PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Carbon Sequestration

4/2008

ENHANCED COALBED METHANE PRODUCTION WHILE SEQUESTRATING CO_2 IN UNMINEABLE COAL SEAMS

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Background

CONSOL Energy Inc. is demonstrating a novel drilling and production process that reduces potential methane emissions from coal mining, produces usable methane (natural gas), and creates a sequestration sink for carbon dioxide (CO_2) in unmineable coal seams. The project team anticipates the test will provide the needed data to formulate effective CO_2 injection procedures, evaluate the CO_2 adsorption capacity of an Appalachian coal seam, and assess the economic feasibility of this potential greenhouse gas (GHG) mitigation approach.

Description

CONSOL's project employs horizontal drilling to drain coalbed methane (CBM) from a mineable coal seam and an underlying unmineable coal seam. Upon drainage of 50–60 percent of the coalbed methane, some of the wells will be used for CO_2 injection to sequester the CO_2 in the unmineable seam, while stimulating additional methane production. The technique starts with a vertical well drilled from the surface followed by a guided borehole that extends up to 3,000 feet horizontally in the coal seam, allowing for production over a large area from relatively few surface locations.

The project involves development of a 200-acre area involving two coal seams. The lower, unmineable seam will be degassed and eventually injected with CO_2. The upper, mineable seam will be degassed to produce coalbed methane, thus avoiding methane emissions when the seam is mined. The upper, mineable seam will be isolated from the lower, unmineable seam to prevent CO_2 migration from the unmineable seam into the mineable seam.

PARTNERS

CONSOL Energy, Inc.

PERFORMANCE PERIOD

9/21/2001 to 12/31/2008

COST

Total Project Value
$13,278,483

DOE/Non-DOE Share
$8,964,176 / $4,314,307

Primary Project Goal

This project is intended to evaluate the effectiveness and economics of carbon sequestration in an unmineable coal seam. Of particular interest will be the enhancement of coal seam methane recovery by the injection of CO_2 and the issues surrounding the injection and monitoring of CO_2 left in the coal seam for a several year period. The project is located in Marshall County, West Virginia.

Objectives

Project objectives are to recover CBM from a series of wells extending up to 3,000 feet horizontally in two stacked coal seams, while measuring the impact of carbon storage in the unmineable coal seam. Horizontal drilling techniques, which disturb less land surface, were used to recover CBM from both seams. After partial CBM drainage, the lower seam will become a sink for CO_2 sequestration.

- Sequester CO_2 in a degassed, unmineable coal seam.
- Demonstrate the economic benefit of this concept by producing coalbed methane (natural gas) to reduce the cost of CO_2 sequestration.
- Demonstrate that CO_2 remains sequestered in the coal seam in which it was injected.
- Demonstrate the application of coal seam methane production technology using horizontal drilling to degasify an unmineable coal seam.

Benefits

This project will provide a documented case study of the effectiveness and economics of carbon dioxide sequestration in an unmineable coal seam. The results can be used by mining and power generation companies that wish to sequester CO_2 in unmineable coal seams and by regulatory agencies and the public to aid in policy and permitting decisions.

Accomplishments

- Vertical wells have been drilled and completed at three sites, designated south, central, and north, with the mineable seam being the Pittsburgh seam, and the unmineable seam the Upper Freeport seam.
- South Well Site: At the south well site, the horizontal drilling of both the Pittsburgh seam and Upper Freeport seam is complete. The Pittsburgh seam's horizontal legs were 3,000 ft. and the upper Freeport seam horizontal legs were 2,500 and 1,500 ft., shorter than planned due to thinning of the coal seam.
- Central Well Site: At the central well site, two wells each with two horizontal legs were drilled in the Upper Freeport seam and completed at 1,000 ft. each, as planned.

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- North Well Site: Two north site Pittsburgh seam wells were completed at 3,000 ft. each, as planned, and one north site Upper Freeport seam well was completed at 2,200 ft., shorter than planned due to thinning of the coal seam.
- An amine plant was installed at the south well site. The amine plant removes CO_2 from the CBM gas and also dries the CBM gas to pipeline quality. Methane-gathering piping was installed from the north, center, and south well sites to the amine plant.
- NETL onsite researchers, in collaboration with the Zero Emission Research and Technology team and West Virginia University, conducted the essential computational modeling and monitoring for pre-test injection simulations. Simulations enable researchers to determine reservoir properties, CO_2 injection and CBM production rates, and structural responses of the reservoir. Simulations also dictate what monitoring networks are needed to predict both the migration of CO_2 within the coal seam and the recovery of methane from the coal seam.
- Two observation wells were drilled, and core samples were collected for laboratory analysis. The core samples help determine coal seam properties that can be used in simulations of CO_2 injection and CBM production.
- The monitoring-and-simulation procedure is an iterative process; information from the monitors will be fed back into the simulators to help update predictions. This cycle, which could last up to a year, will provide better understanding in a short period of time of what is required for the injection process. Data, such as the amount, rate, and pressure of the injected CO_2, will be collected. Surface tilt meters will also be used in a recently implemented process to help measure reservoir deflection and track plume movement.

Planned Activities

- The CO_2 injection system has been installed and will be operational once a UIC permit is received. Bulk liquid CO_2 will be pumped up to injection pressure, then vaporized. Gaseous CO_2 will be injected in the center wells. CO_2 will be metered as it is injected into the unmineable seam through both wells, while CBM recovery will continue at the peripheral production wells. The CO_2 injection rate will be closely monitored and adjusted to maintain a pressure balance in the target coal. CO_2 is projected to permeate through the coal while displacing CBM and adsorbing onto the coal.
- A pre- and post-injection monitoring program will be conducted on the effectiveness of the CO_2 sequestration. Issues to be evaluated include integrity of the target reservoir over time, confinement of CO_2 within the reservoir, and pressure changes in the coal and surrounding geologic strata. The monitoring program is to continue for two years after injection of CO_2.