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

# Carbon Dioxide Storage Validation Phase Field Demonstration at Duke Energy's East Bend Generating Station: Project Overview

## Purpose of the Demonstration

Duke Energy volunteered to take part in a field test of a promising technique for permanently storing carbon dioxide deep under its East Bend Generating Station (Figure 1). The test was one of several conducted in the Midwest by the Midwest Regional Carbon Sequestration Partnership (MRCSP).[1]

**Figure 1. East Bend Generating Station**

Carbon dioxide is the most common of the man-made greenhouse gases that are thought to contribute to global warming, which scientists refer to as global climate change. Coal-fired power plants, steel mills, refineries and other industrial processes are major sources of carbon dioxide emissions in the Midwestern U.S.

Concern about climate change has resulted in efforts to find ways to reduce these emissions. 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.

Although the field test at East Bend was a very small-scale test, it represents an important step in building our knowledge and helping future generations to address climate change. It was one of

[1] The Midwest Regional Carbon Sequestration Partnership is one of seven regional partnerships established by the U.S. Department of Energy. It includes Kentucky, along with Indiana, Maryland, Michigan, New Jersey, New York, Ohio, Pennsylvania and West Virginia. It 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.

over 20 such tests conducted nationwide under the Phase II, Validation Phase of the U.S. Department of Energy's (DOE's) Regional Carbon Sequestration Partnership Program. If successful, geologic sequestration could be economically important to Kentucky and other Midwestern states by allowing the region to produce carbon-neutral, affordable energy to support our region's economy in the future.

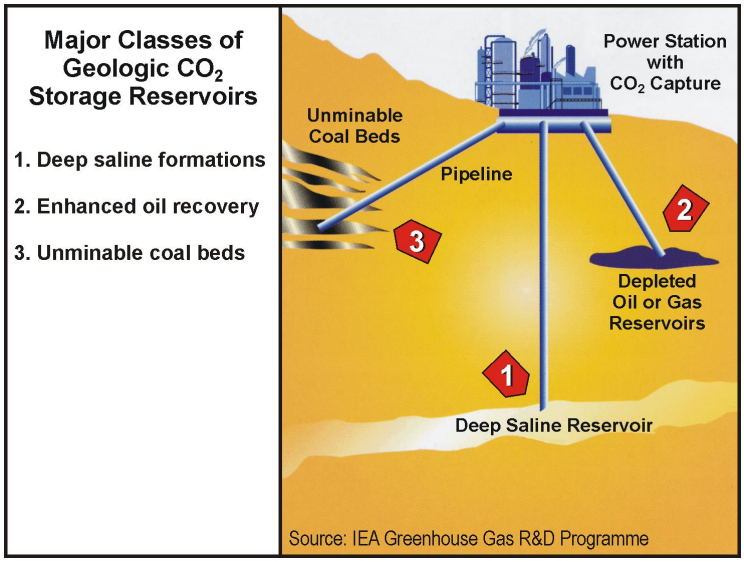


**Figure 2. Formations Suitable for $CO_2$ Storage**

## What Is Geologic Sequestration?

Geologic sequestration is part of a broader approach to reducing carbon dioxide emissions. Typically, this would first involve capturing carbon dioxide from the emissions of power plants and other industrial facilities (in the case of this field test, however, the required amount would be very small and may be obtained from a local or regional supplier). The carbon dioxide is then injected through a deep well into the selected geologic formations. There, the carbon dioxide is permanently stored thousands of feet below drinking water supplies. Suitable formations for geologic sequestration include saline or brine (saltwater) reservoirs, depleted oil and gas fields or coal beds that are too thin or deep to be cost-effectively mined (Figure 2). Furthermore, locations suitable 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 that could provide a pathway for the carbon dioxide to escape. The East Bend demonstration involved injection into a deep saline (brine) reservoir, which is located about 3,000 feet underground, far below the surface and drinking water supplies.

## Activities

The field test activities were conducted in a step-wise fashion over a period of about three years. The steps were designed to develop a detailed understanding of the characteristics and suitability of the rock layers for geologic sequestration. A series of photographs of the various activities is shown on the East Bend page of the MRCSP website at www.mrcsp.org.

1. Beginning in the fall of 2006, the MRCSP project team began gathering information about the nature of the underlying rock layers to confirm that they were suitable for safely storing carbon dioxide.

2. Duke Energy obtained an injection permit from the regulators at the Environmental Protection Agency (EPA), Region 4 in the fall of 2008, after the agency had issued a draft permit for public review and comment. The permit application required an operational plan, which included factors such as determining the pressures at which the carbon dioxide should be injected and a plan for monitoring the safety of the operations.

