

US Carbon Sequestration Program



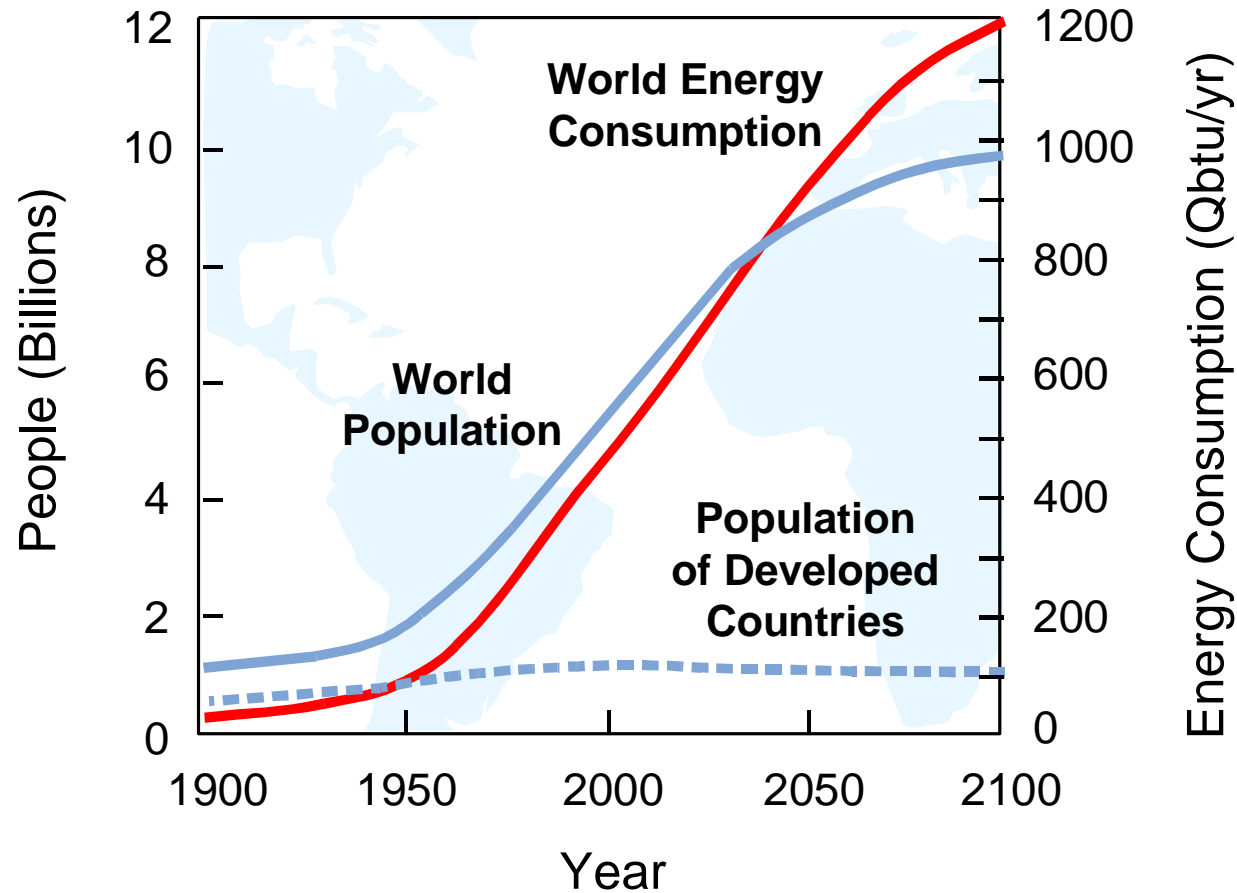
Regional Partnerships in Terrestrial Carbon Sequestration

