



West Coast Regional Carbon Sequestration Partnership—Validation Phase

Background

The U.S. Department of Energy (DOE) has selected seven partnerships, through its Regional Carbon Sequestration Partnership (RCSP) initiative, to determine the best approaches for capturing and permanently storing carbon dioxide (CO₂), a greenhouse gas (GHG) which can contribute to global climate change. The RCSPs are made up of state and local agencies, coal companies, oil and gas companies, electric utilities, universities, private companies, and nonprofit organizations that form the core of a nationwide network helping to establish the most suitable technologies, regulation, and infrastructure needs for carbon sequestration. The partnerships include more than 350 organizations, spanning 43 states and four Canadian provinces. The RCSPs are developing the framework needed to validate and deploy carbon sequestration technologies. The RCSPs will determine which of the numerous sequestration approaches are best suited for their specific regions of the country and identify regulatory and infrastructure requirements that will be needed should policy and economics indicate that sequestration be deployed on a wide scale. 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. The Validation Phase of the RCSP effort (2005–2009) is focused on evaluating promising CO₂ sequestration opportunities through a series of field tests in the seven partnership regions. Presently, activities in the Development Phase (2008–2017) are proceeding and will continue the validation process to determine that CO₂ 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 CO₂ 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.

Description

The West Coast Regional Carbon Sequestration Partnership (WESTCARB), led by the California Energy Commission, includes Alaska, Arizona, California, Nevada, Oregon, Washington, Hawaii, and British Columbia. WESTCARB comprises more than 80 partner organizations, including state resource management and environmental protection agencies, national laboratories and research institutions, colleges and universities, conservation non-profits, oil and natural gas companies, power companies, pipeline companies, trade associations, vendors and service firms,

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 Alaska Department of Natural Resources
 American Air Liquide
 American Petroleum Institute
 Argonne National Laboratory
 Arizona Electric Power Cooperative
 Arizona Geological Survey
 Arizona Oil & Gas Conservation Commission
 Arizona Public Service
 Aspen Environmental Group
 Bascom Pacific LLC
 Bevilacqua-Knight, Inc. (BKl)
 Blue Source
 BP – British Petroleum – America & Alternative Energy
 British Columbia Ministry of Energy, Mines and Petroleum Resources
 California Air Resources Board
 California Climate Action Registry
 California Department of Forestry and Fire Protection – Red Bluff, CA
 California Department of Forestry and Fire Protection – Sacramento, CA
 California Department of Water Resources
 California Division of Oil, Gas, and Geothermal Resources
 California Energy Commission
 California Environmental Protection Agency
 California Forest Products Commission
 California Geological Survey
 California Institute for Energy and Environment
 California Polytechnic State University – San Luis Obispo
 California State University – Bakersfield
 Cement Industry Environmental Consortium
 Chevron
 Clean Energy Systems, Inc.
 Climate Trust
 ConocoPhillips
 DNV Research – Det Norske Veritas
 Electric Power Research Institute (EPRI)
 Errol L. Montgomery & Associates
 Golder Associates
 Greenwood Resources
 HTC Pureenergy
 Jeld-Wen Timber and Ranch
 Kinder Morgan
 Lake County Resources Initiative
 Lawrence Berkeley National Laboratory

and consultants. WESTCARB plans to conduct one saline formation storage test in northern California and one saline formation storage test in northeast Arizona. WESTCARB is also conducting terrestrial sequestration pilot projects in Lake County, Oregon, and Shasta County, California.

The seven states in the WESTCARB account for more than 11 percent of U.S. CO₂ emissions, with the bulk of those being from California and Arizona. Total CO₂ emissions from the industrial and utility sectors, which have large stationary sources that are most amenable to capture, emit over 215 million metric tons of CO₂ per year. The region offers significant potential for sequestration in porous sediments greater than 3,000 feet deep, especially the saline formations of California's Central Valley and Washington's Puget Trough. The West Coast Region also has a wealth of forest and rangelands where improved management practices could sequester large quantities of carbon. Technology discussions, regional meetings, and joint research activities are being conducted to maintain an open dialogue with stakeholders so that a regional strategy can be developed for terrestrial and geologic carbon sequestration projects that meet the area's near- and long-term needs.

