MRCSP: Partnering with Industry for Large and Small Scale CCS Projects

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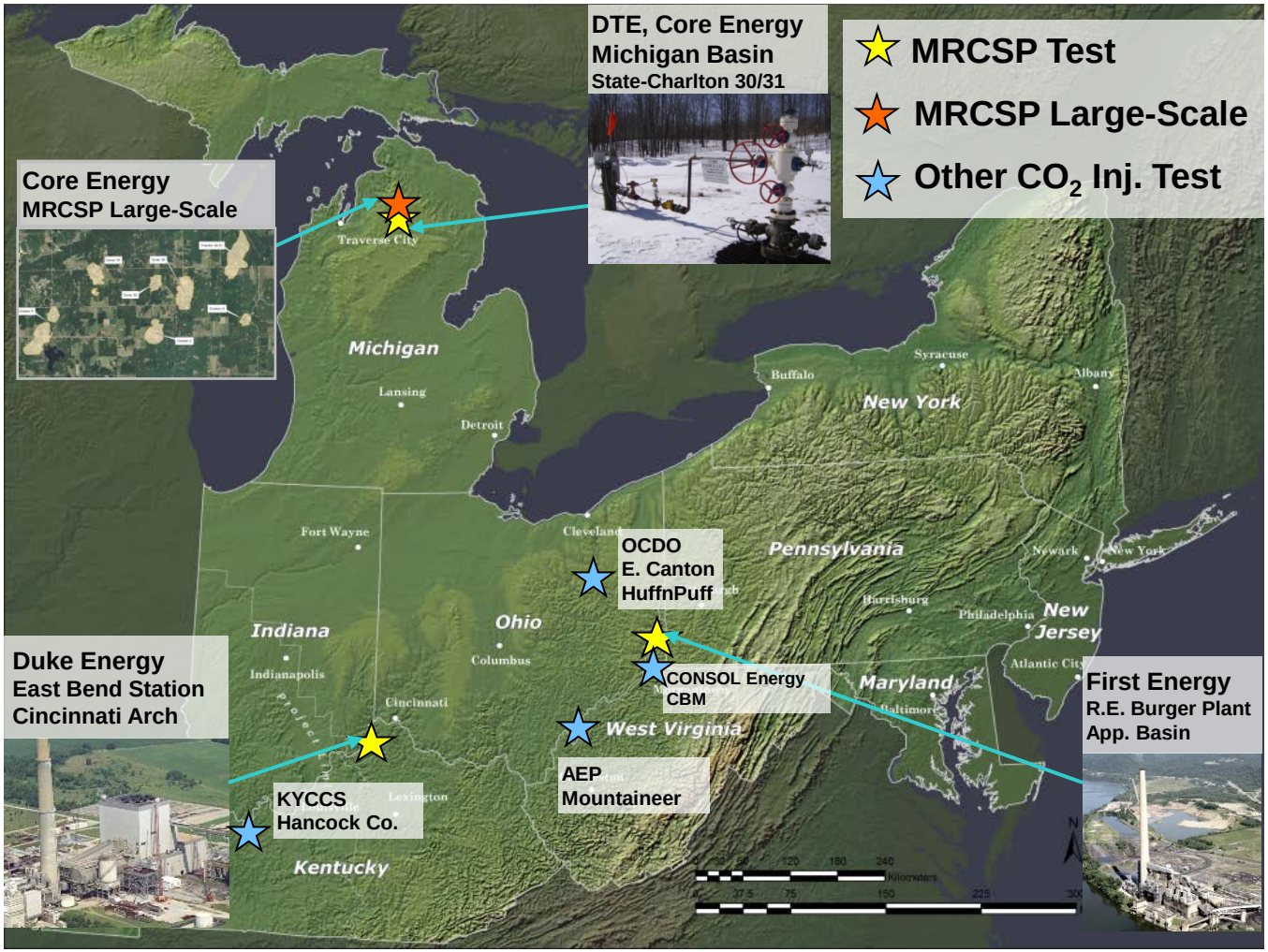
U.S. Department of Energy NETL
Carbon Storage R&D Project Review Meeting
Pittsburgh, Aug. 20-22, 2013

U.S. DOE/NETL

MRCSP Membership - Progress through Collaboration

Public-Private Partnerships play a key role in successful field tests

- Collaborations needed for technology advancement
- Past experience and research tells us
  - Our region has enormous storage potential
  - CCUS can be done safely and effectively



Region home to many field tests

State Geological Surveys are important partners for CCS deployment

- **Refine the mapping (GIS)** for sources and sinks
- **Help translate the results** of field testing into actionable strategies for the stakeholders in our region.
- **Identify promising reservoirs** for geological storage including off shore areas along the east coast.
- **Identify opportunities** for potential piggy-backing operations (logging, coring, and/or seismic) to collect geological data that would otherwise be lost

Department of Geosciences
Michigan Geological Repository for Research and Education (MGRRE)

