

Carbon Capture and Storage: What Role for States?

Presented to: **The National Conference of State Legislators Energy Policy Summit**
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CCS: What Role for States?

- What is CCS?
- Why is CCS Important?
- History of CCS in the US
- Drivers for CO₂ Reductions
- Leadership in CCS
- Opportunities and Challenges
- What's Next

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CCS: What Role for States?

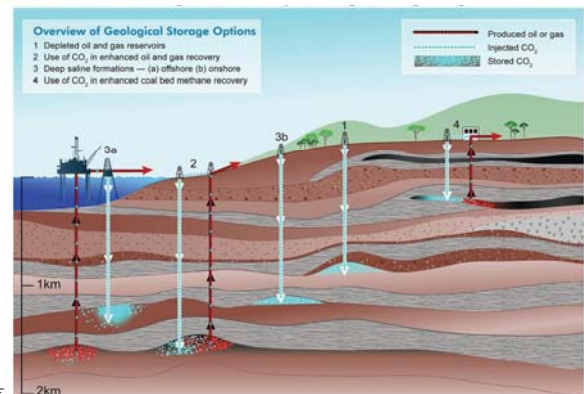
- What is Carbon Dioxide (CO₂)
- What is Carbon Capture and Storage (CCS)?
 - Technical definition

Carbon dioxide (CO₂) capture and storage (CCS) is a process consisting of the separation of CO₂ from industrial and energy-related sources, transport to a storage location and long-term isolation from the atmosphere.
 - Only real certifiable verifiable for sure means of reducing emissions of carbon dioxide.
 - energy conservation and energy efficiency
 - renewable energy, nuclear power, hydrogen and fossil fuels containing lower percentages of carbon
 - terrestrial sequestration, i.e., reforestation, agricultural practices
 - CCS

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Methods for Storing CO₂ in Deep Underground Geological Formations



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Why is CCS Important?

- Relevant to Global Warming Climate Change debate
- Shift in Public Opinion
- Promotes Energy Independence
- Crossroads consideration: benefit vs. waste

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Why is CCS Important?

- Relevant to Global Warming/Climate Change Debate
 - Growing interest within industry and government
 - Leads to Emissions reductions w/o increase in capex for alternative fuels or R&D

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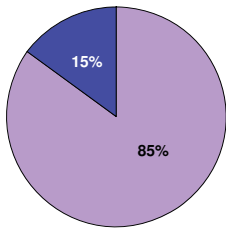
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Why is CCS Important? Shift in Public Opinion

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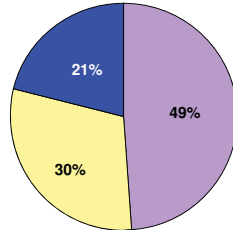
% of Americans Who See Global Warming as Currently Happening



■ Happening ■ Not Happening

Source: ABC News/Time/Stanford Global Warming Poll, March 2006

% of Americans Who See Global Warming as Important



■ Extremely or Very Important
■ Somewhat Important
■ Not Important

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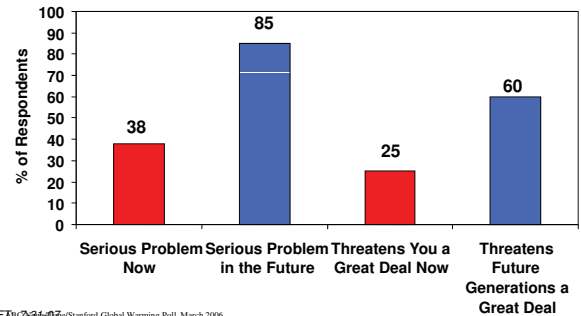
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Why is CCS Important? Shift in Public Opinion

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Level of Threat: Now and Future



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Why is CCS Important?

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- Shift in Public Opinion
 - Change in Leadership – US House & Senate
 - Oscar for Al Gore's "An Inconvenient Truth"
 - Supreme Court Ruling in Mass v. EPA
 - Contemplated in major financial transactions
 - Explosion of Regional and State activity
 - Intergovernmental Panel Climate Change Report

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Why is CCS Important? Promotes Energy Independence

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The United States is a Growing Nation:

