



Plains CO₂ Reduction (PCOR) Partnership



Fact Sheet

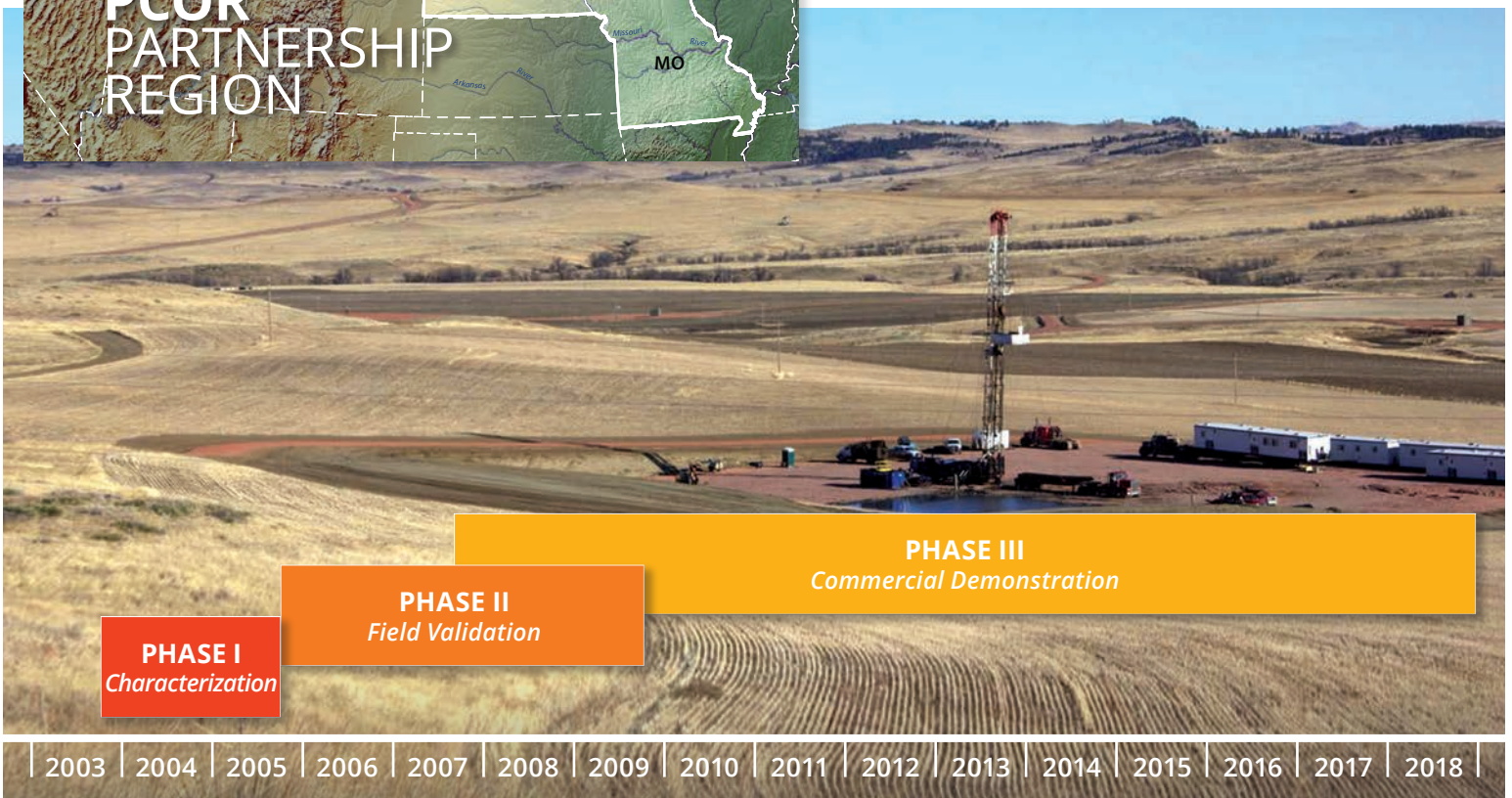
Practical, Environmentally Sound CO₂ Sequestration



PCOR Partnership – Demonstrating CO₂ Storage in the Northern Great Plains

The Plains CO₂ Reduction (PCOR) Partnership Program is now completing the third phase of its multiyear collaboration with public and private sector partners to demonstrate the permanent, safe, and practical underground storage of carbon dioxide (CO₂) from industrial facilities—carbon capture and storage or CCS:

- In Phase I of the program (fall 2003 to fall 2005), work focused on characterizing the more than 900 major stationary sources of CO₂ as well as the geologic storage layers suitable for CO₂ storage in the PCOR Partnership region.
- In Phase II (fall 2005 to fall 2009), the PCOR Partnership completed four small-scale field validation tests.
- The multifaceted Phase III program, active through December 2018, is built around commercial-scale demonstrations and unprecedented collaboration at the local, regional, and cross-border levels.



