

# **CCS Capacity Building Workshop**

## ***CCUS Regulatory Perspective & CO<sub>2</sub> Enhanced Oil Recovery***

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# What Does The Future Hold for CCS As A Matter of National Policy?

- EPA regulatory program will creep towards CCS as BACT – but likely to take many years to play out
- Continued role for government in R&D and demonstration, subject to budget pressures
- CO<sub>2</sub>-EOR will continue to receive favorable attention
  - *Why the ROZ is a hot topic*

# US CCS Deployment Overview

- Several large scale CCS/ICCS projects in various stages of deployment, supportive funding in place
- Extensive research coming in on geologic storage and capacity
- Extensive Federal regulatory work per GHG's and storage set
- Extensive policy work has taken place per GHG's—depends on political will to advance
- Pipeline and compression infrastructure well understood – research on improved technology and compression efficiency underway
- Extensive research work coming in on capture technologies--Base technologies well understood—work on developing energy efficient and cost effective processes underway
- Siting, permitting and construction well understood
- CCS protocols and methodology for accounting and sequestration under development – to be released end of 2011
- Policy work on storage stewardship and liability-Federal and State at various stages—show stopper if not developed
- Land use, ownership and mineral rights well understood, pore space use and ownership getting better definition state by state
- US CCS deployment ultimately depends on public acceptance, political will and the public's willingness to absorb the costs

# Federal Legislative

- Obvious legal drivers for CCS are stalled
  - *No cap & trade*
  - *No clean energy standard*
- Billions of federal dollars in support for CCS have been enacted under numerous programs
  - *Plus tax incentive programs*
- Significant budget pressures on the horizon

# Federal Regulatory

- Clean Air Act GHG permitting program in place
  - *Will CCS be a Best Available Control Technology?*
- Federal injection regulations in effect
  - *Class VI*
  - *Class II*
  - *EPA announced 9-15 that to date no States have sought primacy for Class VI, and that unless and until that situation changes in a given State(s), the Class VI program is now a federal one.*
- Federal GHG inventory reporting regulations in effect
  - *Class UU*
  - *Class RR*
- Some uncertainties remain
  - *Is CO<sub>2</sub> subject to RCRA and CERCLA—recent limited RCRA exemption on the table*

# Hints of Favorable Policy Winds for EOR

- Lugar bill “Practical Energy Plan” with CO<sub>2</sub>-EOR
- Current GOP leadership views CO<sub>2</sub>-EOR as energy independence, not carbon management
- Economic “upside” of EOR in an adverse budget environment
- Carbon Capture Utilization and Storage new approach to CCS

# EOR Deals

- Industrials, IPPs & Utilities: Tenaska, Leucadia National, DKRW, Mississippi Power, TCEP, HECA, others
- Role for EOR in most, if not all, projects
  - *Class VI as back stop but...*
- Typical project hurdles –
  - *Economics*
  - *State legislative and/or PUC approval*
  - *Federal funding/loan guarantees*
  - *Natural gas fired generation easier choice but....*

# CO<sub>2</sub> Storage Potential From EOR Is Huge

Table 5. Comparison of Forecasts of CCS Deployment and Associated Benefits due to ACES

	2020	2025	2030	Estimated Cum by 2030	2035	2040	2045	2050	Estimated Cum by 2050
<u>Coal with CCS Deployment - Capacity (GW)</u>									
NRDC - MARKAL	16.9	36.9	39.8		87	138	154	201	201
NRDC - NEMS	13.6	45.6	108.8						
EIA- NEMS	13.1	31.4	68.9						
<u>Coal with CCS Deployment - CO<sub>2</sub> Stored (million tonnes)</u>									
				(Gt)					(Gt)
NRDC - MARKAL	124	226	243	2.4	521	809	902	1,170	96
NRDC - NEMS	78	224	530	1.6					
EIA- NEMS	85	190	409	1.5					
<u>Incremental Oil Prod. from CO<sub>2</sub> Stored with CCS from Power Plants (MMBbl)*</u>									
				(Billion Barrels)					(Billion Barrels)
NRDC - MARKAL***	1.3	2.4	2.6	9	2.6	2.6	3.9	4.8	37
NRDC - NEMS	0.3	1.4	3.6	6					
EIA- NEMS	0.4	1.3	3.0	6					
* Assumes all CO <sub>2</sub> from CCS is stored in oil fields with EOR potential at a rate of 0.26 tonnes of stored CO <sub>2</sub> per barrel of oil.									
** Assumes a price for captured CO <sub>2</sub> of \$15/ton, which increases economic potential to between 38 billion barrels using "best practices" and 59 billion barrels using "next generation" technologies at oil prices ranging from \$70 and \$100 per barrel."									

Source: White Paper: U.S. Oil Production Potential of Accelerated Deployment of CCS (ARI, 2010)

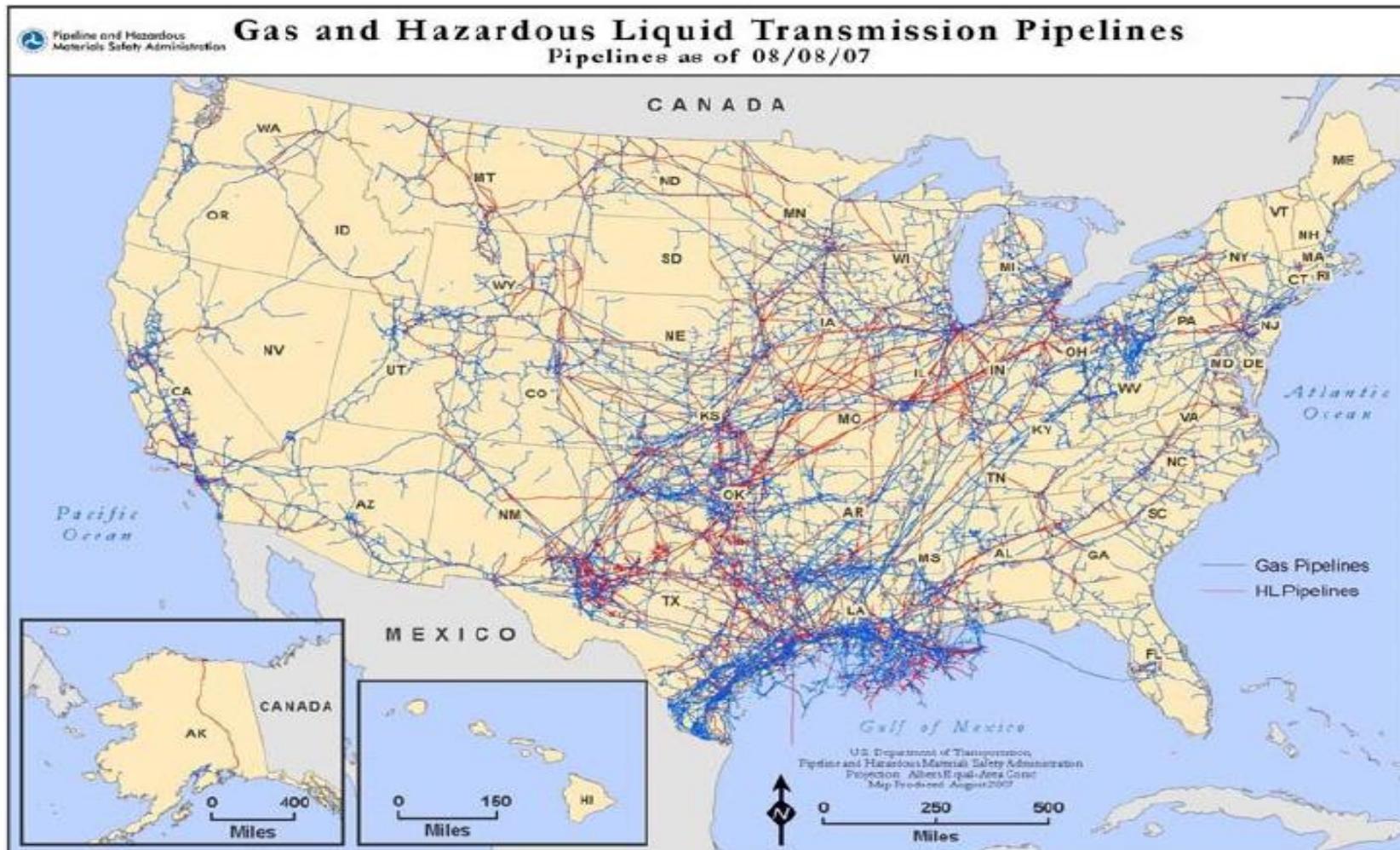
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# Ohio's CO<sub>2</sub>-EOR Potential

