HVO making it big

The Neste HVO production facility in Rotterdam, the Netherlands, is the largest in Europe and among the largest in the world

Hydrotreated vegetable oil boasts a great number of advantages over traditional biodiesel, among them lower emissions, higher fuel efficiency and a chemical structure identical with petroleum diesel. With the growing interest in all markets, particularly in Asia, and the many new production facilities scheduled to come online in a few years, HVO could be the fuel of the future. *Ile Kauppila*

The times in the biofuel sector are a-changin'. In the last decade, the marketplace for diesel based on hydrotreated vegetable oil (HVO) has developed rapidly. Production has increased exponentially and new producers keep popping up to try their luck as demand ramps up in both traditional and new markets. But the greenhorns face tough competition as Finland's Neste – the world's largest HVO producer – seems to reign supreme in the sector.

But what is HVO? Isn't it just another name for biodiesel or is it something different altogether? Neste's head of technical services Markku Honkanen and head of market intelligence Anselm Eisentraut talked to *Oils & Fats International* to explain the basics of HVO and its future prospects.

Feedstock flexibility

HVO can be produced through several processes, such as hydrocracking, but perhaps the most common is hydrodeoxygenation, also known as hydrogenation or simply hydrotreatment. In this process, hydrogen is added to either a plant- or animal-based feedstock. It combines with oxygen, thus removing water from the mix and resulting in a renewable, paraffinic fuel product.

Honkanen and Eisentraut say that in the last decade or so, the feedstocks used to produce HVO mostly consisted of vegetable oils. For example, in 2007, when Neste opened its first commercial scale facility – which was also the world's first HVO plant of this scale – in Porvoo, Finland, co-located with the company's crude oil refinery, it processed mostly palm oil. According to the firm, at this point, palm oil made up 90% of its HVO feedstock.

Palm oil, however, suffers from a bad reputation regarding its sustainability. The EU has decided to phase high ILUC-risk vegetable oils out of its list of sustainable renewable fuels by 2030m including palm oil. Combustion engine manufacturer Volvo Penta – which in the beginning of 2016 approved HVO as a fuel in all of its diesel engines – also notes that other vegetable oils, such as soya and rapeseed, require immense areas of land to produce the quantities of oil needed for HVO production.

As a result, HVO producers have begun to move away from vegetable oils. "These days HVO is produced to a growing degree from waste and residue oils and fats. These come from food, fish and slaughterhouse industries and non-food grade vegetable oil fractions," say Honkanen and Eisentraut.

Neste – a member of the Rountable on Sustainable Palm Oil (RSPO) since 2006 and the holder of the world's first RSPO-RED Supply Chain sustainability certificate – has cut the share of palm oil in its feedstock mix from 90% palm oil to 80% waste and residue materials, such as used cooking oil (UCO). In addition, other possible waste feedstocks include animal and fish fat and camelina, soya and rapeseed oil refining residues.

"Neste uses more than 10 different raw materials to produce our renewable products," say Honkanen and Eisentraut. "An extensive raw material base provides flexibility, as it allows us to respond to the needs of different markets and customers."

Differences with biodiesel

The large number of feedstocks from which HVO can be produced and the fact that HVO is often marketed as a petroleum diesel replacement means the product often gets confused with 'traditional' biodiesel. However, Honkanen and Eisentraut say that the two are completely different products, despite


Photo: Neste

their superficial similarities.

"The chemical composition of HVO is similar to that of conventional diesel. It can be blended with fossil diesel in all proportions or used as a 100% pure product. The maximum allowed concentration of fatty acid methyl ester (FAME) biodiesel in regular diesel in Europe is usually 7% due to quality reasons," they say.

Unlike most traditional biodiesels, HVO can be stored for a long period of time without major changes to its properties. Additionally, HVO does not accumulate water, which Honkanen and Eisentraut say is sometimes a challenge with biodiesel. "Biodiesel should be used within six months from its manufacturing date to minimise the potential of changes in product quality and the risk of microbial growth," the two note.

HVO also benefits from better cold weather performance when compared to biodiesel – an important property in northern countries like Neste's home Finland. For example, the cloud point, indicating the lowest possible storage temperature, of Neste's HVO fuel is -34°C, while the cloud point of rapeseed biodiesel is only -10°C, say Honkanen and Eisentraut. The cold weather characteristics of HVO can be adjusted during the manufacturing process.

The cetane number of HVO – the indicator of how easily a fuel ignites in the engine, with a higher number signifying better ignitability – is higher than traditional biodiesel's or even fossil diesel's. Biodiesels generally have cetane numbers in the range of 50-60, which is roughly similar to petroleum diesel.

HVO, on the other hand, boasts cetane numbers above 70. Honkanen and Eisentraut say the high cetane number helps engines start in cold weather and lowers fuel consumption, particularly in urban environments.

