Carbon Sequestration, FutureGen, and Coal Gasification Development in the Illinois Basin

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Midwest Geological Sequestration Consortium, A DOE Regional Carbon Sequestration Partnership:
Seeking Optimal Sinks

- High CO₂ storage capacity
- High CO₂ injection rate
- Storage mechanism assessment
- Major focus on reservoir characterization for coal seams, mature oil reservoirs, and deep saline reservoirs
- Structural characterization
- Outreach and web site enhancement
  - www.sequestration.org
<table>
<thead>
<tr>
<th>System</th>
<th>Series</th>
<th>Lithology</th>
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<td>Pennsylvanian</td>
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<td>Mississippian</td>
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<td>Cambrian</td>
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**Mt. Simon Sandstone**

**Eau Claire Shale**

**Illinois Basin Stratigraphic Column**

**Maquoketa Shale**

**New Albany Shale**

**Mississippian sandstone and carbonate oil reservoirs**

**St. Peter Sandstone**

**Pennsylvanian coal seams**

**CO₂ EOR in mature fields**

**adsorption on coal**

**New Albany Shale**

**adsorption on shale**

**Maquoketa Shale**

**St. Peter Sandstone**

**Eau Claire Shale**

**Mt. Simon Sandstone**

**major saline reservoirs**

From Leetaru, 2004
The Manlove Project has 90 feet of closure, is 5 miles long and 4 miles wide.
High Porosity

Low Porosity

Mt. Simon Sandstone
Sink Capacities*

- Seven major coal seams: **2.3-3.3 billion** tonnes
  - 6.7 trillion ft³ incremental methane(?)
- Mature oil reservoirs: **140-440 million** tonnes
  - 860-1,300 million barrels incremental oil
- St. Peter Sandstone: **1.6-6.4 billion** tonnes
- Mt. Simon Sandstone: **27-109 billion** tonnes

*DOE, 2007, Carbon Sequestration Atlas of the United States and Canada*
FutureGen: Near-Zero Emission Coal-Fired Electric Generation

- *FutureGen* is a 275 Mw, multifaceted demonstration of coal gasification, electricity generation, hydrogen production, and **carbon sequestration**

- Sequestration = CO$_2$ capture + transport + storage

- Illinois offers storage = geological sequestration potential over a wide area of the Illinois Basin
Mattoon and Tuscola FutureGen Sites

- Predominantly farm land
- Outstanding community support for FutureGen
- Familiarity with industrial facilities and coal mining or quarrying
- Excellent sequestration option on site or 10 mi via pipeline
Sequestration at Mattoon and Tuscola
- Illinois Basin geology contains multiple seals for carbon dioxide (CO$_2$) above the Mt. Simon Sandstone
- Monitoring other sandstones above the Mt. Simon Sandstone can provide warning of any problems

Deep, saline Mt. Simon Sandstone reservoir for CO$_2$
Mt. Simon Sandstone Reservoir

- Mt. Simon Sandstone is used for natural gas storage in Champaign County, IL at 4,000 to 4,200 ft
- Mt. Simon core has been recovered from a few deep exploration wells, such as this sample from near Salem, IL at 8,467 drilled in 1966
CO$_2$ Storage in Sandstone Reservoir Pore Space

Pore space

Pin head

Sand grain
VibroSeis Source Trucks
Mid-Illinois Basin 2D
Geophysical Data

- B. New Albany
- Trenton
- B. Knox
- Precambrian
- Mt. Simon Sandstone
Injection into the Weaber-Horn 1 degree dipping beds

30 years of injection

500 ft

Injection interval

After 100 years of shut-in

Under the seal

Under low perm zone

4.6 miles

Injection interval

1 million tons/yr
Midwest Geological Sequestration Consortium-Illinois State Geological Survey Sequestration Field Tests

- One single-well EOR test completed and reservoir simulation underway for second EOR, a five-spot pattern flood
- Coal seam injection test: two wells drilled, pressure transient testing completed, two more wells to be added to pattern
- Deep saline reservoir test site selected for 1 million ton test, 2D geophysics completed, well specs completed, baseline MMV to be initiated
Matrix Monitoring Strategies

- Geophones run in on tubing, deployed to casing, avoids cement integrity problems, recoverable as needed
- Map any microseismic events monitored using clamped geophone array during active injection
Plume Monitoring Strategies

- Seismic response of plume based on repeat surface 3D ("4D") similar to Sleipner project and offset or walkaway Vertical Seismic Profile (VSP) using geophone array.

Frio Brine Pilot

Daley et al, 2007
MMV in the Field

- Installing monitoring wells
- Installing vadose zone samplers
- Collecting background samples

Formation brine sampling

Groundwater sampling

Monitoring well nest
Single Well EOR Test
Owens No. 1, Loudon Field

- Corrosion control chemicals
- Vadose zone samplers
- Groundwater wells
- Data transmitter
- Data antenna
- Air safety monitor
- Test separator
- Internet connection
Poster Development

- Versatile poster set
  - Technical meetings
  - Public events
  - School events
Multiple New Coal Gasification Projects In Progress to Use Illinois Coal

- Rentech Energy Midwest converting gas-fired ammonia plant to coal
- Will produce 920 tons ammonia fertilizer, 1,800 bbls F-T liquids and 76 Mw to grid daily
- Will use ConocoPhillips E-Gas technology and proprietary F-T coal-to-liquids technology
- $700 million project
Multiple New Coal Gasification Projects In Progress to Use Illinois Coal

- ERORA Group and Tenaska, Inc. developing a 770 Mw (gross) IGCC facility
  - Will use 1.8 million tons of coal annually
  - Project cost: $1.1 billion
  - GE gasification technology
  - Online in 2012
Multiple New Coal Gasification Projects In Progress to Use Illinois Coal

- Power Holdings LLC developing a 50 bcf/yr synthetic natural gas facility
- Will use ~4 million tons coal per year (new mine) with GE gasification technology
- $1.3 billion project
- Gas output 100% subscribed under 20-year contracts
- ~17,000 tons/day CO₂ available
Illinois Seeking FutureGen and Facilitating IGCC, Carbon Sequestration, and CO$_2$ EOR

- Illinois Office of Coal Development leading Illinois’ FutureGen team; eight states formally endorse Illinois sites
- IL SB 1704 provides liability protection for the Alliance and establishes monitoring responsibility at ISGS
- Illinois Office of Coal Development supporting IGCC projects with grants, bonding, and cofunding Midwest Geological Sequestration Consortium, a DOE regional sequestration partnership
- Illinois working across state agencies to attract more IGCC projects that use abundant Illinois coal and are optimized for carbon sequestration
- Illinois seeking public-private partnership to develop a CO$_2$ pipeline backbone to deliver CO$_2$ from these projects to Illinois oil fields
FutureGen for Illinois Coalition

**Coalition Support**
- Indiana
- Kentucky
- Michigan
- Ohio
- Pennsylvania
- Wisconsin
- West Virginia
- Wyoming

**U.S. Coal Production**

**U.S. Coal-Fired Electricity**
More than 40% of coal-fired electricity is produced from the 9 states in the Illinois Coalition.

**U.S. Coal Reserves**
The states in the Illinois Coalition are home to 59% of U.S. coal reserves, while just 2.6% of coal reserves are in Texas.

*Source: Energy Information Administration, Official Energy Statistics from the U.S. Government, 2008 Data*