Lexington, KY
November 6-7, 2001

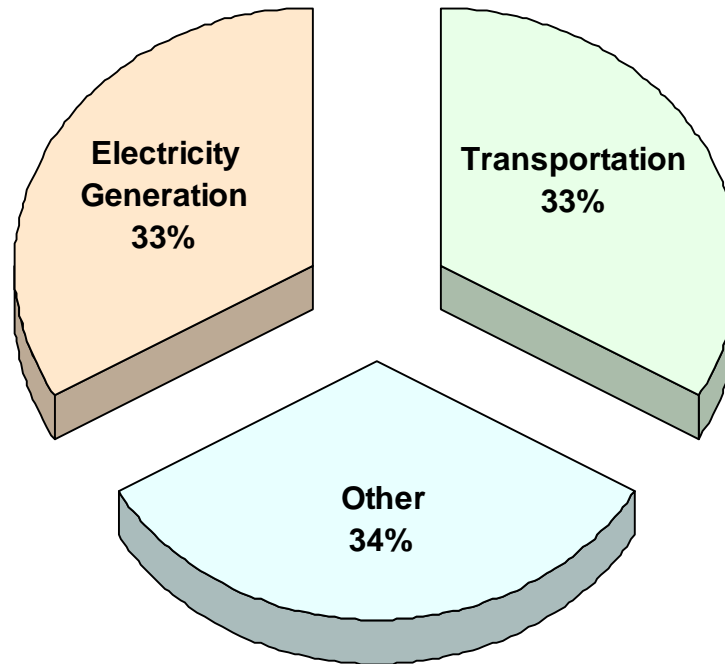
Charles E. Schmidt
National Energy Technology Laboratory



World Energy Use Is Growing Dramatically



Carbon Sequestration Addresses All Carbon Emissions



Direct Carbon Sequestration

Indirect Carbon Sequestration

Capture and store CO ₂ from large point sources	Decarbonize fuels, capture and store CO ₂	Offset emissions by removing CO ₂ from the atmosphere
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Sequestration Program Goals

- Provide economically competitive and environmentally safe options to offset all projected growth in baseline emissions of greenhouse gases by the U.S. after 2010, with offsets starting in 2015
- The long- term cost goal is in the range of \$10/ ton of carbon avoided sequestration net costs



Current Status

- **FY2001 funding** **\$18.8 Million (M) USD**
- **Research portfolio** **~60 projects**
- **Program funding** **~\$100 M**
 (**>\$40 M cost share from project participants**)
- **Major university and industrial participants**
- **Projects focus on reducing the costs of CO₂ capture and geologic sequestration**
- **FY2002 proposed funding** **\$32.2 M**



NETL Sequestration Research Focus Area

- **Main emphasis on geologic sequestration and CO₂ separation and capture**
 - **Initiated 15 new projects in FY2001 (peer review selection process)**
 - **Collaborations with industry, academia, and other government agencies**
- **Expect staffing and other laboratory resources to increase**



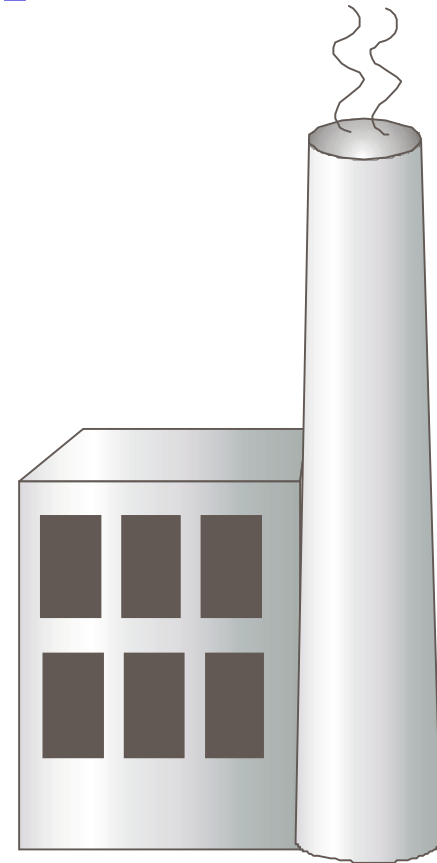
Key Research Areas

- CO₂ separation and capture
- Sequestration in geological structures
- Ocean sequestration
- Integration of energy production systems with terrestrial sinks
- Advanced chemical and biological concepts
- Modeling and assessments (crosscutting)



