

Major DOE/FE Demonstration Projects & Large-Scale Field Tests

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Major CCUS Demonstration Projects

Project Locations & Cost Share

- CCPI
- ICCS Area 1
- FutureGen 2.0

FutureGen 2.0
 Large-Scale Testing of Oxy-Combustion w/ CO₂ Capture & Sequestration in Saline Formation
 ~\$1.3B Total; ~\$1.0B DOE
SALINE – 1.3M TPY 2016 start

Archer Daniels Midland
 CO₂ Capture from Ethanol Plant
 CO₂ Stored in Saline Reservoir
 \$208M Total; \$141M DOE
SALINE – ~1 M TPY 2013 start

Summit TX Clean Energy
 Commercial Demo of Advanced IGCC w/ Full Carbon Capture
 ~\$1.7B Total; \$450M DOE
EOR – 3M TPY 2014 start

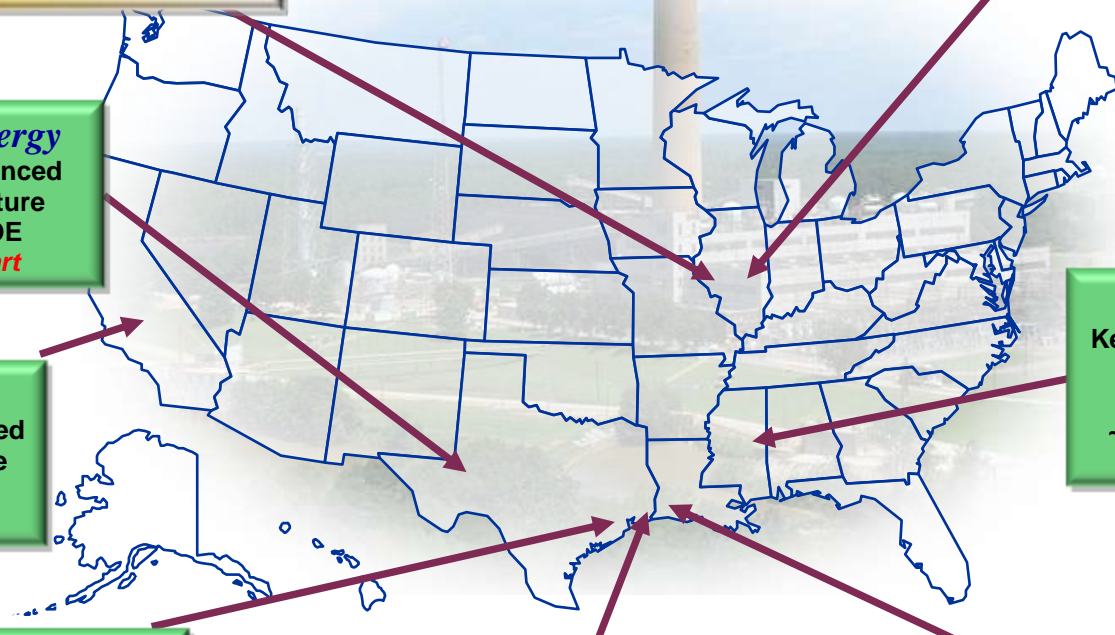
Southern Company
 Kemper County IGCC Project
 IGCC-Transport Gasifier w/Carbon Capture
 ~\$2.67B Total; \$270M DOE
EOR – 3 M TPY 2014 start

HECA
 Commercial Demo of Advanced IGCC w/ Full Carbon Capture
 ~\$4B Total; \$408M DOE
EOR – 3M TPY 2018 start

NRG
 W.A. Parish Generating Station
 Post Combustion CO₂ Capture
 \$339M Total; \$167M DOE
EOR – 1.4M TPY 2014 start

Air Products and Chemicals, Inc.
 CO₂ Capture from Steam Methane Reformers
 EOR in Eastern TX Oilfields
 \$431M – Total, \$284M – DOE
EOR – 1M TPY 2013 start

Leucadia Energy
 CO₂ Capture from Methanol Plant
 EOR in Eastern TX Oilfields
 \$436M - Total, \$261M – DOE
EOR – 4.5 M TPY 2015 start