Last, but not least, HVO does not contain any sulphur or aromatics, and so generates few impurities in an engine. According to an August 2017 study by Gladstein, Neandross and Associates for two southern California air quality management districts, HVO reduces nitrogen oxide (NOx) and particulate matter (PM) emissions by 13% and 29%, respectively.

Honkanen and Eisentraut say that the savings are higher the older the vehicle in which the fuel is burned is. It also generates no ash, which may extend the service life of particle filters. Biodiesel, on the other hand, can generate more NOx emissions than fossil diesel due to its oxygen content. Honkanen and Eisentraut note that the emissions from fossil diesel may also decrease the life span of motor oil and particle filters.

Growing production

In the global HVO marketplace, demand is set to be growing and there may soon be a supply stream changing geographical shift eastward. So far, according to second generation biofuels broker Greenea, most of the fuel demand has come from Europe and North America, but there is growing interest coming from Asia, which could change the map of the HVO supply sector.

Currently, the global installed HVO production capacity stands at 4.745M tonnes (*see Figure 1, pg20*). Neste is the largest producer in the HVO market with a capacity of roughly 2.6M tonnes/year, divided between four plants in Finland, the Netherlands and Singapore. In Italy, ENI has started production at its Venice plant, which has a 350,000 tonnes/year capacity, while in France, Total's La Mede refinery is set to come online soon, adding 500,000 tonnes/year of production capacity to the EU sector.

On the other side of the Atlantic, Renewable Energy Group and Diamond Green Diesel have a combined production capacity of 750,000 tonnes/year, says Greenea. Out of the two, Diamond holds more capacity, having in 2017 expanded its full capacity to more than 800,000 tonnes/year. However, most companies are planning expansions and new players are entering the marketplace. Greenea expects global capacity to grow by more than 40% by 2020, reaching 6.7-7.5M tonnes, if all the expansion projects go through.

While the EU and the USA are poised to remain the top markets, Asia is rising in the marketplace both due to increasing interest of Asian economic superpowers – like China and Japan – to boost their share of the renewable fuels market and the number of planned new production capacity in Asia. HVO-based aviation fuel is also an up-and-coming market segment, says Greenea, although full realisation of HVO's potential could take several years.

Regulatory daydream

Because of the shift to waste feedstocks, Honkanen and Eisentraut note that the name HVO is, in fact, becoming an inaccurate term to describe the product manufactured by most current producers. Indeed, since the product is to an increasing degree not manufactured from vegetable oil, the title HVO sounds like an oxymoron.

