PROJECT facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Carbon Sequestration

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Basic Science of Retention Issues, Risk Assessment & Monitoring, Verification and Accounting for Geologic CO_2 Sequestration

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Background

The existence of naturally occurring CO_2 reservoirs and experience with enhanced oil recovery operations are strong indicators that engineered subsurface storage of CO_2 can be safe and effective. However, large scale deployment will require greater confidence in understanding the fate of the CO_2 in the subsurface for both economic and safety reasons. The participating institutions in the Zero Emissions Research and Technology Collaborative (ZERT) have expertise in development of code to simulate multiphase flow through porous media and fracture networks, facilities and expertise for measurement of fundamental physical and chemical properties of systems under appropriate temperature and pressure conditions, and expertise in monitoring, verification, and accounting.

Description

This project focuses on the basic science and development needs for improving the state of knowledge of carbon dioxide (CO_2) behavior in the subsurface. The project is assessing knowledge gaps in fundamental physical and chemical properties in relevant systems, making measurements of those properties, improving numerical models by improving parameterization using these studies and by extending code capability, and testing efficacy and detection limits of monitoring, verification, and accounting techniques. This information and the improved techniques are being incorporated into a systems-level model for risk assessment.

To date, investigations into geologic sequestration point to great promise, but large issues remain before it can be implemented on a widespread basis. Primary among these are matters related to CO_2 retention in subsurface sinks, including an accurate determination grounded in basic science of what levels of retention are attainable in different geologies; impact of those levels on climate change; development of loss mechanism mitigation strategies; risk assessment, and development of Monitoring, Verification, and Accounting (MVA) tools and methods that can work for low escape levels.

Primary Project Goal

The primary project goal is to perform basic science and technology development to fill critical needs of DOE's Carbon Sequestration Program, specifically in the areas of MVA, improvement of computational techniques, risk assessment, mitigation, and fundamental geoscience studies of CO_2 properties and behavior.

Objectives

- Improve computational tools for simulation of CO_2 behavior in the subsurface.
- Test efficacy of near-surface detection techniques, help establish detection limits for those techniques, and provide data to assist in development of transport models in the near-surface region.

PARTNERS

West Virginia University
Crown Agrofuels
Lawrence Livermore National Lab
Lawrence Berkeley National Lab
Los Alamos National Lab
Pacific Northwest National Lab
National Energy Technology Lab

COST

Total Project Value
$24,530,102

DOE/Non-DOE Share
$24,061,140 / $468,962

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- Develop a comprehensive risk assessment framework that will allow flexible coupling of multiple computational models for different components/processes of the system.
- Perform gap analysis to determine critical missing data for CO_2 properties in the subsurface including thermodynamic properties of CO_2 – brine mixtures, reaction rates, relative permeability, etc. In addition, perform laboratory-based experiments to generate that key data.

Accomplishments

- Advanced and extended numerical simulation capabilities in multiple areas: (a) parallel implementation, (b) reactive transport modeling, (c) injection well models, (d) reservoir to surface leakage modeling, (e) hysteresis modeling, (f) reactive-transport code-static geomodel (Earth Vision) integration, and (g) coupled geomechanical modeling.
- Developed a field site for verification/testing of near-surface detection technologies and transport codes
- Developed a modular framework and a computational decision tool, CO_2-PENS, to address the need for assessing performance and MVA aspects of multiple sites.
- Constructed both batch and flow-through reaction vessels for investigation of CO_2 interaction with formation waters, formation minerals, caprock materials, and cements.

Benefits

This research will provide sound scientific and technological input to enable public education, policy development, and regulatory development. Public awareness for geologic CO_2 sequestration can be gained using the results of this project to answer questions concerning monitoring technologies, leakage countermeasures, and risk assessment methods.

Detailed knowledge of CO_2 behavior in sinks, accurate risk assessment, development of sensitive MVA to assess low seepage levels, and development of seepage and leakage mitigation methods are the necessary ingredients to move geologic sequestration from an intriguing prospect to a solid solution that can be implemented with low, understandable risks, and sound policy.

Biofilm technology for mitigation and Lidar technology for monitoring are showing early stage promise for contributing to the overall sequestration effort. Efforts to create realistic geologic data including heterogeneities, when coupled with sophisticated numerical modeling packages can also play an important role in understanding the ultimate fate of injected CO_2. This program assembles a team of universities and DOE national labs that provide a very strong combined expertise in monitoring, mitigation, verification and risk assessment associated with carbon sequestration. Synergistic collaborations are growing out of the funded activities that will likely result in a more comprehensive approach to MVA and modeling issues. Additional support will allow for continued development of technologies and models.