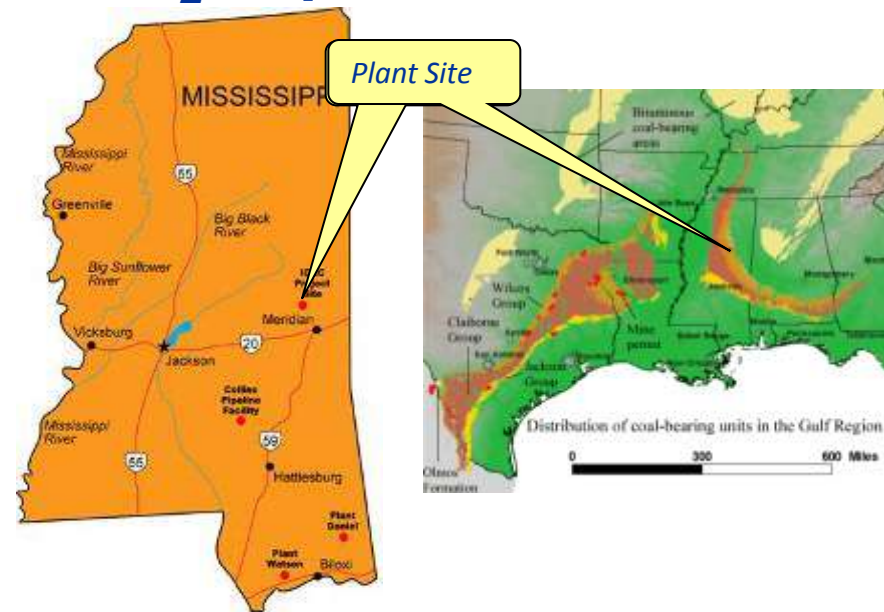
Active DOE/Fossil Energy Major Demonstrations

Program/Project	Technology	TEC/DOE Share	Status/Start-Up
Clean Coal Power Initiative (CCPI) Demonstrations			
Kemper County	IGCC, 67% CO ₂ Cap.	\$2.01B/\$270M (10%)	Construction/2014
Summit Texas	IGCC/Poly, 90% “	\$1.73B/\$450M (26%)	FEED/2014
H ₂ Energy California	IGCC/Poly, 90% “	\$4B/\$408M (10%)	FEED/2018
NRG Parrish	Post-Comb., 90% “	\$339M/\$167M (49%)	FEED/2015
Industrial Carbon Capture & Sequestration (ICCS) Demonstrations			
Archer Daniels Midland	EtOH, 90% CO ₂ Cap.	\$208M/\$141M (68%)	Construction/2013
Air Products Port Arthur	SMR, 90% “	\$431M/\$284M (66%)	Construction/2013
Leucadia Lake Charles	MeOH, 90% “	\$436M/\$261M (60%)	FEED/2015
FutureGen 2.0	Oxy-comb., 90%	\$1.29B/1.05B (81%)	Geol. Char./2016
Total	9 Projects	Various	\$10.4B/\$3.0B (29%) Start-Ups 2013-18

Southern Company Services

Advanced IGCC with CO₂ Capture

- Kemper County, MS
- 582 MWe (net) IGCC: 2 KBR Transport Gasifiers, 2 Siemens Combustion Turbines, 1 Toshiba Steam Turbine
- Mississippi Lignite Fuel
- ~67% CO₂ capture (Selexol® process)
3,000,000 tons CO₂/year
- EOR Sequestration site TBD (Start 2014)
- Total Project: \$2.01 Billion
DOE Share: \$270 Million (13%)



Key Dates

- Project Awarded: January 2006
- Project moved to MS: December 2008
- Construction: July 2010
- NEPA ROD: August 2010
- Operations: May 2014

Status

- NEPA Record of Decision: October 2010
- Construction initiated: September 2010
- Process equipment installation under way



