

Emerging Oil and Gas Technologies with Potential CO₂ Sequestration Applications



Carbon Capture & Sequestration Conference

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Director, SCNGO
May 9, 2006*

National Energy Technology Laboratory



Office of Fossil Energy



National Energy Technology Laboratory

- **Only DOE national lab dedicated to fossil energy**
 - Fossil fuels provide 85% of U.S. energy supply
- **One lab, five locations, one management structure**
- **1,200 Federal and support-contractor employees**
- **Research spans fundamental science to technology demonstrations**



Alaska



Oklahoma



Oregon



Pennsylvania



West Virginia



Strategic Center for Natural Gas & Oil

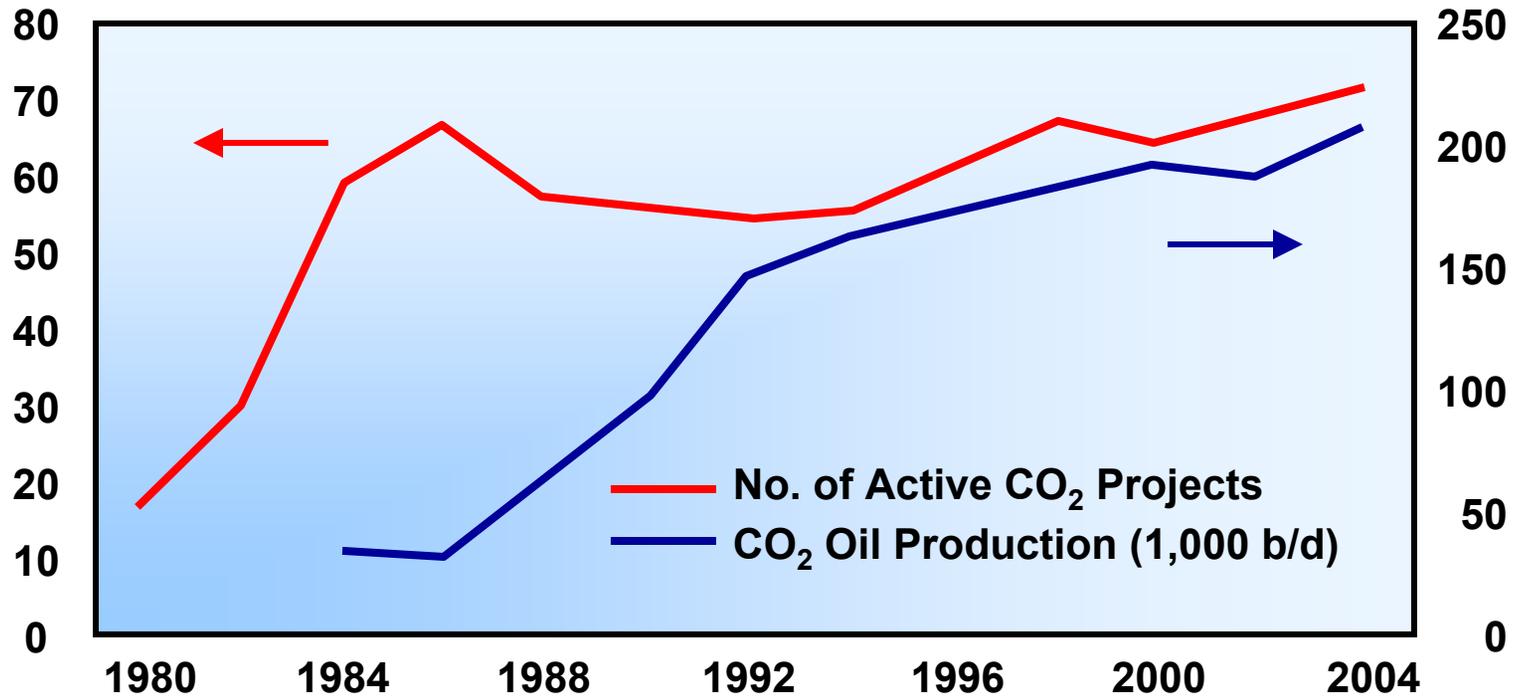
Partnership Approach

- **Implement oil & gas R&D programs for DOE Office of Fossil Energy**
 - E&P; EOR; Methane Hydrates; Res Life Extension; Environmental
- **Careful planning with significant industry input**
 - Technology roadmaps, advisory committees, consortiums, merit / peer reviews
- **Cost-shared R&D conducted with partners**
 - Industry, federal agencies, national labs, universities
- **Modest oil and gas program budget**
 - \$65–\$80 million / year total
- **Extensive experience**
 - > 35 years in oil and gas R&D
 - R&D successes linked to:
 - 25% of U.S. gas production
 - 13% of US oil production



