



# NATIONAL ENERGY TECHNOLOGY LABORATORY



## An Abstract of U.S. DOE R&D

**John R. Duda**

**Director, Strategic Center for Natural Gas and Oil**

**Lexington, KY**

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# National Energy Technology Laboratory

*Where Energy Challenges Converge and Energy Solutions Emerge*

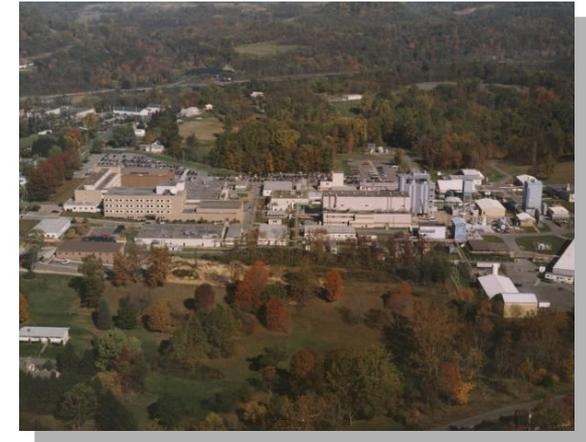
- Only government owned & operated DOE national lab
- Dedicated to energy RD&D, domestic energy resources
- Fundamental science through technology demonstration
- Unique industry – academia – government collaborations



*Oregon*



*Pennsylvania*



*West Virginia*

# Strategic Center for Natural Gas and Oil

*Advancing Technologies Supporting Development of Domestic Unconventional Resources*



- 10s of billions of barrels of residual oil recoverable via CO<sub>2</sub>-EOR in mature fields in 22 states



- Potentially 1000s of Tcf of natural gas from methane hydrate in Alaska and the GoM



- 100s of Tcf of natural gas in shales and tight gas sands across the country

# *Unconventional* Requires New Technology

- **Unconventional natural gas**
  - How to locate natural fractures?
  - How to optimize fracturing-horizontal drilling-spacing-completion decisions?
  - Demands for low environmental impacts + high density drilling near growing communities = concerns
- **Enhanced oil recovery**
  - Will “next generation” technology (+ new CO<sub>2</sub> sources + higher prices) motivate independents?
- **Oil shale**
  - Can in-situ conversion be effective if energy balance, groundwater protection and CO<sub>2</sub> are factored in?
- **Methane hydrates could require a new tool kit ... still don't know all the ground rules**

# Number of Factors Hinder E&P Research Investment by Industry Sectors



- Economic disincentives for major product/service modifications
- Market forces drive short term investments



