

eSAF: Europe's opportunity for global leadership in decarbonising aviation and strengthening European energy resilience

Because they can serve as direct replacements for fossil fuels and make use of existing supply chains, e-fuels as part of Sustainable Aviation Fuels (SAF) are particularly well suited to reducing emissions in sectors that are difficult to electrify directly, such as aviation and maritime transport. Countries that commit themselves to developing eSAF production to serve global SAF demand could reap significant economic rewards, not only in terms of favourable balance-of-trade impacts but also knock-on effects for domestic economic development, resilience and energy system development.

*A pan-European approach facilitates the sharing of best-practices between Member States, helping the eSAF market reach maturity. Financing mechanisms like **the double-sided auction** are critical because while over **40 eSAF large-scale projects are planned** in the EU, none have reached final investment decision (FID) thus far. The double-sided auction, through a market intermediary, can cover both the revenue risk for producers and the price risk for offtakers. It is widely seen by aviation and SAF stakeholders as one of the key tools needed to create a true European SAF industry to support air transport's energy transition, alongside EU funding instruments rewarding either innovation (e.g. the Innovation Fund), cost efficiency (e.g. the Hydrogen Bank) or reducing the cost of SAF (e.g. ETS SAF allowances).*

The double-sided auction helps activate both the demand and supply sides of the eSAF market for national and European players, which will facilitate the first large-scale eSAF projects to reach FID and increase investor confidence in eSAF¹.

1. TRUE NET-ZERO

eSAF, as defined in Europe as synthetic SAF produced from water electrolytic and low-carbon hydrogen, is key to decarbonising the aviation sector as it **reduces lifecycle emissions of aviation fuel by over 90% compared to fossil fuels²**.

After road transport, the aviation sector is the largest source of greenhouse gas emissions in the transport sector, accounting for 13.9% of all transport emissions³. While emissions for road transport are expected to decline, emissions for the aviation and maritime sector are expected to increase in the lead up to 2030⁴.

Unlike biofuels such as HEFA, which face limitations regarding land use and feedstocks⁵, e-fuels like eSAF are produced using low-carbon hydrogen and captured CO₂ (via Direct Air Capture or biogenic sources). When burned, eSAF release the same amount of CO₂ that was captured during production, creating a **closed carbon loop**.

eSAF therefore hold the potential to create a true saving **400 million tonnes of CO₂ emissions globally by 2050⁶** with lower competition for land use and feedstock limitations than biofuels.

Europe current
hosts **60%** of
announced eSAF
production
capacity
worldwide.

¹ Project SkyPower, [Project SkyPower e-SAF Market Intermediary](#) June 2025

² Based on an estimated e-SAF demand of 120 Mt in 2050 and a 90% reduction compared to fossil jet fuel well-to-wake emissions of 3.84 tCO₂e/tonne fuel ([World Economic Forum \(2022\)](#); [German Federal Office for Environment \(2022\)](#); [Mission Possible Partnership \(2022\)](#)).

³ European Commission, [Reducing emissions from aviation - Climate Action - European Commission](#)

⁴ European Environment Agency, [Greenhouse gas emissions from transport in Europe](#), November 2025

⁵ While HEFA SAF will be the primary contributor to meeting ReFuelEU targets, its role will plateau post-2030 when feedstocks are expected to become increasingly constrained. Europe is reliant on imports for its HEFA feedstocks, importing 80% of the total UCO used for biofuel, with 60% of these coming from China and a considerable portion from Indonesia and Malaysia.

⁶ Based on an estimated e-SAF demand of 120 Mt in 2050 and a 90% reduction compared to fossil jet fuel well-to-wake emissions of 3.84 tCO₂e/tonne fuel ([WEF \(2022\)](#); [German Federal Office for Environment \(2022\)](#); [MPP \(2022\)](#)).

2. TECHNOLOGICAL EDGE AND WORKFORCE

With high renewable electricity penetration and strong demand signals, the **EU could become a global leader in synthetic SAF industry** with the appropriate support schemes. While production is currently expensive, it holds significant potential for future cost reductions through technological innovation, scaling, and efficiencies. By 2050, under the best regulatory conditions, **potential cost reductions of 40–50%** can be achieved⁷.

eSAF presents a unique and critical opportunity for the EU to position itself as a global frontrunner for decarbonised aviation, with Europe hosting **60%** of the announced eSAF production capacity worldwide⁸ and having key access to all critical feedstocks needed for eSAF production.

