# Global SAF Market Outlook: Production, Prices, Feedstock Constraints, and Pathway Diversification

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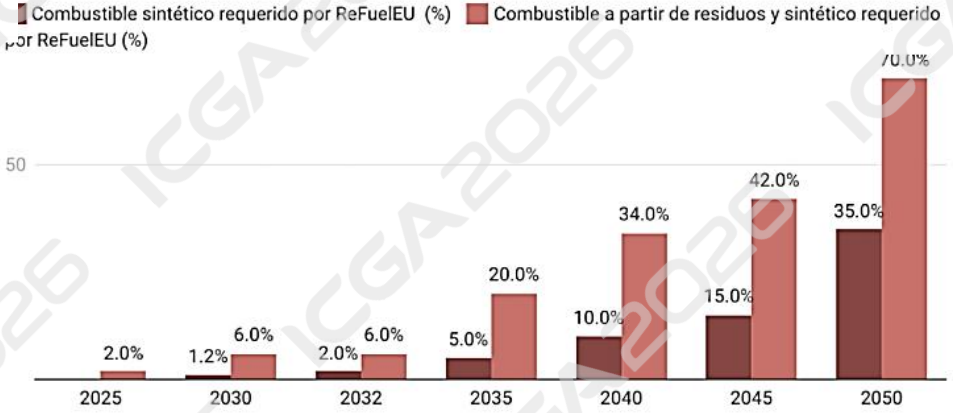
# Renewable Energy Directive (RED III)

## ReFuelEU Aviation

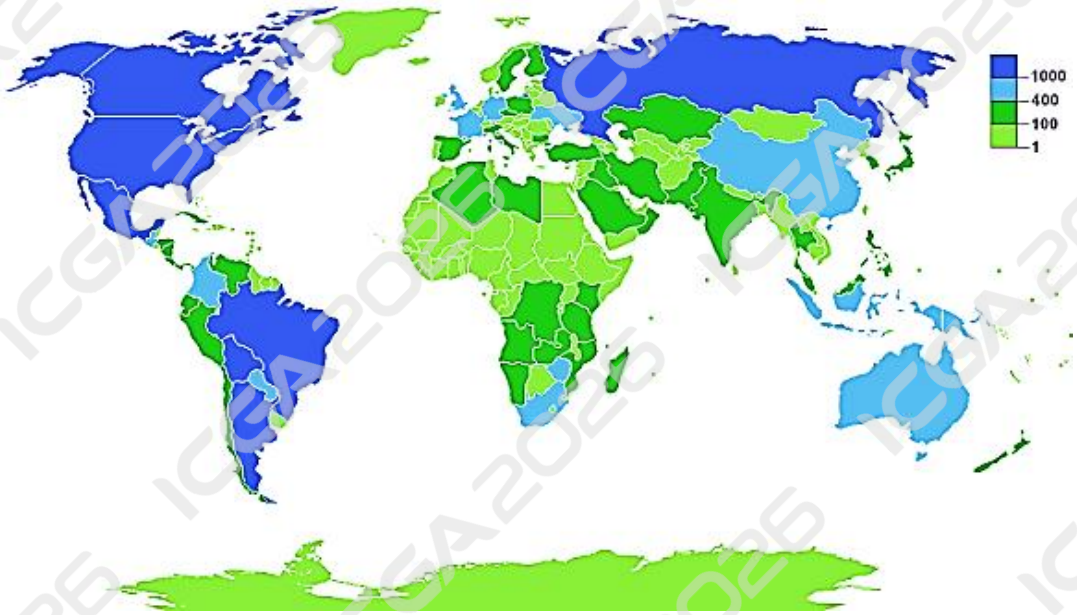


**European Framework**
**Renewable Energy Directive (RED III)**
The Renewable Energy Directive, known as RED III, is the cornerstone of the push for renewable energy in the European Union and sets a **minimum target of 42.5 %** renewable energy in Member States' energy mix by 2030, with the aim of reaching 45% .
The legislation also sets a **target of at least 29% renewable energy in transport** by 2030 or a **GHG intensity of at least 14.5%** by 2030.

Regulation (EU) **ReFuelEU Aviation** sets out mandatory targets for sustainable aviation fuels (SAF) from 2025 onwards for all airports



# ReFuelEU mandates SAF supply at covered EU airports and includes a rising synthetic-fuel requirement




Number of airports by country

## Why SAF matters now

- ReFuelEU Aviation requires increasing SAF shares at EU airports, including a specific synthetic-fuel sub-mandate.
- SAF is a “drop-in” fuel: it can be blended with conventional kerosene and used with limited changes to aircraft and airport fuel systems.
- The challenge is not whether SAF is technically possible, but whether it can be produced at scale, at acceptable cost, with credible sustainability credentials.

# EU SAF Supply: Historical Growth and 2030 Projections

| Year / Milestone | SAF Supply Volume (Tonnes) | SAF Share of Total Fuel | Key Context & Notes |
|---|---|---|---|
| 2024 (Pre-mandate) | 193,000 t | — | Baseline year before ReFuelEU mandates took effect. |
| 2025 (First mandate year) | 1,100,000 t | 2.8% | Nearly 6x the previous year's volume; already exceeding the initial 2% mandate target. |
| 2030 (Mandate target) | 3,700,000 t (Committed capacity) to 5,500,000 t (Including credible announcements) | 6.0% | EASA projects EU production capacity is on track to meet the 6% target. |
| 2030 (e-SAF sub-target) | +600,000 t (Synthetic/e-SAF) | 1.2% | Included in the upper estimate above; represents the specific synthetic fuel sub-mandate. |

***Source:*** *ReFuelEU Aviation Regulation; EASA projections.*

European Union

**EU Emissions Trading System (ETS)**

Between 1 January 2024, and 31 December 2030, a reserve of 20 million carbon allowances from the EU Emissions
Trading System (ETS) will be dedicated to incentivise the use of SAF.
These allowances will cover the price differential – in total or partially – between SAF and conventional jet fuel.

