CARBON CAPTURE

Global CCS progress

Carbon capture and storage is a key part of climate mitigation, reducing CO_2 emissions in hard-to-abate industrial sectors, as well playing a vital role to decarbonise hydrogen production. Significant global CCS initiatives are underway, but the pace should be faster, reports *Brian Davis*.

The Intergovernmental Panel on Climate Change's (IPCC) 1.5°C Special Report emphasised that carbon capture and storage (CCS), along with other renewable technologies, is necessary to reach net zero emissions by 2050. However, 'time is not on our side to achieve the necessary targets', reflects Brad Page, CEO of the Global CCS Institute.

But there are encouraging signs of progress, and rebound from the dreadful impact of the COVID-19 pandemic may spur a 'back better approach' towards environmentally friendly initiatives like CCS.

Well-proven technology

'CCS needs to be an integral part of the solution to building resilient and climate neutral economies and deliver net zero emissions. Investment in the technology can also drive economic growth and employment,' says Guloren Turan, Advocacy and Communications at the Global CCS Institute.

Fortunately, CCS is well-proven technology. Carbon capture has been used since the 1930s to purify natural gas, hydrogen and other gas streams in industrial settings, and CO_2 was first injected underground on a commercial scale in 1972. 'We are not looking for a miracle solution. Obviously, there will be areas of innovation in capture technology, but there are no major technology barriers,' says Turan.

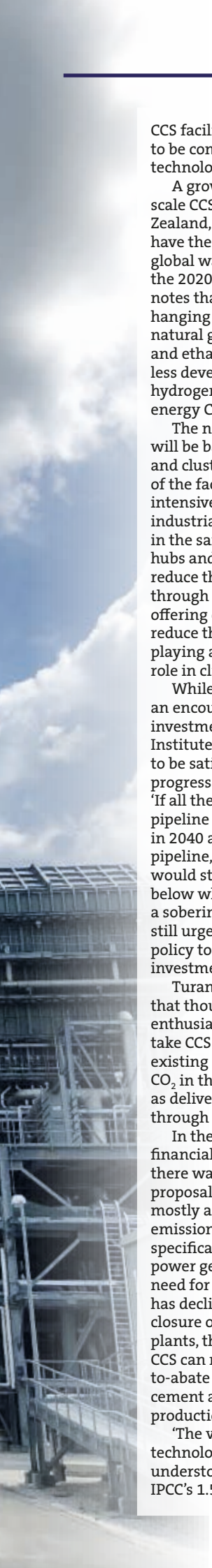
In May this year, Equinor, Shell and Total made the decision to develop the Northern Lights project for CO_2 storage on the Norwegian Continental Shelf. The NKr6.9bn (£0.57bn) project – subject to final investment decision (FID) by the Norwegian authorities and approval from the EFTA Surveillance Authority – will be the first CO_2 storage serving Norwegian and European industries in support of the net zero target. Phase 1 will transport by ship, inject and store up to 1.5mn t/y of CO_2 about 2,500 metres below the seabed. The CO_2 plant will be remotely operated from Equinor's facilities at the Sture terminal, with subsea facilities from the Oseberg A platform in the North Sea. Phase 1 is expected to be operational in 2024. Under the full chain project, CO_2 emissions will be transported from the Norcem plant in Brevik and the Fortum waste-to-energy plant in Oslo.

Meanwhile, CO_2 injection commenced at the Gorgon natural gas processing plant in Barrow Island off the coast of Western Australia in August 2019. It will be the world's largest dedicated geological CO_2 storage facility when it ramps up to full capacity of 4mn t/y CO_2.

The number of CCS facilities worldwide is growing. In 2019, there were 51 large-scale CCS facilities – 19 operating; four under construction; 10 in advanced development using a dedicated FEED (front-end engineering design) approach; and 18 in early development. Those in operation and construction have the capacity to capture and store 40mn t/y CO_2, according to Global CCS Institute estimates. In addition, there are 39 pilot and demonstration-scale

The Petra Nova CCS facility uses post-combustion CO_2 capture at a US power plant

Photo: Global CCS Institute



CCS facilities (operating or about to be commissioned) and nine CCS technology centres.

A growing number of large-scale CCS facilities in the US, New Zealand, Qatar and other locations have the potential to form the new global wave of CCS investment in the 2020s. The Global CCS Institute notes that these go beyond the 'low hanging fruit' opportunities like natural gas processing, fertiliser and ethanol production to include less developed industries like hydrogen production and bio-energy CCS.

The next wave of facilities will be based around CCS hubs and clusters, to take advantage of the fact that many emission intensive facilities (both power and industrial) tend to be concentrated in the same areas. What's more, hubs and clusters significantly reduce the unit cost of CO_2 storage through economies of scale, offering commercial synergies that reduce the risk of investment while playing a strategically important role in climate change mitigation.

While there appears to be an encouraging uptick in CCS investment, the Global CCS Institute notes there is no reason to be satisfied with current progress. Its latest report insists: 'If all the facilities in the CCS pipeline now were operational in 2040 and no more entered the pipeline, CO_2 capture capacity would still be about a factor of 20 below what is required.' This is a sobering thought and there is still urgent need for government policy to incentivise private sector investment in CCS.