Gradual Growth in CO₂ EOR Post-1980s

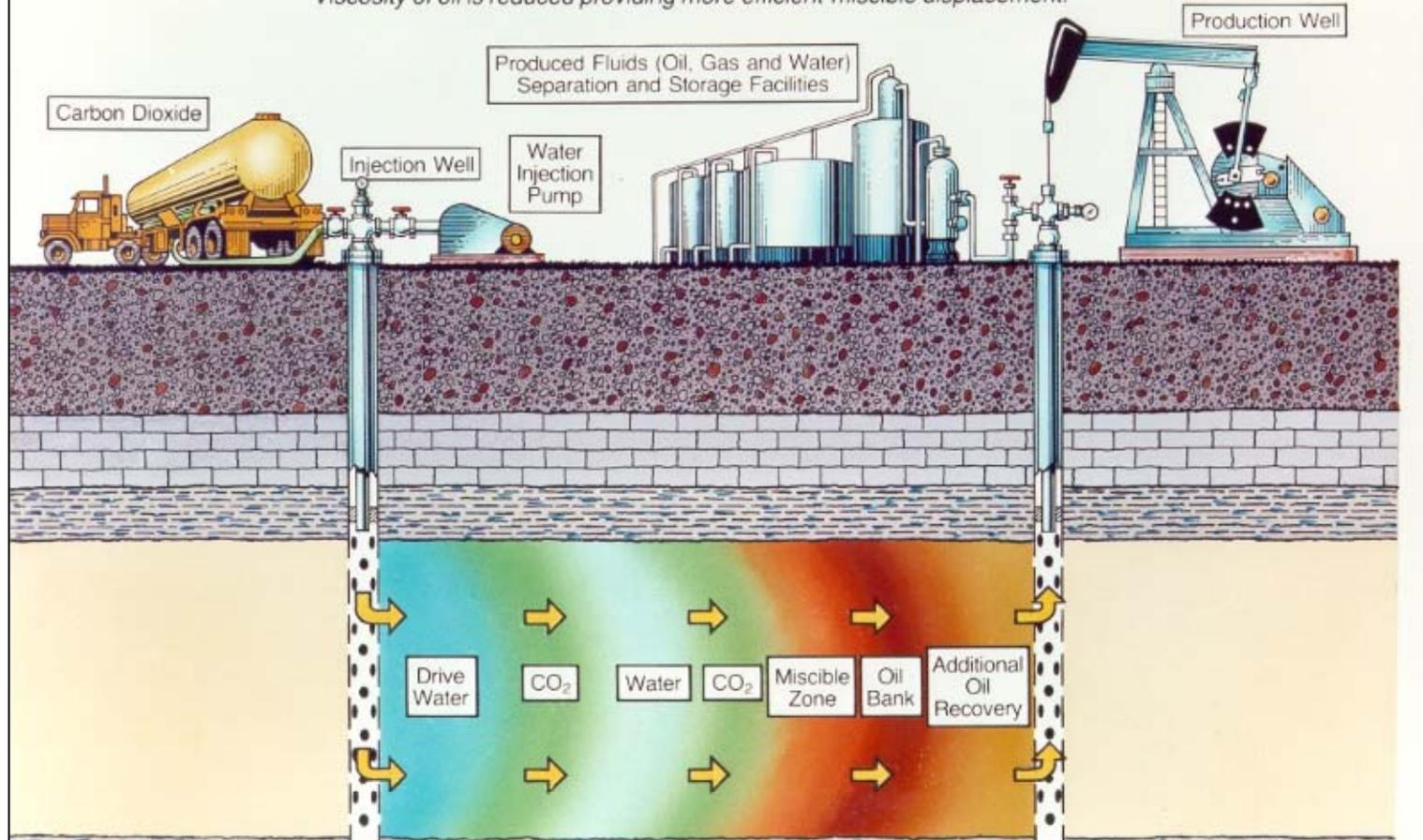
U.S. CO₂ EOR Growth



Carbon Dioxide EOR

This method is a miscible displacement process applicable to many reservoirs. A CO₂ slug followed by alternate water and CO₂ injections (WAG) is usually the most feasible method.

Viscosity of oil is reduced providing more efficient miscible displacement.