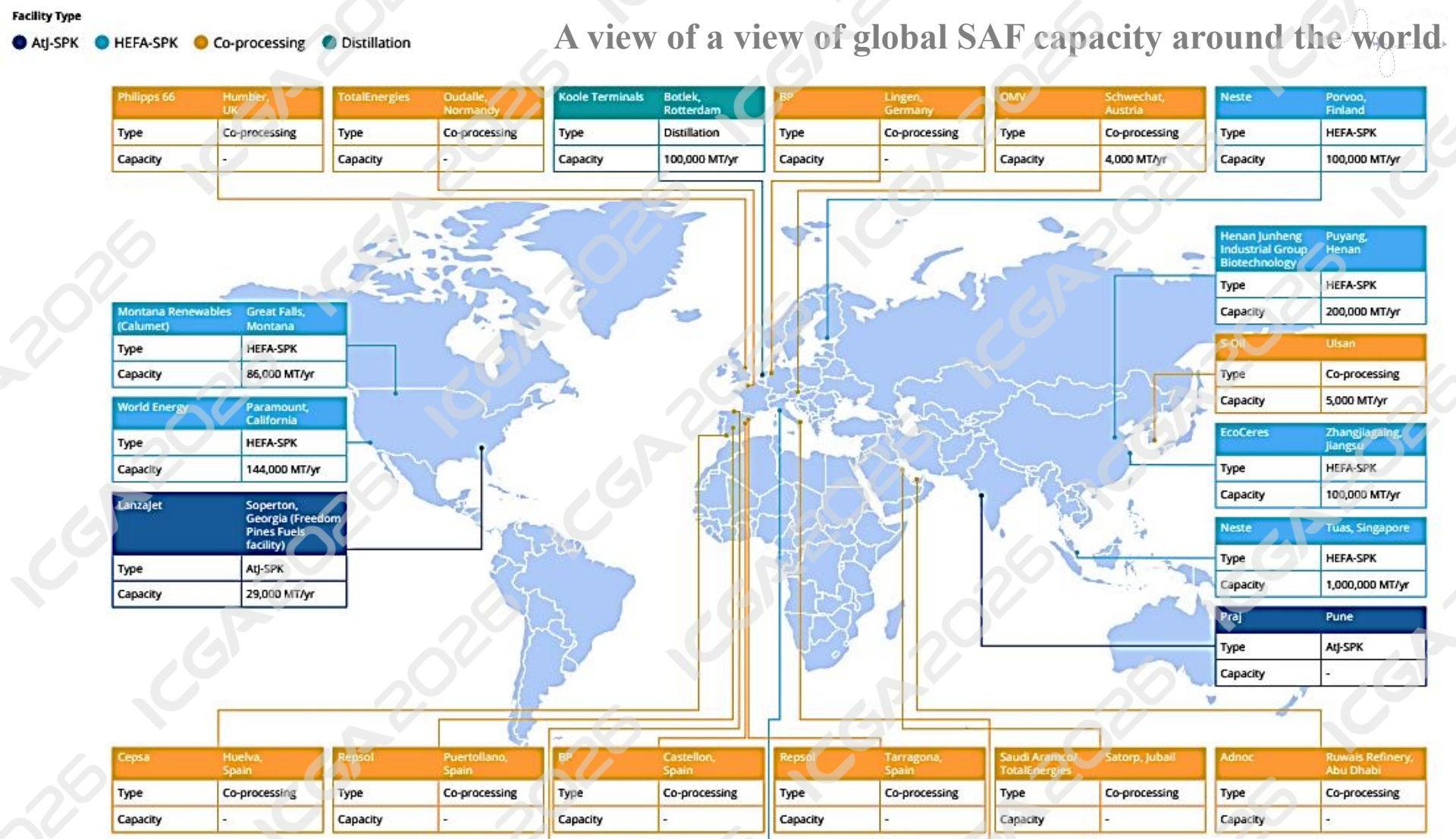
The coverage of the price differential will depend on the type of fuel used:

- • 95% for renewable fuels of non-biological origin (RFNBOs)
- • 70% for advanced biofuels
- • 50% for other eligible fuels




The **regulatory framework for SAFs in the European Union** comprises Delegated Regulations 2023/1184, 2023/1185, Directive 2024/1788 and Delegated Regulation 2025/2359, which set out the **methodology for calculating the emission reductions of RFNBOs**, recycled carbon fuels and low-carbon fuels, respectively.

# A view of a view of global SAF capacity around the world




| Año de operación (construcción) | Proyecto | Empresa | Producción de bioSAF (t/año) |
|---|---|---|---|
| En operación | Complejo Industrial de Cartagena | Repsol | 250.000 |
| En operación. Ampliación en 2026 | La Rábida, Huelva | Moeve | 500.000 |
| 2027 (2026) | Zona Franca de Cádiz | Alfa Laval y Dreexo Energy | Datos no disponibles |
| 2030 (2027) | - | Castellón (BP) | 500.000 |
| **Totales (t)** | | | **750.000** |