- In 2005:
 - added almost 3 million people to population, which now exceeds 300 million
 - built 1+ million new homes
 - started 3+ million new small businesses
 - flew 800 trillion passenger miles
- Energy consumption is proceeding apace. EIA projects that by 2030 we will need an additional:
 - 33 quads of energy – equivalent to combined current consumption of Germany, Italy and the UK
 - 7 million barrels per day of oil – equal to current production of Iran plus Venezuela
 - 4,500 bcf of NG – current production of the Gulf of Mexico plus Wyoming
 - 650 mt of coal – more than half of our current production
 - 240 Gigawatts of installed electric generating capacity – equal to 250 nuclear power plants
 - According to the U.S. Census Bureau, population could approach 500 million people by 2050

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Why is CCS Important? Promotes Energy Independence

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The Price of Oil Dependence:

- **Dependence** means loss of control. In 2000, the EIA projected oil would be \$23 per barrel in 2005. Actual price was \$52.
- **Cost** of imported oil has led to record trade deficits. At current prices, in the next decade **\$2 trillion** will be spent to buy foreign oil -- \$20,000 for each American household.
- **Competition** for energy from China, India and other developing nations must now be factored into our energy planning. To secure oil supply China is making long term deals with major oil producers – Venezuela, Iran, Saudi Arabia, Russia and Nigeria.
- **Peak oil** is a matter of debate but **depletion** of the worlds' major oil fields cannot be denied. At the accepted 5% depletion rate we must produce an additional 4 million barrels of oil per day **just to stay even**.
- **Concentration** of oil supply in questionable regions. Over 75% of the world's oil in OPEC nations and 6% in Russia. As North Sea and Mexico fields deplete, this concentration will increase even further.

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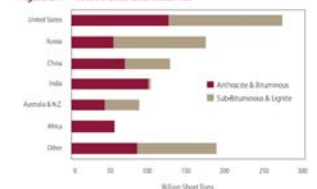
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Why is CCS Important? Promotes Energy Independence

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- The U.S. is the leader in known coal reserves.
- Coal is the fuel source for over 50% of the electricity generated in the U.S.
- Recoverable U.S. coal reserves are enough to supply the U.S. for more than 250 years.

Figure 2.1 Recoverable Coal Reserves



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Why is CCS Important? Promotes Energy Independence

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"Because of our unique ability to sequester CO₂ while increasing oil production from previously depleted oil fields, we ... improve the local economies..., but can also help reduce our nation's need for imported oil."

Gareth Roberts, President and CEO,
Denbury Resources Inc.

"By displacing imported natural gas or oil, coal helps address America's energy security... With the development of CCS technologies, coal power becomes part of the solution to satisfying our energy needs in an environmentally responsible fashion."

Summary of Testimony to the Carbon Capture and Sequestration Subcommittee on Energy and Air Quality of the U.S. House of Representatives
Electric Power Research Institute.

Stu Dalton, Electric Power Research Institute

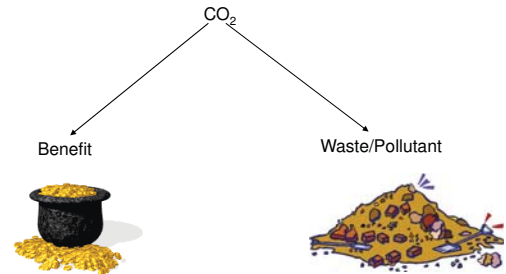
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Why is CCS Important?

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• Crossroads



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Why is CCS Important?

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• Crossroads

– Beneficial Use

Beneficial Uses of CO₂

1	Refrigeration	Used for cooling
2	Fire Extinguishers	Extinguishes some fires by depriving the fire of oxygen
3	Carbonated beverages	Produces carbonation
4	Decaffeinated Coffee	Used in super cooled fluid extraction process
5	Dry ice	Used to make stage fog and other visual effects
6	Feedstock	Can be used as feedstock for chemical manufacturing
7	Biofuels	Aids in the process of algae growth to make biofuels
8	Enhanced Oil Recovery	Aids in recovery of oil from depleted oil and gas reservoirs – huge volumes utilized

– Waste Pollutant

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History of CCS in the US

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- DOE – Early Investigations and the Creation of Seven Regional Sequestration Partnerships
- Carbon Sequestration Leadership Forum
- Development of the FutureGen Program
- Funding of the Interstate Oil & Gas Commission's Carbon Capture and Storage Regulatory Recommendation Reports (Phase I and Phase II Studies)
- Assessments of National Storage Capacity
- "Incidental" Storage Via Enhanced Oil Recovery (EOR) using CO₂

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History of CCS in the US

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• DOE – Regional Carbon Sequestration Partnerships