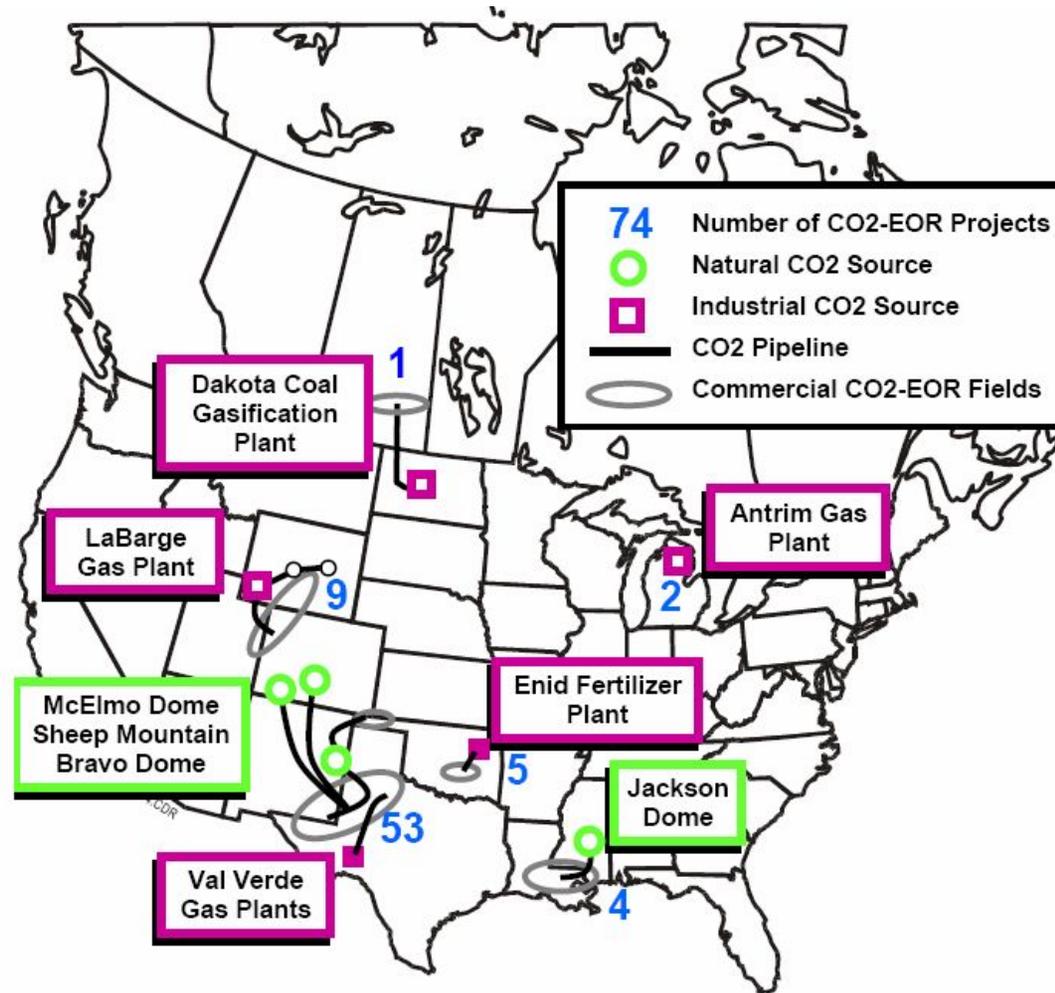


CO₂ EOR Projects Underway

- **More than 70 active projects**
- **Permian Basin of West Texas**
 - 40 fields (53 projects) injected with naturally-sourced CO₂
 - 180 Mbpd incremental oil production
- **Wyoming-Colorado**
 - 7 projects currently injecting with CO₂ from gas plant
 - 33 Mbpd incremental oil production
- **Weyburn Field (Saskatchewan)**
 - 6.5 Mbpd incremental production
 - 95 MMcfd of CO₂ is piped north from lignite gasification plant in Beulah, ND (250 MMscfd source)
- **Other**
 - ~ Dozen projects ongoing or planned in MS, OK, KS, MI

