The US Gulf Coast is poised for rapid methane and CCS development

The US Gulf Coast could establish global leadership in the low-carbon energy transition, given its vast energy infrastructure, concentrated emissions hubs and offshore CO_2 storage potential

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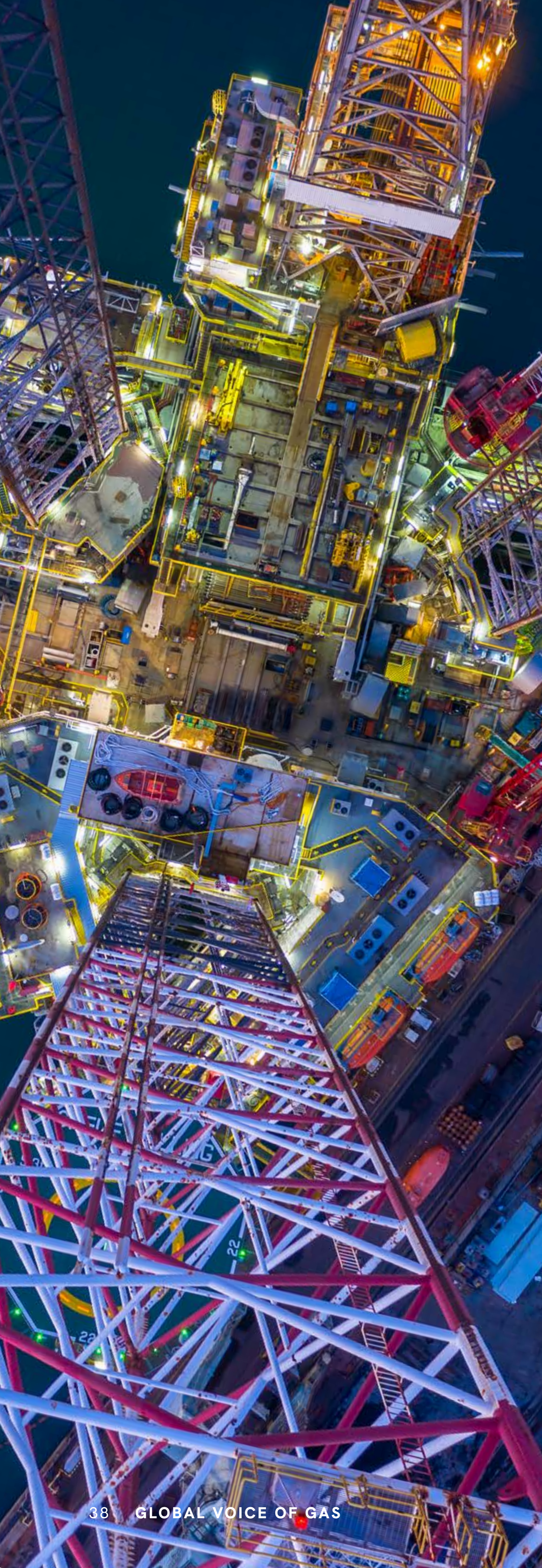
It seems that every week there are more announcements of corporate pledges to achieve low carbon goals by some future date (say 2030). These kinds of announcements have extended beyond the typical oil and gas and petrochemical sectors and now include just about every major business and industry sector in the global economy (now upwards of 20% of the largest global companies), including shipping, aviation, IT (think low-carbon cloud storage), LNG, steel, cement, apparel, agriculture, and many others. →



