CCUS
& THE CHEMICAL INDUSTRY

American Chemistry Council

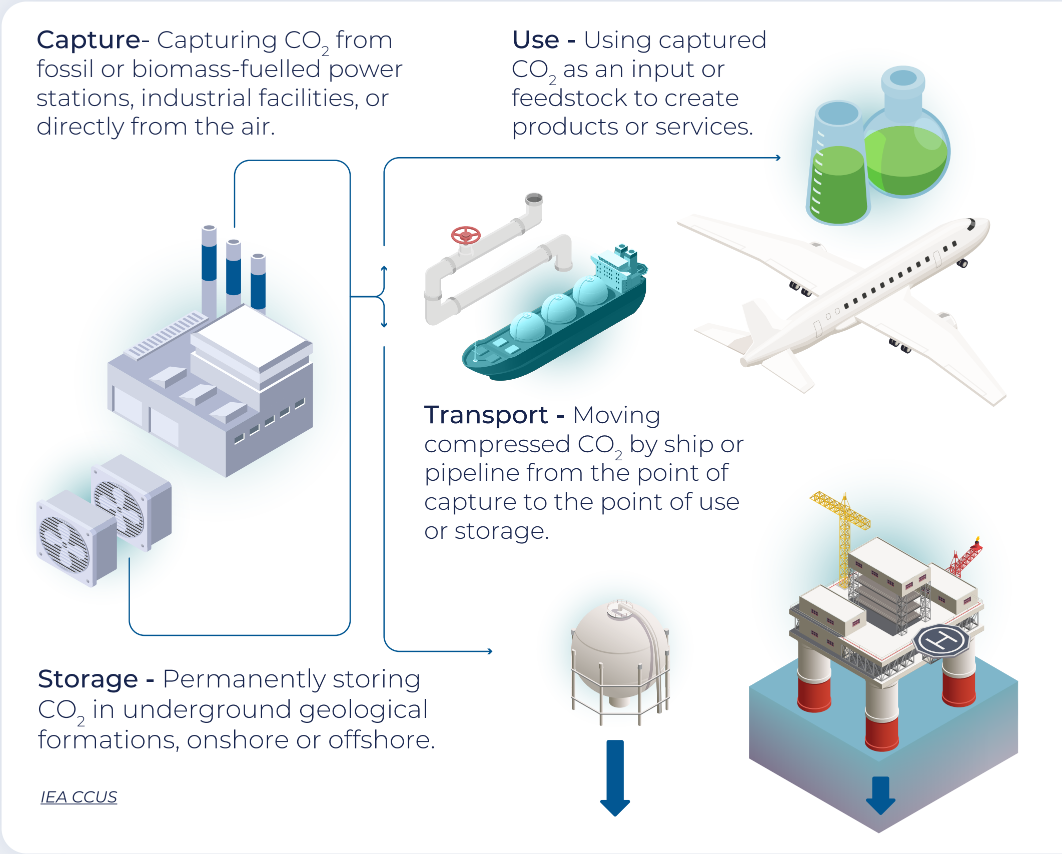
I. WHAT IS CCUS?

The term "Carbon Capture, Utilization, and Storage" (CCUS) encompasses a range of advanced technologies and processes crucial for achieving net-zero emissions globally, particularly in "hard-to-abate" sectors, including chemical manufacturing.

- Central to this approach is the capture of carbon dioxide (CO_2) emissions from major sources like power plants and industrial facilities, as well as Direct Air Capture that directly extracts CO_2 from the atmosphere.
- Once captured, CO_2 is compressed for transport and either channeled to markets or customers who use the CO_2 to make or enhance the performance of products or processes ("utilization"), or injected into deep geological formations, so that it remains isolated from the atmosphere ("storage" or "sequestration").

Each step in this process – carbon capture, carbon transport, carbon utilization and carbon storage – has been used in select industries and countries. As CCUS technologies have evolved, the potential to reduce carbon emissions in other sectors has grown.

II. OVERVIEW OF CCUS



Carbon Capture

There are two main categories of carbon capture: **Point-Source Carbon Capture** and **Direct Air Capture**[1].