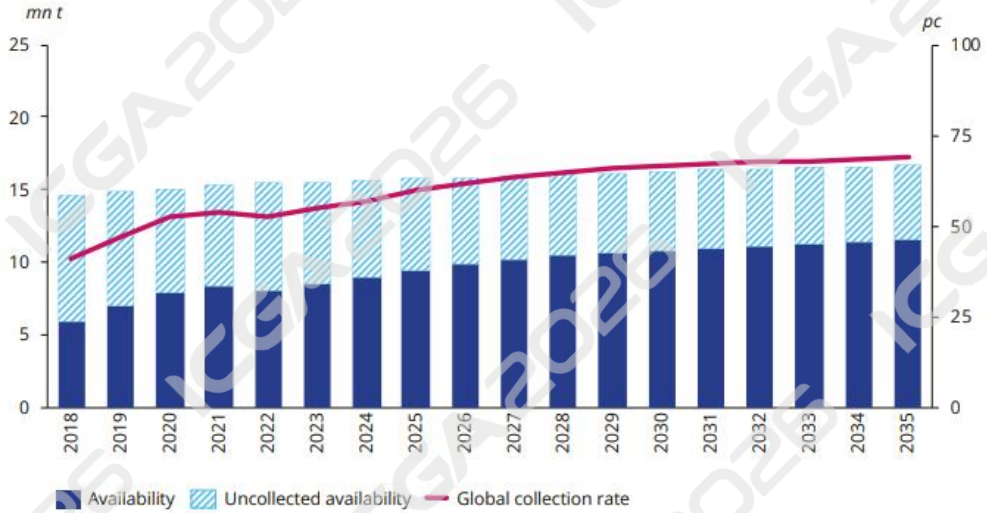
| Año de operación (construcción) | Proyecto | Empresa | Producción de e-SAF (t/año) |
|---|---|---|---|
| 2025 (2027) | RISE | Synhelion | <1.000 |
| 2026 | Repsol-Petronor | Repsol-Petronor | 2.000 |
| 2027 | Breogán | Greenalia y P2X-Europe | 20.000 |
| 2028 | Numantia SAF | Solarig | 48.000 |
| 2028 (2030) | Compostilla Green | Ric Energy | 60.000 |
| 2028 (2030) | Turboleta SAF | Solarig | 60.000 |
| Fecha no anunciada | Datos no disponibles | Ric Energy | 90.000 |
| | Besaya H2 | Ric Energy y Copsesa | Datos no disponibles |
| | Bahía de Huelva | Avalon Renovables | 25.000 |
| | ECO2FLY | Exolum, IGNIS P2X y Holcim | 100.000 |
| | H2 Valdepeñas | Avalon Renovables | 25.000 |
| | La Joya - Málaga | Avalon Renovables | 20.000 |
| **Totales (t)** | | | **450.000** |

