the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Midwest Regional Carbon Sequestration Partnership—Validation Phase

Background

The U.S. Department of Energy (DOE) has selected seven partnerships, through its Regional Carbon Sequestration Partnership (RCSP) initiative, to determine the best approaches for capturing and permanently storing carbon dioxide (CO_2), a greenhouse gas (GHG) which can contribute to global climate change. The RCSPs are made up of state and local agencies, coal companies, oil and gas companies, electric utilities, universities, private companies, and nonprofit organizations that form the core of a nationwide network helping to establish the most suitable technologies, regulations, and infrastructure needs for carbon sequestration. The partnerships include more than 350 organizations, spanning 43 states and four Canadian provinces. The RCSPs are developing the framework needed to validate and deploy carbon sequestration technologies. The RCSPs will determine which of the numerous sequestration approaches are best suited for their specific regions of the country and identify regulatory and infrastructure requirements that will be needed should policy and economics indicate that sequestration be deployed on a wide scale. The RCSP initiative is being implemented in three phases. The Characterization Phase began in September 2003 with the seven partnerships working to develop the necessary framework and identify potential sites to test sequestration. The Validation Phase of the RCSP effort (2005–2010) is focused on evaluating promising CO_2 sequestration opportunities through a series of field tests in the seven partnership regions. Finally, the Development Phase (2008–2017) will continue the validation process to determine that CO_2 capture, transportation, injection, and storage can be achieved safely, permanently, and economically at a large scale. These tests will promote understanding of injectivity, capacity, and storability of CO_2 in the various geologic formations identified by the partnerships. Results and assessments from these efforts will assist commercialization efforts for future sequestration projects in North America.

Description

The Midwest Regional Carbon Sequestration Partnership (MRCSP) has been established to assess the technical potential, economic viability, and public acceptability of carbon sequestration within a region consisting of nine contiguous states: Indiana, Kentucky, Maryland, Michigan, New Jersey, New York, Ohio, Pennsylvania, and West Virginia. A group of leading universities, state geological surveys, non-governmental organizations and private companies, led by Battelle Memorial Institute, has been assembled to carry out this research. The MRCSP's Validation Phase will take the large theoretical sequestration potential identified in the MRCSP's Characterization Phase and show how the region's large, well-distributed,

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Dominion Energy
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Duke Energy
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Indiana Consumer Counsel
Kentucky Geological Survey
Maryland Geological Survey
National Rural Electric Cooperative Association
New Jersey Department of Environmental Protection
New York State Energy Research and Development Authority
New York State Museum Institute
Ohio Coal Development Office within the Ohio Air Quality Development Authority
Ohio Consumers' Counsel
Ohio Corn Marketing Program
Ohio Division of Geological Survey
Ohio Environmental Council
Ohio Soybean Growers
Ohio State University
Pennsylvania Geological Survey
Praxair
Rutgers University
RWE
Schlumberger
Stanford University
The Keystone Center
University of Maryland
West Virginia Geological Survey
West Virginia University
Western Michigan University

COST

Total Project Value
$27,490,564

DOE/Non-DOE Share
$20,993,599 / $6,496,965

and competitively-priced sequestration potential can be used to simultaneously advance economic growth and environmental protection. Specifically, the MRCSP will conduct small-scale CO_2 injection field tests in the region's deep geologic formations to demonstrate the safety and effectiveness of geologic sequestration systems. The MRCSP also will conduct terrestrial sequestration field validation tests to show how naturally stored carbon can be measured and monitored and how carbon credits could be traded in voluntary GHG markets.

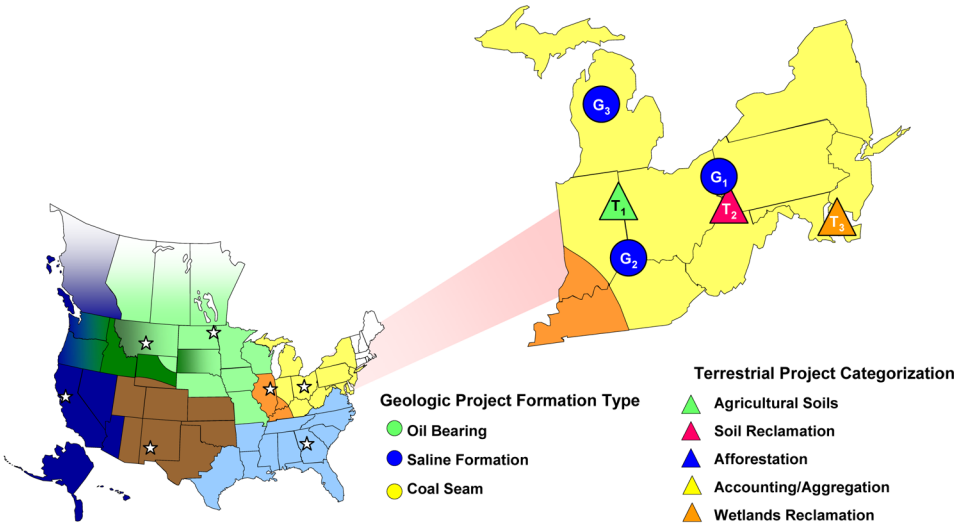
Primary Project Goal

The primary goal of the MRCSP's Validation Phase efforts is to identify the technical, economic, and social considerations associated with geologic and terrestrial CO_2 sequestration and create viable pathways for its deployment.

