WIND-TO-HYDROGEN

Winds of change for green hydrogen

Artist's rendition of an offshore platform able to produce green hydrogen from offshore wind energy at an industrial scale using electrolysis. Energy experts from Tractebel Engineering and offshore engineers from Tractebel Overdick are developing the concept which could be deployed, for example, in the North Sea.

Image: Tractebel-engie

Hydrogen is firmly back on the energy agenda, with production of the gas using excess electricity generated by offshore wind farms being a central concept. Here, *Nick Cottam* looks at the attractions and advantages of 'green' hydrogen production – which could be used to fuel oil refineries, among other uses.

At the time of writing the wind is blowing a hooley along the English East Coast and it's not difficult to be confident that all those offshore turbines are doing their job. In the past decade or so the proportion of UK electricity generation from wind has risen from just 3% to over 20%, and East Anglia with its long stretch of flat, relatively shallow coastline is leading the charge. By the same token, as economies of scale ramp up and supply lines mature, the cost of all this wind power has also fallen dramatically, according to analysts at BloombergNEF, by over 30% for new projects between 2018 and 2019.

What does this mean for the industrialised world? More wind power certainly, and an accelerating drive to electrification, but how to harness that power and make it readily available to meet areas of intense demand? Enter hydrogen and, even more relevant in an era of net zero carbon targets, the goal of producing green hydrogen – at scale.

'The energy transition calls for guts, boldness and action,' noted Marjan van Loon, president-director of Shell Nederland at the unveiling of plans for NortH2, currently Europe's largest green hydrogen project. As part of this project Shell and its partner Gasunie want to power a large hydrogen electrolyser sited in the Dutch port of Eemshaven by up to 10 GW of offshore wind, producing 800,000 tonnes of green hydrogen annually by 2040.

The challenge for those who want to produce green hydrogen is how to achieve the scale needed to meet demand at a sensible price. Some of us remember those school chemistry lessons in which hydrogen was produced from the electrolysis of water. Electricity went in and about the same amount of hydrogen came out as steam. So far so good, but trapping and storing that hydrogen, let alone using it seemed like an unimaginably tall order.

Times, though, are a changing. The policy goal of a greener, healthier, low carbon economy is forcing us to fall out of love with the internal combustion engine and persuading even the likes of Shell to diversify.

The Marjan van Loon statement makes him appear some way removed from being the representative of a company which still generates the majority of its profits from oil. 'This project offers opportunities throughout the entire hydrogen chain,' he noted. 'In addition, it fits well with our New Energies aspirations and our ambitions to find new ways to reduce CO2 emissions and deliver more and cleaner energy.'

Hydrogen to fuel refineries

Thanks to offshore wind, the UK is in a strong position to emulate this Dutch example. More and cheaper wind power is providing a backdrop to the success of companies like Sheffield-based ITM Power, which manufactures large-scale electrolyser units for producing green hydrogen.

Among current initiatives in the UK, the company is leading the Gigastack project, which has received a £7.5mn hydrogen grant from the UK government and is exploring options for the development of a system that will tap into electricity from Ørsted's Hornsea Two 1.4 GW offshore wind farm to power giant electrolysers at a substation in Humberside. This will in turn generate renewable hydrogen for the Phillips 66 refinery. You could say that greening the refining process is at least a step in the right direction.

ITM Power is also involved in another Shell project, this time at the Wesseling refinery in Germany, to build what would be the world's largest PEM (polymer electrolyte membrane) electrolyser, capable of supplying around 1,300 tonnes of hydrogen a year. While this is still a drop in the ocean (as it were) it looks like first step towards changing the core business model of a traditional refinery. In Shell's case there is a downstream focus on using hydrogen to power

shipping and other modes of heavy transport.

As Peter Norfolk, Editorial Director at S&P Global noted at this year's IP Week event, hydrogen is the most abundant element in the known universe and it is increasingly being seen as the green fuel of the future, a low carbon substitute for natural gas.

At the same conference, Shell's Dr Alexandra Ebbinghaus, called for a global policy to drive the transition to a low carbon fuel like green hydrogen. Raise the cost of carbon emissions and we will be among those well placed to expand in areas like green hydrogen, she suggested.

Falling costs

The cost equation is an interesting one and, as the cost of renewable energy continues to fall, so does the potential cost of producing large-scale green hydrogen – assuming there is the capacity to ring fence enough renewable capacity, eg offshore wind, for this purpose. Today, hydrogen made from fossil fuels can cost as little as $1/kg, whereas green hydrogen can cost up to $6/kg. Hence the need for policy instruments to both stimulate demand and supply. This is turn should help to bring down the cost of electrolysis, which is already benefitting from lower cost offshore wind energy.

