



**Plains CO<sub>2</sub> Reduction (PCOR) Partnership**  
*Practical, Environmentally Sound CO<sub>2</sub> Sequestration*



# Plains CO<sub>2</sub> Reduction (PCOR) Partnership *Phase III Prospectus*





What Is the PCOR Partnership?

The Plains CO<sub>2</sub> Reduction (PCOR) Partnership is one of seven regional partnerships operating under the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Regional Carbon Sequestration Partnership (RCSP) Program. The PCOR Partnership is led by the Energy & Environmental Research Center (EERC) at the University of North Dakota in Grand Forks, North Dakota, and includes numerous public and private sector stakeholders. The PCOR Partnership region includes all or part of nine states (Iowa, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, Wisconsin, and Wyoming) and four Canadian provinces (Alberta, British Columbia, Manitoba, and Saskatchewan).

The RCSP Program comprises a significant portion of NETL’s Carbon Sequestration Program and is a government–industry effort tasked with determining the most suitable technologies, regulations, and infrastructure needs for carbon capture and storage (CCS) on the North American continent.

The RCSP Program initiative is being implemented in three phases:

Phase I – Characterization Phase (2003–2005) characterized opportunities for carbon sequestration.

Phase II – Validation Phase (2005–2009) comprised small-scale field validation tests.

Phase III – Development Phase (2007–2018) comprises large-volume carbon storage demonstration tests

What Has the PCOR Partnership Accomplished?

Characterization, Phase I (2003–2005)

During Phase I, the PCOR Partnership assessed and prioritized opportunities for sequestration in the region and helped address the technical, regulatory, and environmental barriers to the most promising sequestration opportunities.

Validation, Phase II (2005–2009)

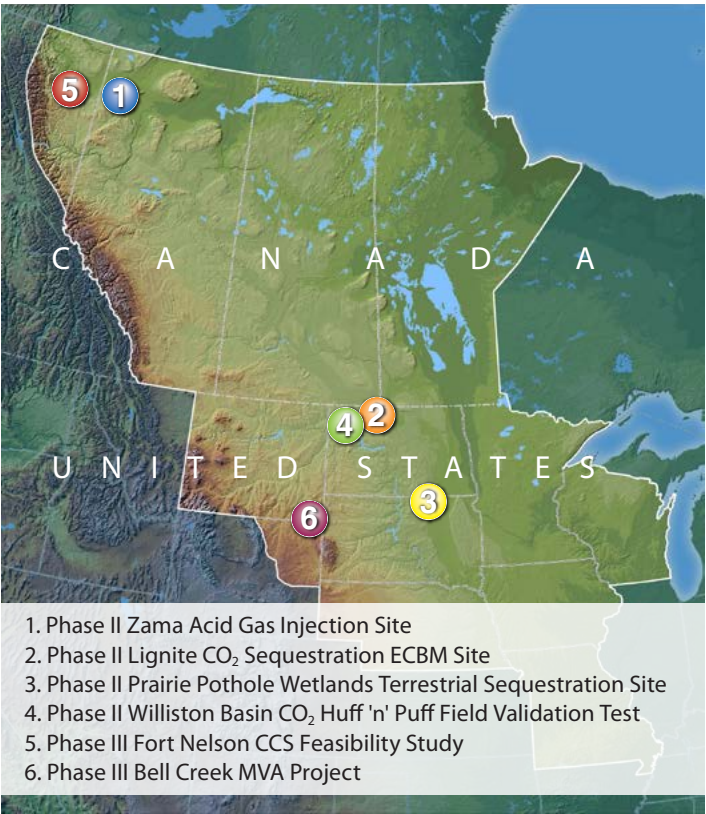
The overall goal of Phase II was to validate technologies and to demonstrate CCS in locations in the Partnership region that could support future full-scale geological and terrestrial sequestration opportunities.

These activities included four field validation tests (three geologic and one terrestrial) along with several supporting activities, including 1) continued refinement of regional characterization of sequestration opportunities, 2) elucidation and clarification of the regulatory and permitting requirements for sequestration, 3) identification of commercially available carbon dioxide (CO<sub>2</sub>) capture technologies, 4) integration of regional efforts with other DOE RCSPs, and 5) continuation of local and regional public outreach initiatives.

The CO<sub>2</sub> sequestration potential of deep carbonate formations, lignites, and pinnacle reef structures was successfully demonstrated. The terrestrial sequestration potential of prairie pothole wetlands was also successfully demonstrated.