Objectives

- Identify, characterize, and map GHG sources and assess the viability and cost of capturing and sequestering emissions.
- Characterize and map the region's geological and terrestrial reservoirs and estimate their CO_2 storage potential.
- Engage public and elected officials at all levels in dialogue on issues affecting implementation of sequestration and the potential value associated with geologic and terrestrial sequestration.
- Validate the potential for implementation of geological sequestration in the region by conducting small-scale CO_2 injection field tests into selected deep geologic reservoirs to demonstrate the safety and effectiveness of geologic sequestration systems.
- Validate the potential for terrestrial sequestration in the region by conducting small-scale terrestrial field tests to demonstrate enhanced carbon uptake and validate measurement techniques used to quantify terrestrial carbon storage.
- Link options for capture, transportation, and geological storage within the environmental and regulatory framework.

Field Projects



Midwest Regional Carbon Sequestration Partnership Validation Phase Field Tests

Geologic Sequestration Opportunities

MRCSP's research estimated more than 229 billion tons (208 billion metric tons) total of potential CO_2 storage capacity in the region's oil and gas fields, unmineable coal seams, and saline formations, which could accommodate hundreds of years' worth of current CO_2 emissions from the region's large point sources, such as power plants, cement plants, ethanol plants and refineries. The MRCSP's research also estimated at least 9.3 billion tons (8.4 billion metric tons) of potential storage capacity in existing depleted oil and natural gas fields (which could lead to hundreds of millions of barrels of additional oil production), 1.1 billion tons (one billion metric tons) of potential unmineable coal bed storage, and 218 billion tons (199 billion metric tons) of storage potential in saline formations. The MRCSP is currently pursuing three small-scale geologic sequestration projects, which are summarized below as part of its Validation Phase project.

Appalachian Basin Geologic Test (G1)

This test provided an opportunity to evaluate the feasibility of injecting CO_2 into three different deep rock formations at depths between 5,900 and 8,300 feet. These formations, the Oriskany, Salina, and Clinton/Medina, are representative of formations that are pervasive cross the Appalachian Valley. The test was conducted at FirstEnergy's R.E. Burger Power Plant near Shadyside, Ohio, which is also host to a separate test of the Powerspan CO_2 capture process called ECO2. Initially, the concept was to test an integrated CO_2 capture, handling, and injection system by integrating the CO_2 injection test with the Powerspan test. Schedules of the two projects did not allow that to happen, resulting in the injection test being conducted with commercial CO_2.

Accomplishment Highlights:

- Regional geologic assessment and site characterization was completed and a test well was drilled to just over 8,300 feet in depth.
- CO_2 injection tests in the Oriskany Sandstone, the Salina Carbonate, and the Clinton/Medina Sandstone were completed in fall 2008, utilizing a commercial source of CO_2 for the tests and regulated with a temporary injection system.
- Significant outreach was conducted and assistance to Annenberg Media in developing an educational video of the drilling program as part of their teacher education program on energy.

Cincinnati Arch Geologic Test (G2)

This saline formation test aims to demonstrate carbon sequestration in the Mt. Simon sandstone formation, a major CO_2 sequestration target in the MRCSP region. Results of the injection testing and monitoring at this site, located on Duke Energy's East Bend Power Plant (located near Rabbit Hash, Kentucky), could be applied to similar power plants in this region. This project will inject approximately 1,000 metric tons of CO_2 at depths between 3,200 and 3,600 feet. The source of CO_2 will be a commercial supplier, and the CO_2 will be delivered to the site via tanker truck.

Accomplishment Highlights:

- Site preparation activities were completed in 2006, which included a site geologic survey, identification of the test well location, and a 2-D seismic survey. A preliminary geologic assessment was completed by the Indiana and Kentucky Geological Surveys.
- The Underground Injection Control (UIC) permitting process was completed in the spring of 2009 with receipt of a UIC injection permit from U.S. EPA Region 4.
- Outreach activities included fact sheet preparation, an open house for plant neighbors, and in-person and email briefings to local area officials.

