

FutureGen 2.0

The World's First Near-Zero Emission Coal-Fueled Power Plant with CO₂ Storage

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FutureGen 2.0

The Global Leadership Project

- FutureGen 2.0 is a ***bold technology response*** to climate change and energy concerns
- Led by the ***world's leading companies that*** depend upon coal for the vitality of their business, in partnership with the U.S. Department of Energy
- FutureGen 2.0 will ***validate the cost and performance*** of an oxy-combustion coal-fueled power plant with near-zero emissions, with integrated CO₂ pipeline and regional CO₂ storage hub
- FutureGen 2.0 enables participants to ***gain the knowledge*** associated with a multi-billion dollar project, at low risk, with moderate financial contribution and staff engagement



“FutureGen reflects [the Obama] Administration's commitment to rapidly developing carbon capture and sequestration technology”

Secretary of Energy Chu

FutureGen 2.0

The Move to FutureGen 2.0

- On August 5, 2010, the U.S. Department of Energy announced *“FutureGen 2.0, a clean coal repowering program and carbon dioxide CO₂ storage network”*
- Original FutureGen
 - IGCC with 90% capture
 - 330-MWe (gross); 240-MWe (net)
- Increasing costs drove the need to revisit the original FutureGen
 - A funding gap existed and neither the State government, Federal government, nor industry was in a position to fill
- The FutureGen Alliance’s mission to advance clean coal technology remains the same, which is the Alliance’s motivation for the supporting the revised effort

FutureGen 2.0

The Move to FutureGen 2.0

- Refocusing created the opportunity for the Department of Energy to make changes:
 - Technology change from IGCC to oxy-combustion
 - DOE has several IGCC projects in its portfolio
 - DOE did not have an oxy-combustion project in its portfolio
 - Oxy-Combustion technology has the potential to be used in repowering applications on a large cross-section of the world's existing pulverized coal-fueled power plants
 - Scale change from 330-Mwe (gross) to 200-Mwe (gross)
 - Oxy-Combustion technology offers scalability benefits
 - Remains commercial scale
 - Brings project size in line with available budget
 - CO₂ storage hub concept provides flexibility for future opportunity of expanded CO₂ storage network

FutureGen 2.0

Commercial-scale, Leading Edge

- 200-MWe (gross), 140-MWe (net) oxy-combustion repowering
- >90% capture
- 1.3 million metric tonnes/year CO₂ captured
- Pipeline transport to CO₂ storage hub
- Saline geologic formation
- Near-zero NO_x, SO_x, PM, Hg, and HAPs emissions
- Advanced technology design to prove integrated operations and lead the way to affordable, low-carbon coal power
- Visitor center, research, and training facilities
- Stakeholder involvement to build technology support



Project Structure

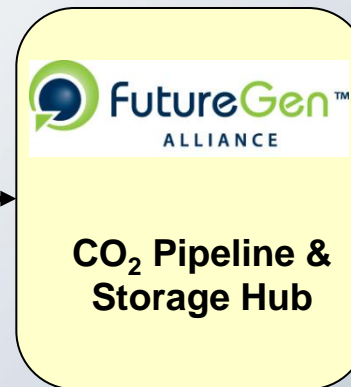
Project Organizational Structure



Project Oversight



Cooperation & Technology Agreement



Project Management & Execution

Project Structure

Alliance Background

- Formed in 2005 as a non-profit organization with a mission of advancing clean coal technology in partnership with the U.S. Department of Energy
- Non-profit consortium of coal production companies, coal trading companies, mining equipment suppliers and coal-fueled utilities
- Alliance is expanding its membership
 - Full members will contribute ~\$10MM each over the life of the project
 - New members will contribute \$100 to \$150K during the initial year
- Balance of the funding is derived from:
 - U.S. Department of Energy
 - Power purchase agreement with associated CO₂ services agreement
 - Modest Financing (<\$200MM depending upon final project cost)

