

PROJECT facts

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



WEYBURN CARBON DIOXIDE SEQUESTRATION PROJECT

Background

Since September 2000, carbon dioxide (CO₂) 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 CO₂ 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 CO₂ over 30 years. CO₂ 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 CO₂ 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.

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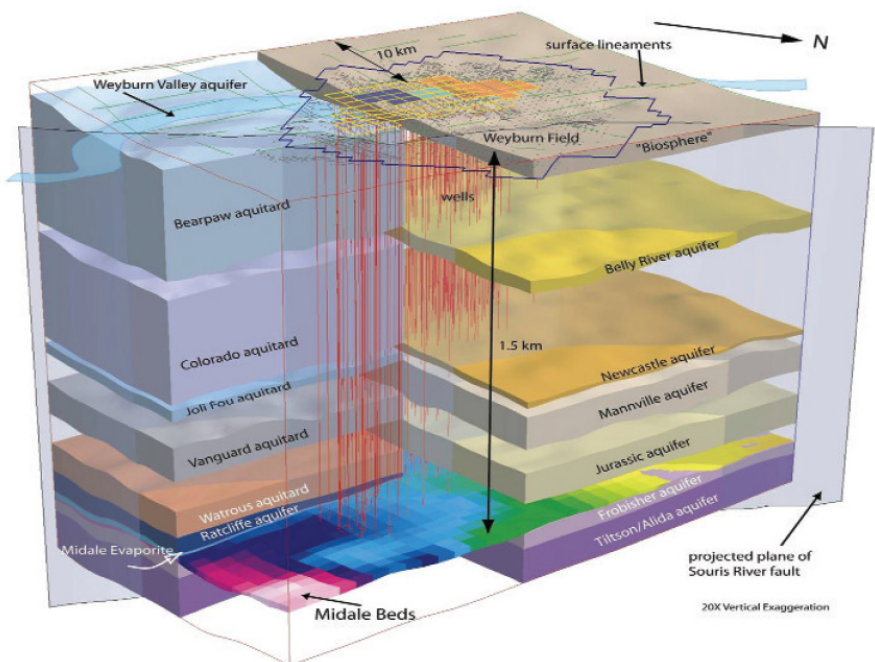
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A 3-D geologic model has been constructed from ~1,000 wells for an area extending 10km beyond the limits of the Weyburn field CO₂ injection area.



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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 CO₂. Phase I of the project culminated in release of the Summary Report (IEA GHG Weyburn CO₂ 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 CO₂ geologic storage projects.

Primary Project Goal

The goal of the Weyburn CO₂ Sequestration Project is to enhance the knowledge and understanding of the underground sequestration of CO₂ associated with EOR. Understanding the mechanisms, the reservoir storage capability, and the economics of CO₂ 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 CO₂ 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 CO₂ and CO₂-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 CO₂ migration out of zone.
- Document safe practices of normal CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ mineral fixation (mineralization, mineral trapping) under these reservoir conditions.

Theme 5—Data validation and management

- Store the Weyburn-Midale data set at PTRC.

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

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 CO₂ is stored; (2) the movement and ultimate geochemical fate of the CO₂ within the reservoir; (3) the reservoir storage capacity; (4) the economic viability of CO₂ storage in the reservoir; and (5) the overall risk assessment, including probability and consequences of CO₂ 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 CO₂ geologic storage projects. These technologies will enable the geologic storage of significant quantities of CO₂ that would otherwise be emitted to the atmosphere and at the same time increase oil recovery and hence improve U.S. energy security.

Widespread CO₂ 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.

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 CO₂ in the Weyburn reservoir over the four years of the Phase I Project.

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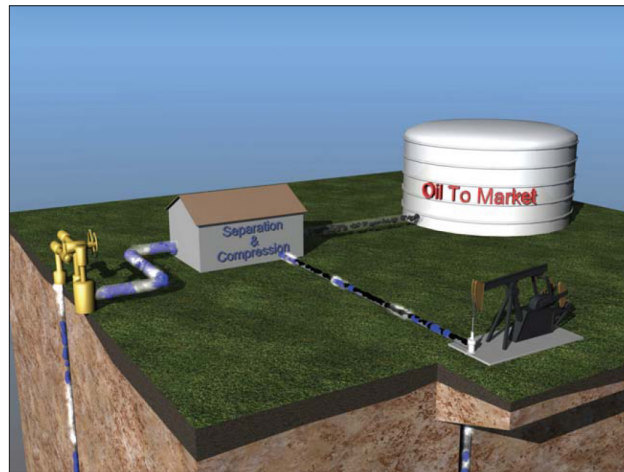
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Water (blue) and CO₂ (white) are compressed and injected into soil reservoirs for enhanced oil recovery. Roughly 30% of the CO₂ returns to the surface with the oil (black), where it is separated and recycled.

Water (blue) and CO₂ (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 CO₂ underground, in the Marly and Vuggy layers, post-production.