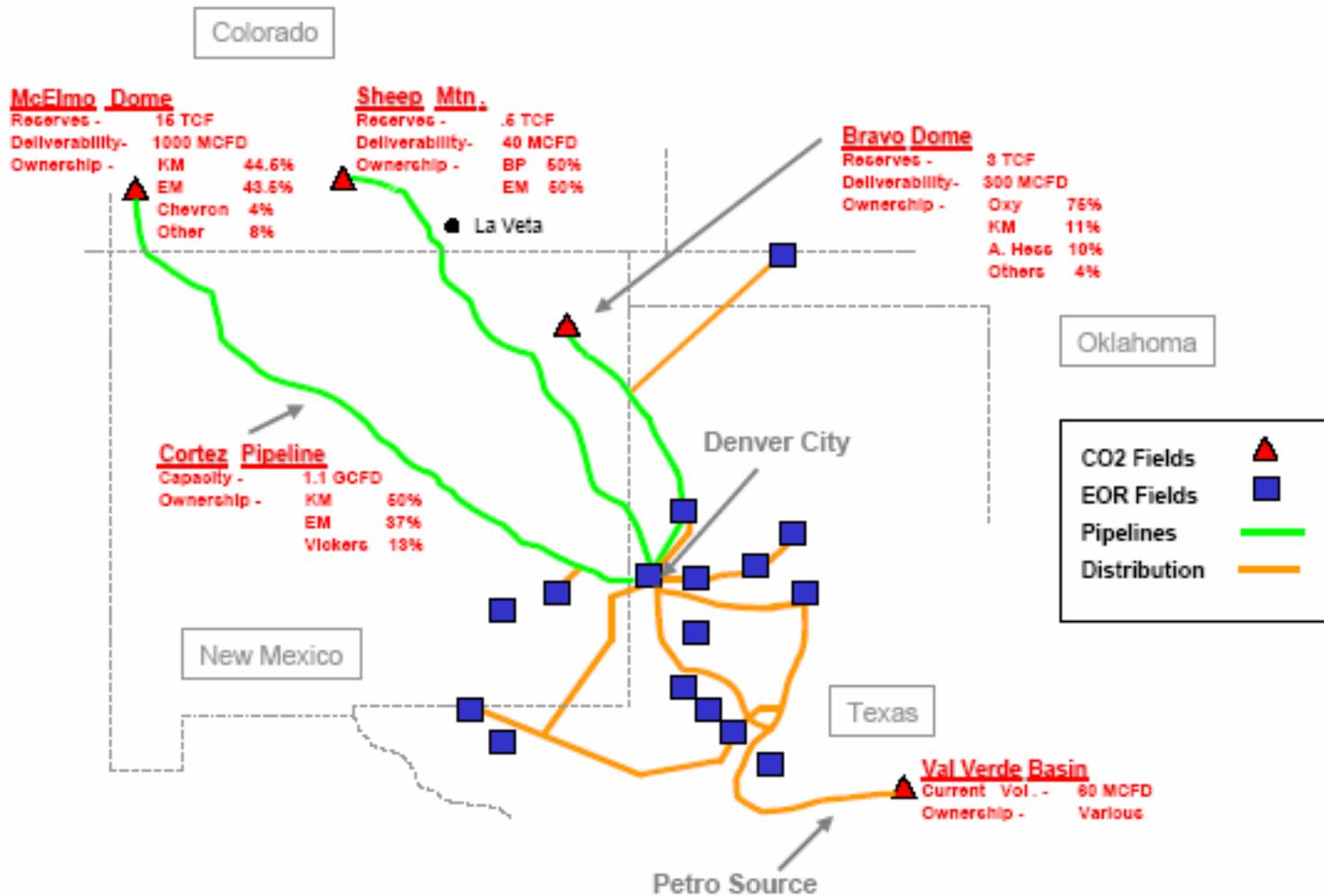


Current CO₂ EOR Projects



Source; Advanced Resources International

Permian Basin CO₂ Sources and Pipelines



Source; Exxon Mobil, SPE-PB EOR Carbon Mgmt. Wksp.

Wyoming-Colorado Source and Pipeline

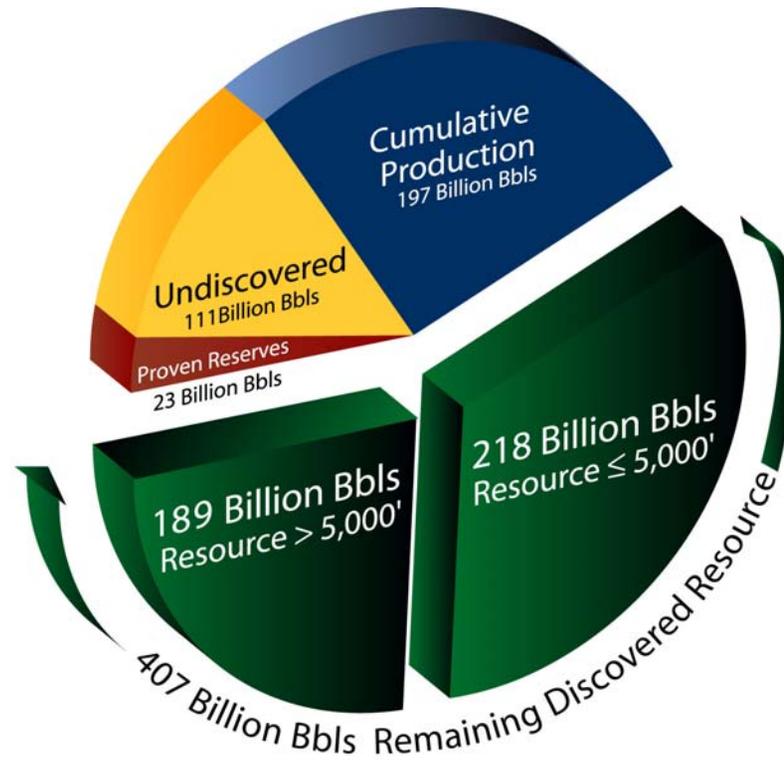


Source; Exxon Mobil, SPE-PB EOR Carbon Mgmt. Wksp.



EOR Program Target

Increase Domestic Oil Recovery



- **407 Billion barrels not economically recoverable with current technology**
- **218 Billion barrels from shallow development alone**
 - **Conservative recovery estimate = 10 years of OPEC imports offset**