- Results kept proprietary to capture value
- High cost of failure



- Lack of funds
- Lack of staff
- Limited market access

# Independent Operators

## *Our Technology Customers*

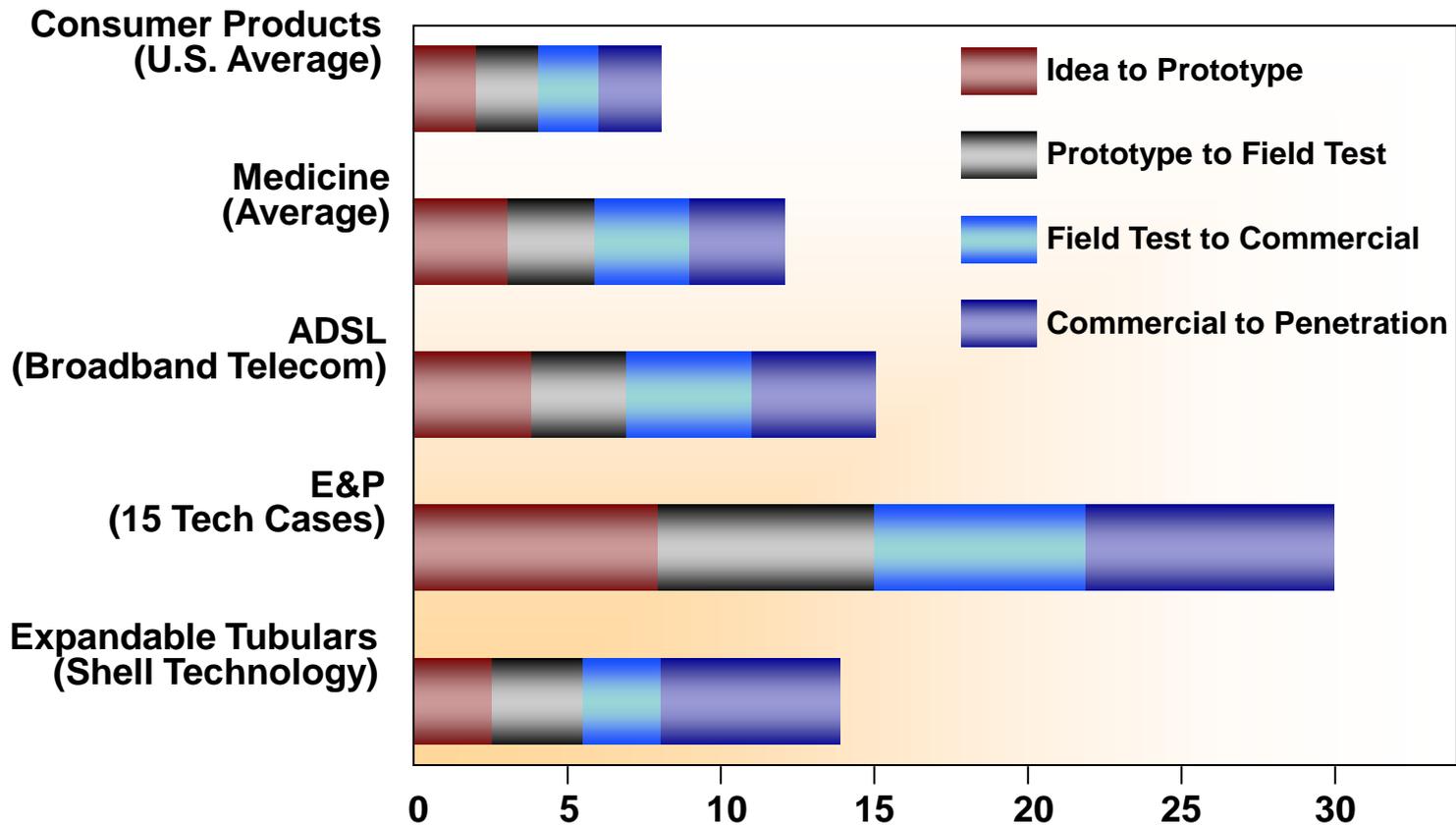
- **5,000 Independent Producers\***
  - Drill almost 90% of the U.S. wells
  - Produce 68% of U.S. crude oil
  - Produce 82% of U.S. natural gas
  - Employ 12 FTE
- **“Active Operators”**
  - 13,774 in 2007 (EIA)
  - (Large, Intermediate, and Small)



**\*(IPAA; Profile of Independent Producers 2009)**

# Early Research Efforts Can Speed Technology Development, Benefits

## Time-to-Market in Years for Various Industries



# The Methane Hydrate Program

## *Fundamental Science*

- **Gas hydrate physics-chemistry**
  - Numerical simulation at molecular to field scales
  - Complex experimentation using sea-floor mimicking devices
- **Gas hydrate evaluation**
  - Geologic models for gas hydrate formation
  - Rock-physics models for improved exploration
  - New sampling tools and devices
- **Gas hydrate in the environment**
  - Slope stability, geohazards
  - Role in global carbon/methane cycling
  - Potential feedback to climate change



# The Methane Hydrate Program

## Field Programs

Advanced LWD tools  
deployed on the Q4000  
- JIP Leg II, April 2009



- **Marine: Hazard assessment and resource delineation**
  - International-Industry JIP led by Chevron
  - 2005 logging/coring program assessed drilling hazards
  - 2009 logging program refined exploration techniques - discovered resource-quality deposits
  - 2011 logging/coring program to collect pressure cores
- **Arctic: Long-term production testing with environmental monitoring**
  - Cooperative Agreement with Alaska operators
  - 2007 coring/testing confirmed producibility
  - 2011 extended scientific field tests planned
    - Direct depressurization
    - Thermal stimulation
    - Methane-CO<sub>2</sub> exchange

