PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Carbon Sequestration

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# MIDWEST GEOLOGICAL SEQUESTRATION CONSORTIUM —DEPLOYMENT PHASE

## CONTACTS


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## Background

As part of a comprehensive effort to assess options for sustainable energy systems, the U.S. Department of Energy has selected seven Regional Partnerships, through its Regional Carbon Sequestration Partnership (RCSP) Program, to determine the best approaches for capturing and permanently storing carbon dioxide ($CO_2$), a greenhouse gas which can contribute to global climate change. The RCSPs are made up of state agencies, universities, private companies, national laboratories, 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. Altogether, the Partnerships include more than 350 organizations, spanning 41 states, and four Canadian provinces.

The Regional Partnerships' initiative is being implemented in three phases. The Characterization Phase began in September 2003 with the seven Partnerships working to develop the necessary framework to validate and potentially deploy carbon sequestration technologies. In June 2005, work transitioned to the Validation Phase, a four-year effort focused on validating promising $CO_2$ sequestration opportunities through a series of field tests in the seven regions. Presently, activities in the Deployment Phase (2008-2017) are proceeding as an extension of the work completed to date and will demonstrate 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 help in the commercialization efforts for future sequestration projects in North America.

The Midwest Geological Sequestration Consortium (MGSC) is led by the Illinois, Indiana, and Kentucky State Geological Surveys and covers the entire state of Illinois, southwest Indiana, and western Kentucky. This Partnership was established to assess carbon capture, transportation, and geologic carbon sequestration options in unminable coal seams, mature oil fields, and deep saline formations in the Illinois Basin. Regional point source emissions in the MGSC area account for over 304 million tonnes (336 million U.S. tons) of $CO_2$ per year (Li, et al., 1997), or about 9% of the total point source $CO_2$ emissions in the United States. MGSC's regional geology offers an optimal environment to safely and permanently store these emissions.

## PARTNERS

Ameren Corporation

American Air Liquide

Archer Daniels Midland Company

Aventine Renewable Energy

British Petroleum

Brigham Young University

Drummond Company

Edison Mission Group

Electric Power Research Institute (EPRI)

Environmental Defense

Illinois Corn Growers Association

Illinois Department of Commerce & Economic Opportunity, Office of Coal Development

Illinois Department of Natural Resources, Office of Scientific Research and Analysis

Illinois Oil and Gas Association

Illinois State Geological Survey

Indiana Gasification, LLC

Indiana Geological Survey, Indiana University

Indiana Oil & Gas Association

Interstate Oil and Gas Compact Commission (IOGCC)

Kentucky Geological Survey, University of Kentucky

Kentucky Oil & Gas Association

Lincolnland Agri-Energy, LLC

Louisville Gas and Electric Energy

Natural Resources Defense Council

Peabody Energy

Power Holdings, LLC

Schlumberger

Southern Illinois University

The Cline Group

# Description

### Project Summary

MGSC will partner with the Archer Daniels Midland (ADM) Company, an agricultural products processing company, to conduct a large volume saline sequestration test at ADM's ethanol by fermentation facility located in Decatur, Illinois. The test will involve the injection of 333,000 tonnes (367,000 U.S. tons) of $CO_2$ per year from the fermentation plant for three years into the Mount Simon Sandstone, a major regional saline formation in the Illinois Basin.

### Injection Site Description

The site is on the property of ADM's ethanol by fermentation operation in Decatur, Illinois (Figure 1). The site occupies about 207 acres and is wholly owned by ADM. A $CO_2$ dehydration/compression facility will be developed near the north boundary of the ADM facility. From there, the $CO_2$ will be moved approximately 3,200 feet through a 4-inch to 6-inch pipe to the injection well location. The site is a preexisting industrial complex with no significant physical impediments to access.

