CCUS gains momentum despite midstream challenges

Carbon capture, utilisation and storage (CCUS) technology has again become popular in discussions on how to combat climate change, but the associated midstream infrastructure necessary to support an energy transition remains underdeveloped and often overlooked.

Midstream refers to the stages of transportation and storage that connect the upstream extraction and downstream distribution of oil and gas. Most often, the midstream relies on a system of pipelines. In addition to CO₂, pipelines also play a vital role in transporting other gases and liquids important for the energy transition, from hydrogen to renewable gas.

CCUS technologies have been around for decades but have waxed and waned in public consciousness and government policymaking. As more businesses make climate pledges and aim to reach net-zero emissions by 2050, momentum is once again stirring around CCUS as a way to reduce emissions while continuing operations from fossil fuel assets.

As of 2020, the global installed capacity of CCUS was about 40mn t/yr. This accounts for less than 1pc of the energy-related CO₂ emissions predicted to be produced in 2021. A massive change in pace and scale of CCUS would be necessary to address the climate challenge.

The CCUS industry requires an advanced transportation network to move the CO₂ from where it is captured to appropriate storage sites. While truck, rail, and ship transport all have a potential small-scale role, an extensive network of pipelines would likely be required for large-scale CCUS.

The funding, regulation and building of such infrastructure does not come without challenges. And without it being prioritised, scale-up is unlikely to occur.

There are about 4,500 miles of CO₂ pipelines in the US. Many of these connections are located near the Permian Basin oilfields in Texas, where naturally occurring CO₂ is injected into wells for enhanced oil recovery (EOR). All except one of the 12 commercial CCUS facilities operating in the US are used for EOR. EOR provides CCUS projects with revenue, but the continued use of oil makes it an inefficient tool to fight climate change.

Clusters and hubs

Government initiatives have helped drive down the cost of CCUS in recent years. Since 2018, the federal 45Q tax credit has provided $35-50/t of captured CO₂. A bipartisan bill passed in December 2020 extended this credit and will provide $6bn in funding to CCUS over the next five years. In addition to tax credits, new projects can benefit from a growing economy of scale. The expansion of CCUS projects into clusters and hubs helps create a lower per unit cost by allowing new CCUS facilities to connect to existing transportation and storage systems. The Carbon Storage Assurance Facility Enterprise (CarbonSAFE) initiative, which was partially funded by the US Department of Energy, has helped reduce the barrier of entry for new projects by developing a US hub of CCUS projects.

The Storing CO₂ And Lowering Emissions (SCALE) Act would build upon the CarbonSAFE initiative and further help facilitate a buildout of infrastructure needed to support CCUS. The bill, part of the Infrastructure and Investment and Jobs Act, would fund future CO₂ storage hubs as
well as Feed studies for transport infrastructure. It would also provide financing to encourage construction of pipeline capacity that would allow for future growth of the industry. The bill would increase funding for the EPA and individual states to advance permitting of CO₂ storage wells, which is another critical roadblock to the buildout of storage infrastructure.

Even with such incentives, investments in infrastructure required to support a large-scale CCUS industry would be substantial. In a blueprint describing a pathway for the US to reach net-zero emissions by 2050, the Labor Energy Partnership initiative proposes gigaton-scale CCUS infrastructure. A gigaton of CO₂ captured would be equivalent to 22pc of the US energy-related CO₂ emissions predicted for 2021.

Unfortunately, it is not as easy as simply repurposing portions of the more than 1.6mn miles of gas pipelines running through the US. After CO₂ is captured, it is usually compressed into a phase of dense fluid—also known as its supercritical or dense phase. Because of this, CO₂ pipelines are kept at higher pressures and have thicker walls than natural gas pipeline. The pipeline walls need to be thick so they are strong enough to withstand the decompression of the CO₂. The immediate environmental risk of leaking CO₂ would likely be lower than an uncontrolled oil or gas release, but ruptures still pose a health risk to those living nearby. Proper operation and maintenance are necessary to prevent pipeline fractures and corrosion, which can occur if water is allowed to interact with the CO₂.

Lack of public support is an additional challenge for CCUS midstream needs. Besides safety concerns, there is also hesitance about the limited success of existing CCUS projects and the cost-benefit tradeoff compared with other climate action projects. Many clean energy advocates do not support additional CCUS projects beyond those necessary to abate emissions in industrial processes lacking cleaner alternatives—such as iron, steel and cement production. There is a concern that investments in CCUS for power plant emissions will end up prolonging the life of the fossil fuel industry.

There are also concerns about issues of environmental injustice, with sites for energy and industrial infrastructure disproportionately located near neighbourhoods with lower-income and minority populations. Public approval can be a critical factor in siting and permitting CCUS midstream infrastructure. CO₂ pipelines that cross public and private land or state boundaries may require agreements between various stakeholders—such as developers, landowners and regulatory groups.

The infrastructure upgrade that CCUS advocates are envisioning will require thoughtful engineering, significant funding, careful design and meaningful community engagement. There is new momentum for CCUS, but challenges such as those for midstream transportation are not yet well addressed. Linking these issues with those for hydrogen and renewable gas might help overcome some of the obstacles.

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