

THE PCOR PARTNERSHIP

Because CCUS requires a new combination of existing and novel technologies, research and demonstration efforts are needed to advance our knowledge of their potential to better manage CO₂. The PCOR Partnership is assessing and prioritizing the opportunities for CO₂ storage in the region and working to resolve the technical, regulatory, and environmental challenges to the most promising storage opportunities. At the same time, the PCOR Partnership informs policy makers and the public about CO₂ sources, storage strategies, and storage opportunities.



THE RCSP INITIATIVE PROGRAM

DOE Regional Initiative Projects

 **EERC**

BATTELLE

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SOUTHERN STATES
ENERGY BOARD

☆ Regional Headquarters

The Regional Carbon Sequestration Partnership (RCSP) Initiative is a key component of the U.S. Department of Energy's (DOE) Carbon Storage Program's efforts to validate geologic storage technologies and support commercialization of CCUS. Since 2003, the DOE RCSPs have been developing expertise in all aspects of CCUS through activities ranging from laboratory and modeling-based investigations to large-scale field tests. The RCSP Program is recognized internationally for its contributions to the science and technology of subsurface characterization, design, operation, and monitoring for geologic storage.

The PCOR Partnership is one of four Regional Initiative Projects established in 2019 from the RCSP Program. Under this DOE-supported initiative, the PCOR Partnership continues to serve its region and broad stakeholder base to advance and accelerate CCUS deployment. Each of the four partnerships is identifying and addressing knowledge gaps and technical challenges, as well as disseminating knowledge to accelerate commercial CCUS deployment. Each partnership will leverage its region's strengths to identify and promote potential infrastructure and/or CCUS projects that will enable the low CO₂ emission industries of the future.

