Synthetic fuels in aviation

Synthetic fuels, also known as e-fuels, can make a significant contribution to decarbonising the aviation sector, but there are significant challenges that need to be overcome. This study describes the barriers to synthetic fuels and assesses the potential political measures that could boost their uptake.

Aviation is commonly seen as one of the sectors that will pose the biggest decarbonisation challenge. Given that the sector is expected to grow at an annual rate of 4% until 2050, it can be expected that the resulting emissions will have an increasing climate impact. However, compared to road traffic, air transport has different technical limitations that prevent it from adopting electricity or hydrogen-based decarbonisation in the near term.

The long lifecycles of aircrafts and development time of aircraft engines complicate the need for a fast and widespread transition to new, low-carbon technologies. New infrastructure and globally uniform standards would be required to achieve this transition and the adoption of new technologies. The aviation sector will not be able to sustain a slow and gradual 20-year shift to new engine designs powered by electricity or hydrogen if it wants to start decarbonising in the near future.

Therefore, to limit and eventually decrease carbon emissions, consideration will need to be given to synthetic fuels that are compatible with existing technology, infrastructure and regulation. Fuels fulfilling this requirement are known as ‘drop-in’ fuels as they can simply be dropped into the existing systems.

The two main drop-in fuel types suitable for aviation are biofuels and synthetic fuels. Synthetic fuels for aviation are produced through a power-to-liquid (PtL) process which, when powered by renewable energy, can result in a carbon-neutral, drop-in fuel for the aviation sector. The transition to synthetic fuels could start by gradually increasing the ratio of synthetic fuel to fossil fuel as the existing infrastructure and aircrafts adapt.

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Given their supply levels, biofuels could have an advantage over synthetic fuels in the short term, but synthetic fuels could be favourable in the long term.

Since fuel types will always be subject to fuel standards, they must be 100% compliant with the relevant standards if they are to achieve successful market entry. The existing regulations already allow for a 50/50 blend of synthetic fuel with conventional jet fuel (kerosene). However, the certification of new synthetic fuels requires a large volume for testing, which can be a challenge for producers developing fuels for research and development (R&D) purposes.

Fuel costs are one of the most important items in an airline’s cost structure, which is perhaps the most significant barrier for synthetic fuels. To be competitive in the market, synthetic fuels have to be equal with or below the cost and the performance level of conventional fuels. However, due to synthetic fuel’s more intricate production process, they come at a higher cost, estimated at between EUR 2.26 and EUR 3.25 per litre compared with around EUR 0.40 to EUR 0.60 for jet fuel.

The barriers described above prevent significant growth in synthetic fuel demand, thus hindering the economies of scale needed to lower synthetic fuel prices. This indicates that there is a need for political strategies, frameworks and measures that promote and guide the uptake of synthetic fuels. The main costs in synthetic fuel production are the energy and capital costs. An instrument that could reduce uncertainty for synthetic fuel production is a guaranteed price for these fuels, similar to that specified for renewables in the German Renewable Energy Sources Act (EEG).

A further political measure could come in the form of incentives to develop synthetic fuels, which would help the industry to move towards large-scale commercialisation through economies of scale. State aid through loan guarantees or subsidies to key R&D areas, such as hydrogen production for synthetic fuels, could encourage further private investment by lowering net production costs and investment risk. This approach was demonstrated by the EU REFHYNE project that provided half the cost of the world’s largest electrolyser, which produces 1,300 tonnes of hydrogen per year (one of the main inputs of synthetic fuels) in Wesseling, Germany.

Political measures to incentivise consumption of synthetic fuels will perhaps be the most important factor. One possibility is a carbon price, which is already implemented under the European Emissions Trading System (EU-ETS), although it would require higher prices and fewer free allowances to the aviation sector to be effective. Another instrument could be taxation of fuels or, conversely, the reversal of energy tax exemptions for aviation fuels. Compulsory blending quotas should also be considered, but could prompt logistical issues. On the other hand, green certificates would separate the physical use of synthetic fuels and the monetary support, so overcoming the logistical issues of quotas and allowing gradual implementation.