The **2024 Draghi Report** notably recommends launching dedicated EU innovation projects leveraging public-private partnerships and cross-border cooperation for decarbonisation in different segments, such as sustainable renewable and low-carbon fuels, including eSAF produced from low carbon and renewable energy⁹.

“The EU’s ambitious plans to decarbonise the transport sector provide unique opportunities (...) to be at the forefront of decarbonisation solutions.

[It] needs to start building a supply chain for alternative fuel”

- The future of European competitiveness, Report by Mario Draghi, September 2024

3. INDUSTRIAL COMPETITIVENESS

The ReFuelEU legislation encourages a strong demand for eSAF as of 2030. Strengthening domestic eSAF production will not only enable Europe to **avoid imports potentially valued at approximately €16 bn** annually as of 2035¹⁰, but also generate benefits for stakeholders throughout the entire domestic value chain, including eSAF producers and offtakers such as European airlines and fuel suppliers. This horizontal approach strengthens the entire European aviation industry and de-risks private investments. Early investments in eSAF would give the EU first-mover advantages, supporting the development of local economic hubs around European airports that attract investment and skilled workers, and potentially position the EU as a future exporter of eSAF instead of continuing to depend on costly imports.

Europe is a global leader in hydrogen patents, including low-emission solutions, holding a **28%** share of all international patent families (IPFs).

- IEA-EPO Report, 2023

Where applicable, the intermediate products hydrogen and green methanol could contribute to the **greening of local industries such as shipping, mining, chemicals, or steel**. In places where these industries do not yet exist, beneficial production conditions for green energy carriers could further lead to the attraction of energy intensive industry (such as steel), with beneficial effects for job creation and local value added

Technologically too, eSAF is key for Europe’s future. Indeed, the EU holds a significant share of global high value patents and tops rankings for innovation in low carbon fuels, essential for decarbonising aviation¹¹.

Investment in eSAF technologies will turn Europe into a pioneer in aviation decarbonisation and present a much-needed opportunity for re-skilling and up-skilling the European workforce. European industry could lead in exporting key e-SAF technologies, services and equipment, **capturing a share of a EUR 350+ bn global market for aviation fuels by 2050**¹². This could result in an additional **20,000 jobs by 2050**¹³. Investments in eSAF could also create positive spillover effects

⁷ Exploring the potential for cost-competitive e-SAF in European aviation towards 2050, [CS Johansen, 2026](#)

⁸ T&E, [The eSAF market : Europe’s head start and the road ahead](#), 2025, pp. 8-10

⁹ The future of European competitiveness, Report by Mario Draghi, September 2024, p. 221.

¹⁰ For a country like France, eSAF imports could reach EUR 2,6 bn annually as of 2035 in the absence of domestic production.

¹¹ The 2023 IEA-EPO report "Hydrogen patents for a clean energy future" identifies Europe as a global leader in hydrogen innovation, holding a 28% share of all international patent families (IPFs). European innovation is heavily focused on low-emission solutions, particularly electrolysis, and holds a strong position in hydrogen storage and distribution. Germany (11% of global total), France (6%), and the Netherlands (3%) are the leading European countries for hydrogen patent.

¹² This assumes a total SAF demand of ~350 Mt by 2050, an e-SAF share of ~35% and an indicative e-SAF price in the long run of ~3,000-4,000 EUR/tonne ([IATA \(2024\)](#))

¹³ Based on [RMI \(2024\)](#), assuming ~20 Mt of e-SAF production in Europe by 2050 and approximately 40 jobs per 50 ktpa e-SAF plan.

for other sectors, including the maritime industry, by supporting the development of Sustainable Maritime Fuels (SMF) as outlined in FuelEU Maritime.

Moving down the supply chain, the produced eSAF has a higher commercial value than hydrogen itself and can generate significant **export revenues**.