The **Point-Source Carbon Capture** approach can trap carbon dioxide where it's more concentrated, like at power stations and factories. It includes several methods:

- Pre-combustion capture, which turns fuel into a gas mix to remove CO_2 early on;
- Oxy-fuel combustion capture, where fuel is burned in almost pure oxygen, leading to a CO_2-rich gas that's easier to separate; and
- Post-combustion capture, which extracts CO_2 from exhaust gases after burning.

The post-combustion method may be particularly useful for updating existing plants. CCUS can be effectively integrated with other decarbonization technologies to help facilitate a more comprehensive and sustainable energy transition.

Direct-Air Capture (DAC) is a leading technology in Carbon Dioxide Removal (CDR), an array of methods designed to extract CO_2 from the atmosphere. DAC uses advanced techniques to mechanically filter CO_2, using solid sorbents or liquid solvents. The collected CO_2 can then be stored or repurposed. In addition to DAC's technological approach, CDR also involves ecological methods and capturing CO_2 from biomass.

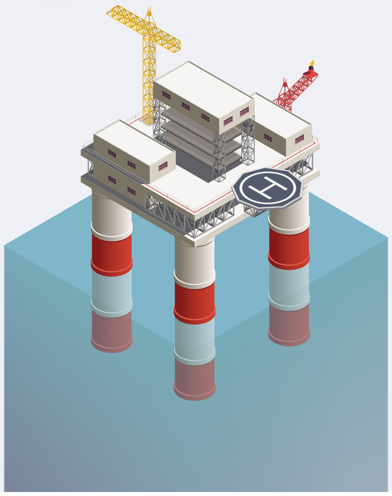
Carbon Utilization

Carbon utilization is an emerging field that can play a crucial role in the journey toward a more sustainable and circular economy. It involves the innovative use of captured CO_2, aligning with principles of circularity, where waste materials are repurposed to create value.

There are two primary approaches to carbon utilization[2]:

- **Non-conversion** directly utilizes CO_2 in its existing form, which is less energy intensive.
- In contrast, the **conversion** approach transforms CO_2 into various valuable products, such as fuels, chemicals and building materials.

While carbon utilization is currently operating in niche markets, it stands at the threshold of significant expansion. This anticipated development, championed by the U.S. Department of Energy (DOE) and the International Energy Agency, is underpinned by a focus on addressing energy and cost challenges, particularly in the chemical industry. Congress also committed significant resources through grant and tax incentives to catalyze innovation and the widespread adoption of carbon utilization technologies[3].



Carbon Storage

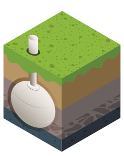
Carbon sequestration, the injection of captured CO_2 into deep geological formations, offers a long-term strategy to store carbon deep underground. By applying stringent site selection, construction, operation and monitoring practices, sequestering carbon in deep saline formations could offer a safe, effective method for storing CO_2 for thousands of years.

U.S. Environmental Protection Agency (EPA) and DOE experts have suggested that depleted oil and gas fields, along with areas with coal mining histories, could offer further storage potential. Additionally, emerging techniques, such as mineral carbonation, are expanding the scope of sequestration possibilities.

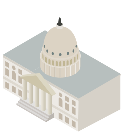
Leveraging these storage resources is one way to deliver substantial CO_2 emissions reduction more rapidly. However, this approach will require significant commitment and cooperation from public and private sector partners and the host communities to site, permit and build the storage projects and critical infrastructure.

III. CURRENT U.S. CCUS LANDSCAPE

The U.S. faces both challenges and opportunities in expanding its carbon capture and storage capabilities to meet future energy transition targets.

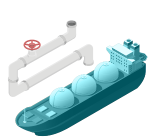


The Princeton Net-Zero America Project estimates that reaching our nation's energy transition goals will require capturing and storing 400 million to 1.8 billion metric tons of CO_2 annually by 2050 – a significant leap from the current capacity of over 20 million metric tons per year.[4] However, such an expansion offers a major investment opportunity, estimated at $100 billion by 2030, and potentially rising to $600 billion by 2050.[5]



The Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA) provide substantial funding for early stages of CCUS deployment. This is particularly crucial for emerging technologies in point-source capture and Carbon Dioxide Removal, where increased funding can help reduce technological and execution risks.

