the ENERGY lab

PROJECT FACTS

Carbon Storage - GSRA

# Monitoring and Numerical Modeling of Shallow $CO_2$ Injection, Greene County, Missouri

## Background

Increased attention is being placed on research into technologies that capture and store carbon dioxide ($CO_2$). Carbon capture and storage (CCS) technologies offer great potential for reducing $CO_2$ emissions and, in turn, mitigating global climate change without adversely influencing energy use or hindering economic growth.

Deploying these technologies in commercial-scale applications requires a significantly expanded workforce trained in various CCS specialties that are currently under-represented in the United States. Education and training activities are needed to develop a future generation of geologists, scientists, and engineers who possess the skills required for implementing and deploying CCS technologies.

The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) has selected 43 projects to receive more than $12.7 million in funding, the majority of which is provided by the American Recovery and Reinvestment Act (ARRA) of 2009, to conduct geologic sequestration training and support fundamental research projects for graduate and undergraduate students throughout the United States. These projects will include such critical topics as simulation and risk assessment; monitoring, verification, and accounting (MVA); geological related analytical tools; methods to interpret geophysical models; well completion and integrity for long-term $CO_2$ storage; and $CO_2$ capture.

## Project Description

NETL is partnering with Missouri State University (MSU) to provide support for graduate students to deploy simulation and modeling software and MVA technologies at the City Utilities geologic carbon sequestration site. Simulation and modeling, as well as MVA technologies, are important tools for implementing large-scale CCS. CCS simulation and risk assessment is used to develop advanced numerical simulation models of the subsurface to forecast $CO_2$ behavior and transport; optimize site operational practices; ensure site safety; and refine site MVA efforts. As simulation models are refined with new data, the uncertainty surrounding the identified risks decreases, thereby providing more accurate risk assessment.

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## PROJECT DURATION

**Start Date**
12/01/2009

**End Date**
09/30/2013

## COST

**Total Project Value**
$293,118 / $0

**DOE/Non-DOE Share**
$293,118 / $0


Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

MSU will calibrate and apply the TOUGH2 simulation package model to the City Utilities $CO_2$ Pilot-scale Injection Test using supporting data (porosity, relative permeability, etc.) from the drilling and testing phase results. TOUGH2 is a general-purpose, numerical simulation program that predicts multi-phase fluid and heat flow in porous and fractured media. MSU will simulate long-term injection to assess sustainable injection rates, pressure increases, potential leakage pathways, plume migration, and dissolution of the $CO_2$ into formation fluids. MVA tools, including tracers, will be selected and deployed at the City Utilities site, and a subsequent long-term monitoring plan and geographic information system (GIS)-based pore-fluid chemistry database will be developed.

The City Utilities CCS project is unique in that the proposed injection is into relatively shallow (< 800 m) strata. At this depth the injected $CO_2$ will be in the gas phase (not in the dense supercritical phase) based on the temperature and low pressure expected at shallow depths, and long-term sequestration will be achieved by hydrodynamic, solubility, and mineral trapping. The project results will determine if shallow CCS is feasible, poses no systematic risk to potable water supplies, and could help establish a rationale for creating additional shallow CCS sites across the country.

Project research will provide further insight and understanding into:

1. Assessing the migration of $CO_2$ in a geologic formation in Missouri.
2. Constructing and updating reservoir modeling based on real project site data.
3. Spatial distribution of certain geochemical information for various geologic formations.

## Goals/Objectives

The overall goal of the project is to provide training to graduate-level students in both critical MVA and simulation and risk assessment technology areas related to geological sequestration of $CO_2$. MVA and simulation tools will be implemented at a real CCS project site. This project has three primary objectives:

1. To train graduate students in the use of multi-phase flow and transport models related to $CO_2$ sequestration.
2. To develop innovative and practical instrumentation/monitoring techniques for detecting leakage (in the rare event that it occurs) from shallow $CO_2$ sequestration reservoirs into overlying aquifers containing calcium bicarbonate-type pore water.
3. To generate a GIS database of the pore-fluid chemistry within and above potential $CO_2$ injection zones in Missouri.

These objectives are crucial to addressing Missouri's geologic situation where nearly all onsite (power plant) $CO_2$ injection schemes would have to utilize shallow (<800 meters below ground surface) geologic strata as reservoirs. Thus, for shallow sequestration projects, effective monitoring is especially important to demonstrate both negligible $CO_2$ leakage and the absence of impacts to water quality in overlying aquifers.

## Benefits

The project will make a vital contribution to the scientific, technical, and institu-tional knowledge necessary to establish frameworks for the development of commercial-scale CCS. The project's proposed simulation and risk assessment model, built from data collected thorough the project's MVA effort, may become an important tool for planning, designing, and managing future CCS projects. The experience gained from this initial shallow CCS project could lead to similar projects throughout Missouri and other states, and open large areas for CCS that previously were considered infeasible. Additionally, the project will offer graduate student research opportunities that will help cultivate a workforce trained in the skills and competencies required to implement CCS technologies on a commercial-scale.