Concrete Tanks



Gasifier Fabrication



Sulfuric Acid Tank Foundations



Underground Utilities

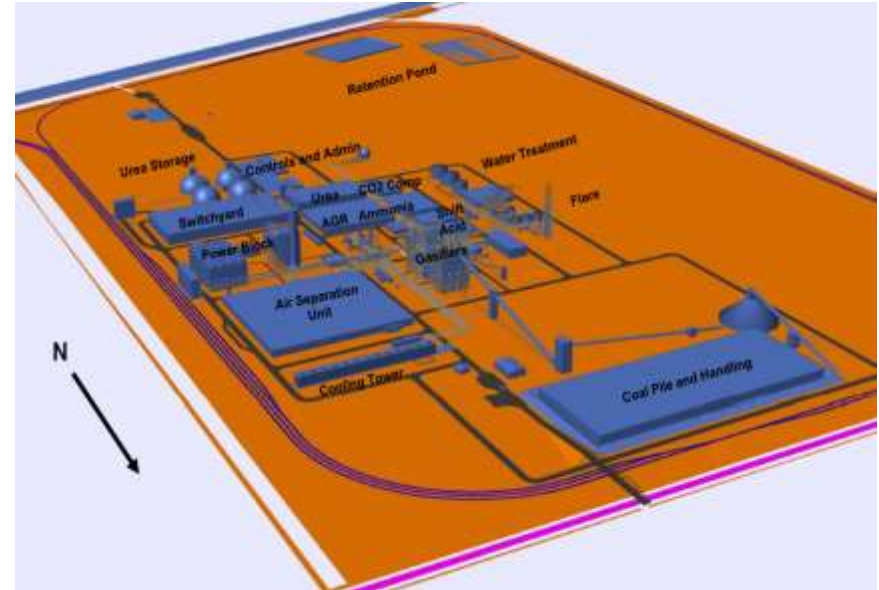
Summit Texas Clean Energy

Advanced IGCC-Polygen w/CCUS

- Penwell, Ector County, TX
- 400 MWe (gross) Greenfield IGCC with Siemens Gasification & Power Block
 - SFG-500 gasifiers (2 x 50%)
 - High H₂ SGCC6-5000F combined cycle (1 x 1)
- PRB subbituminous coal fuel
- 90% CO₂ capture – 3,000,000 tons CO₂/yr
 - 2-stage Water Gas Shift
 - Linde Rectisol® AGR
- Permian Basin EOR (Start: 2014)
- Total Project: \$1.727 Billion
DOE Share: \$450 Million (26%)

Key Dates

- Project Awarded: January 2010
- Construction: June 2012
- Financial Close: 1st Quarter FY2012
- Operation: July 2014



Status

- Air permit: December 2010
- Urea contract: January 2011
- CO₂ contract (60% of total): May 2011
- Power off-take term sheet: June 2011
- Record of Decision: September 2011
- Negotiating project financing

Hydrogen Energy California

Advanced IGCC-Polygen w/CCUS

- Kern County, CA
- Up to 280 MWe (net) IGCC, 1.0 MT/yr Urea/UAN
- 90% CO₂ capture – 3,000,000 tons CO₂/year
- EOR - Elk Hills oil field (Start: TBD)
- Fuels: Bituminous Coal/Petcoke
- Maximize use of non-potable water for power production
- Recycle all IGCC/project wastewater with 100% zero liquid discharge
- Total Project : \$4.0 Billion
DOE - \$408 Million (10%)



*IGCC Poly-generation with
Integrated Carbon Capture & Sequestration*

Key Dates

- Project Awarded: September 2009
- Project Being Re-baselined

Status

- New Owner, SCS Energy: Sept. 2, 2011
- FEED initiated: Sept. 21, 2011

NRG Energy (CCPI-3)

Advanced Post Combustion CO₂ Capture

- Thompsons, TX (near Houston)
- 240 MWe slipstream at NRG Energy's W.A. Parish power plant
- PRB sub-bituminous coal fuel
- 90% CO₂ capture (Fluor's Econamine FG PlusSM process) 1,400,000 tons CO₂/year
- Texas Gulf Coast EOR (Start: 2015)
- Total Project: \$339 Million
DOE Share: \$167 Million (49%)



Key Dates

- Project Awarded: May 2010
- Construction: December 2012
- Operation: January 2015

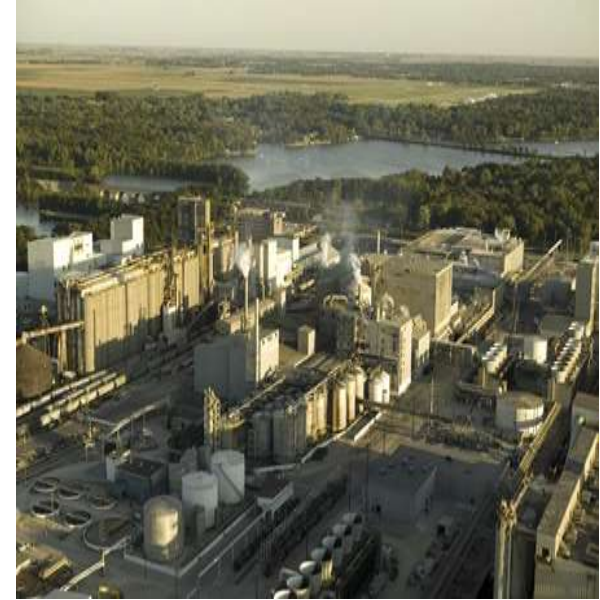
Status

- 60 MWe FEED almost complete
- Project being scaled up to improve economics
- Initiated 240 MWe FEED: May 2010
- Acquisition of EOR Host Site
Completed: October 2011
- NEPA Public Scoping Meetings
Scheduled: November-December 2011

