the ENERGY lab

PROGRAM FACTS

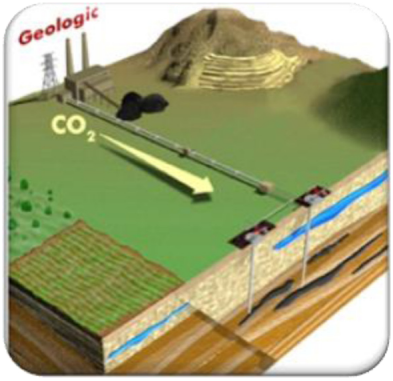
Strategic Center for Coal

Carbon Storage Program

Background

Ensuring that we can continue to rely on clean, affordable energy from abundant domestic fossil fuel resources is the primary mission of the U.S. Department of Energy's (DOE) Office of Fossil Energy (FE) Clean Coal Research Program (CCRP). To accomplish this mission, FE conducts research, development, and demonstration (RD&D) to develop technologies for advanced coal power with carbon capture and storage (CCS) that will be technically viable and economically competitive, while complying with increasingly strict environmental standards.

The **CARBON STORAGE** program within the CCRP is focused on developing and advancing technologies to enable safe, cost-effective, permanent geologic storage of carbon dioxide (CO_2) both onshore and offshore in different depositional systems. The technologies being developed will benefit both industrial and power sector facilities that will need to mitigate future CO_2 emissions. The program also serves to increase understanding of the effectiveness of these advanced technologies and management approaches in different geologic reservoirs appropriate for CO_2 storage, and improve the ability to understand the behavior of CO_2 in the subsurface. These objectives are key to increasing confidence in future safe, effective, and permanent geologic CO_2 storage. There are several options for geologic CO_2 storage in the subsurface, including saline formations, oil reservoirs, natural gas reservoirs, unmineable coal, basalt formations, and organic-rich shale basins. The overall objective of the **CARBON STORAGE** program is to develop and advance both onshore and offshore CCS technologies. These technologies will address technical challenges and ensure cost-effectiveness; validate safe, permanent storage; facilitate public, industry, and international community awareness of R&D for storage; and prove ready for widespread commercial deployment. CCS begins with CO_2 being supplied at the plant gate after it has been captured and compressed as a dense phase, similar to a liquid. At that point it must be transported—most likely by pipeline—to a well characterized site and injected as a supercritical fluid into onshore and offshore deep underground rock formations for safe and permanent storage.



CONTACTS

Traci Rodosta
Technology Manager
Carbon Storage Program
304-285-1345
traci.rodosta@netl.doe.gov

Mark Ackiewicz
Director
Division of CCS Research
301-903-3913
mark.ackiewicz@hq.doe.gov

John Wimer
Director
Coal and Power R&D
304-285-4124
john.wimer@netl.doe.gov

Sean Plasynski
Director
Strategic Center for Coal
412-386-4867
sean.plasynski@netl.doe.gov

To accomplish widespread deployment, technical and economic barriers must be addressed and data and information generated and communicated to inform industry and regulators about the safety and permanence of CCS. The Carbon Storage program is broadening the understanding of geologic formations appropriate for CO_2 storage as well as the behavior of stored CO_2. Research is focused on developing technologies to improve:

- The integrity of new and existing wellbores.
- Tools to monitor and verify permanent storage of CO_2 in the subsurface.
- Technologies to mitigate potential risks and increase storage efficiency.
- Simulation tools to reduce the risk and increase certainty associated with long-term storage operations.

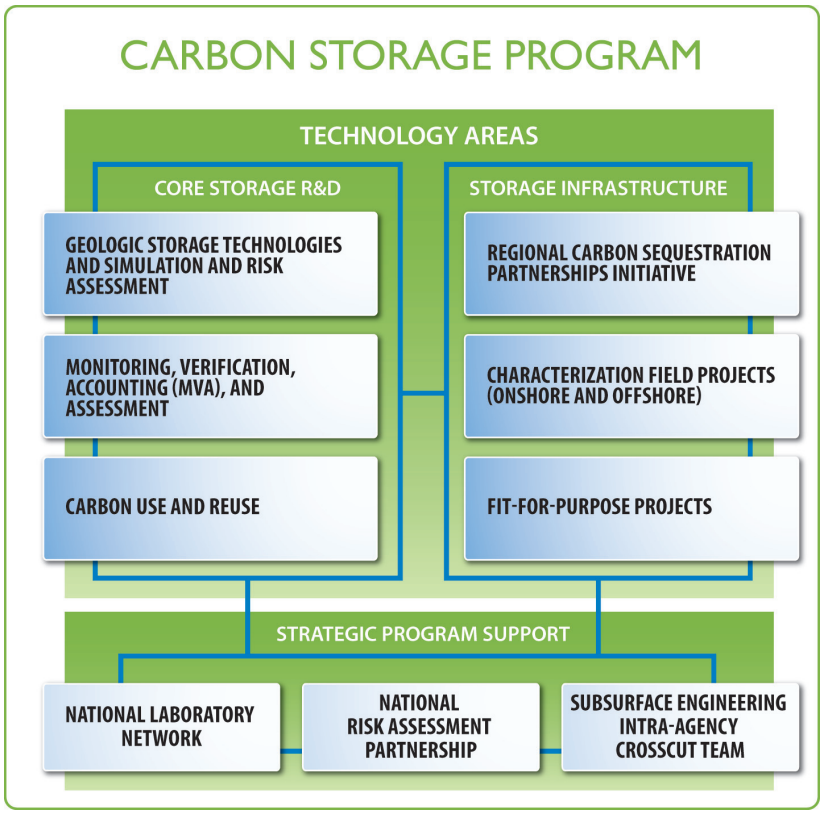
These advances in technology can assure the safe, cost-effective, permanent geologic storage of CO_2 and the establishment of a body of proven "Best Practices" to guide industrial pursuit for the development of storage sites in the variety of geologic formations that will be needed to support CCS in widespread commercial applications. The activities of the Carbon Storage program directly support industry's ability to comply with regulations, as well as the regulatory community's confidence in technologies for reporting and compliance with guidelines.

