The Plains CO_2 Reduction (PCOR) Partnership: Phase II and III Activities

Extended Abstract # 26

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ABSTRACT

Since its inception in 2003, the PCOR Partnership has brought together over 90 public and private sector groups working to lay the groundwork for practical and environmentally sound carbon dioxide (CO_2) sequestration in the heartland of North America. Covering a region of nine states and four Canadian provinces, the PCOR Partnership is one of seven regional partnerships in the U.S. Department of Energy's Regional Carbon Sequestration Partnership Initiative. The program partners contribute time, resources, and expertise in an effort to determine the best solutions to the safe, effective, and efficient management of CO_2 emissions.

The PCOR Partnership region contains vast energy, agricultural, forest, and water resources and offers significant opportunities for both geologic and terrestrial sequestration. Three geologic field validation tests and one terrestrial test are now under way in Phase II. Each test explores a unique aspect of CO_2 sequestration including enhanced oil recovery using a mixture of CO_2 and H_2S, utilization of low-grade lignite coals for enhanced gas production and sequestration, and the evaluation of land management practices to increase CO_2 uptake by plants and wetlands characteristic of the northern Great Plains.

Future activities include two large-scale geologic field demonstration tests that will apply the lessons learned in earlier phases of the program to projects that use greater than 500,000 tons of CO_2 per year. One of these demonstrations will inject a stream of acid gas from a gas-processing plant into a carbonate reservoir at a depth of approximately 4000 feet below the surface. This project will provide insight into the regulatory, injection, monitoring, and verification aspects of a commercial venture of this scale. The second project will evaluate a deep oil reservoir (greater than 8000 feet below the surface) for enhanced oil recovery techniques with the added benefit of CO_2 sequestration.

INTRODUCTION

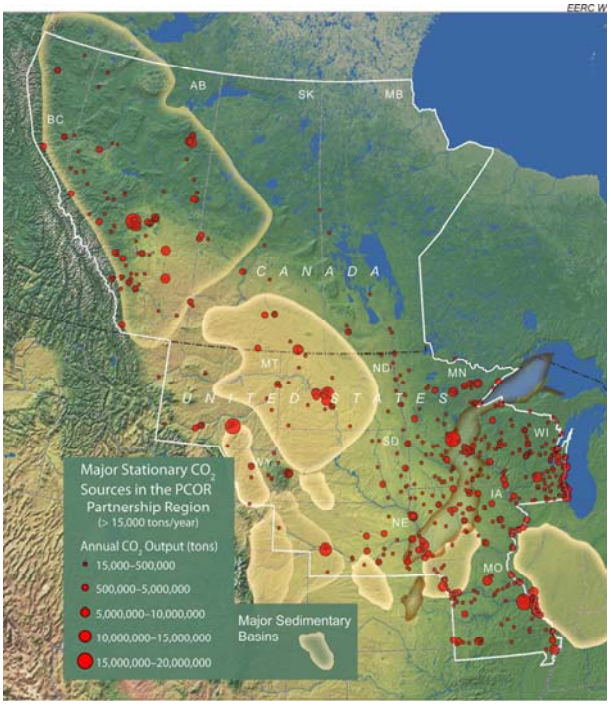
The Energy & Environmental Research Center's (EERC's) Plains CO_2 Reduction (PCOR) Partnership is one of the Regional Carbon Sequestration Partnerships (RCSPs) established by the U.S. Department of Energy National Energy Technology Laboratory. The RCSP Initiative is being implemented in three phases:

Phase I: Characterization (September 2003 to September 2005)
Phase II: Validation (October 2005 to September 2009)
Phase III: Demonstration (September 2007 to September 2017)

The PCOR Partnership region covers an area of over 1.4 million square miles in the central interior of North America and includes all or part of nine states and four Canadian provinces (Figure 1). The region contains vast energy, agricultural, forest, and water resources and offers significant opportunities for both geologic and terrestrial sequestration (Figure 2). Through the fall of 2009, the PCOR Partnership will be developing and conducting four carbon dioxide (CO_2) sequestration field validation tests: three that will store CO_2 in the deep subsurface and one that will store carbon in the near-surface soils and sediments of wetlands and grasslands. These field projects are designed to develop the expertise, real-world experience, and business models needed to implement major, full-scale, long-term CO_2 sequestration projects in the region.

