MANAGING CLIMATE CHANGE AND SECURING A FUTURE FOR THE MIDWEST'S INDUSTRIAL BASE

MRCSP
MIDWEST REGIONAL CARBON SEQUESTRATION PARTNERSHIP

Michigan Basin Carbon Dioxide Storage Validation Phase Field Demonstration

NETL NATIONAL ENERGY TECHNOLOGY LABORATORY

Purpose of the Demonstration

DTE Energy and Core Energy LLC, members of the U.S. Department of Energy's (DOE's) Midwest Regional Carbon Sequestration Partnership (MRCSP)[1] recently participated in a field test to store carbon dioxide in deep underground rock formations. This test was located near Gaylord, Michigan. The carbon dioxide was stored between oil and gas producing zones within a large geologic structure known as the Michigan Basin (Figure 1). The test was one of three geologic tests conducted in the Midwest during the Phase II, Validation Phase, of the Partnership Program (2005-2010).

Carbon dioxide is the most common of the man-made greenhouse gases that are believed to contribute to global warming. Concern about global warming has led to efforts to find ways to reduce carbon dioxide emissions to the atmosphere. Storing carbon dioxide deep underground in carefully selected geologic formations is one of several options being studied. This concept is often referred to as geologic sequestration.

Using carbon dioxide for enhanced oil recovery (EOR) is a very familiar and frequently used technique in Michigan and in other depleted oil fields around the country. The state's oil and gas industry has long experience with well drilling and injecting carbon dioxide into oil-bearing formations to enhance production. Using similar techniques as in oil production, this field test focused on storing carbon dioxide rather than enhancing the production of existing oil.

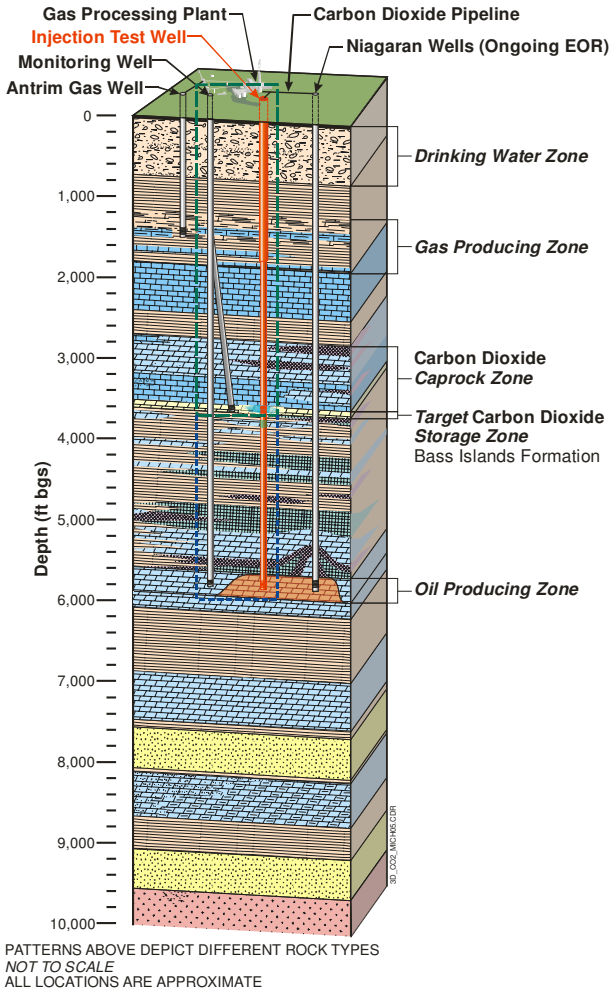

Figure 1. Subsurface Rock Formations

[1] The Midwest Regional Carbon Sequestration Partnership is one of seven regional partnerships established by the USDOE. It includes Michigan, as well as Indiana, Kentucky, Maryland, New Jersey, New York, Ohio, Pennsylvania and West Virginia. The MRCSP is made up of more than 35 members including universities, state geologists, many of the major energy regional companies, and state and federal officials. It is led by Battelle, a non-profit research institute headquartered in Ohio, which is a global leader in technology deployment and commercialization.

