Carbon Capture, Utilization, and Storage

CCUS RESEARCH, DEVELOPMENT, AND DEPLOYMENT

EERC
UND UNIVERSITY OF NORTH DAKOTA

The Energy & Environmental Research Center (EERC) is working with key stakeholders to develop CO_2 mitigation solutions. Carbon capture, utilization, and storage (CCUS) can provide a proven option for utilities and other industries seeking to combine greenhouse gas (GHG) mitigation with operations, creating market advantages and opportunities for the use or sale of captured CO_2.

At the EERC, we conduct applied research for all stages of CO_2 capture and geologic storage projects, from technology demonstrations and regional assessments to detailed site appraisals in support of CCUS deployment. We successfully design and deploy CCUS technologies, including projects at the industrial scale, forming effective partnerships with industry.

Our expertise and extensive experience encompass associated storage incidental to enhanced oil recovery (EOR) operations and dedicated storage in deep saline formations. Capabilities also extend to potential storage in unconventional oil and gas reservoirs and other subsurface scenarios, such as deep unminable coal seams.

CARBON CAPTURE

We have the equipment and expertise to evaluate and develop CO_2 capture systems. Several of our highly adaptable pilot-scale systems can produce combustion flue gas and gasification syngas from virtually any fuel (all coal ranks, liquids, and gases) for testing of postcombustion and precombustion CO_2 capture and separation technologies.

Capture and separation have been successfully demonstrated at Minnkota Power Cooperative's Milton R. Young Station near Center, North Dakota, as part of Project Tundra. The project has received additional federal and state funding and is moving ahead to a front-end engineering and design (FEED) study.

CARBON UTILIZATION

We conduct multidisciplinary research to demonstrate the potential for CO_2-based EOR and associated storage in the unconventional tight Bakken petroleum system, which has the potential to produce over 600 billion barrels of oil. We developed an innovative method to determine the ability of CO_2 to permeate the Bakken's tight formation and mobilize oil, yielding new insight into the chemical and physical mechanisms of CO_2 storage and EOR in these types of formations.

North Dakota CarbonSAFE research has proven the feasibility of CO_2 use for EOR in both conventional and unconventional oil fields. The EERC has shared involvement in other states' CarbonSAFE studies as well, yielding positive results in multiple types of geologic formations.

CARBON STORAGE

We have investigated CO_2 geologic storage at all levels, from regional assessments to detailed site appraisals, in support of CCUS deployment. CO_2 storage due to EOR operations and dedicated storage of CO_2 in deep saline formations are both valued EERC skillsets.

The Red Trail Energy Carbon Capture and Storage Project is assessing the ability to inject captured CO_2 from its ethanol plant into two potential sandstone layers for permanent storage.

SERVICES AND SOLUTIONS

- Pilot-scale testing and evaluation of capture technology:
  - System is portable and can be installed on-site.
- Long-term demonstration of solvent performance and impurity management.
- Modeling and assessment of integration approaches.
- Techno-economic evaluations of capture technologies.
- Technical support for large-scale capture demonstration.
- Proven adaptive management approach for deployment of storage, both in deep saline formations and associated with EOR.
- Implementation of field services: vendor identification and selection, project planning, data acquisition and support, and fully integrated interpretation of data and results.
- Life cycle analysis of CCUS projects, including CO_2 EOR.
- Expertise to develop cost-effective technical programs:
  - Site characterization including field and laboratory testing and evaluation of geologic, geophysical, geomechanical, and petrophysical data.
  - Design and implementation of site-specific, cost-effective MVA (monitoring, verification, and accounting) plans to ensure that business case and regulatory requirements of a CO_2 storage project are met.
  - Development of new cost-effective geophysical monitoring technologies.
  - Reservoir and process chemistry modeling and simulation.
  - Risk assessment and risk management.

PCOR PARTNERSHIP INITIATIVE

The PCOR Partnership Initiative addresses regional capture, transport, use, and storage challenges facing commercial CCUS deployment by focusing on:

- Strengthening the technical foundation for geologic CO_2 storage and enhanced oil recovery.
- Advancing capture technology.
- Improving application of monitoring technologies.
- Promoting integration between capture, transportation, use, and storage industries.
- Facilitating regulatory frameworks.
- Providing scientific support to policy makers.

PCO2R Partnership

The U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) through its Regional Carbon Sequestration Partnerships Initiative, the North Dakota Industrial Commission (NDIC), and partner organizations are fostering the deployment of CCUS in the PCOR Partnership region. The EERC leads the PCOR Partnership Initiative, with support from the University of Wyoming and the University of Alaska at Fairbanks

PROJECT TUNDRA

Our extensive work in CO_2 capture enables CCUS projects to move forward by determining the best capture technology options and system configurations for an existing lignite-fired system. Our research in CCUS informed Minnkota Power Cooperative's Project Tundra, which will assess the final barriers relating to efficiency and economics for implementation of postcombustion capture on the existing fleet of power systems. Project Tundra is led by Minnkota Power and supported by partnerships between the EERC, BNI Energy, NDIC, DOE, and Burns & McDonnell.