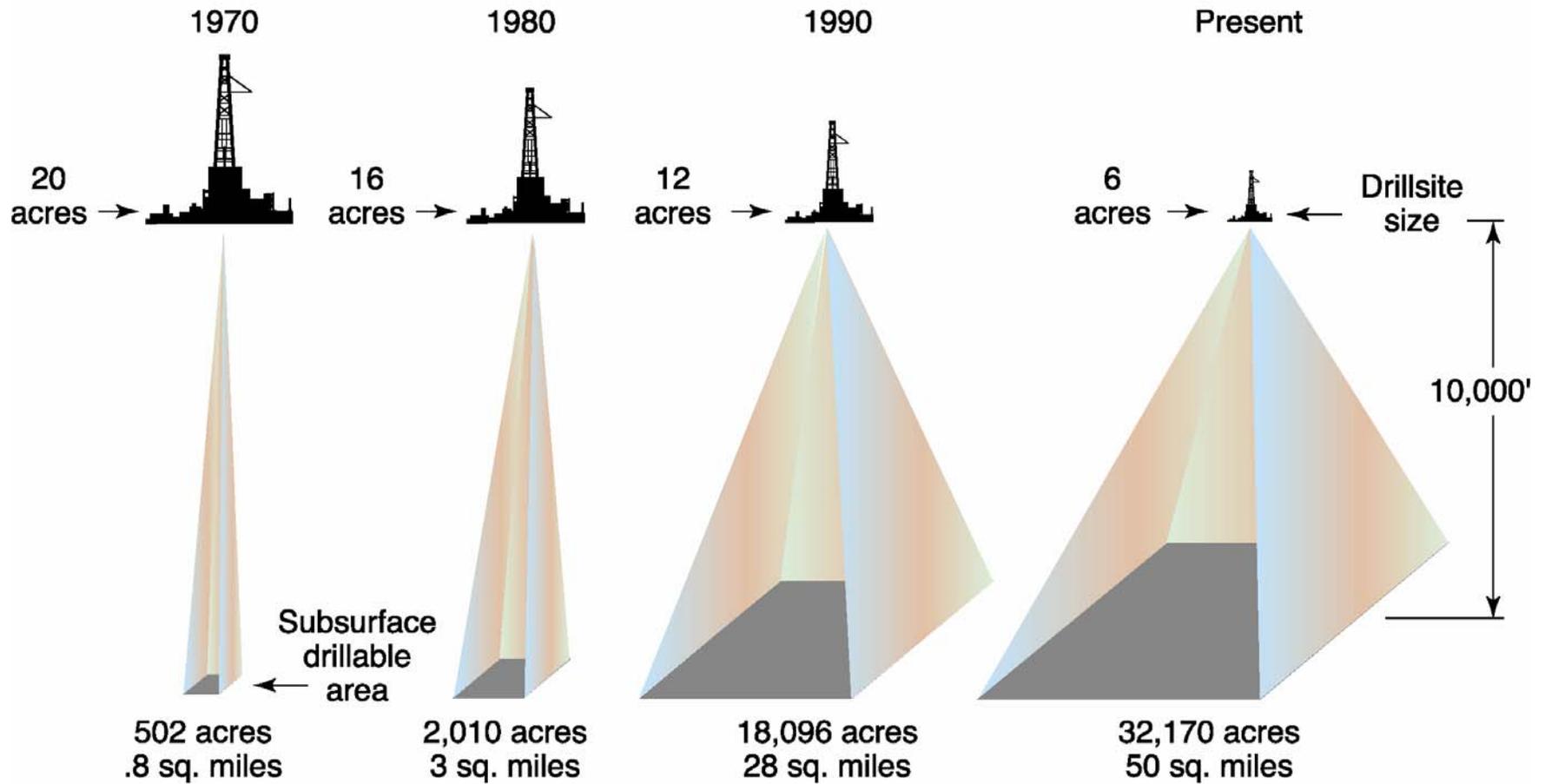
Source: EIA 2004, 2005; MMS 2006; USGS 2004

NETL / SCNGO CO₂ EOR Technologies Program

- **Diverse portfolio of projects**
 - Fundamental research through field demonstration
 - New technologies and methodologies
- **Maximize efficiency & recovery; minimize environmental impact**
 - Improved injection fluids
 - Higher resolution reservoir characterization
 - Lower cost, lower impact drilling systems
 - Better reservoir monitoring & control
- **Potential synergies with CO₂ Sequestration**
 - *Locate and characterize appropriate reservoirs*; determine capacity for fluids & the ease with which gas can be injected
 - *Monitor injected gas movement* & its containment
 - *Minimize cost & environmental impact* of drilling wells & operating injection project



Shrinking Surface Footprint While Expanding Subsurface Contact Area



Source: William Harrison, Kansas Geological Survey

First Highly Efficient Hybrid CT Rig Built and Operating in Lower 48



**Colorado Oil & Gas
Conservation Commission
2005 Operator of the Year
Nominee**

**World Oil Awards
2005
New Horizons
Nominee**

About 300,000 feet of hole in 7 months



Photo courtesy Tom Gipson, Advanced Drilling Technologies, LLC

Microhole Technologies for Imaging

Micro-Electromechanical Systems (MEMS)

