the ENERGY lab

PROJECT FACTS

Carbon Storage – MVA

Surface and Airborne Monitoring Technology for Detecting Geologic Leakage in a CO_2-Enhanced Oil Recovery Pilot, Anadarko Basin, Texas

Background

The goal of the Department of Energy's (DOE) Carbon Storage Program is to develop and advance technologies to significantly improve the effectiveness of geologic carbon storage, reduce implementation costs, and prepare for widespread commercial deployment between 2025 and 2035. Research to develop these technologies will ensure safe and permanent storage of carbon dioxide (CO_2) to reduce greenhouse gas (GHG) emissions without adversely affecting energy use or hindering economic growth.

Geologic carbon storage involves securely and permanently injecting CO_2 into onshore and offshore underground formations. Current research and field studies are focused on developing a better understanding of the science and technologies needed for safe and permanent CO_2 storage in onshore and offshore storage reservoirs, which include: clastic formations, carbonate formations, unmineable coal seams, organic-rich shales, and basalt interflow zones. DOE's Storage Program is accomplishing this through: (1) developing technologies that address technical challenges and ensure the cost effectiveness of carbon storage, (2) validating technologies that ensure safe and permanent carbon storage, and (3) facilitating public, industry, and international community awareness of research and development (R&D) efforts underway related to carbon storage. These technologies will facilitate future CO_2 management for coal-based electric power generating facilities and other industrial CO_2 emitters by enabling the safe, cost-effective, permanent geologic storage and utilization of CO_2 in all storage types.

The Carbon Storage program is comprised of three primary technology areas (1) Core Storage R&D, (2) Storage Infrastructure, and (3) Strategic Program Support. These three areas work together to address significant technical challenges in order to meet program goals that support the scale-up and widespread deployment of carbon capture and storage (CCS). Within these technology areas, emerging technologies are supported through applied laboratory- and pilot-scale research. In addition, promising technology options are being validated through small- and large-scale field projects. This approach allows technologies to develop from concept through validation in the field and increases the Nation's confidence in future safe, effective, and permanent geologic CO_2 storage. The Core Storage R&D technology area is sub-divided into three research areas: (1) Geologic Storage Technologies and Simulation and Risk Assessment (GSRA); (2) Monitoring, Verification, Accounting (MVA), and Assessment; and (3) Carbon Use and Reuse. This project is part of the MVA research area, which is designed to confirm permanent onshore and offshore

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PARTNERS

None

PROJECT DURATION

Start Date	**End Date**
10/01/2013	09/30/2016

COST

Total Project Value

$2,257,965

DOE/Non-DOE Share

$1,806,116 / $451,849

AWARD NUMBER

DE-FE0012173

U.S. DEPARTMENT OF ENERGY

CO_2 storage in geologic formations through monitoring capabilities that are reliable and cost effective. Monitoring is an important aspect of CO_2 injection, because it focuses on a number of permanence issues. Monitoring technologies are being developed for atmospheric, near-surface, and onshore and offshore subsurface applications to ensure that injection, abandoned, and monitoring wells are structurally sound and that CO_2 will remain within the storage complex. This project through Oklahoma State University is developing an integrated monitoring system capable of directly detecting and quantifying CO_2 and methane (CH_4) seepage into the soil and atmosphere.

Project Description

Oklahoma State University, in partnership with the Southwest Regional Carbon Sequestration Partnership (SWP), is developing and implementing new near-surface and airborne monitoring technologies that employ infrared gas analyzers. The proposed research program is focused on the design and deployment of a grid of shallow near-surface and surface sensors (Figure 1) in combination with low-altitude automated airborne (an unmanned aerial vehicle, or UAV) detection of CO_2 and CH_4. These technologies are being tested at the Farnsworth Oil Unit in the Anadarko Basin of the northeastern Texas panhandle, where the SWP and Chaparral Energy, LLC, are conducting a CO_2-enhanced oil recovery field project.

Figure 1. The sensor board selected (capable for use in detecting both CH_4 and CO_2) and the ruggedized case to be mounted as part of the UAV platform.

The study employs a range of techniques to (1) characterize and classify potential leakage pathways, (2) determine gas flux within and atop the soil profile, (3) apply low-altitude detection technology, and (4) analyze the results. The primary focus of this research is to develop and optimize an integrated monitoring system capable of directly detecting and quantifying CO_2 and CH_4 seepage into the soil zone and the atmosphere. The sensor networks approach used in this study will facilitate the identification of potential leakage pathways at future storage sites. The sensor network is being designed to reduce the labor and maintenance demands of the gas monitoring systems currently in use, which could help reduce overall storage project costs. In addition, the sensor network will provide critical information on the movement of gases within the soil and into the atmosphere, which provides the data required to calibrate and validate the airborne sensing systems (Figure 2). The need for calibration and validation necessitates an analytical approach combining surface and airborne technology. The research team intends to use this approach as a bridge to fully automated airborne monitoring systems capable of directly detecting CO_2 concentration, rapid deployment, and yielding reliable results without the aid of near-surface sensor networks.

Objectives

The objective of this research is to develop a multi-faceted approach to directly detect and monitor CO_2 and CH_4 leakage. This approach allows for integration and optimization of both ground-based and airborne sampling using in-ground and surface sensors along with a UAV platform to collect data from an active CO_2 injection site. Specific project objectives are to:

- Evaluate low-cost sensors for CO_2 sensing.
- Use these sensors to develop ground- and airborne-based sensor platforms that minimize the labor cost associated with long-term monitoring.
- Collect data from an active injection site for a period of at least one year.
- Develop monitoring strategies that minimize the need for ground-based monitoring while preserving the quality of the monitoring effort.

Figure 2. Possible UAV platforms that could be used as part of this study

Accomplishments

- The basic geologic framework of the Farnsworth Unit has been characterized. Fracture networks in the shallow subsurface are being analyzed. The orientation of joints and fractures at surface outcrops and in the shallow subsurface provide important data for potential CO_2 migration pathways to the atmosphere.
- The UAV platform (Skywalker X8) and airborne gas sensors (Sensair K-30FR) have both been selected for atmospheric monitoring operations. The final platform is currently being calibrated and fit for use in at the Farnsworth Unit.
- Methods for collecting and managing data from the UAV platform are being investigated. Initial data testing demonstrates a need for Gaussian processing to model correlated data as distributions over a function. This helps to minimize error in network communications and data interpretation.

Benefits

The project is making a vital contribution to the scientific, technical, and institutional knowledge base needed to establish frameworks for the development of commercial-scale carbon capture and storage. Additionally, this project will help ensure storage permanence by developing technologies and methodologies to quantify gas seepage from the ground surface and distinguish natural and man-made seeps. Storage security begins with understanding the types of leakage pathways that pose the greatest risk, and this study will employ an integrated geologic approach for recognizing, classifying, and predicting leakage pathways and seepage locations. The proposed research sets the stage for major advances in the application of near-surface sensor systems and low-altitude UAV monitoring technology.