



Industrial Carbon Capture and Sequestration Technology Area 1 June 15, 2010

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Industrial Carbon Capture and Storage

Large-scale CCS from Industrial Sources (Area 1)

Objectives

- Demonstrate advanced technologies with CCS
- To progress *beyond* the R&D stage of readiness
- Integration with comprehensive Monitoring, Verification & Accounting (MVA)
- Demonstrate sequestration options deep saline formations, basalts, operating/depleted oil and gas fields, and unmineable coal seams

Target

- Industrial sources cement, chemical and aluminum refineries, and steel mills, manufacturing facilities, and power plant using opportunity fuels (petroleum coke, municipal waste, etc.)
- Industries may produce heat, fuels, chemicals, hydrogen or other useful products with or without electricity production.
- 1MM tons / yr of CO₂ emission from each plant for CCS

Project Locations for ICCS Area 1

Carbon Capture and Storage from Industrial Sources



Archer Daniels Midland Company

CO₂ Capture Using Amine Technology and Sequestration

- Develop and demonstrate up to 85% CO₂ capture from co-generation flue gas using amine technology
- Sequester roughly one million tons CO₂ annually in the Mt. Simon Sandstone
- Phase 1 cost: \$2,418,154
- Project site: Agricultural processing and biofuels plant located in Decatur, Illinois
- CO₂ capture from an ethanol plant



**ADM's Agricultural Processing and Biofuels Plant,
Decatur, IL**

Air Products and Chemicals, Inc.

Demonstration of Carbon Capture and Sequestration from Steam Methane Reforming Process Gas Used in Large-Scale Hydrogen Production

- Demonstrate > 90% CO₂ capture using activated Methyldiethanolamine (aMDEA) at hydrogen production plants in Port Arthur, TX
- Provide > 1 million tons CO₂ annually for EOR and sequestration
- Phase 1 Cost: \$901,874 (DOE \$721,499)
- Phase 2 Cost: \$228.8 million
 - Start: July 2010
- Operations:
 - Start: 2013

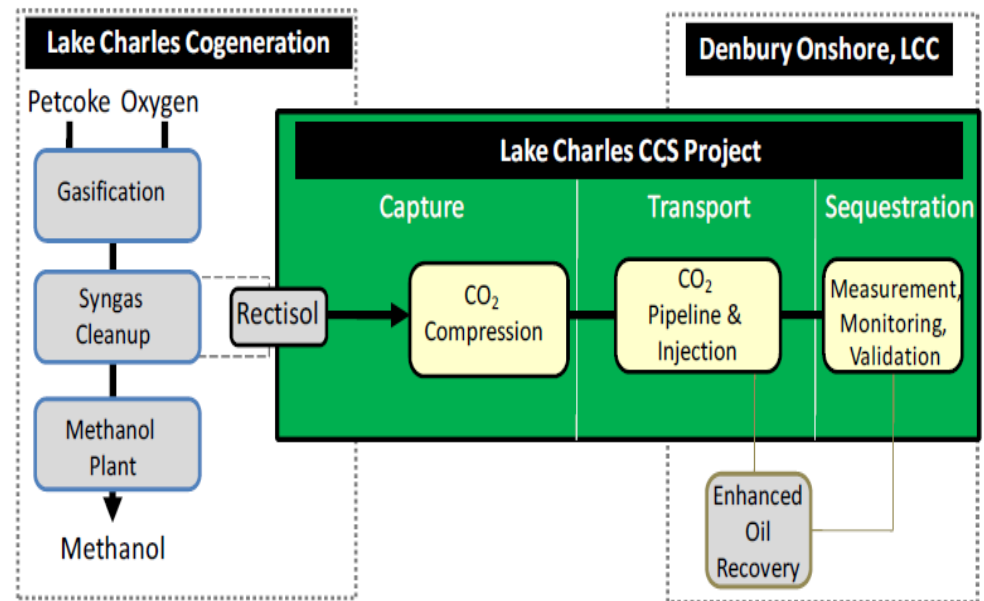


Port Arthur 1 & 2 Hydrogen Production Plants

Leucadia Energy, LLC

Carbon Capture and Sequestration from an Industrial Cogeneration Plant

- Demonstrate 90% CO₂ capture using Rectisol at an industrial cogeneration project in Lake Charles, LA using petcoke feedstock
- Provide 4.5 million tons CO₂/yr for EOR and sequestration
- Total Project Cost:
 - \$113 million
 - DOE \$61.4 million
- Design/Construction
 - Start: Late 2010
- Demonstration
 - Start: Late 2014