Figure 1. PCOR Partnership Phase II field validation and Phase III demonstration tests.

Figure 2. Distribution of major stationary CO_2 sources and sedimentary basins in the PCOR Partnership region.



Whereas the Phase II field validation tests are focusing on validating technologies and identifying locations in the PCOR Partnership region that can support future full-scale geological and terrestrial sequestration opportunities, the most recent phase of the PCOR Partnership is initiating two demonstration projects that focus on full-scale injection of CO_2 into deep saline geologic formations for CO_2 sequestration. The first demonstration involves monitoring, mitigation, and verification (MMV) support for the injection of CO_2 captured from one of the largest gas-processing plants in North America into a saline formation in northeastern British Columbia, Canada. The second demonstration will inject CO_2 into saline formations in the Williston Basin for the dual purpose of sequestration and enhanced oil recovery (EOR).

PHASE II: VALIDATION

The goal of the field validation test in the Zama Oil Field of Alberta, Canada, is to evaluate the potential for geological sequestration of CO_2 as part of a gas stream that also includes high concentrations of H_2S. This acid gas mixture is being injected for the concurrent purposes of CO_2 sequestration, H_2S disposal, and EOR. A pinnacle reef structure at a depth of 1600 meters below the surface is the target for injection. The geometry of the structure is analogous to an upside down cup, reaching a vertical height of approximately 120 meters and covering an area of about 16 hectares. The injection zone is encased in anhydrite that is greater than 90 meters thick at the site and provides a significant seal for the injection operation.

In an effort to prove the long-term efficacy for CO_2 sequestration through EOR using acid gas, the PCOR Partnership, in conjunction with Apache Canada, Ltd., initiated a monitoring, verification, and accounting (MVA) program for the site based on the following philosophy:

- The use of existing data sets should be maximized in an effort to characterize the baseline conditions of the site.
- The use of invasive or disruptive technologies to acquire new data will be minimized.
- MVA data acquisitions will be coordinated with routinely scheduled operation activities.
- Monitoring operations will be as transparent as possible to the day-to-day field operations.

This is being accomplished through the use of a multidisciplinary team assembled to determine and prove the long-term containment of the injectate. Program elements include the evaluation of the geomechanical, hydrogeological, and geochemical regimes associated with the subsurface as well as a robust evaluation of the engineering processes involved in operating an active oil field. The activities at Zama are providing insight regarding sink integrity (i.e., seal degradation), hydrogeological flow regimes, geochemical reactions, and geomechanical properties of this system.

The potential for CO_2 sequestration and enhanced coalbed methane production in Williston Basin (Burke County, North Dakota) lignite is being investigated to evaluate the features of fluid transport in lignite, the stability of CO_2 stored within a lignite seam, the factors controlling the

success of sequestration/methane production operations in lignite, and the economics of the operation. Thus far, the lignite field validation test has drilled a five-spot production/injection well geometry to allow for efficient site characterization, CO_2 injection, and MVA activities. A significant suite of geophysical logging techniques was utilized, and a core of the targeted coal was collected for analysis in order to develop an injection and MVA strategy to be employed in the summer of 2009. All five wells have been perforated, and initial swabbing has occurred. Site preparations continue in order to get ready for CO_2 injection. Monitoring wells are outfitted with monitoring equipment in preparation for injection.

A terrestrial field validation test (McPherson County, South Dakota) is under way to develop carbon offsets from alternate management of wetlands in the Prairie Pothole Region (PPR) in partnership with Ducks Unlimited Incorporated. Work thus far has focused on demonstrating optimal practices for sequestering CO_2 through the restoration of PPR wetlands and surrounding grasslands at a site in north-central South Dakota. The project results are intended to serve as a model to promote and implement terrestrial sequestration across the PPR.