# SCNGO Water-Energy Research



- Large fracture stimulations for shale plays
- Growth in demand for power generation
- Potential long-term demand from oil shale



- Coalbed methane well dewatering
- Mature oil fields with high water cuts
- Increased drilling & fracturing activity



- Increased competition for water supply
- Tighter regulations for disposal
- Opposition to treatment and disposal

## Challenges

- Effective treatment technologies
- Low-volume fracturing technologies
- Produced water volume reduction technologies
- Demand-reducing processes
- Science-based regulations

# Produced Water and Fracturing Flowback Water Treatment Project Portfolio

- **Nine current projects; six led by industry partners and three led by universities (WVU, U. Pitt., Texas A&M)**
- **All projects will be completed in 2010, 2011, or 2012**

## **TOPICS**

- **High Temperature Nanofiltration**
- **Electrodialysis and Reverse Osmosis**
- **Recovery of Low-TDS Frac Flowback Water for Re-use**
- **Salt Byproduct Production**
- **Pretreatment Options to Allow Re-Use of Frac Flowback Water**
- **Management of Flowback Water and Zero Discharge Options**

# Produced Water Management Project Portfolio

- **Seven current projects led by a mix of universities, consulting companies, technology developers and regulators.**
- **All projects will be completed in 2010, 2011, or 2012**

## *TOPICS*

- **Management System for Addressing Water Issues Associated With Shale Gas Development in NY, PA and WV**
- **Produced Water Treatment Catalog and Decision Tool**
- **Water Management Technology to Reduce Environmental Impacts**
- **Integration of Water Resource Models with Decision Systems**
- **Effects of Irrigating with Treated Produced Water**

# Stripper Well Consortium



- Industry-driven consortium est. Oct 2000
- Funded by NETL, NYSERDA, members (75)
- ~100 projects funded
- SWC - \$9.6 million Cost Share - \$7.6 million
- Target: small independents
- Excellent Cooperation amongst members
- Projects: 1 year duration
- Process very Operator friendly

