Sustainable Aviation Fuels III – Industrial Landscape

Introduction

In the previous instalment of the Sustainable Aviation Fuels (SAF) article series, we had a look at the technologies which are currently available for the production of SAF, and which currently supply the market. In addition, we also provided an overview of two up-and-coming technologies which are likely to revolutionise the aviation sector: e-fuels and hydrogen propulsion.

The first commercial partly SAF-powered flight took place in 2008 and was spear-headed by Boeing, Virgin Atlantic and GE Aviation[i]. The International Air Transport Association (IATA) now estimates that since 2016, more than 370,000 flights were performed using a blend of SAF, across 45 airlines worldwide[ii]. Late in 2021, United Airlines performed the very first commercial flight powered by 100% SAF[iii]. The SAF industry is evolving rapidly, driven by the continuous and increasing regulatory support across the world, and by the sustainability commitments announced by multiple leading private businesses and initiatives.

The continued use of fossil resources without a plan to transition to low carbon sustainable fuels is no longer a viable business model for airlines and suppliers. Although some studies have predicted that at current use rates oil and gas extraction sites will dry up in around 50 to 60 years[iv], or at least that fossil resources are finite, it is also argued that new technologies could allow the oil and gas industry to continue supplying fossil fuels for a lot longer[v]. However, it will become increasingly untenable to use such fuels in a zero carbon economy.

Demand is already shifting and more people (mainly younger generations) and businesses, recognize and value sustainable and renewable alternatives over fossil-based options[vi]. It is therefore advantageous for businesses to transition to this new demand, and develop lower cost technologies so that demand can be economically met.

In this third and last instalment of the SAF series, we look at the current industrial landscape for SAF, taking a closer look at the key players within the industry and providing a clearer picture of the current market. The sector is currently dominated by a handful of producers and distributers, working alone or in partnership to establish SAF supply chains. This article demonstrates that these companies use a range of the technologies we have previously reported on, showing that SAF production is a flexible, reliable and deemed to be an economically viable investment under current and emerging drivers for uptake.

Neste

Neste Oyj is a Finnish oil refining company which has placed itself as one of the leaders in the sustainable aviation fuel industry. Neste uses HEFA technology[vii] to produce their patented MY Sustainable Aviation Fuels™, a commercial process run at significant scale. As of today, Neste has an annual capacity of 100,000 tonnes of SAF. This production capacity is expected to increase to 1.5 million tonnes by the end of 2023[viii]. Neste currently has SAF production plants in Porvoo (Finland), Rotterdam (Netherlands) and Singapore. The increase in production planned for 2023 will be the result of expansion works at the Rotterdam and Singapore plants[ix].

LanzaTech

LanzaTech was founded in New-Zealand in 2005 and now has its headquarters in the US, along with offices in several other countries across the world. The company specialises in carbon recycling into fuels and chemicals[x]. In 2020, LanzaTech launched LanzaJet with the aim to support the decarbonisation of the aviation sector through the production of SAF. LanzaJet uses the Alcohol-to-Jet (ATJ) technology to produce SAF from bioethanol. The bioethanol can be derived from conventional or lignocellulosic sources or derived from its proprietary fermentation technology platform. This utilizes microorganisms to ferment carbon monoxide, that can be derived from gasification of biomass to produce syngas, or recycled fossil sources such as steel mill gas, into ethanol[xi]. This year, LanzaJet is expected to open its first ATJ production plant, which is being built in Georgia (US), and which will produce 10 million gallons of SAF from sustainably sourced waste-based ethanol[xii]. The company is also joining forces with SAF supplier SkyNRG to build the first ATJ production plant of its kind in Europe. The new facility, which is expected to be fully operational from 2024, will supply up to 30,000 tonnes of SAF produced from waste-derived ethanol[xiii].

