CARBON CAPTURE: CAPTURING, STORING AND USING CARBON

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The global economy runs on energy and, by and large, energy still requires greenhouse gas emissions. Energy efficiency can reduce demand; renewables are driving down the cost of carbon-free energy and can be coupled with storage or low carbon fuels to drive deep emissions reductions. But there are still situations that may require the use of fossil fuels for the foreseeable future.

In part six of this series, we complement our earlier discussion of the energy transition, energy efficiency, renewables, energy storage and low carbon fuels to look at the opportunities and challenges for carbon capture.

Catalysts for change

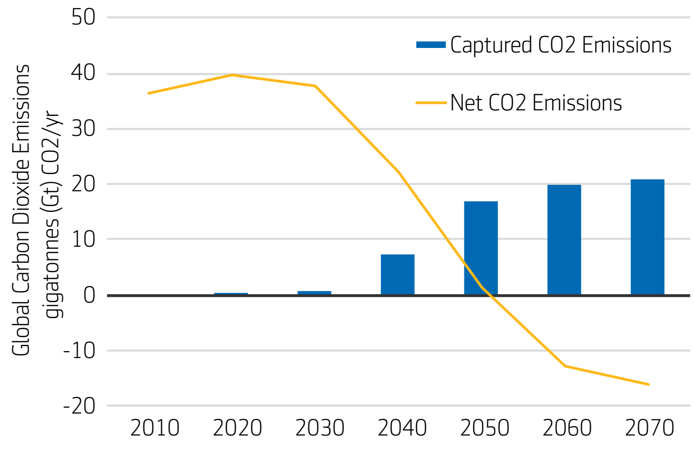
By either making direct use of unique properties of fossil fuels such as high levels of heat or undertaking a process that results in non-energy carbon emissions, industrial emissions can be challenging to mitigate. One approach to reducing the emissions associated with these applications is carbon capture. Often referred to as carbon capture and storage, carbon capture and sequestration (both CCS) or carbon capture utilization and storage (CCUS), there are four primary parts of the carbon capture value chain[1]:

1. Capture: The separation of CO2 from other gases; most commonly thought of post-combustion (e.g. capturing waste gases), it is also possible via pre-combustion (e.g. modifying input fuels to create hydrogen and separate CO2) or oxyfuel (e.g. using pure oxygen for combustion to produce pure CO2 exhaust)
2. Transport: Compressing and transporting captured CO2 to sites for storage or use
3. Storage: Injecting the waste CO2 into geological formations, such as old oil or gas reservoirs or saline formations, for permanent storage
4. Usage: Putting the captured CO2 to an economic or positive use in lieu of geological storage; some uses result in permanent removal effectively acting as storage while others are only temporary

Environmental and economic implications

As the global economy transitions in pursuit of the objectives of the Paris Agreement, achieving net zero emissions by mid-century will require more than mitigation. By definition, reaching a state of net zero will require the permanent removal of carbon emissions (see Exhibit 1). In their Sustainable Development Scenario, the International Energy Agency (IEA) projects greater than hundred-fold growth in carbon capture technology, from 40 Mt of existing annual capacity to over 5,600 Mt in 2050.[2]

Exhibit 1: Net global carbon emissions



Source: IIASA SSP Database. As of 2018.

Industry disruption and investment opportunities

Unlike other low carbon technologies, carbon capture is not self-standing. In order to be useful, it generally needs to be attached or integrated into a process or other emissions point source. As a result, it is expected to play a role in the decarbonization of industry—specifically energy intensive industries with limited other identified options for mitigation. This is particularly important for industries with significant non-energy process emissions. For example, around half of the emissions associated with making cement so some 4% of global GHG emission—are the result of a chemical reaction rather than the use of fuel.[3]

However, deployment to date has mostly been focused on natural gas and hydrogen production where there is a pure waste stream of CO2 that can be captured at a cost of less than USD 15 per tCO2. And, in place of storage, over 80% of existing projects get an added economic boost by pumping the captured gas into nearby oil wells to increase production through a process called enhanced oil recovery (EOR).[4] To help identify additional, similar revenue streams that could support near-term CCS deployment, a 2011 study from the Global CCS Institute reviewed existing and emerging CO2 usage opportunities and found some of the greatest potential in EOR and mineral carbonation.[5]

Despite opportunities, challenges remain

There are a number of barriers to the development and adoption of CCS technology, but four present some of the biggest roadblocks: process dependence, infrastructure, policy and regulation, and alternatives.

