PROJECT facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Carbon Sequestration

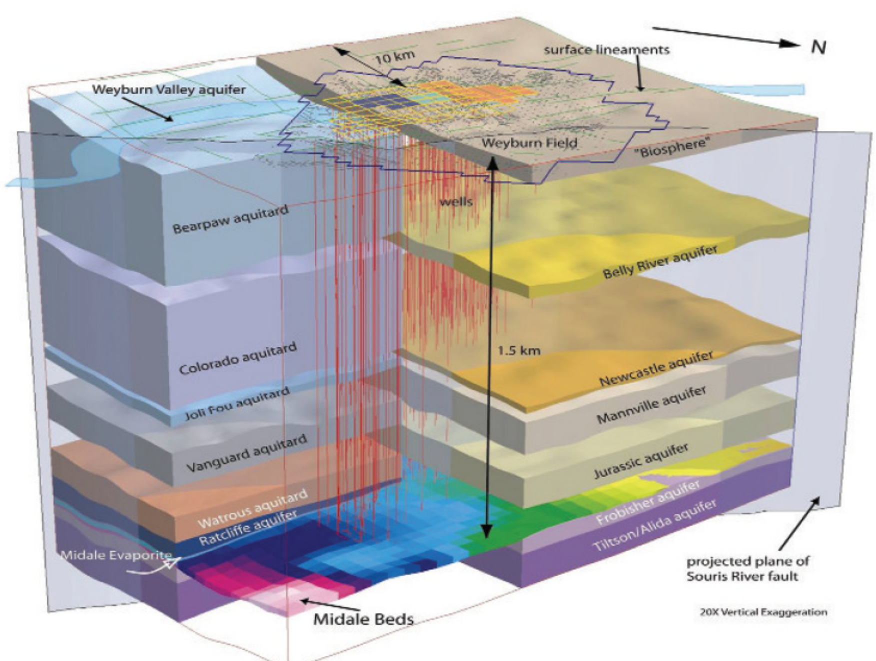
04/2008

Weyburn Carbon Dioxide Sequestration Project

Background

Since September 2000, carbon dioxide (CO_2) has been transported from the Dakota Gasification Plant in North Dakota through a 320-km pipeline and injected into the Weyburn oilfield in Saskatchewan, Canada. The CO_2 has given the Weyburn field, discovered 50 years ago, a new life: 155 million gross barrels of incremental oil are slated to be recovered by 2035 and the field is projected to be able to store 30 million tonnes of CO_2 over 30 years. CO_2 injection began in October of 2005 at the adjacent Midale oilfield, and an additional 45–60 million barrels of oil are expected to be recovered during 30 years of continued operation.

A significant monitoring project associated with the Weyburn and Midale commercial oilfields has been designed to address both the long-term fate and the security of CO_2 storage in geologic formations. This project, divided into two phases, is the largest, full-scale, in-the-field scientific study ever conducted in the world involving carbon dioxide geologic storage.



A 3-D geologic model has been constructed from ~1,000 wells for an area extending 10km beyond the limits of the Weyburn field CO_2 injection area.

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The first phase of the project demonstrated that the natural geologic setting of the Weyburn field is highly suitable for long-term storage of CO_2. Phase I of the project culminated in release of the Summary Report (IEA GHG Weyburn CO_2 Monitoring & Storage Project Summary Report 2000–2004) and presentation of numerous technical papers at the GHGT-7 Conference in Vancouver in September, 2004. A final phase of the project was launched in 2005 to develop a Best Practices Manual for the widespread implementation of practical, safe, and reliable enhanced oil recovery (EOR)-based CO_2 geologic storage projects.

PARTNERS

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Primary Project Goal

The goal of the Weyburn CO_2 Sequestration Project is to enhance the knowledge and understanding of the underground sequestration of CO_2 associated with EOR. Understanding the mechanisms, the reservoir storage capability, and the economics of CO_2 sequestration requires mapping the migration and distribution of existing formation fluid as well as the injected fluids in the area of interest.

Objectives

The technical R&D program in the final phase is organized around five technical themes: geologic integrity, wellbore integrity, storage monitoring methods, risk assessment and storage mechanisms, and data validation and management. The technical objectives are to determine the long-term storage risks and monitoring requirements to mitigate such risks.

Theme 1—Geologic integrity (site selection):

- Develop firm protocols for selection of suitable sites for CO_2 geologic storage using full-cycle risk assessment and other means that integrate hydrogeologic, geophysical, and geologic data sets to create a complete picture of seal integrity.
- Summarize the predicted impact of CO_2 and CO_2-rich fluids on geochemical and geomechanical processes on regional reservoirs and seals.

Theme 2—Wellbore integrity:

- Complete the parameterization of wellbore integrity, develop a list of remediation activities that could be applied, and describe current well abandonment technology trends and how they may impact future abandonment requirements.
- Conduct Cased-Hole Dynamic Testing. This log can be used to test behind casing pressure and formation fluids. In unperforated zones, establish pressures and mobile fluids to look for CO_2 migration out of zone.
- Document safe practices of normal CO_2 EOR operations on wellbore integrity and geomechanics.

