CCJ 80_Layout 1 06/03/2021 12:36 Page 1

Carbon Capture Journal

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CCUS in the U.S.

Decarbonising the U.S. energy system by accelerating innovation

Carbon Capture Coalition policy blueprint to accelerate CCS

ExxonMobil to invest $3 billion in low carbon

Drax applies to build BECCS power plant

- O.C.O Technology working on new mineralisation opportunities
- 2021 will be ‘year to remember’ for CCUS deployment in UK and EU
- CCS to create blue hydrogen from natural gas – Zero Carbon Humber
- Equinor’s progress with Longship and Baker Hughes’ CO2 capture business

CCS to create blue hydrogen from natural gas – Zero Carbon Humber

The Humber region is the perfect location for the construction of a large-scale 'blue' hydrogen plant where the CO2 emissions from hydrogen production are captured and stored. By Stephen B. Harrison, sbh4 consulting

There are several heavily industrialised clusters in the UK. Merseyside in the north west is home to the Stanlow refinery and chemicals parks around Runcorn. Teesside in the north east was where the UK chemicals industry expanded in the 1950s and, until recently was a large steel-making location. However, regarding carbon dioxide (CO2) emissions, the Humber is the largest emitting cluster.

To the west of the Humber estuary is Drax power station, whilst on the north bank of the river is the Saltend Chemicals Park and on the south bank is Scunthorpe steel works and one third of the UK's refining capacity. According to the Government's Energy White Paper, The Humber industrial cluster yields 10 million tonnes of CO2 emissions per year, compared to Merseyside's 5 million and Teesside's 3.9 million.

Saltend Chemicals Park on the North bank of the Humber River. Equinor's H2H Saltend project will produce blue hydrogen by reforming natural gas whilst capturing its CO2 emissions, which will be stored under the North Sea

"If the UK is to decarbonise, then East Yorkshire must be a central part of the solution." That is how Dan Sadler, UK Low Carbon Strategy Director at Equinor emphasises the importance of working towards a carbon neutral Humber cluster.

"Blue hydrogen will be essential for deep and rapid decarbonisation. And there is no place better in the world for low carbon hydrogen production, storage, and utilisation than the Humber cluster in the UK. In this location, we have the perfect combination of natural gas supplies, renewable power generation and hydrogen demand."

Blue hydrogen from North Sea gas

An established natural gas pipeline infrastructure transports North Sea gas to the Humber industrial cluster. The main way to produce hydrogen at scale today is from natural gas using steam methane reformers (SMRs) or auto thermal reformers (ATRs). If the CO2 emissions from the SMR or ATR are captured, the resulting hydrogen is referred to as 'blue hydrogen', or 'Low Carbon Hydrogen' according to the EU CertifHy certification scheme.

Sadler adds that "the onshore and offshore geology around the Humber Estuary will enable super-scale underground hydrogen storage in salt caverns and offshore CCS to capture and store the CO2 emissions from hydrogen production from natural gas."

On the 27th of January, the European Parliament voted that blue hydrogen will be an acceptable bridge on the journey to full decarbonisation with green hydrogen. Whist that policy decision is not of direct impact to the UK, it demonstrates the growing international recognition that blue hydrogen is an essential component of our ambitions for rapid and deep decarbonisation.

Sadler explains his vision for the energy transition in the UK: "I believe that the production of blue hydrogen will create the business case to build storage and distribution infrastructure that can be used for green hydrogen in the future."

Achieving carbon neutrality through a transition from low carbon solutions to renewables

Equinor has committed to carbon-neutral operations by the year 2050 and is investing heavily in wind energy to meet that goal. Sadler develops the point further, adding: "until renewable power generation capacity ramps up sufficiently to make green hydrogen more cost-efficient, we will need low carbon bridging solutions based on fossil fuels combined with CCS. There are only 29 years until 2050. Alongside investment in renewables, blue hydrogen means we can act now to decarbonise quickly and at scale."