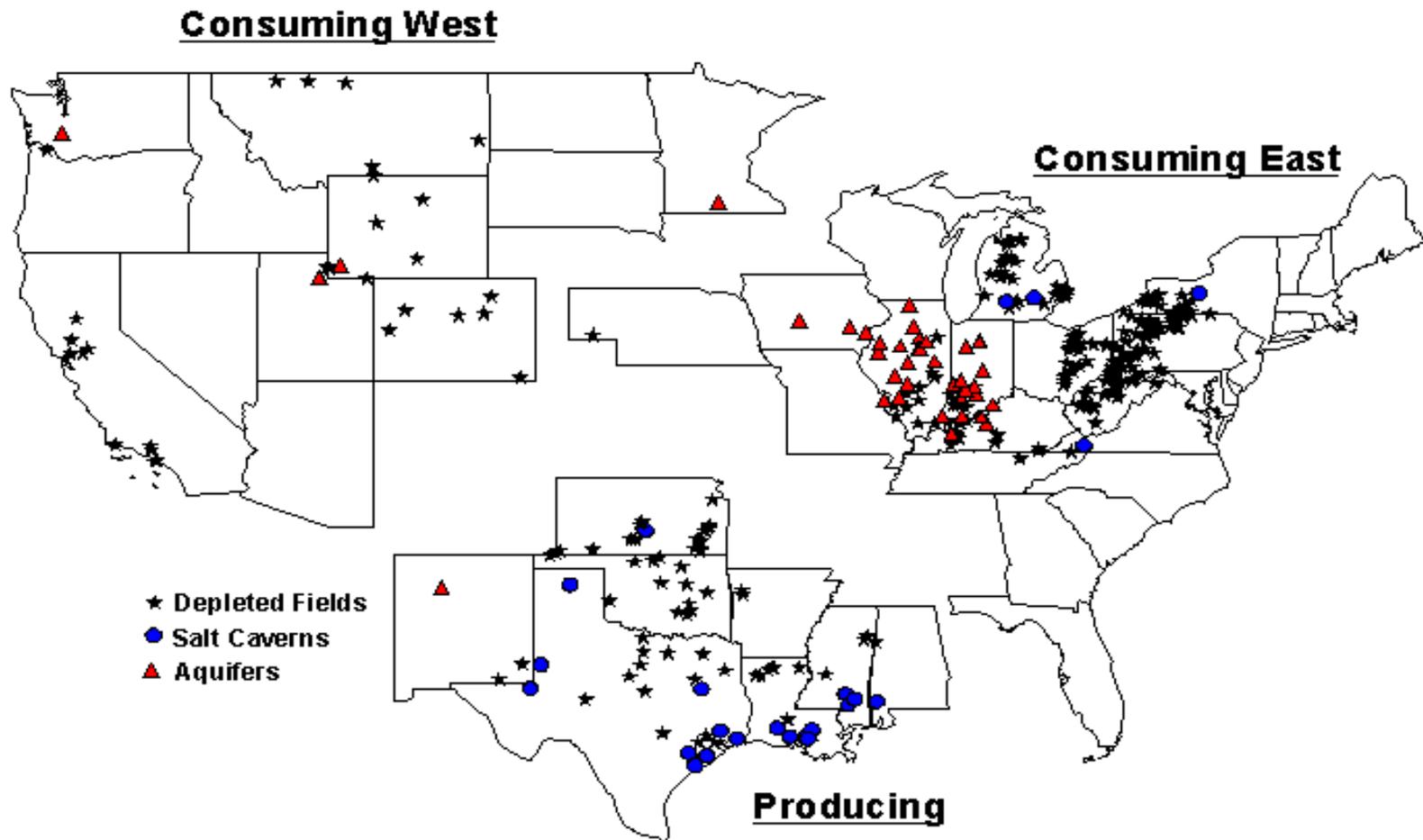
- COLUMBUS June 23-2011 — While much attention is being placed on the development of Ohio's shale oil and gas reserves, a new technical report released by the [Ohio Department of Natural Resources' Division of Geological Survey](#) suggests that existing oil fields beneath eastern Ohio could potentially produce hundreds of millions of additional barrels of oil. According to the report, the ***East Canton oil field has produced about 100 million barrels of oil, which geologists say is less than 10 percent of its potential reserves.***
- ***The Division of Geological Survey estimates that more than 1 billion barrels of oil remain in the ground in this field, a large portion of which could be recovered using carbon dioxide-assisted secondary recovery techniques.*** These processes, commonly used in the western United States, extend a field's productive life by injecting carbon dioxide (CO<sub>2</sub>) into the formation, displacing oil and driving it to a production wellbore. Because of the geologic nature of the East Canton oil field reservoir rock — or “Clinton” sandstone — a CO<sub>2</sub>-assisted secondary recovery program might best produce additional oil reserves. ***The recently released report shows the first results from a study, funded in part by the U.S. Department of Energy that examined the potential effectiveness of CO<sub>2</sub>-assisted secondary recovery in this formation.***
- ***The results suggest that if fully employed this field alone could produce between 76 and 279 million barrels of additional oil.*** And there are many other “Clinton” sandstone reservoirs in the region. The original reservoir pressure is all but gone and extracting more oil is going to be difficult without secondary recovery. ***Now is the time to plan for such operations before the existing wells and infrastructure are abandoned***
- ***Discovered in 1947, the East Canton oil field is Ohio's largest, still-producing oil field and covers nearly 175,000 acres in Carroll, Harrison, Stark and Tuscarawas counties***