Project Structure

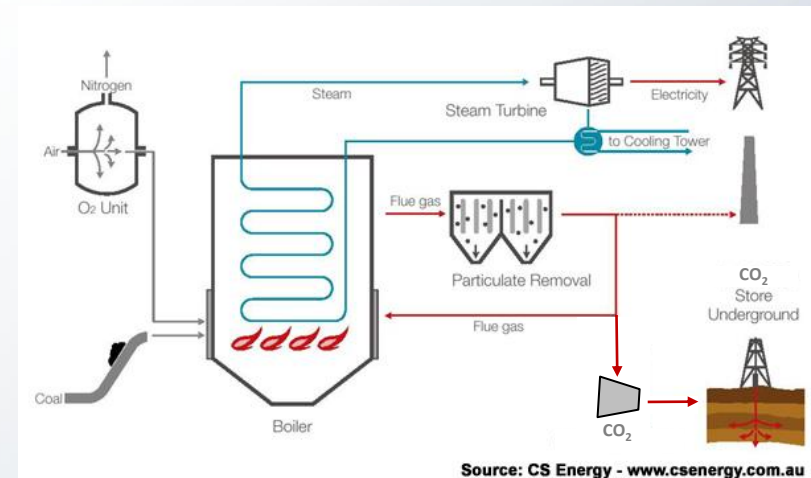
Alliance's International Participation



Project Description

Oxy-combustion Repowering

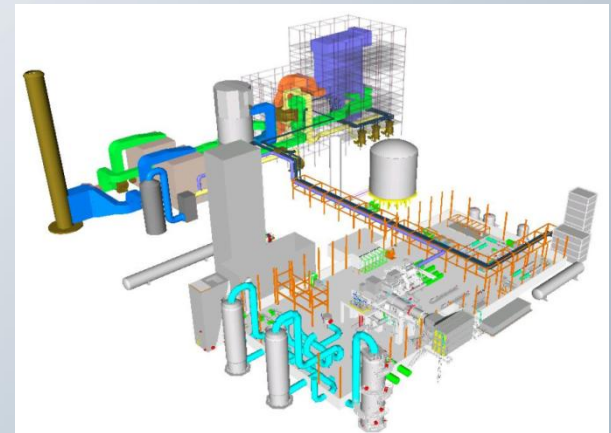
- Oxy-combustion burns coal with a mixture of oxygen and CO₂ instead of air to produce a concentrated CO₂ stream for safe, permanent, storage
- Babcock & Wilcox (B&W) and Air Liquide will provide the oxy-combustion technology
- B&W has tested the technology at 10-MWe scale
- Commercial scale testing is next logical development step



Project Description

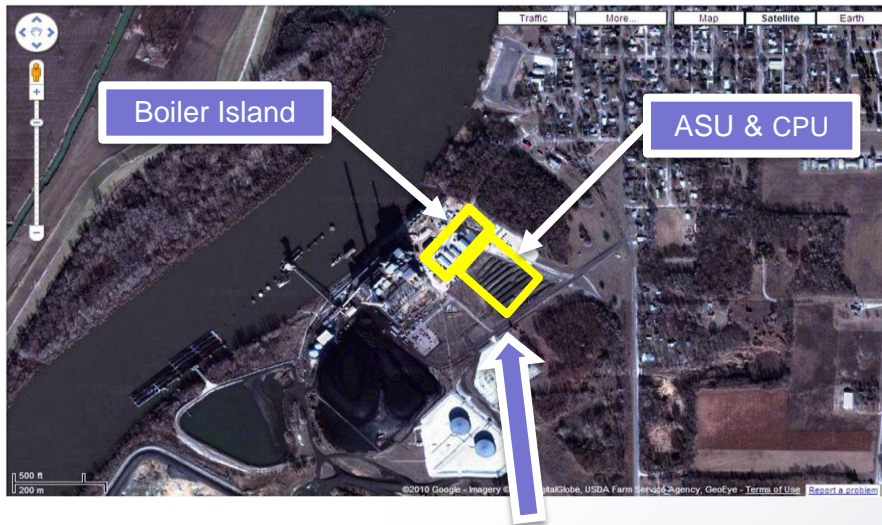
Oxy-combustion Repowering

- Goals:
 - Confirm cost basis for retrofitting/repowering existing coal-fired units
 - Pathway to lower new plant costs (500 – 800 MWe scale)
 - Prove operability and reliability of the integrated process - boiler island, air separation unit and compression & purification unit
 - Provide performance and emissions data for future commercial guarantees
 - Establish operating and maintenance experience for future commercial plants



Project Description

Oxy-combustion Repowering



Performance Overview

Gross Output (MWe)	202
Net Output (MWe)	139
CO ₂ Generated (TPY)	1.45MM
CO ₂ Captured (TPY)	1.31MM
CO ₂ Captured (%)	90