Generally industrial processes are tuned for efficiency and, with CCS acting as essentially an add-on to those processes, the addition of CCS often results in a performance or energy penalty. In this way it is different from many low carbon technologies as it is more similar to pollution control than something truly new and transformative.

Similarly, the need for associated infrastructure limits the opportunities for carbon capture. Considerable investment will be required to build the transportation and storage infrastructure required to safely handle captured CO2. This investment is also in addition to gaining the social license needed to overcome the NIMBYism[6] faced by major energy and infrastructure projects.

Furthermore, as waste, CO2 has little to no market value, resulting in demand for the deployment of carbon capture technology being dependent on policy support and regulatory incentives. In practice, this means that there is unlikely to be widespread adoption without either direct subsidies for the technology and infrastructure itself or a price on carbon sufficiently high to overcome the cost of deployment.

Finally, there are a number of alternatives available to CCS – technologies that accomplish the same end goal of reduction or elimination of GHG emissions but at a lower cost or at a more mature stage of development. For example, while it is possible to retrofit coal-fired power stations with carbon capture technology, replacing the same electricity generation capacity with some combination of renewables, storage and possibly even low carbon fuels would achieve an equivalent outcome at the same or lower cost while simultaneously reducing other negative externalities associated with the continued use of fossil fuels (e.g., air, water and ground pollution).

Key themes and investment considerations

Unfortunately, outside of a few niche applications, CCS has yet to demonstrate itself as a strong candidate for investment. Which isn't to say that it doesn't have a role in a net zero carbon future, but rather, is facing an uncertain road to deployment, especially when options exist to skip the inefficient and potentially destructive extraction-combustion-capture-storage cycle. Where CCS has been tried, it has met with mixed results —most notably in the power sector. For example, SaskPower invested CAD 1.5 billion to retrofit a 110 MW-net coal-fired unit at their Boundary Dam power station in Saskatchewan, Canada which captures 1 million tonnes (Mt) CO2 per year while, in Kemper County, Mississippi, Southern Company spent over USD 7 billion on a failed attempt to build a 582 MW coal plant that could capture some 3.5 Mt CO2 per year.[7,8]

One possible key to unlocking CCS deployment and corresponding opportunities for investment is use. Finding uses for captured carbon would increase the economic attractiveness of deployment and improve the business case for capturing carbon from industrial processes. It could also support the emergence of bioenergy with carbon capture and storage (BECCS), a coupling of technologies with the potential of providing one-third of global energy demand while permanently removing 40 gigatonnes CO2 annually from the atmosphere.[9]

Looking ahead

This look at carbon capture technology, including storage and utilization, concludes our exploration of key themes and technologies related to the energy transition.

However, much has changed since the series started in early 2020. Despite the Covid-19 pandemic, global appetite to accelerate the energy transition has increased: key technologies continue to decline in price and an increasing number of countries and investors alike have been setting net zero emission targets. As a result, we will end this series with one more entry, looking back at the themes, changes and considerations for the future.

Energy efficiency	Doing the same with less
Renewables	Generating energy without carbon emissions
Storage	Decoupling energy demand from generation
Low-carbon fuels	Using alternatives to common fossil fuels
Carbon capture	Capturing, storing and using carbon

References

[1]International Energy Agency (IEA) Energy Technology Perspectives – CCUS In Clean Energy Transitions (September 2020)

[2]Global CCS Institute Global Status of CCS 2020 (November 2020)

[3]Carbon Brief "Q&A: Why cement emissions matter for climate change" https://www.carbonbrief.org/qa-why-cement-emissions-matter-for-climate-change (13 Sep 2018)

[4]International Energy Agency (IEA) Energy Technology Perspectives – CCUS In Clean Energy Transitions (September 2020)

[5]Parsons Brinckerhoff for the Global CCS Institute Accelerating the Uptake of CCS: Industrial Use of Captured Carbon Dioxide (Mar 2011)

[6]NIMBY – short for "not in my backyard" – is a common characterization of opposition by residents to proposed developments in their local area

[7]Massachusetts Institute of Technology "MIT CC&ST Program" http://sequestration.mit.edu/index.html (accessed 12 Dec 2020)

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[9]Utrecht University "Potential of achieving climate target with BECCS is limited" https://www.uu.nl/en/news/potential-of-achieving-climate-target-with-beccs-is-limited (24 Aug 2020)

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