# Experienced with Transport and Storage

# 480,000 Miles of Natural Gas and HL Pipelines



# ~400 Lower 48 Gas Storage Facilities

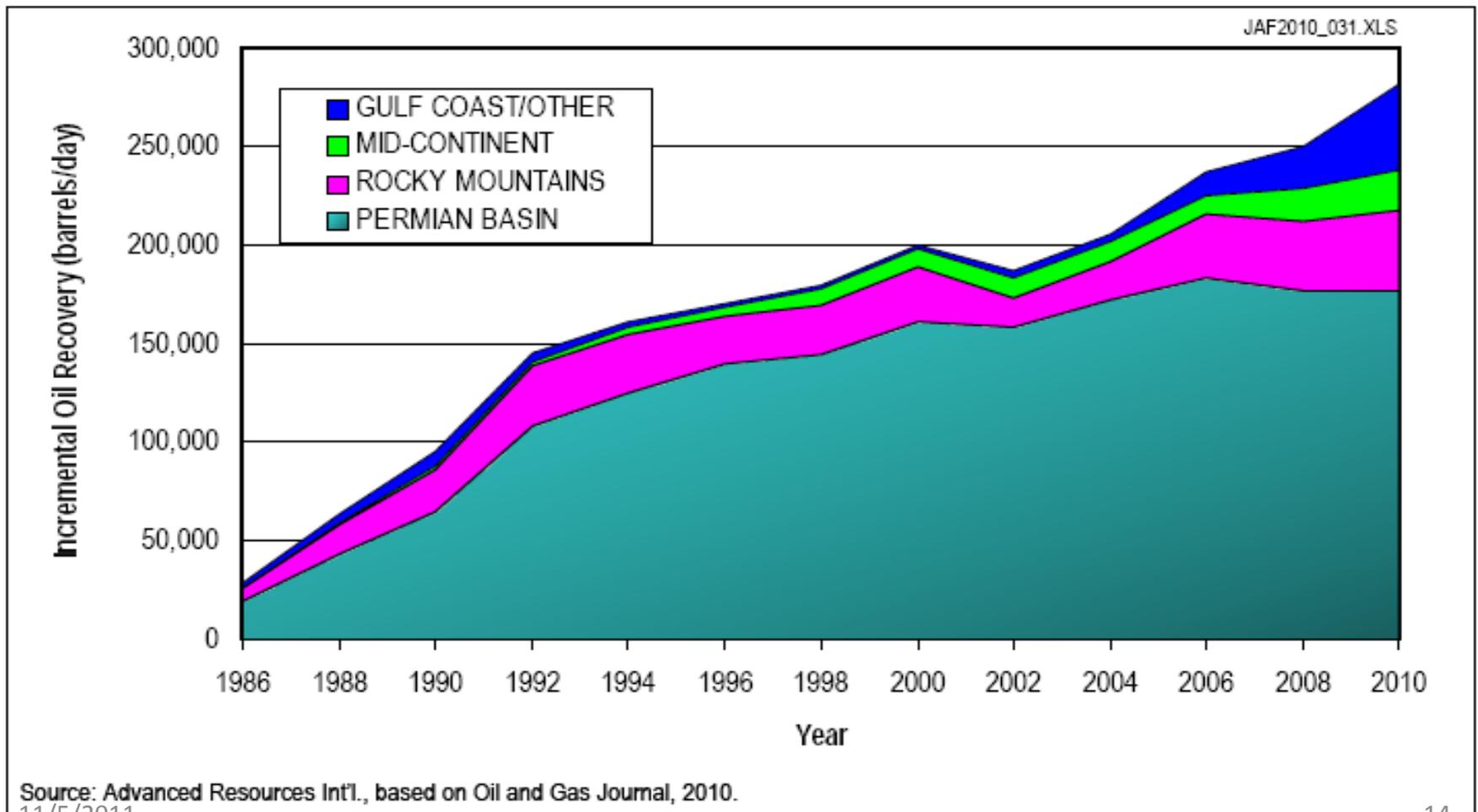


Source: Energy Information Administration (EIA), EIA GasTran Geographic Information System Underground Storage Data Base.

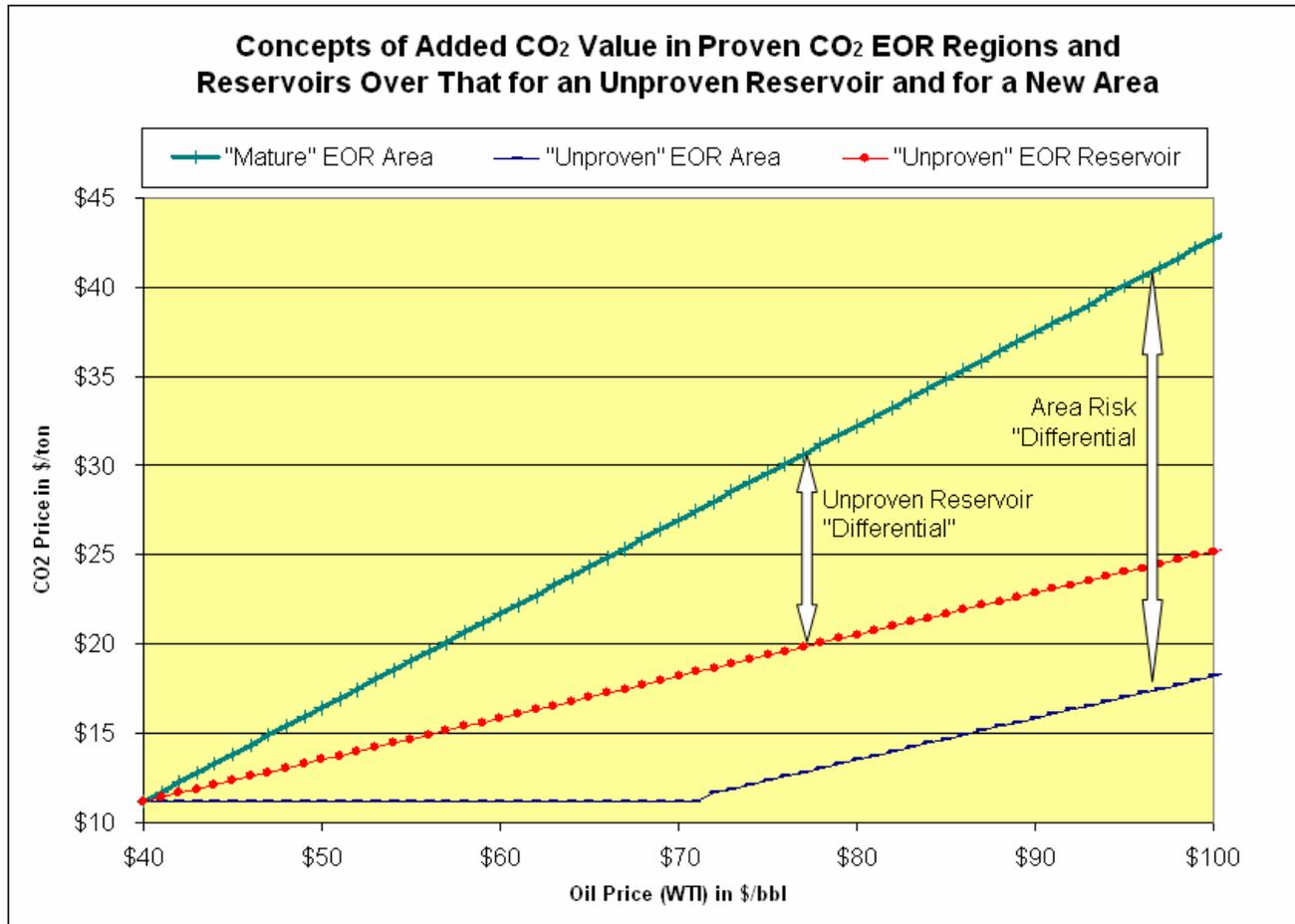
# CO<sub>2</sub> Demand and Infrastructure