Although the test was small in scale, it provided an important step in building our knowledge and helping future generations to address global warming, while ensuring cost-effective sources of energy. Michigan appears to be especially well-suited for development of this technology. Geoscientists at the Michigan Geological Repository for Research and Education at Western Michigan University, who have studied Michigan's underground rock formations extensively, have concluded that the formations may contain enough capacity to store hundreds of years' worth of current emissions from large point sources of carbon dioxide in the state.

What Were the Main Activities?

The test took place in an existing oil and gas field near Gaylord, Michigan. Ongoing EOR operations by Core Energy, LLC, in the area made this an ideal location because much of the infrastructure for the demonstration is already present at the site. This includes carbon dioxide compressors, pipeline, injection systems, and existing wells for monitoring research. One of these existing wells was converted to a monitoring well. Core Energy, LLC, the well owner, worked with the MRCSP to use the injection system for the deep saline formation test. Figure 2 shows the components of the geologic sequestration system.

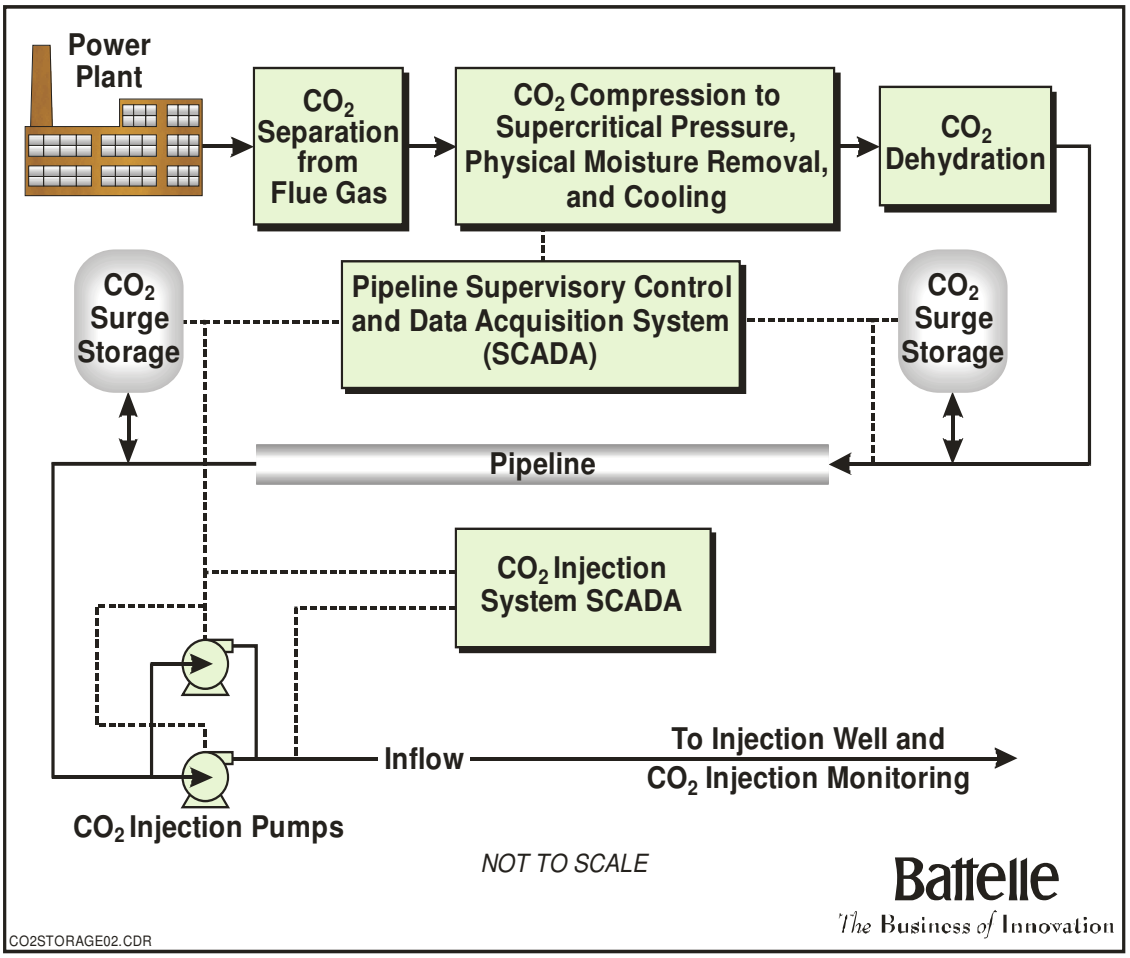

Figure 2. Geologic Sequestration System Components

The carbon dioxide came from DTE Energy's Turtle Lake natural gas processing plant, near Gaylord, Michigan. After compression in the nearby compression facility, it was transported about eight miles via the existing carbon dioxide pipeline to the well. Injection occurred at a depth of 3,000 to 4,000 feet into the saline rock formations, where the injected carbon dioxide will remain trapped—much like oil and gas deposits are trapped for millions of years. This zone is far below drinking water sources, which are at a depth of less than 1,000 feet in this region. Figure 3 shows the protective mechanisms incorporated into the design of the injection well.