*Source: Spotlight on the European SAF market: countdown to 2025*

# Availability of UCO

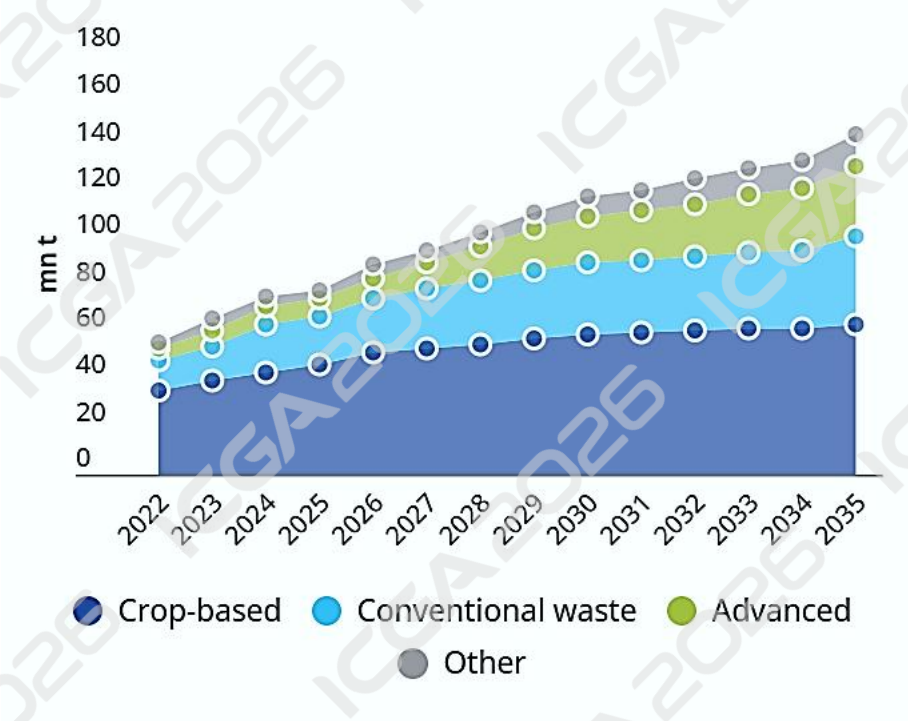



UCO Supply by region

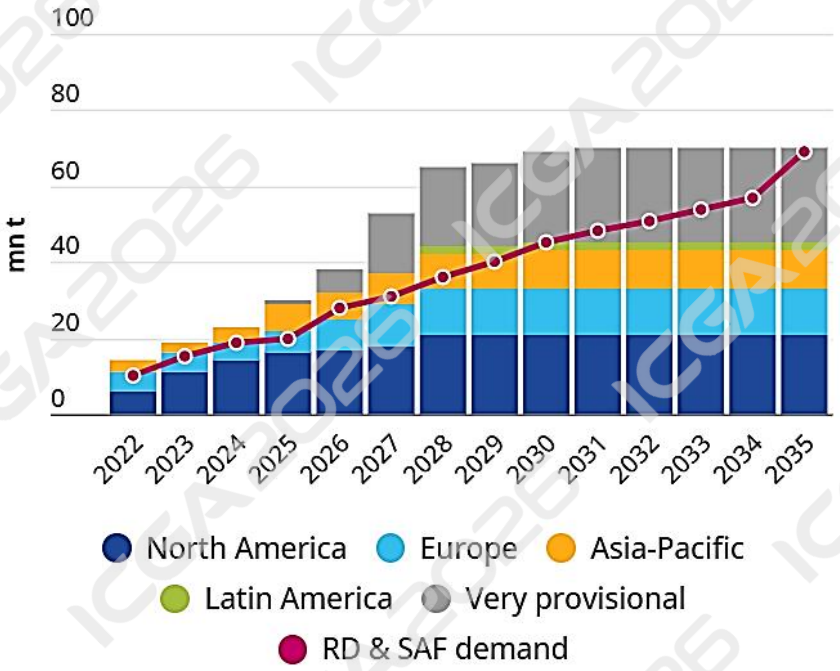



Additional potential UCO collection

# Global supply and demand dynamics for biofuels and waste-based feedstocks




Global biodiesel, RD and SAF feedstock demand




Global RD and SAF capacity

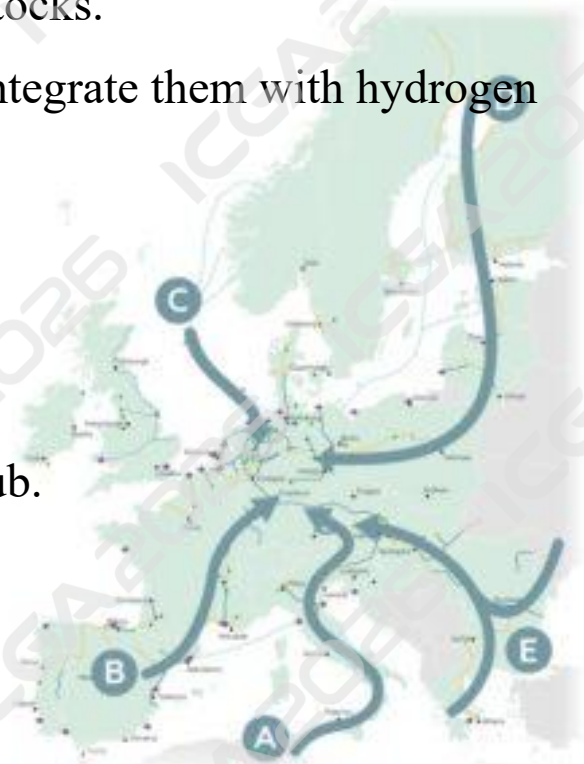
## Call to action

Europe's SAF transition by building an integrated bio-kerosene and e-fuel ecosystem.

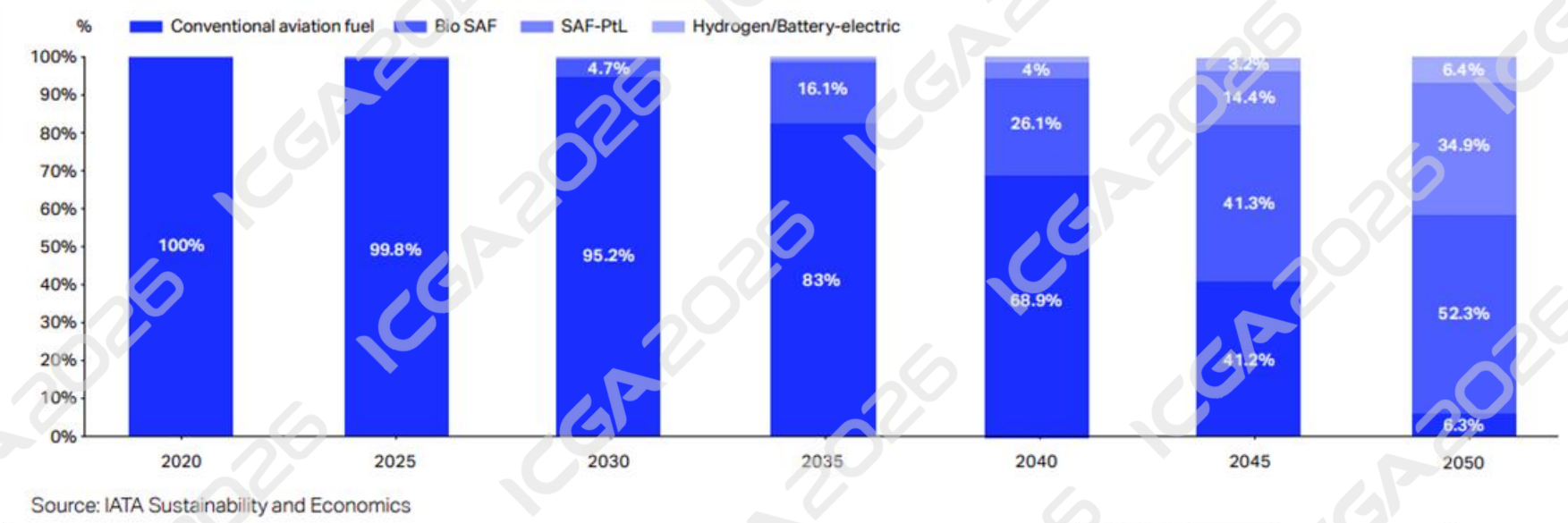
## Actions for the next five years

- Scale advanced bio-kerosene using waste and residue feedstocks.
- Deliver first commercial-scale e-SAF demonstrations and integrate them with hydrogen valleys.
- Secure airline, airport and corporate offtake agreements.
- Accelerate grid, water, port and CO2 infrastructure.
- Build transparent certification and traceability systems.
- Position Spain as a European SAF production and export hub.

