TECHNOLOGY ASSESSMENT

Decarbonization

Status, Challenges, and Policy Options for Carbon Capture, Utilization, and Storage

Highlights of GAO-22-105274, a report to congressional addressees

September 2022

Why GAO did this study

In 2021, CO_2 reached a record high concentration in the Earth's atmosphere for the modern era. Scientific assessments have shown that reducing CO_2 emissions could help mitigate the negative effects of climate change. CCUS is one tool available to help slow, stop, or potentially reverse the rising levels of CO_2 in the atmosphere.

This report discusses (1) the status of available carbon capture technologies; (2) opportunities for using or storing captured CO_2; (3) key challenges that could affect the development, demonstration, and deployment of CCUS technologies; and (4) options policymakers could consider to help address these challenges.

In conducting this assessment, GAO interviewed federal officials, academic researchers, industry organizations, private companies, nongovernmental organizations, technology testing centers, and federal advisory committees; convened an interdisciplinary meeting of 27 experts with assistance from the National Academies of Sciences, Engineering, and Medicine; and reviewed relevant literature. GAO is identifying policy options in this report.

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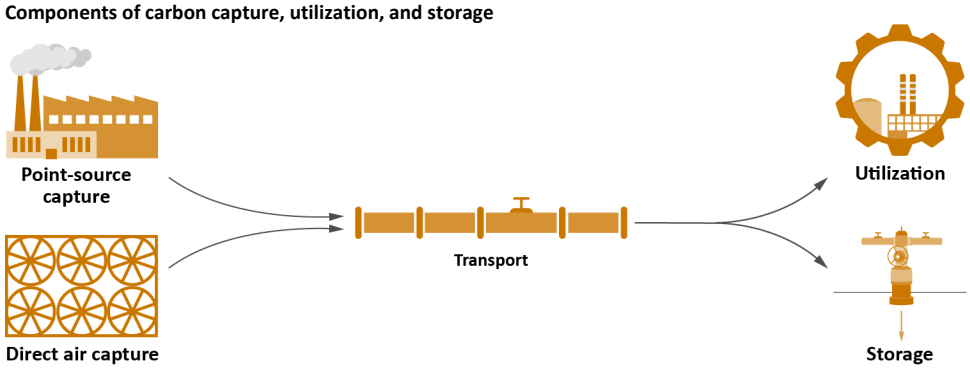
What GAO found

Many technologies for carbon capture, utilization, and storage (CCUS) are ready for wider demonstration or deployment, but multiple challenges limit their use. Carbon capture includes technologies that separate and purify carbon dioxide (CO_2) from a source, which could be an industrial facility (point-source capture) or the atmosphere (direct air capture). Applications of capture technologies at point sources are mature in some sectors (e.g., natural gas processing) but require further demonstration in some of the highest-emitting sectors (e.g., power generation). Direct air capture is not as mature, but has been implemented at pilot scale. Lengthy time to deployment and high costs hinder widespread deployment of both types of carbon capture in the near term.

Technologies for transporting, storing, and directly using captured CO_2 are mature. Companies are beginning to commercialize utilization technologies that convert captured CO_2 into valuable products such as ethanol, sustainable aviation fuel, and mineral aggregates. However, many CO_2-based products are not competitive with conventional products, may be excluded from the market by industry standards, and lack a standardized method for ensuring they effectively reduce CO_2 emissions.

Components of carbon capture, utilization, and storage



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GAO identified three aspects of CCUS deployment where challenges may arise:

- **Cost.** Deploying CCUS is an added cost to doing business but currently offers few opportunities to generate revenue. Incentives such as federal tax credits help offset the high cost of CCUS for some but not all emitters.
- **Infrastructure development.** More widespread deployment of CCUS would require a build-out of infrastructure for each of its components, including transport and storage. Timing of development, negotiating land access, and proximity of facilities are all challenges affecting this build-out.
- **Community engagement.** Deploying CCUS projects relies on acceptance by and effective engagement with local communities. In the past, unsuccessful community engagement and local opposition have contributed to cancellation or relocation of some CCUS projects, while others were well received.

GAO identified seven policy options that could help address these challenges or enhance the benefits of CCUS technologies. The policy options are possible actions by policymakers, which may include Congress, federal agencies, state and local governments, academic and research institutions, and industry. In addition, policymakers could choose to maintain the status quo, whereby they would not take additional action beyond current efforts. See below for details of the policy options and selected opportunities and considerations.

Policy options to help address challenges or enhance benefits of CCUS technologies, with selected opportunities and considerations

Policy Option	Opportunities	Considerations
Research, development, and demonstration (report p. 20) Policymakers could enhance support for consistent funding of research and development and large-scale demonstrations simultaneously.	• Research and development could reduce cost, resolve issues, mitigate risks, and advance emerging technologies. • Demonstrations could reduce cost and establish the viability of carbon capture by promoting learning-by-doing.	• Stakeholders have different ideas for research and development priorities. • Requires careful oversight of large-scale demonstrations.
Technology-neutral standards (report p. 34) Policymakers could encourage the creation, adoption, or use of technology-neutral standards.	• Could incentivize the development or use of products with the best CO_2 benefits. • Could incentivize manufacture in the U.S.	• Standards development is a resource-intensive and lengthy process. • Could be difficult to compare CO_2 benefits of different products without standardized life cycle assessment.
Standardized life cycle assessment guidelines (report p. 34) Policymakers could support the creation and use of standardized life cycle assessment guidelines to validate CO_2 benefits of CO_2-based products.	• Could improve accuracy of comparisons between various CO_2 utilization pathways or products.	• Standards development and life cycle assessment are resource-intensive and lengthy processes. • Coordination of many stakeholders to establish standardized life cycle assessment guidelines may be challenging.
Framework for land access (report p. 44) Policymakers could support development of legal or regulatory frameworks to manage geologic storage of CO_2 at the state level.	• Legal or regulatory clarity could facilitate deployment of CO_2 storage infrastructure. • Pore-space unitization processes could reduce the time and cost of negotiating land access for storage.	• Individual landowners may oppose losing certain property rights due to pore-space unitization. • CO_2 storage projects may cross state boundaries, requiring coordination.
Strategic siting (report p. 44) Policymakers could facilitate strategic siting of CCUS facilities.	• Could minimize financial and logistical barriers to CCUS development. • Carbon capture and utilization industries may accelerate deployment if access to infrastructure increases.	• Certain geographic regions that are inherently more suited for CCUS could benefit more than others from infrastructure investments. • Some communities may not want CCUS infrastructure for several reasons, including perceptions of environmental and safety risks.
Modify incentives (report p. 55) Policymakers could modify existing incentives to facilitate access for CCUS projects.	• Could increase the number or kinds of facilities that deploy CCUS. • Could incentivize new technology development to reduce costs of capture.	• Modifying tax credits could reduce government tax revenues or increase use of fossil fuels. • Modifying market-based approaches could be subject to uncertainty in carbon prices.
Community engagement (report p. 62) Policymakers could support and encourage proactive community engagement around CCUS deployment.	• Better understanding of public opinion could guide community engagement and decision-making. • Could build local support and reduce delays.	• Well-designed education and public awareness campaigns could be resource-intensive. • May require new funding or reallocation of existing resources to support new efforts.

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