WVGES West Virginia Geological and Economic Survey

Kentucky Geological Survey
University of Kentucky

New York State Museum

Rutgers

Industry provide infrastructure needed to support CO_2 injection

Gas processing plant, source of pure CO_2

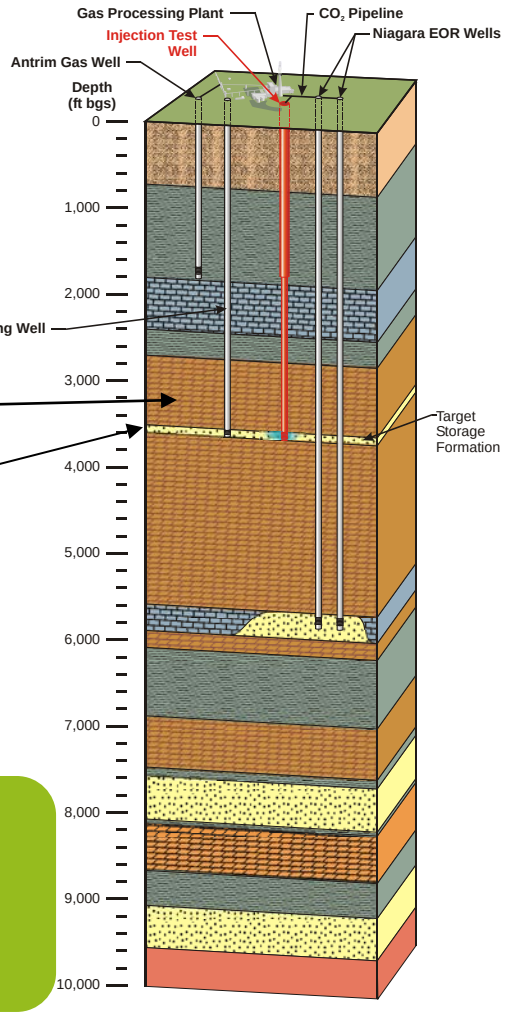
600 T/d Compressor

5000 Foot Deep Test Well Drilled in November 2006

180 feet of core taken

Injection well head

60,000 t CO_2 injected at Michigan



Confining Layer: Amherstburg Limestone

Injection Target: Bass Islands Dolomite 3,500 ft Saline Formation

Geologic Column

Industry relationships with the community can help execute projects

Duke Energy

Kentucky Geological Survey
UNIVERSITY OF KENTUCKY

Indiana Geological Survey 1837 Indiana University

O.D.N.R. Geological Survey

Open houses, facility tours, and briefings needed to successfully permit seismic surveys, well installation and CO_2 injection

Information sharing improves understanding of CCS in the Region

Battelle
The Business of Innovation

MRCSP
MIDWEST REGIONAL CARBON SEQUESTRATION PARTNERSHIP

FirstEnergy

Battelle

O.D.N.R. GEOLOGICAL SURVEY

NETL

WVGES
West Virginia Geological and Economic Survey

PENNSYLVANIA GEOLOGICAL SURVEY EST. 1836

MAKING OHIO COAL THE CLEAN CHOICE

PRAXAIR

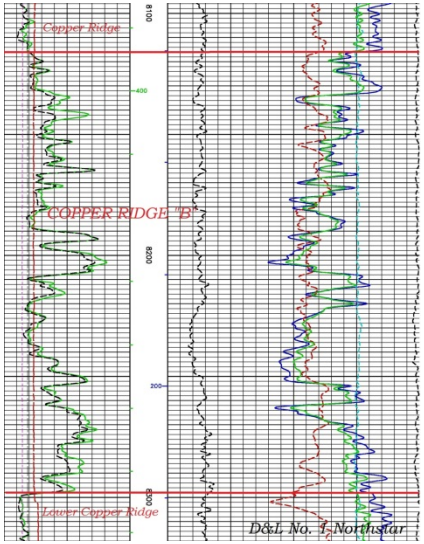
Ohio Development Services Agency

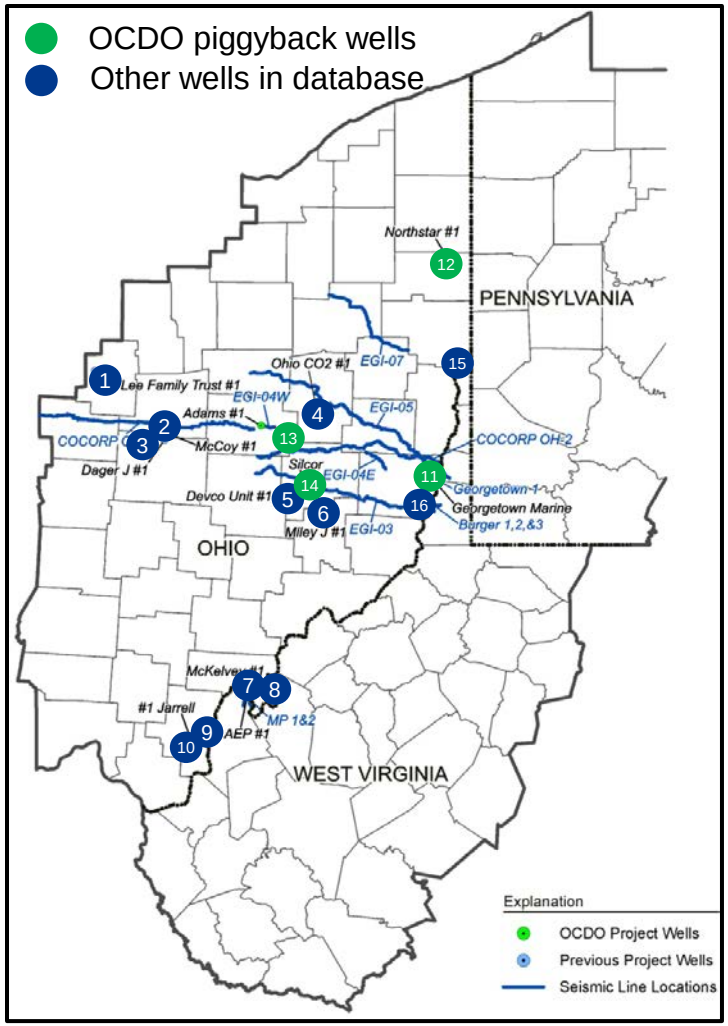
Schlumberger

Appalachian Basin Test provided a deep well point in a complex area

CO_2 Supply System evaluation team included EPRI
Additional Contributions by Numerous Other MRCSP Members