**REPowerEU's 2030 hydrogen demand and supply targets**,
Corridor A – North Africa and Southern Europe.
Corridor B – Southwest Europe and North Africa.
Corridor C – North Sea.
Corridor D – Nordic and Baltic Regions.
Corridor E – Eastern and South-Eastern Europe




Five major corridors are in line with the three proposed by REPowerEU (one through the Mediterranean, one from th North Sea and one through Ukraine).




Share of in-flight energy demand by energy sources under the IATA Roadmap,[2] %

The IATA Roadmap: A Reality Check

The "Valley of Death" is Real

**The Gap**: Transition is incredibly slow between 2025 and 2035.

**The Reality**: Conventional fossil fuel stays above 80% for another decade.

Bio-SAF is the Bridge

**The Bet:** Aviation is betting everything on Bio-SAF for the 2030s.

**The Consequence**: Securing UCO is a strategic priority.

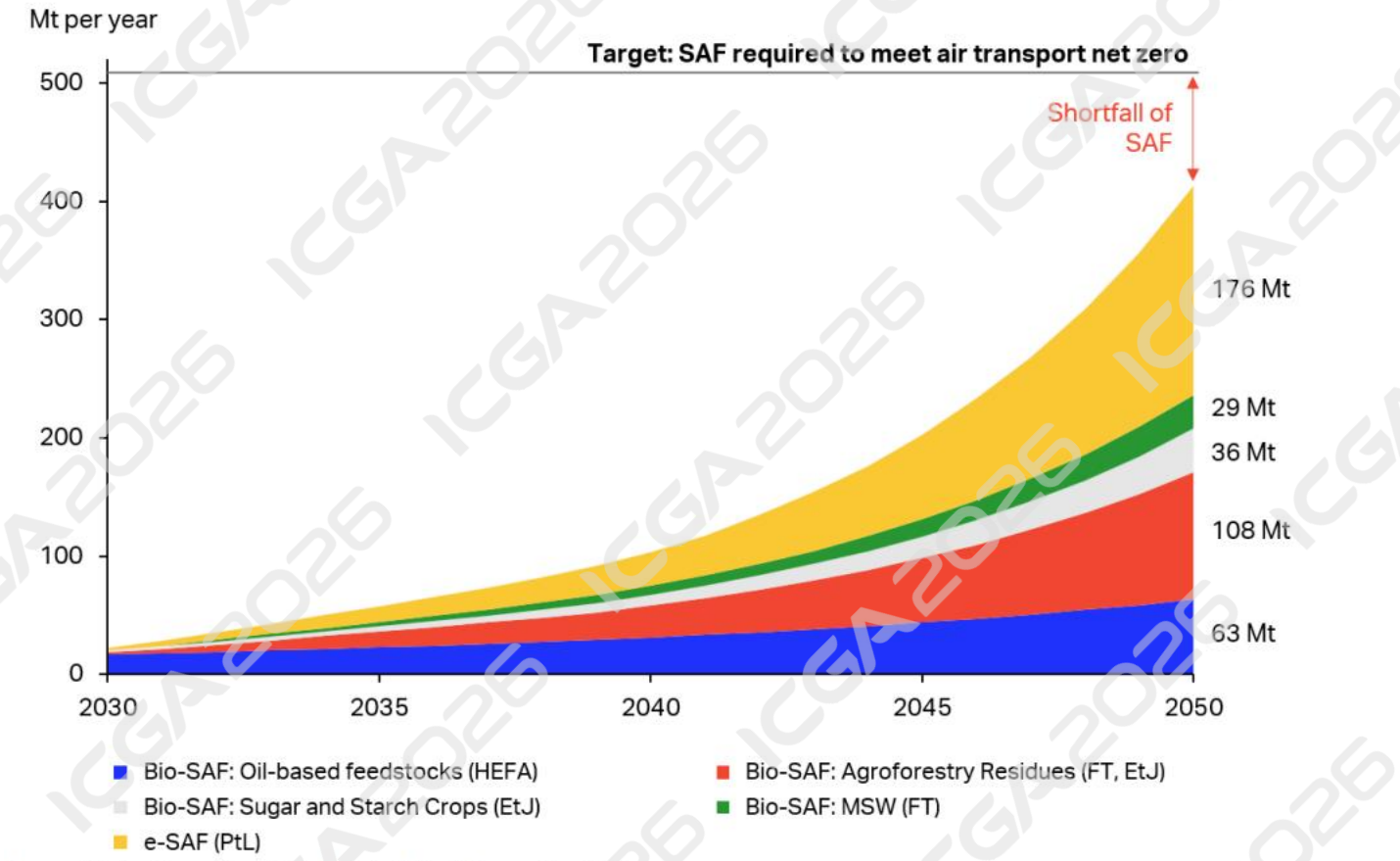
**The Threat:** The "RD vs. SAF" competition is highly dangerous.

