



the **ENERGY** lab

## PROJECT FACTS

### Carbon Sequestration

# Lawrence Berkeley National Laboratory – Consolidated Sequestration Research Project

## Background

The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) is developing carbon capture and storage (CCS) technologies to capture, separate, and store carbon dioxide (CO<sub>2</sub>) in order to reduce green-house gas emissions without adversely influencing energy use or hindering economic growth. Carbon sequestration technologies remove CO<sub>2</sub> by injecting and permanently storing it in underground geologic formations.

Some of the most promising techniques for carbon storage involve injecting CO<sub>2</sub> into geologic formations or for use in terrestrial applications. Lawrence Berkeley National Laboratory (LBNL), one of DOE's national laboratories for science and engineering research, is working on a series of tasks aimed at advancing the state-of-the-science of geologic sequestration by conducting research studies on key topics critical to the success of geologic sequestration. Consistent with NETL's mission, LBNL plans to develop the knowledge base needed to accelerate commercialization of geologic carbon sequestration (GCS) by identifying and removing barriers to sequestration through targeted research.

NETL is providing funding to LBNL for the Consolidated Sequestration Research Project (CSR). CSR is a combination of several previously independent Geologic Carbon Sequestration (GCS) research efforts along with a new risk assessment project. This research is attractive to industry because the CSR program is addressing key uncertainties and technology needs for successful commercial scale deployment. The CSR combines fundamental geological sequestration research and pilot scale programs with risk and basin-scale impact assessment projects. The final CSR deliverables will vary for each task, but includes DOE milestones and reports, along with dissemination of research results including field and laboratory data through peer-reviewed publications, and public presentations.

## CONTACTS

### Sean Plasynski

Sequestration Technology Manager  
National Energy Technology Laboratory  
P.O. Box 10940  
Pittsburgh, PA 15236  
412-386-4867  
sean.plasynski@netl.doe.gov

### Karen Cohen

Project Manager  
National Energy Technology Laboratory  
P.O. Box 10940  
Pittsburgh, PA 15236  
412-386-6667  
karen.cohen@netl.doe.gov

### Barry Freifeld

Principal Investigator  
Lawrence Berkeley National Laboratory  
1 Cyclotron Road – 90R1116  
Berkeley, CA 94720  
510-486-4381  
BMFreifeld@lbl.gov

## PROJECT DURATION

### Start Date

10/01/2009

### End Date

09/30/2012

## COST

### Total Project Value

\$11,107,000

### DOE/Non-DOE Share

\$11,107,000/\$0

## PARTNERS

British Petroleum  
CO<sub>2</sub>CRC  
GFZ Postdam

## NATIONAL ENERGY TECHNOLOGY LABORATORY

Albany, OR • Fairbanks, AK • Morgantown, WV • Pittsburgh, PA • Sugar Land, TX

Website: [www.netl.doe.gov](http://www.netl.doe.gov)

Customer Service: 1-800-553-7681



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Figure 1: Australian Otway Basin CO<sub>2</sub> Project. Naylor-1 monitoring well (left) and schematic of pilot injection operations (right).

## Project Description

LBL will work on a series of individual tasks with the common goal of advancing the science of geological sequestration through state-of-the-art research. The various tasks address DOE program goals to accelerate deployment of and reduce barriers to commercial-scale geologic carbon sequestration. Researching large-scale CO<sub>2</sub> geological storage will further improve our understanding of the potential impacts of carbon dioxide sequestration on groundwater resources. In addition, the research team will assess storage capacity and regulation by developing pressure management schemes for storage capacity enhancement and CO<sub>2</sub> leakage remediation, should it be necessary. Project tasks include project management; identifying ways to improve predictions of injectivity and capacity of saline formations and depleted gas reservoirs; and testing and implementing innovative, high-resolution methods for monitoring CO<sub>2</sub> in the subsurface. Other tasks include researching elements of risk assessment, using modeling and simulation techniques, measuring large scale impacts of geological storage, and collaborative projects to obtain information gained through global partnerships. A detailed description of each task is listed below:

- **Project Management:** Management and coordination of the six work packages will be carried out through effective project management.
- **GEO-SEQ:** The goal of GEO-SEQ Project is to increase

understanding of carbon dioxide storage processes and mechanisms by accomplishing two primary objectives: (1) develop ways to improve predictions of injectivity and capacity of saline formations and depleted gas reservoirs, and (2) develop and test innovative, high-resolution methods for monitoring CO<sub>2</sub> in the subsurface. GEO-SEQ leverages scientific understanding and technology development through highly visible, ongoing, world-class projects, including the Otway Project in Australia and In Salah Industrial-Scale CO<sub>2</sub> Storage Project in Algeria. GEO-SEQ investigates fundamental geochemical and petrophysical processes that underpin GCS using demonstration scale pilots as testing facilities to scale up from laboratory to field scale.