Research Pathways

The Carbon Storage program is comprised of three primary technology areas (1) Core Storage Research and Development (R&D), (2) Storage Infrastructure, and (3) Strategic Program Support. These three areas work together to address significant technical challenges in order to meet program goals that support the scale-up and widespread deployment of CCS. Within these technology areas, emerging technologies are supported through applied laboratory- and pilot-scale research. In addition, promising technology options are being validated through small- and large-scale field projects. This approach allows technologies to develop from concept through validation in the field and increases the Nation's confidence in future safe, effective, and permanent geologic CO_2 storage.

The **CORE STORAGE R&D** focuses on CO_2-specific aspects of storage, including trapping mechanisms, plume tracking and stabilization, pressure management, identification and mitigation of potential release pathways, and CO_2 utilization. This technology area is sub-divided into three research areas.

The Geologic Storage Technologies and Simulation and Risk Assessment area is developing technologies that can improve containment and injection operations, increase reservoir storage efficiency, assess risks, and mitigate potential release of CO_2 in all types of storage formations. Research conducted in the near- and long-term will augment existing technologies



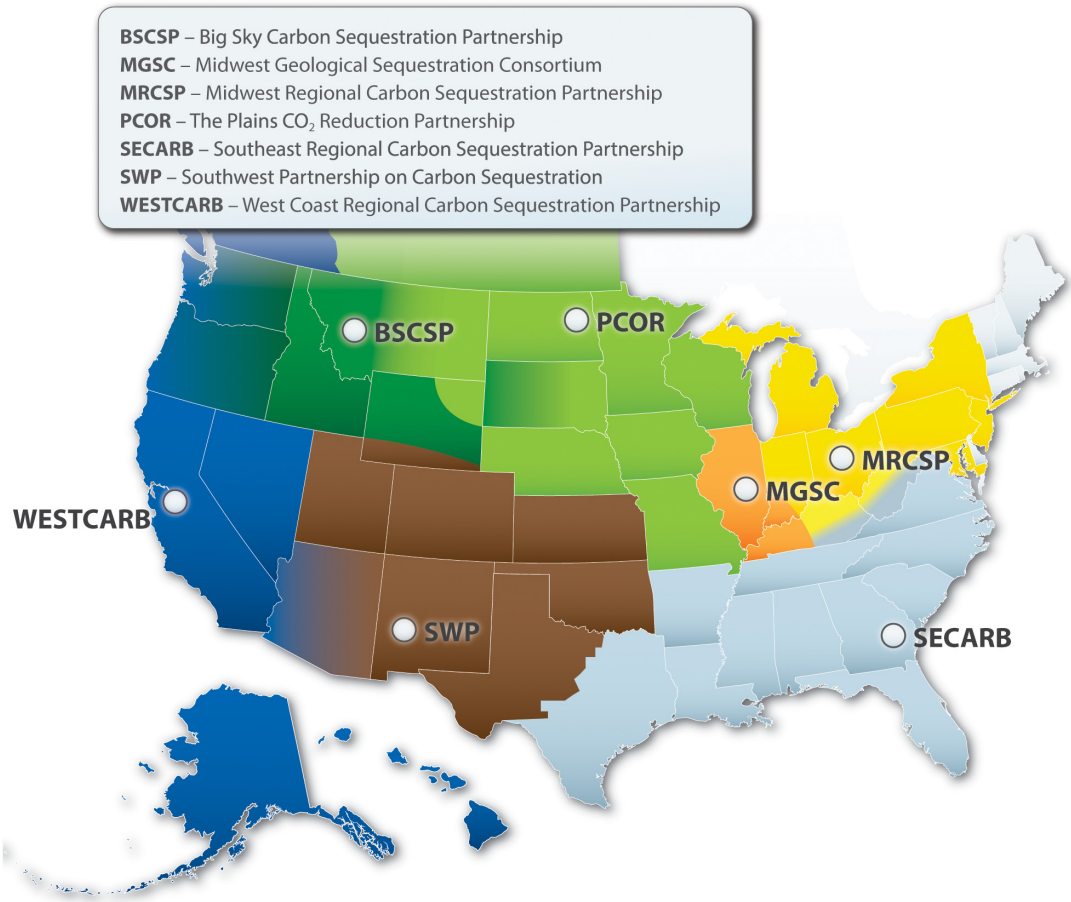
to demonstrate storage of CO_2. Advances in the scientific understanding of fluid flow, geomechanical, and geochemical processes rely upon computer simulators, in combination with laboratory measurement of modeling parameters and field validation. Simulation also plays a critical role in the design of injection strategies and monitoring programs for a storage project.