- **Low-cost innovative technology to:**

- Increase production
- Reduce operating costs
- Reduce environmental footprint

*[www.energy.psu.edu/swc](http://www.energy.psu.edu/swc)*



# Arctic Energy Office

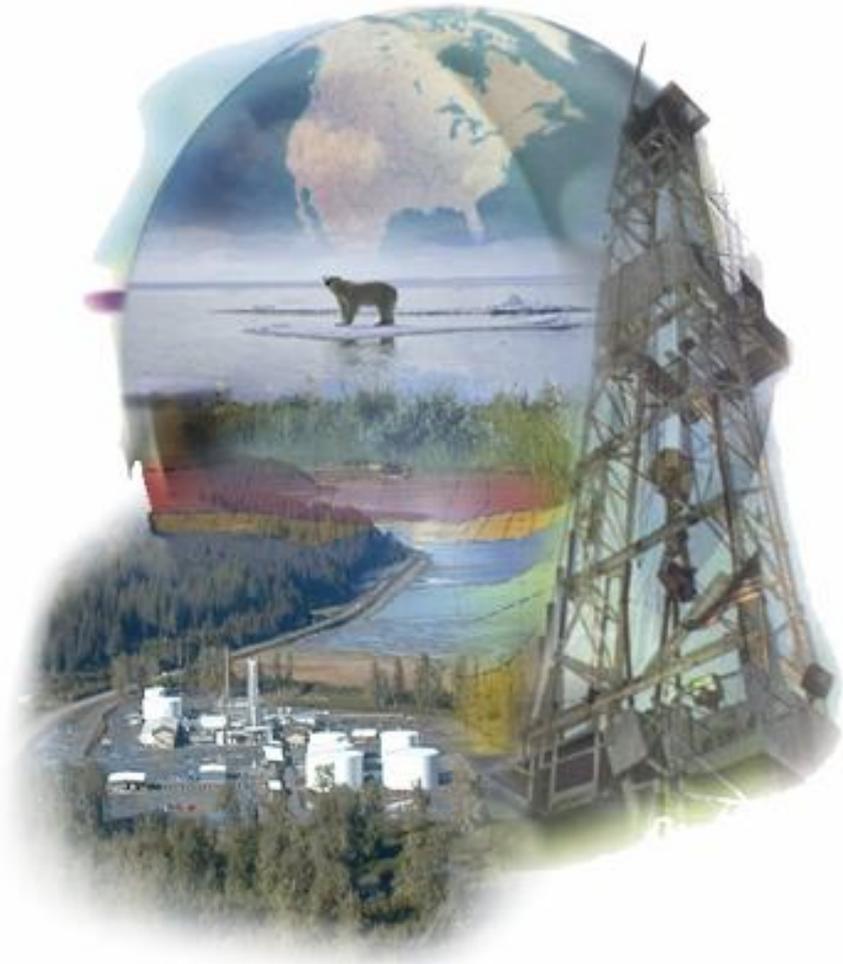
*(Public Law 106-398)*

- **Fossil Energy:**

- Promote research, development and deployment of oil recovery, gas-to-liquids and natural gas production & transportation

- **Remote Power:**

- Promote research, development and deployment of electric power in arctic climates, including fossil, wind, geothermal, fuel cells, and small hydroelectric facilities



# EPACT 2005, Subtitle J, Section 999 UDW and Unconventional Resources

- **NETL complementary R&D**
  - Four research “thrust” areas
- **Consortium administered**
  - Ultra-deepwater
  - Unconventional gas
    - **Tight sands**
    - **Gas shales**
    - **CBM**
  - Small producers

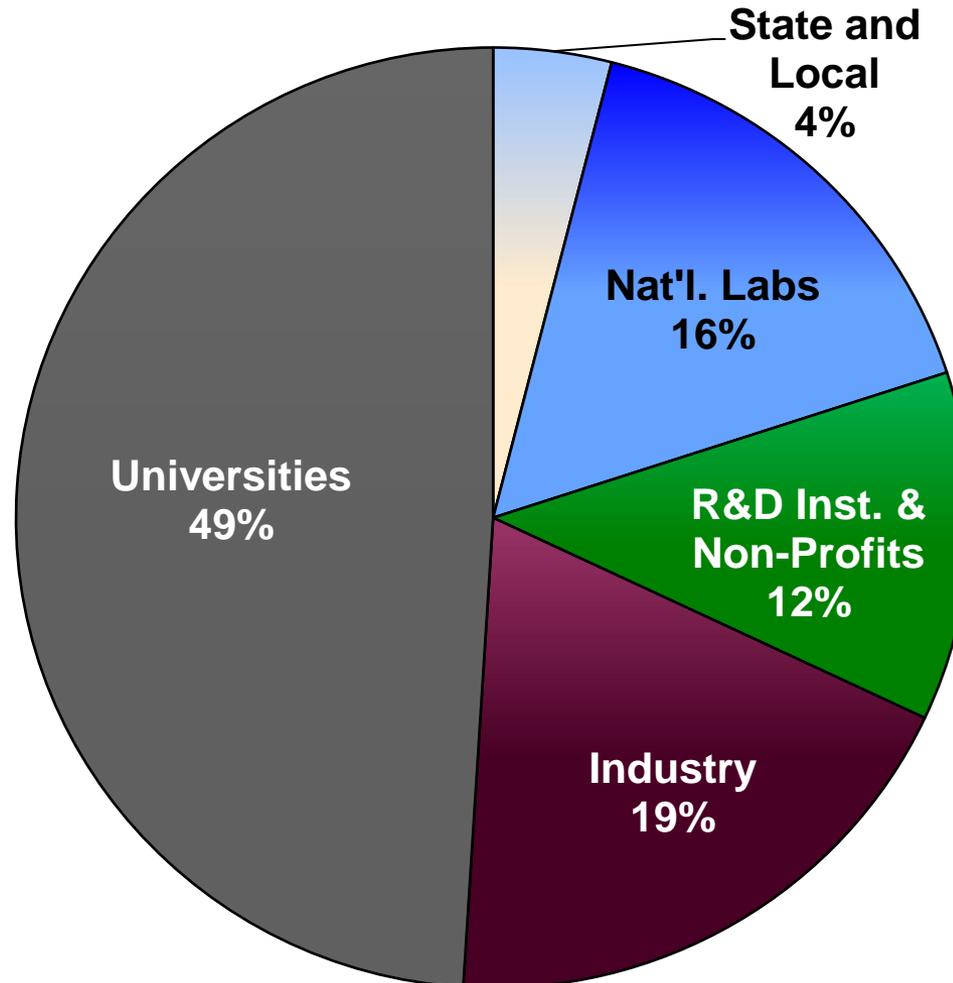


# EPACT 2005, Subtitle J, Section 999 Program Requirements

- **Federal Advisory Committees**
- **Annual Plan (to Congress)**
- **Report to Congress**
- **Independent audit**
- **Technology transfer**
- **Small producer/IP**



