differ between incentives, mandates and voluntary ambitions.

UK (RTFO):
10% SAF in 2030;
22% SAF in 2040

EU ETS: ReFuelEU* aviation regulation
2% by 2025; 70% by 2050

Republic of Korea (2024)
International flights to use a mix ~1% SAF from 2027.

C-SAF Roadmap
10% by 2030

Turkey: RTFO under development.
Draft regulation to start at 1% in 2025, increasing to 5% by 2030.

USA: SAF Grand Challenge, Inflation Reduction Act,20% GHG reduction (2030)
3 billion gallons SAF by 2030
100% SAF as aviation fuel by 2050

Japan:
10% SAF mandate by 2030 (under discussion)

Sustainable Skies Act:
Production and consumption of 3 bill. gallons per year by 2030. Tax credit between 1.25-1.75 USD/gal of SAF

National Sustainable Aviation Fuel Roadmap

China: China Civil Aviation Green Development Policy and Action
Target of 50k tonnes of SAF use by 2025

India:
2% by 2026;
5% by 2030

Kenya (2024):
SAF National Steering Committee
Policy (under development)
SAF incorporated in Kenya new Civil Aviation Bill 2024

Sustainable Air Hub Blueprint
1% by 2026; 3-5% by 2030

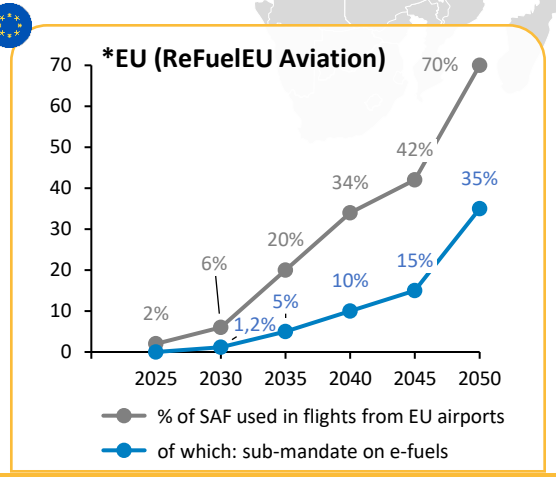
Malaysia: National Energy Transition Roadmap incl. mandate for blending target of 47% by 2050.

ProBIOQAV:
1% SAF blend by 2027;
10% by 2037

Chile (2024):
SAF Roadmap 2030 (adopted)
Production start by 2030
Target 50% of bio-SAF use by 2050

Jet zero Council target
>10% by 2030;
1.1 B$ in SAF R&D funding from Australia Renewable energy Agency