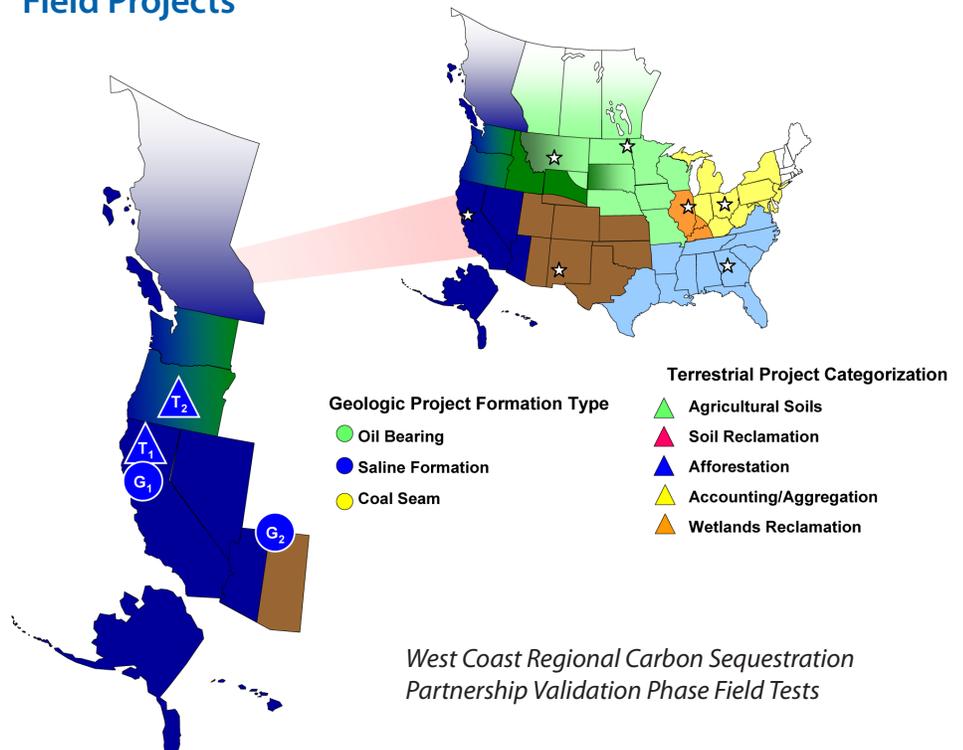
Primary Project Goal

WESTCARB's primary goal is to validate the feasibility, safety, and efficacy of carbon storage in two deep saline formations (one in Arizona and one in California) and in forests and rangelands. A secondary goal is to improve the geologic and terrestrial characterization begun during the Characterization Phase (2003–2005) for especially promising storage locations.

Objectives

- Conduct pilot tests to validate carbon storage technologies.
- Refine and enhance the broad regional evaluation of carbon sequestration potential.
- Identify opportunities for a large-scale CO₂ storage test in the region.
- Seek community input on issues surrounding pilot-scale and commercial-scale sequestration project development.

Field Projects



Geologic Sequestration Opportunities

California offers outstanding opportunities for CO₂ sequestration because of its many deep sedimentary basins and the potential of value-added benefits from enhanced oil recovery (EOR) and enhanced gas recovery (EGR). In Oregon and Washington, sedimentary basins between the Coast and Cascade mountain ranges also offer excellent sequestration opportunities – a series of basins in the western portions of both states contain sediments up to 20,000 feet (6,000 meters) thick. In Washington, the Puget Sound Basin also contains deep coal formations suitable for sequestration that may have potential for enhanced coal bed methane (ECBM) production. In Nevada, many small basins have been identified. In Alaska, the oil and natural gas fields on the North Slope are of prime interest because of the large potential for EOR using CO₂. Further, a deep sedimentary basin below the Cook Inlet is near some of Alaska's major CO₂ sources. Finally, in Arizona, sediments underlying the Colorado plateau offer potential storage sites and are in the vicinity of major coal-fired power plants.

