

Plains CO₂ Reduction Partnership— Validation Phase

Background

The U.S. Department of Energy (DOE) has selected seven partnerships, through its Regional Carbon Sequestration Partnership (RCSP) initiative, to determine the best approaches for capturing and permanently storing carbon dioxide (CO₂), a greenhouse gas (GHG) which can contribute to global climate change. The RCSPs are made up of state and local agencies, coal companies, oil and gas companies, electric utilities, universities, private companies, and nonprofit organizations that form the core of a nationwide network helping to establish the most suitable technologies, regulations, and infrastructure needs for carbon sequestration. The partnerships include more than 350 organizations, spanning 43 states and four Canadian provinces. The RCSPs are developing the framework needed to validate and deploy carbon sequestration technologies. The RCSPs will determine which of the numerous sequestration approaches are best suited for their specific regions of the country and identify regulatory and infrastructure requirements that will be needed should policy and economics indicate that sequestration be deployed on a wide scale. The RCSP initiative is being implemented in three phases. The Characterization Phase began in September 2003 with the seven partnerships working to develop the necessary framework to validate and potentially deploy carbon sequestration technologies. The Validation Phase of the RCSP effort (2005–2009) is focused on evaluating promising CO₂ sequestration opportunities through a series of field tests in the seven partnership regions. Presently, activities in the Development Phase (2008–2017) are proceeding and will continue the validation process to determine that CO₂ capture, transportation, injection, and storage can be achieved safely, permanently, and economically at a large scale. These tests will promote understanding of injectivity, capacity, and storability of CO₂ in the various geologic formations identified by the partnerships. Results and assessments from these efforts will assist commercialization efforts for future sequestration projects in North America.

Description

The Plains CO₂ Reduction (PCOR) Partnership is a diverse group of public and private sector stakeholders working together to better understand the technical and economic feasibility of capturing and storing CO₂ emissions from stationary sources in the central interior of North America. The PCOR Partnership is managed by the Energy & Environment Research Center (EERC) at the University of North Dakota and is one of seven RCSPs funded by DOE and a broad range of project sponsors. The region generates about 16 percent of U.S. CO₂ emissions from major stationary sources. The PCOR Partnership region has abundant geologic sink opportunities. Under the PCOR Partnership Characterization Phase (2003–2005), key reservoir characterization data were gathered for over 1,900 oil fields in the oil-producing states and provinces

CONTACTS

Sean Plasynski

Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochran Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4867
sean.plasynski@netl.doe.gov

Andrea McNemar

Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507
304-285-2024
andrea.mcnemar@netl.doe.gov

Edward N. Steadman

Technical Contact
Energy & Environmental Research Center
University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018
701-777-5279
esteadman@undeerc.org

John A. Harju

Associate Director for Research
Energy & Environmental Research Center
University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018
701-777-5124
jharju@undeerc.org

NATIONAL ENERGY TECHNOLOGY LABORATORY

Albany, OR • Morgantown, WV • Pittsburgh, PA

Website: www.netl.doe.gov

Customer Service: 1-800-553-7681

U.S. DEPARTMENT OF
ENERGY

Geologic Sequestration Opportunities

The PCOR Partnership is conducting three geologic sequestration Validation Phase field tests and one wetland terrestrial sequestration investigation. The field trials involve storage of CO₂ and comprehensive monitoring of depleted oil and natural gas reservoirs, unmineable coal seams, and wetland restoration and management. These activities, along with continued regional characterization and integration with other RCSPs, are providing a firm technical foundation for the PCOR Partnership's large-scale Development Phase tests (initiated in September 2007) and for future commercial-scale deployment of carbon capture and storage (CCS) in the region.

Lignite in North Dakota Field Validation Test (G1)

Up to a maximum of 400 tons (363 metric tons) of CO₂ at a drilling depth of approximately 1,200 feet will be injected into unmineable lignite seams of the Williston Basin to determine the suitability of these strata for both CO₂ sequestration and coalbed methane production. The test is located in Burke County, North Dakota, and will determine whether long-term contact with CO₂ affects the physical stability and gas storage capacity properties of lignite and the hydrodynamic properties of the seam. Lignite coal seams in North Dakota may have the capacity to store 380 million tons (344 million metric tons) of CO₂ and the potential to produce 1.1 trillion cubic feet (Tcf) of methane.