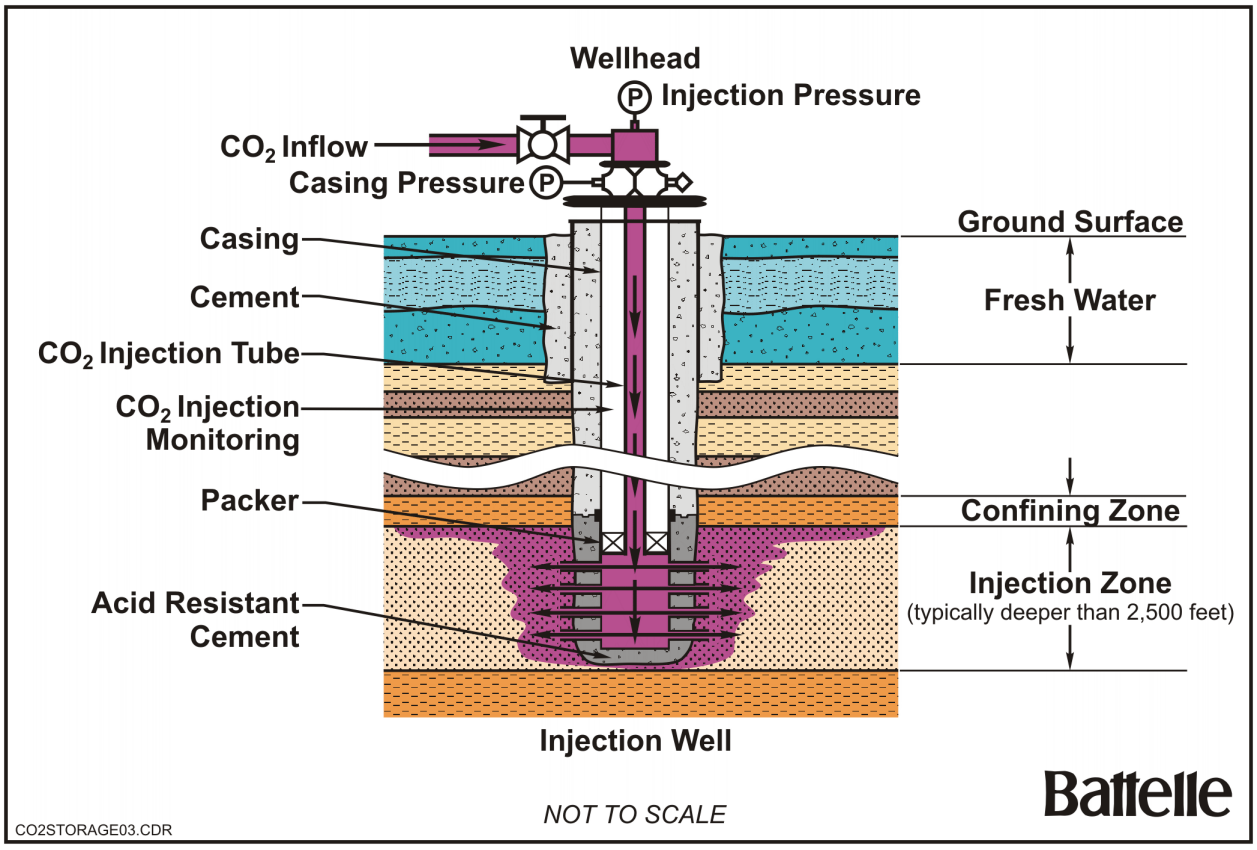

Figure 3. Injection Well Design and Protective Mechanisms

Field demonstration activities were spread over about three years. In an initial test, which took place during a three-week period in February and March, 2008, approximately 10,000 metric tons of carbon dioxide were successfully injected. During 2009, the test was expanded to inject an additional 50,000 metric tons. This follow-on test was completed in the summer of 2009. Field activities included the following:

(1) During the summer of 2006, members of the MRCSP study team evaluated the design of a well that had been closed and determined that it could be used as a monitoring well. The team also identified a nearby area to drill a new injection well.

(2) The team successfully applied for a drilling permit from the Michigan Department of Environmental Quality and completed drilling the injection well and converting the existing well into a monitoring well in the fall of 2006. Core samples taken from the well were studied to confirm the suitability of the location for safely storing carbon dioxide. Suitable locations for

storage must be deep enough to keep the injected carbon dioxide pressurized, isolated from groundwater supplies, protected by cap rocks that act as a seal to keep the carbon dioxide in place, and free of major faults or abandoned wells.

(3) After confirming that the site was suitable, the MRCSP study team prepared an application for an injection permit to the U.S. Environmental Protection Agency (EPA) Region 5. The permit, which was granted in December 2007, specified the pressure at which the carbon dioxide should be injected and required preparation of a plan for monitoring the safety of the operations and subsequent well closure or use.

(4) As the recorded well owner, Core Energy submitted the applications for the drilling and the injection permits on behalf of the MRCSP.