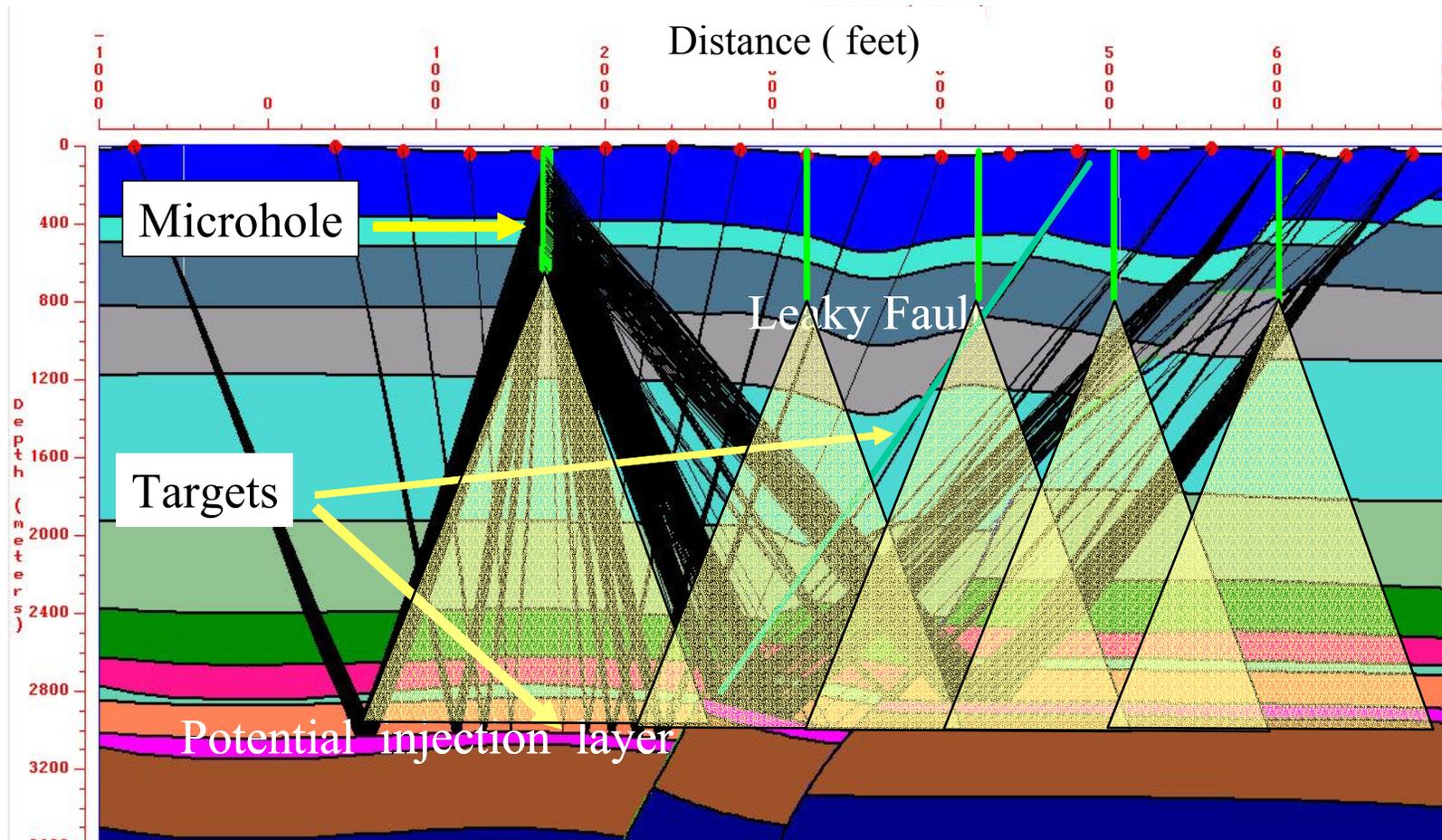


*Field Deployed
MEMS Geophone Array*

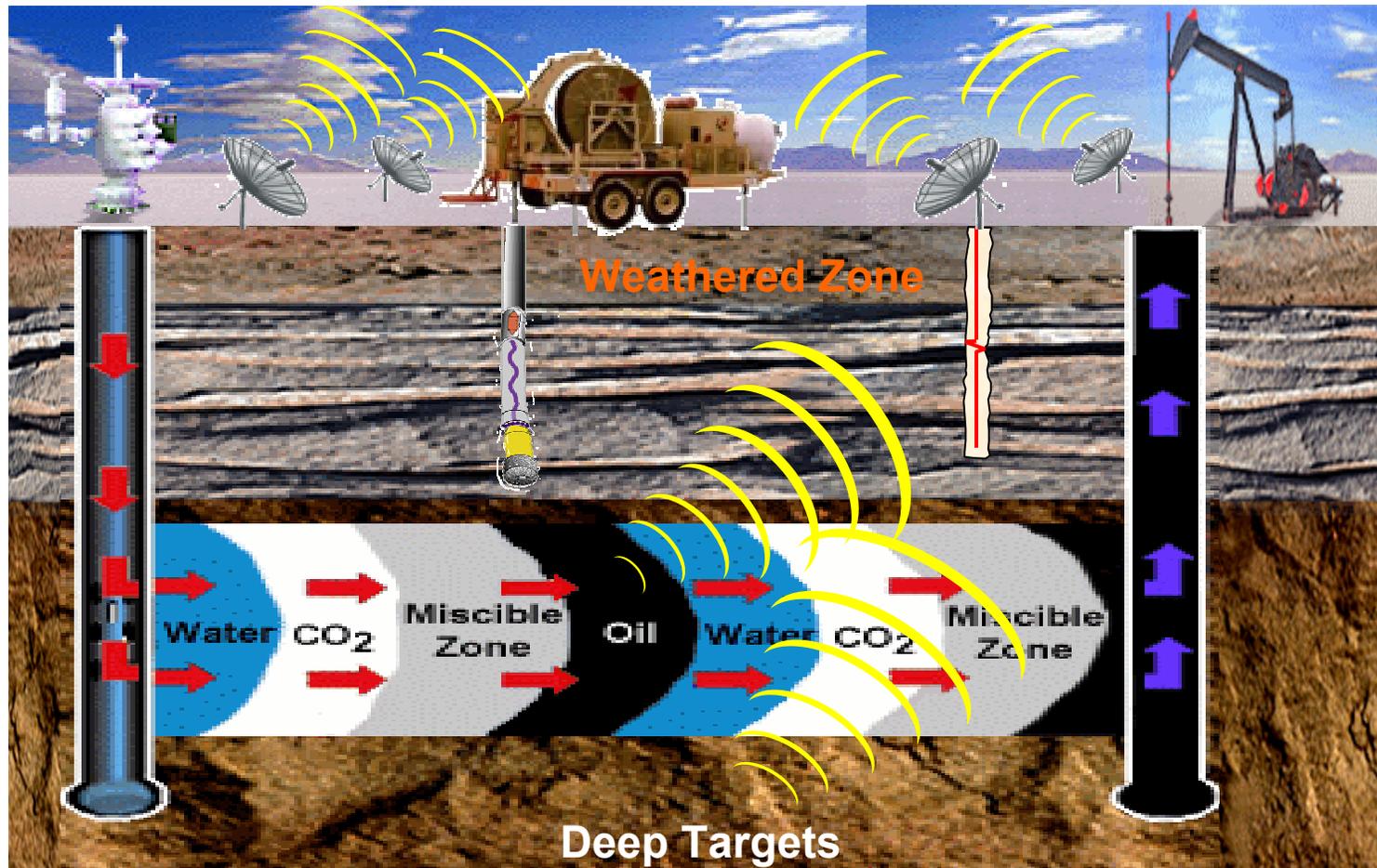


- Changes the way we explore for oil and gas
- Changes the way we monitor EOR projects