PHASE I
Characterization

PHASE II
Field Validation

PHASE III
Commercial Demonstration



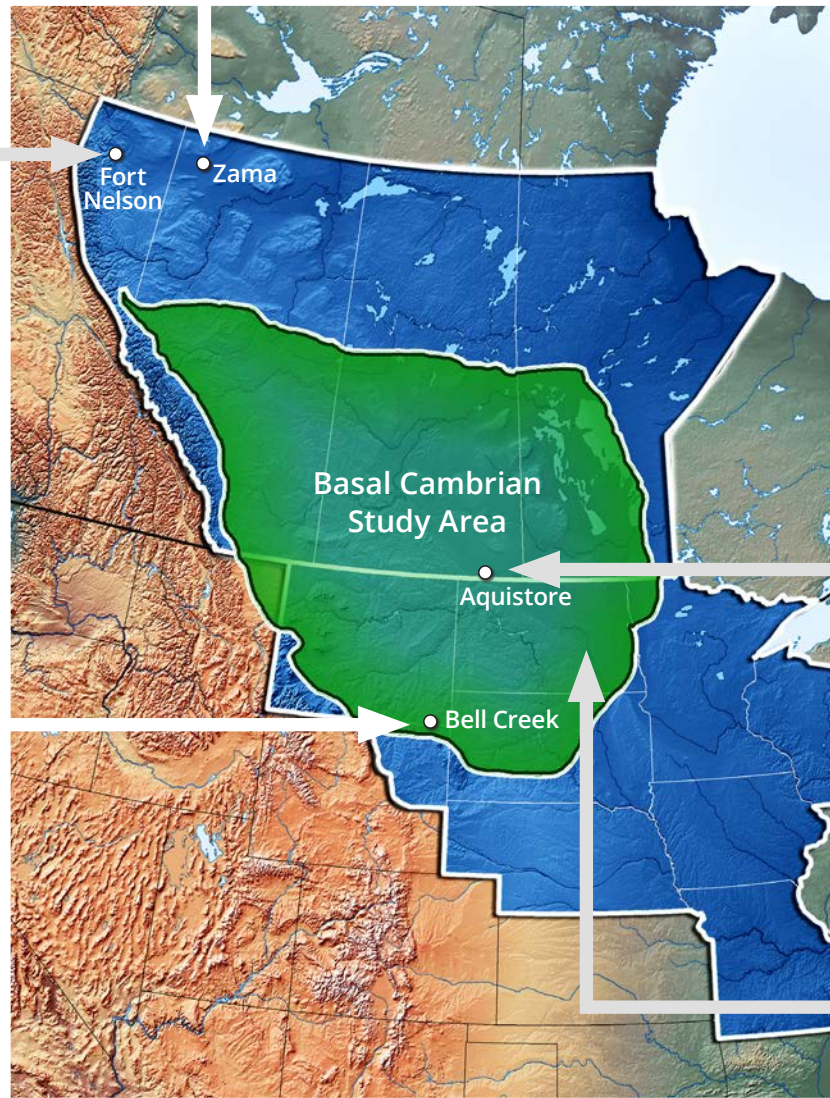
Fort Nelson CCS Feasibility Study

The Fort Nelson Carbon Capture and Storage Feasibility Project examined the potential to implement a CCS project in a deep saline formation. Led by Spectra Energy Transmission (Spectra), the project was an international collaboration comprising industry, government, and researchers. Through an iterative process, the PCOR Partnership worked with Spectra to develop new integrated processes for site characterization; modeling and simulation; monitoring, verification, and accounting (MVA); and effective risk assessment and mitigation. While the research verified the technical feasibility of a CCS project near Fort Nelson, British Columbia, future economic conditions will determine its implementation.