(5) The initial test involved injecting about 10,000 metric tons into the target storage zone over a period of about three weeks in February and March, 2008. As required by the permit, activities at all stages were monitored to track the condition of the well and the injected carbon dioxide. Project researchers observed that the behavior of the carbon dioxide in the formation closely matched the behavior predicted by the computer model prior to the field test. The field test data were used to further calibrate the model.

(6) After completing the initial test, the research team concluded that the site offered a valuable opportunity to build on the knowledge already gained about the storage of carbon dioxide. Plans were therefore begun to conduct a second test that would provide a better understanding about the long-term behavior of carbon dioxide, as well as the performance of the monitoring and computer modeling tools used to track the carbon dioxide.

(7) The second test, which involved the injection of up to 50,000 metric tons of carbon dioxide, took place in mid-February through July 2009. As with the initial test, it was done in compliance with all state and federal permitting requirements and activities were monitored throughout to track the condition of the well and the injected carbon dioxide.

After completion of this second, expanded test, the research team began post-injection monitoring. When monitoring is complete, the team will evaluate the results and post to the Web site.

How can I Get More Information or Provide Input?

If you have questions about the project, please contact T.R. Massey, Battelle, at 614-424-5544; masseytr@battelle.org; Traci Rodosta, DOE, at Traci.Rodosta@netl.doe.gov; or Steve Rawlings, DTE, at rawlingss@dteenergy.com (231-932-2841).

The MRCSP Web site (www.mrcsp.org) includes a series of snapshots that illustrate project activities (click on the menu button *Geologic Demonstrations* and move to the Michigan Basin site). Additional fact sheets that provide more detailed information about geologic tests are available from the web site, including information about global climate change, carbon sequestration and the overall activities of the MRCSP.