# FutureGen 2.0

## Background

The combustion of fossil fuels for electricity generation is one of the largest contributors to carbon dioxide ($CO_2$) emissions in the United States and the world. Future Federal legislation and/or regulation may further limit $CO_2$ emissions from U.S. power generation. Efforts to control $CO_2$ emissions from this sector are under way through the development of carbon capture and storage (CCS) technologies.

CCS could virtually eliminate $CO_2$ emissions from power plants that use fossil fuels. CCS employs the separation of $CO_2$ from the plant's flue gas and its subsequent compression, purification, and transportation via pipeline to an underground geologic formation for permanent storage. Before this process can be widely implemented, the technical challenges that remain must be overcome by methods that do not substantially raise the cost of generated electricity from the power plant. Cost-effective methodologies suitable for CCS application are currently being investigated.

## Description

The Department of Energy (DOE) awarded $1 billion in American Recovery and Reinvestment Act (ARRA) funding (in addition to $53.6 million in prior-year appropriations) to Ameren Energy Resources (AER) and the FutureGen Industrial Alliance (Alliance) to build FutureGen 2.0 – a clean coal repowering program and $CO_2$ storage network. The FutureGen 2.0 Program is implemented through two separate cooperative agreements (awards) that will run concurrently to achieve the FutureGen 2.0 objectives: the Oxy-Combustion Large Scale Test and the Pipeline and Regional $CO_2$ Storage Reservoir Project. Each award has a separate management team, partners, duration, and cost. However, the individual awards are integrated in a manner that the achievement of FutureGen 2.0 objectives is dependent on the success of both awards.

AER, teaming with Babcock & Wilcox (B&W) and Air Liquide Process & Construction, Inc. (Air Liquide), is responsible for the Oxy-Combustion Large Scale Test portion of FutureGen 2.0 and will repower Unit 4 of their Meredosia Power Plant with advanced coal oxy-combustion technology. Meredosia Unit 4 is a 202–megawatt, oil-fired unit approximately 20 miles west of Jacksonville, IL.

## CONTACTS

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## CONCURRENT AWARDS

**Oxy-Combustion Large Scale Test** – *implemented by Ameren Energy Resources under Award Number FE0005054*

**Pipeline and Regional $CO_2$ Storage Reservoir Project** – *implemented by FutureGen Industrial Alliance under Award Number FE0001882*

# *Oxy-Combustion Large Scale Test*

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## PARTNERS

Babcock & Wilcox

Air Liquide Process & Construction, Inc.

## AWARD DURATION

**Start Date**
10/01/2010

**End Date**
12/31/2018

## COST

**Total Project Value**
$737,179,996

**DOE/Non-DOE Share**
$589,744,000 / $147,435,996

Government funding for this award is provided in whole or in part through the American Recovery and Reinvestment Act.

The Alliance is responsible for the Pipeline and Regional $CO_2$ Storage Reservoir Project portion of FutureGen 2.0, which involves the selection of the new host sequestration site for $CO_2$ captured from Meredosia Unit 4. The Alliance has identified its preferred sequestration site in Morgan County, IL, and has identified two alternate sites, one in Christian County, IL, and one in Douglas County, IL. The Alliance will also establish a $CO_2$ pipeline network from Meredosia Unit 4 to the new host sequestration site, a geologic sequestration research complex, an education and training center, and a visitor center. This joint effort will create the world's first full-scale oxy-combustion, coal-fired plant designed for permanent $CO_2$ capture and storage.

DOE's National Energy Technology Laboratory (NETL) has identified oxy-combustion as a cost-competitive approach for repowering existing coal-fired facilities for the capture of $CO_2$ for geologic sequestration. Conventional coal combustion technology uses air to burn coal, which results in a high-nitrogen flue gas, with a dilute concentration of $CO_2$. However, oxy-combustion technology separates oxygen from the air and mixes it with $CO_2$, to burn coal in a boiler designed to produce a flue gas with concentrated $CO_2$. Additional technology then purifies and compresses the $CO_2$ for pipeline transport to the geologic sequestration host site for safe, permanent storage. The coal oxy-combustion technology used for FutureGen 2.0 is anticipated to create a near-zero emissions plant by delivering at least 90 percent of the plant's generated $CO_2$ for sequestration and eliminating almost all of the mercury,

*Meredosia Plant*

sulfur oxides ($SO_x$), nitrogen oxides ($NO_x$), and particulate pollutants from plant emissions. The coal-fired oxy-combustion technology has been successfully pilot tested by B&W at their research facility in Alliance, OH.

The compressed and purified $CO_2$ will be transported using proven pipeline technology to the selected geologic storage site. Originating at the Meredosia power plant site, the $CO_2$ pipeline will be designed to accept and permanently store at least 1.3 million metric tons (MMT) per year of $CO_2$ captured at Ameren's Meredosia plant, for a minimum of 30 years' capacity. Over the projected life of the power plant, the storage field is expected to accept a minimum of 39 MMT (i.e., 1.3 MMT over 30 years).

