

SYNTHETIC FUELS



BRIEFING PAPER /
3RD MAY 2022

Production of British synthetic fuels from nuclear sources provides the opportunity for exceptionally high reductions in emissions in the transport sector and could create thousands of high value UK jobs.

The transport sector, including aviation, shipping and heavy road transport, faces competing demands of growing the economic value that travel provides all nations and the absolute necessity to decarbonise transport to help mitigate climate change. The sector is also increasingly concerned about accessing low-carbon fuels at the scale required to meet targets.

Synthetic fuels come from a wide range of sources and potentially offer a Net Zero compliant solution without the need for major infrastructure upgrades or modification to engines or other instruments. Without an alternative to fossil fuels soon, we will be left with several billions of pounds worth of stranded assets and an inability to maintain the current ease of global transport.

However, to be classified as sustainable, synthetic fuels must be deliverable at scale and not displace land needed for other uses, such as agriculture. Delivery is therefore currently limited by availability of feedstocks and the maturity of the technology, which is not yet cost competitive with traditional fossil-based products.

Decarbonising transport

1. Transport produced 27% of the UK's total emissions in 2019. Of this, the majority (91%) came from road transport vehicles (111 MtCO₂e)¹
2. Flights are the most carbon-intensive way to travel (domestic flights 254gCO₂/km per person, long haul flights 195, driving alone 171, bus 104, rail 41)²
3. Annual cost of health damages from transportation emissions hit \$1 trillion in 2015³

What are synthetic fuels?

Synthetic fuel is a carbon-neutral alternative to traditional fossil fuel that has significant potential in being the climate friendly choice of the transport sector in its Net Zero plans due to having similar energy densities to fossil fuels and ability to “drop in” to current fuel transportation systems (i.e. pipelines) and engines.

There are two main types of synthetic fuels we will be referring to in this briefing:

- Electrofuels, which are made when captured CO₂ reacts with H₂ made from the splitting of water powered by low-carbon electricity or heat
- Biofuels, which are made through the chemical or thermal treatment of biomass or biofuels (Note: we are not including fuels that do not include low energy input, such as those that go through fermentation.)

The clean electricity needed to create sustainable fuels can be supplied from low-carbon sources, such as nuclear power or renewables. However, with renewable-generated electricity, the UK Government has suggested only excess output can be used to produce hydrogen and synthetic fuels as electricity is needed to power homes and buildings. This would mean there would need to be an additional scale of generation capacity and storage to mitigate the intermittency of these technologies.

Nuclear energy provides consistent, low-carbon power and can therefore be considered a more reliable feedstock.

¹ Transport and environment statistics: Autumn 2021, Department for Business, Energy & Industrial Strategy, October 2021 <https://www.gov.uk/government/statistics/transport-and-environment-statistics-autumn-2021>

² Greenhouse gas reporting: conversion factors 2019, Department for Business, Energy & Industrial Strategy, June 2019 <https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019>

³ Vision 2050: A strategy to decarbonize the global transport sector by mid-century, International Council on Clean Transportation, September 2020 <https://theicct.org/publication/vision-2050-a-strategy-to-decarbonize-the-global-transport-sector-by-mid-century>

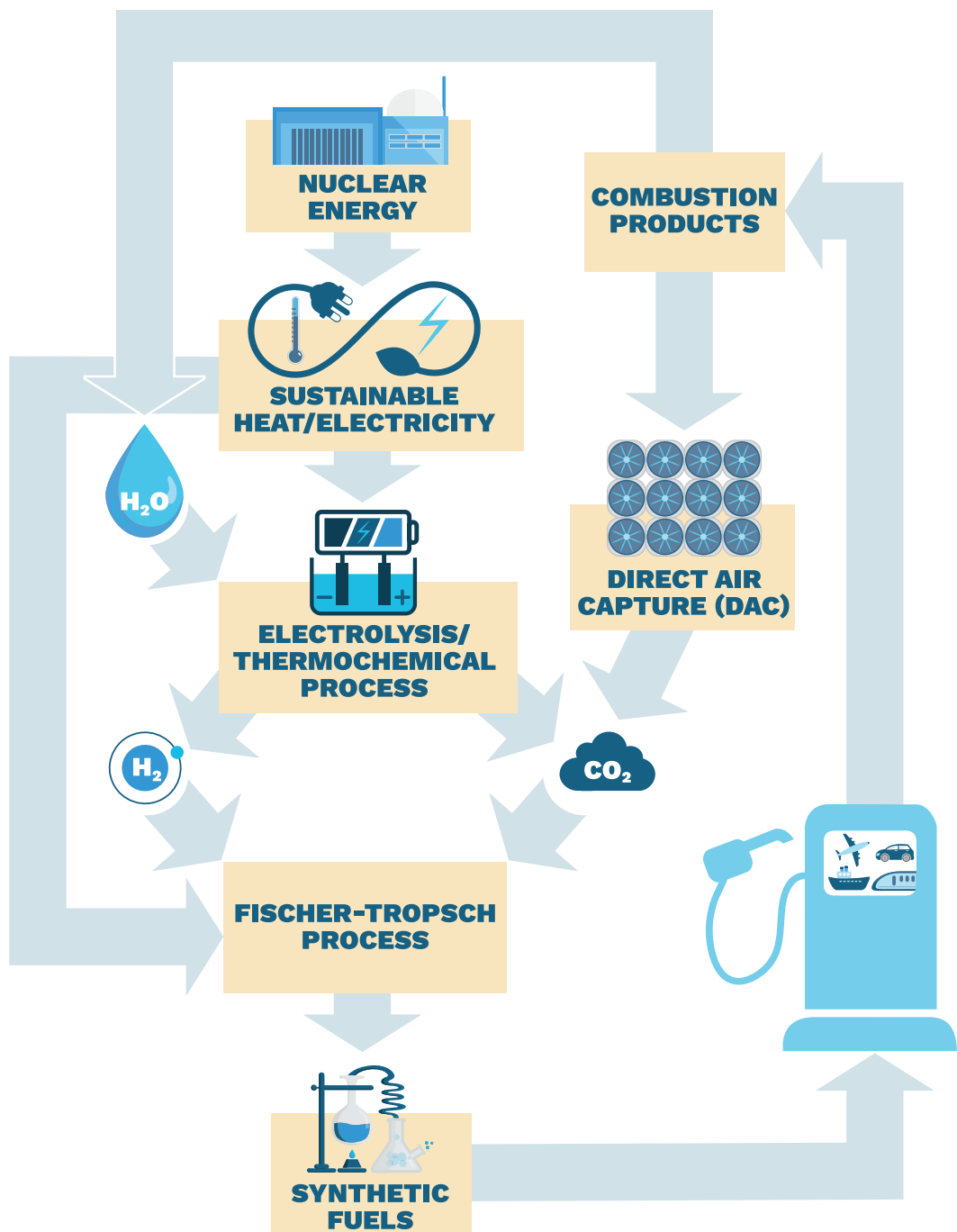
How does it work?