Turan makes the point that though there is renewed enthusiasm for CCS, 'we need to take CCS forward for new and existing sources and address CO_2 in the atmosphere, as well as delivering negative emissions through bioenergy with CCS'.

In the aftermath of the global financial crisis in 2008/2009 there was a decline in CCS project proposals. CCS was thought to be mostly a solution for reducing emissions in power generation, specifically to clean-up coal-fired power generation. Although the need for CCS in power generation has declined significantly with the closure of many coal-fired power plants, there is recognition that CCS can reduce emissions for hard-to-abate industries like chemicals, cement and steel, as well as for production of clean hydrogen.

'The versatility of CCS technology is now better understood, coupled with the IPCC's 1.5°C report, which said we can only resolve climate change by reducing emissions.' She continues: 'Unfortunately, we have already passed that point, and the only way to reduce dangerous levels of CO_2 emissions sufficiently is to start sucking CO_2 out of the atmosphere, while also using CCS and reforestation, together with renewables and better energy efficiency.'

Turan suggests the big problem in terms of emitting CO_2 is what economists call 'externality'. In most parts of the world people are free to produce CO_2, with little or no consequences. However, change is underway with moves to set a uniform carbon price, so that individuals, companies and societies can properly account for the carbon pollution. Initiatives like the Carbon Tracking Scheme (CTS) are starting to put a value on carbon.

According to the World Bank, roughly 20% of global CO_2 emissions have a carbon price. But less than 5% is high enough to reach the goals of the Paris Agreement. An International Monetary Fund (IMF) report last year suggested that the carbon price needs to reach about $75/t to reach IPCC or Paris Agreement targets for effective emissions reduction, compared with $16–20/t today. 'We are a long way from what the carbon price needs to be in order to drive significant CCS investment and encourage changing behaviour to meet those targets,' states Turan.

Pandemic impact

Turan does not anticipate that the COVID-19 pandemic will slow down CCS plans significantly. 'Under normal circumstances one would assume that some of these projects will experience slowdown as they are large capital projects. But we are not seeing companies taking their foot off the gas, so to speak. The oil and gas companies we talk to see CCS as a strategic investment for the longer-term, particularly in the context of the energy transition.'

But she admits: 'Clearly, economically challenging times are ahead of us. Nobody has a crystal ball, so it is difficult to say with 100% certainty that nothing will slow down. But CCS can help in meeting climate targets and economic recovery, potentially creating at least 100,000 construction jobs globally by 2050.' ●

Large-scale CCS project spotlight

The port of Rotterdam (Porthus) CCS initiative anticipates FID in 2021, serving major refining and industrial facilities by 2023 with dedicated geological storage for 2–5mn t/y CO_2 capture capacity.

Two large-scale CCS facilities are under construction in Canada. The Alberta Carbon Trunk Line (ACTL) with the North West Redwater partnership and Sturgeon refinery CO_2 stream is due to begin operation soon, for hydrogen production from oil refining, and storage for enhanced oil recovery (EOR). A second scheme is under construction by ACTL with Agrium, for fertiliser production and CO_2 capture for EOR.

Two major CCS construction projects are underway in China. Sinopec's Qilu Petrochemical CCS project is aiming for 400,000 t/y CO_2 capture capacity, and the Yanchang Integrated CCS demonstration will serve a chemical plant, with similar capacity, to start operation in 2020 or 2021. The Sinopec Eastern China CCS project is also in early development.

Phase 2 of the Abu Dhabi CCS project for natural gas processing is due to begin operation in 2025 with 1.9–2.3mn t/y CO_2 capacity for EOR. Phase 1 of Abu Dhabi CCS began operation in 2016 and is notable for being the first CCS plant to use emissions from iron and steel production, with 800,000t/y CO_2 capacity.

Meanwhile, several significant CCS projects are in the pipeline in the US. The Lake Charles project for conversion of 4–20mn t/y CO_2 for methanol production is due for start-up in 2024. The Dry Fork integrated CCS plant is linked to a power generation plant and will inject 3mn t/y CO_2 in dedicated geological storage or use some capacity for EOR by 2025. Similarly, the Carbonsafe Illinois plant is to use post-combustion capture of CO_2 from power generation and ethanol production for dedicated underground capture or EOR. Further CCS projects are underway at Project Tundra, at the Integrated Mid-Continent stacked carbon storage hub, and the Oxy and White Energy ethanol facility.

In Australia, the Carbonnet CCS project is under evaluation, following the 4mn t/y Gorgon CCS project which came onstream in 2019.

The Hydrogen 2 Magnum (H2M) CCS project in the Netherlands is also under study, with plans for operation by 2024.

There are two existing coal-based power generation plants with CCS. One in Canada at Boundary Dam, which has been operating since 2014, and the Petra Nova CCS plant in the US, both utilising post-combustion capture.

Plans for several UK CCS hubs are discussed on pp30–31. ●