Results of the Phase II activities indicate that the PCOR Partnership region has tremendous opportunities for geologic CCS and carbon sequestration in terrestrial settings.

What’s Ahead for the PCOR Partnership?



PCOR Partnership Phase II validation test sites and Phase III demonstration sites.

Phase III (2007–2018)

In Phase III, the PCOR Partnership is building on the information generated in its characterization (Phase I) and validation (Phase II) phases. The PCOR Partnership plans to fully utilize the infrastructure of its region to maximize CO<sub>2</sub> injection volumes.

A programmatic RCSP Phase III goal is the injection of approximately 1 million tons of CO<sub>2</sub> a year into at least one regionally significant geologic formation. Each of the RCSP large-volume injection tests is designed to demonstrate that the CO<sub>2</sub> storage sites have the potential to store regional CO<sub>2</sub> emissions safely, permanently, and economically for hundreds of years.

Phase III Objectives

The overall mission of the Phase III program is to 1) build upon Phase I and II assessments of regional sequestration data to verify the ability of target formations to store CO<sub>2</sub>, 2) facilitate the development of the infrastructure required to transport CO<sub>2</sub> from the source to the injection site, 3) facilitate development of the rapidly evolving North American regulatory and permitting framework for CO<sub>2</sub> storage, 4) develop opportunities for PCOR

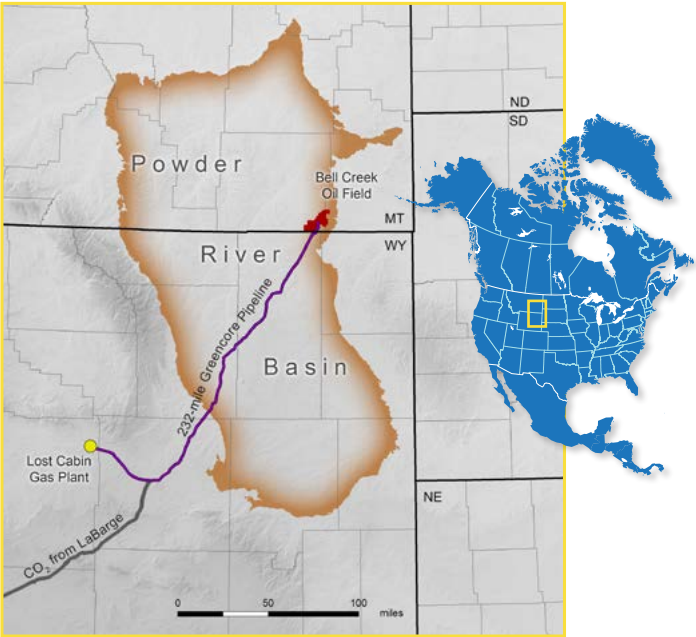
Partnership partners to capture and store CO<sub>2</sub>, 5) continue collaboration with the other RCSPs, and 6) provide outreach and education for CO<sub>2</sub> sequestration stakeholders and the general public.

The PCOR Partnership is working toward the establishment of the Bell Creek oil field in Powder River County, southeastern Montana.

Bell Creek Combined CO<sub>2</sub> EOR and CO<sub>2</sub> Storage Project

The PCOR Partnership is working with Denbury Onshore LLC (Denbury) to study CO<sub>2</sub> storage associated with a commercial enhanced oil recovery (EOR) project at the Denbury-operated Bell Creek oil field. The Bell Creek Field is an oil-bearing, Lower Cretaceous sandstone reservoir located at a depth of approximately 4500 feet (1372 meters) in southeastern Montana. CO<sub>2</sub> is being sourced from the ConocoPhillips-operated Lost Cabin and the ExxonMobil-operated Shute Creek gas-processing facilities, both located in Wyoming. The CO<sub>2</sub> is transported to the Bell Creek Field from the Lost Cabin facility via the Denbury-operated Greencore pipeline and from the Shute Creek facility via a tie-in of the Anadarko-operated pipeline into the Greencore pipeline. As of June 2016, 3.2 million tonnes of associated CO<sub>2</sub> storage has been injected in the Bell Creek Field since the EOR process began in May 2013.

To aid in the development and monitoring of the Bell Creek CO<sub>2</sub> EOR project, the PCOR Partnership applied an adaptive management approach that integrates site characterization; modeling and simulation; risk assessment; and monitoring, verification, and accounting (MVA) activities. This iterative process was designed specifically for large-scale CO<sub>2</sub> injection projects to continually improve the accuracy of each activity throughout the project’s life cycle. This approach provides valuable data that can be used to improve storage performance. Through this approach, the PCOR Partnership has successfully proven practices and technologies that support informed decisions regarding site selection, injection programs, operations, and monitoring strategies with applicability at potential commercial-scale injection sites throughout the region.