# Size and Scope of Demand is Rising

Growth of CO<sub>2</sub>-EOR Production in the U.S.

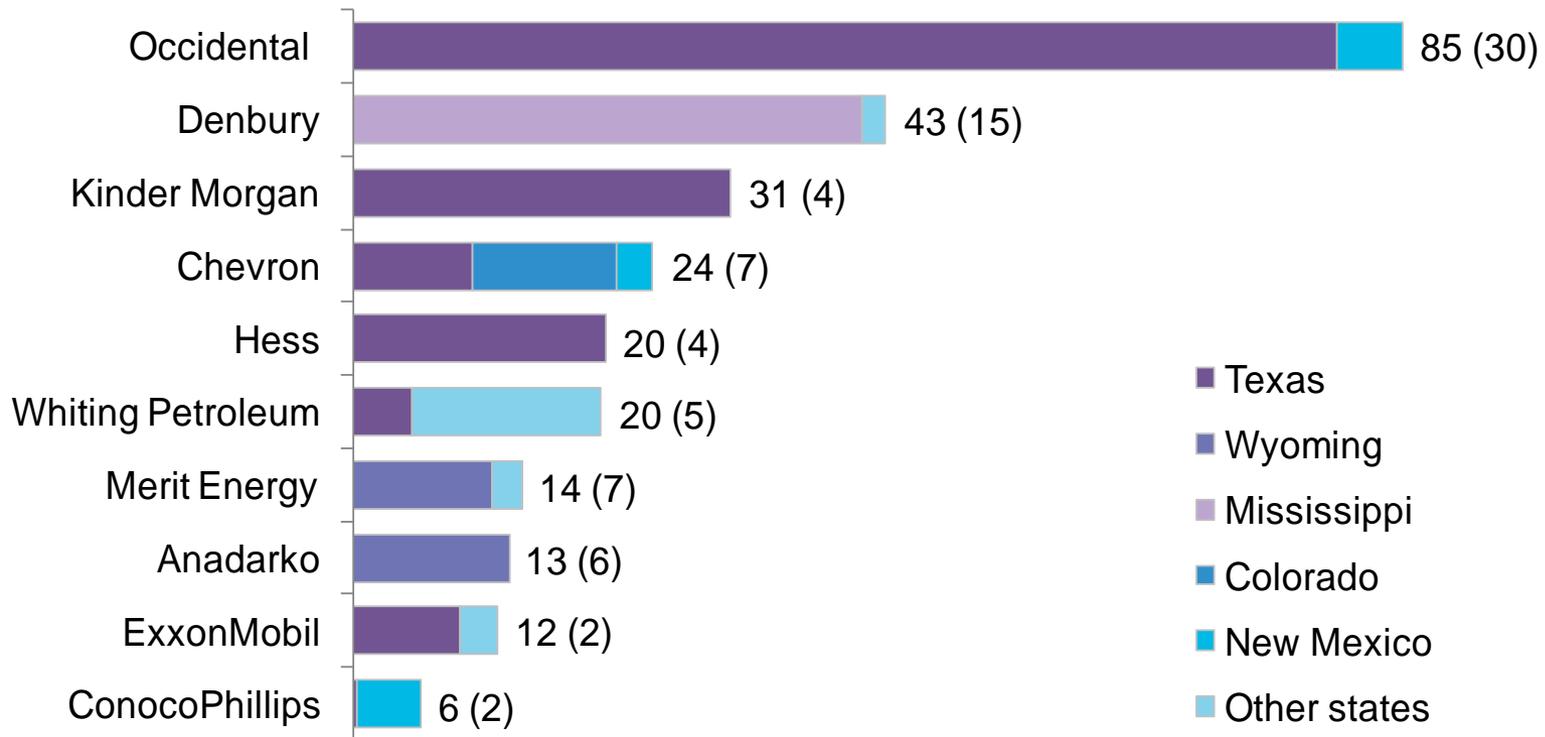


# CO<sub>2</sub> Valuations



# Top 10 Producing US CO<sub>2</sub>-EOR Operators 2010

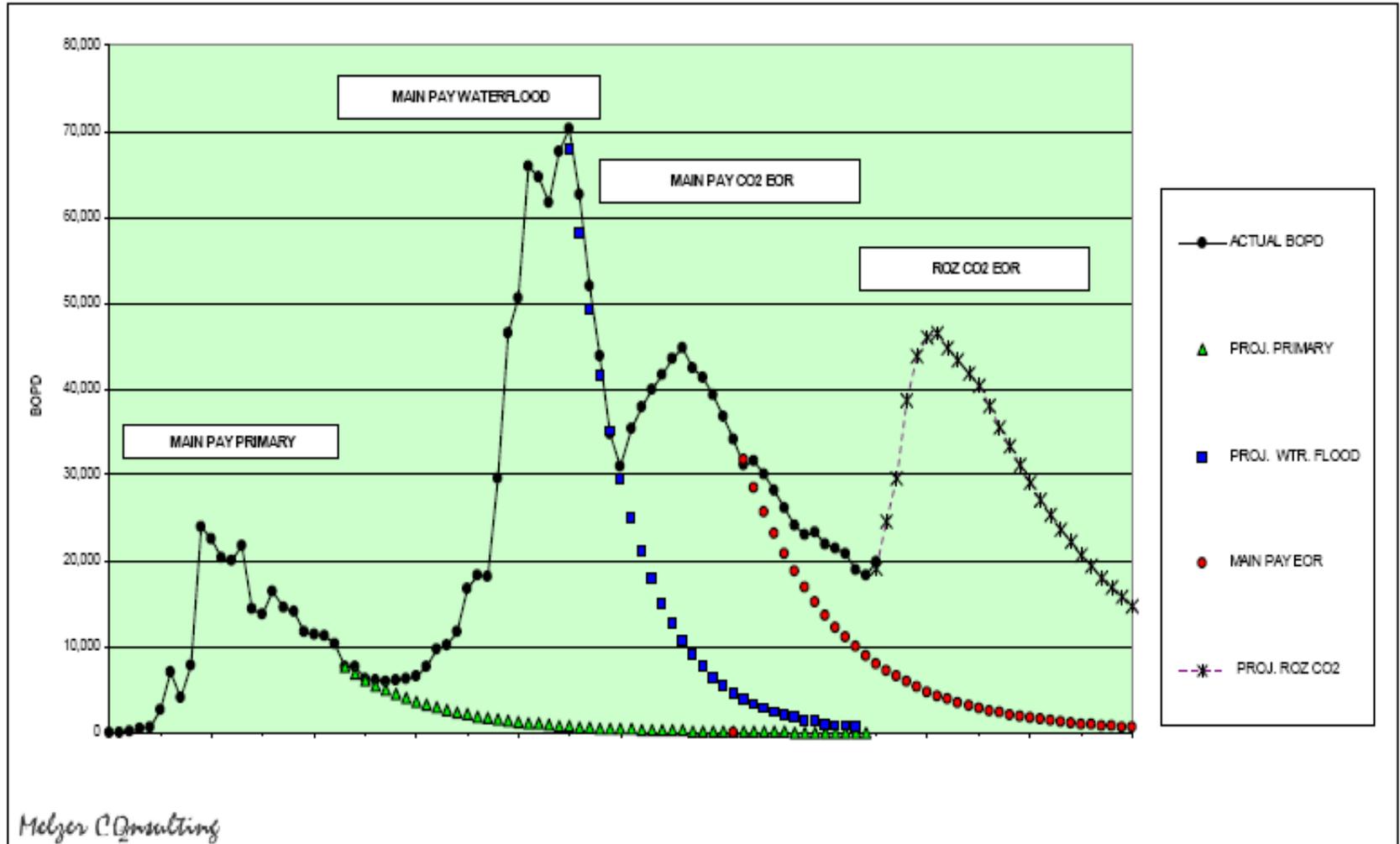
(k bbl/d, No. Projects)