Federal support for CCUS pathways is anchored by the 45Q tax credit, a financial incentive that could bolster the financial feasibility of carbon management projects. Offering up to $85 per ton for carbon that is securely stored or utilized, the 45Q credit can provide a stable, performance-based revenue stream that developers can account for in assessing potential projects. This incentive is structured to support projects for 12 years post-completion, with the condition that they must begin construction by the end of 2032. However, while the 45Q tax credit represents a positive step, it may be insufficient to fully address the financial burdens of large-scale CCUS projects.



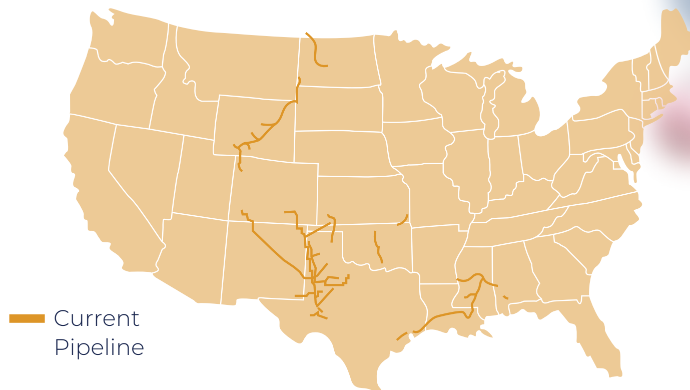
Moreover, development of regional carbon management hubs, supported by various DOE programs, is vital. These initiatives promote shared infrastructure, thereby optimizing the transport and storage requirements essential for widespread deployment of CCUS technologies.

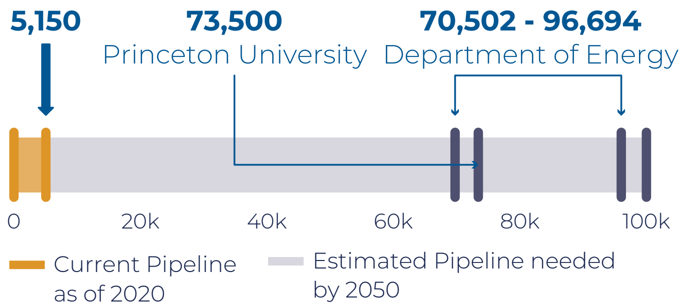
IV. ADVANCING OPPORTUNITIES FOR CCUS

Investment in Infrastructure

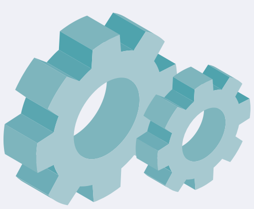
Currently, the U.S. has approximately 5,000 miles of operational CO_2 pipelines, mostly built to support enhanced oil recovery (EOR). According to several DOE studies, CO_2 pipeline capacity must be scaled from 30,000 to 96,000 miles by 2050[10]. Comprehensive infrastructure development that includes strategically located storage hubs, a national network of high-capacity CO_2 pipelines, diverse transport options, and robust policy frameworks, is vital for the smooth integration of CCUS into wider decarbonization plans.

An important aspect of CCUS project success is securing local community support. Effective implementation of CCUS initiatives hinges on the involvement and approval of local communities. This necessitates a collaborative approach, where developers and regulators actively engage with communities, ensuring their concerns and needs are integral to the project development process. Inadequate community engagement can lead to resistance or delays, further complicating the project's feasibility.





US GAO: Status, Challenges, and Policy Options for Carbon Capture, Utilization, and Storage

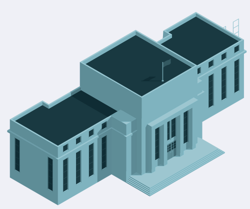


Modernize the Permitting Process

To effectively realize the potential of CCUS in the chemicals industry, it is vital to modernize the existing permitting process. Presently, the slow pace of permit approvals poses a significant challenge, with a backlog of over 50 MTPA (million tonnes per annum) of underground well injection applications pending review. This delay hinders progress toward supporting 70 to 110 MTPA by 2030.

Expediting the timeline for storage capacity development and issuing permits for carbon storage projects and supporting pipelines and infrastructure is essential.