# Performer Category Distribution (Function of Funding) (Appropriated Projects Only)



Does not include four Methane Hydrates projects:

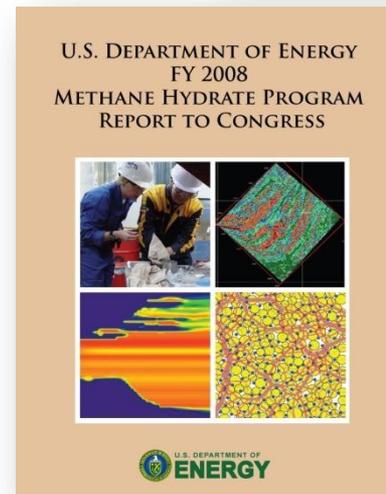
- Chevron
- BP
- ConocoPhillips

# A Disciplined Program

## *Planning, Evaluating, Reporting*

- **Federal Advisory Committees**
- **NAS review**
- **Peer/merit review**
- **Inter-agency coordination**
- **Industry advisory committees**
- **Reports to Congress**
- **Workshops and forums**
- **Multiple plans**

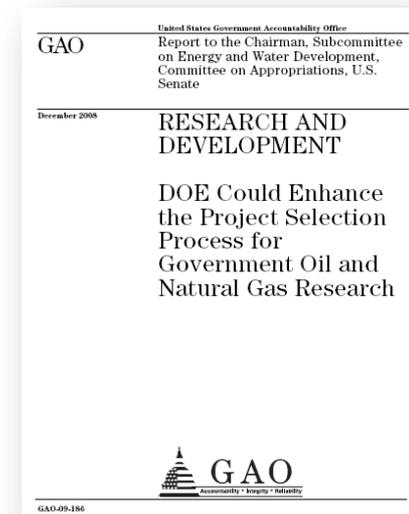
NATIONAL ACADEMY OF SCIENCES



# URTAC

# General Accountability Office Review

- GAO [initial] report published December 2007; considered favorable
- Congressional request for follow up inquiry/Phase II effort
- SCNGO staff presentations on selected topics July 2008
- Volumes of follow up data provided
- Final report issued December 29, 2008
- R&D project selection recommendation
- DOE fully implemented *CAP*
- Action closed



# International Collaborations Pursuing Global Solutions

- **Oil and Gas Industry Forum**
- **U.S. – China Protocol**
  - Annex III
- **Shale Gas Initiative (China)**
  - Dept. of State
- **NETL MOU's**
  - CAS, CNPC, and others
- **Gas hydrate**
  - Japan, India, Korea, and others

