PAYNE COMMENTARY SERIES: **EXPLAINER**

Carbon Capture, Utilization, and Storage: What it is and Why it's Part of a Comprehensive Climate Solution

by Greer Gosnell and Laura Singer

In the revised bipartisan Infrastructure Investment and Jobs Act (IIJA), funding for electric vehicles shrank by 90% to just $15B, while the $363B allocated for clean energy tax credits vanished entirely, significantly weakening the climate focus of the originally proposed legislation.

Yet, emphasis on carbon capture, utilization, and storage (CCUS) remains alive and well, thanks to rare bipartisan support for the technology that hopes to save millions of jobs in the industrial sector—which is responsible for 25% of U.S. emissions—and hard-to-abate sectors such as aviation and shipping.

Per the legislation, Congress considers CCUS "critical for achieving mid-century climate goals". The legislation includes significant support for CCUS, including more than $12b in funding. As such, CCUS may finally solidify its inclusion in the suite of technologies tasked with tackling the climate challenge.

Still, CCUS faces serious obstacles and is poorly understood by the public. While interest has risen considerably in the last few years, it has previously received significant attention and fallen off the map.

This time feels different. We now have a time-constrained window of opportunity to avoid dangerous climate change, an increasingly bipartisan focus on the problem highlighted by a new climate-focused Republican congressional committee, increasing global net-zero commitments, and unprecedented pressure on heavy polluters to clean up their act with haste. With its strong showing in the new infrastructure bill, CCUS is almost certainly here to stay.

So, what is CCUS, and what role will it play going forward?

What is CCUS?

CCUS refers to a broad suite of technologies that seek to prevent carbon dioxide (CO_2) emissions or remove previous emissions from the atmosphere. Carbon can be captured from a variety of point sources – including power plants, refineries, and industrial facilities – as well as directly from the air, in the case of direct air capture (DAC). According to the International Energy Agency, capturing carbon from industrial facilities such as cement and steel plants could be critical to ensuring that global economic growth, particularly in the developing world, does not come at the cost of the climate.

Captured carbon is stored either permanently underground or temporarily for subsequent utilization. The most common utilization to date – enhanced oil recovery, where CO_2 is pumped into oil formations to encourage additional oil production – has been undertaken in the US for nearly 50 years. However, captured CO_2 can be used for myriad other purposes, from construction – for curing concrete, or mixing into cement and building materials – to conversion to fuels and chemicals.

Is CCUS necessary to reach global climate targets?

CCUS is critical for mitigating emissions from existing energy assets in advanced and developing economies, not to mention those planned or under construction. These include coal and natural gas plants – still being built in many parts of the world – as well as natural gas processing infrastructure.

CCUS can also help to address emissions from hard-to-abate sectors – such as energy-intensive manufacturing, aviation, and shipping – for which there are currently no low-carbon alternatives for oil and gas. As such, CCUS features prominently in nearly all climate scenarios where warming is kept below 1.5 degrees.

In addition to being used to mitigate emissions, there is increasing recognition that some measure of carbon dioxide removal (CDR) – through DAC or other negative emissions technology -- will be required to stabilize the climate. Most recently, the IPCC highlighted the need for CDR in all scenarios that limit warming to 1.5 degrees; these scenarios differ only in the scale of CDR required, dictated by how quickly emissions reductions are undertaken.

Scaling up, quickly

A significant number of projects are under development. The US is home to a majority of existing CCUS facilities, while Europe is also moving quickly in this space, and will host a majority of the projects announced in 2021.

However, scale and pace will have to dramatically increase before CCUS can play a significant role in climate mitigation. In order to meet projections in IEA's Sustainable Development Scenario, global installed carbon capture capacity will have to grow to more than a hundred times its current level, while currently planned facilities would only capture about triple the current CCUS capacity.

The 45Q tax credit, enacted in 2018 and recently finalized and extended, is intended to incentivize further development in the space: it provides a $35 credit per ton of CO_2 temporarily sequestered and $50 for each ton permanently sequestered. This federal legislation, by putting a price on carbon, has helped to stoke development of CCUS projects, though credits are often insufficient to cover the cost of most CCUS applications. Significantly higher credits are available for projects in California under the Low Carbon Fuel Standard (LCFS), where market-based tax credits reached more than $200/ton in 2020.

The IIJA includes significant support for demonstration projects and CCUS hubs, both of which can serve to decrease the risk and costs associated with future CCUS projects.

CCUS in perspective: necessary, but not nearly sufficient

As major emitters announce commitments to net-zero emissions futures and developing economies set their sights on dramatic growth in the interim, the fossil fuel industry hangs in the balance. Combined with dramatic declines in the cost of renewable energy and advances in complementary technologies, historically dominant fossil fuels such as coal, oil, and natural gas face an uncertain future.

These unfolding dynamics have broached the question of whether there is a meaningful role for energy derived from hydrocarbons in a world increasingly built on agreement around the need to ambitiously tackle the climate problem. As environmentalists call for an end to fossil fuels, their abundance and compatibility with extensive existing infrastructure, capital, and skills creates a problem of path dependence wherein abrupt transition could create many losers.

CCUS can reduce the extent of 'stranded assets' and lost livelihoods in a carbon-constrained world while enabling the continued use of fossil fuels where they provide the most benefit, particularly for the purpose of economic growth and reliable energy access in emerging economies. Moreover, as costs decline, utilization of captured carbon for enhanced oil and gas recovery can contribute toward achieving short-term energy security and coal-to-gas switching in rapidly industrializing countries like India, where demand is increasingly outpacing domestic supply and coal remains cheap and abundant.

Of course, CCUS is no panacea and comprises just one element of a vastly broader solution to the fossil fuel conundrum that calls for continued investment in zero- and negative-carbon technologies to remain within "safe" carbon budgets. That said, its role may be most important in areas like hard-to-abate industry and transportation, low-carbon hydrogen production, and in parts of the developing world where fossil-based power and industrial plants can help to lift millions out of poverty.

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