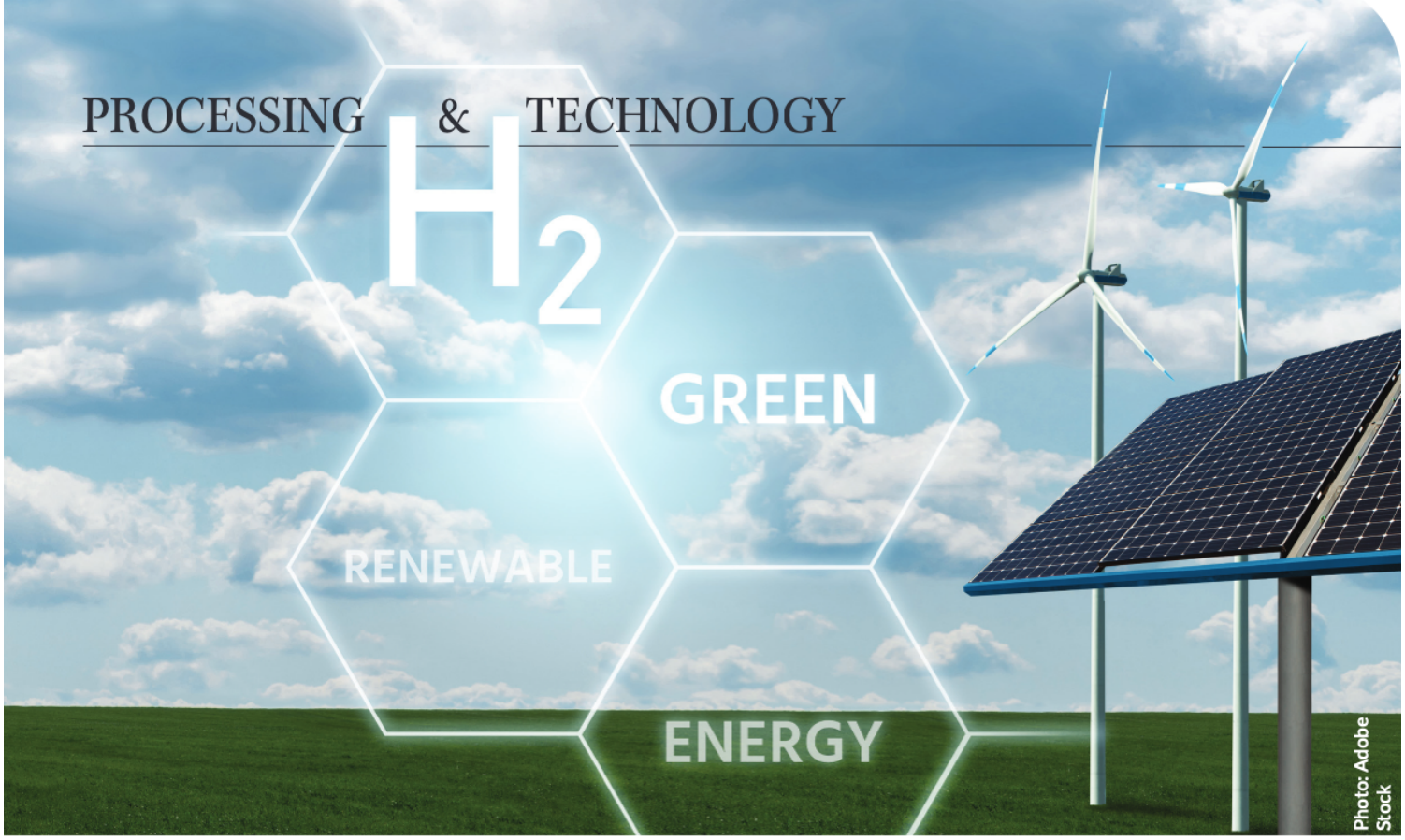

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Towards green hydrogen

Lack of reliable supply is driving edible oil refiners and other end users towards on-site hydrogen production, with green hydrogen emerging as a competitive option

Ile Kauppila

Hydrogen is the single most abundant chemical in the universe. It makes up roughly 75% of all normal matter. However, if the element is so common, why are hydrogen end users – such as hydrogenated or hydrotreated vegetable oil producers currently dealing with a shortage?

The answer lies in hydrogen's nature. Although abundant, most hydrogen on Earth is bound into molecules, like water or various organic compounds.

