Issue Brief: Carbon Capture, Utilization and Storage (CCUS)

According to the International Energy Agency (IEA), carbon capture, utilization and storage (CCUS) capabilities need to be drastically expanded in order to meet the goal of keeping the global average temperature increase below 2°C. The IEA estimates that to achieve this target, the number of industrial scale carbon capture facilities needs to increase from the existing 19 to more than 2,000 by 2040.

Carbon **capture** refers to the process of capturing carbon dioxide from either a point source (e.g., the flue of a power plant or industrial facility) or the atmosphere (i.e., direct air capture). That carbon can then be **utilized** to make goods such as carbonated beverages, or to extract fossil fuels via **Enhanced Oil Recovery (EOR)**. Or it can be **stored** in underground geological formations such as saline aquifers or depleted oil reservoirs.[1]

Benefits of CCUS

- **Cutting emissions.** According to the International Energy Agency (IEA) and the Intergovernmental Panel on Climate Change (IPCC), including some form of carbon capture and storage (CCS) in decarbonization efforts is the most cost-efficient way of achieving net zero goals. In its Fifth Annual Assessment Report (AR5), the IPCC stated that excluding CCS from emissions reduction solutions could double the costs of decarbonization. More importantly, according to the IEA, achieving net zero emissions might be impossible without CCUS. It may also be the most effective way of reducing emissions in hard-to-abate sectors such as the industrial sector. The decarbonization of cement and steel production, for example, is difficult to achieve due to the emissions that stem from the production process itself and the use of fossil fuels to achieve the high temperatures required.

- **Hydrogen** shows great promise in potential future use for the decarbonization of cement and steel production, yet most hydrogen in the market is produced using coal or natural gas. Coupling CCUS with hydrogen production would further enable the decarbonization of the industrial sector.

- **Facilitating a reliable and resilient grid.** Until there are durable solutions for the intermittency of renewable power generation, CCUS can decarbonize electricity generation that still relies on fossil fuels.

- **Negative emissions.** CCUS offers a way of compensating for emissions that are difficult to, via processes such as Direct Air Capture (DAC) and Bioenergy with Carbon Capture and Storage (BECCS) – which refers to power generation from biomass coupled with carbon capture and storage.

- **Jobs**. According to the Rhodium Group, carbon capture retrofits may provide between 67,000 and 100,000 jobs per year over the next 15 years in 21 states in the Central United States. CCUS may also create additional employment throughout the supply chain that will feed these innovative technologies, creating a multiplier effect for employment. Furthermore, CCUS may also help smooth the transition to low-carbon processes in the industrial and power generation sectors: while many fossil fuel powered plants will eventually close, CCUS may support these industries and the communities that rely on them for employment as they transition to cleaner technologies.

- **Innovation spillover.** Recent studies indicate that CCUS deployment will create valuable spillover effects in sectors such as technology, financial services and manufacturing of low-carbon products.

1: CCUS as described in this Issue Brief is separate from but related to terrestrial sequestration, which is the capture of CO2 by trees and plants through actions such as reforestation and other nature-based solutions.

Current Technology

Types of Capture

- **Point sources.** CO_2 can be captured from stationary sources such as the flue of an emitting power or industrial facility. This can be done with the help of **solvent** liquids that absorb CO_2 when they come into contact with it; with solid **sorbents**; with **membranes** that allow for partial capture of CO_2 as it flows through them; or **oxy-combustion**, whereby fuel is burned with pure oxygen instead of ambient air to produce highly concentrated CO_2 and water, which is easier to capture.

- **Direct Air Capture (DAC)** involves capturing CO_2 from ambient air (with either solvents, sorbents or membranes). One disadvantage of this type of capture is that it tends to be significantly costlier than capture from point-sources.