Sustainable Biofuels Mandate



Legend

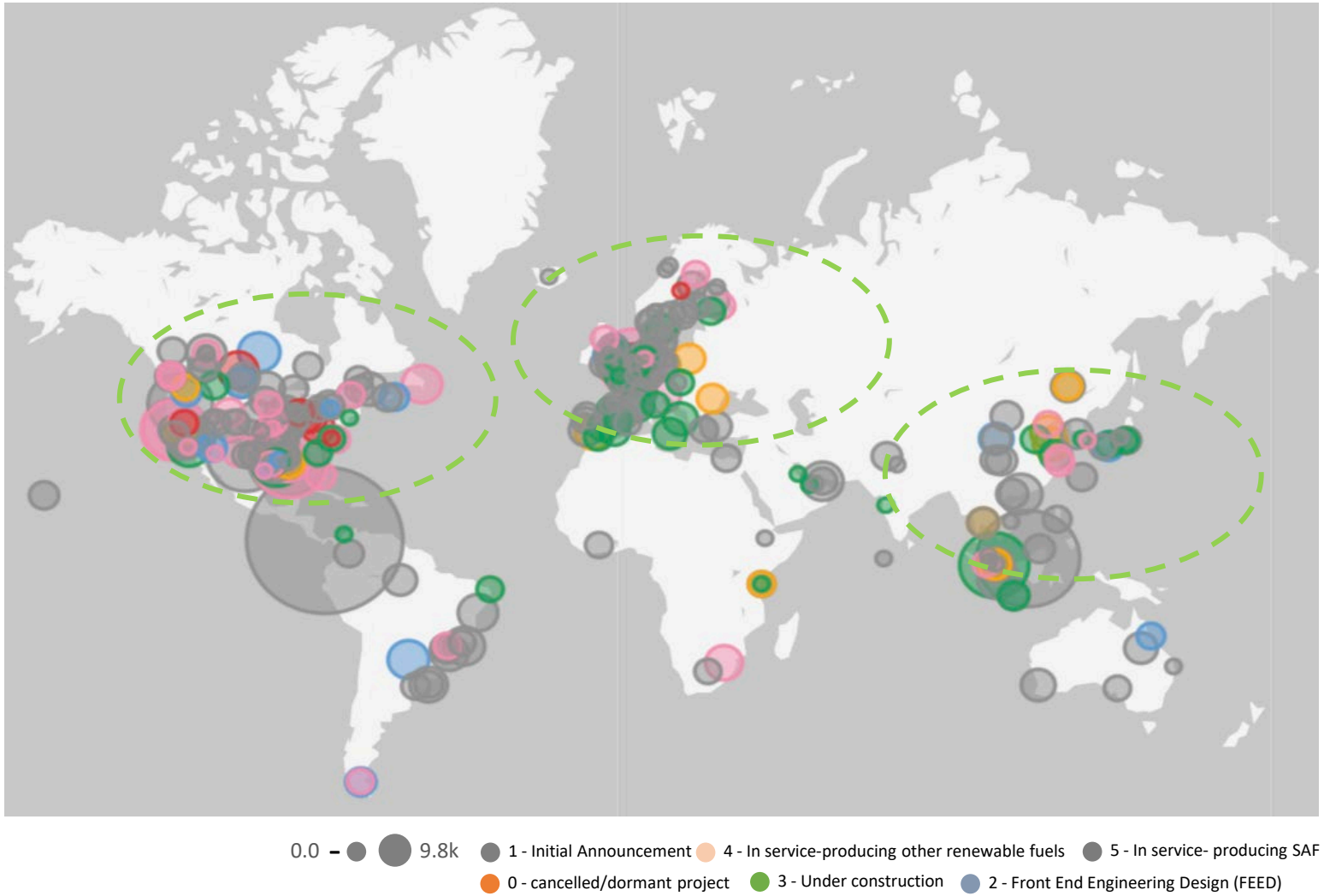
SAF Demand

GHG reduction mandate

Volume mandate

Source: CACAP; ICAO(2024);
RTFO: Renewable Transport Fuel Obligation
ProBIOQAV: National Sustainable Aviation Fuel Program

SAF production is mainly localised in EU and North America, where policies are mainly developed.



Source: ICAO(2024)

Despite some of the **policies** are only **under development** (not in force), this is enough to **stimulate SAF production** and the appearance of **new SAF projects**.

HEFA & co-processing is dominated by legacy fuel companies, whereas next generation SAF projects are developed by newly formed companies.

HEFA
Hydroprocessed Esters and Fatty Acids

Co-processing

AtJ
Alcohol-to-Jet Synthetic Paraffinic Kerosene

FT-SPK
Fischer-Tropsch Synthetic Paraffinic Kerosene

PtL
Power-to-Liquid

Other
CHJ/HEFA-SPK, Gasification/Methanol-to-Jet, HTL, Pyrolysis/hydrotreating, Sun-to-Liquid, Thermal cracking

