the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Development of a 1 x N Fiber Optic Sensor Array for Carbon Sequestration Monitoring

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 Montana State University (MSU) to develop a low-cost, reconfigurable 1 x N fiber optic sensor array for subsurface, large area monitoring of carbon sequestration sites. This type of technology can be used to assess soil gas CO_2 fluxes over a large area. MSU will first focus on developing a single channel fiber optic sensor and a fiber probe. The fiber sensor probe is the portion of the detector system that will be placed underground allowing the photonic bandgap (PBG) fiber to be used for subsurface CO_2 measurements. PBG fibers are dielectric fibers that prevent propagation of electromagnetic waves in certain frequency ranges. The transmitter detector components include a laser, a reference photo-detector, and a fiber circulator. MSU will develop software to operate the single channel fiber

CONTACTS

Sean Plasynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4867
sean.plasynski@netl.doe.gov

Brian Dressel
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-7313
brian.dressel@netl.doe.gov

Kevin Repasky
Principal Investigator
Montana State University
P.O. Box 173515
Bozeman, MT 59717
406-994-6082
repasky@ece.montana.edu

PROJECT DURATION

Start Date

12/01/2009

End Date

11/30/2012

COST

Total Project Value

$299,204

DOE/Non-DOE Share

$299,204 / $0

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

sensor that will control the operating wavelength of the laser and record the laser temperature, reference detector voltage, and transmission detector voltage. The CO_2 concentration will be measured based on the amount of light absorption between the transmitter and receiver array. MSU will perform laboratory testing to demonstrate that the single channel fiber optic sensor can monitor elevated CO_2 concentration successfully in a controlled setting.

The initial single channel fiber optic sensor and fiber probe will be refined and a 1 x 4 fiber sensor array developed (Figure 1). MSU will apply the experience gained from designing the initial fiber sensor array to develop a second generation fiber sensor probe design. The 1 x 4 fiber sensor array will incorporate all the necessary optical components, including a 1 x 4 fiber optic switch, and custom software to operate the array. Once the sensor detector array and four sensor detectors are operational, MSU will develop a response curve that shows the transmission as a function of concentration for known CO_2 concentrations. The measured response curve will be compared to a published theoretical response curve to confirm the operation of the fiber sensor array. The 1 x 4 fiber optic sensor array will be field tested at the MSU Zero Emissions Research Technology (ZERT) field site which was developed for providing controlled underground CO_2 releases (Figure 2).

Goals/Objectives

The objective of the project is to develop a low cost 1 x 4 fiber optic sensor array for sub-surface CO_2 detection. The proposed sensor array will be economical, scalable (up to N fiber probes using one laser and two detectors), easily deployable, and reconfigurable for use in CO_2 soil gas detection over large surface areas in a real time application. Additionally, university students will have hands on training in the development and deployment of a fiber sensor array for carbon sequestration monitoring.

Benefits

Overall, the project will make a vital contribution to the scientific, technical, and institutional knowledge base needed to establish frameworks for the development of commercial-scale CCS. The project will lead to the development of a sensor that can be used to monitor carbon sequestration sites for high CO_2 fluxes (often a signal that CO_2 may be leaking from the injection reservoir) in real-time over a large area. A CO_2 sensor capable of this application can contribute to ensuring the integrity of the storage site and preserving public safety by detecting and determining the location of high concentrations of CO_2.

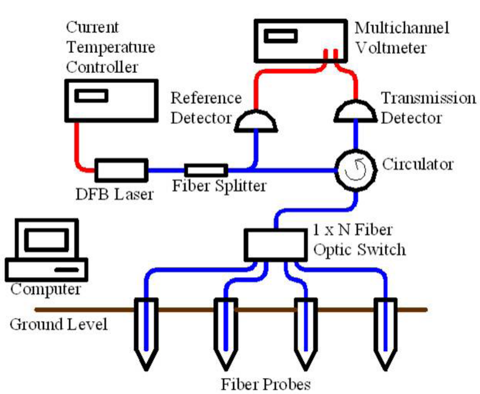

Figure 1. Schematic of the proposed 1 X 4 fiber sensor array.

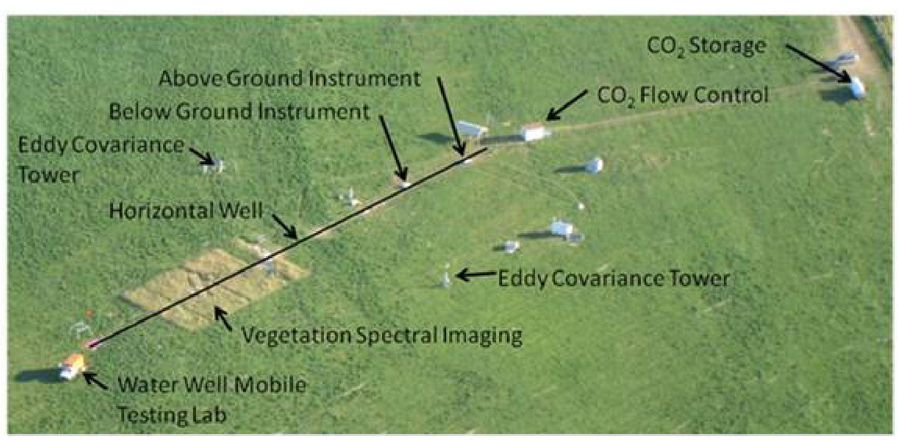

Figure 2. Zero Emissions Research Technology (ZERT) field site which provides controlled underground CO_2 releases.