SkyNRG

SkyNRG is a Dutch SAF supplier which also uses HEFA technology to refine waste oils into sustainable aviation fuel[xiv]. Due to concerns over the long-term availability of waste oils, the company is also actively involved in projects which aim to develop alternative feedstocks and technologies to mitigate potential waste oil shortages[xv]. As of today, SkyNRG has supplied SAF to 30 airlines across the world. It now aims to developed a "self-sustaining network of regional supply chains" which it refers to as "Direct Supply Lines" (or DSLs). Each DSL will be designed to refine local feedstocks in a local SAF production plant, and will set up a network of long-term offtake partners which will distribute and utilise the SAF. The first DSL of its kind (DSL-01), is currently under construction in Delfzijl, in the Netherlands. The plant will use local used cooking oil and industrial waste oils as feedstocks to produce SAF, BioLPG and naphtha. The plant will also be powered by green hydrogen, and SAF supply to the local airport will be delivered using pre-existing infrastructure. Once completed, the plant is expected to produce 100,000 tonnes of SAF.[xvi]

Fulcrum BioEnergy

Fulcrum is a US-based company which uses the process of gasification combined with the Fischer-Tropsch technology[vii] to convert municipal solid waste (MSW) into biofuels, including SAF[xvii]. The company's first "waste-to-transportation" plant became operational at the end of 2021 in Nevada (US). It is expected to produce as much as 11 million gallons of renewable synthetic crude oil (or syncrude) annually. This syncrude is then further refined into usable biofuels by partner Marathon Petroleum, a petroleum refining company[xviii]. Fulcrum has also applied to build a SAF production plant in the North-West of England (in Stanlow), which would convert non-recyclable household waste into an annual capacity of 100 million litres of SAF. If successful, the so-called Fulcrum NorthPoint facility should become operational from 2025 and supply regional airports such as Manchester Airport[xix].

Total

Total is a French energy company created in 1924. Total's business relied on the exploitation of fossil resources, however, Total's current ambitions have evolved to include a lot more renewable and sustainable alternatives to fossil fuels[xx]. Total's sustainability ambitions include SAF, which the company now produces from waste oils using the HEFA production pathway. In April 2021, Total began producing SAF at its La Mède and its Oudalle biorefineries in France[xxi]. La Mède alone has the potential to produce 100,000 tonnes of SAF per year[xxii]. All the SAF produced by Total in France is supplied to French airports across the nation. From 2024, Total is also expected to produce as much as 170,000 tonnes of SAF annually at its new Grandpuits biorefinery, situated near Paris[xxiii].

Air BP

BP was created in London in 1909 and quickly positioned itself as a global leader in energy supply, mainly through the exploitation of fossil resources such as coal, oil and natural gas. In the 1920s, BP created its aviation branch, AirBP, which became famous as the company that supplied the fuel for the first transatlantic flight in 1927[xxiv]. Today, AirBP is implanted in 600 airports across 55 countries, and is now in charge of pursuing BP's sustainable aviation fuel ambitions. AirBP is a supplier of SAF which it acquires from producers around the globe. In addition, the company also invests in biorefineries where their partners produce SAF. For instance, BP invested in Fulcrum's Nevada biorefinery which became operational in 2021[xxv].

Gevo

Gevo Inc. is a US biofuels company which produces a range of products, including SAF. The company uses the ATJ production pathway, converting carbohydrates into iso-butanol and, subsequently, converting this iso-butanol into ATJ-SPK which is suitable for blending in conventional plane engines[xxvi]. In 2021, Gevo announced its Net Zero Projects endeavour. Renewable fuel production plants will be built to produce SAF and renewable gasoline, while simultaneously producing large amounts of feed for cattle. This will result from the corn used as feedstock, from which the starch will be used to produce the renewable fuels. The remaining corn residues will be used as feed[xxvii]. As of today, Gevo has secured contracts for the production of around 123 million gallons of SAF and renewable gasoline annually[xxvii,xxviii].

Phillips66

Phillips 66 is a US-based refining company which specialises in energy and chemicals production. Although the company mainly deals in petroleum-based products, it has begun expanding its activities to incorporate the production of SAF from waste feedstocks. Phillips 66 will start producing SAF at its UK Humber Refinery in 2022 and will deliver it directly to UK airports via existing infrastructure. The fuel will be supplied to British Airways, with whom Phillips 66 signed a multi-year SAF supply agreement in late 2021[xxix]. With this plant, the company will become the first to produce SAF in the UK.