As a result, pure hydrogen must be commercially produced. And, as with so many other industries, the unprecedented world events of the last few years have changed the hydrogen landscape, Tom Skoczylas, regional sales manager for Western North America, Latin America, and South Asia at Nel Hydrogen, tells *Oils & Fats International (OFI)*.

"For many commercial facilities, hydrogen is a utility, not unlike electricity or cooling water in a chemical plant. So the reliability of on-time supply is critical, and with the logistics crisis and the increased demand for hydrogen, the reliability of that supply is in jeopardy," says Skoczylas.

The current lack of reliable supply is driving edible oil refiners and other end users towards on-site hydrogen production, boosting investment in hydrogen production technologies. Due to the current political and economic climate, green hydrogen is emerging as a competitive option that could lead the entire hydrogen industry to become more environmentally friendly.

Hydrogen comes in many colours

But what exactly is "green" hydrogen? Hydrogen itself is colourless but the different colour codes associated with it refer to the method used to produce it. The most common types of hydrogen are:

- **Brown (or black) hydrogen**: Hydrogen that has been produced through the gasification of coal, which releases large amounts of CO_2 and carbon monoxide into the atmosphere.
- **Grey hydrogen:** Hydrogen produced from natural gas through steam methane reforming (SMR), which also releases CO_2.
- **Blue hydrogen:** Hydrogen sourced from natural gas where the CO_2 emissions are captured and stored through carbon capture, storage, and utilisation (CCSU) technologies.
- **Green hydrogen:** Hydrogen produced through the use of renewable energy and technologies that create zero CO_2 emissions.

There are also other less common or experimental production methods, such as turquoise, purple, pink and red hydrogen. However, the quartet previously mentioned are currently the only commercially viable production methods.

Green is inching ahead

In recent years, there has been an increasing push towards green hydrogen production over other colours.

According to Skoczylas, this translates to a growing adoption of electrolysis. "Green hydrogen can only be produced with electrolysers, at least commercially. That is, using electricity to separate water into hydrogen and oxygen gas," he says.

As Skoczylas explains, electrolysis – sometimes called power-to-gas – works by directing an electric current into water through a positively charged cathode and a negatively charged anode. The current splits water molecules into their two constituents, hydrogen and oxygen, with hydrogen appearing at the cathode. The hydrogen is collected and used as it is, or mixed with other compounds.

The process is relatively simple, and chemistry teachers regularly showcase it ▶

Edible oil producers use hydrogenation to turn liquid oils into more solid fats, as well as to increase an oil's

in classrooms at a small scale.

Indeed, electrolysis and green hydrogen are nothing new, says Skoczylas. "Original commercial electrolysers could have been green 100 years ago if the electricity was renewable. In fact, Nel Hydrogen had many of its systems installed as early as the 1920s and 1930s, and they were green because the electricity came from hydropower."

This highlights one significant factor in green hydrogen production: the electricity used to make it must come from renewable sources. If the power originates from a coal plant, for example, the gas is no longer green, but brown, Skoczylas says.

Electrolysis may currently be the most viable green hydrogen production method, but it is not the only one. For example, American H2-Industries has received preliminary approval to build a first-of-its-kind green hydrogen plant in Egypt using the company's proprietary thermolysis technology to convert organic, plastic, and sewage waste into hydrogen.

The plant would annually transform 3.6M tonnes of waste into more than 270,000 tonnes of emissions-free hydrogen at half the cost of current technologies, H2-Industries says in a statement. The company, however, did not have a projected opening date at the time of writing.

Driving economics

The global shift towards more environmentally-friendly policies has definitely contributed to green hydrogen's popularity. But Skoczylas emphasises that there is another major factor at play as well.

"What's really driving the forward progress with green hydrogen is that the economics are now coming into alignment to produce green hydrogen that is more competitive. That has been attributed to the reduction in electricity prices, primarily because of the increase in installation capacities of renewable power production systems like solar and wind."

As a result of increased renewable power capacity, Skoczylas says the cost of green hydrogen has fallen below that of grey or brown hydrogen in parts of the world where solar or wind power are abundant.

"The success in the renewable energy industry is what's driving the interest in green hydrogen production, enabling cost reductions and increased interest in capacities."

However, on average, green hydrogen costs roughly US$$3-9/kg, while the price for grey hydrogen varies between US$1-2.50/kg, according to PWC Global.