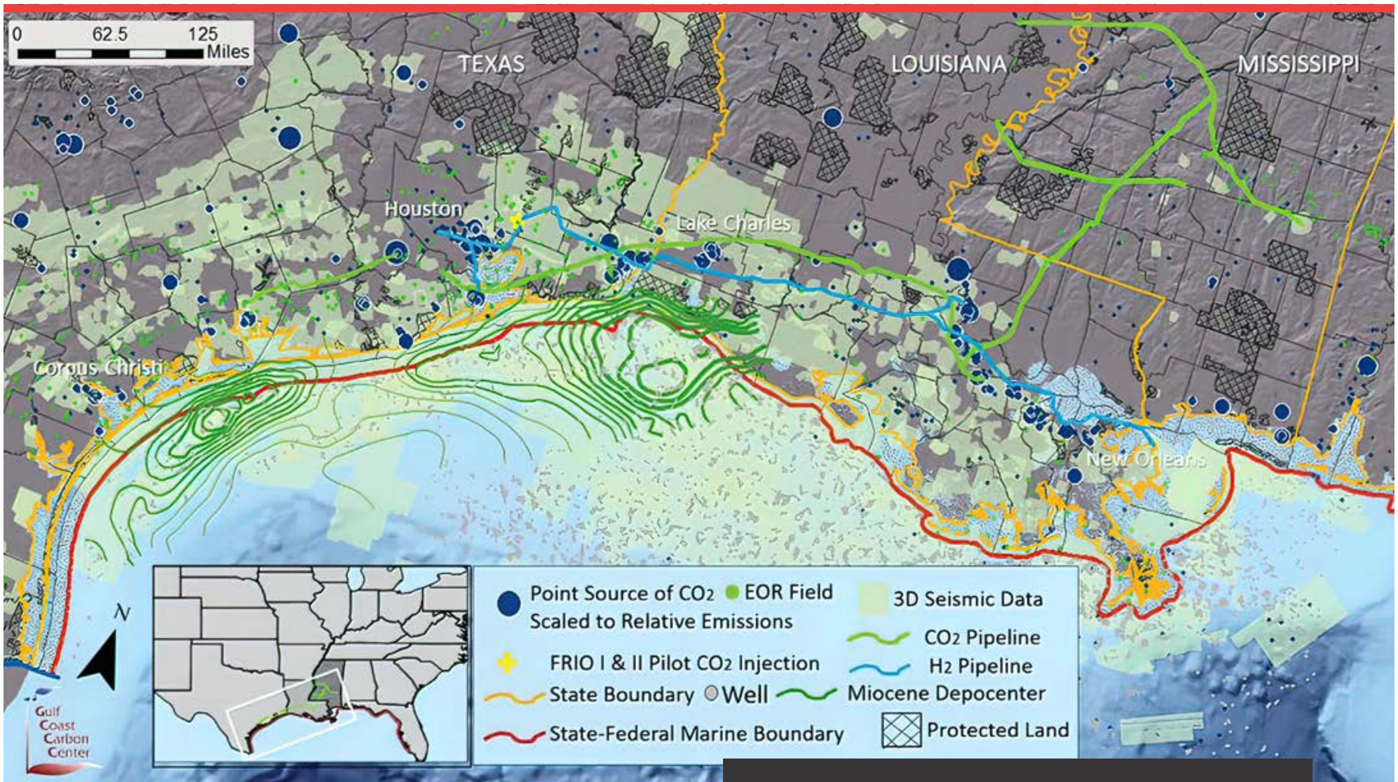
Regardless of how rapidly reliance on fossil fuels may be reduced globally, tools for reducing ongoing emissions are needed, including possibly even direct removal from the atmosphere (DAC). In the US, the shale gas revolution has created new export opportunities for LNG, when a decade ago those facilities were designed for import. So, if there is a defined need to reduce emissions from these existing and future sources, the question then becomes: how?

It is generally agreed by those who think deeply about the topic that few of the low-carbon goals can be met efficiently and, more importantly, cost effectively, without carbon capture and storage (CCS). While there are indeed many ways to make gains in emissions reductions (efficiency, renewables, nature-based solutions, reuse, etc.) there is arguably no single more effective hammer in the emissions reduction toolbox than CCS, and one that is able to address hard-to-otherwise-abate sectors. Furthermore, it seems there may be no more concrete way to defend ESG or corporate low-carbon statements than by permanently storing CO_2 emissions underground that would otherwise have gone into the atmosphere. Stored CO_2 can be credibly documented through wellhead metering and effective monitoring and regulatory compliance.

The rapid development of offshore CCS projects around the North Sea (Northern Lights in Norway, Porthos and Athos projects in Rotterdam, Teesside-Humber and Acorn in the UK) seems to provide some insight into the growing realisation that offshore CCS can provide for, and indeed is likely to outperform, our collective goals for reducing emissions using the technology.

Recent announcements of offshore acreage leases for CCS in Texas and the MoU between the Port of Corpus Christi and the Texas General Land Office reinforces this trend. China has now announced a first offshore CCS project, as has Indonesia, and Brazil (Lula) and Australia (Gorgon) have been active in offshore CCS for years. It is generally apparent now that the offshore basins that were the primary sources of hydrocarbon production will become the workhorses of the nascent CCS industry as well, leading to untold opportunities to re-commission infrastructure and create additional value.

My co-authors and I at the Gulf Coast Carbon Center recently outlined the roadmap for the concept of regional CCS hub development for the Gulf Coast of the US in an open-access article in the journal of *Greenhouse Gases Science and Technology*, entitled Carbon capture, utilisation, and storage →



Map of the north-western Gulf Coast (TX, LA, MS – see inset map, lower left) illustrating the extremely favourable setting for further developing CCUS hubs in the Gulf Coast.

hub development on the Gulf Coast. That article highlights the existing vast energy infrastructure, concentrated emissions hubs, and tremendous offshore deep subsurface geologic storage potential in the Gulf of Mexico (*see Figure 1*). In short, the Gulf of Mexico can be the end game for abatement of CO_2 emissions from a host of crucial energy chains in the US. Infrastructure includes existing CO_2 and hydrogen pipelines, petrochemical handling facilities, available depleted oilfields for CO_2 enhanced oil recovery, and vigorous development of LNG exports.

