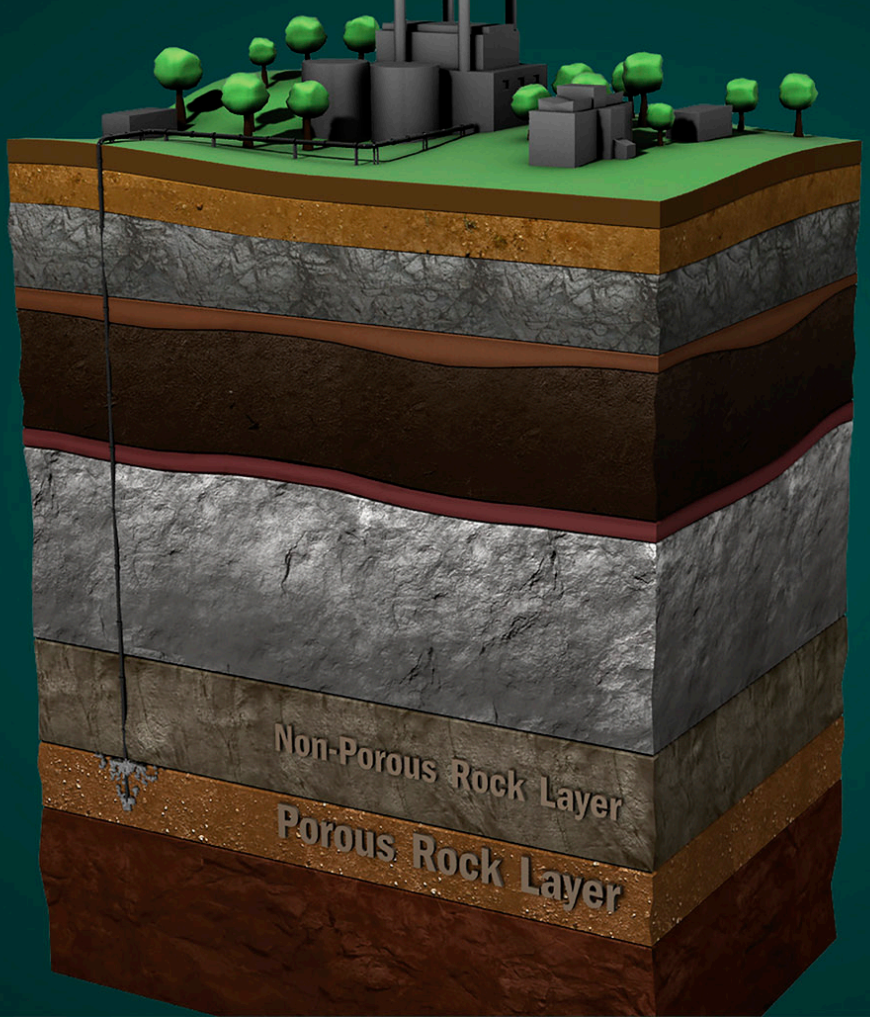
CARBON STORAGE PROGRAM



NETL

NATIONAL ENERGY TECHNOLOGY LABORATORY

OVERVIEW

Fossil fuels account for more than 80 percent of total U.S. primary energy use because of their abundance, high energy density, and the relatively low costs associated with production, safe transport, and use. To ensure energy security, an environmentally sustainable approach will be required to ensure that the CO_2 injected into the subsurface remain safely and permanently in the reservoir. In addition, a carbon management approach capable of lowering industrial emissions in a manner that is both economical and publicly acceptable in the long-term is desirable.

The Carbon Storage Program at the National Energy Technology Laboratory (NETL) is focused on developing and advancing technologies to enable safe, cost-effective, permanent geologic storage of CO_2 both onshore and offshore in different depositional environments. 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 the understanding of the effectiveness of advanced technologies in different geologic reservoirs appropriate for CO_2 storage—including saline formations, oil reservoirs, natural gas reservoirs, unmineable coal, basalt formations, and organic-rich shale basins—and to improve the understanding of how CO_2 behaves in the subsurface. These objectives are key to increasing confidence in safe, effective, and permanent geologic CO_2 storage.

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NETL implements this effort as part of DOE's Clean Coal and Carbon Management Program.