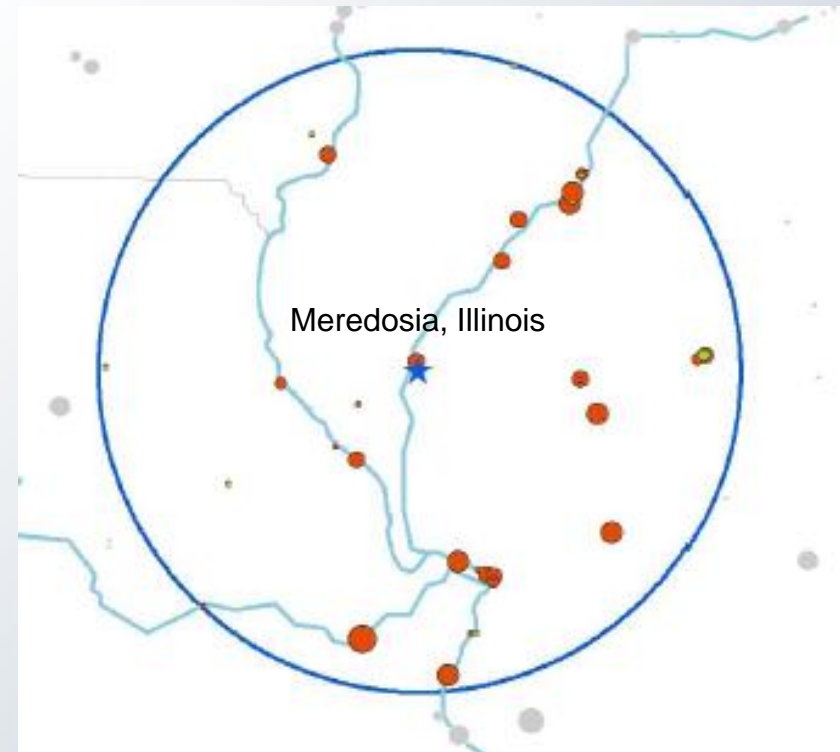
Meredosias Plant

- Location - Meredosias, IL
- Operated by Ameren Energy Resources
- Units 1, 2, 3 coal-fired (two retired), Unit 4 oil-fired
- Fires Illinois coal, with the potential to test blends
- Truck & barge unloading facilities for coal
- Unit 4 is an excellent plant to repower with oxy-combustion technology:
 - Built in 1975
 - Currently idle
 - Appropriate scale; 200 MWe, 2400psig, 1000F, 1000F
 - Turbine/generator have low operating hours and can be placed in service as part of repowered plant

Project Description

CO₂ Pipeline and Storage Hub

- Develop a regional deep saline storage facility that would sequester CO₂ from Meredosias and other sources
- The concept of CO₂ hubs is not new
 - Included in Australian CCS Roadmap
 - Common in European discussions
 - CO₂ pipeline networks used in enhanced oil recovery applications
- Multiple major CO₂ sources within 100+ miles of Meredosias



Project Description

CO₂ Pipeline and Storage Hub

- **Tasks**

- Sequestration Site Selection

- Several Local Communities have expressed interest
 - Current expectation is for a regional sequestration site

