

Project: Center for Zero Emissions Research & Technology

Brief Description: \$10 million is requested to further develop the virtual research center for Zero Emissions Research & Technology involving national labs (Pacific Northwest National Laboratory (PNNL), Los Alamos National Laboratory (LANL), the National Energy Technology Laboratory (NETL) Lawrence Livermore National Lab (LLNL) and Lawrence Berkeley National Lab (LBNL)) and two research universities (Montana State University (MSU) and West Virginia University (WVU)) in heavy coal producing states to monitor and validate deep geological carbon dioxide sequestration and clean power and hydrogen generation from coal.

Executive Summary: More than half of the anthropogenic carbon dioxide emissions worldwide are due to transportation energy and electrical power generation. New technologies hold great promise to significantly reduce these emissions from fossil fuels, but the engineering, economic, and environmental viability of these zero emission fossil energy technologies must be validated. *For this reason, the Center for Zero Emissions Research and Technology (ZERT), an independent DOE sponsored research center focused on the advanced research aspects of geologic sequestration has been established.* This virtual center encompasses multiple DOE national laboratories and two research universities located in large coal producing states (one eastern and one western). ZERT is playing a critical role in basic research and engineering in support of the Carbon Sequestration Regional Partnerships and the overall carbon sequestration program..

Project Description: There are multiple issues that need to be addressed concerning geologic sequestration: Investigation of various geologies and CO₂ behavior in those formations; reservoir modeling including potential pathways to the biosphere; geosciences studies including in situ mineralization, caprock stability, fundamental chemistry and hydrodynamic properties of supercritical CO₂-brine mixtures; development of monitoring technologies (for decades of storage, annual leakage rates must be sub 1% requiring ultra-trace detectors for CO₂); leakage countermeasures; risk assessment methods; integrated monitoring, measurement, and verification systems.

Of critical importance is the integration of computer modeling and the monitoring, measurement and verification efforts to address sequestration questions such as: What is the impact of de-pressurization (e.g., during oil or gas production) and/or pressurization (during CO₂ emplacement) on reservoir integrity? Will a CO₂ plume interact with the natural seals differently from oil, gas, or water? How can potential failure points (e.g., abandoned wells, clay-filled fractures) be identified and assessed prior to emplacement? What are the potential subsurface environmental impacts on overlying aquifers at a specific site over years, decades, or centuries?

ZERT is improving computer simulation codes to address CO₂ specific behavior, developing frameworks for assessing risk, validating existing monitoring techniques as well as developing new ones, measuring fundamental physical and chemical properties of CO₂ under subsurface conditions to improve understanding of its behavior in geologic formations, and developing mitigation technologies and strategies. ZERT is making information and tools available to the Regional Partnerships and sequestration community.

Congressional Action Needed: Funding of \$10 million dollars in FY10 is requested.

Importance to the Nation: The heavy U.S. reliance on foreign energy sources is an obvious national security issue. U.S. coal reserves are projected to be capable of providing more than 200 years of the nation's energy needs, but current technologies would result in this being a polluting and greenhouse gas producing energy source. The Center for Zero Emissions Research and Technology would help develop and validate zero emission technologies for energy production from fossil fuels. This would provide an economic benefit in coal and power producing states as well as the national security benefit.

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Center for Zero Emissions Research (ZERT) – Talking Points

The Center for Zero Emission Research and Technology has the capabilities and expertise to perform basic science and engineering investigations to assist the Carbon Capture and Storage program. Contributions to date include the following.

- Two major simulation codes (TOUGH and STOMP) have been modified to address issues relevant to CO₂ behavior in geologic formations. Modifications include: reactive transport modeling; inclusion of hysteretic effects; and coupled geomechanical modeling.
- Code improvements have been used by at least three of the Regional Partnerships and for the FutureGen project.
- LANL through the ZERT program has developed a modular framework and a computational decision tool, CO₂-PENS to address the need for assessing performance and measurement, monitoring and verification aspects of multiple sites. CO₂-PENS is the first-ever performance and decision analysis tool specifically developed for CO₂ sequestration.
- We have constructed both batch and flow-through reaction vessels for investigation of CO₂ interaction with formation waters, formation minerals, caprock materials, and cements. Reaction rates and thermodynamic properties are being measured and this information is being provided for parameterization of codes.
- We are performing experiments investigating the ability of microbes to form biofilm or mineral (via bio-mineralization) barriers in cores with the goal of using this as a leakage mitigation method. Results indicate biofilms can be formed at sequestration relevant temperatures and pressures, that they dramatically reduce permeability, and they can survive (at least short term) challenges by supercritical CO₂.
- We have developed a field site to test near-surface CO₂ detection methods to determine detection limits and efficacy. This site also improves our understanding of CO₂ transport in the near surface region and allows for validation of computer simulations. This effort has gained international attention.
- Australia and Brazil have consulted with us concerning development of additional test sites. Should these sites proceed, agreements are in place to share data and site access.
- Because of ZERT activities, MSU is a collaborator on proposals pending from University of Stuttgart, Princeton, Texas Bureau of Economic Geology, the US Geologic Survey, and the Pontifical Catholic University of Brazil.