Shell Northern California Saline Formation CO₂ Storage Pilot (G1)

A geologic CO₂ storage pilot in a saline formation is planned for the western Sacramento Valley in northern California. WESTCARB's partner, Shell Oil Company, will enhance the project team's expertise in the areas of earth sciences, drilling, and CO₂ injection. The test will involve drilling injection and monitoring wells to 10,000–12,000 feet, injection of 2,000 tons (1,815 metric tons) of CO₂, and monitoring with geophysical and geochemical sampling techniques.

Accomplishment Highlights:

- A site owned by a private landowner was selected for the pilot test.
- Sandia Technologies, LLC was contracted as the site project manager responsible for overseeing drilling operations and performing the CO₂ injection test.
- A draft Underground Injection Control (UIC) permit application for the saline experiment is in the final stages of preparation.

Arizona Utilities CO₂ Storage Pilot (G2)

This project involves drilling a well approximately 3,800 feet deep to evaluate saline formation CO₂ storage in Arizona's Colorado Plateau region. Potential storage targets are the Naco and Martin formations. Approximately 2,000 tons (1,815 metric tons) of CO₂ will be injected into the chosen saline formation, and CO₂ dispersion into the formation will be monitored.

Accomplishment Highlights:

- Public outreach meetings were held in August 2007 and November 2008 in Holbrook, Arizona, to inform elected officials, safety officials, community leaders, and the public of the proposed project and to invite their questions and involvement.
- Partners' media release on the public meeting, for local and statewide distribution, resulted in several news articles.
- Contracting for a field site manager is complete.
- National Environmental Policy Act clearance has been granted for the project.
- Pending receipt of final permits (EPA Region 9 UIC and Arizona Temporary Aquifer Protection Permit), CO₂ injection well drilling is anticipated to begin in Spring 2009.

PARTNERS (cont.)

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Massachusetts Institute of Technology
National Council for Air and Stream Improvement
Nevada Bureau of Mines and Geology
Nexant, Inc.
Occidental Petroleum
Oregon Department of Forestry
Oregon Forest Resources Institute
Oregon State University
Pacific Forest Trust
Pacific Gas and Electric
PacifiCorp
Peabody Energy
Portland General Electric
Ramgen Power Systems
Renewable Fuel Technologies LLC
Rooney Engineering Inc.
Salt River Project
San Francisco Department of the Environment
Schlumberger
SFA Pacific
Shell International
Sierra Pacific Resources
Southern California Edison
Stanford University – Global Climate Energy Project
Taisei Corporation
Terralog Technologies
The Collins Companies
TransAlta Centralia Generation
Tucson Electric Power
U.S.D.A. Forest Service
U.S. Environmental Protection Agency, Regions 9 and 10
U.S. National Park Service
University of Alaska – Fairbanks
University of California – Berkeley
University of California – Davis
University of Hawaii - Manoa
Utah Automated Geographic Reference Center
W.M. Beaty and Associates
Washington State Department of Natural Resources
Western Governors' Association
Western Interstate Energy Board
Western Shasta Resource Conservation District
Western States Petroleum Association
Wheelabrator Shasta Energy Company
Winrock International

Terrestrial Sequestration Opportunities

Shasta County Terrestrial Sequestration Project (T1)