“Designer Seismic”: Revolutionary Approach to High Resolution Seismic Imaging

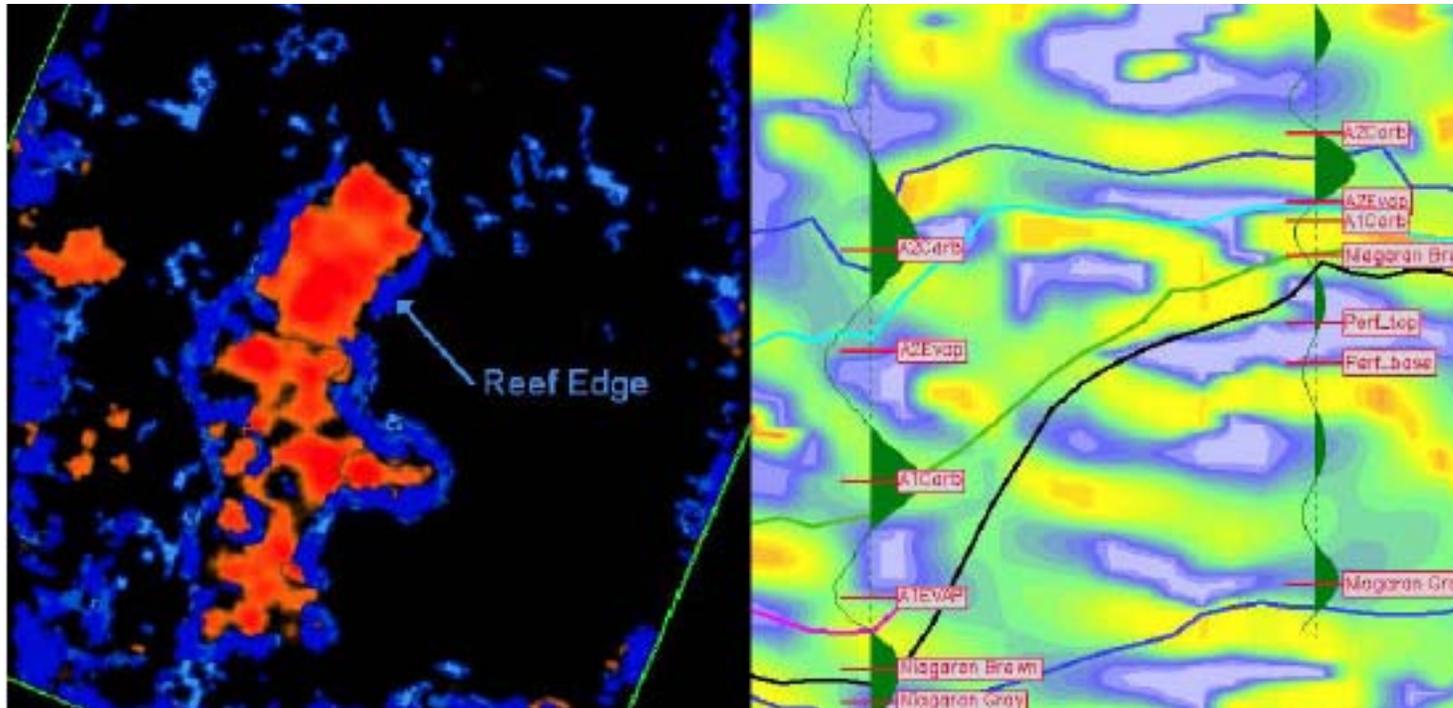


Reservoir Monitoring Using VSP Microhole Technology



Note: Modified from Kinder Morgan CO₂ LP Company

4D Seismic “Instantaneous Frequency” Analysis Used in Michigan Basin Carbonate Reef Structures



- **New interpretation methods for surface seismic**
 - Improved reservoir simulations (storage design and validation)
 - Improved sweep control

