PROJECT facts

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

Carbon Sequestration

4/2008

SOUTHWEST REGIONAL PARTNERSHIP ON CARBON SEQUESTRATION—DEPLOYMENT PHASE

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Background

As part of a comprehensive effort to assess options for sustainable energy systems, the U.S. Department of Energy has selected seven Regional Partnerships, through its Regional Carbon Sequestration Partnership (RCSP) Program, to determine the best approaches for capturing and permanently storing carbon dioxide (CO_2), a greenhouse gas which can contribute to global climate change. The RCSPs are made up of state agencies, universities, private companies, national laboratories, and nonprofit organizations that form the core of a nationwide network helping to establish the most suitable technologies, regulations, and infrastructure needs for carbon sequestration. Altogether, the Partnerships include more than 350 organizations, spanning 41 states, two Indian nations, and four Canadian provinces.

The RCSP initiative is being implemented in three phases. The Characterization Phase began in September 2003 with the seven Partnerships working to develop the necessary framework to validate and potentially deploy carbon sequestration technologies. In June 2005, work transitioned to the Validation Phase, a four-year effort focused on validating promising CO_2 sequestration opportunities through a series of field tests in the seven regions. Presently, activities in the Deployment Phase (2008-2017) are proceeding as an extension of the work completed to date and will demonstrate that CO_2 capture, transportation, injection, and storage can be achieved safely, permanently, and economically at a large scale. These tests will promote understanding of injectivity, capacity, and storability of CO_2 in the various geologic formations identified by the Partnerships. Results and assessments from these efforts will assist commercialization efforts for future sequestration projects in North America.

The Southwest Regional Partnership on Carbon Sequestration (SWP), coordinated by the New Mexico Institute of Mining and Technology, includes the states of Arizona, Colorado, Kansas, New Mexico, Oklahoma, Texas, Utah, and Wyoming. The SWP includes over 50 organizations. The eight states in the SWP account for about 10 percent of U.S. CO_2 emissions from stationary sources. The region offers significant potential for sequestration in saline formations, unmineable coal seams, and depleting oil and gas reservoirs. Of particular interest is the use of CO_2 for enhanced oil recovery (EOR) in tandem with sequestration.

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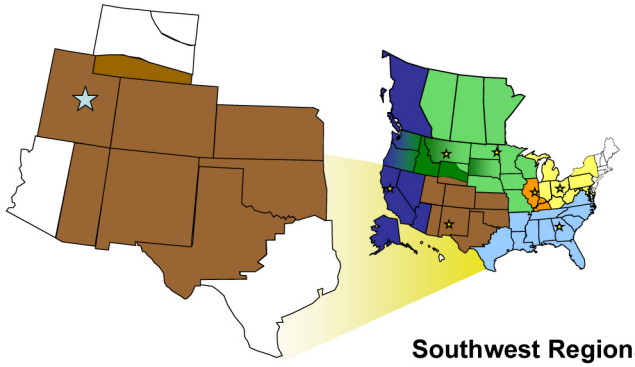
PARTNERS

- Advanced Resources International (ARI)
- Applied Sciences Lab
- Arizona Geological Survey
- Arizona State University
- Blue Source, LLC
- Center for Energy & Economic Development (CEED)
- Chevron
- Colorado Geological Survey
- Colorado School of Mines
- Colorado State University
- ConocoPhillips
- Dine College
- Electric Power Research Institute (EPRI)
- Energy & Geoscience Institute (EGI)
- Gas Technology Institute (GTI)
- Intermountain Power Agency
- Interstate Oil and Gas Compact Commission (IOGCC)
- KinderMorgan CO_2 Company, L.P.
- Los Alamos National Laboratory
- Navajo Nation
- Navajo Nation Oil and Gas Company
- New Mexico Bureau of Geology
- New Mexico Environmental Department
- New Mexico Institute of Mining and Technology
- New Mexico Oil and Gas Association (NMOGA)
- New Mexico Oil Conservation Division
- New Mexico State University

Project Description

Project Summary

SWP will accomplish a major sequestration deployment in the Farnham Dome in central Utah. This test will follow an injection schedule over 4 years, leading up to 900,000 tonnes (1 million U.S. tons) of CO2 per year. The target formations for this deployment include deep Jurassic-, Triassic-, and Permian-aged sandstones in the Farnham Dome of Utah. These formations are also targets of potential commercial sequestration throughout the western United States. The SWP plans include a "dual completion" with injection in two different formations at the same time. By carrying out two tests in two different formations within the same stratigraphy, portability of science and engineering results can begin to be evaluated.