Zama Project

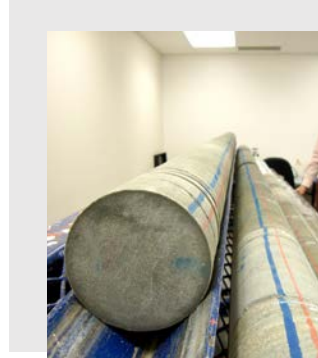
Prior to the initiation of the Zama Acid Gas EOR, CO₂ Storage, and Monitoring Project in 2006, Apache Canada's natural gas production and processing operations in the Zama oil and gas field released thousands of tons of CO₂ into the atmosphere each year. The project has injected and/or recycled all CO₂ from the oil and gas field into six pinnacle reef reservoirs, including the Aquistore. In Phase III, the PCOR Partnership collaborated with Apache Canada to characterize and model these six active Zama EOR reservoirs, enabling Apache Canada to better understand the EOR potential and the ultimate CO₂ storage capacity of the field. History-matching data verified the accuracy of the modeling and the work that demonstrated CO₂ containment in the reservoir.



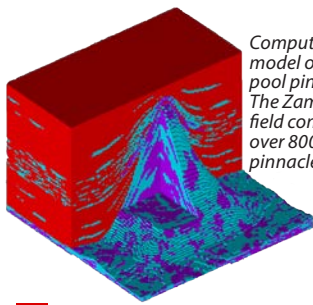
Bell Creek Demonstration

The PCOR Partnership is working with Denbury Resources, Inc. (Denbury) to study CO₂ storage associated with commercial enhanced oil recovery (EOR). Denbury's activities are focused on conducting a commercial EOR project, while PCOR Partnership activities are focused on understanding CO₂ storage that occurs as part of commercial CO₂ EOR. More specifically, an adaptive management approach (characterization, modeling/simulation, risk, and MVA) is being applied to demonstrating and validating how cost-effective MVA strategies can build off of commercial oil and gas data being acquired as part of the Bell Creek CO₂ EOR project to verify and account for CO₂ storage associated with EOR. The project is also demonstrating how the data can be used to improve storage resource estimates, understand factors that affect storage performance, and validate next-generation MVA techniques broadly applicable to CO₂ storage opportunities throughout the region.

PCOR Partnership Phase III activities.

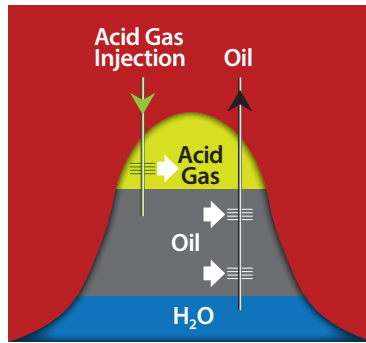


Monitoring
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CO₂ into the
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characterize
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capacity of its
simulation



Computer model of the F pool pinnacle. The Zama oil field comprises over 800 pinnacle reefs.

- Cap Rock
- Tight Reservoir
- Permeable Reservoir



Fluid behavior in the F pool pinnacle during acid gas EOR operations.

Aquistore Project

SaskPower operates the world's largest commercial coal-fired power plant CO₂ capture system. Most of the captured CO₂ is sold for EOR, but up to 600 metric tons (660 U.S. tons) is directed daily to the nearby Aquistore project for dedicated geologic storage in the Cambrian-aged Deadwood Formation at a depth of 3396 meters (11,140 feet). Aquistore is demonstrating the technical and economic feasibility of injecting CO₂ into a deep saline formation and helping provide the know-how for other entities to do the same. Using geologic modeling and numerical simulation, the PCOR Partnership is providing technical assistance to understand the site's performance and provide a solid basis to plan for any future site activity. The site is intensively monitored under a cooperative program managed by the Petroleum Technology Research Centre. SaskPower owns the injection and observation wells and may continue injection operations beyond the life of the Aquistore research project.



Basal Cambrian Project

In a project completed in 2013, researchers from twelve organizations in the United States and Canada collaborated to evaluate the CO₂ storage resource potential of the deep, thick, sandstone layer known as the Cambro-Ordovician saline system. This regional, extensive sedimentary layer underlies much of the Canadian and American northern Great Plains. A comprehensive computer model of the system's geology was developed to evaluate the CO₂ storage resource, examine potential chemical interactions in the target horizon, and categorize the integrity of existing wells penetrating the system and its cap rock. Results indicated that this lowermost saline system is a viable target for long-term CO₂ storage in both Canada and the United States. With an adequate number of injection wells in optimal locations, this storage zone could accept the annual CO₂ output of the PCOR Partnership region for decades.