Piggybacking on drilling and seismic survey activities provide geologic data for modeling





3D/3C seismic data

•Core Energy (MI)

Advanced Wireline Logs

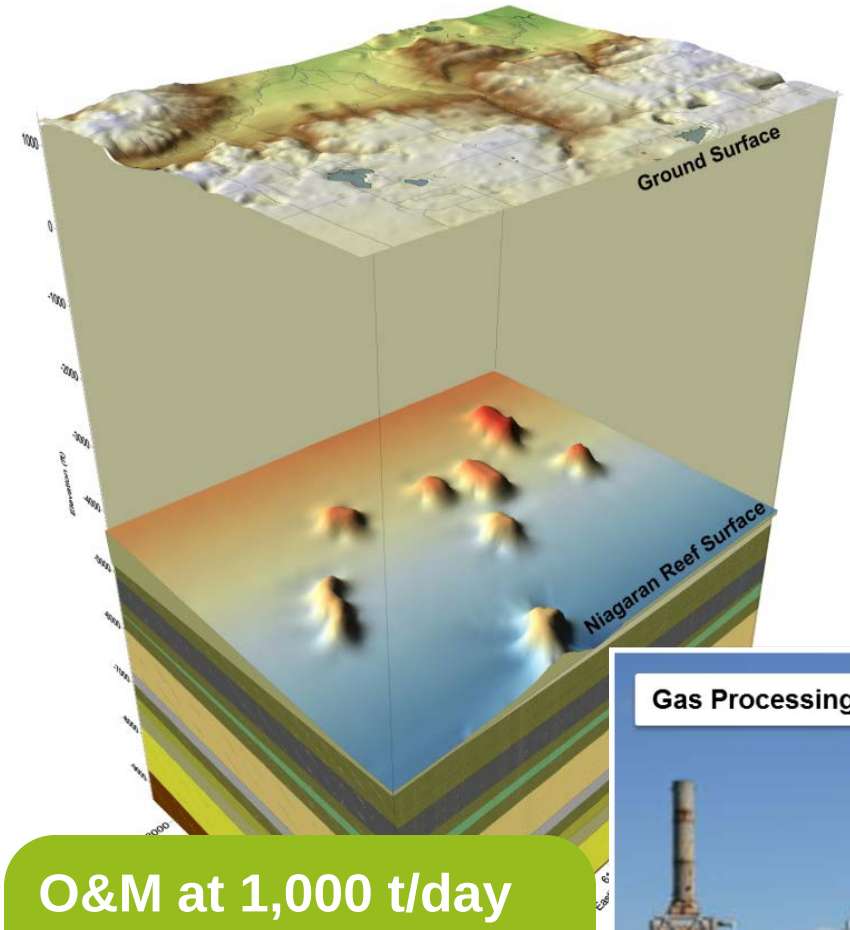
- Cutter Well (OH)
- Tuscarawas (OCDO)
- Cargas Well (MI)
- Duke Well (IN)

Seismic Line Purchase

- Eastern Ohio
- Northern Michigan

State Agencies like OCDO also crucial for MRCSP success

Oil and Gas Infrastructure critical for enabling CCS R&D for Phase III



- Core Energy has 7 CO_2-EOR fields in varying life stages
- Considerable in-kind cost sharing through existing wells, geological characterization efforts and other infrastructure

CORE ENERGY, LLC

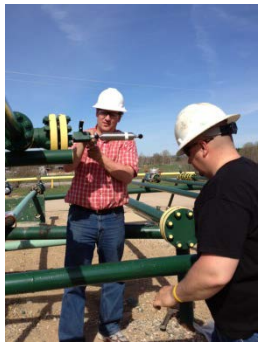
O&M at 1,000 t/day has begun.
More than 200,000 tCO_2 injected.

CCS is also about job creation

Battelle
The Business of Innovation

MRCSP
MIDWEST REGIONAL CARBON SEQUESTRATION PARTNERSHIP

Over 10 years MRCSP has drilled several multimillion $ wells, hired dozens of vendors, and collaborated with universities, state agencies, and others.



PCOR Partnership – Partnering with Industry

Carbon Storage R&D Project Review Meeting
Developing the Technologies and infrastructure for CCS
Pittsburgh, Pennsylvania
August 22, 2013

John Harju
Associate Director for Research

Energy & Environmental Research Center (EERC)…
The International Center for Applied Energy Technology®

UND THE UNIVERSITY OF NORTH DAKOTA

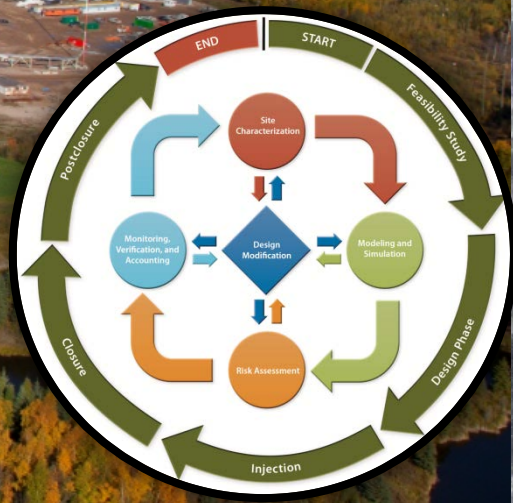
A Strong and Diverse Partnership

Zama and Apache Canada

Partnering with Apache Canada was key for developing an unobtrusive monitoring, verification, and accounting (MVA) plan that focused on the economically viable and technically feasible MVA techniques at a commercial project.