Archer Daniels Midland Company (ICCS)

CO₂ Capture from Biofuel Plant

- Decatur, IL
- CO₂ is a by-product (>99% purity) from production of fuel grade ethanol via anaerobic fermentation
- Up to 90% CO₂ capture; dehydration (via tri-ethylene glycol) & compression – 1,000,000 tons CO₂/year
- Sequestration in Mt. Simon sandstone saline formation (Start: July 2013)
- Total Project: \$208 Million
DOE Share: \$141 Million (68%)



Key Dates

- Phase 2 Awarded: June 2010
- FEED Complete: April 2011
- Construction: May 2011
- Operation: July 2013

Status

- Detailed design in progress
- NEPA completed
- Construction in progress
- UIC Class VI permit submitted: July 2011

Archer Daniels Midland Company (ICCS)

Construction Status – October 2011



Switchgear Building



Ground Water Well



Compressor Building



Alternate Power Supply

Air Products & Chemicals (ICCS)

Steam Methane Reforming with CO₂ Capture

- Port Arthur, TX (Hydrogen plant at Valero Refinery)
- 90% CO₂ capture (Vacuum Swing Adsorption) from two steam-methane reformers (SMRs), yielding >1,000,000 tons CO₂/year
- ~28 MWe cogeneration unit to supply makeup steam to SMRs and operate VSA and Compression Equipment
- CO₂ to Denbury pipeline for EOR in West Hastings oilfield (Start: 2012)
- Total Project: \$431 Million
DOE Share: \$284 Million (66%)



Key Dates

- Phase 2 Awarded: June 2010
- FEED Complete: November 2010
- Construction: August 2011
- Operation: January 2013

Status

- CO₂ off-take agreement executed with Denbury; CO₂ capture & utilities agreement executed with Valero
- Permit By Rule (PBR) & Standard Air Permits Issued by TCEQ: May 2011
- Phase 2B authorized by NETL: June 2011
- FONSI Issued: July 2011
- Construction in progress

Air Products & Chemicals (ICCS)

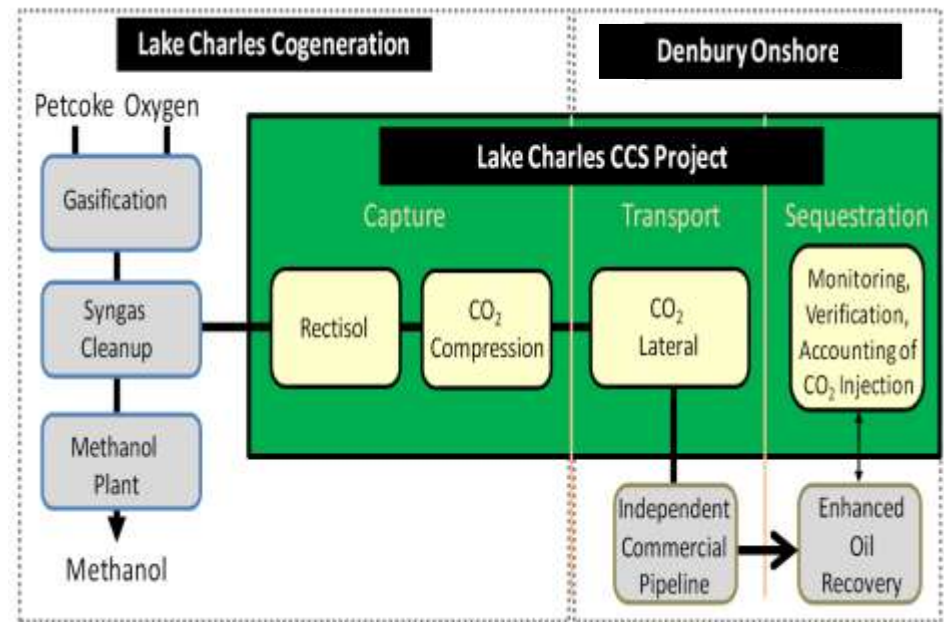
Construction Status – November 2011



Leucadia Energy (ICCS)

