the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Basin-Scale Leakage Risks from Geologic Carbon Sequestration: Impact on Carbon Capture and Storage Energy Market Competitiveness

Description

Through its core research and development program administered by the National Energy Technology Laboratory (NETL), the U.S. Department of Energy (DOE) emphasizes monitoring, verification, and accounting (MVA), as well as computer simulation, of possible carbon dioxide (CO_2) leakage at CO_2 sequestration sites, along with risk assessment of those sites. MVA efforts focus on the development and deployment of technologies that can provide an accurate accounting of stored CO_2, with a high level of confidence that the CO_2 will remain permanently sequestered. Effective application of these MVA technologies will ensure the safety of sequestration projects with respect to both human health and the environment, and provide the basis for establishing carbon credit trading markets for sequestered CO_2. Risk assessment research focuses on identifying and quantifying potential risks to humans and the environment associated with CO_2 sequestration, and helping to ensure that these risks remain low.

This three-year project—performed by Princeton University in partnership with Brookhaven National Laboratory and the University of Minnesota—will develop a framework to examine geologic carbon sequestration (GCS) investment decisions in light of uncertainty in CO_2 leakage risks, potential subsurface liability, and the associated losses in carbon credits. The project team will use this framework to quantify damages that derive from interferences with competing subsurface resources; identify regulatory, and liability management alternatives; and determine the role of geochemical reactions in affecting the probability of CO_2 leakage through alteration of the integrity of caprocks and well cements. The geographic focus of the project will be the states that are part of DOE's Midwest Regional Carbon Sequestration Partnership (MRCSP). The test injection into the Bass Island Dolomite Formation in the Michigan Basin will serve as the specific application site, but a basin-scale approach will be taken to examine impacts on competing subsurface uses.

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COST

Total Project Value
$2,465,728

DOE/Non-DOE Share
$1,965,729 / $499,999

Under likely climate change mitigation regimes, the transition to a sustainable energy future will depend on the successful implementation of carbon capture and GCS. Their widespread adoption will occur only if the technology is economically competitive, politically feasible, and aligned with the DOE performance goal of 99 percent CO_2 storage permanence with a 10 percent or less energy cost premium. The greatest uncertainty for a GCS project lies with the costs and liabilities from imperfect performance, in which some of the CO_2 stored in deep geologic formations leaks out. This leakage translates into the loss of carbon mitigation credit, as well as potential interference with other subsurface resources, such as hydrocarbons or potable water. In order for GCS to be successful, therefore, CO_2 leakage rates must be projected with a high level of certainty, translated directly into costs and liabilities, and evaluated at each site, formation, and basin within the context of the entire energy economy and competing subsurface land uses. These are the challenges that this project is formulated to address.

Primary Project Goal

The overall project goal is to develop capabilities that can link the energy market competitiveness of GCS with the potential liabilities and economic losses from CO_2 leakage. The project team will develop a framework to quantify leakage risk in probabilistic terms, and combine it with a basin-scale model of competing subsurface land uses. Model output will be used to evaluate market competitiveness of alternative GCS options and to assess implications of different regulatory and legal frameworks.

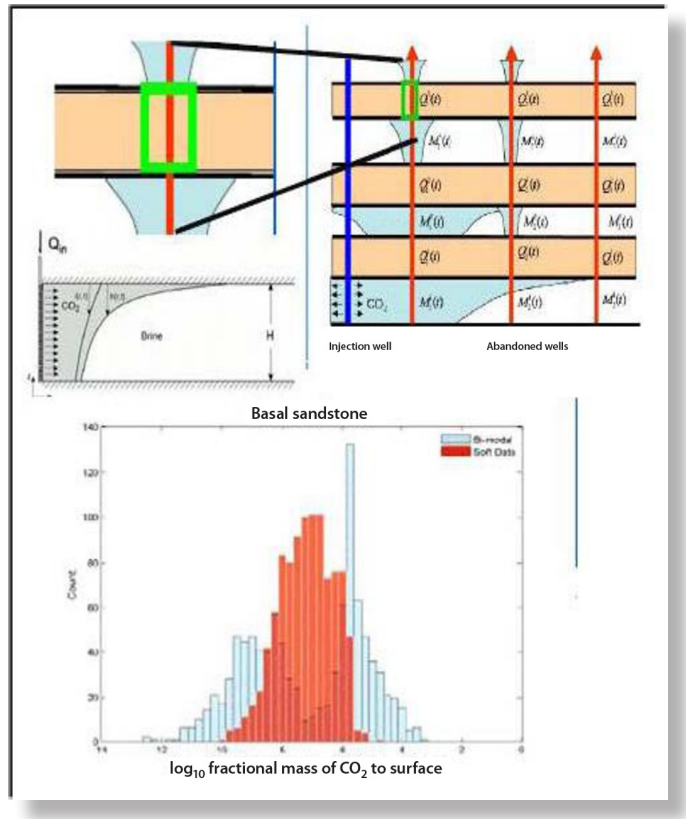
Accomplishments

This project was awarded on September 30, 2009. The project team will accomplish specific objectives for three phases of work. These phases will be performed in parallel and their objectives are as follows:

- Develop a framework to examine GCS investment decisions in light of uncertainty in CO_2 leakage risks, potential subsurface liability, and the associated losses in carbon credits.
- Quantify and bound GCS project risks that derive from damages and interferences with competing subsurface resources, and examine regulatory and liability-management alternatives. Determine the role of geochemical reactions in affecting the probability of CO_2 leakage through alteration of the integrity of caprocks and well cements. What is known (and unknown) about these reactions and their kinetics will be described in a probabilistic manner and translated into uncertainties in CO_2 leakage rates.

Benefits

The expected impact of this work is threefold. First, the project will reduce uncertainties in predictions of CO_2 leakage rates by quantifying the extent to which geochemical reactions can jeopardize the integrity of caprocks and well cements. Second, the project will demonstrate how CO_2 leakage and subsurface liability impact energy market competitiveness of GCS in the Midwest. Third, the project will produce a general framework for analysis of GCS energy marketplace competitiveness nationwide.



Princeton's ELSA modeling approach, showing a semi-analytical solution for injection and leakage plumes, and Darcy flow through leaky wells. Model output is a probability distribution of CO_2 leakage to the surface. Shown here are two different assumed probability distributions of leakage permeabilities.