Fort Nelson and Spectra Energy

Partnering with Spectra Energy was key for developing an adaptive project management approach that integrates site characterization, modeling, risk assessment, and MVA throughout a project's lifetime.



Bell Creek and Denbury Resources Inc.

Partnering with Denbury Resources Inc. has been the key to success for developing an MVA plan on a full field, large – scale CO_2 EOR project.

Industry Partners are the Key To Project Success!

Having a strong partnership with oilfield service companies, software providers, and industry experts has been instrumental in executing successful carbon capture and storage projects in the Plains CO_2 Reduction (PCOR) Region!

Contact Information

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John Harju, Associate Director for Research
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Southeast Regional Carbon Sequestration Partnership

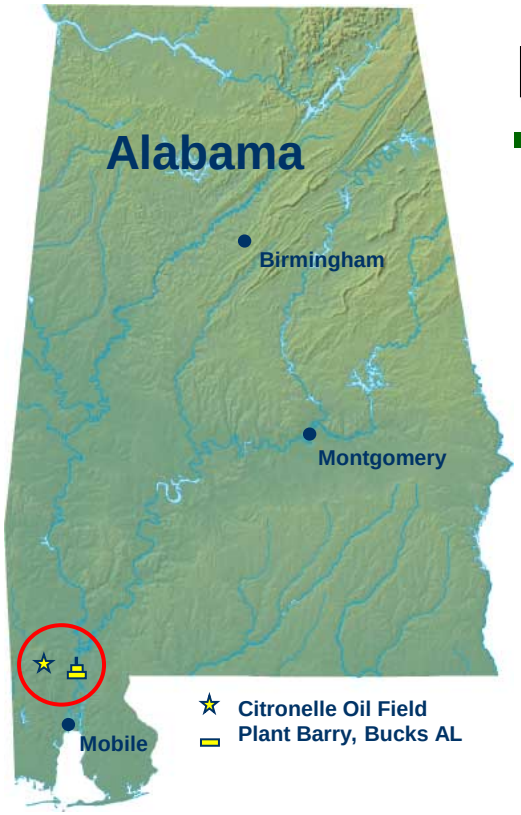
Partnering with Industry for Large Scale CCS Projects