**e-SAF is the Lifeline**

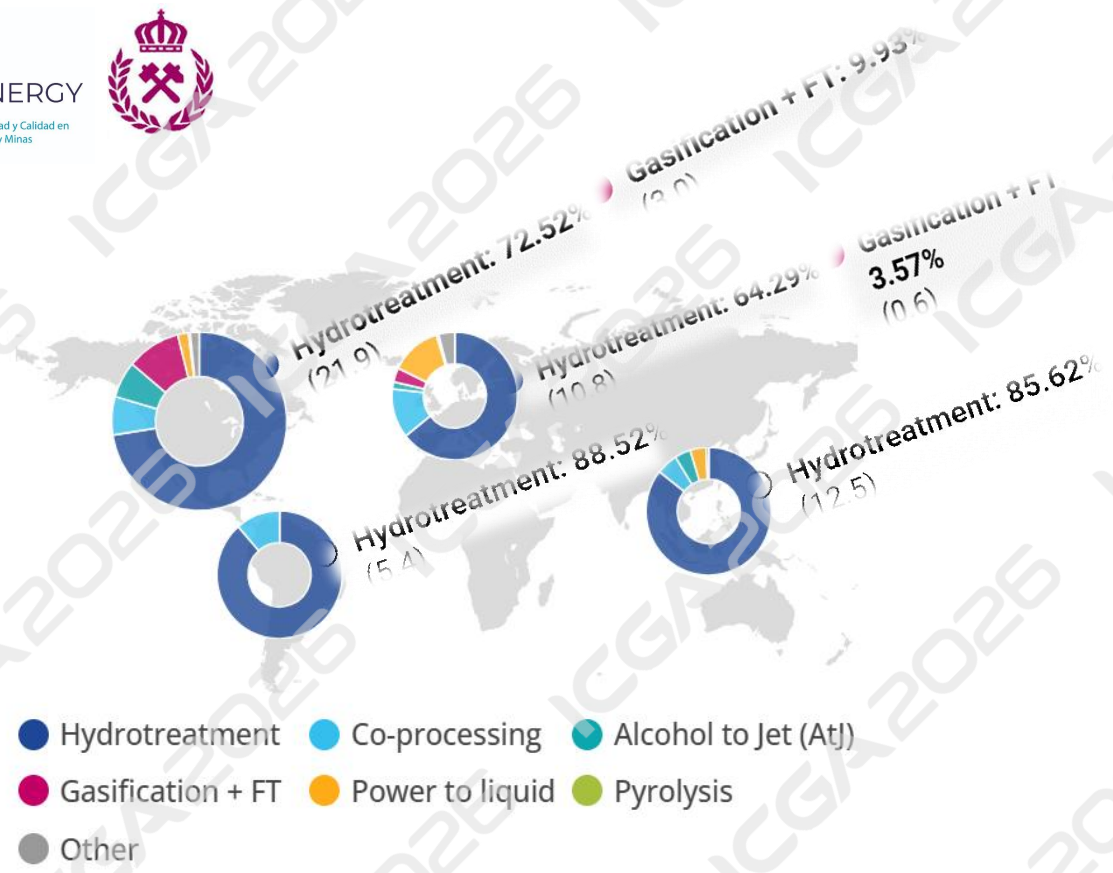
**The Target**: Conventional fuel must drop below 10% by 2050.

**The Scale-Up**: e-SAF must grow from 0% to 35% in just one decade (2040–2050).

**The Action**: Massive investments are needed today to build the plants of 2040.




Source: Worley Consulting, IATA Sustainability & Economics, 2025



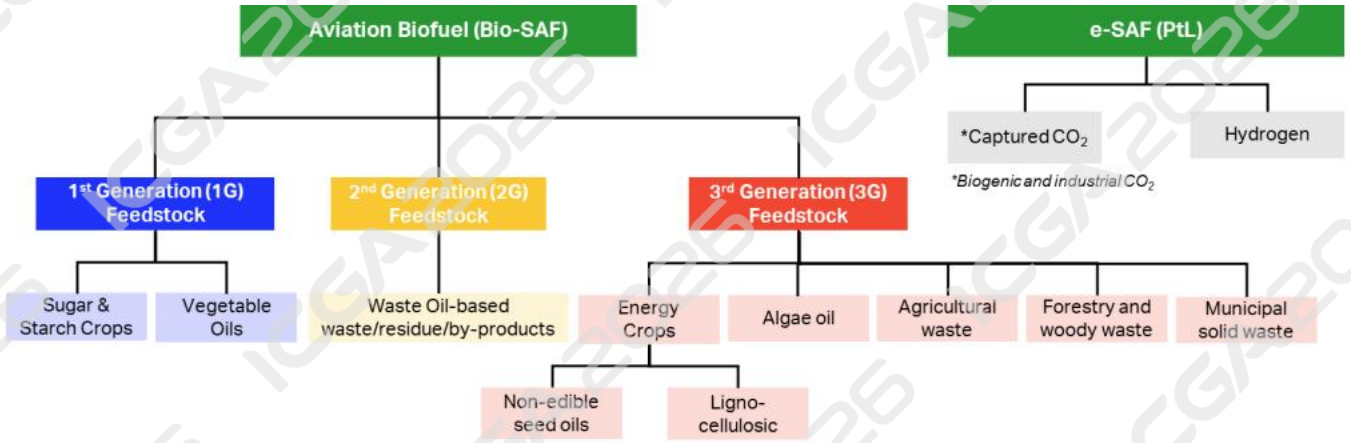

Based on 2030 capabilities in Mt

**HEFA** pathway based on oils and fats completely dominates all regions of the world.

- **Europe**: Represents 72.52% of its total capacity (21.9 million tonnes projected).
- **North America**: Represents 64.29% (10.8 million tonnes).
- **Asia-Pacific**: It is the region most dependent on this technology, at 88.52% (12.5 million tonnes).
- **South America**: Represents 85.62% (5.4 million tonnes).

