Big Sky Carbon Sequestration Partnership—Development Phase

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) initiative, to determine the best approaches for capturing and permanently storing carbon dioxide (CO_2), a greenhouse gas (GHG) which can contribute to global climate change. The partnerships 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 RCSPs include more than 350 organizations, spanning 43 states 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 Development 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 help in the commercialization efforts for future sequestration projects in North America.

The Big Sky Carbon Sequestration Partnership (BSCSP), led by Montana State University, includes Idaho, Montana, eastern Oregon, South Dakota, eastern Washington, and Wyoming. The Big Sky Partnership includes more than 60 organizations. The six states in the Big Sky Partnership account for 131 million tons (119 million metric tons) of CO_2 annually. The region offers significant potential for sequestration in saline formations. Also of interest is the use of CO_2 for enhanced oil recovery (EOR).

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PARTNERS

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Boise State University
Bullivant Houser Bailey PC
Center for Advanced Energy Studies
Center for Energy & Economic Development (CEED)
Cimarex Energy
Columbia University, Lamont-Doherty Earth Observatory
Det Kongelige Olje- Og Energidepartementet
Energy Northwest
EnTech Strategies, LLC/New Directions
Environmental Financial Products
Environmental Protection Agency
Exxon-Mobil
Heller Ehrman, LLP
IBM
Idaho Carbon Sequestration Advisory Committee
Idaho Department of Environmental Quality
Idaho National Laboratory
Idaho Soil Conservation Service
Idaho State University
Inland Northwest Research Alliance
Institute de Physique du Globe de Paris
Institute for Energy Technology (Norway)
Intertribal Timber Council
Jackson Hole Center for Global Affairs
Los Alamos National Laboratory
Montana Bureau of Mines and Geology
Montana Department of Environmental Quality
Montana Farm Bureau Federation
Montana GIS Services Bureau IT Services
Montana Natural Resource Information System
Montana Office of the Governor
Montana State University – Bozeman
Montana Tech
National Carbon Offset Coalition
National Geophysical Research Institute (India)
National Tribal Environmental Council
Nez Perce Tribal Council
Norwegian Univ. of Science and Technology
Oregon State University

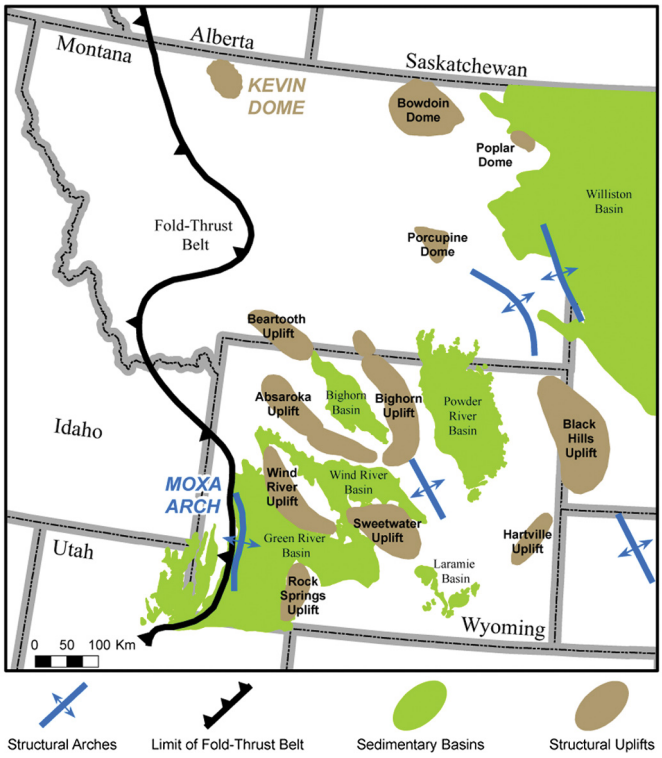
Project Description

Project Summary

In the Development Phase, the BSCSP will conduct a large-volume test into a sandstone or limestone formation in the Moxa Arch area of western Wyoming to demonstrate the ability of a geologic formation to safely, permanently, and economically store more than two million tons of CO_2. The anticipated site area possesses favorable geologic conditions and large sources of CO_2 from ongoing oil and gas production and processing operations exist. The project will demonstrate the entire CO_2 injection process—pre-injection characterization, injection process monitoring, and post-injection monitoring—and provide the foundation for the future development of CO_2 capture and storage opportunities in the region. The Big Sky Partnership plans to drill a CO_2 injection well and then inject up to one million tons of CO_2 per year into a sandstone or limestone formation at a depth of approximately 11,000 feet. Eolian sandstone formations are present throughout the region and present the opportunity to store more than 100 years of CO_2 emissions from point sources in the region, while several massive limestone formations possess favorable caprock conditions, significant porosity and permeability, and the potential for mineralogical changes that could enhance their CO_2 storage capability. It is expected that CO_2 for the project will be available via an operating petroleum or natural gas processing facility in the vicinity of the selected injection site.

Injection Site Description

The planned injection site occurs west of LaBarge, Wyoming, and is east of the thrust belt that creates the LaBarge Platform and Moxa Arch geological features. The injection site will be located as close as possible to the CO_2 supply, which is expected to come from an operating petroleum or natural gas processing facility.