The challenge of supply

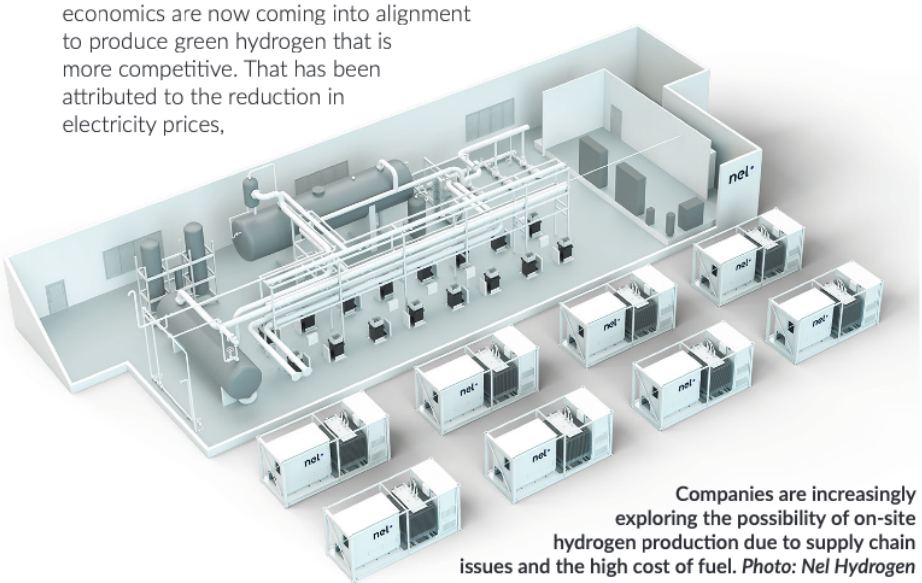
Although the cost of pure hydrogen at the point of production has gone down in some parts of the world, that has not transferred to the end users, such as edible oil producers. Instead, the price of the gas has only increased.

"The traditional hydrogen supply mode to the market is via large centralised production facilities. The gas is repackaged and distributed by gas companies to consumers in the form of liquid or gas, hauled by trucks in cryogenic tanks or compressed tube trailers and bottles. The price of gas supplied in that manner has certainly increased," explains Skoczylas.

He sees two factors driving the hydrogen costs up. Firstly, there are the supply chain issues affecting all industries in the world. Feeding into these problems is the high price of fuel. Since hydrogen is delivered to local markets in a liquid form stored in truck-hauled tankers, the basic cost of moving hydrogen is steadily heading upwards.

The second issue is demand and data from the International Energy Agency (IEA) illustrates this. Hydrogen demand has been increasing steadily for the past 20 years, reaching roughly 90M tonnes in 2020, and it shows no signs of slowing down. As hydrogen producers – whether green, grey, brown or blue – can easily find buyers, they can set their prices. Naturally, this means the prices will go up.

For end users, this poses a problem. They are paying more for hydrogen but due to the logistics crisis, what they buy may not show up when they need it.



Companies are increasingly exploring the possibility of on-site hydrogen production due to supply chain issues and the high cost of fuel. *Photo: Nel Hydrogen*

Edible oil refiners

This situation is leaving hydrogen end users in a difficult position. Among them are edible oil refiners. Although they are small in numbers compared to the largest hydrogen consumers (ammonia production and petroleum oil refining),

stability and shelf life *Photo: Adobe Stock*

hydrogen is a vital commodity to this industry. The most common applications are the production of hydrogenated and hydrotreated vegetable oils (HVO).

Edible oil refiners use hydrogenation to turn unsaturated, liquid oils into more saturated solid fats. They use a nickel catalyst (which is removed in the final product) to combine the fat with hydrogen, reducing the number of carbon-to-carbon double bonds in lipids. As a result, the oil becomes solid at room temperature, enabling it to be used to replace butter or animal fats in cooking, spreads and other food uses. Additionally, hydrogenation increases the fat's oxidative stability and shelf life.

HVO, on the other hand, is a biofuel produced from various vegetable oils and animal fats, such as canola, palm or waste cooking oil, or tallow. In the production process, the feedstock oil or fat is first hydrogenated – as in edible fats production – to remove double carbon bonds in the triglycerides.