4. ENERGY RESILIENCE AND SECURITY

Domestic eSAF production enhances energy security by reducing reliance on imported SAF and fossil fuels. eSAF projects will increasingly be considered as a strategic importance factor and can contribute to the EU's energy independence goals and aid EU technology competitiveness.

eSAF can be utilised for both civil and military purposes, making it a strategic asset amidst the ongoing geopolitical uncertainty which increases security of supply concerns. By producing fuels locally using renewable electricity, water, and captured CO₂, militaries can break their reliance on volatile international oil markets¹⁴.

Small-scale, modular e-fuel production units can be deployed closer to theatres of operations, decreasing dependence on long, vulnerable supply chains.

Domestic EU production of eSAF reduces the need for imports of fossil fuels for conventional aviation fuels. This decreases Europe's dependence on foreign suppliers, grants autonomy to European fuel suppliers and allows the EU to be in control of its own supply chain.

“The low-carbon energy transition can reduce Europe’s militaries’ dependence on foreign fuel imports and exposure to commodity price shocks, while improving operational effectiveness, ensuring reliable sources of green energy and managing any supply chain dependencies.”

- *Safer Together, Report by Sauli Niinistö, October 2024.*

5. ENERGY FLEXIBILITY AND DEVELOPMENT OF REMOTE RENEWABLE RESOURCES

eSAF can be **easily stored and transported** over long distances without any energy loss. They solve one central problem of the energy transition: the inability to feed renewable energy into the grid continuously and thus have it permanently available. Indeed, renewable energy sources like wind and solar are variable. When supply exceeds demand, renewable energy companies often face **curtailment** (the reduction, restriction, or shutting down of assets).

eSAF production can **contribute to the intermittency and storage challenge** of the energy transition: It balances the electricity grid by using up excess energy, preventing it from being wasted.

eSAF can be produced in remote sunny or windy areas not connected to the electricity grids, or in regions with high hydropower potential. eSAF can be shipped around the world using existing infrastructures, enabling the export of renewable energy to regions with high energy demand but limited local production potential.

Also, where applicable, the intermediate products hydrogen and green methanol could contribute to the **greening of local industries such as shipping, mining, chemicals, or steel**. In places where these industries do not yet exist, beneficial production conditions for green energy carriers, like hydrogen and green methanol, could further lead to the attraction of energy intensive industry (such as steel), with beneficial effects for job creation and local value added.

¹⁴ The Hague Centre for Strategic Studies (HCSS) has just published a white paper on “European Military Fuel Readiness: The Role of Alternative Fuels in Military Logistics” to address the challenge of fuel security and explore the role of alternative fuels in European defence. See [here](#).

6. INDUSTRIAL SYNERGIES: BIOFUELS, CCUS, COMPONENTS

eSAF production (and of intermediate products such as low carbon hydrogen and methanol) presents various opportunities for creating forward and backward linkages to the domestic economy and thus for **contributing to socioeconomic development**.

Clear synergies exist between biofuel, carbon capture utilisation and storage (CCUS), and eSAF production, most obviously via the utilisation of biogenic CO₂ as a feedstock for eSAF production. The synergy lies in utilizing biogenic CO₂ from biofuel processes as a feedstock for eSAF, while employing CCUS to manage waste emissions and optimize carbon efficiency.

By-product CO₂ from fermentation processes and from biomethane plants are among the cheapest sources of CO₂ feedstock for e-fuels production, making e-fuels production a logical development of biofuels production sites.

Moving up the supply chain, local suppliers can provide **finished systems, components**, and other inputs to the e-SAF plants (e.g. solar panels, wind turbines, electrolyzers, and other necessary services and technologies).

7. INDUSTRIAL BY-PRODUCTS OVER EFFECTS FOR OTHER INDUSTRIES

In addition to aviation fuels, the eSAF synthesis process may produce e-diesel and e-naphtha, important feedstock in the chemicals industry and a precursor to gasoline. Depending on the actual Fischer–Tropsch/Methanol-to-Jet refinery designs, in addition to the 570,000 metric tonnes of eSAF needed to meet the RFEU quota in 2030, about 100,000 metric tonnes of **e-naphtha** and 275,000 metric tons of **e-diesel** (about 0.8 % of German diesel sales in 2019) would be produced. Indeed, **e-naphtha** is used as a feedstock for petrol, plastics, cosmetics and pharmaceutical applications.

These secondary products, also CO₂-neutral, could be used to help defossilise the chemicals industry or other difficult-to-abate segments of the transport sector, such as shipping or road transport.