Battelle Pacific Northwest Division

Boise White Paper Mill Carbon Capture and Sequestration

- Demonstrate 90% CO₂ capture using Fluor Econamine FG PlusSM technology at a paper mill
- Sequester 650,000 tons CO₂ annually in deep flood basalt formations
- The Boise Mill's existing #3 Black Liquor Recovery Boiler chosen to supply the CO₂ capture system
- Total Project Cost: \$173,625,000 (DOE \$138,900,000)
- Design/Construction:
 - Start: Sept. 2010 / Dec. 2011
- Demonstration
 - Start: Jan. 2014



Boise Wallula Paper Mill

ConocoPhillips

Sweeny IGCC Carbon Capture and Sequestration Project

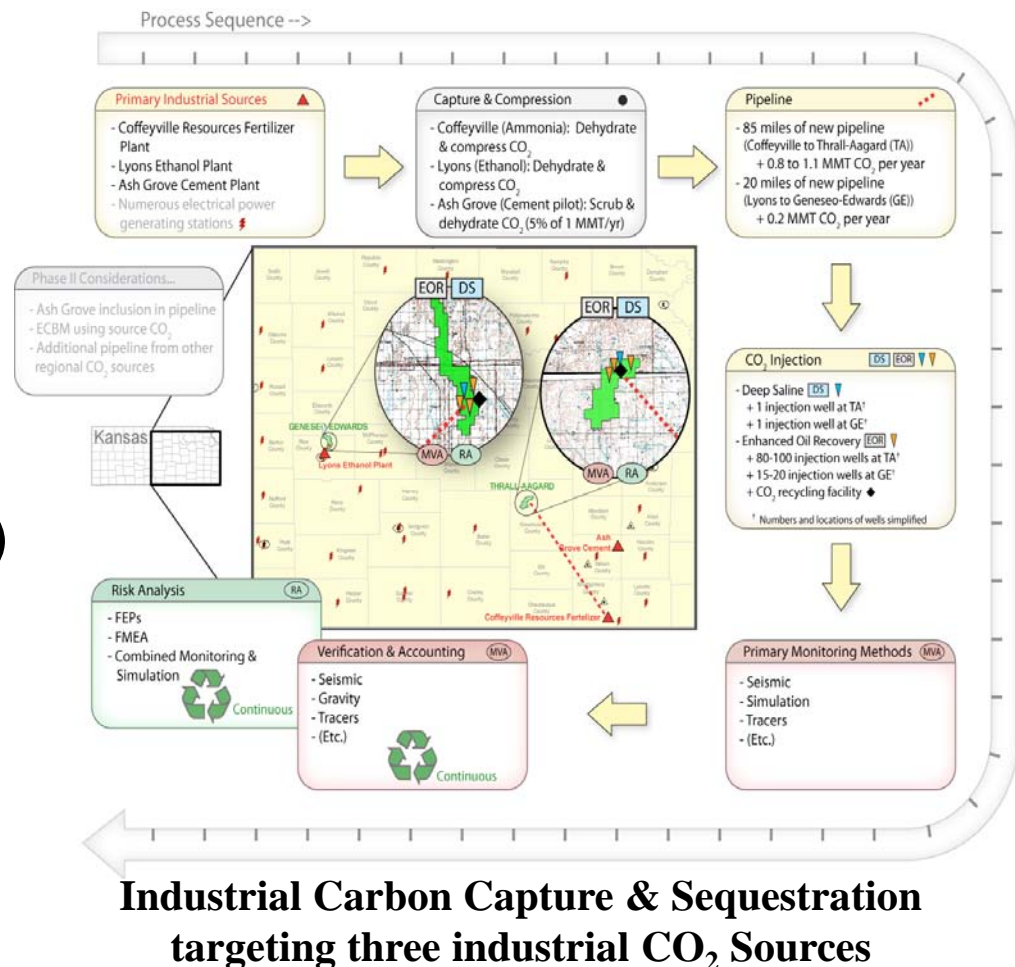
- Demonstrate 85% CO₂ capture using Selexol AGR (two-stage) at a 683 MWe (net) IGCC in Sweeny, TX, with Advanced ConocoPhillips E-Gas™ gasification and petcoke feedstock
- Sequester 5.6 million tons CO₂ annually in a depleted natural gas field
- Total Project Cost: \$4.1 billion (DOE \$585 million)
- Design/Construction:
 - Start: Jan. 2012
- Start Up:
 - July 2014