The European Bank for Reconstruction and Development's (EBRD's) Cristian Carraretto notes that there is every reason to believe that green hydrogen can become competitive with natural gas by 2050. 'Here we are probably in the same situation as we were a decade or two ago with renewable energy,' he says: 'where there is a solution still more expensive than the alternatives. But even today it's only two or three times more expensive, so if things keep going and if there is a policy push going forward, our expectation is that it will become really cost competitive soon.'

Again we come back to the need for a policy push in the same way that carbon capture and storage (CCS) requires the leg-up of more robust carbon pricing. In fact so called grey hydrogen, currently used throughout the world and made from natural gas, can itself become clean, if not technically green, hydrogen if CCS technology is fitted.

A realistic combination for many governments, and a policy approach supported by the European Commission, is the production of both green and clean hydrogen. Green hydrogen is starting to be produced using renewable energy while clean hydrogen can be produced by natural gas with CCS fitted to capture CO2 upstream and prevent it being emitted into the atmosphere.

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A hydrogen economy?

The idea of a hydrogen economy, fuelled by offshore wind and other forms of renewable and CCS-cleaned energy is perhaps not so far-fetched, given the intense energy demands of sectors like manufacturing and heavy transport. 'There are some sectors that are typically hard to decarbonise,' notes Carraretto. 'Sectors like steel, or chemical industries, or to some extent aviation – which still use fuel in their systems.'

In the UK, offshore wind continues to deliver more power to the grid. The challenge for the UK and other countries is innovating to deliver even more wind power so there is enough surplus for the production of large-scale green hydrogen. The deployment of technologies such as floating offshore wind may help this process, allowing developers to build wind farms in even deeper (and more hostile) parts of the North Sea.

According to a RenewableUK model, this technology could reach parity with seabed-fixed offshore turbines in the 2030s as developers head further offshore for more consistent wind power.

This would be a boost to UK governments balancing a net zero carbon target with mainstream economic priorities. It also offers potential sustenance to the growing number of green hydrogen projects now underway, both in the UK and other parts of the world. It is no surprise that green hydrogen is now seen as one of several potential low-carbon fuels that could eventually take the place of today's fossil hydrocarbons.

Political pull

In May, the International Energy Agency's Executive Director Faith Birol suggested that hydrogen electrolysers could become one of the decade's stand-out technologies. 'These technologies should play a key role in bolstering Europe's transport and energy as the continent emerges from the crisis and looks to develop more advanced manufacturing for export,' noted Birol alongside Frans Timmermans, Executive Vice-President of the European Commission.

Politicians the world over, you could argue, have never been in greater need of grandstanding innovation projects, and green hydrogen development looks set to play its part in the mix.

This could be one reason for a recent announcement by Jo Bamford, owner of Wrightbus and hydrogen firm Ryse Hydrogen, that he plans to introduce 3,000 hydrogen buses to the UK. This, he believes, will lead to a 'knock-on transformation' of other heavy-duty vehicles, such as lorries, trains, ships and even ambulances and police cars and help to create hundreds of thousands of new green jobs across the country. While there are already hydrogen buses helping to reduce pollution on the streets of London, Bamford expects orders from a host of other cities seeking to maintain the cleaner, healthier atmosphere that people have enjoyed during the pandemic.

'We have an opportunity with hydrogen-powered transport to make a huge difference to air quality, and for UK jobs as well,' he notes. 'With increased orders on this scale, I could increase the workforce at Wrightbus by nearly 700%.' Using emotive arguments like this Bamford is cleverly seeking both to influence and benefit from the wind of change. Politicians will want to play their part in making this and other private sector initiatives viable.

Strategic thinking

Governments, including those of the UK, Germany, Australia and Japan are working on, or have announced, hydrogen strategies. As in the case of CCS, they recognise that there is a need to jump-start projects in order to reduce costs and stimulate demand. Discussions around green hydrogen have clearly picked up since the outbreak of coronavirus, which could itself become an important catalyst for moving towards a hydrogen economy, suggests Diederik Samson, who heads up the European Commission's climate cabinet.

We come back to the point that big projects coupled with low-carbon innovation matter to politicians, now more than ever. With the winds of change blowing strongly, the development of green hydrogen is certainly in that category. ●