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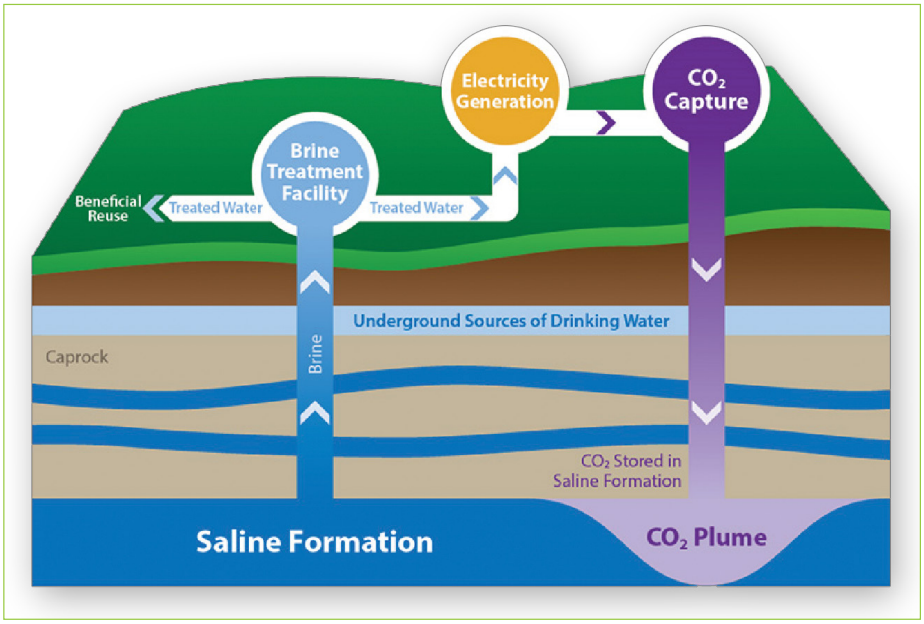
OBJECTIVE

The overall objective of the Carbon Storage Program is to develop and advance carbon capture and storage (CCS) technologies both onshore and offshore that will significantly improve the effectiveness of the technologies, reduce the cost of implementation, and be ready for widespread commercial deployment in the 2025–2035 time frame. Technical and economic barriers must be addressed and data generated to inform regulators and industry on the safety and performance of CCS. NETL capabilities have been employed to pursue CCS goals in two technology component areas: (1) Advanced Storage Research and Development (R&D) and (2) Storage Infrastructure. A third area, Risk and Integration Tools crosscut these two areas.

To better understand geologic formations, researchers at NETL's High-Pressure Immersion and Reactive Transport Laboratory in Albany are studying subsurface systems.

The Advanced Storage R&D Technology Component involves both applied laboratory and pilot-scale research focused on developing new technologies and systems for geologic storage. Advanced Storage R&D encompasses three technology areas: Wellbore Integrity and Mitigation; Storage Complex Efficiency and Security; and Monitoring, Verification, Accounting and Assessment (MVA). The Wellbore Integrity and Mitigation area's focus is on developing new tools to measure well integrity and new materials, tools and techniques to repair well issues. Storage Complex Efficiency and Security is focused on developing advanced models and methods to reduce computational time and uncertainty as well as improve understanding of geomechanical and geochemical impacts. Efforts within MVA are designed to confirm permanent storage of CO_2 in geologic formations, both onshore and offshore, through multilevel monitoring programs that are both reliable and cost-effective. The level of technology R&D conducted in the Core R&D efforts ranges from laboratory- to pilot-scale activities. Technologies are normally developed in the Core R&D projects to the point where individual companies, utilities, and other business entities are able to design, manufacture, and build the equipment and instrumentation needed to implement or commercialize the processes.

The Storage Infrastructure Technology Component includes the Regional Carbon Sequestration Partnership (RCSP) Initiative, characterization field projects (onshore and offshore), and "fit-for-purpose" projects, which are focused on developing specific subsurface engineering approaches to address critical research needs for advancing CCS to commercial scale. Current and future research in this area is focused on field studies—including regional characterization and field validation testing of technologies—to demonstrate that different storage types in various formation classes, distributed over different geographic regions, both onshore and offshore, have the capability to safely and permanently store CO_2. Fit-for-purpose projects, such as the brine extracted storage test projects, have been initiated to address reservoir pressure management. The Storage Infrastructure Component works to validate new technologies and benefits from specific solutions developed in the Advanced Storage R&D Component. In turn, data gaps and lessons learned from field projects are fed back to the Advanced Storage R&D Component to guide future research.



Carbon storage diagram showing CO_2 injection into a saline formation while producing brine for beneficial use.