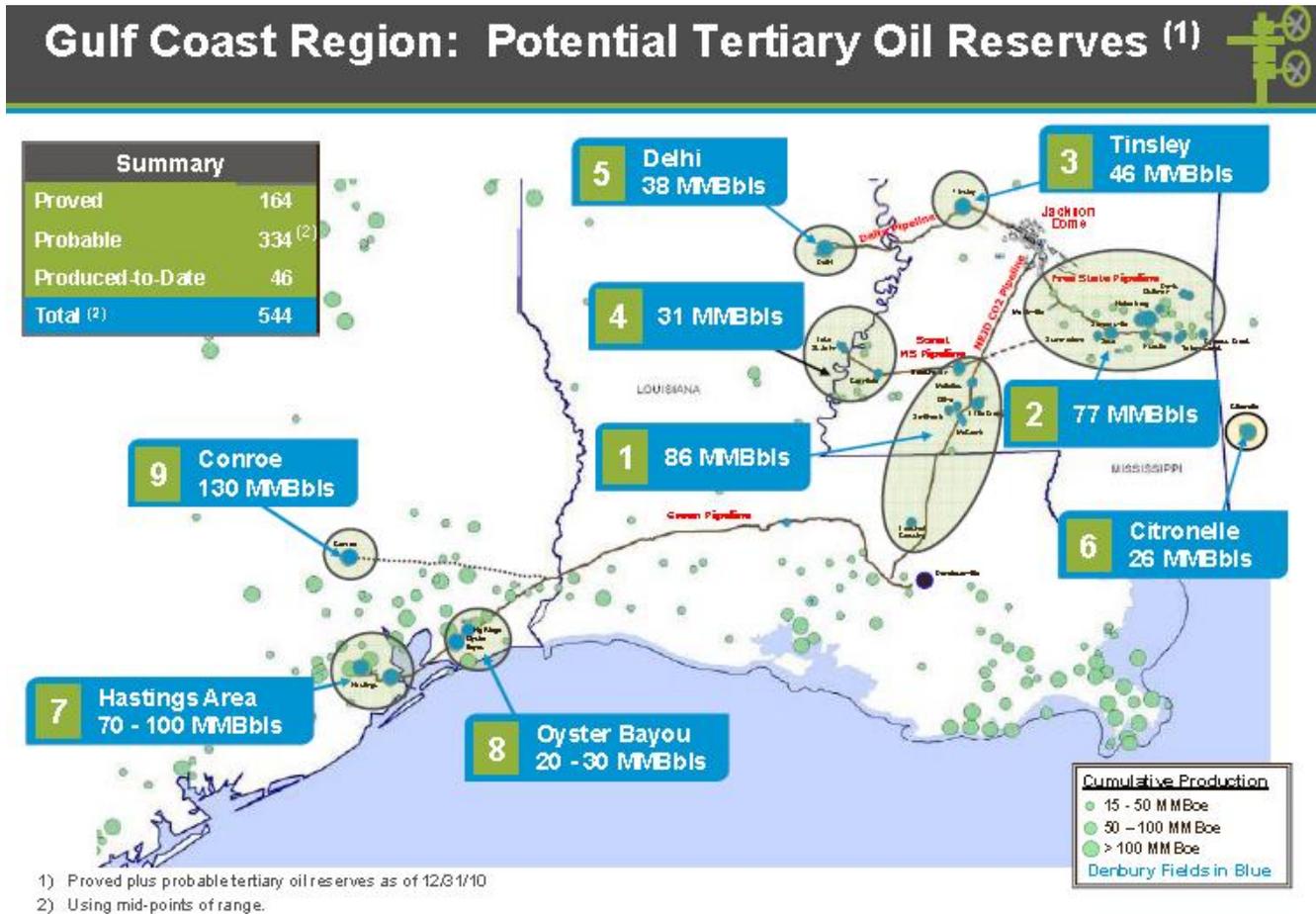
Note: Denbury acquired Encore on 1 November 2009, doubling their potential CO<sub>2</sub>-EOR recoverable reserves with Encore's assets in the mountain states, not shown in this figure

Source: Oil & Gas Journal 2010, Bloomberg New Energy Finance.