There are now multiple examples of successful integrated CO_2 capture, transport, and subsurface injection in the Gulf Coast, such that CCS is quickly moving from demonstration to full commerciality. CCS has been under development for more than 20 years, which is a typical evolutionary path for new technology to reach widespread commerciality. It is demonstrably proven safe and reliable as currently deployed. Handling of CO_2 (transport) is already routine in many industrialised areas. Subsurface geological storage is undertaken in subsurface geology using the same principles, engineering, and fluid physics as those settings that have retained hydrocarbons for millions of years. Thus, the primary barriers are not technical but rather related to policy and economics.

The development of CCS will not only facilitate decarbonisation of key energy chains, but can also provide job retention and growth, and increase competitiveness in the rapid 'greening' of global energy economy. And blue hydrogen seems to be having its moment in the headlines as well (recall $CH_4 \rightarrow H_2 + CO_2$). The consulting firm *McKinsey* estimates that the market for carbon credits could be worth upward of $50bn in 2030. It is hard to identify other energy markets that could rival the growth that is expected in low carbon solutions including CCS in the next ten years.

Globally, CO_2 is likely to move to the areas where it is most cost effective to conduct giga-ton scale storage where economies of scale can be realized – the basins adjacent to industrial ports on continental margins. This point is elaborated on in another 2019 open-access journal article in *Nature Scientific Reports* by myself and Dr. Phil Ringrose of Equinor. In that paper it is estimated that to achieve global emissions reduction goals by 2050, essentially four to five marine basins globally need to deploy CCS through offshore injection at rates of development consistent with the number of wells →

drilled for hydrocarbon extraction in the Norwegian North Sea since exploration began. Suffice it to say that CCS is likely to be a regional growth industry that rivals the scale of historic hydrocarbon extraction, which makes sense since we are essentially reintroducing the unwanted parts of hydrocarbons (CO_2) back into the same regions they were extracted from. Many see an element of poetry to that.

Most are unaware of the sleeping giant in the global low-carbon energy transition: shipping. Multiple companies in several countries are actively developing low carbon solutions for shipping. It will soon be possible to transport low-carbon fuels (possibly earning a price premium) and energy (LPG, LNG) and energy carriers (ammonia and hydrogen) by ship, power those ships with low-carbon fuels or otherwise capture the emissions from vessel power, and also transport liquefied CO_2 (LCO_2) such that vessel deadheading will be eliminated. The Norwegian Northern Lights project intends to use vessels to transport CO_2 from emitters to offshore storage. Other marine patents related to CO_2 are in development by multiple entities.

To summarise: CCS is more mature than many realise – all the component technologies are currently available (and many are in development), it is demonstrably safe and effective (as demonstrated through extensive regulatory monitoring) and the financial feasibility is attractive, especially in the US where Section 45Q tax credits lead to baseline $500mn project tax credit value for a 1 mm metric tonne/year injection for 12 years (notwithstanding the potential near-term enhancements currently under consideration). If a company's business thesis is that the global demand for methane and (blue) hydrogen is likely to grow in coming decades to address various low-carbon energy needs, then CCS is an imperative. The good news is that it can be profitable in the right place (favourable geology adjacent to concentrated emissions hubs, as in the Gulf Coast, etc.). Implementing CCS will drive growth and increase competitiveness in a global market increasingly demanding low carbon energy, especially related to methane development. ■

A $100bn Gulf CCS hub

US major ExxonMobil floated the idea in April of a $100bn project that could eventually capture up to 100mn metric tons/year of CO_2 from industry in the Houston area and sequester it beneath the Gulf of Mexico. The US Department of Energy estimates that geological formations along the Gulf coast could sequester as much as 500bn mt of CO_2 – equivalent to more than 130 years of total US industrial and power generation emissions based on the level in 2018.

"Houston has two features that make it an ideal site for CCS: it has many large industrial emission sources, and it's located near geologic formations in the Gulf of Mexico that could store large amounts of CO_2 safely, securely and permanently," Joe Blommaert, president of ExxonMobil Low Carbon Solutions, wrote on April 19 in a blog post.

According to Blommaert, the US could establish a "CCS Innovation Zone" along the Houston Ship Channel and the surrounding area, potentially capturing all CO_2 emissions from the petrochemical, manufacturing and power generation facilities there. The CO_2 would then be transported offshore via pipeline for storage.

"It would be a huge project, requiring the collective support of industry and government, with a combined estimated investment of $100bn or more," Blommaert explained. "But the benefits could be equally big: early projections indicate that if the appropriate policies were in place, infrastructure could be built in Houston to safely capture and permanently store about 50mn mt of CO_2 annually by 2030. By 2040, it could be 100mn mt."

Lessons learned from the project could eventually be applied to other areas of the US where industrial activity is similarly concentrated near to potential sequestration sites, he said, such as in the Midwest or at other locations along the Gulf Coast.