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Briefing paper

Sustainable aviation fuel: what does it mean for airport expansion?

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Key points

- Sustainable aviation fuels (SAFs) are the aviation industry's main focus for reducing the net CO2 emissions from flying.
- Unsubsidised SAF will never achieve cost-parity with fossil jet fuel.
- Scale-up of SAF will be slow and expensive due to fundamental resource constraints.

Why is everyone talking about SAF and what is it?

Cited as a "game changer" in the announcement of UK government support for a Heathrow third runway, sustainable aviation fuel (SAF) is the only technology already available for deployment which allows flying without burning fossil fuel. There have already been test flights running on 100% SAF, and many airports worldwide – including Heathrow – routinely blend SAF into their fuel.

SAF is broadly defined as a replacement for jet fuel (kerosene, a hydrocarbon liquid typically refined from crude oil) which can be produced without extracting fossil fuels. The carbon within SAF must come from a source which is already part of the global carbon cycle rather than from fossil sources. This can be municipal waste, plant biomass (biofuels), or even CO2 drawn directly from the atmosphere (e-fuels). The basic concept of synthetic fuel production is now a century old, with the most widely-known process (Fischer-Tropsch synthesis) having been developed and deployed in Germany in 1925. But hopes for scaling up alternative fuels for aviation have come into particular focus in recent years given the expectation for all sectors to move away from fossil fuels in order to achieve climate change mitigation targets.

The degree to which a SAF is "climate friendly" depends on how it is produced. When burned, SAF releases as much carbon as conventional jet fuel. The difference is that, in the case of SAF, the carbon released was already part of the global carbon cycle (i.e. carbon which is not permanently sequestered), so in theory there is no net contribution to global warming – it is "net zero" in carbon when considering the full life cycle analysis (LCA). However, this can be compromised if, for example, the SAF is produced using non-renewable energy sources (specifically those using fossil fuels without subsequent carbon capture) or if generating the fuel's raw ingredients ("feedstock") causes additional carbon release (for example, by triggering changes in land use).

At present, hardly any SAFs are fully net zero in their impact. Under UK rules, a fuel can classify as 'sustainable' even if it achieves only a 40% emissions reduction. Furthermore, since SAFs are currently required to be blended with at least 50% fossil jet fuel before they can be used on a commercial flight, a flight using the maximum permitted level of SAF may achieve only a 20% emissions reduction compared to a flight using 100% jet fuel.

Nevertheless, everyone is betting big on SAF. Under the Biden administration, the US set a target of 3 billion gallons (11 billion litres) of domestic SAF production by 2030 with a factor of 10 increase by 2050. The UK and EU have implemented mandates of – respectively – 10% and 6% SAF by 2030, growing to 22% by 2040 in the UK and 70% by 2050 in the EU. Both policies include a specific sub-mandate for e-fuels – those produced directly from atmospheric CO2 without requiring a biological feedstock. Meanwhile the industry body IATA, which has stated a goal of net zero carbon emissions by 2050, claims that 65% of its target will be achieved through the adoption of SAF.

Why aren't we using 100% SAF already?

Despite strong global investment, scale-up of SAF has been slow; globally only 0.3% of the jet fuel burned by civil aircraft in 2024 was SAF, and 6% is considered a "realistic" 2030 target for the EU.

The first cause of slow uptake is cost. The basic steps which apply to refining fossil fuels are still necessary for refining SAF, but with the additional costly and energy-intensive steps of growing or gathering the material and then condensing them into a liquid energy carrier. These costs are highest for e-fuels made using "direct air capture" (DAC), where the carbon must be drawn directly from the atmosphere (a step which means these fuels are generally rated the best in terms of lifecycle analysis). A meta-analysis found that, for SAF production to break even, it would need a minimum selling price of 190 to 500% the price of fossil jet fuel for this reason.

The second challenge is resource availability. The cheapest SAF is made from semi-refined sources such as used cooking oil which are already energy-dense and are generally considered to be waste. However, these resources are limited. As cheap, low-risk options run out, SAF must be produced from resources which are more expensive or in ways which might compromise its sustainability (such as displacing food production or converting land in such a way that stored CO_2 is released). At the other end of the spectrum, DAC e-fuels have an essentially unlimited source of carbon but are very energy-intensive to produce.

SAF will always cost more to produce than fossil jet fuel. This will remain the case even if SAF is scaled up, if production technology is improved, and if subsidies for SAF and/or taxes or other policy-induced costs on fossil fuels are introduced. As a result, while such subsidies might make consumer prices of SAF lower than jet fuel, a political choice to cut those measures would once again make SAF unprofitable.

Meanwhile, even 100% carbon-neutral SAF would not solve all of aviation's sustainability problems. While it might help offset the industry's CO_2 emissions, burning SAF still creates nitrogen oxides (NO_x) that are harmful for the climate and for human health, as well as contributing to the formation of condensation trails (contrails) which are estimated to be responsible for as much global warming to date as all historical aviation CO_2. Although SAF has been hypothesized to help reduce contrail impacts by up to 44%, it will still be only a partial solution.

What does this mean for Heathrow?

Heathrow at its current capacity uses around half of all the fuel burned at UK airports and generates around half the UK's aviation emissions. The question of whether expansion at our biggest airport (alongside other airports being given the green light for growth) is consistent with the UK's climate commitments cannot be answered by an assumption of easy, sustainable, affordable scale-up of SAF.

Significant uncertainties remain about future levels of SAF production and consumption. And, as set out in this briefing, the fundamental cost and resource challenges of producing SAF mean that it's unlikely to be the game changer that many are hoping for.

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