ADVANCED STORAGE R&D

Wellbore Integrity
and Mitigation

Storage Complex Efficiency
and Security

Monitoring, Verification,
Accounting (MVA), and
Assessment

STORAGE INFRASTRUCTURE

Regional Carbon Sequestration
Partnership Program

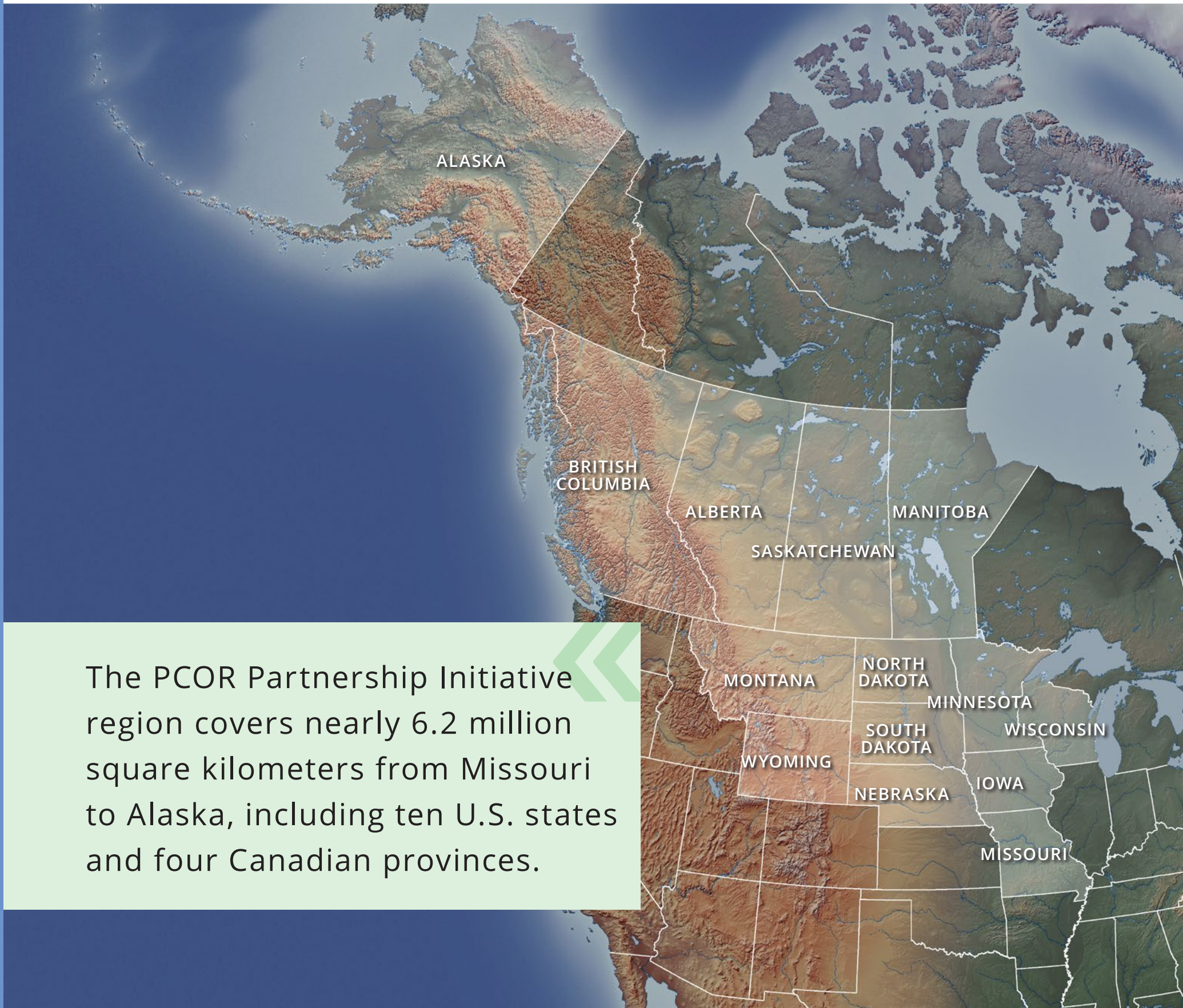
Characterization Field Projects
(onshore and offshore)

Fit-for-Purpose Projects

RISK AND INTEGRATION TOOLS

THE DOE CARBON STORAGE PROGRAM³⁴ comprises three technology areas: Storage Infrastructure, Advanced Storage R&D, and Risk and Integration Tools, which is a crosscutting technology research effort linking Advanced Storage R&D and Storage Infrastructure.

