Feature

Expert view: Why combining biomass and green hydrogen may solve...

Airbus A350-1000 refuelled with SAF © Airbus

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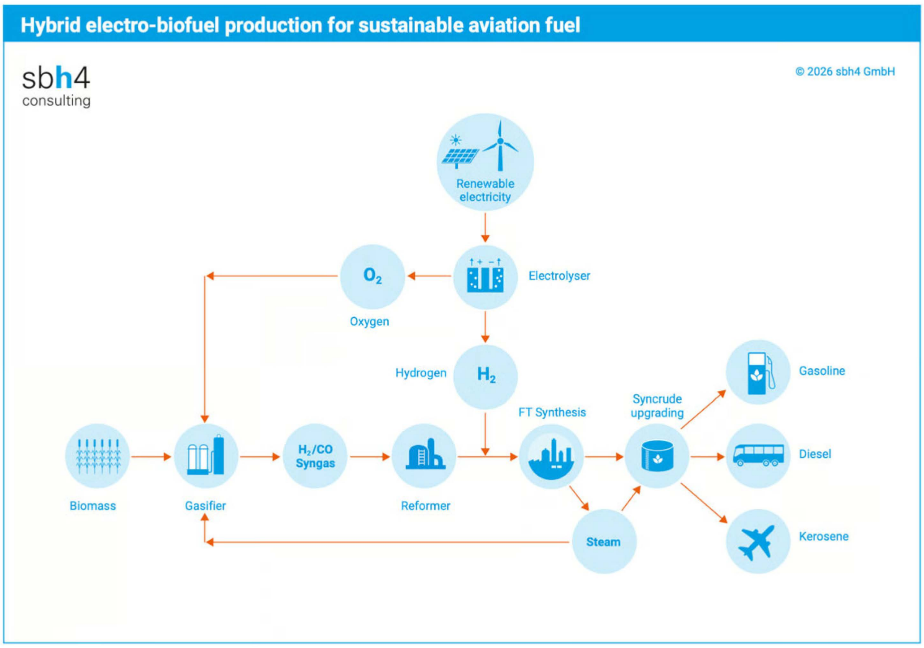
Today, all sustainable aviation fuel (SAF) pathways face structural barriers to widespread adoption.

Power-to-liquid (PtL) methods using green hydrogen face cost pressures and competition for renewable electricity. Gasification from biomass sources faces finite feedstocks and hydrogen-deficient syngas.

However, combining the two imperfect processes could unlock affordable and scalable SAF production.

Easing both challenges

Questions remain over whether PtL is the best use of green electricity, given surging global power demand and the continued reliance on fossil fuels for generation. Furthermore, demand for clean power from data centre build-out will push up prices for renewable energy and make green hydrogen economics even more challenging.



Gasification of residual biomass, such as forestry cuttings and post-harvest waste, is an alternative pathway to produce SAF, which is more affordable than the pure electrofuels route.

The challenge of the gasification-only process is that the syngas produced is very rich in carbon monoxide (CO), but it does not contain sufficient hydrogen to produce liquid fuels such as kerosene and diesel. Looking into the very long term, the amount of available forestry waste is finite and driven by timber production, which is the primary use of the harvested tree.

By combining both, forestry waste biomass resources could be extended by green hydrogen to mitigate the scalability concerns. The carbon from the biomass is fully utilised with minimal carbon dioxide (CO2) emissions. And the high cost of the pure electrofuel is reduced through the combination with the more affordable waste biomass feedstock.

Waste to value

To ease the pressure on biomass feedstocks, municipal solid waste (MSW) and industrial wastes can be used as an alternative to, or supplement to, biomass as feedstocks for the gasifier.

MSW contains about 50% of biogenic material. Furthermore, the re-use of the fossil components of MSW to produce fuel avoids the need to extract virgin fossil fuels and thereby reduces overall carbon dioxide emissions.

Residual forestry biomass may cost in the order of €100 ($117) per tonne when chipped and delivered to the gasifier. On the other hand, the use of MSW will result in a 'gate-fee' revenue stream for waste disposal, in addition to the sale of fuel from the process. This can improve the project economics and tip the balance in favour of using MSW as the gasifier feedstock.

FTS fuels

Fischer-Tropsch synthesis (FTS) is a core technology for bio-electrofuels production. It reacts CO with hydrogen to form a mix of hydrocarbons known as synthetic crude, or syncrude. Like fossil crude, it must be refined to yield marketable liquid fuels.

Isomerisation, hydrocracking, hydrodeoxygenation and hydrotreating may be required to achieve the 'jet' specification for aviation kerosene. These are hydrogen-consuming processes used in many petroleum refineries today. The emerging world of electro-biofuels can leverage experience and expertise from the established energy sector.

FTS tends to produce a mix of linear, paraffinic hydrocarbons of various chain lengths. Some of these paraffins are too short to be used as diesel or kerosene, and others are too long. The long, waxy molecules can be hydrocracked to make smaller chain hydrocarbons, which are suitable for diesel and kerosene. Hydrogen reacts with the waxes in the presence of a catalyst to crack them.

During FTS, it is likely that oxygenates like alcohols and esters may be formed. They can be corrosive and damaging to fuel storage infrastructure. So, hydrogen is reacted with these molecules to remove the oxygen atoms and yield water.

Making the grade

Another processing requirement of FTS syn-crude is isomerisation. A mixture of linear hydrocarbons can freeze at the very cold temperatures encountered during high-altitude flight.

Isomerisation converts the long straight paraffins to branched hydrocarbon isomers and takes place in a reactor in the presence of hydrochloric acid and a catalyst, which is often based on platinum.

The isomerisation reaction itself does not consume hydrogen. However, hydrogen is added in the overall isomerisation process to support side reactions such as the cracking of carbon-carbon double bonds that may simultaneously take place.

Isomerised, non-linear molecules remain liquid at colder temperatures. This is essential for aviation fuel, since the temperature at high altitude can be as low as -40 °C. Thankfully, the 'jet' fuel specification is very strict about controlling these safety-critical aspects of liquid fuel quality.

Bio-electrofuels projects

The energy transition is awash with project 'announcements', many of which never proceed beyond a pre-feasibility study. Some have been overly speculative and unlikely to progress beyond early-stage development.

On the other hand, hybrid electro-biofuels projects are perceived by many to be in the sweet spot of clean fuels, and are being catalysed by the biofuel and PtL sub-mandates within SAF adoption regulations in the EU and UK.

These are the kinds of projects that should, and will, make it through front-end engineering design and final investment decision to commercial operations.

As an example, at its BioTJet project in Pardies, France, Elyse Energy has proposed biomass torrefaction, grinding and entrained flow gasification using the Thyssenkrupp PRENFLO technology for syngas generation.

Syngas processing and FTS fuels production and upgrading will then take place using the Axens GASEL technology. Axens is both an equity partner and key technology licensor, and will provide performance guarantees around many aspects of this project.

32,000 tonnes per year of electrolytic green hydrogen will enrich the hydrogen content of the gasifier syngas to produce SAF and naphtha as bio-electrofuels. The electrolyser park is known as H2-Lacq.

BioTJet and H2-Lacq are two key components of the wider E-CHO industrial hub project, which additionally includes bio/e-methanol production from electrolytic hydrogen and the CO2 produced during the biomass gasification process. This aspect of the project is referred to as eM-Lacq.

The integrated plant is slated to go online towards the end of this decade.

Projects such as this illustrate how hybrid pathways may offer the most credible route to scaling SAF within real-world resource and cost constraints.

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