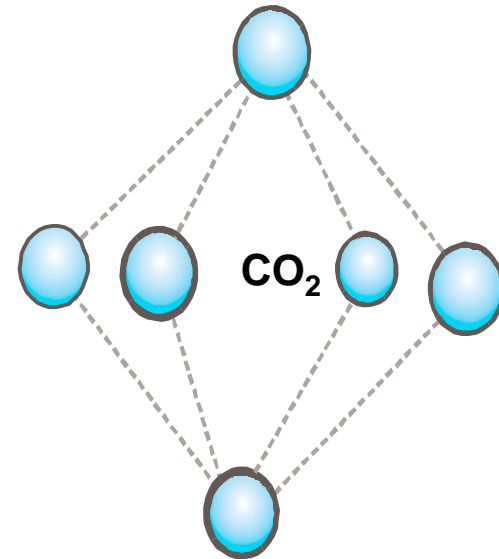
CO₂ Capture Assessments of Retrofit Options

- Existing 450 MW coal-fired power plant
- Evaluating three options
 - MEA scrubber
 - Enriched O₂ combustion
 - MEA/MDEA scrubber
- Developing cost (operating & capital) and performance data



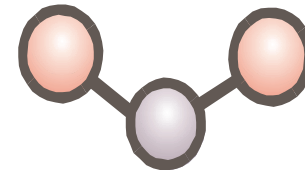
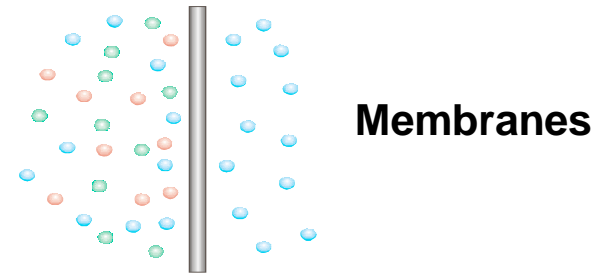
CO₂ Capture Technology Breakthroughs

- CO₂ separation using hydrates
 - Relatively mild conditions
 - Significantly lower energy requirements for regeneration
- Pilot-scale testing underway
- Best suited for gasification systems



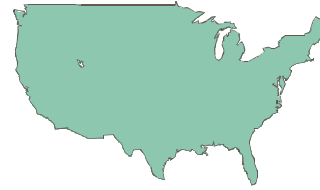
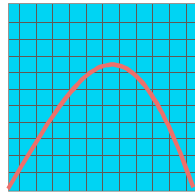
CO₂ Capture Technology Breakthroughs

- Thermally optimized
- Highly selective, able to operate in flue gas conditions
- Vortex tube contactor
- Dry, regenerable sorbent
- Multi-pollutant removal capabilities