Petcoke Gasification to Methanol

- Lake Charles, LA
- GE Energy Gasification (5 gasifiers: 4 hot/1 spare)
- 730 Million gallons/year methanol
- 90% CO₂ capture (Rectisol® process); 4,500,000 tons CO₂/year
- CO₂ to Denbury pipeline for EOR in Texas at the West Hastings oil field (Start 2015)
- Total Project: \$436 Million
DOE Share: \$261 Million (60%)



Key Dates

- Phase 2 Awarded: June 2010
- Complete FEED: July 2011
- Construction: October 2012
- Operation: June 2015

Status

- NEPA EIS in progress
- Negotiating product off-take agreements

FutureGen 2.0

Oxy-Combustion w/ CO₂ Sequestration

- Meredosias, IL & Morgan Co., IL
- 200 MWe gross oxy-combustion repowering of Ameren's Meredosias Unit 4 steam turbine (Start 2016)
- 90% CO₂ capture (cryogenic separation) 1,300,000 tons CO₂/year
- Deep saline sequestration in Mt. Simon formation
- Total Project: \$1.3 Billion
DOE Share: \$1.05 Billion (81%)



Key Dates

- Complete FEED: October 2012
- Construction: November 2012
- Operation: May 2016

Status

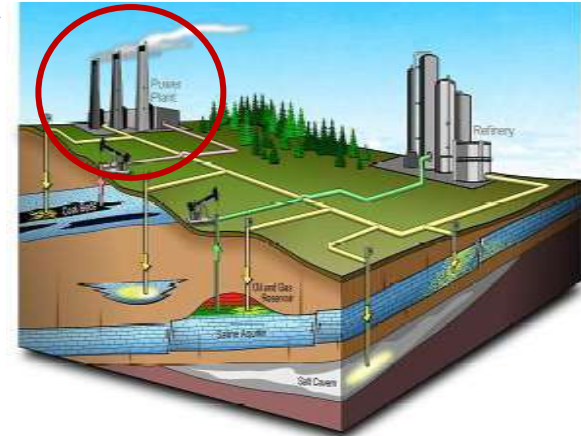
- Pre-FEED in progress
- Sequestration site characterization and validation In progress
- NEPA in progress, scoping meetings held, EIS being drafted

FutureGen 2.0: Oxy-Combustion Repowering



A large-scale integrated test to repower Ameren's existing Meredosias Unit 4 with oxy-combustion & carbon capture technology

- ✓ A purpose-built oxy-combustion system
- ✓ Confirmation that oxy-combustion is a viable repowering/new build technology for coal-fueled power plants, incorporating a testing program that will utilize Illinois bituminous coals & other coals
- ✓ Basis for industry acceptance: lowers equipment, operational, reliability & financial risks for future commercial deployments to meet U.S. & world energy needs



Benefits of the Meredosias Host Site

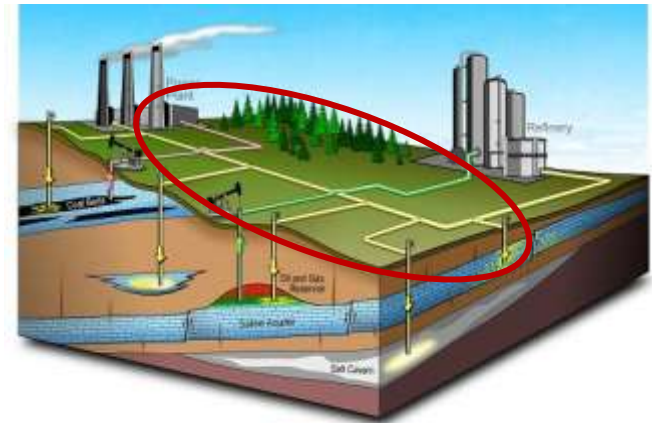
- ✓ Existing site infrastructure conserves capital cost
- ✓ It is the “right size” unit
 - Demonstrates retrofit/repowering potential for existing coal units
 - Large enough test of the technology to support commercial deployment (e.g., 500-800 MWe, supercritical) without another, intermediate, scale-up step
 - Small enough to conserve capital expense for a large-scale integrated test
 - ~3500 tpd CO₂ to storage