Partnership	Partnership Lead	States Represented
Midwest Regional Carbon Sequestration Partnership	Battelle Memorial Institute	IA, IY, MI, MO, OH, PA, WV
An Assessment of Geological Carbon Sequestration Options in the Illinois Basin	The Board of Trustees of the University of Illinois, Illinois State Geological Survey	IL, IN, KY
Southeast Regional Carbon Sequestration Partnership	Southern States Energy Board	AL, AR, FL, GA, LA, MS, NC, SC, TN, TX, VA
Southeast Regional (Tuscaloosa) Carbon Sequestration Partnership	New Mexico Institute of Mining and Technology	AL, CO, IA, NE, NM, TN, TX, UT, WY
West Coast Regional Carbon Sequestration Partnership	State of California, California Energy Commission	AK, AZ, CA, NV, OR, WA
Big Bix Regional Carbon Sequestration Partnership	Montana State University	SD, MT, ND, WY
Plains CO ₂ Reduction Partnership	University North Dakota - Energy & Environmental Research Center	IA, MO, MN, ND, NC, MT, SD, WI, WY

• Carbon Sequestration Leadership Forum

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History of CCS in the US FutureGen

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- Announced in 2003, FutureGen is \$1.5 billion public-private partnership to design, build, operate a near zero emissions coal-fueled power plant
- FutureGen will produce 275 MWs of electricity using IGCC while simultaneously capturing and permanently sequestering CO₂ emissions
- Possible Sites:
 - Jewett, Texas
 - Odessa, Texas
 - Mattoon, Illinois
 - Tuscola, Illinois
- Timeline:

Final Site Selection	Start Construction	Begin Operations
December 2007	2009	2012

- FutureGen will integrate coal gasification, electricity generation, emissions control, CCS and hydrogen production in the first commercial scale demonstration project.

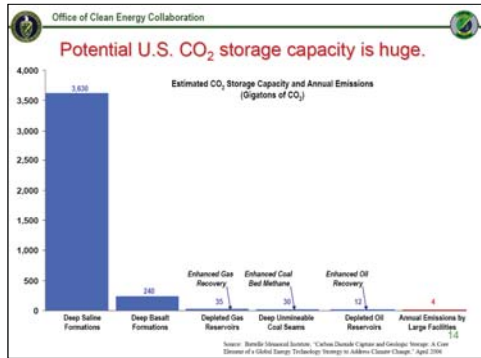
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History of CCS in the US

U.S. Storage Capacity

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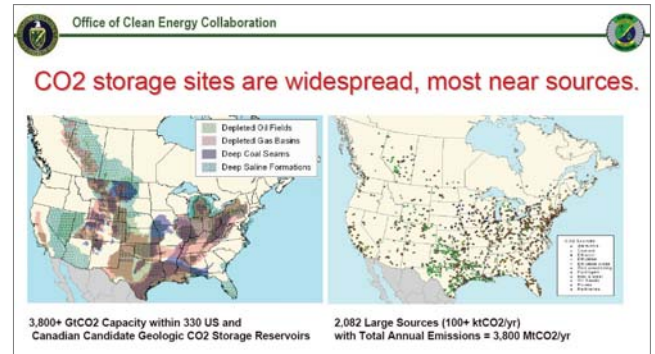
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History of CCS in the US

U.S. Storage Capacity

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History of CCS in the US

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- Enhanced Oil Recovery (EOR)
 - Field of Dreams
 - Production Potential
 - Bridge to Regional Infrastructure Development and Large-scale Storage

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History of CCS in the US

Enhanced Oil Recovery – Field of Dreams

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Status of U.S. CO₂-EOR



- Currently, 82 CO₂-EOR projects provide 237,000 B/D of production
- Affordable natural CO₂ launched CO₂-EOR activity in the 1980's
- Federal tax credits (Sec.43) and state severance tax relief still encourage CO₂-EOR

Weyburn Enhanced Oil Recovery Project

(An Operating Project Maximizing Oil Recovery and CO₂ Storage)



- Largest CO₂-EOR project in Canada
 - CO₂ = 1.4 Bbbls
 - 155 MMbbl incremental
- Outstanding EOR response
- World's largest geological CO₂ sequestration project
 - 2.4 MMt/year (current)
 - 7 MMt to date
 - 21 MMt with EOR
 - 55 MMt with EOR/sequestration

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History of CCS in the US

Enhanced Oil Recovery – Production Potential

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	(Billion Barrels)
TECHNICALLY RECOVERABLE	89
ECONOMICALLY RECOVERABLE*	47

* Using a \$40 per bbl oil price

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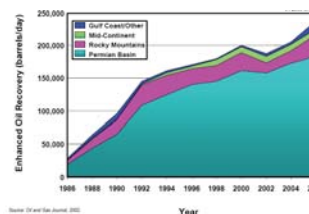
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History of CCS in the US

Enhanced Oil Recovery – Production Potential

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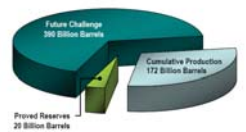
Growth of CO₂-EOR Production in the U.S.