Carbon Storage R&D
Project Review Meeting
August 22, 2013

Kimberly Sams
Asst. Director, Geoscience Programs
Southern States Energy Board

Richard A. Esposito, Ph.D., P.G.
Principal Research Geologist
Southern Company

Project Partner Framework

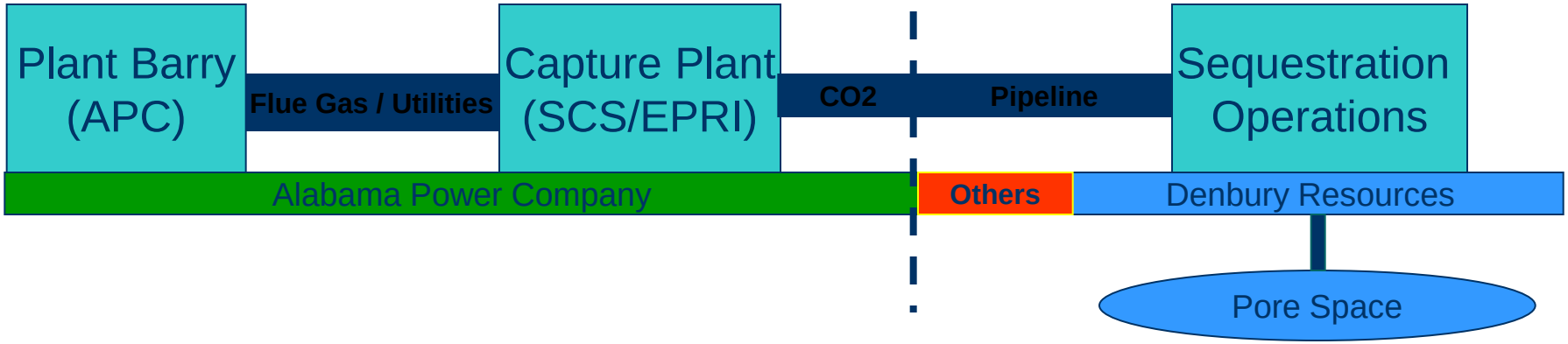


Capture Project

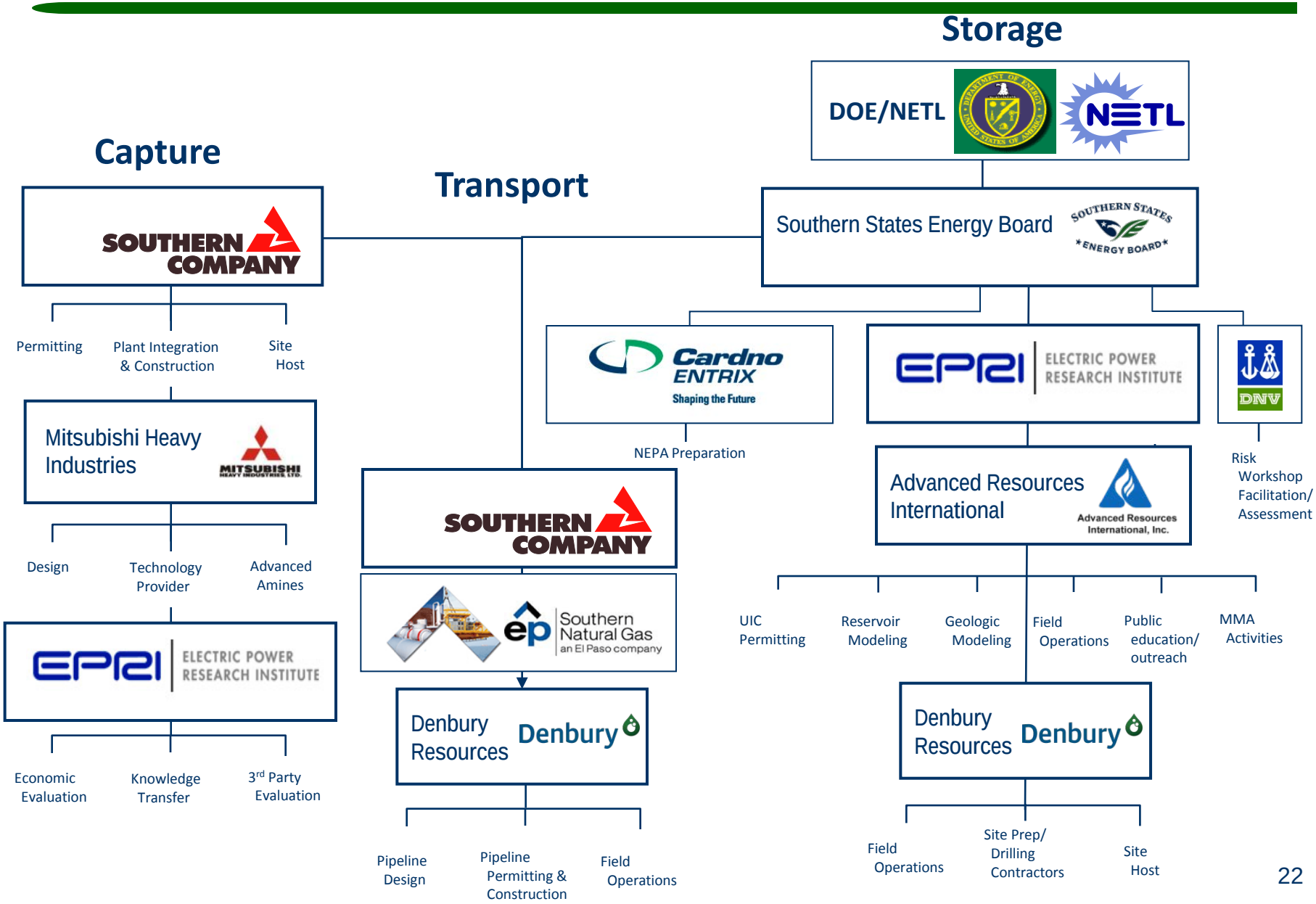
- Southern Company collaborating with Mitsubishi Heavy Industries
- Location: Alabama Power Company's Plant Barry
- Execution/contracting: Southern Company

Sequestration Project

- Project: DOE's SECARB Phase III
- Prime contractors: Southern States Energy Board (SSEB) and Electric Power Research Institute (EPRI)
- CO_2: Southern Company supplying
- Sequestration: Denbury Citronelle Field
- MVA: SSEB, EPRI, Advanced Resources International, Inc. (ARI)