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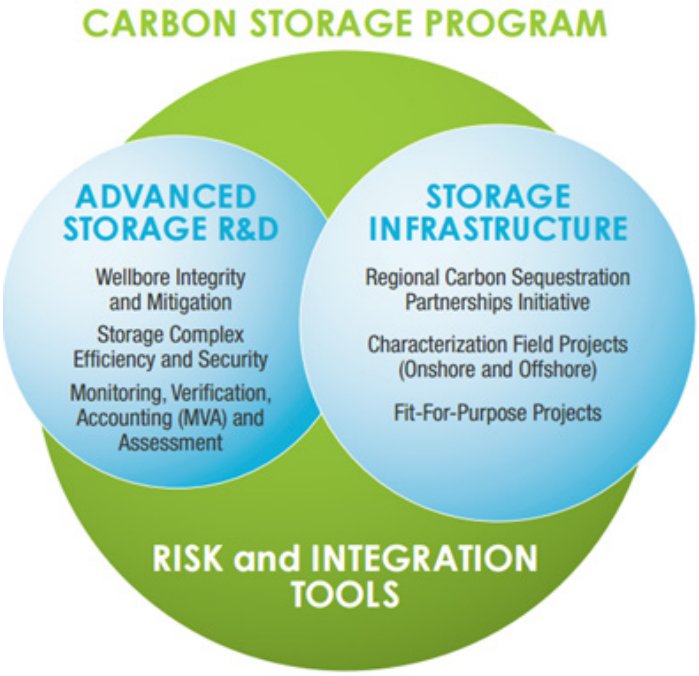
The Risk and Integration Tools, such as the National Risk Assessment Partnership (NRAP), the Energy Data Exchange (EDX), and the CO_2 Storage Prospective Resource Estimation Excel Analysis (CO2-SCREEN) tool support both the Advanced Storage and Infrastructure components. NRAP is a U.S. Department of Energy (DOE) multi-national laboratory initiative that harnesses core capabilities developed across the national laboratories to carry out science-based predictions of the critical behavior of engineered-natural systems that can be applied to risk assessment for safe, long-term CO_2 storage. NRAP collaborates with the Storage Infrastructure field projects to obtain field data to develop and validate their protocols and predictive tools. EDX is an online system providing access to information and data relevant to fossil and renewable energy systems. EDX coordinates historical and current data and information from a wide variety of sources to serve as a research and rapid response tool for a wide variety of users. CO2-SCREEN was developed by NETL to screen saline formations by applying DOE methods and equations to provide a dependable method for calculating prospective CO_2 storage resources. CO2-SCREEN is a tool within EDX.

The Carbon Storage Program supports several integrated domestic and international activities to ensure CCS technologies are cost-effective and commercially available. The program relies on its own capabilities as well as the national laboratory network to complement the program approach to reducing CO_2 emissions. NETL provides the DOE Fossil Energy R&D Program an onsite location where fundamental and applied fossil energy R&D is performed by government engineers and scientists. The DOE Subsurface Technology and Engineering Research, Development and Demonstration (SubTER) team identifies and facilitates crosscutting subsurface R&D. The Carbon Storage Assurance Facility Enterprise (CarbonSAFE) initiative is intended to determine the feasibility of developing integrated CCS storage complexes, constructed and permitted for operation in the 2025 time frame. The Carbon Storage Program also relies on international collaborations. DOE is partnering with several international organizations, such as the International Energy Agency's Greenhouse Gas R&D Programme and the Carbon Sequestration Leadership Forum. DOE is also directly engaged in several large-scale CCS demonstration projects around the world, spanning five continents.



OPPORTUNITIES

NETL's Carbon Storage Program has a distinguished record of working with universities and initiatives that include other national laboratories, international organizations, regional partnerships, and government engineers and scientists. Additional information about that history of cooperation and new opportunities for collaboration can be found on NETL's Carbon Storage Program website: http://www.netl.doe.gov/research/coal/carbon-storage.

The Energy Data eXchange (EDX) is an online coordination and collaboration platform developed by NETL to support subsurface energy research. Efficient and timely research has always been driven by access to existing information, the ability to quickly share and coordinate data with collaborators, and the ability to disseminate the results of work products as they develop. EDX supports these needs, offering timely access and coordination to data for researchers that require information associated with subsurface energy sources. In addition, EDX is utilized as a platform for rapidly disseminating NETL's research products. More information is available on the EDX website: https://edx.netl.doe.gov/.

Each month, NETL compiles the **Carbon Storage Newsletter** to summarize recent public and private sector carbon storage news from around the world. Subscription information and directions for this free resource is available via the subscription page at http://listserv.netl.doe.gov/scripts/wa.exe?SUBED1=SEQUESTRATION&A=1.

NETL's **CCS Database** includes active, proposed, and terminated CCS projects worldwide. The information is taken from publicaly available sources to provide convenient access to information regarding efforts by various industries, public groups, and governments toward development and eventual deployment of CCS technology. Information about NETL's CCS Database is available at http://www.netl.doe.gov/research/coal/carbon-storage/strategic-program-support/ database.

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