There are multiple technical pathways from nuclear energy to synthetic fuels that have been identified, which are likely to be included in the Department for Transport's (DfT) Sustainable Aviation Fuels (SAF) Mandate. This mandate would require the aviation sector to use an increasing percentage of synthetic fuels—which fall under the category of SAF—towards 2050, so long as the production route offers at least a 75% reduction in emissions compared to traditional fossil fuels.

Nuclear power can help produce synthetic fuels by:

1. Generating low carbon electricity and heat to enable hydrogen production through electrolytic and thermochemical processes;
2. Nuclear heat can drive Direct Air Capture (DAC) technology, which extracts CO₂ directly from the atmosphere. This CO₂ can be recycled from burning synthetic fuels and can be synthesised again to make more fuel;
3. Low-carbon power from nuclear can be used to drive synthetic fuel production processes, such as Fischer-Tropsch, to make synthesise hydrocarbons.

FIGURE 1
PRODUCTION ROUTE FOR SUSTAINABLE AVIATION FUEL



Several steps in the process are already proven with commercial solutions already being explored by companies in the nuclear sector. Others require investment to enable innovation leading to at-scale production including the coupling of all technologies together.

Nuclear-derived synthetic fuels could propel the transport sector to meet its growth targets while delivering on decarbonisation obligations and adding major value to the UK economy with domestic nuclear energy deployment alongside synthetic fuel production. To achieve this requires early decisions on nuclear energy development and deployment, and innovation in the application of nuclear to drive existing technology.

Economic opportunity

With applications across the aviation, shipping and road vehicle sectors worldwide, the opportunity for nuclear-derived synthetic fuels is highly significant.

For example, the global market for aviation fuel alone is currently predicted to be \$240 billion by 2026⁴ and the global synthetic fuels market is predicted to be valued at \$15.3 billion by 2030,⁵ due to the amount of decarbonisation needed in the aviation sector.

Current analysis of decarbonisation routes for the transport sector relies heavily on DAC, as the industry assumes constraints in the use of synthetic fuels mean the technology is not able to be delivered at scale.

While there are world leaders in the research of synthetic fuels, such as the US, Scandinavia and the Netherlands, no country has cracked the code yet. If the UK can become a leader in this area, the export opportunity is sky-high.

There is also an opportunity beyond synthetic fuels, as nuclear-derived sustainable fuels can help to decarbonise other forms of transport that do not suit electrification, and hard to abate sectors such as plastics, steel, ceramics and other energy-intensive industries.

Recommendations

1. Include synthetic fuels from nuclear sources in DfT's SAF mandate when it is passed into legislation.
2. All relevant UK bodies including Government departments and teams to recognise the opportunity presented and consider actions they can take in collaboration to deliver benefits to transport, aviation and nuclear sectors, and the UK overall.
3. Initiate a programme of research and innovation devoted to nuclear-derived hydrogen and synthetic fuel production to rapidly move the necessary technologies to commercialization, including demonstrating and incentivising DAC technology development.
4. Include nuclear-derived synthetic fuel production in the necessary UK national infrastructure planning activities and initiate activities to identify suitable UK sites or combined nuclear and synthetic fuel production systems.
5. Government and non-government Net Zero modelling and assessment should include nuclear-derived synthetic fuels and be based on the costs of nuclear energy when financed with a Regulated Asset Base model.

⁴ Aviation Fuel Market, Allied Market Research, March 2020 <https://www.alliedmarketresearch.com/aviation-fuel-market>

⁵ Global Sustainable Aviation Fuel Market (2020 to 2030) - Rising Demand for SAF by Airlines Presents Opportunities, ResearchAndMarkets.com, October 2020 <https://www.businesswire.com/news/home/20201022005788/en/Global-Sustainable-Aviation-Fuel-Market-2020-to-2030---Rising-Demand-for-SAF-by-Airlines-Presents-Opportunities---ResearchAndMarkets.com>

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