Types of Utilization

Captured carbon can either be **utilized** or stored. Utilization refers to the different ways that captured carbon can be repurposed to produce valuable products or services. Some examples of ways that CO_2 can be re-utilized are:

- **Enhanced Oil Recovery (EOR)** is a process whereby CO_2 is injected into existing oil reservoirs to extract more hydrocarbons. As CO_2 gas moves through minerals to push oil out, some of it becomes trapped (this is known as residual trapping), and the rest is recycled to be injected again in a closed-loop system.

- **Synthetic limestone.** By combining CO_2 with calcium contained in common rock waste, a company named Blue Planet has found a way to produce limestone (calcium carbonate). This can in turn be repurposed to make cement.

- **Stronger concrete**. Companies such as Carbon Cure have developed a way to inject CO_2 into cement, which reacts with calcium to form calcium carbonate particles, and makes the concrete stronger.

- **Chemicals.** Companies such as Lanzatech use carbon dioxide to produce various chemical products.

- **Agriculture**. Carbon dioxide can be used to increase the yield of greenhouse crops, by increasing photosynthesis rates.

- **Manufactured products.** CO_2 can also be used to produce things such as carbonated beverages.

Types of storage

- **Geologic storage.** Carbon dioxide captured by any means can be stored in underground formations such as depleted oil and gas reservoirs, saline aquifers, or porous rock formations . This is often done by compressing carbon dioxide into a supercritical state, making it almost as fluid as water. An estimated total of 3,071 million metric tons of CO_2 are emitted every year from stationary man-made sources in the United States, and there are between 2,618 and 21,978 billion metric tons of storage resources available in the United States (including oil and natural gas reservoirs, unmineable coal, and saline formations).

- **Utilization processes** such as the fabrication of **concrete with injected CO_2** or **EOR** also function as a form of storage, given that the carbon dioxide never reaches the atmosphere again. **Residual trapping** associated with EOR is, in itself, also a form of **geologic storage.**

CRES Forum Policy Recommendations

CRES Forum is a member of the Carbon Capture Coalition. The following recommendations are consistent with those defined by the coalition in the 2021 Federal Policy Blueprint.

- **Enhancements to 45Q.** The tax credit from section 45Q of the U.S. tax code provides a tax credit of $50 per metric ton of CO2 in geologic storage, and $35 per metric ton of CO2 used in EOR or other utilization projects. Providing, longer term, and greater incentives for the development of CCUS technologies that are scalable and ready for commercialization will facilitate reaching decarbonization goals with the help of CCUS. This can be done by increasing the value of the credit, increasing the credit payment length (or establishing a permanent credit), and providing clearer guidance for those who want to claim the credit. Finally, modifying the threshold for carbon capture capacity of qualifying facilities would expand the number and types of projects that are able to participate, thus incentivizing innovation and multiplying the available approaches to carbon capture that may be scalable.

- **Federal funding for R&D in innovative storage technologies.** Significant federal investment is required if CCUS to be deployed at scale necessary to reach net zero by 2050. This includes a robust Department of Energy, CCUS research, development and demonstration program.

- **Differentiate companies that use CCUS by promoting transparency and benchmarking for firm- and product-level emissions.** A better framework for emissions reporting, in the shape of a federal greenhouse gas emissions registry, would increase transparency and accountability for industrial plant-level emissions reductions, and drive additional investment in offsets. Disclosure of the carbon content of different products can stimulate their commercialization, thus creating incentives for increased use of carbon capture technologies among companies.

- **Support deployment of infrastructure to transport CO2.** Captured CO2 must be transported to sites where it can be utilized and/or stored. This requires a pipeline infrastructure to be deployed, which in turn necessitates facilitating collaboration between federal, state, tribal and non-governmental stakeholders for planning, permitting, and siting.

- **Create jobs in historical oil and gas and industrial areas** that rely on the fossil fuel, mining and industrial sectors for employment, and also often suffer the most adverse health effects due to their proximity to air polluting facilities, through federal training programs in partnership with local educational institutions and labor organizations.