- Pipeline Design

- Obtain Rights of Way, design, and install pipeline to serve sequestration site

- Develop Sequestration System

- Characterize site
 - Design injection wells and necessary appurtenant systems

- Operate Pipeline and Sequestration Site

- Receive CO₂ from Meredosia Plant at fence line and possibly other sources

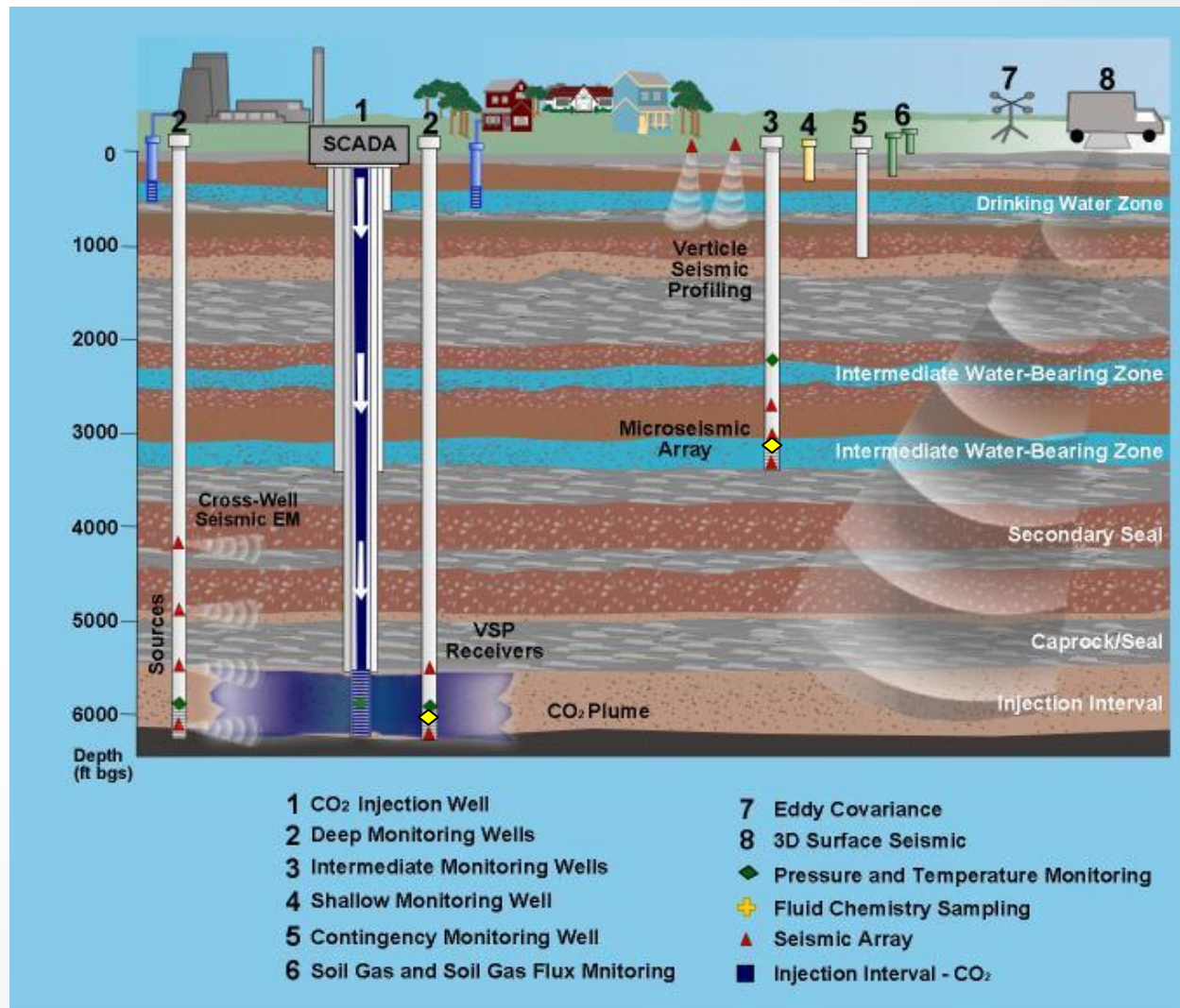
Project Description

CO₂ Pipeline and Storage Hub

- Goals:
 - Prove-out the siting, regulatory, liability, operational insurance, storage costs, and other operational protocols
 - Provide pathway to siting of subsequent commercial hubs
 - Conduct CO₂ storage research (seismicity studies, monitoring, verification and accounting protocols and technologies)
 - Establish visitor, research, and training facilities
 - Conduct an integrated (power plant to storage site) three-year test campaign
 - Convert to commercial operations thereafter

Project Description

Subsurface Research “Laboratory”



Summary

Budget and Schedule

- Budget
 - \$1.3B (preliminary)
 - CAPEX: repowering, pipeline, and storage hub
 - OPEX: 3-years O&M plus 2-years additional CO₂ monitoring
 - Approximately 20% industry funded

- Schedule
 - Pre-FEED complete – June 2011
 - FEED / NEPA complete – June 2012
 - Design, procurement, construction complete mid-2015
 - Commissioning & start-up complete end-2015
 - Integrated testing complete 2018
 - Convert to commercial operations 2019

Summary

U.S. Government Commitment



*“FutureGen is a priority”
President Obama*



“FutureGen reflects this Administration’s commitment to rapidly developing carbon capture and sequestration technology”

Dr. Steven Chu, Secretary of Energy



“We [DOE] are fully committed and moving without hesitation.” “We are going to get this done.”

Dr. James Markowsky, Assistant Secretary of Energy for Fossil Energy

The U.S. Department of Energy has >\$1B in cash to support the project.

Summary

Unique Opportunity for Industry

- FutureGen 2.0 is ***on the fast track***
- FutureGen 2.0 ***creates significant value***
 - Supports a technology-based climate change strategy, which mitigates the financial risk of climate change while protecting the environment
 - Validates the cost and performance of an integrated near-zero emissions coal-fueled power plant
 - Provides detailed engineering design and cost information to participants
 - Provides an opportunity to engage
 - Creates the technical basis to retain coal in global energy mix
- FutureGen 2.0 is an opportunity to ***share the cost and manage the risk*** of “near-zero emissions” technology development



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