Velocys

Velocys is a UK-based renewable fuels producer which uses waste-based feedstocks and the gasification/Fischer-Tropsch processing pathway to produce SAF and biofuels for heavy-duty transport vehicles. Velocys is currently developing a plant in Immingham in the UK, where it aims to produce SAF made from household and commercial waste which would otherwise be landfilled or incinerated. Once completed, the plant will use up to 500,000 tonnes of municipal mixed waste and will have an annual production capacity of 20 million gallons of SAF[xxx]. Velocys and British Airways are collaborating to develop the Immingham plant and their waste-to-jet technology through their joint venture Altalto[xxxi].

Commercial collaborations

For SAF to become widely used, commercial supply chains must be established. Here, SAF producers form partnerships with fuel suppliers and/or users (such as airlines), to allow for the successful distribution of the product. All of the companies presented in this article are involved in such commercial partnerships, one of which was briefly mentioned in the case of BP and Fulcrum. The diagram below presents a few instances of current SAF producer/supplier partnerships:

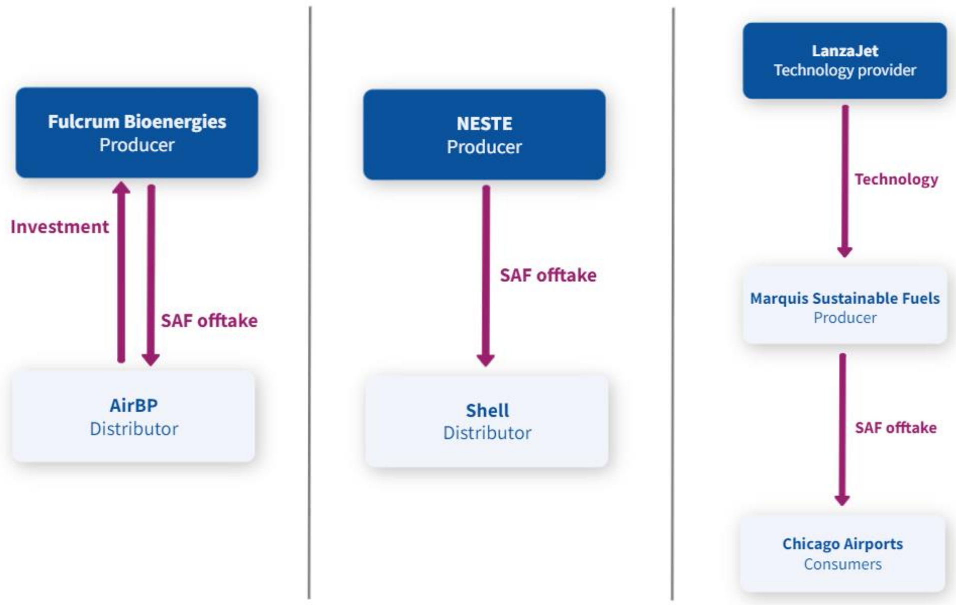

Table 1. Examples of established commercial SAF supply chains[xxxii,xxxiii,xxxiv].

Conclusion

Through this series of articles, we can see that sustainable aviation fuels are fast becoming recognized as part of the world's sustainability and decarbonisation ambitions. While industrial stakeholders continue to be at the forefront of technological innovation, international leaders are starting to offer more support to the SAF industry to ensure its success and longevity.

Currently, the main issue remains scale. For the aviation sector to reach its 2050 decarbonisation goal, billions of litres of SAF will be needed on a yearly basis. Upscaling production presents major issues and it will be a difficult balancing act. The added costs of SAF are borne by fuel users and their passengers with uptake driven by a mix of international agreements and in the near future by possible likely inclusion mandates and GHG reduction targets. Alongside this the sustainable supply of feedstocks will have to be ensured. The first large scale supply chains are still in their early stages of development. Supply of individual base feedstocks, such as used cooking oil may yet be a limiting factor for some fuels, but the diversity of conversion technologies and associated feedstocks, as well as opportunities for carbon capture through e-fuels should support significant sector development.

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