DOE, in conjunction with the Illinois State Geological Survey through the Midwest Geological Sequestration Consortium (MGSC), has performed assessments of the geology that is available for $CO_2$ storage in downstate Illinois. The $CO_2$ will be stored within the Mount Simon sandstone geologic formation, which is well known for its depth, $CO_2$ storage capacity, and thick overlying rock seals that will contain the $CO_2$. However, not all parts of the Mount Simon formation are suitable for storage, so the $CO_2$ storage site must be in a location that is technically appropriate. The practices used to store the $CO_2$ will have many similarities to those used for safe storage of natural gas, which occurs on a large scale in Illinois. To provide a full account of the stored $CO_2$ and confirm its permanence within the geologic formation, the Alliance will execute a monitoring, verification, and accounting (MVA) program.

## Goals/Objectives

The overall goal of FutureGen 2.0 is to test technologies that will help reduce $CO_2$ emissions in the United States from coal-fired power generation by implementing innovative technology, allowing the nation to remain competitive in a carbon-constrained economy and become a world leader in carbon capture and storage.

The key goals of the Oxy-Combustion Large Scale Test are to:

- Be the first-of-its-kind commercial-scale, oxy-fired coal plant in the world.
- Exhibit the full integration of an air separation unit and an innovative $CO_2$ compression and purification unit into a full-scale utility application for electric power generation.
- Repower an existing 202-megawatt plant with the oxy-combustion technology.
- Validate technical and economic feasibility of the oxy-combustion technology for utility power plant applications.
- Be a Near Zero Emissions Plant (NZEP).
- Treat 100 percent of the flue gas, and remove more than 90 percent of the $CO_2$, resulting in the capture of approximately 1.3 MMT per year of $CO_2$ from the plant.

## *Pipeline and Regional $CO_2$ Storage Reservoir Project*

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## PARTNERS

Battelle Memorial Institute

## AWARD DURATION

**Start Date**
10/01/2010

**End Date**
12/31/2020

## COST

**Total Project Value**
$552,535,075

**DOE*/Non-DOE Share**
$458,604,112 / $93,930,963

**Note: Includes $53.6M prior-year appropriations.*

Government funding for this award is provided in whole or in part through the American Recovery and Reinvestment Act.

The key goals of the Pipeline and Regional $CO_2$ Storage Reservoir Project are to:

- Facilitate validation of the technical feasibility and economic viability of near-zero emission energy from coal.
- Verify effectiveness, safety, and permanence of $CO_2$ sequestration in saline formations.
- Establish standardized technologies and protocols for $CO_2$ MVA.
- Gain domestic and global acceptance of the FutureGen 2.0 concept and facilitate broad deployment of both new and repowered oxy-combustion coupled with CCS.

## Benefits

The overall benefit of FutureGen 2.0 will be to ensure that the United States remains competitive in a carbon-constrained economy while serving as a model to the nation for reducing $CO_2$ emissions. Initial benefits will include the jobs created in Illinois by the construction of the plant oxy-combustion repowering, $CO_2$ pipeline, $CO_2$ injection and monitoring wells, and the planned research, visitor, education, and training facilities. Additional benefits will be realized through the preservation of jobs at the power plant and new permanent employees responsible for the operation and maintenance of the transport pipeline and $CO_2$ storage facility. Furthermore, new jobs will be created associated with the operations of the geologic sequestration research complex, the education and training center, and the visitor center.

Ongoing benefits to the United States as a whole will occur through the availability of proven life extension technology for older, existing coal-fired power plants and through the training of future operators for careers in coal plant repowering, future $CO_2$ pipeline networks, and storage facility development at the state-of-the-art international training center. The FutureGen 2.0 awards also present unique advantages:

- Repowering of an existing coal-fired power plant with advanced coal oxy-fired combustion technology with the potential for over 90 percent $CO_2$ capture.
- Potential initiation of a $CO_2$ transmission infrastructure directly coupled to a deep saline $CO_2$ storage repository.
- Creation of an estimated 900 jobs in downstate Illinois and another 1,000 jobs for suppliers across the state.
- Opening of the over $300 billion market for coal unit repowering or retrofit.
- Demonstration that Illinois coal can be an environmentally clean domestic energy option for base load electric generation that can save mining, manufacturing, engineering, and construction jobs in the power generation industries, as well as local and national jobs that support those industries with cars, trucks, mining equipment, housing, and other basic needs.
- Provision of a technical and economic basis for repowering or retrofitting up to 30 coal-fired units in Illinois and as many as 590 units nationwide that otherwise may not meet anticipated environmental regulations.
- Support for the State of Illinois goals regarding the deployment of Clean Coal Facilities and regional $CO_2$ sequestration.
- Addressing oxy-combustion technology, complementary to DOE's other large-scale IGCC and post-combustion CCS projects.

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