HYDROGEN

# Putting hydrogen to the test

**The potential use of hydrogen for home heating and other applications is being trialled at a series of projects around the UK – as *Nick Cottam* reports.**


The Spadeadam project features a 1-km pipework test loop designed to replicate the national gas transmission system

*Photo: DNV GL*

When the world wakes up after COVID, hydrogen will have a new impetus and a significant role to play as part of efforts to transition to a low carbon (net zero) global economy. Putting the hydrogen hype to one side, this is the message coming out of a series of trials underway in the UK and overseas.

While countries such as France, Germany, Japan and Australia have pledged billions of dollars of investment in a hydrogen future, the UK is taking its own cautious steps, following the government's loudly trumpeted announcement of a green revolution. Initiatives such as HY4Heat, H21, H100 Fife and HyDeploy are all underway, the onus being to demonstrate how hydrogen can be used safely and efficiently as a source of heat for homes and businesses.

'There are many great initiatives underway in the UK at the moment,' says Graham Bennett, who heads up DNV GL's Energy Transition Team for the UK and West Africa. 'The UK gas network is well on the way to demonstrating its ability to handle hydrogen and just needs a clear signal of support from government, and funding approvals from its regulator Ofgem.'

## Hydrogen-ready boilers

This came, in part at least, when the UK government's Committee on Climate Change (CCC) advised in December 2020 that all new boilers should be hydrogen ready by 2025 at the latest. There are currently around 1.3mn new gas boilers sold every year and more than 22mn in total connected to the gas network.

A key first step has been to show that it is possible to safely run a hydrogen blend on existing appliances and distribution networks. To this end, for example, a blend of 20% hydrogen has been successfully piped to 130 homes and faculty buildings at Keele University in the UK's first live pilot to test the gas. HyDeploy, a £7mn project backed by Ofgem's Network Innovation Competition, has established that a hydrogen blend can be used with minimal disruption to customers while also producing a significant fall in carbon dioxide emissions.

The CCC estimates that if a 20% blend was rolled out across the country it could save around 6mn tonnes of carbon dioxide emissions a year – the equivalent of taking 2.5mn cars off the road.

A follow-up trial, HyDeploy 2, will take the blend to 670 homes in the North East, while in Scotland up to 1,000 homes in Fife could be receiving green hydrogen by the end of 2022. In the first phase of the H100 Fife trial, some 300 homes are being fitted with hydrogen boilers, heaters and cooking appliances as part of the UK bid to reach net zero carbon by 2050. The Scottish government is supporting the Fife trial with a grant of £6.9mn, part of an £18mn Ofgem pot to support the project.

Upstream there are UK projects such as HyNet and Acorn, both designed to make so-called blue hydrogen from natural gas – the latter, located at Peterhead, north of Aberdeen, is seeking to square the sustainability circle through the use of carbon capture and storage (CCS). The net zero holy grail is the production of green hydrogen in sufficient quantities from renewables; the Catch 22 being that you need an awful lot of renewable energy to isolate enough hydrogen.

## Dedicated delivery

'What we really needed to make this work,' says Bennett 'is a National Hydrogen Delivery Authority. At the moment there is no dedicated source of hydrogen for domestic consumption and the gas networks are only allowed under regulations to transport gas.' That could change as operators demonstrate they can produce green hydrogen at scale. For example, the wind energy producer Ørsted is seeking to harness power from its Hornsea Two facility which is set to become the world's largest offshore wind farm with the potential to produce green hydrogen.

In what Ørsted's Damien Speight describes as 'nature's recipe for a world run entirely on

green energy,' the company has teamed up with electrolyser manufacturer ITM Power, Phillips 66 oil refining company, and low carbon energy consultant Element Energy to develop the North Sea demonstration project Gigastack.

Phase 2, which has received £7.5mn of funding from the Department for Business, Energy and Industrial Strategy (BEIS), will involve the production of the UK's first 100 MW electrolysers designed to support large-scale green hydrogen production. The process uses electrolysis to separate water into its constituent parts, the end result being that you capture the hydrogen.

Another significant downstream trial is taking shape at DNV GL's Spadeadam research centre in Cumbria. This offline trial is the first of its kind in the UK and involves the testing of hydrogen-ready boilers which have been developed and manufactured for domestic use. It also features a 1-km pipework test loop which is designed to replicate the national gas transmission system.