The Monitoring, Verification, Accounting (MVA), and Assessment area is designed to confirm permanent onshore and offshore CO_2 storage in geologic formations through monitoring capabilities that are reliable and cost effective. Monitoring is an important aspect of CO_2 injection, because it focuses on a number of permanence issues. Monitoring technologies are being developed for atmospheric, near-surface, and onshore and offshore subsurface applications to ensure that injection, abandoned, and monitoring wells are structurally sound and that CO_2 will remain within the storage complex.

The Carbon Use and Reuse area focuses on pathways and novel approaches for reducing CO_2 emissions by developing beneficial uses for CO_2, such as the conversion of CO_2 to useable products like polycarbonate plastics, mineralization and cement, or fuels and chemicals, with revenue offsetting a portion of the costs.

The **STORAGE INFRASTRUCTURE (REGIONAL CARBON SEQUESTRATION PARTNERSHIPS)** focuses on conducting current and future research in the field, including carrying out regional characterization and field validation testing to demonstrate that different storage types in various formation classes, distributed over different geographic regions, and both onshore and offshore, have the capability to safely and permanently store CO_2. This research will provide a sound basis for commercial-scale CO_2 projects. The Storage Infrastructure Technology Area works to validate new technologies and benefits from specific solutions developed in the Core Storage R&D component. Inturn, data gaps and lessons learned from small- and large-scale field projects are fed back to the Core Storage R&D component to guide future R&D.

Experience and knowledge gained through the Regional Carbon Sequestration Partnerships (RCSP) Initiative large-scale field projects is providing a firm foundation for future large-volume field projects, both onshore and offshore. The RCSP Initiative has been instrumental in developing processes and procedures for site characterization applicable for future commercial-scale projects. In addition to work conducted through the RCSPs, research within STORAGE INFRASTRUCTURE is focused



on next-generation onshore characterization projects, offshore prospective storage resource assessment, and "fit-for-purpose" projects. "Fit-for-purpose" projects are designed to address different types of research needs necessary to advance CCS. These research needs include subsurface engineering, utilizing brine extraction for pressure management, and efforts to characterize and understand residual oil zones as a possibility for "net carbon negative oil."

STRATEGIC PROGRAM SUPPORT activities contribute to an integrated domestic and international approach to ensure that CCS technologies are cost-effective and commercially available. The activities bring strategically focused expertise and resources to bear on issues that are key to commercial deployment of storage technologies. The Carbon Storage Program relies on International Collaborations to complement the program's approach to reducing CO_2 emissions. DOE is partnering with the International Energy Agency's Greenhouse Gas R&D Program (IEAGHG), the Carbon Sequestration Leadership Forum (CSLF), the U.S.-China Clean Energy Research Center (CERC), and is also engaged in a number of large-scale CCS demonstration projects around the world. Another example of the program's integrated approach is the DOE Subsurface Technology and Engineering Crosscut Technical Team (SubTER), which identifies and facilitates crosscutting subsurface R&D and policy priorities. This new initiative is focusing on subsurface research, such as discovering, characterizing, predicting, and monitoring the subsurface; accessing wells and their integrity; engineering and permeability control; and sustained production while sustaining the environment.

The National Laboratory network participates in collaborative research efforts. Research includes the evaluation of new technology concepts, products, and materials that is strategically targeted to address high priority research gaps. This strategic support activity also includes the development of the Energy Data eXchange™ (EDX), an online system providing access to information and data relevant to fossil and renewable energy systems.

The National Risk Assessment Partnership (NRAP) is a DOE multi-national laboratory initiative that will continue to harness core capabilities developed across the national laboratories in order to carry out science-based prediction of the critical behavior of engineered-natural systems that can be applied to risk assessment for safe, long-term CO_2 storage.

More information is available via the Carbon Storage program website.

Collection of RCSP field project activities