Sustainability Briefing
Are sustainable aviation fuels ready for take-off in 2025?

Sustainable aviation fuel (SAF) is key to reducing emissions in the aviation sector, and is now mandatory within the European Union (EU). As of January 1, 2025, all flights departing from EU airports must be fueled by at least 2% SAF, a share set to rise to 70% by 2050.[1] This requirement can initially be met using biofuels only, such as those produced from waste oils, but from 2030 on specific sub-quotas for e-kerosene will apply.

Although the fuel quota provides a clear pathway for SAF adoption, significant challenges remain in building a future-proof aviation industry. One major obstacle is the high price of SAFs. In 2023, the average market price of SAFs in the EU was around 340% higher than that of fossil kerosene.[2] This price gap may widen without further policy support, driven by the need to blend the more expensive e-kerosene. Another critical challenge is scaling up SAF production – especially e-kerosene – in the EU and globally.

The EU's Clean Industrial Deal announced in February 2025 pledges to address these issues.[3] A key policy focus will be the scaling up of SAF production by increasing the bankability of EU-based projects and reducing the price gap of domestically produced e-kerosene.

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A net-zero aviation future requires large quantities of SAF

Global aviation accounts for around 2.5% of CO_2 emissions.[4] Strong growth in aviation demand is outpacing aircraft fuel efficiency, causing emissions to rise relentlessly.[5]

To reduce aviation-related emissions, SAFs offer a practical solution. Chemically similar to fossil kerosene,[6] these drop-in fuels can be used in high proportions in existing aircraft, can be produced globally, and transported to demand centers using existing infrastructure. The International Air Transport Association (IATA), the leading global industry body representing all actors across the aviation value chain, estimates that SAFs could drive 65% of the emission reduction needed to achieve the body's net-zero emission goal by mid-century.[7]

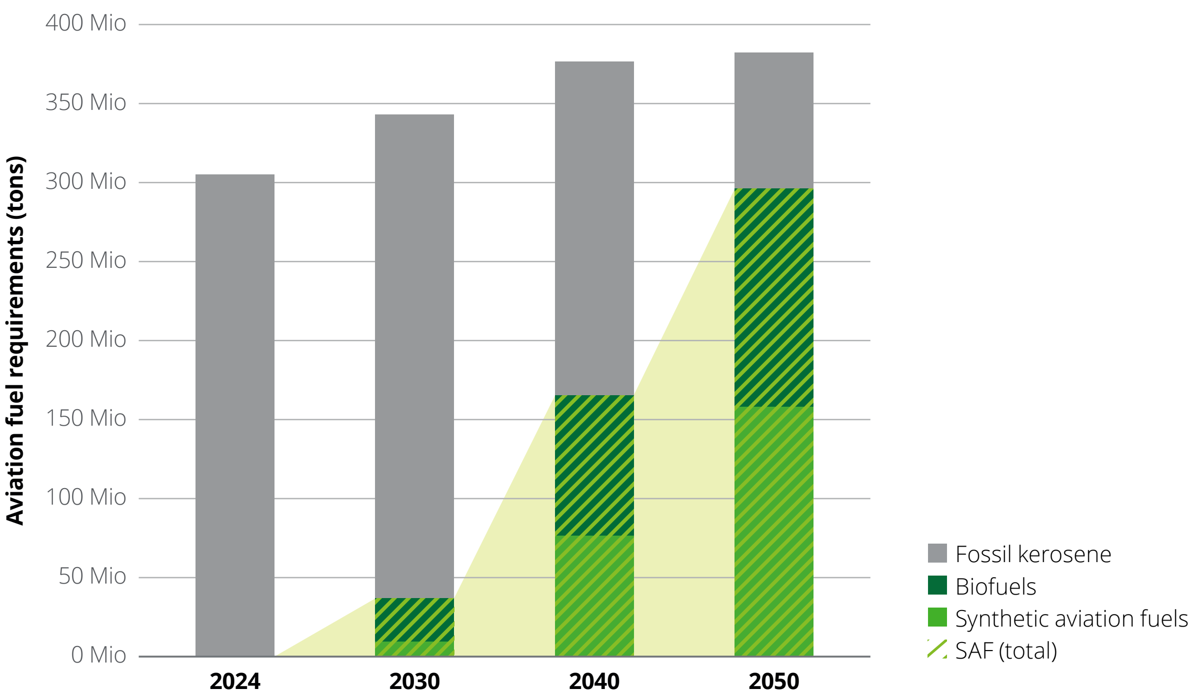
The remaining emission reductions will be met by new aircraft technologies, continued improvement in air-traffic management and aircraft operations, and carbon capture and offsetting.[8]