Map Showing La Barge Platform and Moxa Arch Locations

Description of Geology

The target formation will be located in or near the Moxa Arch, a natural geological structural trap in southwest Wyoming that occurs at a depth of 9,840 feet (3,000 meters) or greater. The LaBarge Platform encompasses a large structural closure at the northern limit of the Moxa Arch. The Moxa Arch is a large north-south trending anticline, bounded on the south by the Uinta Mountains and trending north for 120 miles before plunging beneath the leading edge of the Wyoming Thrust Belt. The west flank of the anticline dips below the Wyoming Thrust Belt, and the east flank is the western margin of the Green River Basin. The Nugget Sandstone is a very extensive saline formation located on the LaBarge Platform and extends across the remainder of the Moxa Arch and into the Green River Basin. The porous sandstones that are the injection target have an average thickness of greater than 200 feet, an average porosity of greater than 15 percent, and are highly permeable. The seal consists of 500+ feet of the overlying Twin Creek limestone, capped by 1,000+ feet of the Jurrasic Strump-Pruess shale section. The Madison and Bighorn Limestone formations are massive units, hundreds of feet thick, which may also provide sufficient injectivity and storage capacity for large-scale CO_2 sequestration, and may provide additional sequestration capability via mineralization of injected CO_2.

Source of CO_2

The source of the CO_2 for the large-volume sequestration test is expected to come from an operating petroleum or natural gas processing facility in the Moxa Arch region. The CO_2 will be at supercritical conditions within the natural gas processing facility, so relatively little additional pressurization will be required prior to injection into the targeted geologic formation.

Simulation and Monitoring of CO_2

To achieve its monitoring, verification, and accounting (MVA) goals, the Big Sky Partnership will employ a team from Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Montana State University – Bozeman, and the University of Washington to oversee the monitoring effort. The fundamental direct monitoring methods to be employed include soil gas surveys, geophysical detection of subsurface CO_2 (2-D or 3-D seismic, single, or multicomponent), and sampling of monitoring wells for geophysical indicators of the presence of CO_2. Project progress may dictate the use of additional monitoring tools and techniques. The system will consist of one injection well and a minimum of four monitoring wells. Data obtained will be used to improve project simulation.

Goals and Objectives

The primary objective of the large-volume sequestration test is to demonstrate that the selected formation and other analogous formations are viable and safe targets for sequestration of a large fraction of the region's CO_2 emissions. Specific objectives include:

- Evaluate the formation responses to injection of commercial volumes of supercritical CO_2 and derive the relevant MVA, modeling, risk assessment, and economic evaluation tools for future projects.
- Track the post-injection migration and containment of the CO_2 in the Nugget Sandstone to compare with pre-injection reservoir model predictions and use the data to refine multiphase flow reactive-transport modeling of CO_2 sequestration in saline formations.
- Evaluate the various MVA procedures used for their performance during deep sequestration.

PARTNERS (cont.)

PacifiCorp
Portland General Electric (PGE)
Power Procurement Group (PPG Power)
PPL Montana
Puget Sound Energy (PSE)
Ramgen Power Systems, Inc.
Research Council of Norway
Ruckelshaus Institute for Environment & Natural Resources (University of Wyoming)
Russian Academy of Sciences
Sage Resources
Schlumberger
Semiarid Prairie Agricultural Research Centre (SPARC)
SINTEF Petroleum Research (Norway)
South Dakota School of Mines and Technology
Southern Montana Electric
State Geological Survey Units
Summit Energy
The Sampson Group
Unifield Engineering
United Power/Edison Mission Group
University of Idaho
Univ. of Wyoming GIS Center
Univ. of Wyoming Enhanced Oil Recovery Institute
Wageningen University (The Netherlands)
Western Governors' Association
Wyoming Carbon Sequestration Advisory Committee
Wyoming Department of Environmental Quality
Wyoming State Governor's Office
Yellowstone Ecological Research Center

COST

Total Project Value

$130,627,114
(includes work performed by DOE National Laboratories)

DOE/Non-DOE Share

$66,885,648 (National Labs: $11,096,837) / $63,741,466

The partnership also aims to refine the regional characterization of carbon sinks, sources, infrastructure, and capacity estimates in terrestrial systems and in geologic formations (e.g., basalts) that are predominant in the Big Sky Region. The regional characterization objectives are to:

- Understand the costs of carbon sequestration.
- Determine the best management practices to sequester carbon in the soil of agricultural systems.
- Refine regional assessments of CO_2 sources and capacity estimates.
- Keep the public informed of the project operations and BSCSP activities and disseminate project findings.

Benefits to the Region

The Nugget Sandstone is a Jurassic-aged regional sheet sandstone that covers the entire southwestern area of Wyoming. It is equivalent to the Navajo Sandstone (Utah) and has similar properties to the Tensleep Sandstone (Montana and Wyoming), Weber Sandstone (Wyoming, Colorado, and Utah), Quadrant Sandstone (Montana), and the Sundance Sandstone (Wyoming). Thus, it has important regional significance. The Big Sky Region currently emits 131 million tons (119 million metric tons) of CO_2 per year. The volumetric storage estimate of 441 billion tons (400 billion metric tons) for saline formations in the Big Sky Region allows ample storage capacity without stressing the region's ability to contain CO_2. These volumes are sufficient to support commercialization of this sink.