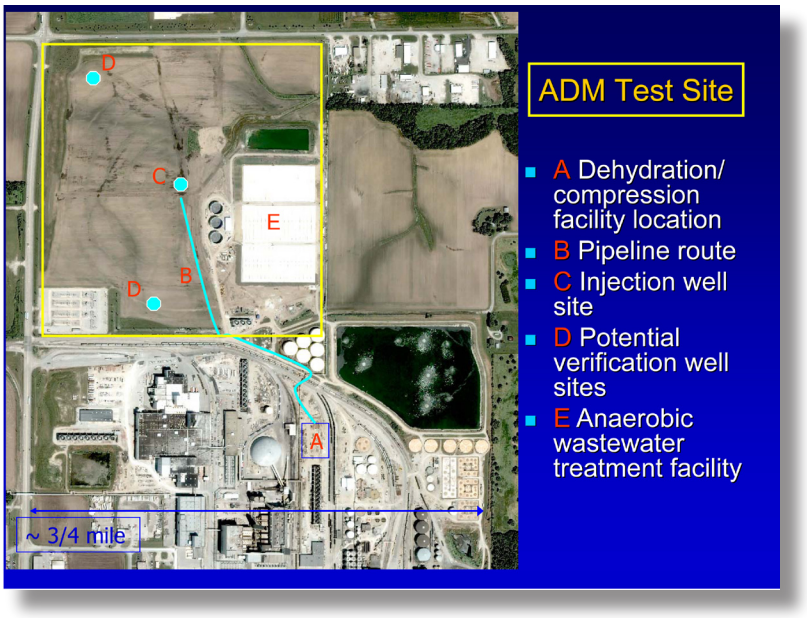


*Figure 1. Aerial photo of ADM Test Site in Decatur, Illinois*

### Description of Geology

The target formation is the Cambrian-age Mt. Simon Sandstone, the thickest and most widespread saline reservoir in the Illinois Basin (Figure 2). It is overlain by the Eau Claire Formation, a regionally extensive, low-permeability shale and underlain by Precambrian granitic basement. The Mt. Simon is used extensively for natural gas storage in the northern half of Illinois, and detailed reservoir data from these projects show that the upper 200 feet of the Mt. Simon has the necessary porosity and permeability to be a good sequestration target. A regional isopach map of the

Mt. Simon suggests the probability of more than 1,000 feet of Mt. Simon present at the ADM site. Data from a well drilled 17 miles from the ADM site and a second well drilled 51 miles south of the ADM site indicate good porosity in the Mt. Simon. MGSC estimates that the average porosity of the Mt. Simon at the ADM site will be around 12%. The top of the Mt. Simon Sandstone at the ADM site is estimated to lie at a depth of approximately 5,500 feet.

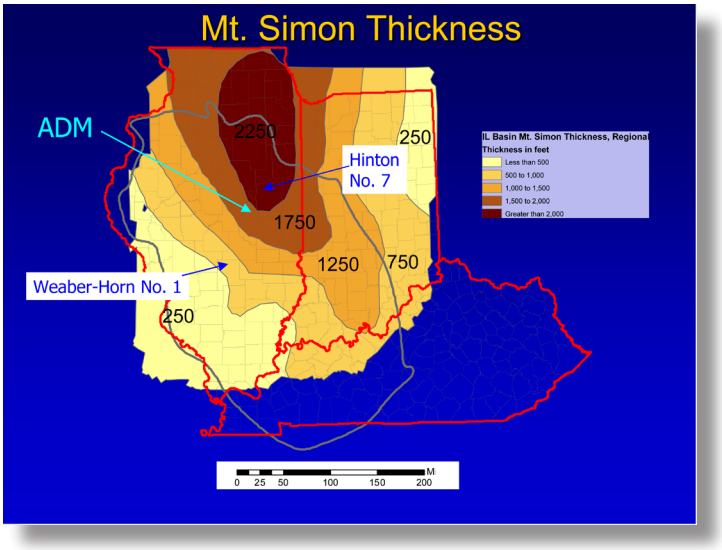


*Figure 2. Regional diagram showing thickness of Mt. Simon Sandstone*

Within the Illinois Basin, the Devonian-age New Albany Shale, Ordovician age Maquoketa Formation, and the Cambrian-age Eau Claire Formation thick shale units function as significant regional seals. Also, many minor, thinner Mississippian- and Pennsylvanian-age shale beds form seals for known hydrocarbon traps within the basin. All three significant seals are laterally extensive and appear, from subsurface wireline correlations, to be continuous within a 100-mile radius of the test site. The Eau Claire is estimated to be 300-500 feet thick and is expected to be the primary seal at the ADM site. The Ordovician Maquoketa Shale and the New Albany Shale are anticipated to act as secondary seals. There are no mapped regional faults and fractures within a 25-mile radius of the ADM site.