Creating a net-zero aviation industry thus requires large-scale production and use of SAFs. Deloitte estimates that in a net-zero scenario, total production volumes of SAFs will need to reach 37 million tons by 2030 and 297 million tons by 2050. In the long-term, these volumes will consist of nearly equal shares of biofuel and synthetic fuel, the two main SAF categories (Figure 1).

Aviation biofuels are projected to scale rapidly. They are primarily produced from oils and fats using the so called HEFA (Hydrotreated Esters and Fatty Acids) production pathway, which has long been in use, particularly for biodiesel production. Biofuels can also be produced from other renewable feedstocks, but various sectors compete for their deployment and feedstock is limited, throwing up a barrier to scale production.

Synthetic aviation fuels (also known as e-kerosene) are not yet available on the market but production is projected to ramp up rapidly by 2040. These fuels are produced from clean hydrogen and sustainably sourced carbon dioxide (CO_2) (see box), and offer greater scalability than biofuels, since CO_2 is more abundant than biogenic feedstocks.[2]

Fig. 1 – Achieving net-zero in global aviation requires a massive increase in SAF production.



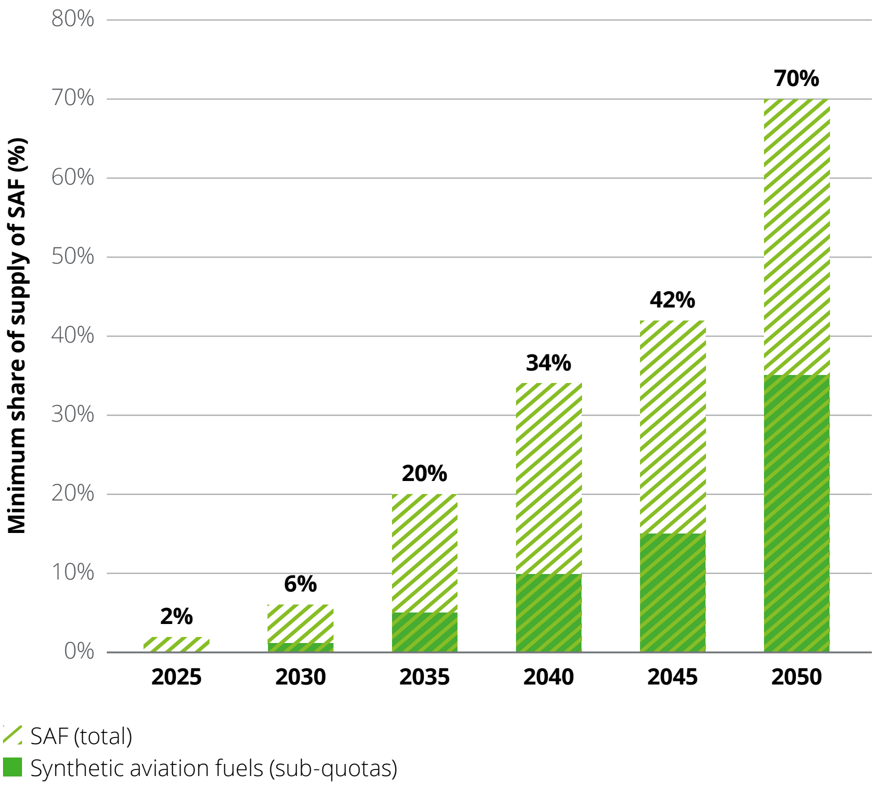
Source: Deloitte. 2024. Low-carbon fuels: The last mile to net-zero.