Map showing CO<sub>2</sub> pipeline route.

Fort Nelson CCS Feasibility Study

If determined feasible, the Fort Nelson project plans to inject up to 2 million tons of CO<sub>2</sub> (mixture of CO<sub>2</sub> and hydrogen sulfide [H<sub>2</sub>S]) a year into a deep saline formation. The CO<sub>2</sub> would be captured from one of the largest gas-processing plants in North America and transported approximately 10 miles in a supercritical state via pipeline to the target injection location. The target zone is the Devonian-age Elk Point carbonate rock (limestone and dolomite) group at a depth of >7200 feet.



Spectra Energy’s project site in the remote northeastern corner of British Columbia, Canada.

The thickest and most comprehensive seal for the carbonate rock formations under consideration would be provided by the massive and extensive shales of the Fort Simpson and Muskwa Formations, which are characterized by low permeability and high geomechanical strength. This cap provides a very competent seal for underlying brine-saturated formations. The cumulative average thickness of the Fort Simpson and Muskwa shale is approximately 1800 feet, and in some areas, the thickness can be in excess of 3300 feet.

For the Fort Nelson demonstration, Spectra Energy is determining the feasibility of installing significant infrastructure to transport the supercritical CO<sub>2</sub> to a proposed injection site, including construction of compressors, a dehydration system, a pipeline for the CO<sub>2</sub> stream, and a pumping system.

Simulation and Monitoring of CO<sub>2</sub> Behavior in the Subsurface

An emphasis on cost-effectiveness and integration with routine oilfield activities is the driving philosophical basis for developing the MVA plans to be implemented as part of the development phase. Potential MVA techniques will include the following: pressure monitoring, fluid sampling (oil, gas, water), pressure and geochemical monitoring of overlying formations, downhole geophysical monitors (passive microseismic and/or tiltmeters), vertical seismic profile (VSP) surface CO<sub>2</sub> measurements, ion chemistry and isotopes of sampled fluids, and tracer (e.g., perfluorocarbon) monitoring. Extensive reservoir simulation modeling that includes geochemical and geomechanical processes is also part of the Phase III MVA protocols.



# Why Should You Be a Partner?

## Award-Winning Efforts

PCOR Partnership products, e.g., a series of documentaries broadcast on public television, have won numerous awards, including the Aurora Awards, the Telly Award, and Communicator Awards for Excellence.

PCOR Partnership leaders have received recognition from partners and peers, including the Interstate Oil and Gas Compact Commission Chairman's Stewardship Award for Environmental Partnership and the Lignite Energy Council's Distinguished Service Awards.

## Shaping CCS Regulations

The PCOR Partnership monitors proposed environmental regulations, participates on CCS and pipeline task forces, testifies before state legislatures, and works closely with governing entities throughout its region and nationwide.

## Regulatory and Annual Meetings

The PCOR Partnership holds a meeting each year to update its partners on the project and to seek input on future activities.

The PCOR Partnership is holding regulatory meetings to gain an understanding of existing and pending CCS regulations within its region to ensure that regulatory strategies will be better coordinated such that, ultimately, the coordination will enhance opportunities for CCS.

## International Recognition

Two PCOR Partnership projects have received Carbon Sequestration Leadership Forum recognition. The Zama Acid Gas EOR, CO<sub>2</sub> Sequestration, and Monitoring Project and the Fort Nelson CCS Feasibility Study received recognition in 2007 and 2009, respectively.

## Support and Products You Need

We are always willing to provide assistance to our partners and continually generate products that inform and educate. The partners-only Decision Support System (DSS) is continually updated to provide current information, access to products, headline news, and regulatory information. The geographic information system (GIS) portion of the DSS contains information on the region's sources and geologic sinks in a map-based format for in-depth data analysis. Call or e-mail if you are interested in a DSS tutorial.



2015 PCOR Partnership Annual Meeting, September 16–17, 2015, in Chicago, Illinois.

## How can you be involved in Phase III?

We are currently seeking ongoing commitments to Phase III as well as additional partners for sponsorship of PCOR Partnership activities.

### To learn more, contact:

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Visit the PCOR Partnership Web site at [www.undeerc.org/PCOR](http://www.undeerc.org/PCOR).

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