R & D facts

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NETL Carbon Management Research Program

The National Energy Technology Laboratory (NETL) is leading and conducting research that addresses the President's Global Climate Change Initiative by pursuing novel approaches to monitor, capture, and permanently store carbon dioxide (CO_2). Increased levels of CO_2 in the atmosphere are linked to climate change. Researchers agree that fossil-fueled power generation plants contribute about one-third of the CO_2 emissions from all fossil fuel sources. Therefore, the primary target for CO_2 capture and storage is from large stationary sources that are dominated by coal-powered electric generation plants.

Innovations in carbon capture and storage technologies will allow continued use of our abundant domestic coal resources — a 250-year supply at current production rates. To this end, NETL is involved in initiatives at the regional, national, and international levels to improve available technologies for addressing climate change — slowing the growth in greenhouse gas emissions, while ensuring availability of plentiful energy essential to our Nation's economic vitality.

NETL's Carbon Management Research Program conducts research and analysis to develop energy-efficient and cost-effective methods to manage CO_2 emissions from fossil fuel energy production. This work is: (1) expanding the options to help meet near-term goals for reducing greenhouse gas intensity; (2) ensuring the readiness of future technologies (to meet the 2012 reassessment required by the Global Climate Change Initiative); and (3) making the longer-term goal of greenhouse gas emission stabilization more achievable. NETL's Office of Research and Development has established "Centers" to conduct research in three key areas: carbon capture, permanent storage, and assessment of risk associated with permanent storage.

Center for Carbon Capture

NETL's Center for Carbon Capture develops and evaluates breakthrough approaches that will significantly reduce the complexity and energy intensity of CO_2 capture. Research focuses on revolutionary approaches to energy production that use systems to remove CO_2 during energy production, rather than scrubbing it from a by-product stream. For example, NETL is developing membranes to separate CO_2 from combustion gases. Once separated, the CO_2 is easily captured and can be sequestered. Another example is oxy-fuel firing, whereby CO_2 can be easily separated from the exhaust gases by simply condensing out the water.

NETL researchers will use a combination of laboratory studies and numeric models to evaluate novel approaches to carbon capture. Utilizing their expertise in modeling and simulation, NETL researchers will extrapolate laboratory findings to projected applications (e.g., a virtual demonstration) before considering large-scale testing. NETL collaborations with technology developers are likely to foster larger scale applications of carbon capture technologies.

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Center for Permanent Storage

A chemist at NETL uses infrared spectroscopy to investigate the mechanism by which carbon dioxide will be stored in coal seams, and the storage capacity of the coal seams.

Another major carbon management issue is identifying adequate storage sites (or "sinks") for the CO_2 — places where CO_2 can be stored for several hundred or even thousands of years. The storage must have low environmental impact and low cost, and conform to national and international laws. Primary underground storage options include depleted oil and gas reservoirs, deep saline formations, and unminable coal seams. Experts in NETL's Center for Permanent Storage have been working closely with the Carbon Sequestration Regional Partnerships, providing technical assistance and guidance in selecting sites and answering key site-specific questions related to storage capacity. A suite of modeling techniques is being developed to quantify CO_2 flows near the surface, through intermediate strata, and in deep subsurface sinks. The Center also is developing techniques and computer models that will be used by the Regional Partnership participants to verify long-term storage acceptability of geologic formations that are representative of potential storage options in many other locations. Based on recent assessments, the United States has an estimated 230 candidate geologic storage sites.

The Center is developing several types of verification techniques, including soil CO_2 flux measurements, groundwater sampling and analysis, aeromagnetic flyover surveys for existing and abandoned wells, characterization of surface fault exposures, core flow analysis using specialized equipment at NETL, CT-scanning of cores to assess fractures and rate of diffusion of CO_2 into the strata, and adsorption isotherm studies of relevant strata.

An NETL engineer extracts a core sample from Pittsburgh #8 coal. The sample will be tested within NETL's Geological Sequestration Core Flow Laboratory. The research provides information on the parameters of permeability (flow) and storage capabilities of coal and reservoir rock (i.e., sandstone) under actual pressure and temperature conditions (for example, at a depth of 1500 feet) when injecting carbon dioxide for potential sequestration efforts.

The models being developed and refined include:

- Near-surface modeling of CO_2 flow to aid in design and interpretation of monitoring networks, in conjunction with statistical techniques;
- Modeling of flow through actual fractures to better understand flow phenomena;
- Development of unique fracture generation and flow simulation software to model flow through intermediate strata; and
- Simulation of migration through the target formation.

Center for Risk Assessment

The NETL Center for Risk Assessment is developing a plan to identify risks associated with the permanent sequestration of CO_2. Using the features, events, processes, and models that have been developed for risk assessments elsewhere as a basis, one key component of the Center's risk assessment activity will be to identify the risks associated with a "sample" field project being undertaken by one of the Regional Partnerships. This approach will tie modeling and monitoring techniques to the risk assessment model, in order to identify potential events, and probabilities of events, that affect CO_2 storage. Development of a carbon storage risk assessment capability will provide a very useful tool that will be used to support the performance of environmental assessments and impact studies of carbon capture and long-term storage options. Results of risk assessments also could be used to inform the public about the safety of carbon sequestration.