The EU sets ambitious quotas to enable scaling of the SAF market

SAFs represent a crucial decarbonization solution for the EU aviation industry to reach the Union's goal of a 90% reduction of transport-related emissions by mid-century. But its high production costs mean SAFs are not cost competitive with fossil kerosene, hindering its market uptake. To move SAFs beyond their nascent market stage, the EU is stepping in with ambitious fuel quotas under the ReFuelEU aviation regulation (Figure 2). Starting January 1, 2025, aircraft fuel suppliers must comply with these quotas.

Initially, the quotas can be met using biofuel only. Sub-quotas for e-kerosene apply as of 2030 to address the limited availability of biofuel feedstock. ReFuelEU aviation also aims to prevent unsustainable biofuel production practices by minimizing the risk of increased land use and environmental harm (see box). The EU emphasis on limiting land-use impact distinguishes it from other major biofuel producing countries, which continue to rely on conventional feedstocks such as sugarcane, corn, and soybeans[9], as exemplified by the Farm to Fly Act proposed in the United States.[10]

Fig. 2 – The world's most ambitious SAF mandate started in the EU on January 1, 2025.



Source: Regulation (EU) 2023/2405.

The EU defines the following fuels as sustainable aviation fuels and thus eligible under the fuel quota.[2]

- **Synthetic aviation fuels:** Also known as e-kerosene and power-to-liquid (PtL), these fuels are generally produced from water (H_2O) and carbon dioxide (CO_2). Renewable electricity is used to split water via electrolysis, to produce hydrogen, while CO_2 is captured from the atmosphere (direct air capture, DAC) or from point sources such as biofuel production and, until 2041, from industrial facilities regulated under an effective emission pricing system such as the EU ETS. An exception to this is CO_2 from electricity generation, which is only allowed to be used until 2036.
- **Aviation biofuels:**[11]
  - **Biofuels:** Fuels derived from used cooking oil, certain animal fats, damaged crops and similar feedstocks, typically produced via the HEFA production pathway.
  - **Advanced aviation biofuels:** Biofuels made from feedstocks such as wood, agricultural residue and, under specific conditions, intermediate crops. These production technologies largely lack commercial readiness.
- **Recycled carbon aviation fuels:** Fuels produced from liquid or solid waste streams, or from waste processing gas and exhaust gases of non-renewable origin, that are not suitable for recycling or that are an unavoidable and unintended consequence of the production process in industrial plants.

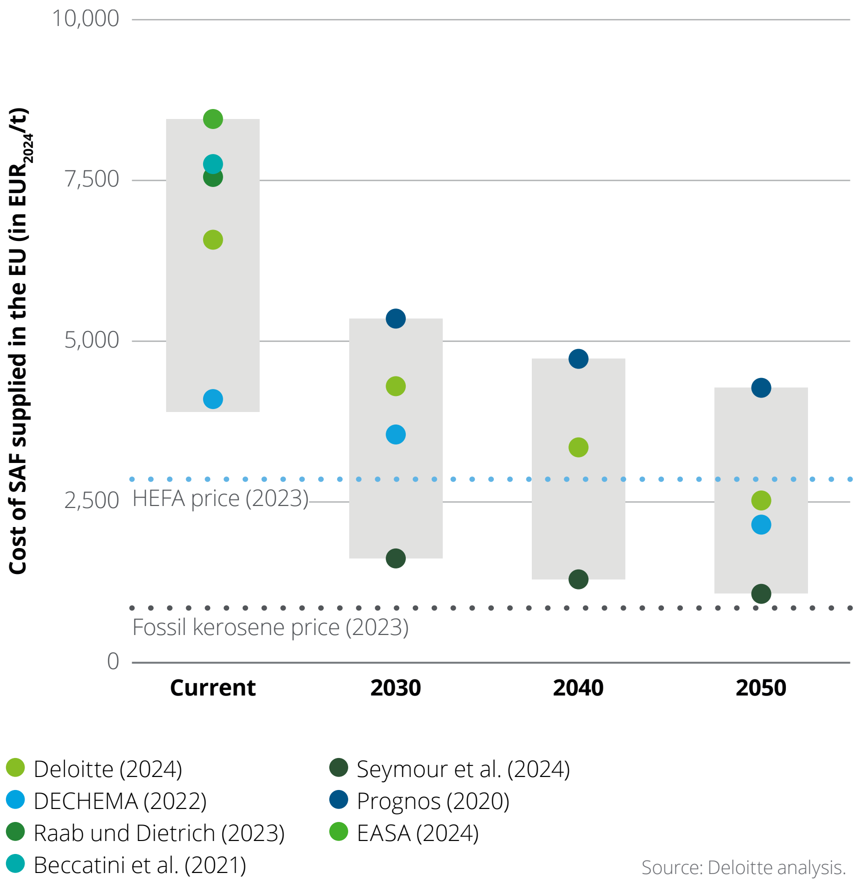
With fuel quotas set to reach 70% by 2050, the EU is taking the global lead in regulatory measures for establishing the SAF market. At the global level, key stakeholders recognize the importance of SAFs in reaching climate targets, and SAF mandates are already being planned and implemented in several countries, including Japan, Malaysia, Canada, Türkiye, and Indonesia.[12] However, only the United Kingdom has introduced a fuel mandate that approaches the level of ambition of ReFuelEU aviation. On January 1, 2025, it implemented a mandatory SAF share that will rise to 16% by 2035, but only to 24% by 2050.[13]

