the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Pacific Northwest National Laboratory – Capture and Sequestration Support Services

Background

The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) is helping to develop technologies to capture, separate, and store carbon dioxide (CO_2) to reduce green-house gas (GHG) emissions without adversely influencing energy use or hindering economic growth. Carbon capture and sequestration (CCS)—the capture of CO_2 from large point sources and subsequent injection into deep geologic formations for permanent storage—is one option that is receiving considerable attention. Without CCS technologies, greenhouse gas emissions would continue to contribute to global climate change.

NETL is committed to advancing geologic carbon sequestration technology through funded research projects focused on removing obstacles to commercial-scale carbon sequestration deployment. Both existing and newly developed CCS technologies hold great promise to significantly reduce emissions from fossil fuels, but the engineering, economic, and environmental viability of these technologies must be assessed, tested, and validated. Demonstrating clean and economically viable electricity production from fossil fuels as well as acceptance of carbon sequestration by the public are of critical importance to wide-scale deployment.

NETL is providing funding to Pacific Northwest National Laboratory (PNNL), one of DOE's multi-program, multi-disciplinary research laboratories to conduct research studies on key topics critical to the success of geologic sequestration, including developing a risk assessment research working group, developing a global fossil energy technology strategy, investigating promising geologic storage formations (basalts), and developing lower cost carbon capture and geologic storage technology.

CONTACTS

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

Dawn Deel
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0990
304-285-4133
dawn.deel@netl.doe.gov

Peter McGrail
Principal Investigator
Pacific Northwest National Laboratory
P.O. Box 999
Richland, WA 99352
509-371-7077
Fax: 925-371-7249
pete.mcgrail@pnl.gov

PROJECT DURATION

Start Date
09/01/2009

End Date
09/30/2011

COST

Total Project Value
$3,710,000

DOE/Non-DOE Share
$3,710,000 / $0

NATIONAL ENERGY TECHNOLOGY LABORATORY

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

Website: www.netl.doe.gov

Customer Service: 1-800-553-7681

U.S. DEPARTMENT OF ENERGY

Project Description

Pacific Northwest National Laboratory is working on four individual tasks related to the capture and permanent sequestration of carbon dioxide and other greenhouse gases. This work is focused on investigating both promising geologic storage formations and key concepts needed for successful geologic sequestration of CO_2. These four tasks include:

Risk Assessment Working Group: PNNL is collaborating with a newly formed national laboratory working group to complete a detailed assessment and implementation work plan for the science base needed to support risk assessment for large-scale CO_2 storage projects. Their mission is to reduce greenhouse gas emissions from hydrocarbon-based fuels. The working group is developing a common framework for risk analysis that is thorough enough to be applied to a wide range of geologic settings where CCS might be deployed. The risk assessment framework will also be used to address diverse stakeholder needs and compare the risks of CCS systems to other risks commonly encountered in everyday life. The risk analysis work conducted on this project will (1) answer key outstanding questions about performance, safety, and effectiveness of geologic carbon sequestration based on previous field tests, (2) design a science-based plan to address these questions, and (3) provide tools, methods, and research results to the wide community of stakeholders through peer-reviewed publications and national and international conferences.

Global Fossil Energy Technology Strategy Program: This program is an international, multi-client, industry-government partnership exploring the role of fossil energy technologies in a climate-constrained world. Results and lessons-learned from this project will inform decision-makers on the U.S. Climate Change Technology Program, the U.S. Climate Change Science Program, the U.S. Department of Energy's Carbon Sequestration Program, and other key programs that advance a broad portfolio of options to address climate change. The program's structured analytical process facilitates a robust, shared understanding among industrial and government stakeholders that are involved in ongoing dialogue surrounding the future of fossil energy within the U.S. energy system and the future of energy R&D.

Sequestration in Basalt Formations: PNNL is conducting research needed to address commercial-scale injection strategies, CO_2 fate and transport, and improved seismic imaging methods for characterization of basalt formations to provide a path forward for commercial use of these formations for CO_2 sequestration. Basalt formations have received limited attention to date with respect to their potential for permanent sequestration of anthropogenic CO_2. Major basalt formations occur in various parts of the world and may be attractive storage formations for carbon dioxide sequestration. Unlike sedimentary rock formations, basalt formations have unique properties that chemically trap injected CO_2, effectively and permanently. Past NETL-funded research on geologic sequestration in basalts resulted in significant benefits for both the national and international communities. Information gathered on storage capacity, injectivity, and reactivity with CO_2 is the foundation for proceeding with a field pilot study in Washington State under the Regional Carbon Partnership program. As a result, interest in sequestration in basalts is now truly international with studies underway in India, Italy, Iceland, and Australia.