CO₂ Sorbents/Solvents

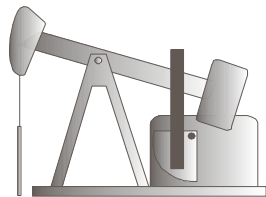
Geologic Sequestration



Understand the process,
optimize performance

Identify suitable sites

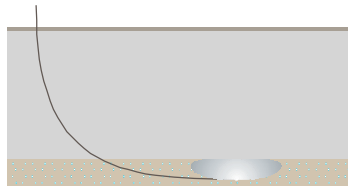
Verify environmental
acceptability



Oil Reservoirs



Coal Seams



CO₂ Injection into
a Saline Formation

2004	2006	2008
2006	2008	2010
2008	2012	2015

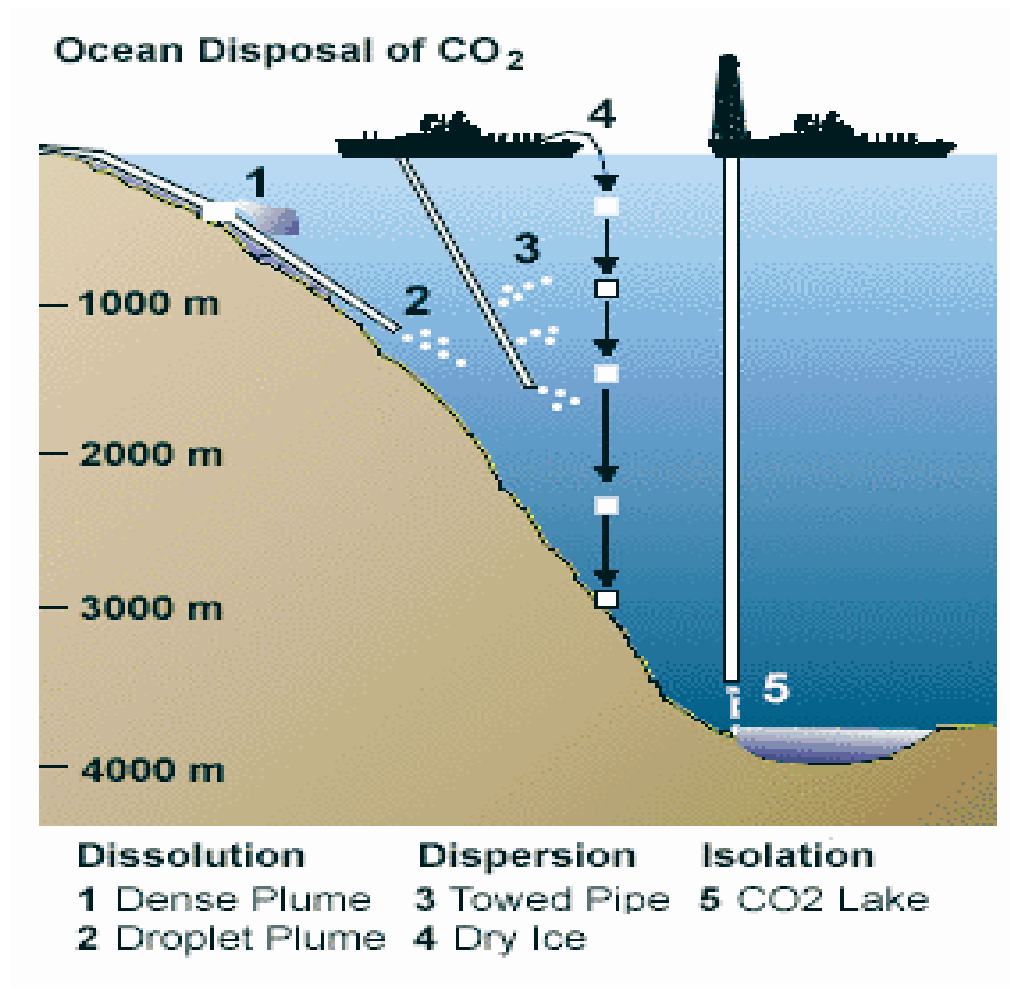
Geological Sequestration Research Priorities

- **Capacity Evaluation**
- **Sequestration Mechanisms**
- **Long-Term Integrity**
- **Environmental Impacts**
- **Safety**



Ocean Sequestration

- Deep Ocean Injection CO₂
 - Theoretically the largest sink (>100,000 GTs)
- Potential for Significant Indirect Carbon Sequestration



Ocean Sequestration Research Priorities

- **Environmental Impacts**
- **Carbon Cycle Chemistry**
- **Long-Term Integrity**
- **Ocean Circulation**
- **Transport and Injection Technology**



Integration with Terrestrial Sinks Forests and Agricultural Systems

- Partnering with TVA and EPRI to amend coal mine spoil at Paradise Station
 - Using coal combustion byproducts
- Results could produce three-way win
 - Sequester carbon
 - Improve quality and productivity of the land
 - Provide local habitat for plants and animals
- Four additional projects aimed at reclaiming degraded lands



Advanced Conversion and Utilization Concepts

- Develop advanced approaches to chemical, biological, or other processes to recycle, reuse, or store GHG produced in energy systems
 - advanced photosynthetic processes
 - advanced fuel conversion cycles
 - new CO₂-based products
 - produce methane hydrates using CO₂ hydrates



Advanced Conversion Processes



- Electricity generation using metal oxide as reducing agent
 - Produces steam and high-pressure CO₂
 - Reduce metal oxidized in air
- Can be used with gasified coal or natural gas