Geologic Characterization and Modeling

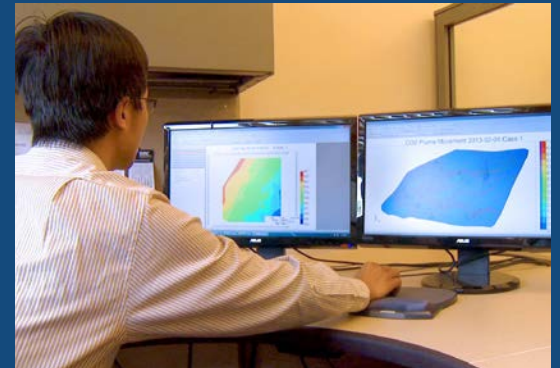
The location and development of large-scale CO₂ injection projects are built on an understanding of subsurface geology at multiple scales—regional, local, individual wells, and even at the microscopic level. Through experience in laboratory testing, data acquisition, characterization, and assessment, the PCOR Partnership has developed extensive expertise in building geologic and geomechanical models and conducting geostatistical simulations. This capability can help project developers determine 1) the storage capacity of the target formation; 2) the mobility and fate of the CO₂ at near-, intermediate-, and long-term time frames; and 3) the potential for leakage of the injected CO₂ into overlying formations and/or the near-surface environment. In addition to supporting effective commercial operations, these capabilities are critical to developing and implementing effective environmental safeguards.

Characterization



Geologic characterization begins with in-house laboratory analysis.

Modeling



The modeling-to-predictive simulation workflow includes geochemical, mechanical, and thermal inputs; characterization and laboratory data; and several optimization and validation steps.

Integrated Approach

The PCOR Partnership takes an iterative approach to project design and assessment. Elements from site characterization, modeling and simulation, risk assessment, and MVA strategies are integrated and continually reassessed as the project moves from initial design, through testing, and into the operation and closure phases. For example, knowledge gained from site characterization can improve the accuracy of values assigned to geologic reservoir properties. This reduced uncertainty, in turn, improves the ability to model behavior in the storage zone, assess risks, and refine the MVA design. As its knowledge and experience of CCS grows, the PCOR Partnership is better able to assist project developers, provide insight to regulators, and help inform and educate the public.



Facilitating Sound, Consistent CCS Regulations

CCS projects within the PCOR Partnership region have to satisfy requirements of the appropriate national regulatory regimes as well as the requirements of state or provincial regulatory agencies. The PCOR Partnership conducted annual “regulatory roundup” meetings to provide state and provincial regulators with an annual update of the regulatory, legislative, and policy activities related to CO₂ capture, utilization, and storage (CCUS) within the PCOR Partnership region. The meetings also provided an opportunity to renew working relationships, learn from each other’s successes, and have an open forum for discussions of technical and regulatory policy, including carbon management strategies and items of interest related to the CCUS industry. The PCOR Partnership continues to help members stay abreast of evolving regulatory conditions, and through its members’ actions, has played a role in assisting the Interstate Oil and Gas Compact Commission in efforts to help clarify regulations.



Outreach and Education – Informing and Engaging Stakeholders

Engaging the public, policymakers, and industry on CCS remains an essential component of PCOR Partnership activities. Public and partners-only Web sites provide information in terms and context tailored to meet the needs of these distinct demographics. Fact sheets, scientific presentations, posters, and reports inform technical audiences while products such as the regional atlas, presentations, and nontechnical posters tell the story of CCS for a general audience. The PCOR Partnership continues its long-standing collaboration with Prairie Public Broadcasting to provide educational activities and documentary productions.

The Water Working Group – Understanding Water and CCS

The PCOR Partnership plays a central role in guiding the Regional Carbon Sequestration Partnerships’ (RCSP’s) Water Working Group (WWG) in its mission to identify and respond to stakeholder concerns regarding water and CCS, from carbon capture through transportation to injection and storage. Comprising experts from government, academia, and industry,

WWG represents different regions of North America, each with their own unique set of challenges surrounding water resources and CCS. Through its Web site, its presentations at scientific and industry conferences, and its fact sheets, WWG provides outreach and technical expertise on critical CCS water issues.

Summing It Up

Summary results and recommended future research will be presented at the 2018 Greenhouse Gas Technologies Conference in Melbourne, Australia. Highlights of technical results will be published in a special issue of the International Journal of Greenhouse Gas Control.

The Plains CO₂ Reduction (PCOR) Partnership is a group of public and private sector stakeholders working together to better understand the technical and economic feasibility of storing CO₂ emissions from stationary sources in the central interior of North America. The PCOR Partnership is led by the Energy & Environmental Research Center (EERC) at the University of North Dakota and is one of seven regional partnerships under the U.S. Department of Energy’s National Energy Technology Laboratory Regional Carbon Sequestration Partnership Initiative. To learn more, contact:

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Visit the PCOR Partnership Web site at www.undeerc.org/PCOR. New members are welcome.



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