FutureGen 2.0: CO₂ Transmission Pipeline



- **Pipeline to transport CO₂ from Meredosia to preferred CO₂ storage site in northeastern Morgan County, Illinois**
 - ~30 miles of pipeline from Meredosia to Morgan County site
 - 12-inch diameter pipeline; 2000 psi operating pressure
 - 4-mile wide corridor to be studied as part of EIS





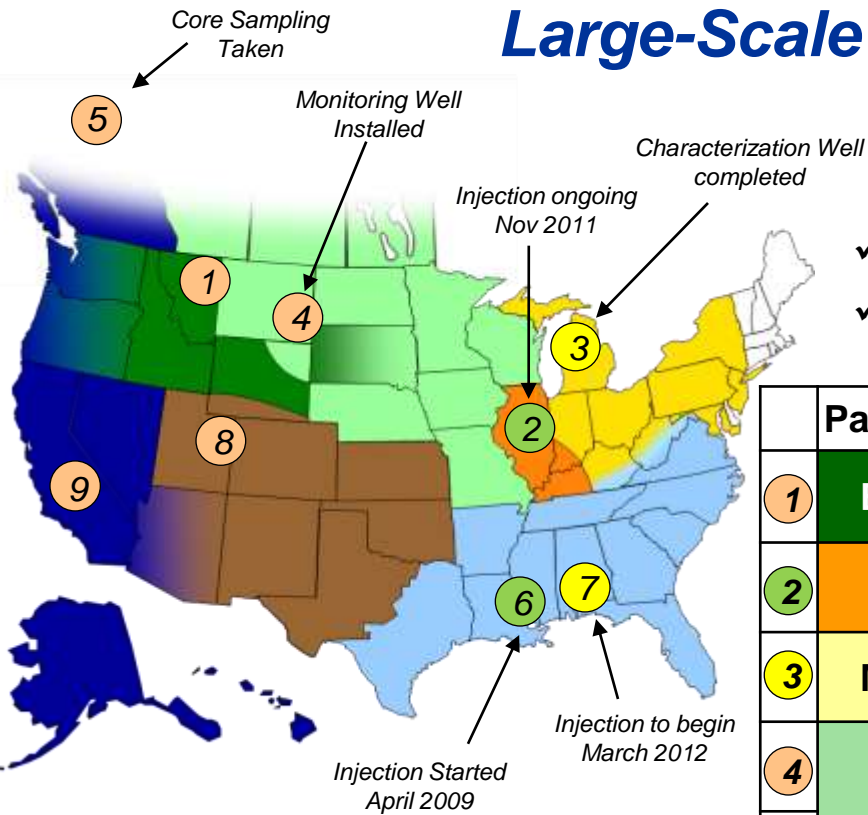
FutureGen 2.0: Current Status



- **For business reasons unrelated to FutureGen 2.0, Ameren's leadership role on the project will be reduced; FutureGen Alliance is requesting DOE approval to assume Ameren's leadership role on the power plant portion of the project**
- **Initial Total Project Cost Estimate**
\$1.29 billion
 - **\$1.05 billion DOE cost share, or 81%**
 - **\$241 million Industry cost share, or 19%**
- **Pre-FEED Cost Estimate**
\$1.65 billion
 - **Design adjustments & value engineering may reduce the \$1.65 billion**
- **Anticipated project on-line date: 2016**

RCSP Phase III: Development Phase

Large-Scale Geologic Tests



- ✓ Injection Targets -minimum planned volumes
- ✓ Two ongoing RCSP Injection Projects

- Injection Ongoing
- 2012 Injection Scheduled
- Injection Scheduled 2013-2015

Note: Some locations presented on map may differ from final injection location

	Partnership	Geologic Province	Storage Type
● 1	Big Sky	Sweetgrass Arch-Duperow Formation	Saline
● 2	MGSC	Illinois Basin-Mt. Simon Sandstone	Saline
● 3	MRCSP	Michigan Basin-St Peter SS or Niagaran Reef	Saline/Oil
● 4	PCOR	Powder River Basin-Muddy Formation	Oil Bearing
● 5		Alberta Basin-Sulphur Point Formation	Saline
● 6	SECARB	Interior Salt Basin-Tuscaloosa Formation	Oil/Saline
● 7		Interior Salt Basin-Paluxy Formation	Saline
● 8	SWP	Wasatch Plateau-Navajo Sandstone	Saline
● 9	WESTCARB	Regional Characterization	TBD