PCOR PARTNERSHIP INITIATIVE REGION

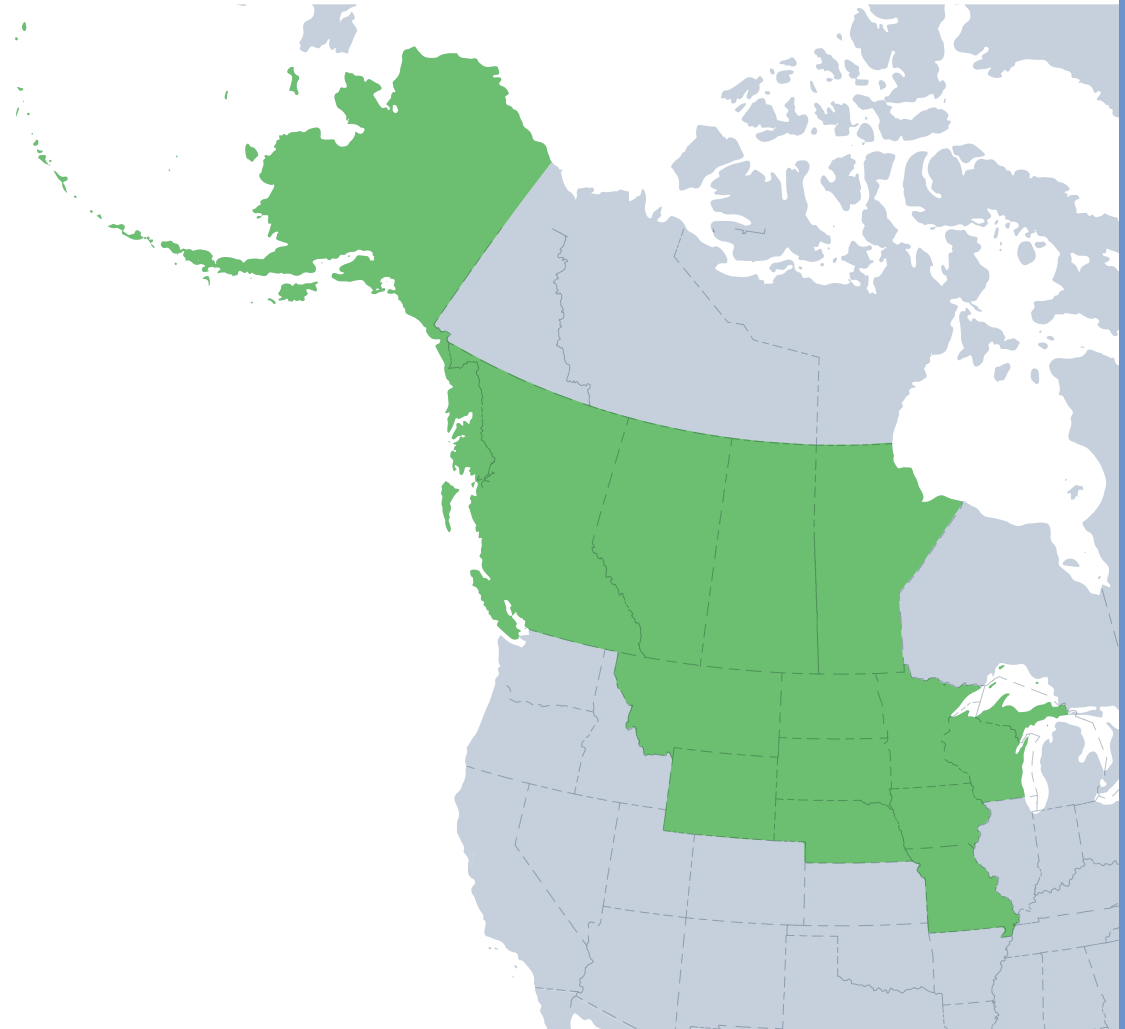


The PCOR Partnership Initiative region covers nearly 6.2 million square kilometers from Missouri to Alaska, including ten U.S. states and four Canadian provinces.

PCOR PARTNERSHIP

The EERC leverages the combined years of experience of the PCOR Partnership and the Partnership for CO₂ Capture (PCO₂C) to address regional capture, transport, use, and storage challenges facing commercial CCUS deployment by:

- Strengthening the technical foundation for geologic CO₂ storage and EOR.
- Advancing capture technology.
- Improving application of monitoring technologies.
- Promoting integration between capture, transportation, use, and storage industries.
- Providing scientific support to regulatory agencies and policy makers.



The PCOR Partnership—funded by DOE’s National Energy Technology Laboratory (NETL), the North Dakota Industrial Commission (NDIC), and partner organizations—is accelerating the commercial deployment of CCUS. The EERC leads the PCOR Partnership, with support from the University of Wyoming and the University of Alaska Fairbanks.



PHASED APPROACH

The DOE RCSP Program began with three phases that ran from 2003 to 2019 and laid the foundation for CCUS commercialization by validating and demonstrating the capacity for permanent, economic, and safe geologic storage of CO₂. The work during the RCSP Program helped to establish effective methods and reliable approaches to developing and deploying CCUS projects across the different RCSP regions.

PHASE I (CHARACTERIZATION PHASE)

Beginning in 2003, Phase I consisted of characterizing regional CO₂ emission sources and potential geologic storage locations within each RCSP region.