Finally, a clear and standardized regulatory framework for CO2 pipeline siting, under the oversight of PHMSA, will streamline pipeline construction.



Federal Support for CCUS Pathways

Modest federal support for CCUS projects in the United States can impede the ability of CCUS technologies to help meet net-zero emissions targets by 2050.

- Current estimates suggest that an investment of \$50 billion to \$80 billion by 2030, increasing to \$300 billion to \$600 billion by 2050, is essential to develop CCUS technology, capture projects, and particularly for transport and storage infrastructure, which constitutes about 10% of this investment need.
- While federal incentives such as the 45Q tax credit represent a positive step, they are insufficient to fully address the financial burdens of large-scale CCUS projects, which require substantial upfront costs and financial risks, which are not entirely mitigated by existing federal support.

V. CCUS POTENTIAL IN THE CHEMICAL INDUSTRY

The chemical industry, responsible for

5% of global GHG emissions

due to its reliance on carbon-intensive processes

by 2050, CCUS could account for approximately

20% of emission reductions

in the chemical sector

The chemical industry, responsible for about 5% of global GHG emissions, faces a complex decarbonization challenge, due to its reliance on carbon-intensive processes[6].

- The chemical sector is among the hardest to abate. While there is no single pathway to decarbonizing the U.S. chemical sector, manufacturers, EPA and DOE all have identified CCUS as a critical component of a comprehensive abatement strategy.

Other emerging energy sources, notably lower-emissions hydrogen and biofuels production, can complement CCUS adoption. These approaches have gained further attention following the final statement from COP28[7], which highlighted the urgency of accelerating zero- and low-emission technologies.

The high concentration of CO_2 in certain chemical process streams may make carbon capture a viable strategy for segments of the chemical sector, particularly those located near key geological storage zones like the Gulf Coast and Midwest[8]. In addition, the chemical industry can work to advance technology that will drive adoption of CCUS across hard-to-abate sectors. This is vital as CCUS will continue to play a significant role in reducing emissions, even as alternative energy sources evolve.

DOE estimates that by 2050, CCUS could account for approximately 20% of emission reductions in the chemical sector[9]. This potential increase in CCUS development may position the chemical industry as a crucial contributor to a sustainable, low-carbon future, with potential impact extending far beyond its own emission reductions.

VI. CONCLUSION: ACC AND MEMBERSHIP ROLE

The path to effective carbon capture solutions is expected to encompass a range of technologies. The American Chemistry Council (ACC) and its member companies are actively contributing to this journey. ACC members are deeply involved in evaluating various CO2 capture technologies and driving innovations aimed at reducing the costs associated with CCUS. Additionally, they are exploring new avenues for utilizing captured carbon, thereby expanding its potential applications.

ACC and its member companies are pivotal players in the broader landscape of innovation, playing a key role in promoting innovation in industrial carbon capture technologies and expanding demand for CO2 storage, capacity and infrastructure. ACC and members are engaging with federal and state officials to shape the effective design of incentives such as tax credits, grants and loans.

1 *https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_chapter3-1.pdf*

2 *https://iea.blob.core.windows.net/assets/50652405-26db-4c41-82dc-c23657893059/Putting_CO2_to_Use.pdf*

3 *https://www.energy.gov/fecm/carbon-utilization-program*

4 *Congressional Budget Office, "Carbon Capture and Storage in the United States:" www.cbo.gov/system/files/2023-12/59345-carbon-capture-storage.pdf*

5 *U.S. Department of Energy, The Pathway To: Cabon Management Commercial Liftoff: https://liftoff.energy.gov/carbon-management/*

6 *https://www.sciencedirect.com/science/article/pii/S2590332223002075*

7 *https://unfccc.int/news/cop28-agreement-signals-beginning-of-the-end-of-the-fossil-fuel-era*

8 *Deloitte Carbon capture, utilization and storage hubs: A necessity to achieve emission goals in hard-to-abate sectors*

9 *https://unfccc.int/sites/default/files/resource/cma2023_L17_adv.pdf*

10 *https://liftoff.energy.gov/wp-content/uploads/2023/04/20230424-Liftoff-Carbon-Management-vPUB_update.pdf*