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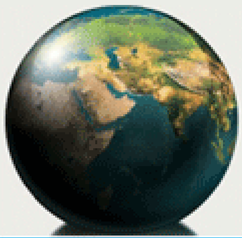

Decarbonizing the Energy Sector and Industry

The Role of CC(U)S

Decarbonizing the Energy Sector and Industry: The Role of CC(U)S

Event Brief – May 2019

Carbon capture, utilization and storage: A timely debate

There is no doubt that achieving the Paris Agreement objectives of keeping the increase in global average temperatures to well below 2°C above pre-industrial levels and limiting the increase to 1.5°C will be a race against time. According to the IPCC,[1] the planet has already warmed by 1ºC, and it will likely reach 1.5ºC before 2050. In this context, the autumn of 2018 saw the publication of two influential documents – the IPCC's special report on the 1.5°C target and the EU's draft long-term climate strategy – which clearly brought the need for low-carbon technologies and negative emissions to the forefront. Carbon capture, utilization and storage (CC(U)S), often in combination with bioenergy, plays a large role in many of the pathways and scenarios described.

It is therefore time to take a renewed, strategic look at CC(U)S. The following brief draws from insights from an event held at the ESADEgeo Center for Geopolitics and Global Economy in May 2019, entitled *Decarbonizing the Energy Sector and Industry: The Role of CC(U)S.* The event examined CC(U)S from a wide range of angles – from science and technology, business and industry, and policy and governance – in order to provide a clear picture of the current deployment of the technology and the challenges and opportunities that lie ahead. For this brief, the speakers' insights were complemented with findings from the most recent literature on the topic.

Why is CC(U)S needed? The dual challenge

The world is facing a dual challenge: the need to sharply reduce GHG emissions while simultaneously meeting growing energy demand. According to IEA's New Policies Scenario, global primary energy demand will expand by more than 25% between 2017 and 2040, due to the accelerating growth of the global economy and population and the rapid process of urbanization.[2,3] For comparison, this is roughly the equivalent of adding another China and India to today's global demand. Yet at the same time, following the IPCC report, in order to limit global warming to a maximum of 1.5ºC, "global net human-caused emissions of carbon dioxide (CO_2) would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050. This means that any remaining emissions would need to be balanced by removing CO_2 from the air".[4]

[1] IPCC, 2018a.
[2] IEA, 2018: 35.
[3] Note that the IPCC's P1 1.5 pathway sees global energy demand declining rather than growing. However, this scenario would require large-scale behavioral change in order to reduce energy usage patterns.
[4] IPCC, 2018b: 2.

CC(U)S is one way to do this. It is an emissions removal technology that captures carbon dioxide emitted during power generation or in industrial processes, compresses it, and then transports it to either store it permanently deep underground (in geological formations), or to use it a resource to create certain products.[5,6] For a number of energy-intensive industries such as steel and cement, CC(U)S is currently one of the only viable pathways to emissions reductions. Along with (re)forestation and other land-use policies, CC(U)S forms part of a portfolio of carbon dioxide removal measures. It can also be combined with bioenergy; in which case it is referred to as BECCS.[7]

What is the current state of CCS technology and deployment? A drop in the ocean

Capturing carbon dioxide is not a new technology. It was first deployed at commercial scale in 1972, when several natural-gas processing plants in the Val Verde area of Texas started to employ carbon capture to supply a nearby oil field with CO_2 for Enhanced Oil Recovery (EOR) operations. Progressively, CCS became involved in further applications, including fertilizer production, coal-fired power, steel manufacturing, chemical and hydrogen production and BECCS.[8] Nevertheless, for all the experience with carbon capture and the widespread optimism about the technical feasibility and integration of all the components of carbon capture and *storage*,[9] the technologies are currently at a stage of mixed maturity. Some sectors, including gas processing, coal-fired power and steel, have demonstrated CCS at scale in minimum one plant, but others, such as cement or steam crackers, are still seeking implementation of their first demonstration.[10]

Altogether, there are 43 large-scale CCS facilities around the world (18 in commercial operation, 5 under construction and 20 in various stages of development), which collectively capture around 37 Megatons of CO_2 per annum.[11] This capacity is just a drop in the ocean compared to the actual needs. The IEA's Sustainable Development Scenario, for example, estimates that 2,300 Megatons of CO_2 will need to be captured per year by 2040.[12]

What are the major barriers to the widespread adoption of CCS? How can they be addressed?

Pilita Clark once wrote in the *Financial Times* that "If there was a prize for false starts, dashed hopes and failed promises, the carbon capture and storage industry would be a strong contender".[13] Indeed, despite the promise CCS holds, it has faced important challenges that have held back its potential and stalled its large-scale deployment. The question is whether and how these challenges, which are detailed below, can be overcome, in a context where the urgency of fighting climate change is rising.