The Shasta County, California terrestrial pilot includes afforestation of marginal lands, conservation-based forest management, and fuel reduction/biomass energy activities to reduce GHG emissions from catastrophic wildfires. In the afforestation area, native conifer and oak species are being restored to rangelands and fire-damaged forest lands, with 11 pilot projects underway ranging from about 10 to 100 acres each. In the fuel reduction/biomass energy area, the project will test forest management activities to reduce the potential for large GHG releases from catastrophic wildfires. Building on existing fire models, project researchers are developing new methodologies for rigorous area and emissions baselines, quantifying expected emissions with-treatment versus baseline, and conducting measurement and monitoring activities. Fire-prone forests are being treated by the landowners/managers to restore forest health by removing suppressed understory trees, brush, and other fuels. Where feasible, biomass fuel is transported to a local biomass power plant to generate electricity that can offset power demand that may have otherwise been met by fossil fuel combustion. Finally, in the conservation-based forest management area, the project is using a partnership between a conservation group and timber companies to restore and maintain high-quality forest habitats and test the practicality and effectiveness of existing forest carbon accounting protocols.

Accomplishment Highlights:

- Four hundred landowners contacted and 48 surveyed, resulting in 16 site-specific afforestation planting and maintenance plans being developed.
- Eleven afforestation pilots underway with landowner agreements signed, totaling 460 acres for planting in 2008 and 2009. Three additional agreements are in negotiation.
- National Environmental Protection Act Categorical Exemption received on all projects to date.
- Site preparation complete on 10 afforestation projects for 2008–2009 planting, with planting completed on four projects.
- Pre-treatment measurements completed on four fuel reduction projects; post-treatment completed on two.
- High level of landowner interest; landowners are willing to share costs.

Lake County Terrestrial Sequestration Project (T2)

The Lake County, Oregon terrestrial pilot includes fuel reduction/biomass energy activities to reduce GHG emissions from catastrophic wildfires and analysis of the feasibility of afforestation. Like the Shasta pilot, this pilot is testing forest management activities to reduce the potential for large

GHG releases from catastrophic wildfires, applying new methodologies for rigorous area and emissions baselines, quantifying expected emissions with-treatment versus baseline, and conducting measurement and monitoring activities. The two terrestrial pilot projects combined will provide insight into the transferability of fire risk reduction as a CO₂ emission mitigation strategy across forests of the WESTCARB region, as well as produce documentation on establishing baselines and carbon benefits measurements. This pilot is also studying the feasibility of establishing plantations of fast-growing trees on suitable agricultural or grazing land that could be harvested for biomass power on short rotations.

Accomplishment Highlights:

- New 13 MW biomass power plant under construction by Marubeni Sustainable Energy and new \$6 million Collins Companies small-log sawmill complete, in part due to efforts of WESTCARB partners, including the Lake County Resources Initiative, Collins Companies, U.S. Forest Service, Oregon Department of Forestry, and others.
- Pre-treatment measurements complete on two fuel reduction projects.
- GreenWood Resources completed the establishment of a network of nine varietal test sites in the western states. Test sites will be managed for three years and assessed for a variety of performance standards, and biomass obtained will be used for combustion fuel for ethanol conversion.
- Collins has expanded its Fremont Sawmill operation in Lakeview by building a new \$6.6 million small log mill. The mill is the direct result of the 20-year Interagency Biomass Supply MOU and 10-year Stewardship Contract effort spearheaded by the Lake County Resources Initiative, and provides an added tool for improving management of forests and hazardous fuels in Lake County.

Benefits

This project provides a comprehensive assessment of the sources, and potential storage sites for CO₂ in the West Coast Region. These data are being integrated with comparable data from other partnerships to provide a source/storage site database with spatially referenced data covering most of the United States and Canada. This effort is also providing information to evaluate potential capacity and value-added benefits from EOR and EGR. The estimate of CO₂ storage resources in the region is up to 900 billion U.S. tons (820 billion metric tons) for saline formations and 8.5 billion U.S. tons (7.7 billion metric tons) for oil and natural gas reservoirs. Results obtained from the tests will be critical to the development of commercial CO₂ storage sites that can accommodate large industrial point sources in the region, including highly efficient and technologically sophisticated coal- and petroleum coke-based power plants, oil refineries, cement and lime plants, and ethanol or other biofuel plants.