Duke Energy's East Bend Facility

FirstEnergy's R.E. Burger Plant

Michigan Basin Geologic Test (G3)

This test involves total injection of approximately 66,000 tons (60,000 metric tons) of CO_2 into a saline formation between depths of 3,400 to 3,500 feet. The test location is the Charlton 30/31 field in Otsego County, Michigan, site of an enhanced oil recovery (EOR) operation managed by MRCSP partner, Core Energy. The site, located in the northern part of the Michigan Basin, is in the vicinity of a natural gas processing plant (operated by MRCSP partner DTE Energy) which currently provides CO_2 for both the test and ongoing EOR operations. Captured CO_2 from the nearby gas processing plant and existing EOR operations provide available infrastructure for testing CO_2 sequestration in adjacent saline formations. The target saline formation is the Bass Islands Dolomite. Site geology is well-characterized due to oil and natural gas exploration in the area with many available well logs.

Injection well at Michigan site

Accomplishment Highlights:

- Initial injection of approximately 11,000 tons (10,000 metric tons) of CO_2 was completed in March 2008.
- Completed post-injection monitoring, including a combination of cross-well seismic, hydraulic monitoring, PFT tracers, microseismic array, and wireline logging.
- An additional 55,000 tons (50,000 metric tons) of CO_2 is currently being injected and should be completed by summer.
- Outreach efforts have included informational materials, public meetings with regular follow-ups to local stakeholders and ongoing briefings to key officials and community opinion leaders.

Terrestrial Sequestration Opportunities

Terrestrial sequestration research is focused on five land use categories: 1) non-eroded prime croplands; 2) eroded prime croplands; 3) marginal lands such as forest, pasture, and severely eroded croplands; 4) minelands; and 5) wetlands. The region's total terrestrial sequestration potential for these five land use classes is estimated to be 155 million tons of CO_2 (141 million metric tons CO_2) per year, the majority of which would come from conversion of marginal lands of forest (109 million tons CO_2/year [99 million metric tons CO_2/year]), followed by wetlands (15 million tons CO_2/year [14 million metric tons CO_2/year]), non-eroded croplands (15 million tons CO_2/year [14 million metric tons CO_2/year]), eroded croplands (12 million tons CO_2/year [11 million metric tons CO_2/year]), and mineland restoration (6.6 million tons CO_2/year [6 million metric tons CO_2/year]). Ancillary, non-climate benefits associated with terrestrial sequestration within the MRCSP region include improved soil quality, reduced erosion and sedimentation, bio-filtration of pollutants, and decreased rates of CO_2 emissions. Adoption of recommended management practices may enhance crop yield in some soils, decrease the magnitude of soil erosion and non-point source pollution, and reduce the transport of pesticides and heavy metal runoff.

Terrestrial Sequestration Field Test: Croplands (T1)

This field test will employ monitoring, verification, and accounting (MVA) protocols, and technologies of thirteen cropland plots over the MRCSP region, primarily in the states of Ohio, Indiana, and Michigan. Soil sample analyses will be used to determine the actual rate of sequestration and potential for the region's farmlands to adopt "no-till" or reduced-tillage practices to increase the amount of carbon stored in agricultural soils. The potential benefit over a 20-year period could result in an estimated 275 million tons (250 million metric tons) of additional CO_2 sequestered. The stored carbon may be sold as CO_2 offset credits.

Terrestrial Sequestration Field Test: Minelands (T2)

Soil samples from five mined sites reclaimed to grass and legumes in Monongalia County, West Virginia were collected and analyzed to assess soil carbon accumulation. The Waynesburg coal seams for all five mine sites were contour mined beginning as early as 1982 and as late as 2007 using front end loaders. Overburden material placed on the disturbed land consisted of 70 to 80 percent sandstone, with shale making up the remaining 20 to 30 percent of material. Mining operations ceased at different times for each of the sites (1990, 1998, 2000, 2005, and 2007), which allowed comparison across reclaimed mine sites over time. Soil sample collection began in 2006 and has continued annually to assess the change in soil carbon accumulation over time. The project is also performing economic analyses to assess the trade-offs between existing land management activities and those that enhance carbon sequestration. The analysis involves estimating the difference in soil carbon accumulation rates in soils on sites reclaimed to grass/legumes and forest, which capture carbon in aboveground (biomass) and belowground (soil) systems.

Terrestrial Field Test: Wetland- Blackwater Wildlife Refuge (T3)

This test, with major funding from the Maryland Department of Natural Resources Power Plant Siting Project, will monitor the carbon sequestration rates in tidal marshes at the Blackwater National Wildlife Refuge near Cambridge, Maryland, where lost tidal marsh is being restored using clean dredged material. Results will be used to estimate carbon sequestration rates in restored marshes over time, evaluate the extent to which various management practices influence this process, and develop a sampling protocol for CO_2 validation in restored marshes.

Benefits

The Validation Phase has provided the first steps toward demonstrating cost-effective ways to reduce CO_2 emissions in Midwest region, and results are providing the knowledge base for stakeholders to develop robust carbon mitigation strategies. The experience gained with three different UIC permitting groups—EPA Region 5, EPA Region 4, and Ohio EPA—has proven valuable in developing relationships and processes for future permitting. Lessons learned from outreach activities during the pilot tests will be very beneficial as MRCSP proceeds into the Development Phase of the program.