SAF deployment is becoming ubiquitous for airlines. Airlines have operated demonstration flights with 100% SAF (typically on one engine only) and many more airlines are making public commitments to buy SAF. More SAF commercial flight announcements are made every day.

Putting together all production pathways, Europe can aspire to produce 3.66 million tonnes of SAF in 2030. This may be sufficient to address the SAF demand from European airlines and their 5% SAF mandate by 2030. It will be insufficient to reach more ambitious targets such as those set by governments or airlines (~10% SAF by 2030).

The mismatch between demand for SAF and the ability to produce it, is not just a European problem. From a sustainability point of view, SAF should be produced close to where it is deployed. Europe needs the equivalent of 7 large SAF production facilities to meet its mandates and more than 14 to meet 10% SAF targets by 2030.

RECENT SAF DEVELOPMENTS

Global jet fuel consumption reached ~290 million tonnes* in 2019. It nearly halved in 2020 but is expected to return to its pre-pandemic levels by 2024. The U.S. Energy Information Administration estimates that the global jet fuel consumption for commercial aviation at 531 million tonnes† in 2050 [EIA, 2022]. Aviation fuel burn contributes to 2-3% of the world's CO_2 emissions, a percentage expected to grow in the absence of sustainability development.

Sustainable Aviation Fuels (SAFs) have been developed as an alternative to standard jet fuel and are seen as the pathway to achieving the goal of net-zero carbon emissions by 2050. Nearly 300 airlines pledged to decarbonise aviation by 2050 – via IATA's Fly Net Zero commitments. Achieving this target will take a combination of SAF deployment (65%), carbon capture and offsetting (19%), new technology (13%) and improved infrastructure and operations (3%).

SAF – primarily biofuel – has been used in commercial aviation for nearly 15 years. The first commercial flight to use SAF took place in 2008 on a Virgin Atlantic flight from London to Amsterdam with a Boeing 747-400 aircraft with 20% biofuel mixed with standard kerosene in one of its four fuel tanks. Since then, the deployment of SAF has grown every year, including 100% SAF-powered flights. United Airlines flew the first commercial flights with 100% SAF (~1.5 tonnes) in one of its two engines on a Boeing 737 Max 8 in 2021, and Airbus performed a test flight on an A380 widebody aircraft with 100% SAF in one of its four engines in March 2022.

Globally, SAF usage reached 80,000 tonnes in 2021 – from only 6.5 tonnes in 2016. The current use of SAF is equivalent to ~50,000 flights like the one United Airlines flew with 100% SAF in one of its engines. The aim is to accelerate production to reach 360 million tonnes by 2050.

The consensus is that SAF supply cannot grow sufficiently fast without government collaboration. EU estimates that SAF demand will increase from 0.05% to 2.8% of airline fuel consumption by 2050 without additional EU intervention [EC, 2021]. ReFuelEU Aviation, the EU initiative part of the "Fit for 55" proposal, aims to boost the uptake of SAF in Europe. The mandate will impose blending SAF with standard jet fuel and will start with a minimum volume of 2% SAF in 2025, increasing every five years to reach a 63% SAF in 2050. It gradually increases the use of mandated SAF to 5% in 2030 and 63% in 2050.

Moreover, some airlines intend to increase SAF usage to even more ambitious levels. For example, IAG deployed ~2.5 tonnes of SAF in 2021 and plans to deploy 115,000 tonnes of SAF in 2030, targeting 25% of its fuel consumption as SAF by 2050. Such exponential growth in demand for SAF requires significant progress in producing SAF.

* All fuel usage numbers have been transformed to tonnes or million tonnes for comparability. Airlines report fuel usage in various units (USG, litres, kg, tonnes, Ktonnes, million tonnes). Some rounding error is introduced when transformations are used, and it is possible rounding errors already exist in the original figures. However, the sense of scale of these statistics is more important than their precision.

† Reported by EIA in 23,662 trillion British thermal units (Btu).