3. After obtaining a drilling permit from the Kentucky Division of Oil and Gas in June 2009, the project team began drilling a well to conduct tests. These tests enabled them to determine the nature and strength of the underground rock and the character of the deep salt water formation.

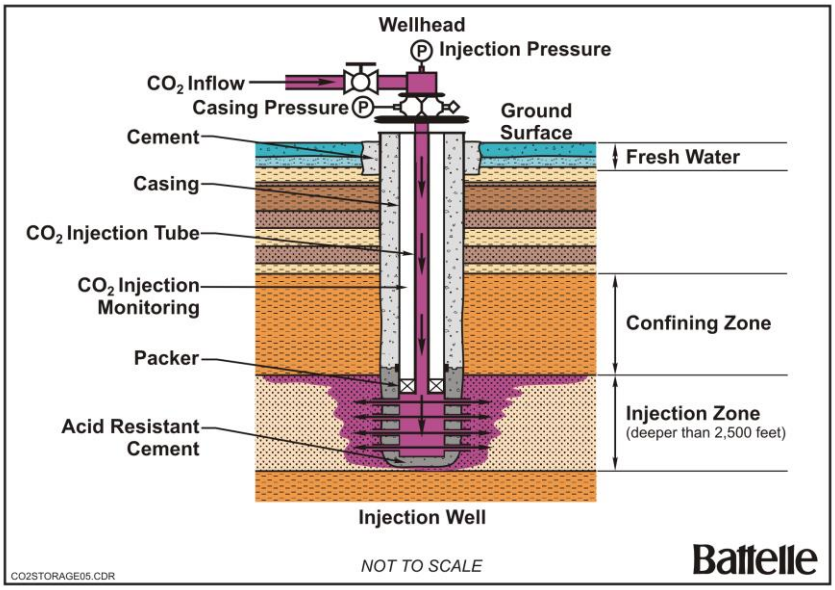


**Figure 3. Injection Well Design and Protective Mechanisms**

4. Finally, the project team injected a very small amount of carbon dioxide (about 1,000 tons) which was obtained from Praxair, a regional supplier of gas. Before injection, the carbon dioxide was compressed to a liquid-like state. It was then injected through a well into rock formations that are filled with salty water, where it will remain trapped—much like oil and gas deposits are trapped for millions of years. Injection occured at a depth of 3,000 to 4,000 feet, far below drinking water sources which are at a depth of less than 100 feet in this region. As shown in Figure 3, the well is soundly constructed to prevent leakage.

5. Duke Energy held a public informational meeting at the beginning of the project in 2006 and a second one in September 2009 to update the plant neighbors on activities.

6. As required by the permit, the project team will monitor activities at all stages to track the condition of the well and the injected carbon dioxide.

7. After completing the test, the project team will evaluate the results and determine whether the well should be capped for permanent closure or maintained for future use.

## What Will Neighbors See or Hear?

The most noticeable activities to neighbors were the seismic survey and well drilling. Although noticeable, none of these activities was disruptive. The MRCSP project team conducted the seismic survey during the fall of 2006. This is a technique similar to an ultrasound, which develops below-surface images by placing sensitive microphones on the ground that record reflections from vibrations created by a special type of truck called a vibroseis truck, shown in Figure 4. The survey took about two weeks. Much of the work took place on East Bend property and along roads within a five mile radius of the East Bend Generating Station. The seismic survey results were positive and provided a basis for proceeding with drilling a well.

**Figure 4. Seismic Survey**

The second major activity during this first project phase was the well drilling. A deep well, similar to an oil or gas well, was drilled on East Bend property (See Figure 5), where the project team had been collecting data and conducting tests to determine the nature and strength of the underground rock and the character of the deep salt water formations. Neighbors may have noticed trucks entering or exiting the plant site to transport the drilling rig and related equipment (pipes, concrete, etc.) during the drill set up and take down. Because of the distance to property lines, however, drilling and testing were not reported as being noticeable to neighbors.

**Figure 5. Drilling the Test Well**

## How can I Get More Information?

If you have questions or want more information, please contact T.R. Massey, Battelle, at 614-424-5544, masseytr@batttelle.org;. When completed, a report on all Phase II, Validation Phase field tests, including the test at East Bend, will be posted to the web site at www.mrcsp.org. The web site also provides a series of snapshots of the field test activities, as well as information about global climate change, carbon sequestration and the overall activities of the MRCSP and activities at other field sites, similar to those at East Bend.