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5 IEA, 2019.
6 When carbon dioxide is captured and used as a resource to produce a new product, it is referred to as CCU (carbon capture and utilization). CCU tends to be less prominent item on the mitigation agenda than CCS, because it covers a range of different applications with varying mitigation effects, because of its current limitations in terms of scale, and due to uncertainty regarding its overall impact on emissions (De Coninck, 2019: 1; European Commission, 2018: 62)
7 For a full glossary of terms, see Matthews, J.B.R. [ed.], 2018.
8 Global CCS Institute, 2017: 28-29.
9 De Coninck *et al.*, 2009: 2.
10 De Coninck, 2019: 2.
11 Global CCS Institute, 2018: 12.
12 IEA, 2019.
13 Clark, 2012.

- **High costs:** CCS projects involve both high upfront costs – especially for transportation and storage infrastructure – and high operational costs, given that all the individual components of CCS are energy-intensive. Separating CO_2 from the other gases in an industrial plant's exhaust stream, compressing it, transporting it by pipeline and injecting it deep underground under high pressure are processes that consume a significant amount of the heat and electricity.[14] R&D can meaningfully reduce this so-called "energy penalty",[15] yet this is largely conditional on climate policies that can boost the confidence of private investors and catalyze long-term capital investments. If CCS is to be used at a large scale, it will need to become cost-competitive compared to other mitigation technologies and improve on its current trajectory of cost reductions.[16]

- **Absence of sufficient incentives:** A fundamental part of any policy framework that seeks to support climate change mitigation is the presence of a sufficient value on carbon. Without a definitive price signal that places a value on emissions reductions, any potential developer of capture plants will be reluctant to bear the high costs of a project. However, governments around the world have fallen short in their efforts to price carbon so far. In fact, 87% of global greenhouse gas emissions still face no carbon price at all, and less than 1% of global emissions falls under a carbon price equal to the social cost of carbon.[17] The IEA has found, nevertheless, that "a commercial incentive as low as USD$40 per tonne of CO_2 could trigger investment in the capture, utilisation and storage of up to 450 million tonnes of CO_2 globally".[18] Meanwhile, other incentive mechanisms are also being explored, including a new tradable asset class specific to CCS.[19]

- **Social acceptability:** Among the four possible decarbonization pathways mentioned in the IPCC report on the 1.5°C target, there is one in which CCS is avoided completely and replaced, for the most part, by large reductions in energy demand.[20] According to Myles Allen, a Coordinating Lead Author of this report, various civil society organizations have clung to this scenario to advocate that CCS is not necessary to limit global warming.[21] This reaction suggests that the social acceptance of CCS cannot be taken for granted. On the contrary, CCS is often regarded with skepticism, for a number of reasons. For one, it is sometimes seen as being, presumably, in open competition with other mitigation options. However, this idea disregards the technology's potential to complement renewables by reducing emissions in large industrial sectors that renewables cannot penetrate – notably, steel, cement, chemicals, fertilizers, petrochemicals, paper and pulp.[22] For another, CCS is sometimes negatively framed as an already-profitable industry profiting from public investments. Identifying alternative narratives – for example, highlighting the role of CCS in helping to keep certain industries in place in their present forms longer, thereby contributing to a "just transition" – will be critical.[23]

- **Risks:** A number of risks form a further barrier to large-scale CCS deployment of CCS. One is related to the necessary coordination of multiple investment decisions for each CCS project. Each decision – related to the multiple steps in the CCS chain, such as transport and storage

[14] Kemp, 2014.
[15] The US Department of Energy research program, for example, has contributed to a significant reduction in the energy penalty from CO_2 capture in power generation, from over US$100/ton in 2005, to US$60/ton currently, and is targeting US$40/ton by the 2020–2025 timeframe (Global CCS Institute, 2017: 46).
[16] De Coninck, 2019.
[17] Jenkins, 2019: 1.
[18] IEA, 2019.
[19] Heidug and Zakkur, 2019: 20-23
[20] De Coninck, 2019: 1.
[21] Allen, 2019.
[22] Global CCS Institute, 2017: 11.
[23] De Coninck, 2019.

infrastructure – has a long lead-time, which generates significant risks. Moreover, once projects are operational, the interdependency remains, as the failure of one of the components to deliver on their obligations may affect the costs and revenues of others. This cross-chain risk can be limited by adopting a hub and cluster model which utilizes a transport and storage (T&S) network.[24] Another is long-term storage risk: under current technology, the risk of leakage from an appropriately selected storage site is very small, but not zero. This liability may daunt possible storage operators, and more thinking is necessary on possible technological and regulatory measures to mitigate this risk.[25]

Final thoughts

Despite facing a set of challenges and dilemmas, carbon capture and storage may be the only viable route to decarbonizing certain hard-to-abate industrial sectors, such as clinkers and cement, in the short- and mid-term. With the urgency of the fight against climate change mounting and with global warming of 1.5ºC looming closer on the horizon, it has become clear that policymakers cannot afford the luxury of discarding any mitigation options – and CC(U)S is one of them. As with any other technology, policy and regulatory certainty will play an important role going forward.

[24] Zapantis *et al.*, 2019: 16-18.
[25] *Ibid.*, 2019: 20.

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ESADEgeo Center for Global Economy and Geopolitics
Av. Pedralbes 60-62, 08034 Barcelona, Spain
+34 934 95 21 46

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