Accomplishment Highlights:

- Injection is expected to begin March 2009.
- Downhole monitoring equipment has been deployed.
- Drilling of one CO₂ injection well and four monitoring wells were completed in a five-spot pattern during the summer of 2007.
- A 30-foot core was retrieved (including 20 feet of cap rock) for geophysical and geochemical analysis.
- Gas samples from the wells have been obtained and are being analyzed for methane content and to provide baseline for MMA.
- Preliminary results from data analysis indicate the existence of multiple coal seams with sufficient areal extent and low-permeability clay layers above and below the target seam. The targeted coal seam (~1,200 ft) was selected as the best candidate for CO₂ injection.
- The project will be featured in an upcoming production of the Public Broadcasting Service series NOVA and TV Tokyo, America.
- Preliminary simulations have been run which provide guidance for the possible outcome of CO₂ injection activities in the coal seam.

Zama Field Validation Test (G2)

The field validation test being conducted at Apache Canada's Zama oil field in Alberta, Canada is evaluating the potential for geologic sequestration of CO₂ in an acid gas stream that also includes high concentrations of hydrogen sulfide (H₂S) for the concurrent purposes of CO₂ sequestration, H₂S disposal, and EOR. Approximately 230,000 tons (208,600 metric tons) of CO₂ and 80,000 tons (72,560 metric tons) of H₂S will be stored in the oil field over the lifetime of the commercial project at a drilling depth of 5,500 feet. The target formation is a carbonate pinnacle reef structure of the Middle Devonian Keg River Formation—one of the hundreds of such structures within the Zama sub-basin. The project is providing insight regarding the impact of high concentrations of H₂S on sink integrity, MMA, and EOR productivity within a carbonate formation. It is anticipated that the EOR operations will yield 180,000–276,000 barrels of incremental oil recovery per year.

PARTNERS (cont.)

Montana Public Service Commission
Murex Petroleum Corporation
National Commission on Energy Policy
Natural Resources Canada
Nexant, Inc.
North American Coal Corporation
North Dakota Department of Commerce
Division of Community Services
North Dakota Department of Health
North Dakota Geological Survey
North Dakota Industrial Commission
Department of Mineral Resources,
Oil and Gas Division
North Dakota Industrial Commission
Lignite Research, Development and
Marketing Program
North Dakota Industrial Commission Oil
and Gas Research Council
North Dakota Natural Resources Trust
North Dakota Petroleum Council
North Dakota State University
Otter Tail Power Company
Petroleum Technology Research Centre
Petroleum Technology Transfer Council
Prairie Public Broadcasting
Pratt & Whitney Rocketdyne, Inc.
Ramgen Power Systems, Inc.
RPS Energy
Saskatchewan Industry and Resources
SaskPower
Schlumberger
Shell Canada Energy
Spectra Energy
Strategic West Energy Ltd.
Suncor Energy Inc
Tesoro Refinery (Mandan)
University of Alberta
University of Regina
U.S. Department of Energy
U.S. Geological Survey Northern Prairie
Wildlife Research Center
Western Governors' Association
Westmoreland Coal Company
Wisconsin Department of Agriculture,
Trade, and Consumer Protection
Xcel Energy

COST

Total Project Value

\$26,059,889

DOE/Non-DOE Share

\$15,913,178 / \$10,146,711

Accomplishment Highlights:

- Injection of acid gas into the test formation began December 2006.
- Over 20,000 tons of acid gas (~14,000 tons CO₂) has been injected as of October 2008.
- In March 2007, the Zama Field Validation Test was recognized by the Carbon Sequestration Leadership Forum for the MMA strategy employed at the site.