University of Utah

Integrated Mid-Continent Carbon Capture, Sequestration and Enhanced Oil Recovery (IMCCS) Project

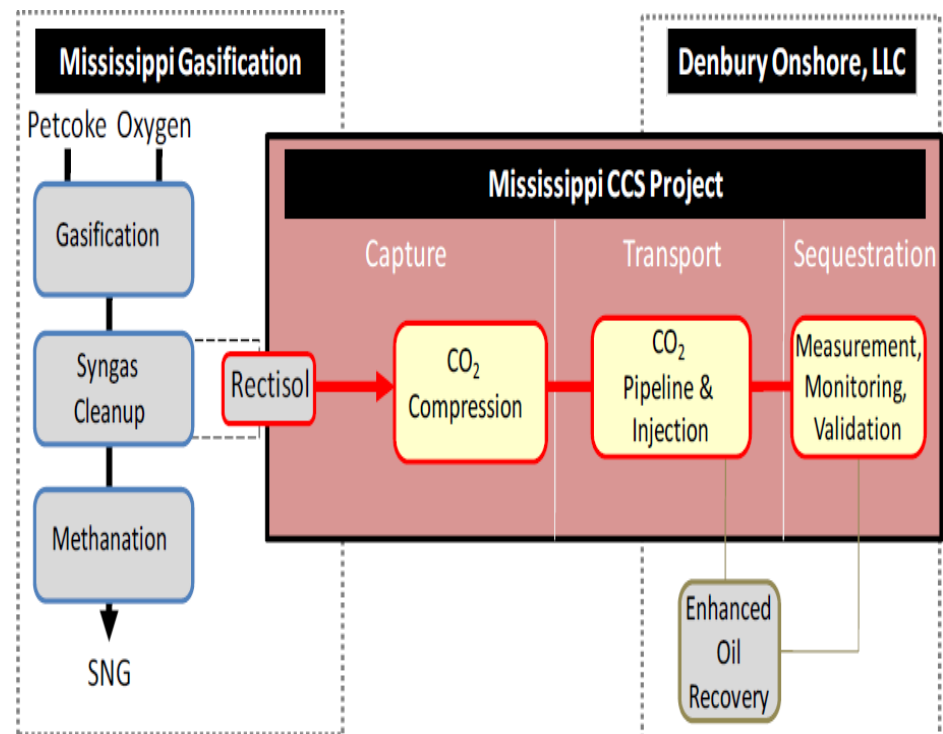
- **Project location: Kansas**
- **Demonstrate CO₂ capture from ammonia, ethanol, and cement plants**
- **Sequester 1 million tons CO₂ annually in EOR and saline formations (stacked)**
- **\$3,527,534 Phase 1 costs (\$2,788,373 DOE)**



Leucadia Energy, LLC

Carbon Capture and Sequestration from an Industrial Gasification Plant

- Demonstrate 90% CO₂ capture using Rectisol at an industrial gasification plant in Moss Point, MS using petcoke
- Provide 4 million tons CO₂ per year for EOR and sequestration
- Total Project Cost:
 - \$263 million
 - DOE \$136 million
- Design/Construction
 - Start: Late 2010
- Demonstration
 - Start: 2015



Praxair, Inc.