Southeast Regional CS Partnership

Cranfield Site Large-Scale Project

Target Formation

- Lower Tuscaloosa

CO₂ Source

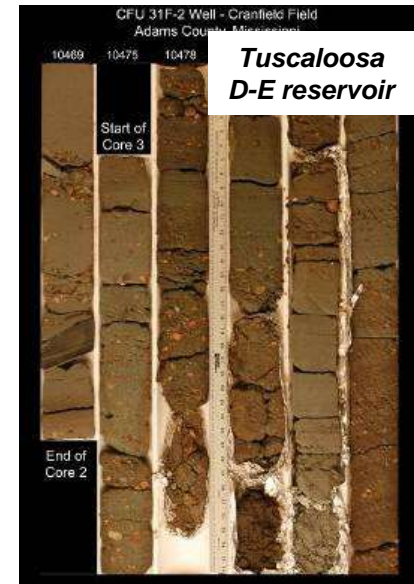
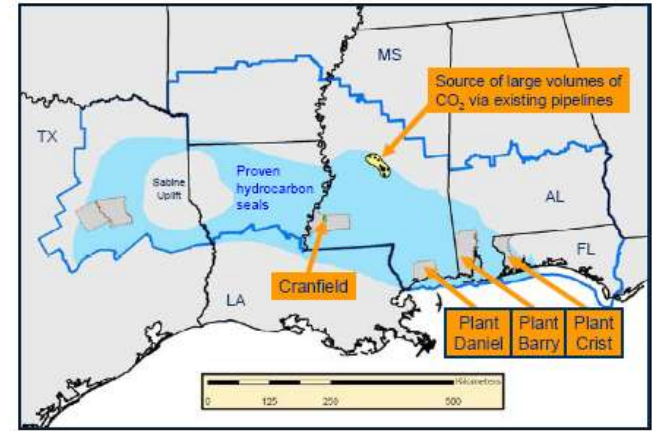
- Jackson Dome (natural source) delivered via Denbury Resources' Sonat CO₂ pipeline

CO₂ Injection Amount (Current)

- > 3.0 million metric tons (P3 only)
- > 3.5 million metric tons (combined P2 and P3)

Current Status

- Injection began on 04/01/2009
- Injection rate was ~ 432 metric tons/day, now < 100 metric tons/day
- Observation wells (F2 and F3) are between 220-370 feet from injection well
- Electrical Resistivity Tomography (ERT) receivers were installed in the two observation wells



Southeast Regional CS Partnership

Plant Barry Site Large-Scale Project

Target Formation

- Upper Paluxy Formation

CO₂ Source

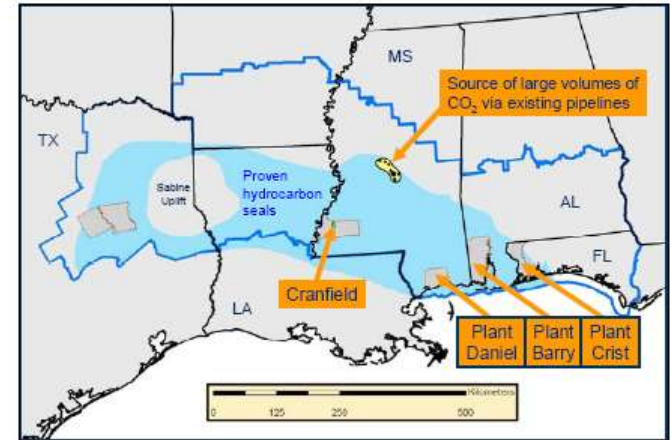
- Southern Company's Plant Barry Power Station

CO₂ Injection Amount

- ~ 250,000 metric tons over 2 years (March 2012)

Current Status

- Final Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) signed March 2011
- Characterization well drilled January 2011
- Capture Unit Shake-down at Southern Company's Plant Barry Coal-fired Power Plant started June 3rd
- UIC Class V Injection well permit (November 2011)
- Pipeline construction completed (November 2011)
- Injection well drilling completed (December 2011)
- Back-up Injection well completed (January 2012)
- CO₂ injection expected to start (March 2012)



