CO_2 Sequestration Validation Test in a Deep, Unminable Lignite Seam in Western North Dakota

Background

In response to increasing levels of carbon dioxide (CO_2) in the atmosphere, the U.S. Department of Energy has developed the Regional Carbon Sequestration Partnership (RCSP) Program. The RCSP includes seven regional partnerships focused on conducting comprehensive evaluations of the opportunities for CO_2 capture and storage in North America. One of the options for storage is the injection of CO_2 into underground geological formations such as oil reservoirs, brine-saturated formations, and coal seams. The Plains CO_2 Reduction (PCOR) Partnership, led by the Energy & Environmental Research Center at the University of North Dakota, has been assessing the northern Great Plains region for potential geological storage opportunities. The PCOR Partnership region includes all or part of nine states and four Canadian provinces.

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Figure 1. Burke County test site.

Characterization activities conducted in 2003 and 2004 confirmed that a variety of geological options exist in the region, including storage in deep brine-saturated formations, depleted and producing oil fields, and unminable coal beds. The latter two options may have an economic benefit through the enhancement of oil or natural gas recovery.

In 2007, the PCOR Partnership initiated a field-based test in Burke County in northwestern North Dakota to evaluate the potential to simultaneously store CO_2 and enhance natural gas recovery from a lignite coal seam (Figure 1). The goals of the test are to 1) ensure that the CO_2 can be safely injected and permanently trapped in lignite by means of adsorption (physical attachment), 2) assess the feasibility and economics of CO_2-enhanced methane production from lignite, and 3) develop protocols for similar operations in other coal seams in the region.

Update on the Progress of the Test

In August 2007, five wells were drilled on the Burke County test site (Figure 2). Prior to drilling, a public meeting was held in Bowbells, North Dakota. The purpose of the meeting was to inform local residents about the commencement of the field operations.

In August and September 2007, a series of tests were conducted on the wells. Geophysical information on the properties of the subsurface system was collected. In November 2007, operations were shut down for the winter. It is anticipated that activities will resume in April or May 2008, depending on weather conditions.

The analysis of the data collected in the fall of 2007 confirmed that the targeted coal seam has sufficient thickness to provide enough storage capacity to conduct a relevant CO_2 injection test. The target coal seam is overlain and underlain by relatively impermeable rocks that will prevent vertical migration of the injected CO_2, thereby confining it to the zone of injection. Additionally, gas samples and approximately 30 feet of rock and coal core samples, ten of which were the primary coal seam of interest, were retrieved from one of the wells.

Analysis of all data collected in the field is ongoing. The gas and core samples (Figure 3) are being analyzed for the following parameters:

- Gas content
- Gas specific gravity
- Methane and CO_2 isotherms
- Diffusion coefficient
- Gas desorption time
- Coal ash and moisture contents
- Coal density and compressibility
- Rock porosity and permeability

The next steps in the study are to conduct a series of tests in the field to more fully determine the ability of the coal seam to support CO_2 injection and to compare and calibrate the laboratory data with the data generated in those field tests. The results of laboratory- and field-scale experiments will be used to design an optimum injection program to ensure safety of the operations. Additionally, a numerical computer model of the geologic system will be created and will serve as a means to predict the fate of the CO_2 within the coal seam.

Currently, it is planned that the injection of CO_2 will be conducted in the summer or fall of 2008. At that time, a monitoring, mitigation, and verification (MMV) plan will be implemented to monitor the underground movement of CO_2. The MMV data may also be used to modify and improve the injection design, if needed.

Figure 2. Drilling a well at the Lignite Field Validation Test Site.

Figure 3. Collecting the core at the test site.

The Plains CO_2 Reduction (PCOR) Partnership is a group of public and private sector stakeholders working together to better understand the technical and economic feasibility of sequestering CO_2 emissions from stationary sources in the central interior of North America. The PCOR Partnership is managed 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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