*Source: Argus Biofuels Analytics Q2 2025*

# Global SAF feedstock 2025-2050




**Feedstock classification**

| Feedstocks | Route | ASTM-certified pathway | |
|---|---|---|---|
| Oil-based feedstocks | Hydroprocessed Esters and Fatty Acids (HEFA) | HEFA-SPK | Bio-SAF |
| Sugar & starch crops | Fermentation + Ethanol-to-Jet (EtJ) | AtJ-SPK | Bio-SAF |
| Agricultural/Forestry residues, lignocellulosic energy crops | Gasification + Methanol-to-Jet (MtJ)* | | Bio-SAF |
| Agricultural/Forestry residues, lignocellulosic energy crops | Gasification + Fischer-Tropsch (FT) | FT-SPK | Bio-SAF |
| Municipal solid waste | Gasification + Fischer-Tropsch (FT) | FT-SPK | Bio-SAF |
| Municipal solid waste | Fermentation + Ethanol-to-Jet (EtJ) | AtJ-SPK | Bio-SAF |
| Captured $CO_2$ | Power-to-Liquid via Fischer-Tropsch (FT) | FT-SPK | e-SAF |
| Captured $CO_2$ | Power-to-Liquid via Ethanol-to-Jet (EtJ) | AtJ-SPK | e-SAF |
| Hydrogen | Power-to-Liquid via Methanol-to-Jet (MtJ)* | | e-SAF |

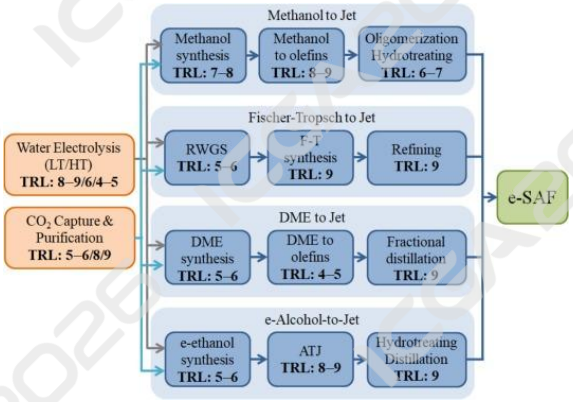
*The Methanol-to-Jet route is under ASTM evaluation.

Source: Worley Consulting, IATA Sustainability & Economics, 2025

## e-fuels?

e-Fuels, or power-to-liquid fuels, are synthetic fuels made from low-carbon hydrogen and captured $CO_2$.

- Renewable electricity powers electrolysis to create green hydrogen.
- $CO_2$ is captured from biogenic sources, industrial emissions or DAC.
- Hydrogen and $CO_2$ are synthesised into syngas, then converted into kerosene through Fischer-Tropsch or related processes.
- e-kerosene can be used as SAF and is central to ReFuelEU's synthetic-fuel sub-mandate*
- **Under ReFuelEU, at least 1.2% of fuel supplied at EU airports must be synthetic fuels such as e-SAF by 2030*




| Pathway | TRL | Energy efficiency | Carbon efficiency | Process complexity | Key characteristics |
|---|---|---|---|---|---|
| **Fischer-Tropsch (FT)** | 7 – 9 | 31 – 42% | 50% | Very high | Broad hydrocarbon distribution, intensive upgrading |
| **Methanol-to-jet (MTJ)** | 6 – 9 | 30 – 54% | 56 – 63% | Medium | High selectivity via methanol/olefin chemistry, high potential for $CO_2$-based SAF |
| **Dmethyl Ether-to-jet (DME)** | 4 – 6 | No data | No data | Medium-high | Less mature variant of methanol pathway, limited scale-up data |
| **Alcohol-to-jet (ATJ)** | 6 – 9 | 51% | 59% | Medium | High carbon efficiency, dependent on alcohol production route |

Technology Readiness Levels for specific e-SAF production steps

# The e-fuel cost challenge

e-fuels are strategically important but remain expensive; cost reduction requires system integration.

## Main cost drivers

- Renewable electricity price and curtailment
- Electrolyser capital cost, efficiency and utilis
- CO2 capture and transport
- Synthesis and upgrading facilities
- Water, land, grid connection and permitting

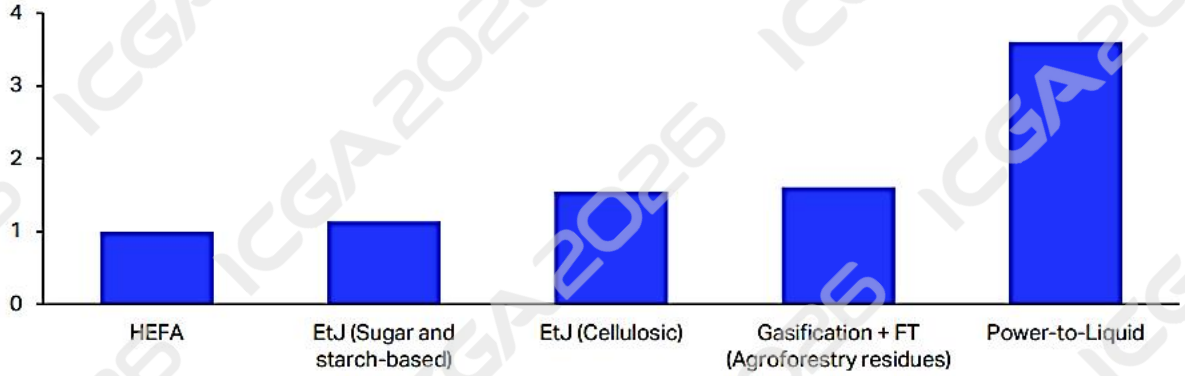
| Steps | Approximate Cost Contribution | Source/Note |
|---|---|---|
| Start: Baseline | €0 | Beginning of production cost |
| + Renewable Electricity | ~€2,000 | Dominant cost; powers electrolysis |
| + Electrolyzer CAPEX | ~€1,500 | Major capital outlay (amortized) |
| + $CO_2$ Supply | ~€200 - €800 | Low for industrial; high for DAC |
| + Synthesis & Upgrading | ~€1,500 - €2,500 | Remaining CAPEX/OPEX for FT/MtJ |
| = Final Cost | ~€5,200 - €6,800+ | Aligns with studies showing €5,000 - 7,000/t range |