Midwest Geological Sequestration Consortium

Decatur Site Large-Scale Project

Target Formation

- Mt. Simon Sandstone

CO₂ Source

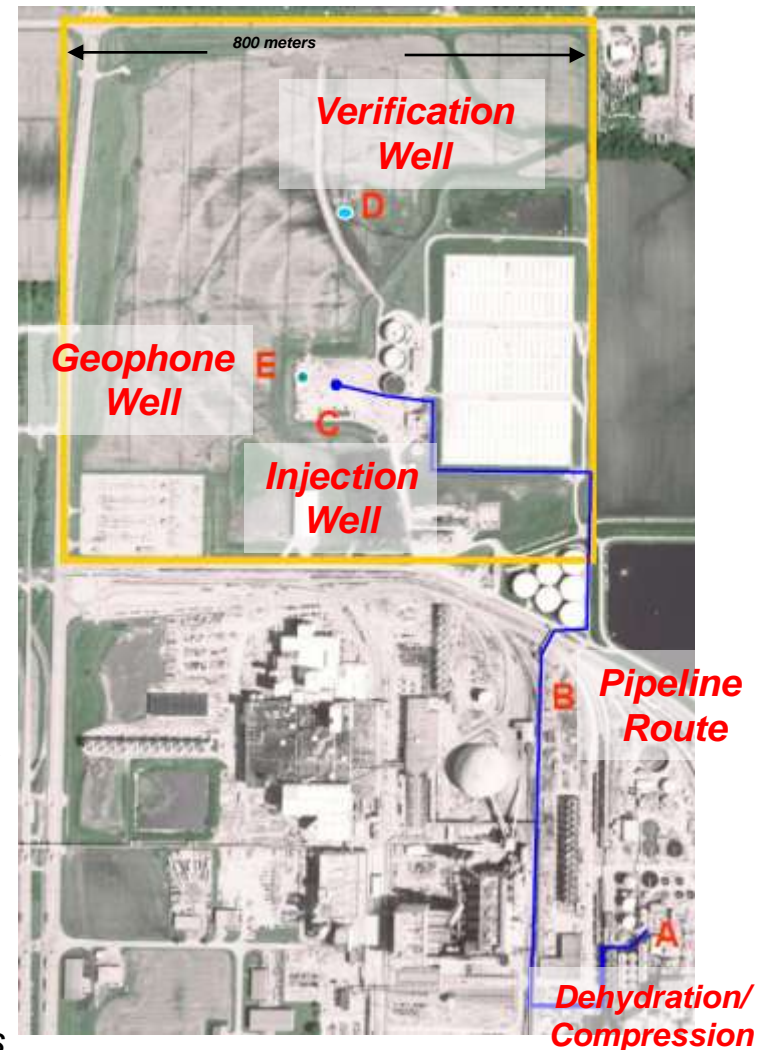
- ADM's Ethanol Production Facility

CO₂ Injection Amount

- 1 million metric tons over 3 years (Nov 2011)

Current Status

- Completed 4 square mile 3D seismic survey
- Completed drilling injection well, groundwater monitoring wells, geophone well, and verification well.
- CO₂ Pipeline installed and connected to injection wellhead.
- Installed all subsurface monitoring equipment.
- Completed commission of compression/dehydration facility
- Completed baseline fluid samples from verification well.
- Completed satellite interferometry (InSAR) baseline imaging data collection.
- UIC Permit finalized in March, 2011. Approval from IEPA to begin injection granted November 4, 2011.
- As of mid-January 2012 cumulative CO₂ injection volume is 50,000 metric tons



Midwest Regional CS Partnership

Michigan Site Large-Scale Project

Target Formation

- Niagaran Reef, oil bearing

CO₂ Source

- Core Energy provider per Natural Gas Processing Facility

CO₂ Injection Amount

- 1 million metric tons over 4 years
- Injection anticipated to begin 2012

Current Status

- Completed preliminary geologic assessment of Otsego County area
- Completed “Communications Plan” and met with various stakeholders including government and regulatory agencies
- Initiated Environmental Assessment (EA) Process
- Completed 3D Seismic Survey



MRCSP Well Drilling



CO₂ Compression Facility

Plains CO₂ Reduction Partnership

Bell Creek Site Large-Scale Project

Target Formation

- Colorado Group/Muddy Sandstone Formation

CO₂ Source

- Lost Cabin/Madden Gas Plant operated by Conoco Phillips

CO₂ Injection Amount

- As much as 1 million tons/year
- Injection anticipated late 2012 or early 2013

Current Status

- Working with commercial partner (Denbury Resources Inc.)
- Developing integrated modeling and MVA plan
- Completed installation of the monitoring well