"However, product names cannot be ▶


Markku Honkanen, head of technical services, Neste


Anselm Eisentraut, head of market intelligence, Neste

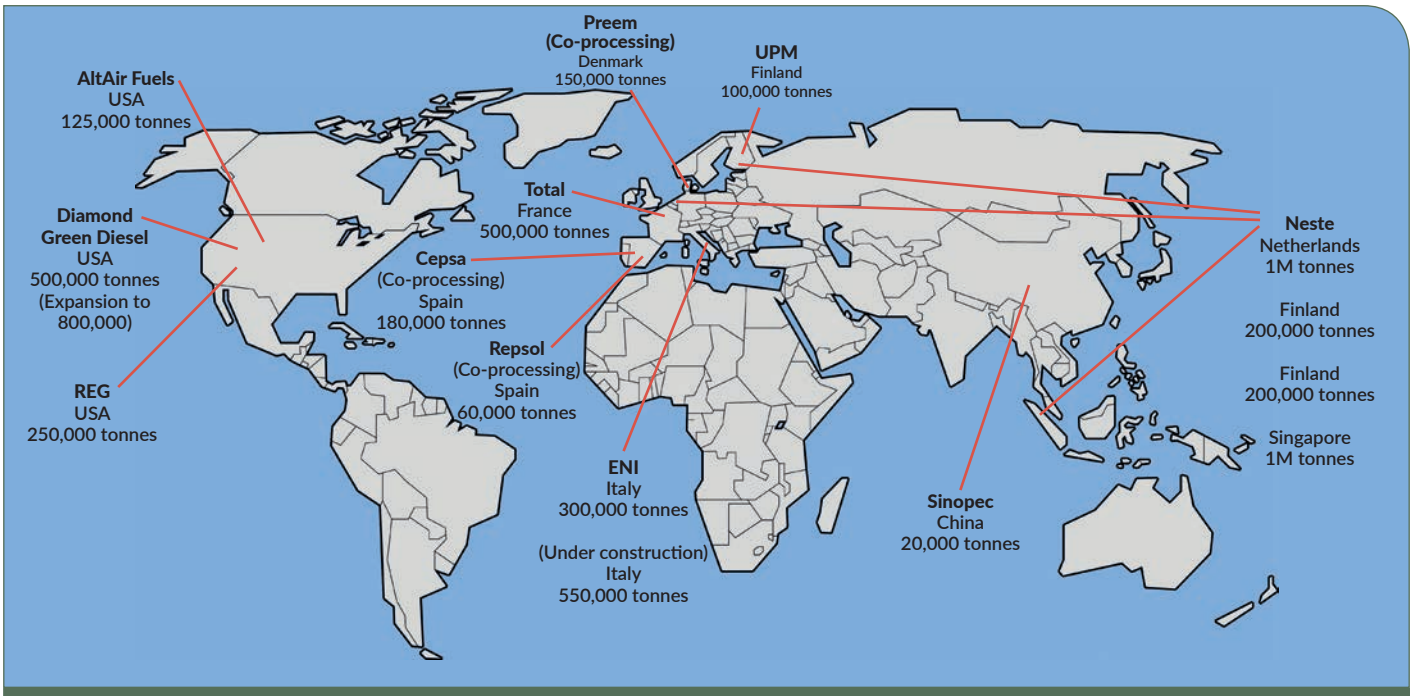

Figure 1: Current and planned HVO production units

Figure: Greenea, Neste

▶ easily changed to better describe the origin of the fuels, as they are common in European regulation, fuel standards and biofuel quality recommendations set by automotive companies," they explain.

As the fuel is popularly called HVO, despite the actual feedstock used to make it, the term might cause some confusion among consumers. Therefore, producers often give their products different brand names. Neste, for example, calls its product Neste MY Renewable Diesel, while both Diamond Green Diesel and ENI have titled their fuels Green Diesel.

Regulations-wise, HVO is a relatively non-problematic fuel. Due to its identical chemical composition with petroleum diesel, it does not suffer from the limits imposed on the blending of conventional biodiesel. The EU, for example, limits conventional biodiesel blending at 7% based on the EN590 diesel standard, while elsewhere in the world blending limits of 10% and 20% can be found. High concentrations of traditional biodiesel can cause problems with engines, says Neste, but HVO poses no such problems.

"In fact, HVO is the biocomponent recommended by the latest and strictest Worldwide Fuel Charter (WWFC) specification. WWFC 5 does not allow the use of traditional biodiesel, but it does recommend the use of renewable diesel because of its high cetane number, for example," say Honkanen and Eisentraut.

To ensure compliance with EU renewable fuel regulations, Neste spearheaded the development of the HVO Verification Scheme (HVO-VS). Approved by the EU Commission, the HVO-VS is a sustainability verification system designed to verify biofuels' compliance with the sustainability criteria embedded in the EU Renewable Energy Directive (RED). The scheme is audited by an independent third party and is currently used to verify RED compliance of waste- and residue-based biofuels.

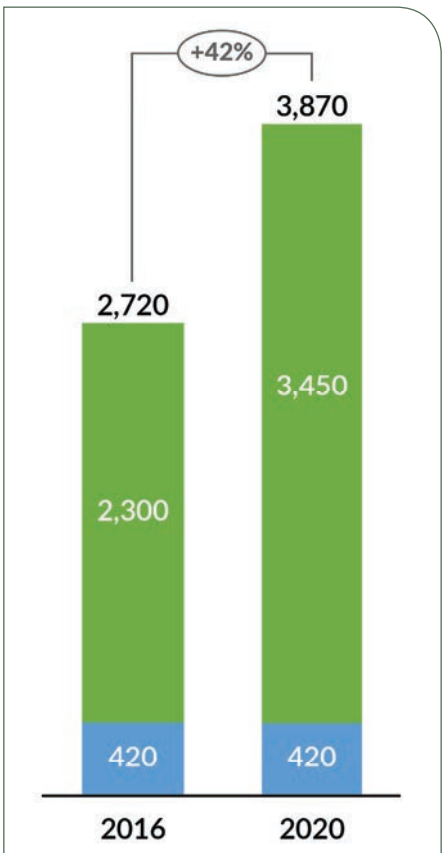

Figure 2: EU HVO capacity ('000 tonnes)

Figure: Greenea

Others catching up?

Both Honkanen and Eisentraut and Greenea trust that the future can be very bright for HVO. "We believe that the demand for renewable diesel will continue to increase globally, going forward, as more and more countries and regions are stepping up their emissions reduction ambitions," say Honkanen and Eisentraut.

For the sovereign market leader Neste, development of pre-treatment capabilities is a key focus area. Additionally, Honkanen and Eisentraut list non-technical challenges such as regulatory developments, ensuring and further developing sustainability and developing new customer segments for renewable diesel and jet fuel as issues producers will be concentrating on.

Greenea notes that HVO price development will be an interesting factor to keep an eye on. US producers are expected to increase their output in the next few years, which should positively influence liquidity on the market. Greenea says this might put pressure on prices, breaking Neste's near-monopoly.

But Honkanen and Eisentraut are not worried, saying that while some might consider the price of Neste's HVO fuel a disadvantage, that is not the case.

"Indepedent research shows that HVO – such as Neste MY Renewable Diesel – is one of the cheapest options to reduce emissions in transport. And it is the only option that can be adopted now, without any modifications into engines or fuel distribution systems," they say. ●

Ile Kauppila is the former assistant editor of OFI