The PCOR Partnership is working closely with Eagle Operating Company to conduct field and laboratory activities that will determine the effects of injecting CO_2 into a carbonate formation in the northwest MacGregor oil field in North Dakota. The purpose of the activities is to evaluate the potential dual purpose of CO_2 sequestration and EOR in carbonate rocks deeper than 8000 feet. A technical team that includes Eagle, the EERC, and Schlumberger Carbon Services will conduct a variety of activities to 1) determine the baseline geological characteristics of the injection site and surrounding areas, 2) inject approximately 400 tons of CO_2 into the target oil reservoir using a “huff ‘n’ puff” approach, and 3) evaluate the effect that injected CO_2 has on the ability of the oil reservoir to sequester CO_2 and produce incremental oil. Eagle Operating will carry out the injection process, while the EERC will conduct the baseline geological characterization work. The CO_2 MMV activities at the site will be jointly designed and implemented by the EERC and Schlumberger Carbon Services.

PHASE III: DEMONSTRATION

Phase III features two commercial-scale demonstrations of geologic sequestration of CO_2 from human activities. These two demonstrations, the Fort Nelson Demonstration in northeastern British Columbia and the Williston Basin Demonstration in western North Dakota, are designed to sequester a total of over 15 million tons of CO_2 by 2017 in deep, well-characterized, underground storage reservoirs.

The Fort Nelson Demonstration will be one of the first commercial-scale geologic sequestration projects to emplace CO_2 into a North American brine reservoir. To accomplish this, over 1 million tons of CO_2 from Spectra Energy’s existing gas-processing facility in northeastern British Columbia, Canada, will be compressed to a supercritical state before being transported via pipeline approximately 3 miles (5 kilometers) to an injection site. The CO_2 is from an acid gas stream (85% CO_2, 15% H_2S). Once at the injection site, the CO_2 will be sent into the ground to a depth of approximately 5000 feet (1500 meters). There the supercritical CO_2 will be injected into the carbonate rocks (limestone and dolomite) of the Elk Point Group rock formations and dissolve into the highly saline water that fills the pores of the Elk Point Group rocks. Once the

CO_2 enters the pores of the carbonate rocks, the naturally high pressure and temperature conditions in the Elk Point Group will maintain the CO_2 in the supercritical state permanently. Currently, drilling plans, performance risk assessment, and an MMV program are being developed. Exploration well drilling is tentatively set for June 2009. Four shallow groundwater monitoring wells are scheduled to be drilled in March 2009.

The Williston Basin Demonstration will be the first large-scale carbon capture and storage (CCS) project utilizing CO_2 from a retrofitted conventional coal-fired power plant. The plan calls for a portion of the flue gas output of Basin Electric Power Cooperative's Antelope Valley Station will be processed to capture its CO_2. This CO_2 will then be dehydrated, compressed to supercritical conditions, and combined with additional supercritical CO_2 from the adjacent Great Plains Synfuels Plant before being transported about 150 miles (220 kilometers) via pipeline to the sequestration site. Once at the sequestration site, the CO_2 will be injected at a depth of nearly 2 miles (approximately
10,000 feet or 3000 meters) into the pore space of an oil reservoir. The demonstration will emplace approximately 1 million tons of CO_2 a year.

CONCLUSION

The 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 CO_2 emissions from stationary sources of CO_2 in the central interior of North America. Over the past 5 years since its inception, the PCOR Partnership has assessed and prioritized the opportunities for sequestration in the region and helped to resolve the technical, regulatory, and environmental barriers to the most promising sequestration opportunities. At the same time, the PCOR Partnership has informed policy makers and the public regarding CO_2 emission sources, sequestration strategies, and sequestration opportunities. The results of the first 5 years of effort in the PCOR Partnership have also developed the data sets and information needed to develop a regional vision for carbon management.

The Partnership is working to achieve this regional vision with respect to CO_2 sequestration that draws on the existing regulatory framework, expertise, and economic drivers of the region's industries. Judicious site selection, the establishment of geologic sequestration units, and the implementation of practical cost-effective MMV strategies are all key elements to making this regional vision a reality. In this vision, the EOR opportunities would be exploited first, followed by nonresource recovery-related sequestration in the future. At present, the region's demand for CO_2 for EOR applications outstrips the current supply. The PCOR Partnership region is poised to play a major role in the establishment of CCS as a commercial technology because of a combination of favorable geology and socioeconomic conditions.