### Source of $CO_2$

The $CO_2$ will be obtained from ADM's Ethanol Production Facility. Outlet $CO_2$ streams from ethanol fermentor vents are typically 99%-plus pure $CO_2$, saturated with water vapor at 80 °F and atmospheric pressure. Common impurities are ethanol and nitrogen in the range of 600 to 1000 ppmv each. Other impurities in lesser amounts often include oxygen, methanol, acetaldehyde, and hydrogen sulfide. The $CO_2$ will be purified, dehydrated, compressed to ~2,000 psi and delivered to the wellhead as supercritical $CO_2$. The dehydration/compression facility is proposed to be located near the north boundary of the ADM facility.

### Injection Operations

MGSC plans to inject approximately 1,000 tonnes (1,100 U.S. tons) of supercritical $CO_2$ per day for a total of 1,000,000 tonnes (1.1 million U.S. tons) over three years

## COST

**Total Project Value**
$4,425,178

**DOE/Non-DOE Share**
$3,929,010 / $496,168

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## WEBSITE

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It is the intention of MGSC to utilize the site that ADM owns in Decatur, Illinois, for all injection activities, thus requiring a minimum of transportation activities. The initial data well drilled on the site will serve as the initial injection well. The purified, dehydrated, supercritical $CO_2$ will be received from a new dehydration/ compression facility.

### Simulation and Monitoring of $CO_2$

The monitoring, mitigation and verification (MMV) program will have operational, verification, environmental, and mitigation components, with monitoring occurring before, during, and post-injection. The program will rely heavily on 3-D seismic data collected during the first year of injection to monitor the plume's position. The MMV program will be evaluated yearly and modified as needed. A wide range other monitoring techniques may be used, including soil gas sampling, well logging, visible and infrared imaging, $CO_2$ land surface flux monitoring, and geochemical methods. Groundwater models such as MODFLOW and GFLOW will be used to develop a conceptual model for shallow groundwater flow and estimate the time for potential contaminants to travel outside the area of the injection site. This will provide a risk assessment for nearby water supplies in the unlikely occurrence of a $CO_2$ leak either during or following $CO_2$ injection. Geochemical models such as Geochemist's workbench, PHREEQCI, and TOUGHREACT will be used to conduct thermodynamic modeling of shallow groundwater and injection-formation brine. These models will provide insight on the long-term fate of injected $CO_2$ and will be used to study the regional impact of multiple injection wells on flow within a saline aquifer across the Illinois Basin.

## Goals and Objectives

MGSC's overall goal is to validate the information and technology developed under the Characterization and Validation Phases relative to research and field activities, public outreach efforts, and regional characterization. Specific objectives include:

- Demonstrating the ability of the Mount Simon Sandstone to accept and retain 1.0 million tonnes (1.1 million U.S. tons) of $CO_2$ injected over a period of three years.
- Achieving a more thorough understanding of the science, technology, regulatory framework, risk factors, and public opinion issues associated with large-scale injection operations.
- Validating monitoring, mitigation, and verification (MMV) activities, modeling, and equipment operations.
- Refining capacity estimates of the target formation using results of the test.

## Benefits to the Region

The MGSC region currently emits 304 million tonnes (336 million U.S. tons) of $CO_2$ annually (Li, et al., 2007). The target Mount Simon Sandstone is estimated to have a regional potential $CO_2$ storage capacity in the Illinois Basin of 27.1 to 108.6 billion tonnes (29.8 to 119.4 billion U.S. tons). Based on the current emissions rate, 50% of the emissions for the next 100 years amounts to 15.1 billion tonnes (16.6 billion U.S. tons). The total is less than the low end of the Basin's estimated storage capacity. Thus, this project is vital to establish the sequestration capabilities of the Mount Simon Sandstone.