Organization Chart



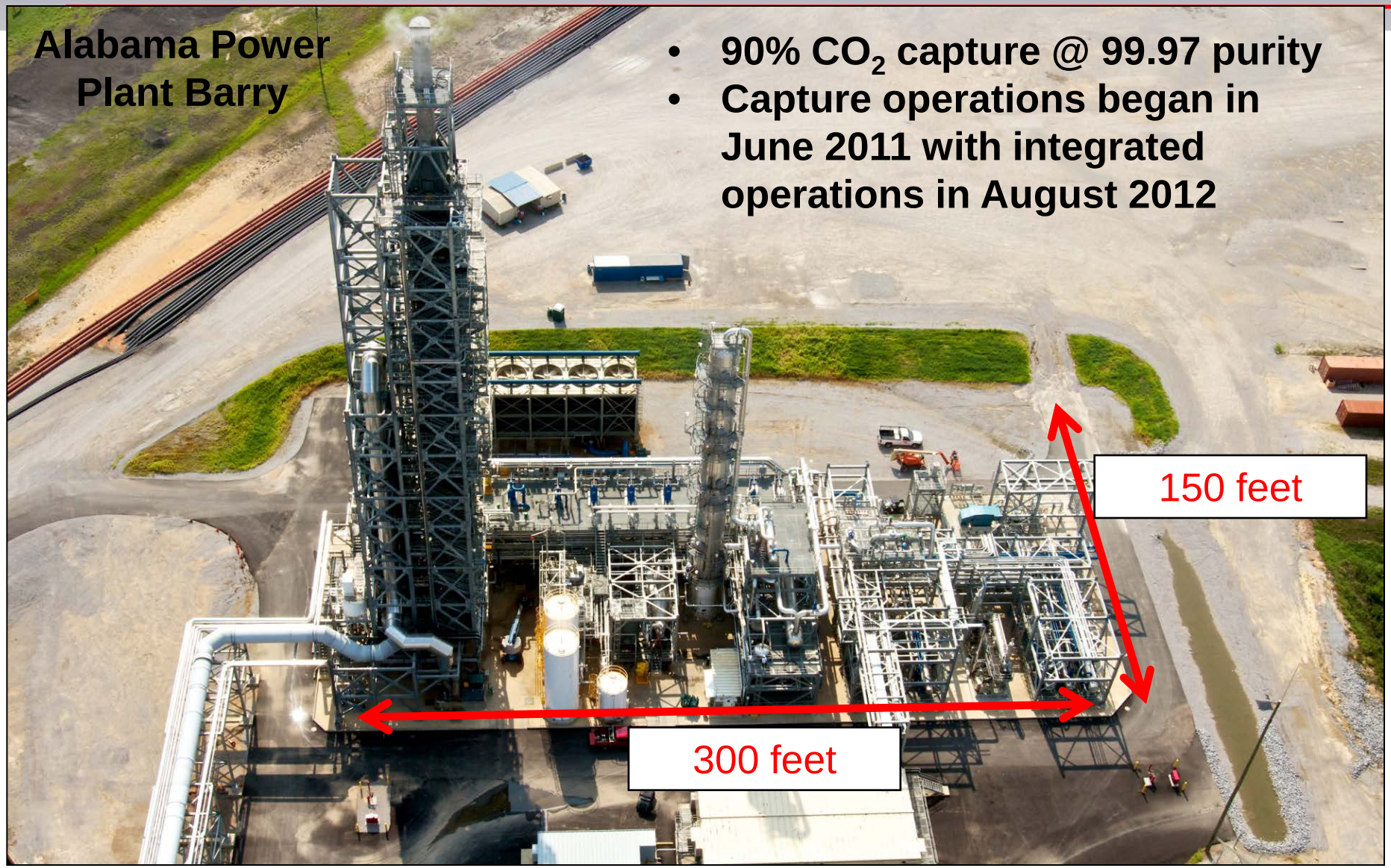
Agreements

- **CO_2 Off-take Agreement**
  - Southern Company & Denbury
  - Supply and off-take of anthropogenic CO_2 for transportation and use
- **Construction Terms & Considerations Agreement**
  - Southern Company & Denbury
  - Construction of CO_2 pipeline on Alabama Plant property
- **Backstop Agreement**
  - Southern Company & Denbury
- **Transportation Services Agreement**
  - SSEB & Denbury
  - Scope and terms of CO_2 delivery to Citronelle
- **MVA Service Agreement**
  - ARI & Denbury
  - Commitment to provide a site and to provide services required for MVA of injected CO_2
- **R&D Agreement**
  - ARI & EPRI
  - Engineering and MVA services

25-MW CCS Demo

"World's largest carbon capture facility on a fossil-fueled power plant"

SOUTHERN COMPANY



CO_2 Pipeline and Measurement Design

Check meter station & building at Denbury Citronelle Field

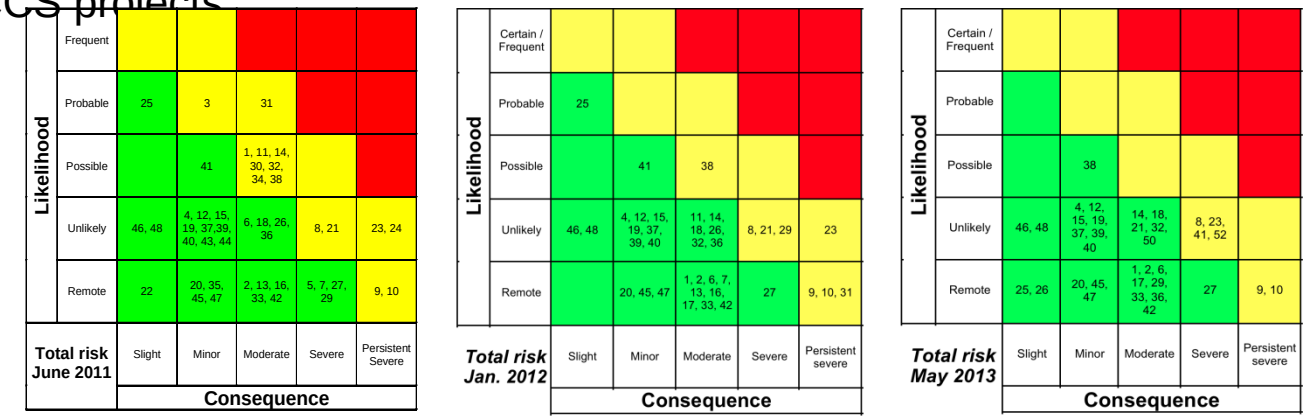
Check meter station to horizontal pump

Discharge side of horizontal pump

D-9-7#2 Wellhead with injection line

Keys to Success (and motivation)

- **Partners are "risk sophisticated"**
  - Perceived risks vs. real risks
  - Risk workshops at critical stages of the project to identify potential risk scenarios and risk owners and to develop mitigation plans"
- **"Learning by Doing" approach**
  - Understand the the coordination required to successfully integrate all components of a CCS project
  - Develop the business agreements for integrated projects and allocating risk among capture plant constructors/operators, CO_2 pipeline constructors/operators, and injection field developers/operators was a complex process that has provided extremely useful information for future commercial CCS projects



SECARB Anthropogenic Test – Evolution of Risks over time (June 2011 to May 2013)