## Safe as houses

Safety, says Bennett, is a key element of the Spadeadam trial, the focus being to develop a safety case for the transmission and distribution of hydrogen as a fuel for home and business heating. 'There are more people killed in homes from carbon monoxide poisoning than from gas explosions or fires. You have to weigh up the risks and benefits in a trial like this and there is no carbon monoxide risk from hydrogen.'

Perhaps fittingly in this context, DNV GL Research Centre is part of RAF Spadeadam, where technological innovation has been a feature since the 1950s. While host DNV-GL must deliver a credible safety case for the practical use of hydrogen as a fuel, the £10mn FutureGrid initiative is being led by National Grid, with partners Northern Gas Networks and Fluxys, the operator of Belgium's gas transmission network.

'Sectors such as heat are difficult to decarbonise and the importance of the gas networks to the UK's energy supply means projects like this are crucial if we are to deliver low carbon energy, reliably and safely to all consumers,' commented Antony Green, the head of National Grid's hydrogen project.

Within the test loop of pipework, the Spadeadam site features a snapshot of modern living; in this case a row of uninhabited terrace houses which are designed to replicate real-world energy requirements and any risks from putting hydrogen into the mix. Each house, featuring a different layout and design, contains a hydrogen-ready boiler and a standard domestic set-up for heating and hot water.

## A blended solution

'We will be using hydrogen at various blends,' explains Bennett. 'You can use a fuel mix of 20% hydrogen without any conversion whatsoever but this doesn't achieve the scale of decarbonisation we need for net zero. If we want to achieve a 100% hydrogen solution then the boilers need converting.'

The CCC has estimated that the UK needs to be spending between £15bn and £20bn every year between now and 2050 on decarbonisation initiatives if we are to have any chance of meeting net zero – a tall order whatever the state of the economy.

The Spadeadam trial is linked to what is known as the H21 programme, a collaboration between all UK gas and transmission networks to see how the existing system could be repurposed to safely carry hydrogen to homes and businesses. The aim is to keep the test facility separate from the UK's national transmission system, allowing tests to be carried out in a controlled environment.

While hydrogen will only be one element in the UK's future zero carbon energy mix, it will be an important one predicts Bennett. 'We will need electric heat pumps, for example, but hydrogen will be the least disruptive change for domestic consumers.'

## Customer buy-in

This is evident from the first phase of HyDeploy, led by the gas distributor Cadent in partnership with Northern Gas Networks and Keele University. 'The results reflect those we were getting from laboratory testing before the pilot began,' comments Ed Syson, Chief Safety and Strategy Officer for Cadent. 'The gas network and gas appliances are operating normally and customers are positive about the project. They haven't noticed any difference to their gas supply and haven't needed to change the way they use gas.'

The Spadeadam test houses are served by two sets of gas networks, one for standard methane and one for hydrogen. Each network is engineered with valves to change flows and mixtures and produce test leaks as required. 'One of the key advantages of hydrogen,' says Bennett 'is its ability to enable decarbonisation across multiple sectors. This will be most important for domestic and industrial heat, transport, power generation, and to act as an energy storage medium for variable renewables.'

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>
> **Graham Bennett, DNV GL**

## Massive investment

He adds: 'A coherent vision for the entire energy system is needed. Every option we look at will cost more than existing solutions. Costs will come down as has been the case with wind power but it is estimated that we will need to spend around £1tn by 2050 to meet our net zero target.'

Keele University's Professor Zoe Robinson stresses the human dimension when introducing a new fuel such as hydrogen. 'Social acceptance is a key part of technical energy transitions,' she says. 'One of the learning points from our research so far is that evaluating the opinions of people taking part is important, both for increasing our knowledge but also making those people feel valued.'

An ITM Power electrolyser is also helping to drive Keele's HyDeploy trial, using an electric current to split water molecules into hydrogen and oxygen. Keele was deemed suitable for the trial because it has its own private gas network which can be safely isolated from the wider UK network. Prime concerns for households involved have revolved around cost and safety and, as Bennett notes every option for transforming our energy system will cost more than existing solutions.

The challenge is to drive down costs through economies of scale – larger investment, bigger projects and ultimately lower capital costs to produce large volumes of green hydrogen. 'The world urgently needs to massively ramp up deployment of breakthrough solutions like green hydrogen,' says Nigel Topping, COP26 High Level Champion for Global Climate Action. 'The bold vision and leadership of businesses can propel green hydrogen along an exponential growth trajectory to support economic recovery and deep decarbonisation sooner than anticipated.' ●