Southwest Regional Carbon Sequestration Partnership Deployment Phase Test

Injection Site Description

The Farnham Dome injection site is located just southwest of the Uinta basin near Price, Utah, 120 miles south of Salt Lake City, in central Utah. Farnham Dome is an elongated surface anticline located along the northern plunge of the San Rafael uplift.

Drilling along the crest of Farnham Dome in the 1920s and 1930s resulted in the discovery of significant deposits of CO_2 in the Jurassic Navajo Sandstone and small shows of CO_2 in Triassic, Permian, and Pennsylvanian reservoirs. Given that the more shallow Jurassic units hold significant CO_2, the deeper Triassic and Permian units appear promising with respect to large CO_2 capacities and low risk with respect to leakage. The area provides an excellent deployment test opportunity for analysis of high injection rates and high resolution monitoring of CO_2 in multiple rock layer horizons. These deep saline formations are major targets for commercial-scale sequestration associated with future coal-fired power plants planned for the area. Much of the Farnham Dome site falls under jurisdiction of the U.S. Bureau of Land Management.

Description of Geology

The target formations are deep saline units present throughout the SWP region, as well as in many states outside the region. In all cases, the seal is the Morrison Formation, a thick (400 feet) shale/gypsum/siltstone of Jurassic age, also regionally present throughout the SWP states. At the Farnham Dome and all other sites, the target units lie within a true "stacked" system—above the Morrison formation lies the Dakota formation, a Cretaceous-aged sandstone similar to the deep Triassic and Permian sands, and capped by the Pierre/Mancos shale, a very thick (1,500 feet to 5,000 feet) shale unit. The SWP has gathered porosity, permeability, mechanical, compositional, and geophysical data associated with these target formations and seals.

Source of CO_2

For the Farnham Dome deployment site, the sources of CO_2 include natural CO_2 from the Jurassic-aged Nugget Sandstone. A second potential source is a coalbed methane (CBM) production field northwest of Price, Utah; the CBM operation currently vents over 100,000 tons of CO_2 per year. A short pipeline will need to be added to facilitate injection of captured CO_2 into the deep saline reservoirs at Farnham Dome. All CO_2 captured will be 97 percent pure, with the remainder nitrogen (air).

Injection Operations

For the Farnham Dome site in Utah, a minimal length of pipeline will be added in order to deliver the CO_2 for deep injection. Blue Source LLC, a SWP partner, and Savoy Energy LLC, the field operator, are completing designs for necessary pipelines. Upon completion of the Deployment Phase test, this pipeline will be used to transport the captured CO_2 from the Farnham Dome site to the Uinta Basin EOR market.

Simulation and Monitoring of CO_2

The project will require extensive monitoring and simulation to determine if the storage operations are effective in trapping the injected CO_2 for millennia. Vertical seismic profiling and microgravity methods will be particularly utilized, given their proven ability to resolve the size of the CO_2 plume. Monitoring, mitigation, and verification (MMV) techniques that will be used include repeat 3-D seismic surveys, pressure monitoring, groundwater chemistry monitoring, pressure and fluid sample monitoring from other locations, soil gas sampling, and other methods. A variety of "in house" and commercial/public simulation tools will be used, including GEM, TOUGH2, TOUGHREACT, FEHM, CO_2-PENS, COMSOL, THRUST3D, MRKEOS and SWEOS.

Goals and Objectives

SWP's overall goal is to validate the information and technology developed under the Characterization and Validation Phases relative to research and field activities, public outreach efforts, and regional characterization. Specific objectives include:

- Develop an overall methodology that optimizes engineering and planning for future commercial-scale sequestration projects.
- Conduct successful large-scale CO_2 injection projects targeted at Jurassic and older sandstone formations.

PARTNERS, CONT.