To enable industry around the Humber to use low carbon energy, the Zero Carbon Humber anchor project is the construction of the H2H Saltend large-scale blue hydrogen plant at the region's largest emitting chemicals park. "We are planning for at least 95% CO2 capture and sequestration from the hydrogen production facility", confirms Sadler. "That means that there will be some CO2 emissions, but they can be offset against bio-energy CCS (BECCS) elsewhere in the scheme."

Looking at the bigger picture around the Humber Estuary, the net-zero carbon emissions target can be achieved because the Drax power plant runs predominantly on biomass and future implementation of BECCS from its emissions would make it a carbon-negative power generation facility.

In a net-zero future, CO2 from the industrial cluster will be transferred out to the North Sea in a pipeline to safely store the gas in suitable underground geological formations. Sadler adds that "Equinor has more than 20 years of experience operating CCS schemes in the North Sea." The first of these involves the Sleipner West gas field in the Norwegian sector.

"The second Equinor CCS scheme started up in 2007, with its first CO2 injections in 2008. It is linked to the Melkøya LNG plant at Hammerfest, 500 Km inside the arctic circle", says Sadler. Equinor is also leading the Northern Lights project which will transport and store CO2 from various locations. In that scheme, liquefied CO2 is shipped from a cement factory to an onshore terminal in western Norway before it is compressed to high pressures and injected deep underground for permanent offshore storage.

CCS and underground hydrogen storage – geology is the key

One of the applications of hydrogen produced in the emerging Humber cluster will be domestic heating. That is a challenging application in terms of balancing supply and demand, as domestic heating is extremely seasonal.

"I come from Yorkshire, so I know what the weather is like around the Humber", says Sadler. "We use lots of gas in the winter but in the summer, there is less demand. This seasonal fluctuation can be balanced with large-scale storage which can reduce the cost of the overall scheme. We must develop infrastructure that provides affordable energy to the public and maintains the competitiveness of UK industry."

One of the reasons that the Humber is ideal for an integrated low-carbon hydrogen production, storage and utilisation cluster is the presence of underground salt strata. It is possible to create very large caverns in the salt that can be used as gas-tight hydrogen storage chambers. Unlike CCS, where the CO2 is permanently buried under ground, these caverns in the salt are like hydrogen storage tanks that can be filled and emptied as required.

Underground hydrogen storage is used in Texas as a strategic reserve of hydrogen to support refineries and petrochemicals customers. Salt caverns at Teesside have been in use for hydrogen storage since 1972. Worldwide, there are many underground salt caverns used to store natural gas and other hydrocarbons.

"We cannot choose where the salt is, just as we cannot influence where the optimum geology exists for CCS", says Sadler. "But our geological surveys show the conditions in East Yorkshire are ideal for salt caverns, so we can work in harmony with the natural features around the Humber Estuary and use these underground salt formations to enable decarbonisation."

More information

www.zerocarbonhumber.co.uk
sbh4.de

Carbon Capture for marine and offshore industries

Carbon Capture is a potential supplemental solution for reducing a vessel or offshore unit's overall carbon footprint says the American Bureau of Shipping (ABS) in an article as part of its Offshore Thought Leadership Series.

Unless a vessel or offshore unit is combusting zero carbon content fuels such as ammonia and hydrogen, other carbon-based fuels such as liquefied natural gas, liquefied petroleum gas, methanol, bio or renewable diesel and dimethyl ether will produce CO2 as a byproduct after combustion.

If the carbon-based fuel is produced renewably, the overall carbon footprint might be reduced, or even become net zero. CCS for shipboard application refers to a set of technologies that can be used to capture CO2 from vessel or offshore unit exhaust gas and store it for subsequent disposal or use.

Over the last 20 years many research groups around the world have explored carbon capture technologies to increase efficiency and reduce the size and cost of the system.

CO2 has been safely transported and used in many industries for decades and can be moved by ship, truck or pipeline.

The majority of carbon capture systems have been designed and demonstrated in electric power plants. However, it is possible to deploy CCS technologies onboard vessels or offshore units to capture, store and transfer CO2 ashore for use. Maritime deployment of CCS is now being researched and piloted by multiple firms.