Keys to Success (and motivation)

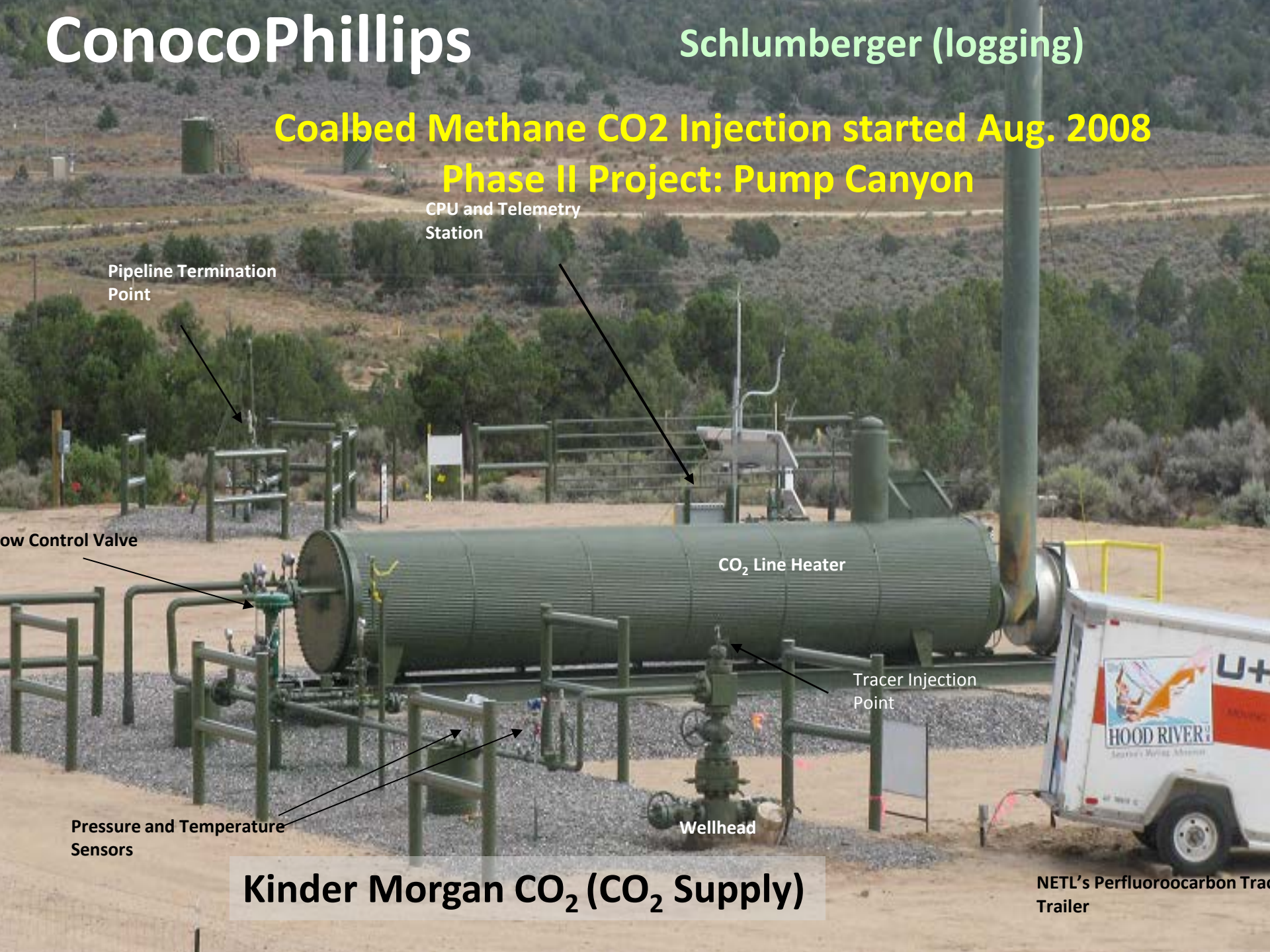
- **Commercial deployment of CCS technologies is a win-win situation**
  - Southern Company: CO_2 mitigation technologies; avoidance of stranded assets and related technology investments
  - Denbury: sources of anthropogenic CO_2 to supplement natural CO_2 supply from the Jackson Dome
  - NETL: fully integrated, large-scale project to demonstrate feasibility of CCS technologies and remove barriers to commercial deployment
  - SSEB members: low electricity prices for residents; low electricity rates attracts new businesses and new jobs; retention of jobs in our coal states

Resolute Energy Corporation

Geophone Cable Deployment – October 2007
Phase II Project: Aneth EOR-CO2

Injection Started April 2008

Kinder Morgan CO_2 (CO_2 Supply)