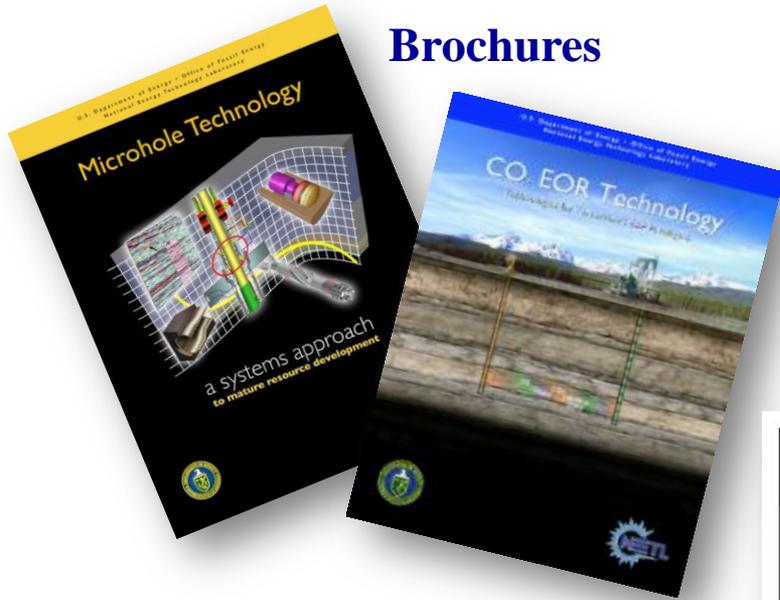


One of two groups stop for a photo in front of a 15,000 psi line in the Casa Field after completion of a 10-stage hydraulic fracturing treatment in the Woodford Shale. Dr. Jo Chengzuo is 4th from left, followed by John R. Duda of SONGO and Vince White of Devon.