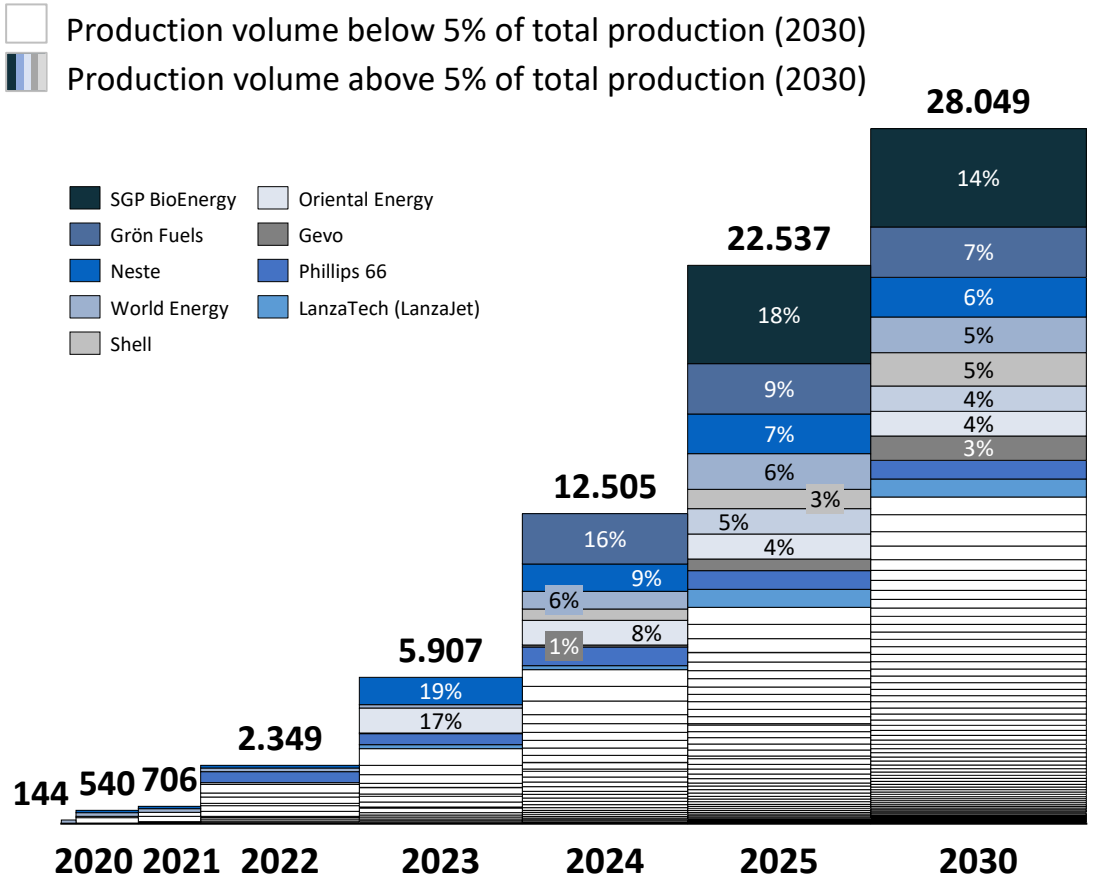
Established players from oil & gas

Dedicated, project developers

Exemplary / Non-exhaustive

Minority of producers represents the majority of SAF production in 2030

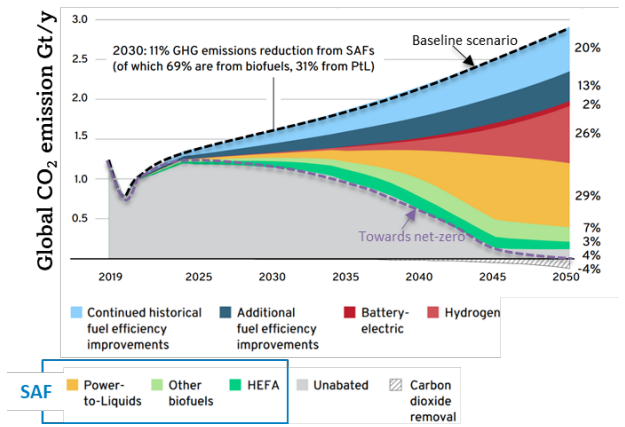
in thousand tons p.a.



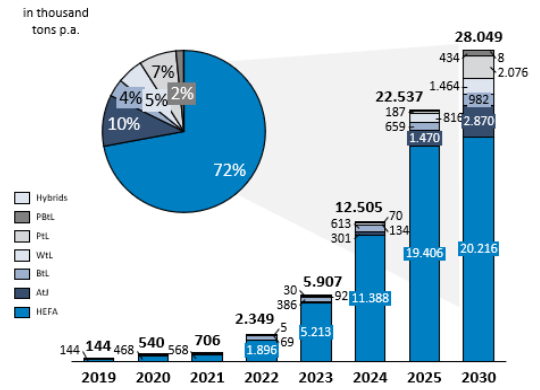
- **SPG BioEnergy** and **Grön Fuels** are the dominating players in 2030 followed by **Neste** and **World Energy** accounting for **over 30% market share** from a **today's perspective**.
- **Production figures** are relatively **volatile** as many new projects start, while other projects encounter significant delays or do not materialize.
- **Time lags linked to plants going on stream**, leave competitors with time to catch up on the first mover advantage..

Source: CBR Sustainability Partners, 2023;
Remark: Based on operating or announced projects to enter in operation until 2030.

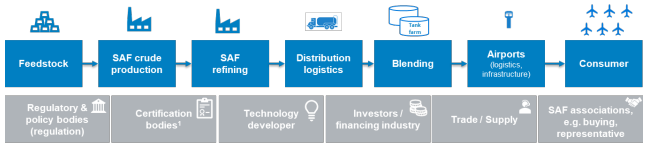
Key take-aways for our three days SAF Training



Achieving **net-zero emissions** by **2050** depends on the **pace of scaling up** and **deploying SAF** in the aviation sector.



As of today, **global SAF capacity** only covers **~5.6-7.0%** of demand in 2030, with **HEFA** as main supply, thus accelerated **SAF technology adoption** and **project development** is needed.



SAF is a **multiple stakeholder approach** along the **SAF value chain**, starting from **Direct Supply Lines** to the **development** of a **new industry**.

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