This process is followed by hydrocracking, which uses hydrogen gas to break molecules to improve the quality of the fuel. HVO is similar in quality to biodiesel and they both use the same feedstock, but biodiesel is produced through transesterification.

Whether they engage in hydrogenation or hydrotreatment of edible oils, producers need their hydrogen supply to be reliable. As the global supply chains struggle, they are increasingly exploring the possibility of on-site hydrogen production, says Skoczylas.

"If producers are buying hydrogen distributed to them from a gas company, the price of that hydrogen is mostly dependant on the transport distance. To make their own hydrogen, what drives the cost of the hydrogen per kilogramme is the CapEx on the production equipment and electricity price. What's really attractive about on-site production is that your cost per kilogramme of hydrogen is almost 90% electricity," he explains.

As a result of the growing appeal of on-site production, hydrogen solution companies like Nel Hydrogen are now seeing increased investment in hydrogen production equipment. However, Skoczylas notes that all of that investment is not going strictly to green hydrogen.

"There are lots of assessments being done, on a project-by-project basis, on whether to choose grey or green. It's really coming down to the economics. There's some political pressure to go green and if the economics are favourable, chances are that the consumers will utilise green technology, but it may not be a requirement," says Skoczylas.

He adds, though, that there is another significant factor weighing the scales towards green – public opinion. Pressure from the market may drive edible oil refiners and other hydrogen consumers to choose green hydrogen over grey, even if the immediate economics might not be better. Green hydrogen can allow companies to market their products as more environmentally conscious, which may give them an edge over competitors.

Rising hydrogen demand

If the demand for hydrogen is high now, it is about to grow even higher. Neither market research companies nor Skoczylas see any reason for the demand to shrink. This should give hydrogen producers a significant boost.

"We see significant and tremendous growth in the next 5-15 years. You can practically categorise it as exponential growth. It's partly because of the increased demand for green hydrogen as a function of the reduced cost of electricity from renewable sources, and the global and political drive to reduce greenhouse emissions. Electrolysis technology enables producers to achieve that," says Skoczylas.

Indeed, PWC Global projects hydrogen demand to rise from the roughly 80M tonnes to anywhere between 90-200M tonnes by 2030. By 2050, the demand could reach a high of more than 600M tonnes, depending on climate change developments and governmental policies, the professional services firm says.

Industry predictions also support the view that demand is going up. For example, Data Bridge Market Research estimates that the hydrogenated oils market will grow at a CAGR of 4.3% between 2022 and 2028, with its value more than tripling to US$100.84bn. This growth, driven by an increasing demand for hydrogenated palm oil, bakery goods, and beauty products, directly translates to a higher need for hydrogen. HVO production, meanwhile, is projected to rise from 7M tonnes in 2020 to 29.5M tonnes by 2025.

Capacity growth is coming

So, does this mean the price of hydrogen will keep creeping upwards? Not necessarily. S&B Global Platts Analytics estimates that an additional 3.4M tonnes of new annual green hydrogen capacity will come online by 2025.

Total electrolyser deployment should advance even faster in the five years following, hitting 16.7M tonnes by 2030. Meanwhile, blue hydrogen production capacity is seen to increase from 2.5M tonnes now to nearly 25M tonnes by 2030, according to Quantum Commodity Intelligence.

Skoczylas agrees that the capacity for green – and otherwise coloured – hydrogen is increasing. He further explains that, against some market predictions, the new capacity may not be where one would expect.

Certainly, the initial spike will be in Europe, the USA and China because that is where the hydrogen is mostly consumed. Going forward, however, he says that green hydrogen production will move to other places, such as South America.

"For example, take Chile. In the south, they have capacity factors for wind plants that are approaching 90%. There's a unique region in Patagonia where the wind is very reliable and predictable. And then you have the north of Chile, which has high elevation, very good solar radiation and very little cloud coverage. It's a lot easier to make investments in production facilities because you can expect the ROIs."

With that renewable energy, regions like Chile and the Middle East could rise to become major hydrogen producers, which could drive down the price of green hydrogen.

And that, says Skoczylas, is what will ultimately entice more edible oil refiners and other consumers to move away from polluting grey and brown hydrogen.

"All these industries are looking for two things. They want anything that can reduce the cost of the hydrogen they depend on. And if they can do it in a green fashion, then that's just gravy on top," he concludes. •

Ile Kauppila is OFI's former assistant editor