DEMAND FOR SAF IN EUROPE

Fuel burn reporting by airlines is a voluntary metric. Not all airlines choose to disclose this statistic and often report fuel burn reduction instead – either as progress from year to year or as improvement following fleet renewal over a longer time. Some airlines may report CO_2 emissions from which fuel burn could be derived, although not precisely, especially when a combination of carbon offsetting or SAF deployment is used. Estimating the fuel needed in the European market, for example, is not a perfect exercise. However, we derive it from a sample of individual airlines and airline groups that report their aggregate fuel usage. IAG and Lufthansa group, together with Ryanair, easyJet, SAS, Finnair and TAP Portugal, represent nearly 45% of the European fleet size. Their fuel consumption is ~30.5 million tonnes. If this figure is extrapolated based on the fleet size, the total fuel consumption for the whole European fleet is ~68 million tonnes.

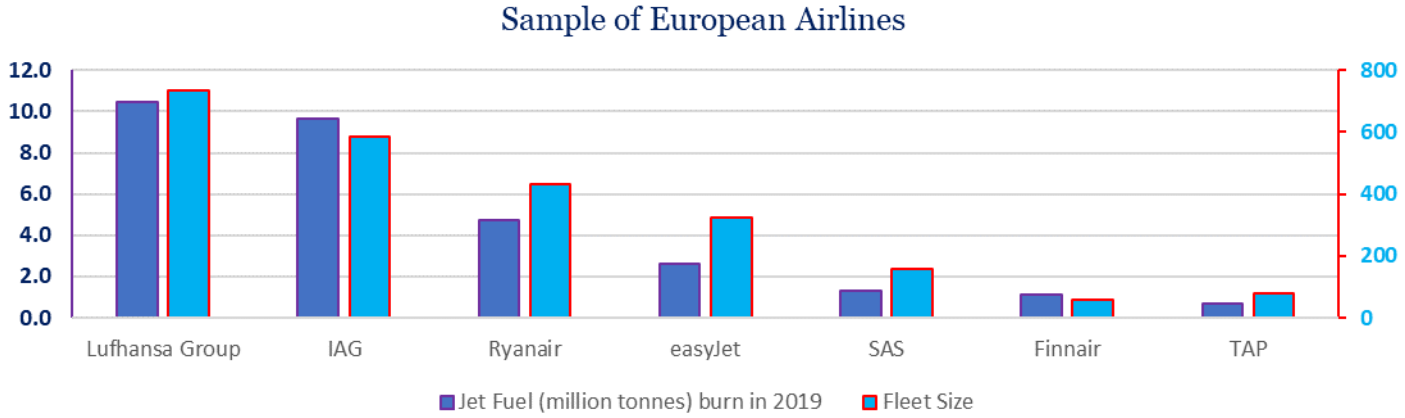

Figure 1. Sample annual fuel burn from 7 European airlines that cumulatively represent 45% of the European fleet. Notably, the other major airline group in Europe, Air France-KLM, does not currently publish fuel burn data.

Making a simplified assumption that the demand for jet fuel in the European market will remain constant at 2019 levels for the rest of the decade, 2022-2030, we simulate the need for SAF by assuming two scenarios. In Scenario 1, we assume the European mandate of 5% SAF by 2030; in Scenario 2, we assume a more ambitious, self-imposed target of 10% SAF for all airlines. We assume an exponential growth model, with little progress in the deployment of SAF in the immediate years and faster catching up toward the end of the decade. To reach these levels of 5% and 10% SAF, the annual growth rate is 0.225 for Scenario 1 (5%) and 0.335 for Scenario 2 (10%). The SAF levels in 2030 are 3.5 and 7 million tonnes for Scenarios 1 and 2, respectively. Cumulatively during this period, 16 and 25 million tonnes of SAF would be required for the two scenarios.

Combining the production of SAF from all its different pathways, of which HEFA contributes 50%, the EU estimates a potential supply of 3.66 million tonnes in 2030 [EPRS, 2020]. This may satisfy the demand side under Scenario 1, but it will be insufficient for the targets under Scenario 2.

One of Europe's largest SAF plants by Shell Energy in Rotterdam, due to begin production in 2024, will have 820,000 tonnes capacity per year, of which half would be SAF [Shell, 2021]. The world's largest biofuel production plant is planned in Panama and will start production in 2027. Once completed, the production of SAF is expected to be 8.35 million tonnes per year, enough to cover all of Europe's demand in 2030 under both scenarios. This facility will become a distribution hub likely serving the Americas. There is an argument for similar large-scale projects in Europe. However, it is more likely that SAF production will remain segmented across smaller production facilities in Europe. Europe needs the equivalent of 7 large facilities, such as Shell's plant in Rotterdam, to meet the 5% mandate in Scenario 1 and at least 14 large plants for the 10% target under Scenario 2 in 2030.