# Life-cycle of a Producing Field



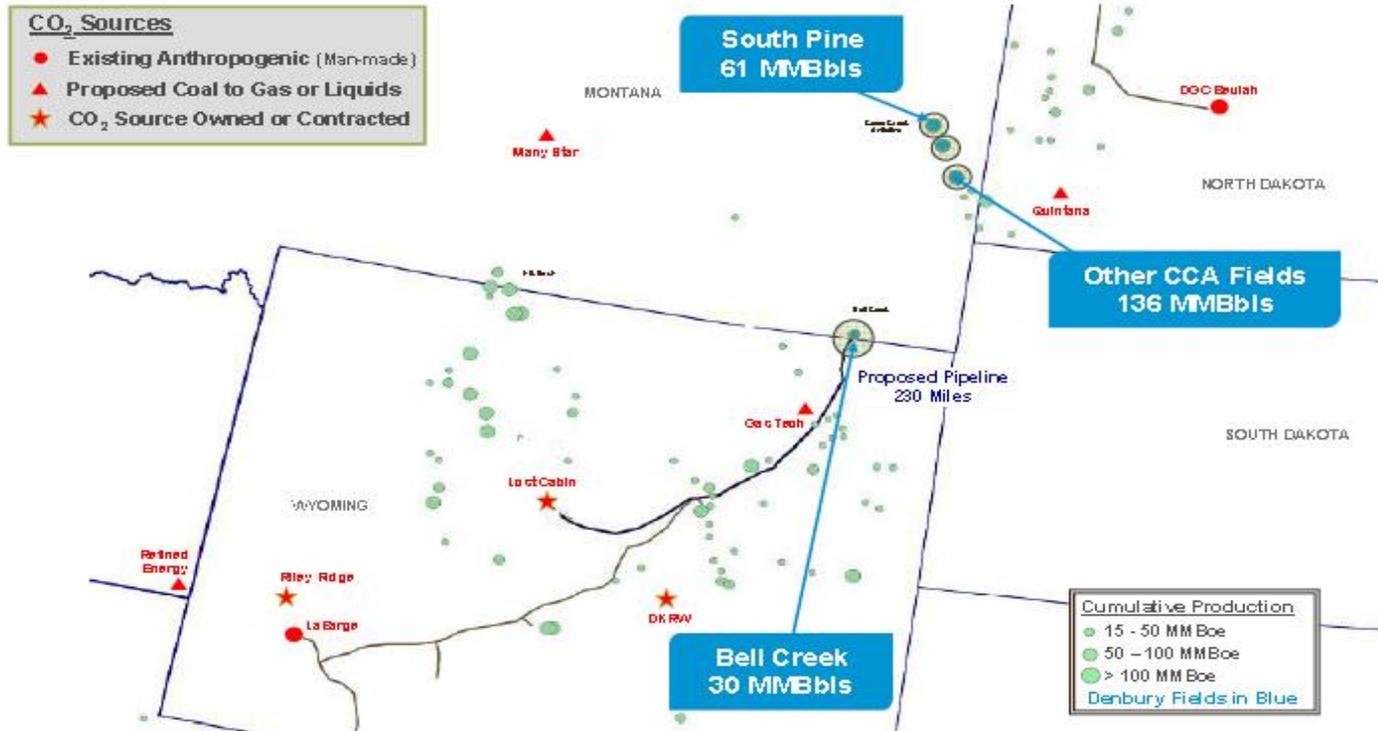
# Most Projects Involve EOR in or to the Gulf Coast ...





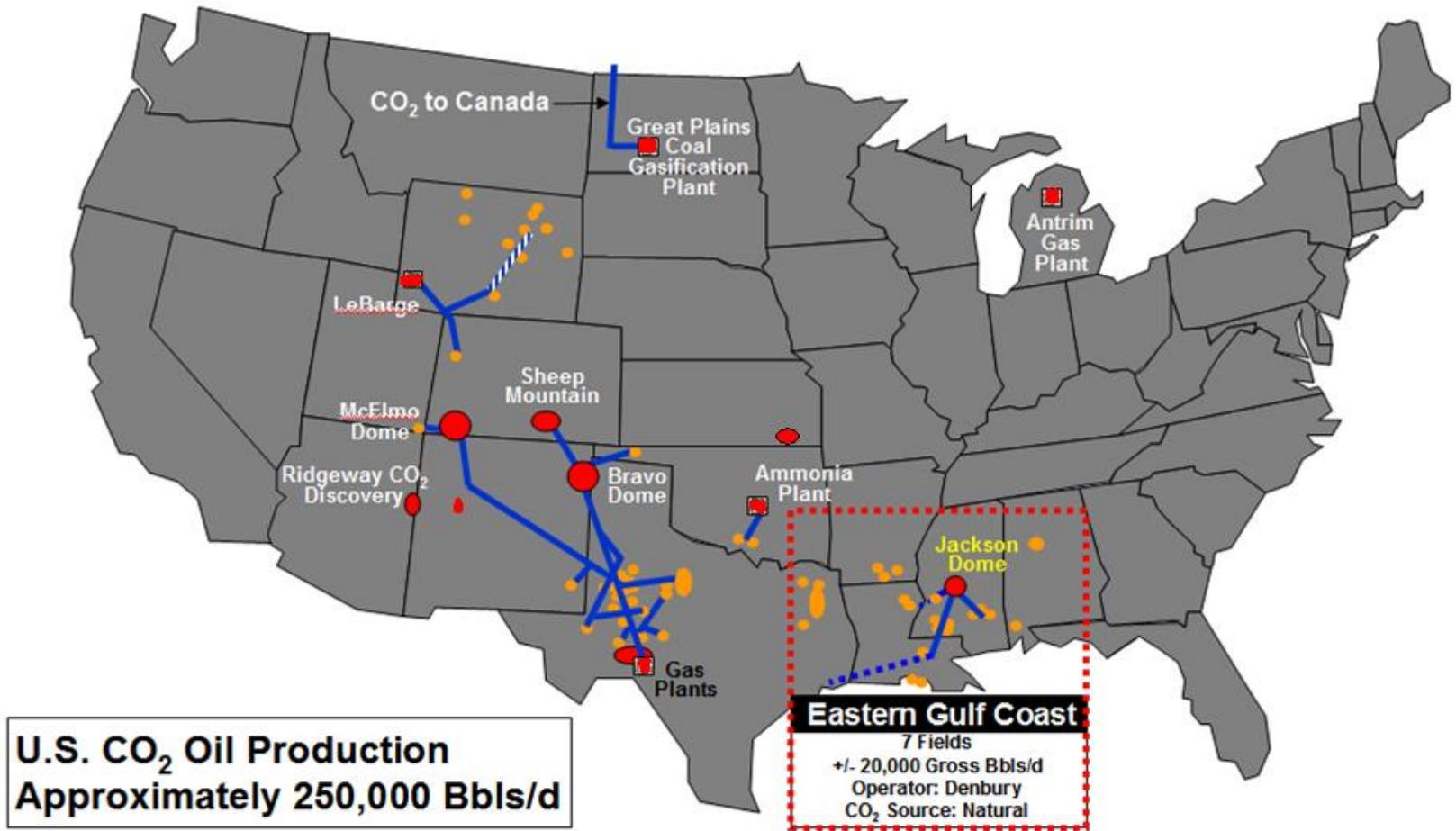
# ... And As Storage In the Rocky Mountain Region