Co-Sequestration: PNNL is initiating an Advanced Capture and Co-Sequestration project (ACCS). The project mission is to further develop carbon capture and geologic storage technology with a near zero cost penalty goal. ACCS will employ the capabilities at NETL, PNNL, and collaborating partner institutions to implement a multidisciplinary approach for identifying key co-sequestration opportunities. Major research needs for successful co-sequestration include (1) identifying needs and pursuing R&D on promising low-cost technologies

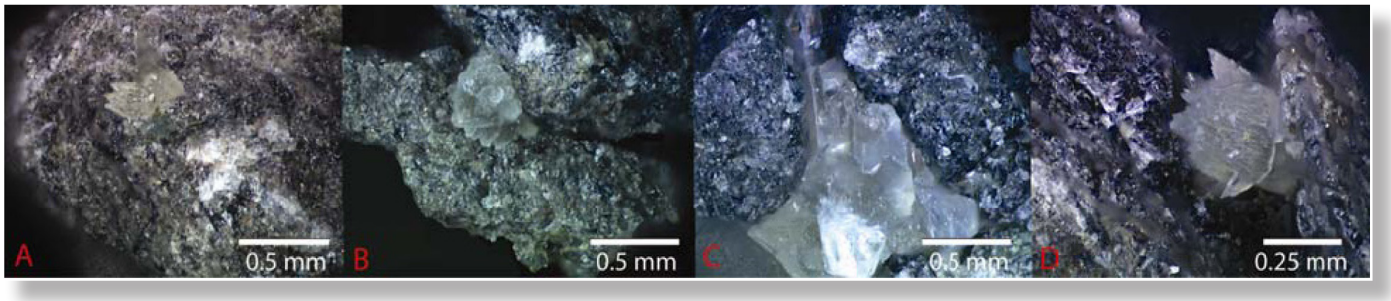

Figure 1. Columbia River Basalt and carbonate precipitates after exposure to CO_2 for A) 86 days, B) 377 days, C) 777 days, and D) 1,334 days

for simultaneously capturing CO_2 and other air pollutants from combustion and gasification-based systems, (2) metals corrosion/erosion processes that affect compression and pipeline/wellbore components in sequestration systems, (3) phase behavior of multicomponent gas mixtures in the subsurface and permanence of CO_2 storage, (4) potential regulatory and permitting impacts, and (5) identifying the constraints, opportunities, and potential economic advantages for co-sequestration.

Figure 2. Elemental sulfur accumulating as a result of acid gas processing at the Zama Gas Plant in Alberta, Canada. As part of NETL's Regional Carbon Sequestration Partnership (RCSP) Validation Phase effort, the Zama Gas Plant is capturing and sequestering a co-contaminant stream of carbon dioxide and hydrogen sulfide (H_2S) for enhanced oil production purposes. Co-sequestration reduces the accumulation of and treatment costs for elemental sulfur for the Zama Gas Plant. While not an electric generating facility, the RCSP Validation Phase efforts at the Zama Plant are a good example of co-sequestration capture and subsequent geologic storage.

Collaboration with China on Clean Energy Research: PNNL will facilitate cooperation with the Chinese Academy of Sciences in the domain of clean Energy and permanent storage of CO_2 and other criteria pollutants. Collaborative research is anticipated to be pursued in following areas: (1) Transform EOR Project into Safe CO_2 Sequestration Sites, (2) Modeling CCS Deployment in China, (3) Warm Syngas Cleanup Technology, (4) Warm (Hot) CO_2 Capture Technology, (5) Advanced Ash and Refractory Control Technologies, (6) Advanced Catalytic Processes for Syngas Conversion to Oxygenated Fuels, and (7) Optimized Methods for Syngas Conversion to Synthetic Natural Gas with CO_2 Separation.

Goals/Objectives

PNNL's work is focused on conducting research to further understand the necessary science and fundamental principles that lead towards advancing carbon capture and storage as a key climate change mitigation strategies. These tasks investigate a wide-array of mitigation strategies and remove barriers to commercial-scale geologic carbon sequestration deployment. The overall project goal is to support NETL and the Office of Fossil Energy in areas related to the capture and permanent sequestration of CO_2, including risk assessment, energy efficiency, and sequestration in basalt formations.

Benefits

The applied research that PNNL proposes is intended to advance CCS by developing a common framework for risk analysis for large-scale injection tests, and to reduce the overall cost of electricity through co-sequestration, and to investigate the potential for newer, promising geologic storage formations to store CO_2. Benefits gained by this research are vital to the success of CO_2 sequestration over the long term. This work is focused on investigating the necessary science that will lead towards large-scale deployment of geologic CO_2 sequestration technologies.

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