PHASE II (VALIDATION PHASE)

Beginning in 2005, validation of the most promising regional storage opportunities was addressed through a series of small-scale field projects in various carbon storage targets such as saline formations, coal seams, basalt formations, and terrestrial systems. The validation projects provided valuable information on reservoir and seal properties of formations and initial validation of geologic modeling and field monitoring technologies.

PHASE III (DEVELOPMENT PHASE)

In 2008, Phase III focused on large-scale field projects in saline formations and oil and gas fields, with the target goal of injecting at least 1 million metric tons per project. These large-scale demonstration projects advanced CCUS project management knowledge and supported the development of storage-related technologies in characterization, geologic modeling and simulation, risk assessment, mitigation, and monitoring.

PHASE I
CHARACTERIZATION

PHASE II
VALIDATION

PHASE III
DEVELOPMENT

CHARACTERIZATION PHASE

During Phase I, the PCOR Partnership assessed and prioritized opportunities for storage in the region and helped address the technical, regulatory, and environmental barriers to the most promising storage opportunities. The effort resulted in practical and environmentally sound strategies for carbon management in the PCOR Partnership region, derived from assessments of CO₂ emission sources, sinks, regulations, deployment challenges, transport considerations, and capture and separation technologies.

Phase I activities identified four source–sink combinations in the Williston and Alberta sedimentary basins that merited field validation testing in Phase II.

Learnings from Phase I include:

- Multiple CO₂ storage targets exist within the PCOR Partnership region, including oil fields, saline formations, and coal seams.
- The presence of CO₂ sources and storage options, and their relative proximity to each other, supports the deployment of CCS projects within the PCOR Partnership region.



VALIDATION PHASE

The goal of Phase II was to validate technologies and to demonstrate CCS in locations in the PCOR Partnership region that could support future full-scale geologic and terrestrial storage opportunities. From 2005 to 2009, the PCOR Partnership conducted four field validation projects that demonstrated the effectiveness of CO₂ storage in different settings and under varying conditions. The field validation tests demonstrated the CO₂ storage potential of multiple storage targets, including deep carbonate formations, lignite coals, pinnacle reef structures, and the prairie pothole wetlands.

In addition to the validation projects, several supporting activities were conducted during Phase II, including 1) refinement of regional characterization of storage opportunities, 2) clarification of the regulatory and permitting requirements for geologic CO₂ storage, 3) detailed review of commercial CO₂ capture technologies, 4) integration of regional efforts with other DOE RCSPs, and 5) continuation of local and regional public outreach initiatives.



Phase II Validation Projects



ZAMA FIELD VALIDATION

Determined acid gas injection for the purpose of acid gas disposal, geologic storage of CO₂, and EOR. Prior to this project, the CO₂ portion of the acid gas was vented to the atmosphere, while sulfur was separated and stockpiled in solid form on-site. This project enabled the simultaneous beneficial use of each of these materials to produce more oil and reduce GHG emissions.

LIGNITE FIELD VALIDATION

Investigated the ability of unminable lignite seams to store CO₂ during enhanced coalbed methane (ECBM) production. The validation test demonstrated CO₂ did not significantly move away from the injection wellbore and was contained within the coal seam, suggesting that comparable operations could be successfully implemented at other field sites.



NORTHWEST MCGREGOR FIELD VALIDATION

Evaluated the potential for injecting CO₂ into a deep carbonate reservoir for the dual purpose of CO₂ storage and EOR at depths greater than 2000 meters. The results indicated that CO₂-based huff 'n' puff operations are a technically viable option for improving oil recovery in deep carbonate reservoirs, even those with relatively low primary permeability.

TERRESTRIAL FIELD VALIDATION

Developed the technical capacity to systematically identify and apply alternative land use management practices to the prairie pothole ecosystem (at both local and regional scales) that result in GHG reductions and potentially salable carbon offsets. The project demonstrated that restoration of previously farmed wetlands results in the rapid replenishment of soil organic carbon lost to cultivation at an average rate of 0.4 tonnes per hectare per year.