A major barrier to market introduction is the high production cost of SAFs

The SAF mandate aims to accelerate the adoption of alternative fuels by ensuring a steady demand path within the EU, but high production costs remain a challenge for their uptake. In 2023, the average market price of HEFA SAF in the EU was EUR 2,768 per ton – 340% higher than the price of fossil kerosene.[2] Based on these prices, the quota now in place is estimated to lead to a 5% increase in fuel cost.

While HEFA SAF will play a key role in meeting the quota in the coming years, synthetic fuels must be in use by 2030. A review of cost estimates in the literature shows that production costs are expected to decrease over time as production scales and technologies further mature. However, the cost of SAFs produced with CO_2 from direct air capture (DAC) will still be 30% to 280% higher by 2050 compared with the price of conventional jet fuel in 2023 (Figure 3).[14] SAFs produced with DAC are more expensive than those produced with CO_2 from point sources such as industrial facilities. However, as decarbonization progresses, this CO_2 source will become increasingly scarce.[2]

Fig. 3 – Production costs for synthetic kerosene are expected to remain high.



Source: Deloitte analysis.

The main cost drivers of synthetic fuels are stringent energy requirements that lead to significant operating costs, followed by high capital expenditure. Financing costs further contribute to overall expense. Deloitte estimates that the cost of capital for solar power projects, such as those providing the renewable electricity needed to produce synthetic fuels, varies from 7% in Western Europe to about 18% in Sub-Saharan Africa.[15] A key strategy for reducing the cost of the debt and equity and improving SAF bankability is to mitigate risk, including political, regulatory, technical, market, and financial risks.

Building a competitive and sustainable aviation industry in the EU

The mandatory fuel quota in place since January 1, 2025, has the EU aviation industry embarking on an ambitious journey towards a climate-neutral yet competitive future. Major challenges include reducing the price gap and scaling SAF production in the EU and globally.

Several instruments can help reduce costs and improve the bankability of SAF projects, one of which is offtake contracts. These are long-term purchase agreements (typically up to 20 years) with SAF producers that ensure stable revenue streams. Such contracts help mitigate price fluctuation and demand uncertainty, making it easier for producers to secure funding and scale production. For instance, the largest contract in 2024, measured in SAF volume,[16] secures IAG's European airlines a long-term supply of e-kerosene produced by Twelve in the United States.[17]

Meanwhile, none of the planned European production of e-kerosene has yet passed final investment decision.[18] The EU's Clean Industrial Deal promises a window of opportunity, and the European Commission has announced a Sustainable Transport Investment Plan prioritizing short- and medium-term support for sustainable aviation fuels.[3] Specific instruments to reduce the price gap for domestically produced synthetic fuels have been announced for the longer term.[19]

The journey to widespread SAF adoption is challenging, and strategic policy measures, innovative financing solutions, and long-term investment will play a crucial role in preparing sustainable aviation for take-off.

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