## Rockies Region: Potential Tertiary Oil Reserves (1)



1) Probable and possible reserve estimates.

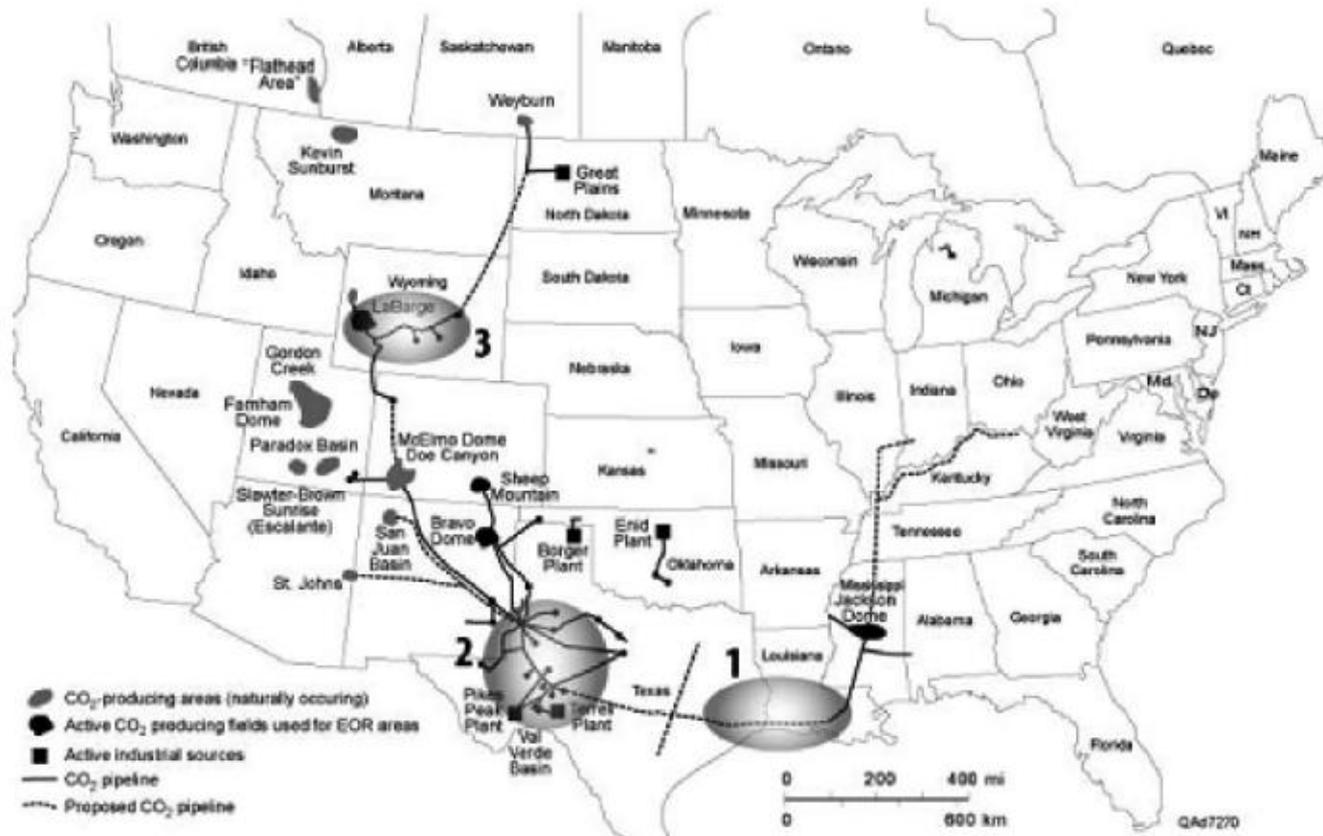
# Current CO<sub>2</sub> Pipeline Network



# Likely CO<sub>2</sub>-EOR Scenario

Source: MIT-BEG 2010 Study

- A Framework Depiction of a National CO<sub>2</sub> Pipeline Network ("The Horseshoe"). The shaded ellipses represent three areas where very large EOR/CCS projects are active or proposed.



# IOGCC-SSEB CO2 Pipeline Transportation Task Force (PTTF)

- Offshoot of IOGCC's Carbon Capture and Geologic Storage Task Force

- Collaboration:



