What is Carbon Capture, Transport, Utilization, and Storage?

Energy Resources

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About the Handbook

A ‘how-to’ action guide to empower legislators, ministries, regulators, and NOC officials for understanding the policies, rules, and best practices that countries can adopt and implement for CCUS.

Available here:

cldp.doc.gov/carbon-capture-utilization-and-storage-ccus-resources

About the Handbook (Cont.)

- Sponsored by **U.S. Department of State, Bureau of Energy Resources.**
- Drafted over one week in an intense session with eight expert co-authors.
- Co-written by authors representing:
  - Government
  - NGOs
  - Multilaterals
  - Industry
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What is Carbon Capture, Transport, Utilization, and Storage?

Key Takeaways

- Carbon dioxide is typically emitted at the site where it is produced. CCUS takes the CO_2 before it is released and transports it where it can be used or stored underground permanently.
- CCUS is a set of four interdependent components: capture, transport, utilization, and storage. Each requires its own consideration by policymakers.
- It is essential for policymakers and regulators to understand the evolving options and technology behind each of these four components.
- Although the "U" in CCUS stands for Utilization, it is estimated that most CO_2 will need to be injected underground.
- There are several cross-cutting considerations, such as technical requirements for CCUS projects will need to integrate safety provisions throughout the value chain.

What is Carbon Capture, Transport, Utilization, and Storage?

Capture

CO_2 capture can be captured from point sources or the atmosphere

The choice of capture technology deployed is typically based on selection criteria that can span facility type, geographic location, and cost, where facility types are subdivided into low and high CO_2 concentration sources, in terms of emissions purity before capture.

- ***High-Concentration Capture***: CO_2 from high-concentration sources may require very little processing before being transported. Some examples include oil refining, hydrogen production from natural gas, ammonia production, and natural gas processing applications.

- ***Low-Concentration Capture***: This type of capture generally deeds to be designed for the specific host application and typically includes chemical solvents, cryogenic separation, membranes, and sorbents.

What is Carbon Capture, Transport, Utilization, and Storage?

Capture

Carbon dioxide removal (CDR) is a process by which CO_2 is removed from the atmosphere and permanently stored. Two such processes include:

- ***Direct Air Capture (DAC)***: involves the use of solvent-based or sorbent-based technologies to remove CO_2 from the air.

- ***Biomass CCS***: involves the conversion of feedstocks directly into energy or a chemical product, with the removal of the carbon produced by the process.

Case Study: Scale Up of Alabama Power's Plant Barry 25-Megawatt Capture Project

In 2009 a 25-megawatt CCUS Demonstration Project at Alabama Power Company's Plant Barry in the U.S. was the world's largest carbon capture on a pulverized coal power plant.

CO_2 was captured from the flue gas, compressed onsite, and transported 12 miles to the geologic storage site.

Test data collected provided an excellent test foundation to scale-up this technology from the **25-megawatt** slip stream capture to the **240-megawatt** capture system at NRG's W.A. Parish Generating Station near Houston, Texas.

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Transportation

After capture, CO_2 can be transported via:

Pipeline	• Used onshore and offshore • Onshore: CO_2 transported in carbon steel pipelines buried underground • Offshore: pipelines will generally be laid on top of the seabed • To be transported via pipeline, needs to be compressed • Can be energy intensive and lead to associated emissions of CO_2 if power for compressors is not from low carbon sources
Rail	• Mainly occurs using pressurized tank cars that transport liquid CO_2 • Operator must develop the appropriate infrastructure to liquefy, store, onload, and offload CO_2 • Must consider boiling off some CO_2, known as boil-off losses, incurred during transport
Truck	• Widely used for relatively short-haul small volume transport • Typically, low-volume cryogenic tankers or pressurized vessels are used to move CO_2 • Requires onloading and offloading facilities to transfer the CO_2 to and from the trucks
Ship	• Requires onloading and offloading facilities at the waterfront to facilitate transport • Considered a viable option for offshore projects aiming to store either small volumes or volumes from multiple sources, and a viable option for the cross-border transport of CO_2

What is Carbon Capture, Transport, Utilization, and Storage?

Storage

After transport, CO_2 can be stored geologically in deep saline reservoirs, depleted oil and gas reservoirs, and other formations.