# Comprehensive Technology Transfer

Brochures

Conference Exhibits

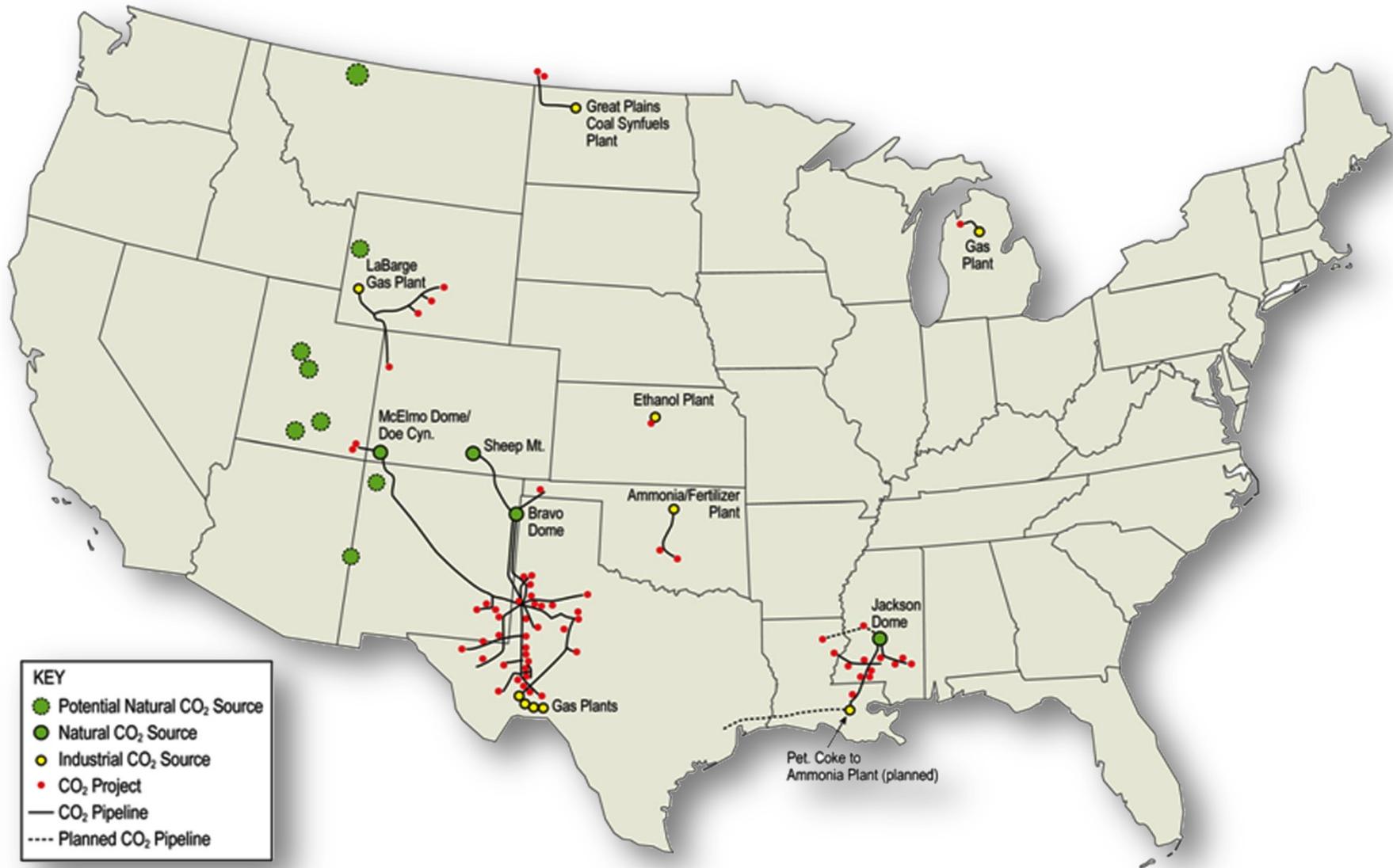


Presentations

Newsletters and Journals

NETL Website

# CO<sub>2</sub> Availability and EOR Projects



# Task 3: Areas with Large, Untapped CO<sub>2</sub>-EOR Potential

Cluster	Best Practices		Next Generation		Δ Technically Recoverable
	Active Projects	Best Practices (MMBO)	Active Projects	Next Generation (MMBO)	
Permian	58	13,539	-	22,717	9,179
Central Texas	0	6,491	-	9,940	3,449
Mid Continent	8	6,365	-	10,165	3,801
California	0	5,672	-	8,966	3,294
East Texas	0	4,389	-	7,015	2,626
Gulf Coast (Non TX)	15	4,142	-	5,878	1,735
Rockies	16	2,916	-	5,565	2,649
Williston	0	1,839	-	2,799	960
Appalachia	0	1,236	-	1,944	708
Illinois	0	594	-	2,376	1,782
Michigan	8	215	-	276	61
<b>Grand Total</b>	<b>105</b>	<b>47,398</b>	<b>-</b>	<b>77,642</b>	<b>30,244</b>

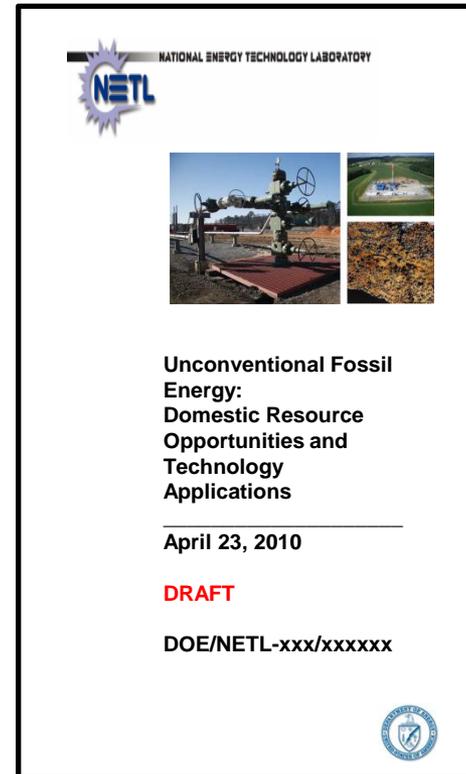
# WV CO<sub>2</sub> EOR Potential

- Total of 51 WV reservoirs assessed; 31 considered to have incremental oil technically recoverable via CO<sub>2</sub> EOR
- 26 of 31 reservoirs are immiscible floods
- 5 of 31 are miscible floods (all 5 between 3000 and 3200 feet)
- All reservoirs are sandstones
- Major reservoirs for CO<sub>2</sub>-EOR are Big Injun, Gordon, and Berea

Sand	No. of Potential Floods	Total OOIP (MMBO)	State of Art EOR Oil (MMBO)	State of Art CO <sub>2</sub> Demand (MMmt)	Next Gen EOR Oil (MMBO)	Next Gen CO <sub>2</sub> Demand (MMmt)	Immiscible or Miscible
Big Injun		720.90	86.38	18.60	86.38	18.60	immiscible
Gordon		371.53	38.41	9.19	71.74	10.69	immiscible miscible
Berea		335.44	27.73	5.87	27.73	5.87	immiscible
Others		562.53	45.35	13.63	69.86	14.98	immiscible miscible
<b>Total</b>		<b>1990.4</b>	<b>197.87</b>	<b>47.29</b>	<b>255.71</b>	<b>50.14</b>	immiscible miscible

# Unconventional Fossil Energy Technologies Draft Strategy Report

- Required by FY10 Appropriation
- Resource potential
- Current R&D; gaps
- *Prioritization* criteria
- 30 day public comment
- Finalize/publish report



**Thank You...**

**Questions?**