Large Volumes of Domestic Oil Remain "Stranded" After Primary/Secondary Oil Recovery

Original Oil In-Place: 582 B Barrels*

"Stranded" Oil In-Place: 390 B Barrels*



Source: US and World Annual, 2011

*All Barrelics bases on the Appalachian Basin.

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History of CCS in the US

Enhanced Oil Recovery—Bridge to Development

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- Jump start infrastructure development for CCS
 - Although saline formations have the largest capacity for storage, initial projects will be connected to EOR operations that provide the experience and resources to initiate CCS
 - Additional income stream from offset credits will make CCS economical
 - CCS for EOR has the potential to provide the commercial drivers for transport infrastructure

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Drivers for CO₂ Reductions

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- Choices Ahead for CO₂ Reductions: Carrots vs. Sticks
 - Incentives for Early Action and Risk Takers
 - Carbon Tax
 - Cap & Trade

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Leadership/Early Adopters

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- Feds vs. States

Federal Gov't	States
•2001 Voluntary Policy	•RGGI
•Energy Policy and Conservation Act of 2005	•WGGI
•Current Legislation	•California
	•Florida
	•New Jersey
	•Texas
	•Wyoming
	•New Mexico
	•Etc.

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Leadership/Early Adopters

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- New Mexico
 - Interim Report on Identified Statutory and Regulatory Issues: Carbon Dioxide Sequestration, New Mexico Energy, Minerals, Natural Resources Department, Oil Conservation Division dated June 27, 2007*
 - Identifies the issues and challenges to be addressed by potential statutory and regulatory changes, questions, concerns and recommendations of the stakeholder group, and to present preliminary findings and research to date for further policy development

* Ref : <http://www.emnrd.state.nm.us/OCD/documents/InterimReportCO2Sequestration.pdf>

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Leadership/Early Adopters

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- Wyoming

- Wyoming Pipeline Authority
 - Realized Success with Two Natural Gas Pipeline Projects (Kern River PL (loop) and Rockies Express
 - Expanded to Include CO₂ Pipelines
- Wyoming Infrastructure Authority
 - Recently Announced Coal Gasification Partnership with PacifiCorp
 - Will involve CCS
 - WIA provided with \$1 billion in bonding authority



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Leadership/Early Adopters

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- California

- AB 705 – CO₂ Storage Bill
 - Impacted by Public Concerns
 - Setback for CCS
- AB 1925 – Study of CCS by California Energy Commission



"There is overwhelming scientific evidence and knowledge that catastrophic leakage from a geologic sequestration site is extremely unlikely..."

Letter to the Honorable Loni Hancock/California Assembly, from Dr. Susan Hovorka, Gulf Coast Carbon Center, et al.

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Leadership/Early Adopters

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- CCS Not Yet Adopted as an “Offset”
- Maine legislation makes provisions for CCS
- Hope that other states will follow

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Leadership/Early Adopters

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- Texas
 - HB 3732 – Implements the first State Certification Program for CCS for EOR
 - Recognizes CCS (including EOR) as a “Qualifier” for Clean Energy
 - Provides severance tax reduction for Industrial CO₂ EOR
 - Provides Ad Valorem Tax Abatement for CO₂ Capture
 - HB 1967 – CO₂ Pipelines

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Challenges and Opportunities

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- Commodity/pollutant
- Commercialization (and Rewarding Early Action)
- Infrastructure Development
- CCS Increases Electricity Costs \$0.02 kwh
- Subsurface Ownership
- Liability Issues Unresolved
- Need for Regulatory Frameworks (State-by-State)
- Public Perception and Acceptance
- CO₂ Demand and Market development without Required Reductions
- Need for Large-scale commercial demonstration projects

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Next Steps

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- Educate, Influence & Inform
- Mobilize citizens and policymakers
- Unified Voice
- Carbon Policy Driver
 - Is it necessary?
 - Are Carrots Enough?
- Policy Development Forums
 - North American Carbon Capture & Storage Association
 - Texas Carbon Capture & Storage Association

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Questions?

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