- NM Petroleum Recovery Research Center (PRRC)
- Occidental Permian Ltd.
- Oklahoma Gas and Electric
- Oklahoma Geological Survey
- Oklahoma State University
- PacifiCorp
- Public Service Company of New Mexico (PNM)
- Resolute Natural Resources Company
- Sandia National Laboratories
- Southern California Edison
- Texas A&M University
- Texas Bureau of Economic Geology
- Tucson Electric Power Company
- United States Geological Survey
- U.S. Department of Agriculture
- University of Missouri
- University of Oklahoma
- University of Utah
- Utah Automated Geographic Reference Center (AGRC)
- Utah Division of Air Quality
- Utah Division of Oil, Gas, & Mining
- Utah Energy Office
- Utah Geological Survey
- Utah State University
- Waste-Management Education & Research Consortium (WERC)
- Western Governors' Association
- Xcel Energy
- Yates Petroleum Corporation

COST

Total Project Value
$88,845,571

DOE/Non-DOE Share
$65,437,395 /$23,408,176

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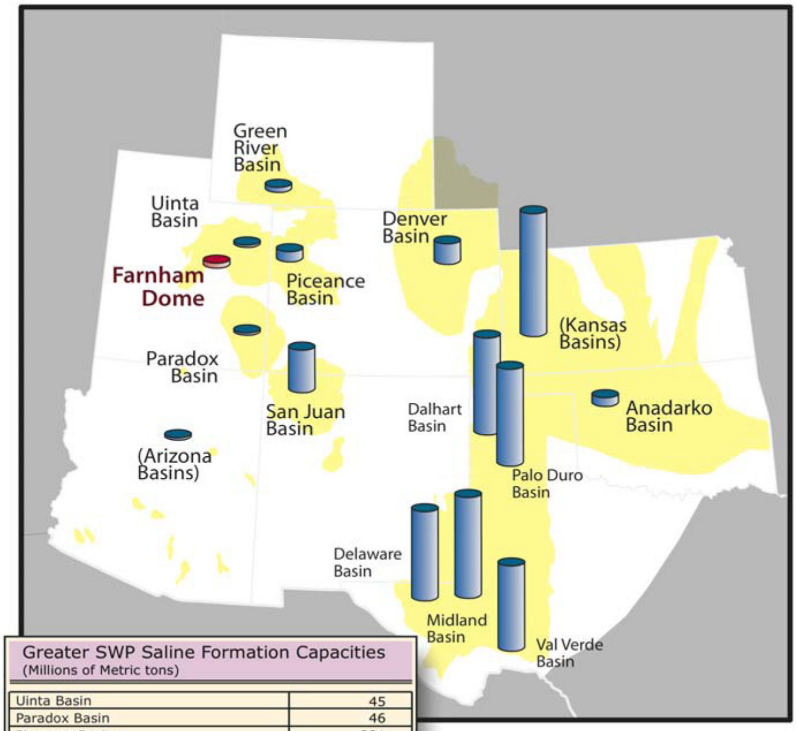
- Achieve a more thorough understanding of the science, technology, regulatory framework, risk factors, and public opinion issues associated with large-scale injection operations
- Validate MMV activities, modeling, and equipment operations.
- Refine capacity estimates of the target formation using results of the tests



Greater SWP Saline Formation Capacities
(Millions of Metric tons)

Uinta Basin	45
Paradox Basin	46
Piceance Basin	231
Anadarko Basin	212
Denver Basin	433
Green River Basin	114
NM & TX Permian Basins	12,572
KS & eastern CO Basins	3,332
Arizona Basins	14
San Juan Basin	1,086
Total	18,088
Farnham Dome (8 sq. km)	1.5
Farnham Dome (201 sq.km)	36.5
Farnham Dome (804 sq. km)	138.0

Figure 1. SWP region CO_2 sequestration capacities for deep saline formations that are Jurassic and older in age. Different capacities indicated for Farnham Dome correspond to different radii (extent of subsurface structure) under consideration for sequestration.

Benefits to the Region

The SWP's Characterization and Validation Phase analyses determined that the region's point sources emit approximately 320 million tonnes (350 million U.S. tons) of CO_2 per year, which for 100 years (assuming no change in emissions rate) translates to 32 billion tonnes (35 billion U.S. tons) total storage capacity needed. The SWP's Characterization and Validation Phase analyses provide an initial estimate of capacity of the deep Jurassic and older saline formations in the SWP region to exceed 18 billion tonnes (20 billion U.S. tons). The Farnham Dome site, in comparison, is projected to store at least 138 million metric tons of CO_2 in formations that are Jurassic and older (Figure 1). During the Deployment Phase, SWP will continue to refine capacity estimates and evaluate injectivity and other critical factors relevant to regional storage goals.