- **Certification Framework and National Risk Assessment Program:** This is a continuation of LBNL's effort in developing the Certification Framework (CF) to assess the safety and effectiveness of geologic carbon sequestration sites, with application of the CF to Regional Carbon Sequestration Partnership (RCSP) Phase III projects. Unlike smaller pilot projects, the RCSP Phase III projects involve CO<sub>2</sub> injection at larger scales requiring further applications "and risk assessment development. This task also includes the new National Risk Assessment Program effort involving collaborative research in five topical areas with NETL and three other national laboratories.

- **Sim-SEQ:** Sim-SEQ is a modeling and simulation activities inter-comparison and evaluation performed within the RCSP program. It enables model uncertainties to be evaluated and their impacts assessed, as well as improve future modeling efforts by making lessons learned and improvements made by one research team available to other research teams. A broad Technical Team consisting of both LBNL and RCSP scientists and reservoir engineers will evaluate and compare different approaches to reservoir and coupled reservoir-geomechanical and geochemical models. Various modeling groups established by the RCSPs will develop individual models (based on a single set of site characterization data) for the Southeast Regional Carbon Sequestration Partnership Phase III Cranfield Site using their respective model approaches and simulators. This will allow for a direct comparison of models and interaction between multiple RCSP modeling groups.
- **Large-Scale Hydrological Impacts of CO<sub>2</sub> Geological Storage:** This project is to develop a better understanding of the potential magnitude and extent of water-pressure increase and brine displacement in deep saline reservoirs in response to full-scale deployment of future CO<sub>2</sub> storage. Several predictive assessment tools featuring different degrees of complexity are being developed and utilized,

ranging from semi-analytical estimation methods to complex high-performance prediction models. The study consists of three main topical areas: to improve the prediction reliability of basin-scale models (*Model Confidence*); to quantify the impact of brine pressurization and migration on groundwater resources (*Impact Assessment*); and to evaluate pressure management schemes via brine extraction (*Management and Mitigation*). The study will further improve overall understanding of the large-scale hydrological impacts of geologic carbon sequestration on groundwater resources and corresponding implications on storage capacity estimation and Area-of-Review regulation, and to develop pressure management schemes for storage capacity enhancement and CO<sub>2</sub> leakage remediation in the unlikely event that it is needed.

- **CO<sub>2</sub>SINK Collaboration:** The CO<sub>2</sub>SINK collaborative project will obtain information gained through the mid-scale geological sequestration experiment (involving injection of approximately 100,000 metric tons of CO<sub>2</sub> in a saline formation) planned for Ketzin, Germany. The objective of CO<sub>2</sub>SINK is to further the scientific fundamentals of geological carbon sequestration and increase public confidence that CO<sub>2</sub> injection and storage can be done safely, and without adverse environmental consequences. As part of the CO<sub>2</sub>SINK project, LBNL



Figure 2: Aerial view of the CO<sub>2</sub> Storage Site (CO<sub>2</sub>SINK Project) in Ketzin, Germany. Picture is from [www.co2sink.org](http://www.co2sink.org).

will conduct Distributed Thermal Perturbation Sensor (DTPS) measurements in two observation boreholes to understand the movement and behavior of CO<sub>2</sub> in the subsurface, as well as perform laboratory-based studies on sample cores to develop rock physics models for predicting seismic waveform propagation as a function of variable CO<sub>2</sub> saturation.

## Goals/Objectives

LBNL's Consolidated Sequestration Research Project provides knowledge and lessons learned from performing distinct tasks with the common overall goals of developing the knowledge base needed to enable the commercialization of geologic carbon sequestration (GCS) and by identifying and removing barriers to sequestration through targeted research. The CSRP combines GEO-SEQ's fundamental research and pilot-scale demonstration projects with additional projects in risk assessment, model inter-comparison, geochemistry, and basin-scale impact assessment to address issues critical for successful commercial-scale carbon dioxide storage.

## Benefits

The comprehensive products of the CSRP will differ for each task, but ultimately embrace Department of Energy (DOE) goals and objectives for the CCS program, milestones, field and lab data collection, peer-reviewed publications, and public presentations. The carbon sequestration community will benefit from a close working relationship with numerous domestic and foreign industrial and academic teams as well as through interactions with and assistance given to other regional projects; and by publications and presentations made available to all parties interested in removing barriers to commercial-scale geologic carbon sequestration.