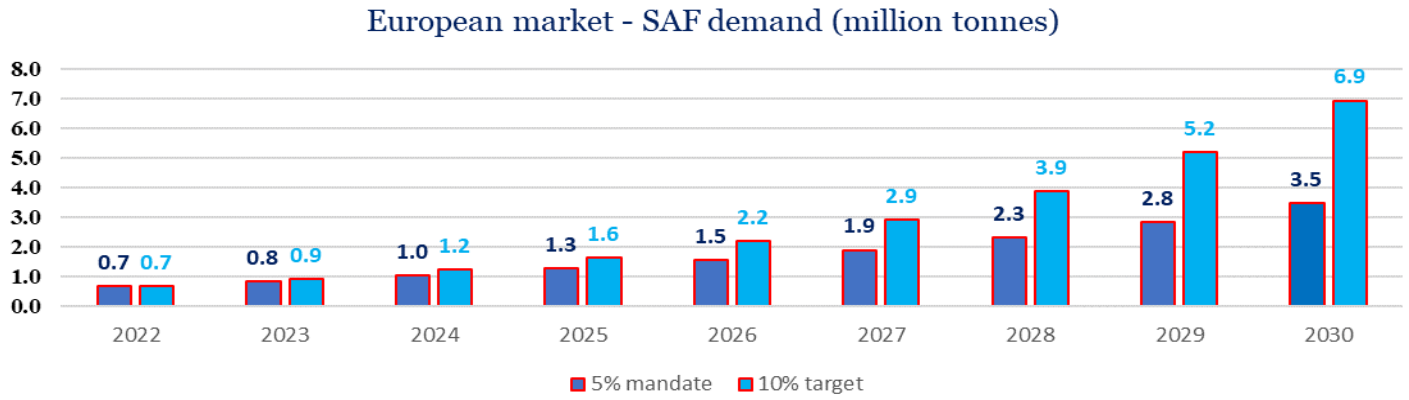

Figure 2. Simulation results: exponential growth in the deployment of SAF under two scenarios. Scenario 1 assumes 5% fuel consumption will come from SAF, i.e., 3.5 million tonnes; Scenario 2 assumes 10% SAF in 2030, i.e., 7 million tonnes. These are conservative estimates based on the assumption the demand for jet fuel remains constant at 2019 levels during 2022-2030.

CONCLUSIONS

SAF production in Europe may be on track to meet the mandates by 2030 but cannot meet higher targets set by governments or airlines. This could improve if policy frameworks were introduced to ease financing SAF facilities and plants were optimized for jet fuel production instead of other biofuels [WEF, 2021]. Europe needs the equivalent of 7 large SAF plants, each able to produce more than half a million tonnes of SAF annually to meet the 2030 mandates or the equivalent of 14 large SAF plants in 2030 to meet the 10% SAF targets by some governments and airlines. To reach 63% SAF in 2050, Europe will need even more SAF facilities and larger-scale plants.

REFERENCES

[EIA, 2022] U.S. Energy Information Administration (2022). "Annual Energy Outlook 2022." Table 47, Air Travel Energy Use. https://www.eia.gov/outlooks/aeo/data/browser/#/?id=57-AEO2022&sourcekey=0

[EPRS, 2020] European Parliament (2020). Sustainable Aviation Fuels. https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/659361/EPRS_BRI(2020)659361_EN.pdf

[EC, 2020] European Commission - ReFuelEU Aviation (2020). Inception impact assessment – Ares (2020)1725215. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12303-Sustainable-aviation-fuels-ReFuelEU-Aviation_en

[Shell, 2021] Shell (2021). Shell to build one of Europe's biggest biofuels facilities. https://www.shell.com/media/news-and-media-releases/2021/shell-to-build-one-of-europes-biggest-biofuels-facilities.html

[WEF, 2021] World Economic Forum (2021). Guidelines for a Sustainable Aviation Fuel Blending Mandate in Europe https://www3.weforum.org/docs/WEF_CST_EU_Policy_2021.pdf

Author Ana Magdalina. Address: Research Department, 4th Floor, Mespil Court, Mespil Road, Dublin, D04 E516, Ireland.
E-mail: ana.magdalina@fpg-amentum.aero

Disclaimer