Williston Basin EOR Field Test (G3)

The Williston Basin demonstration test will evaluate the potential for geological sequestration of CO₂ in a deep carbonate reservoir for the dual purpose of CO₂ sequestration and EOR. Characterization studies indicate that the oil fields of the Williston Basin may have over one billion tons of CO₂ storage capacity. Additionally, the volume of incremental oil that could be produced from Williston Basin oil fields has been estimated to be approximately one billion barrels. With the Development Phase project now underway, results of the Validation Phase activities will be used to support the large-scale deployment project.

A total of 400–800 tons (362–725 metric tons) of CO₂ will be injected into a target formation that will likely be in either the Devonian Duperow Formation or the Mississippian Madison Group of the McGregor Oil Field, at 8,000 feet. Evaluations have focused on determining the properties of candidate sites that may be suitable to host the EOR demonstration project, including performing robust reservoir modeling activities. Construction requirements will include the modification of wells for CO₂ injection and the infrastructure and facilities necessary to transport the CO₂. With respect to injection operations, it is anticipated that CO₂ will be injected into the target zone using a minimum of two injection wells in 2009.

Accomplishment Highlights:

- Eagle Operating has committed to conduct a CO₂ "Huff n' Puff" in the Northwest McGregor Oil Field on the Nesson Anticline. The tentative plan is to inject CO₂ in March 2009.
- Reconnaissance-level evaluations were conducted at several reservoirs in the Williston Basin that may be suitable candidates for the injection and MMA activities.
- Geophysical logs were obtained for 100 wells in the Billings Anticline–Dickinson and Nesson Anticline areas.
- Petrophysical models, which provide a more detailed evaluation of sealing formations and zones of porosity that are not hydrocarbon bearing, were developed for possible fields.

Terrestrial Sequestration Opportunities

PCOR Terrestrial Field Validation Test (T1)

Wetland restoration activities in the Prairie Pothole Region will provide the background information needed to determine carbon of sets, develop protocols and standards, and provide a market-based carbon sequestration strategy in the future. The project will consist of a field study for collection of the scientific

information necessary to facilitate market development; the identification, development, and application of alternative land use management practices that will result in GHG reductions; and the development of appropriate protocols that will provide the background data needed for the eventual determination of carbon of sets to be sold in voluntary GHG markets. This regional sink opportunity has a capacity to store 135 million tons (122 million metric tons) of CO₂.

Accomplishment Highlights:

- 2007 grassland and wetland sampling efforts were completed at North Dakota and South Dakota sites.
- 75 cores were collected and are presently in storage and awaiting processing.
- The first full season of GHG flux monitoring from cropland, restored wetland, and native prairie wetland catchments was completed in December 2007. The result of these efforts produced the collection of over 4,000 individual gas samples that are currently being analyzed.
- Soil samples have been collected on 13,970 acres of native grassland, restored grassland, and cropland to date. Sample sites are located in North and South Dakota, Montana, Iowa, and Minnesota.
- Progress has been made towards Voluntary Carbon Standard (VCS) and International Standard Organization (ISO) recognition of carbon of sets from native prairie preservation.

Benefits

This project will benefit the United States by providing a comprehensive assessment of the sources and potential sinks for CO₂ in the central interior of North America. The data are being integrated with the data from other partnerships to provide a database covering the entire nation. The project will promote cooperation among stakeholders and help promote public acceptance of CO₂ sequestration. Analysis of existing EOR projects in the region will also provide valuable data to increase the understanding of this option for CO₂ sequestration.

The PCOR Partnership Validation Phase projects are demonstrating that geologic storage is not just an option for the distant future, but is now being implemented on a large scale for both environmental and commercial reasons. The PCOR Partnership estimates additional oil recovery through regional EOR applications of over 1.4 billion barrels, with a value of approximately \$100 billion at U.S. \$50 per barrel. Overall, based on the geological formations characterized to date, the PCOR Partnership region has the capacity to sequester 116 billion tons (106 billion metric tons) of CO₂ in saline formations, 3.3 billion tons (3 billion metric tons) in depleted oil and natural gas fields, and 7.7 billion tons (7 billion metric tons) in unmineable coal seams.