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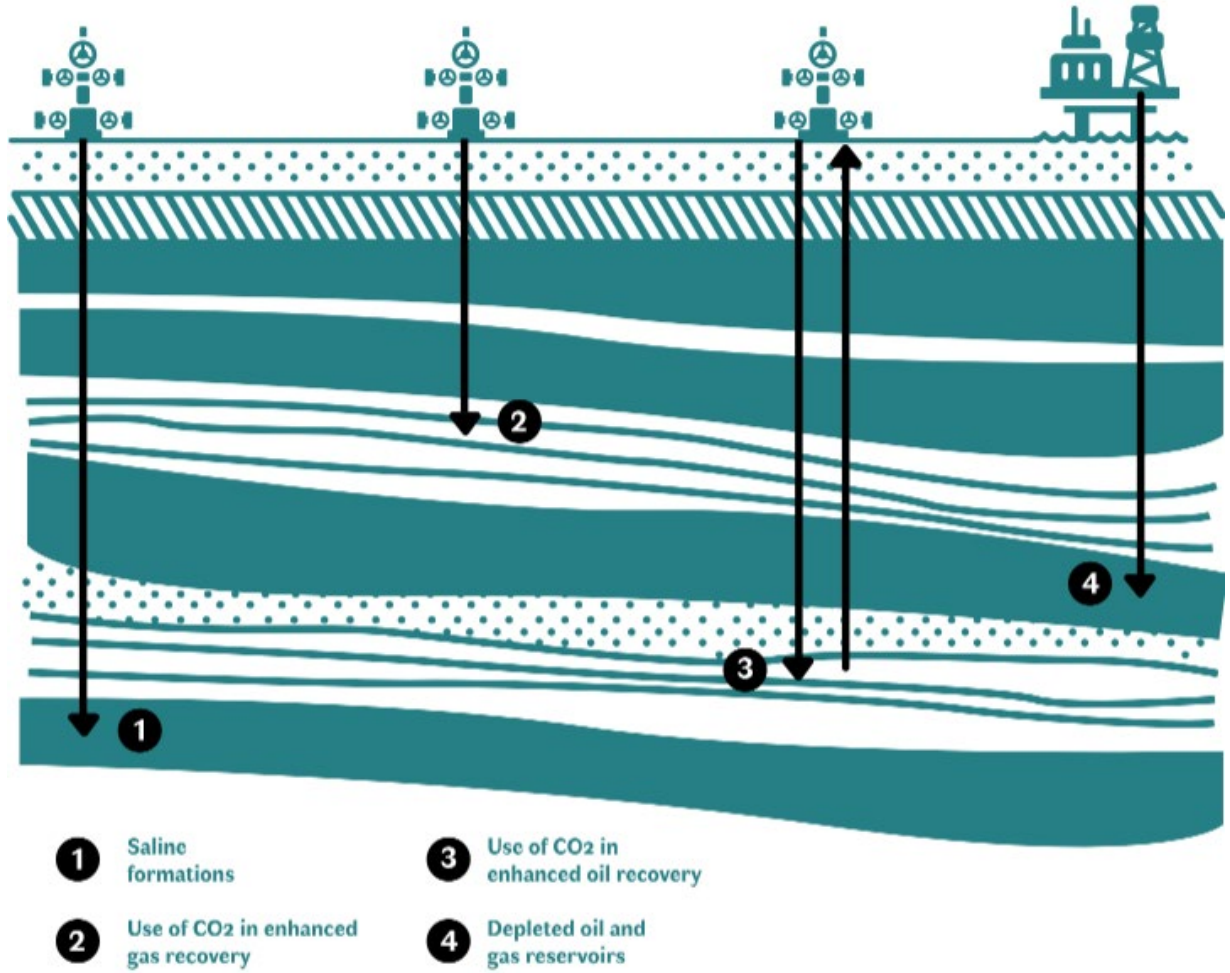
Saline Formation Storage: porous sedimentary strata that exist within onshore/offshore basins and are commonly made up of sandstones and carbonates that contain brine within their pore spaces. These formations present some of the largest opportunities for storing commercial volumes of CO_2.

4

Depleted Oil/Gas Reservoirs: oil and gas reservoirs that are nearing/at the end of their productive lives may be potential candidates for storing CO_2. These are similar to saline formations but have oil and gas trapped in them.



What is Carbon Capture, Transport, Utilization, and Storage?

Utilization

After transport, CO_2 can be utilized to assist in the extraction of hydrocarbons or product creation.

Utilization can contribute to the development of CCS infrastructure, particularly for:

- ***Enhanced Oil Recovery (EOR)***: a process designed to produce hydrocarbons CO_2 from a geologic reservoir using the injection of CO_2
- ***Enhanced Gas Recovery (EGR)***: a hydrocarbon production technique that can be used in either natural gas reservoirs or coal seems. EGR works by directly replacing natural gas

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Case Study: Assessing Products from Captured CO_2 in India's Cement Industry

In 2021, the Asian Development Bank (ADB) supported a cement study in India to assess feasibility of products converted from captured CO_2.

The study evaluate urea, soda ash, mineralization, methanol, algae for feed, and algae for oil.

Financial analysis indicated a low return on investment under the standard conditions assumed.

To improve commercial viability, the study concluded that the following are critical:

- ✓ Availability of low operational costs for onsite electricity and steam
- ✓ Specific price level of carbon credits to fill the financial viability gap

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Cross-Cutting Considerations

- ***Safety***: CCUS projects will need to integrate safety provisions throughout the value chain, including protection from major CO_2 releases; monitoring incremental air emissions of hazardous air pollutants; and assessing storage integrity.

- ***Risk Analysis and Management***: Financial, operational, storage, health/safety, and public perception risks may be present in CCUS projects. Regular risk management and mitigation workshops should be conducted to identify, track, and close risks.

- ***Quality Specifications***: CO_2 products from different capture sources may have a different composition of impurities. Transportation and storage options will require some of these impurities to be removed as a measure to protect the transport or storage infrastructure from damage.

- ***Integrated Infrastructure***: As CCUS infrastructure is built, it will be important to integrate all necessary components for the CCUS project.

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