PROJECT TUNDRA

BEST

The North Dakota Brine Extraction and Storage Test (BEST) project is developing active reservoir management (ARM) techniques that have potential to improve the performance of geologic CO_2 storage. ARM uses the extraction of native brine from the same formation where CO_2 is being stored to manage reservoir pressure to improve injection and minimize a CCS project's risk and operating profile. Modeling suggests that ARM can theoretically reduce the size of the permitted area, the area of review, and the postinjection monitoring period for CCS projects by more than 90%. The ARM being conducted by the EERC through the BEST project is the first at-scale field pilot designed to validate ARM performance. The results will be valuable for determining the expected techno-economic performance of ARM for a range of potential implementation scenarios that could benefit CCS projects.

Treatment and handling of high-TDS (total dissolved solids) waters associated with energy production are challenging and not readily or economically accomplished using conventional water treatment techniques. Geologic injection is often required to effectively manage fluids associated with electrical power generation, oil and gas production, and active reservoir management for geologic CO_2 storage. As part of a public–private collaboration, the EERC constructed a facility in western North Dakota to pilot-test high-TDS water treatment technologies. These technologies can produce alternate sources of water for industrial or domestic use, produce salable products, and meaningfully reduce brine disposal volumes. The pilot testing conducted through the BEST project provides critical understanding of technology performance under field operating conditions.

NORTH DAKOTA CARBONSAFE, CARBONSAFE–WY, MIDCONTINENT

The North Dakota Carbon Storage Assurance Feasibility Enterprise—CarbonSAFE for short—is assessing the feasibility of commercial-scale geologic storage of CO_2 to manage CO_2 emissions captured from coal-based energy facilities. The project is part of an ongoing effort to ensure clean, affordable energy and the wise use of North Dakota's resources. The North Dakota project is one of 16 projects funded under DOE's CarbonSAFE Initiative. DOE's CarbonSAFE Initiative supports projects that address key research in the path toward the deployment of CCUS technologies, including the development of safe, commercial-scale geologic storage sites for CO_2.

RED TRAIL ENERGY CCS

Red Trail Energy (RTE), which owns an ethanol plant near Richardton, North Dakota, and the EERC began investigating CCUS to reduce the CO_2 emissions associated with ethanol production. Reducing emissions at an ethanol facility makes the produced fuel more valuable to states that have low-carbon fuel programs. It could also qualify the facilities for federal tax credits for capturing and storing CO_2 in deep geologic formations. In partnership with NDIC through the North Dakota Renewable Energy Program, and with DOE, research has been ongoing since 2016. Technical and economic feasibility of CCUS technology with ethanol production has been successfully demonstrated for the RTE site. Recent activities include construction and implementation following approval of the first North Dakota CO_2 storage facility permit in October 2021.

BELL CREEK AND CEDAR CREEK ANTICLINE PROJECTS

With the support of Denbury Resources Inc. (Denbury), the EERC successfully completed the integrated technical assessment of 5 million tons of associated storage at Denbury's Bell Creek Field as part of the PCOR Partnership. This collaboration has facilitated the ongoing field assessment of several innovative technologies through the PCOR Partnership and multiple separately funded projects. Denbury continues to support the PCOR Partnership in the advancement of EOR technology to foster CCUS deployment. Denbury is implementing a commercial project that injects approximately 1 million tons (0.9 million tonnes) of CO_2 a year into its Bell Creek oil field to rejuvenate oil production and permanently store anthropogenic CO_2 deep underground. The EERC is adding value to Denbury's project through additional characterization, monitoring, and modeling. This collaborative effort will result in a new standard for safe and practical long-term geologic storage of anthropogenic CO_2.

FEED AT COAL CREEK STATION

A FEED study is being conducted for full-scale carbon capture at the Coal Creek Station located 50 miles north of Bismarck, North Dakota. The EERC is leading the FEED, utilizing our experience in carbon capture and providing critical information learned during previous slipstream testing with our portable pilot-scale carbon capture system. The EERC is being supported by NDIC, Rainbow Energy, Mitsubishi Heavy Industries, and Burns & McDonnell.

PCO_2C

Beginning in 2008, the EERC worked with DOE and 30 private sector partners under the Partnership for CO_2 Capture (PCO_2C). The program began to develop, evaluate, and reduce the energy requirements and associated costs of promising carbon capture technologies. PCO_2C advanced technologies along the development pathway in preparation for scale-up and deployment. The EERC designed and fabricated world-class systems to test postcombustion and precombustion capture technologies on its existing solid fuel combustion and gasification test facilities.

Partnership for CO_2 Capture

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