** Spain - the ECODES report gives €5,631/t in the optimistic scenary*

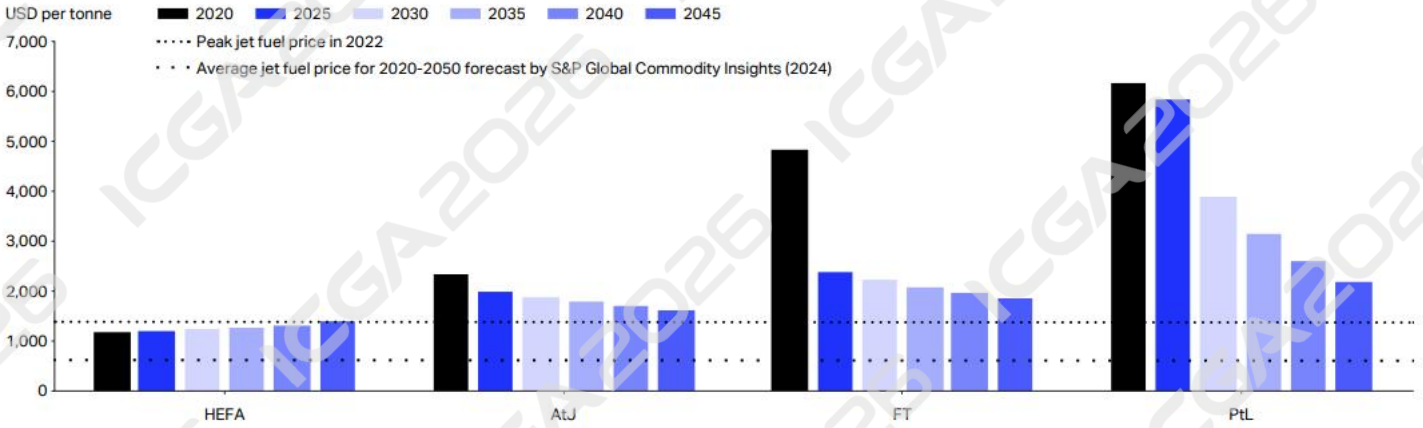
## Cost-reduction levers

- Co-location with cheap renewables and hydrogen production.
- Long-term power purchase agreements.
- Shared CO2, hydrogen and storage infrastructure.
- Industrial-scale learning and standardisation.
- Carbon contracts for difference or premium SAF procurement.

# Indicative cost comparison by production route




Indicative levelized cost of SAF by production route, Indexed HEFA = 1




Source: IATA Sustainability and Economics

## Bio-kerosene versus e-fuels

The strongest Spanish strategy is sequencing: build credible bio-SAF supply now while preparing e-fuel infrastructure for the 2030s.

| Dimension | Bio-kerosene | e-Fuels |
|---|---|---|
| Main input | Waste, residues, oils, biomass | Renewable power, water, CO2 |
| Maturity | Higher, especially HEFA | Earlier stage |
| Near-term volume | Stronger | Limited |
| Long-term scalability | Constrained by feedstock | Potentially very large |
| Cost today | Lower | Higher |
| Policy relevance | Core SAF compliance | Essential for synthetic-fuel mandate |
| Spanish advantage | Refining, ports, waste and residues | Solar, wind, hydrogen and land |

## Risks and mitigations

The Spanish SAF opportunity is large, but execution risk is real.
The biggest failure mode is announcing plants without secured electricity, $CO_2$, feedstock, logistics and offtake.

| Risk | Impact | Mitigation |
|---|---|---|
| Feedstock scarcity | Limits bio-kerosene growth | Diversify into residues, wastes, AtJ and e-fuels |
| High e-fuel cost | Slows investment | Long-term PPAs, subsidies, premium demand, scale |
| Grid congestion | Delays hydrogen and e-fuel projects | Early grid planning and co-located renewables |
| Permitting delays | Increases project cost and uncertainty | One-stop permitting and spatial planning |
| Certification complexity | Undermines market confidence | Digital traceability and robust chain of custody |
| Weak offtake | Makes projects unbankable | Airline contracts, corporate SAF programmes, public procurement |

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# Thank you



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# Global UCO Collection Rate Forecasts

| Source / Forecast | Year | Global UCO Collection Rate | Notes |
|---|---|---|---|
| Forecast | 2035 | 69% | Based on the OECD-FAO downward revision and the "practical maximum" concept |
| GEP Research (Alternative Forecast) | 2025 | ~62% | Global collection rate estimate |
| GEP Research (Alternative Forecast) | 2030 | ~71% | Slightly higher |
| GlobalData / Clean Fuels | 2030 | 0.6 – 1.25 gal/capita | A per-capita range rather than a percentage |
| Practical Maximum (Western Europe) | — | ~85% | |

## Cross-sector value chains: the central idea

SAF is not an aviation-only product; it is an industrial-energy-system product.

- Aviation provides demand and price signals.
- Renewable-energy developers supply power.
- Hydrogen producers supply a key intermediate.
- Industry supplies CO2, heat, waste and integration sites.
- Agriculture and waste management supply feedstocks.
- Ports and fuel logistics connect production to airports and export markets.
- Finance converts projects into investable assets.