Carbon Capture and Sequestration (CCS) from a Hydrogen Production Facility in an Oil Refinery

- Demonstrate CO₂ capture using Praxair's Vacuum Pressure Swing Adsorption (VPSA) Process at a BP refinery, Texas City, TX
- Sequester approximately one million tons of CO₂ annually for EOR and sequestration
- Phase 1 Cost: \$2,335,796
- Phase 1 Start:
 - Nov. 16, 2009

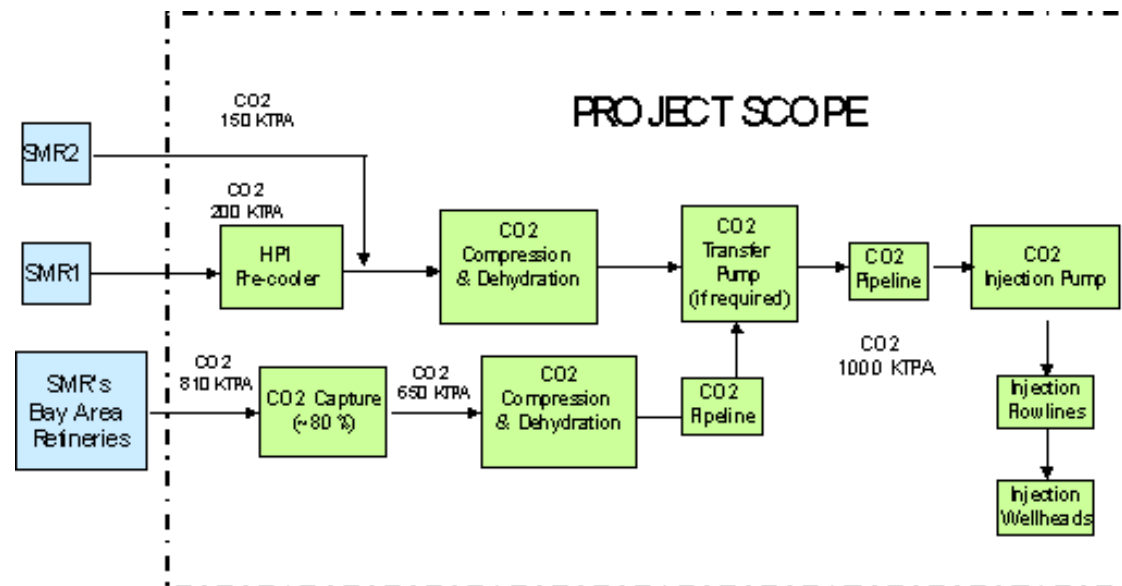


BP's Texas City Refinery, BP, P.L.C

C6 Resources (Shell-affiliate)

Northern California Oil Refinery CO₂ Reduction Project

- Demonstrate CO₂ reduction in Solano County, California by CO₂ capture from an oil refinery
- Sequester 1 million tons CO₂ annually in a saline formation
- Phase 1 Cost: ~\$4.8 million (DOE ~ \$3 million)
- Phase 2 Cost: ~\$560 million (DOE ~ 50% target)
- Design/Construction:
 - Start: March 2013
- Demonstration
 - Start: 2015



Cemex USA

CO₂ Capture and Sequestration for the Cement Industry

- Demonstrate a dry sorbent CO₂ capture technology at a cement plant in Odessa, TX
- Sequester between .5 - 1 million tons CO₂ annually in an EOR or saline formation
- Phase 1 Cost: ~\$1.8 million (DOE ~ \$1.45 million)
- Phase 2 Cost: ~\$190 million
- Design/Construction:
 - Start June 2012
- Demonstration
 - Start: June 2014



Wolverine Power Supply Cooperative

Carbon Capture on a CFB Power Plant with EOR and Sequestration

- Demonstrate CO₂ capture with Dow Chemical advanced amines at a 2 unit, 600 MW, CFB power plant
- Provide 1,000 tons per day of CO₂ EOR and sequestration
- Phase 1 Cost: \$3.4 million (DOE \$2.7 million)
- Design / Construction / Demo
 - Start: 2010 / 2011 / 2014



Wolverine Clean Energy Venture Host Site,
Rogers City, MI

Industrial Carbon Capture and Storage

Area 1 Phase 1: (7 months) - Multiple awards (11) to development -

- Preliminary design
- Project management plan
- Project schedule
- Project cost estimate
- Financial commitments pertaining to the non-DOE share of the project cost
- Funding plan
- Financial business plan
- Site commitment
- Environmental information for permitting and NEPA process
- Commercialization plan.

Industrial Carbon Capture and Storage

Area 1 - Phase 2

- **Front End Engineering and Design**
- **Detailed Design**
- **Construction**
- **Demo**