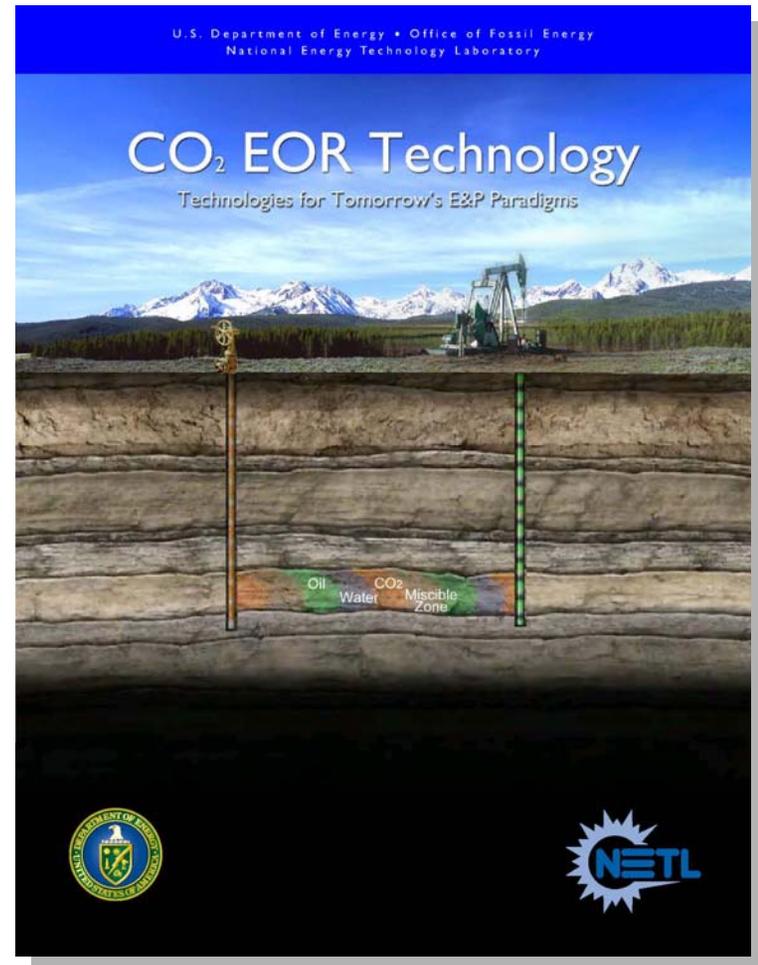
EPACT Section 354c

- **Purpose: Fund CO₂ EOR field demonstrations to:**
 - Encourage development and use of anthropogenic CO₂ sources
 - Recover more oil via CO₂ EOR and enhance sequestration into oil and gas fields
- **FY06: CO₂ EOR Solicitation**
 - Solicitation Closes May 5th
 - Workshop held Feb 22nd
 - Over 100 participants
 - Estimate \$7-8 Million DOE Funds
 - Expect 2 to 5 awards: Sep 30th



CO₂ EOR Brochure

- **Current CO₂ EOR Portfolio:**
 - 1 Integrated Field Demonstration
 - 1 Low Impact Access and Imaging (designer seismic)
 - 7 Modeling & Process Control
 - 4 Advanced Seismic Methods
- **Additional Info Contact:**
Oil & Gas Technology Manager;
Roy Long, 918-699-2017
roy.long@netl.doe.gov



For More Information

NETL's website:
www.netl.doe.gov

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SPR Completes Drawdown Deliveries
The Department of Energy has completed the last delivery of crude oil sold through its online competitive sale of the Strategic Petroleum Reserve stockpile. The sale resulted in award of 11 million barrels of crude oil to five companies who submitted favorable bids. Read more >

01:13:06 :: Technology Advance Aids Quest for Deep Gas
A cement developed as part of DOE's Deep Trek program has been commercially applied by several companies to stop seal failures in gas wells at depths up to two miles. Read More >

01:03:06 :: Jeffrey Jarrett to Lead Fossil Energy Office
Jeffrey D. Jarrett was sworn in as the 10th Assistant Secretary for Fossil Energy after being confirmed by the Senate on December 17, 2005. Jarrett brings more than 30 years of energy and environmental experience to the job. Read More >

OFFICE OF FOSSIL ENERGY
Ensuring that we can continue to rely on clean, affordable energy from our traditional fuel resources is the primary mission of DOE's Office of Fossil Energy. Fossil fuels supply 80% of the nation's energy, and we are working on such priority projects as pollution-free coal plants, more productive oil and gas fields, and the continuing readiness of federal emergency oil stockpiles.

Read more about:
Fossil Energy Organization
Business & Funding Opportunities

Office of Fossil Energy:
www.fe.doe.gov

National Energy Technology Laboratory Site Map GO

NETL

THE ONLY U.S. NATIONAL LABORATORY DEVOTED TO FOSSIL ENERGY TECHNOLOGY

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Tackling U.S. Energy Challenges

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Domestic coal, oil, and natural gas resources can contribute enormously to our Nation's economic strength, energy security, and quality of life through the 21st century.

View Secure & Reliable Energy Supplies

Research for an energy-secure America //
[DOE Announces Commercial Success in Deep Trek Program](#)
A "supercement" developed in DOE's Deep Trek program has been commercially applied by several companies during recent drilling operations to stop seal failures in wells at depths up to 2 miles.

NEWS & FEATURES // All >

- Significant Milestone Achieved in SECA Fuel Cell Development Program
- DOE Announces Commercial Success in Deep Trek Program
- Draft Environmental Assessment (EA) for the LINC from Coal Mine Methane for Industrial and Transportation Applications Project (PDF-3.94MB)
- Draft EIS for the Gilberton Coal-to-Clean Fuels

EVENTS CALENDAR // All >

- 2006 West Virginia Science Bowl
- 2006 SW Pennsylvania Science Bowl
- 2006 Oklahoma Science Bowl

PUBLICATIONS & PROJECTS // All >

- Annual Site Environmental Report (PDF-2.81MB)
- Oil & Natural Gas Supply
- Coal & Power Systems
- Carbon Sequestration
- Hydrogen & Clean Fuels