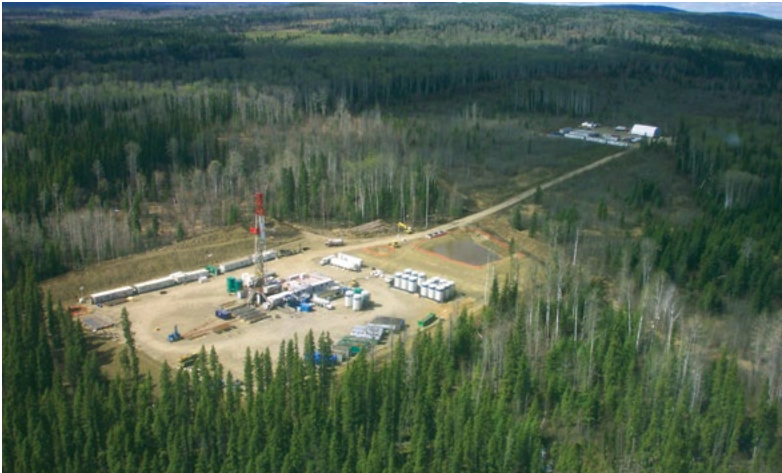
DEVELOPMENT PHASE

In 2007, the PCOR Partnership entered Phase III, the Development Phase, with the goal of demonstrating large-scale CO₂ storage. The RCSP Phase III projects had a target of injecting at least 1 million metric tons of CO₂ and set out to demonstrate that the CO₂ could be injected and stored safely, permanently, and economically. Results from these efforts provided the foundation for CCUS technology commercialization.

The PCOR Partnership teamed with industrial partners to develop two commercial-scale CCUS demonstrations in the region. One of the large-scale tests focused on CO₂ storage in a saline formation, while the other investigated associated CO₂ storage resulting from EOR.



Phase III Commercial Demonstration Projects



FORT NELSON FEASIBILITY PROJECT

Investigated the feasibility that CO₂ from a commercial natural gas-processing facility can be safely and cost-effectively stored in a deep carbonate saline formation. The results of this project suggest that commercial-scale CCS in the area is technically feasible and cost-effective MVA that meets or exceeds the geologic storage standards of the Canadian Standards Association. The project aimed to inject approximately 2.2 million tonnes of CO₂ annually.

BELL CREEK DEMONSTRATION PROJECT

Demonstrated that commercial EOR operations can safely and cost-effectively store regionally significant amounts of CO₂. This collaborative project with Denbury Onshore, LLC (Denbury) showed that CO₂ storage can be achieved in association with EOR and that MVA methods can be used to effectively monitor CO₂ storage during regular EOR operations. During the demonstration, over 5.4 Mt of CO₂ was injected and stored through the commercial EOR process in the Bell Creek Field, while over 16 monitoring techniques were evaluated for their effectiveness in tracking subsurface CO₂.



AQUISTORE PROJECT

Provides storage to a commercial CO₂ capture plant and an active oil field for EOR operations. In addition to the Phase III large-scale demonstration projects, the PCOR Partnership supported the Aquistore Project through geologic modeling and simulation. Aquistore is injecting and storing CO₂ from SaskPower's Boundary Dam Carbon Capture Facility near Estevan, Saskatchewan.



PCOR PARTNERSHIP PARTNERS





From 2003 to today, the PCOR Partnership has brought together more than 120 public and private sector stakeholders with expertise in power generation, energy exploration and production, geology, engineering, the environment, agriculture, forestry, and economics. Also during this time, the separate PCO₂C involved more than 40 private industry partners and focused on evaluating and developing cost-effective CO₂ capture solutions for utility application. The combined group of partners shown forms the foundation of the PCOR Partnership and supports its efforts by providing data, guidance, financial resources, and practical experience with CCUS.