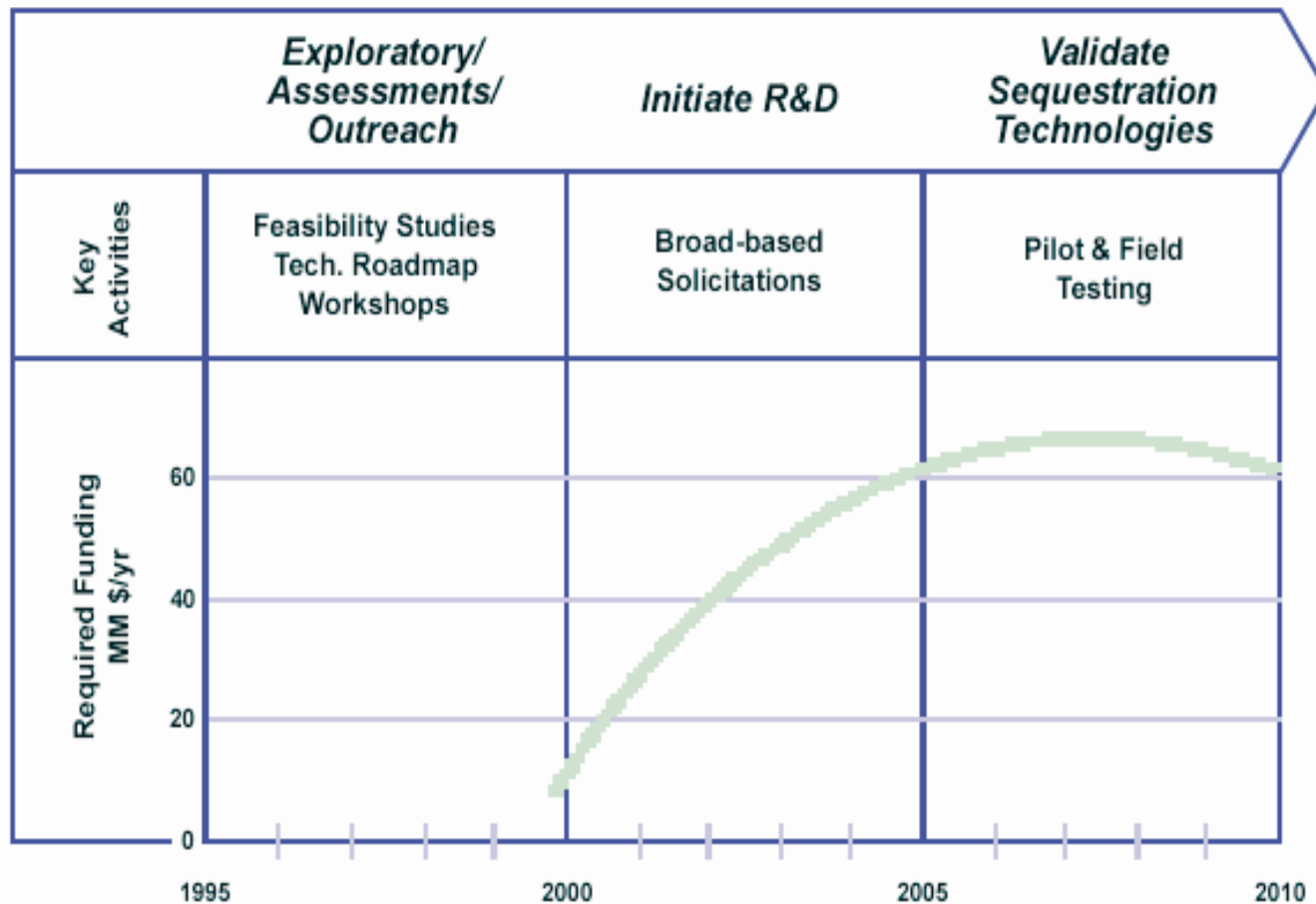
Assessments

Matching CO₂ Sources and Sinks

- **Collaboration between state geological surveys from Kansas, Indiana, Kentucky, Ohio, and Illinois**
 - **Develop database listing major point sources and potential storage sites**
 - **Evaluate efficacy of sites for sequestration (oil/gas reservoirs, uneconomic coal seams, and saline formations)**
- **Database available to public to facilitate awareness of sequestration opportunities**



Program Phases & Proposed Budgets



The Third Option