Theme 3—Storage monitoring methods:

- Characterize the accuracy of monitoring technologies for quantitatively predicting the location and volume-in-place of CO_2 and determine from the four-dimensional (4-D) seismic program interpretation results if multi-year programs are appropriate for ongoing monitoring and verification.
- Conduct in situ time-lapse well logging to calibrate seismic imaging and verify and constrain the results from seismic and other monitoring approaches, while continuing with a passive seismic program.
- Verify predictions through spinner surveys and selective drilling, coring and logging of vertical slim holes to determine CO_2 distribution.

Theme 4—Risk assessment and storage mechanisms:

- Complete the full-field risk assessment from Phase 1. All relevant storage and leakage mechanisms should be modeled and studied, with risk levels determined for various operations scenarios.
- Describe the ultimate fate of CO_2 in the Weyburn-Midale system, the relative volumes in each storage and trapping mechanism, the time to become trapped, and the factors which affect these. Study ways to stimulate and accelerate CO_2 mineral fixation (mineralization, mineral trapping) under these reservoir conditions.

Theme 5—Data validation and management

- Store the Weyburn-Midale data set at PTRC.

Benefits

The benefit of the first phase of the Weyburn project—benefit that will continue in the final phase of the Weyburn-Midale project. This includes establishment of comprehensive knowledge of (1) the geologic nature of the EOR reservoir and the region where the CO_2 is stored; (2) the movement and ultimate geochemical fate of the CO_2 within the reservoir; (3) the reservoir storage capacity; (4) the economic viability of CO_2 storage in the reservoir; and (5) the overall risk assessment, including probability and consequences of CO_2 leakage.

The monitoring, verification, risk assessment, and management technologies developed for Weyburn and Midale's geologic environments will be transferable to other sites and enable a startup of commercial-scale, EOR-based CO_2 geologic storage projects. These technologies will enable the geologic storage of significant quantities of CO_2 that would otherwise be emitted to the atmosphere and at the same time increase oil recovery and hence improve U.S. energy security.

Widespread CO_2 geologic storage is a transitional technology that will allow the world to meet climate change challenges and commitments while progressing to a more sustainable energy future that combines alternative and renewable energy technologies with zero-net-emission fossil energy technologies.

PERIOD OF PERFORMANCE

06/01/2005 to 09/30/2010

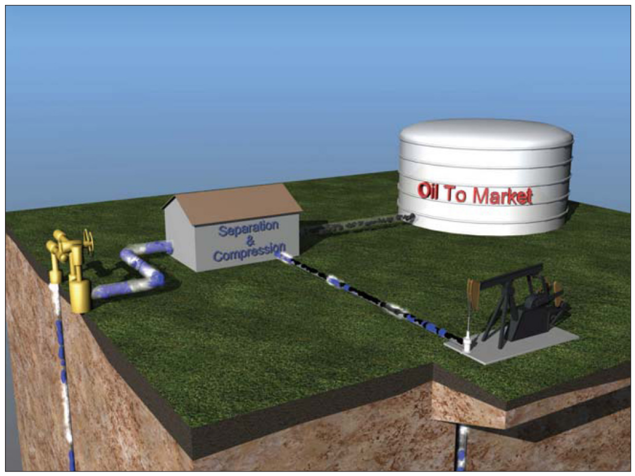
COST

Total Project Value
$40,000,000

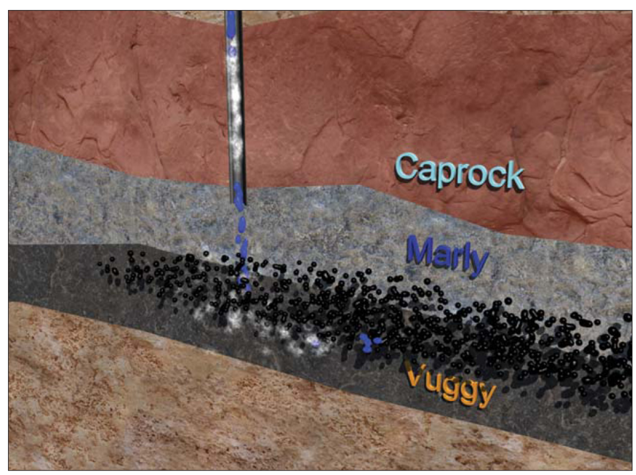
DOE/Non-DOE Share
$4,000,000 / $36,000,000

Accomplishments

During the Project's initial four-year study, researchers developed and evaluated a variety of monitoring technologies; conducted long-term risk assessments; completed frequent, regular seismic, ground water, and soil-gas surveys; matched reservoir modeling against production and injection statistics; and performed repeated and frequent reservoir fluid sampling to understand geochemical mechanism occurring in the reservoir. The regular frequency of geoscience surveys proved critical to tracking the movement of CO_2 in the Weyburn reservoir over the four years of the Phase I Project.



Water (blue) and CO_2 (white) are compressed and injected into soil reservoirs for enhanced oil recovery. Roughly 30% of the CO_2 returns to the surface with the oil (black), where it is separated and recycled.



Water (blue) and CO_2 (white) are used in the Weyburn and Midale fields for enhanced oil recovery in the Marly and Vuggy layers. Research shows the dense, impervious caprock is capable of securing CO_2 underground, in the Marly and Vuggy layers, post-production.

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