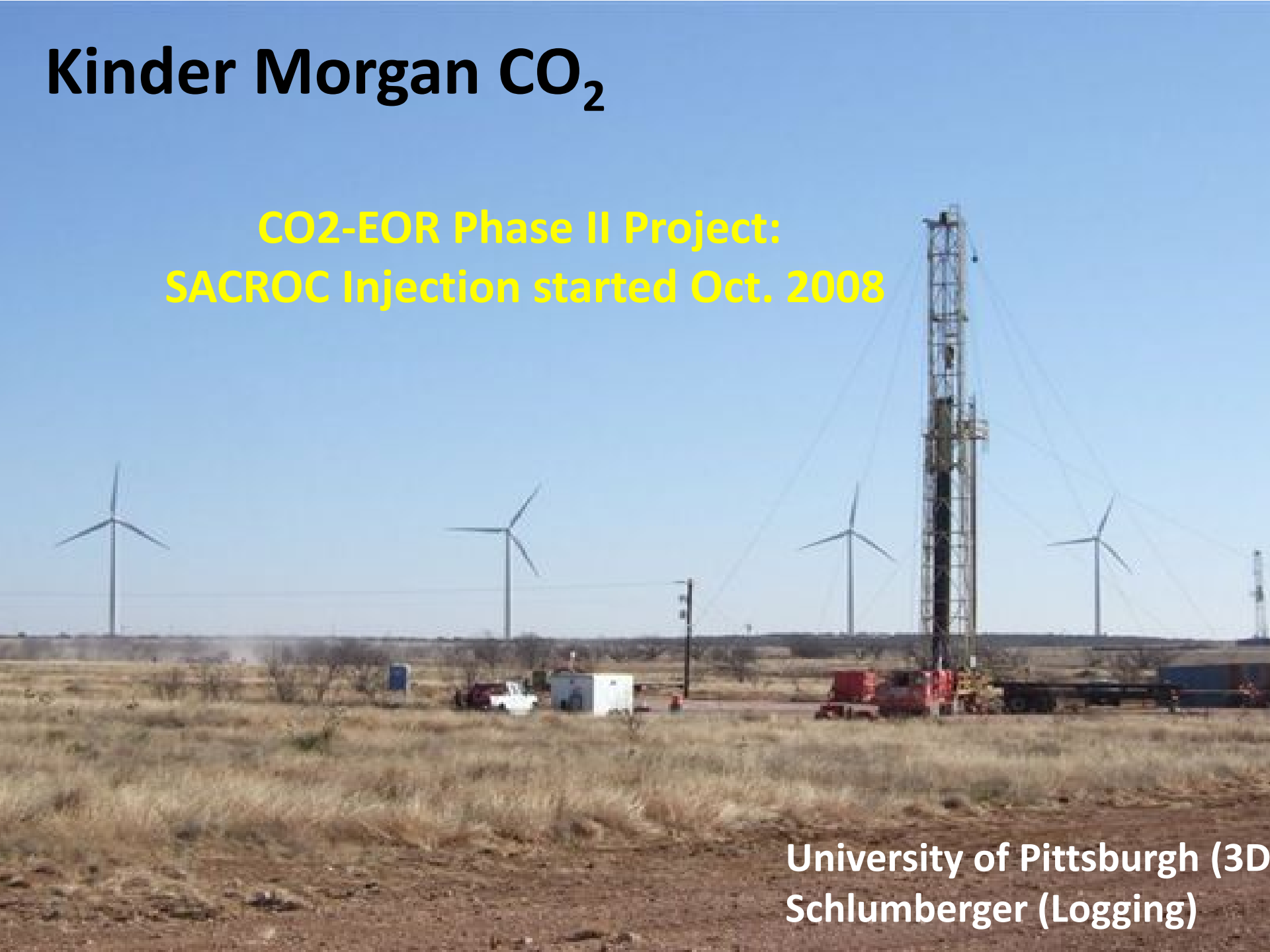

ConocoPhillips
Schlumberger (logging)
Coalbed Methane CO2 Injection started Aug. 2008
Phase II Project: Pump Canyon
CPU and Telemetry Station
Pipeline Termination Point
ow Control Valve
CO_2 Line Heater
Tracer Injection Point
Pressure and Temperature Sensors
Wellhead
Kinder Morgan CO_2 (CO_2 Supply)
HOOD RIVER
NETL's Perfluoroocarbon Trac
Trailer

ConocoPhillips

Sandia National Lab

Coalbed Methane Produced Water Terrestrial Test
Phase II Project: Pump Canyon ~ July 2008

Kinder Morgan CO_2



Chaparral Energy LLC

Schlumberger Carbon Services

CO_2-EOR Phase III Project:
Farnsworth Unit 3D Surface Seismic Survey, Jan. 2013

Smaller Companies

	Benefits	Problems
Management	Talk to top manager or very close	
Decision	Rapid Response	
Permits		May require SWP help
Cost Share		May not be able to fulfill, is a significant % of business
Liability		We are required to take more risk. Hard to incorporate into their budget
Cooperation	Working with decision makers	
Reports		May not be set up for DOE cost accounting
Employees	If available willing to work with us	May be short handed
Priority	High	
Commitment		If seen as a problem with bottom line can be low

Medium Size Companies

	Benefits	Problems
Management	Contacts general close to top management	
Decision	Within reasonable time	
Permits	Permitting a normal process	
Cost Share	Fairly easy	May put company project at risk
Liability	Set up to take risk. Minimal risk for SWP	
Cooperation	Working with or near to decision makers	
Reports	Will provide information for SWP to make up reports	Do not particularly want to be encumbered with too much paper work
Employees	Usually very willing to provide information and work with SWP	
Priority	Moderate	
Commitment	Must fit into corporate strategy. Need a corporate champion. Once committed, good	

Large Companies

	Benefits	Problems
Management		Never see and many levels from project work
Decision		Generally changes are slow and permission may be slow coming
Permits	Permitting normal process	
Cost Share	Insignificant % of Budget	
Liability	Use to considerable risk and have insurance set up	
Cooperation		Slow and cumbersome
Reports		Not a high priority
Employees	Have the manpower and expertise to aid considerably in the project	May be slow in getting manpower to aid
Priority		Low
Commitment	Must fit into corporate strategy. Once committed, very high	