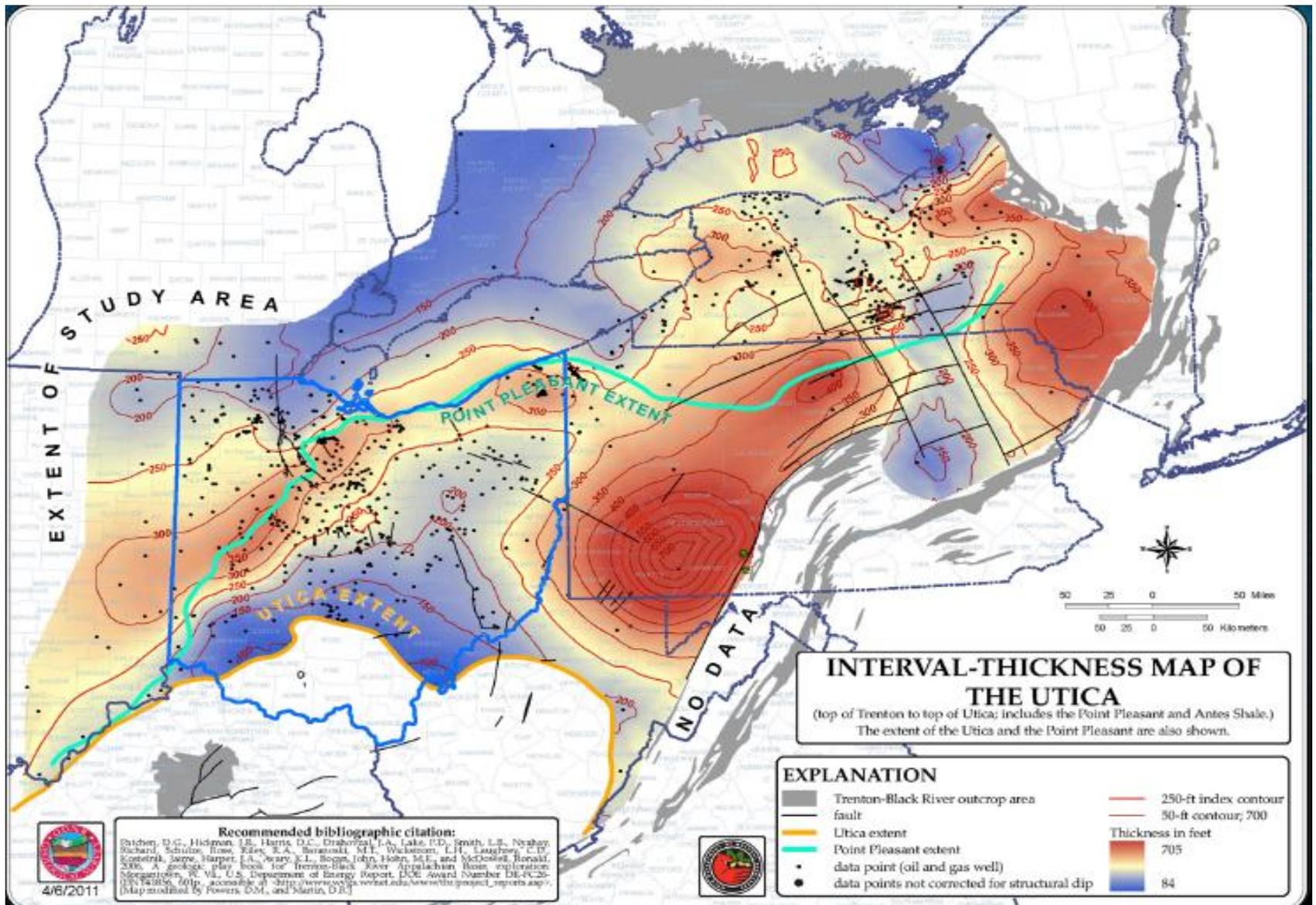
- Released: January 31, 2011
- Where to find:

<http://www.iogcc.state.ok.us/Websites/iogcc/Images/PTTF%20Final%20Report%202011.pdf>

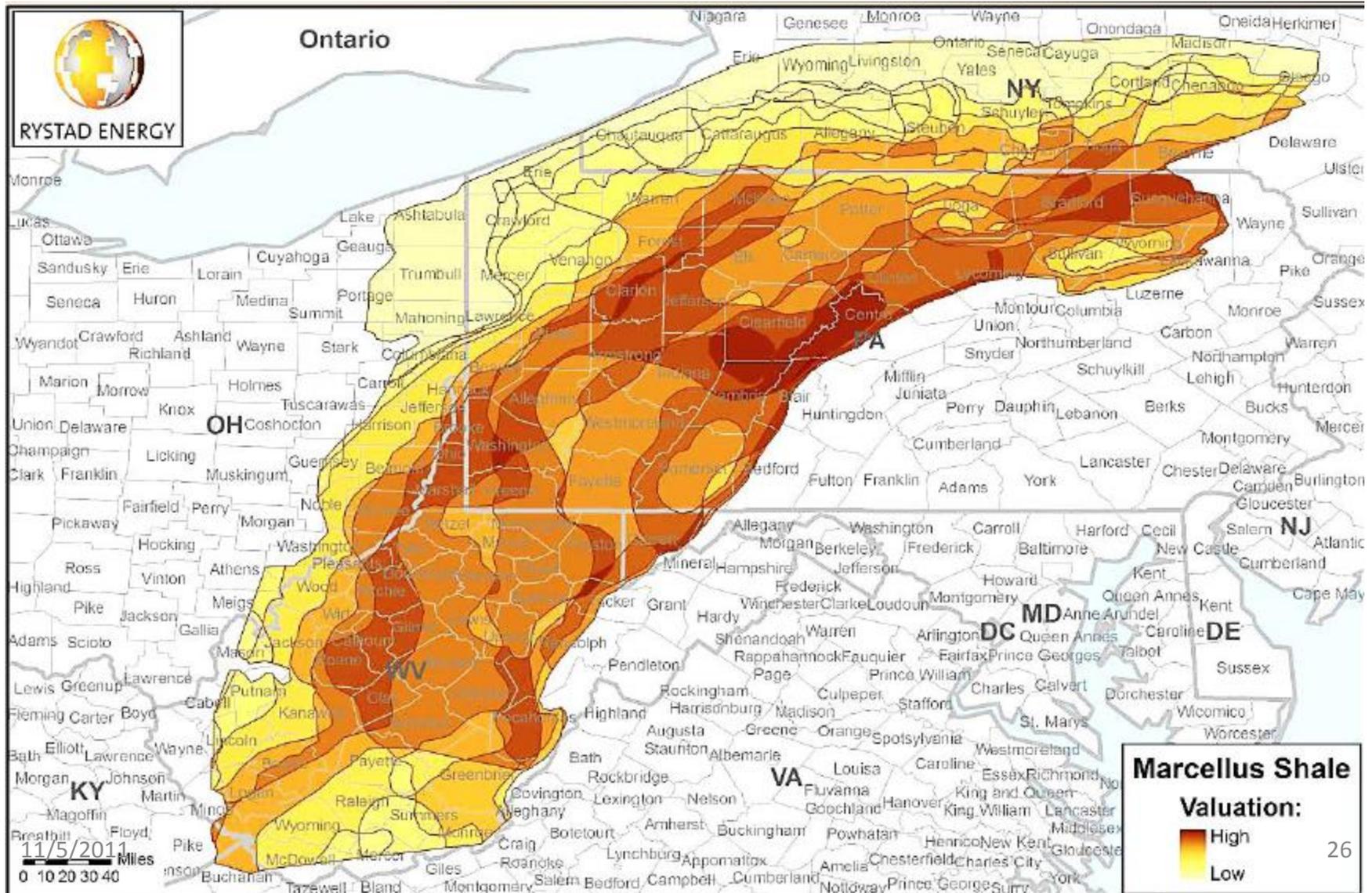
# Could Shale Basins find 2<sup>nd</sup> Life?

- Eventually the fractured shale production zones will deplete economically and may hold an opportunity for long term sequestration and/or enhanced production with CO<sub>2</sub>.

# Extent of the Utica Shale

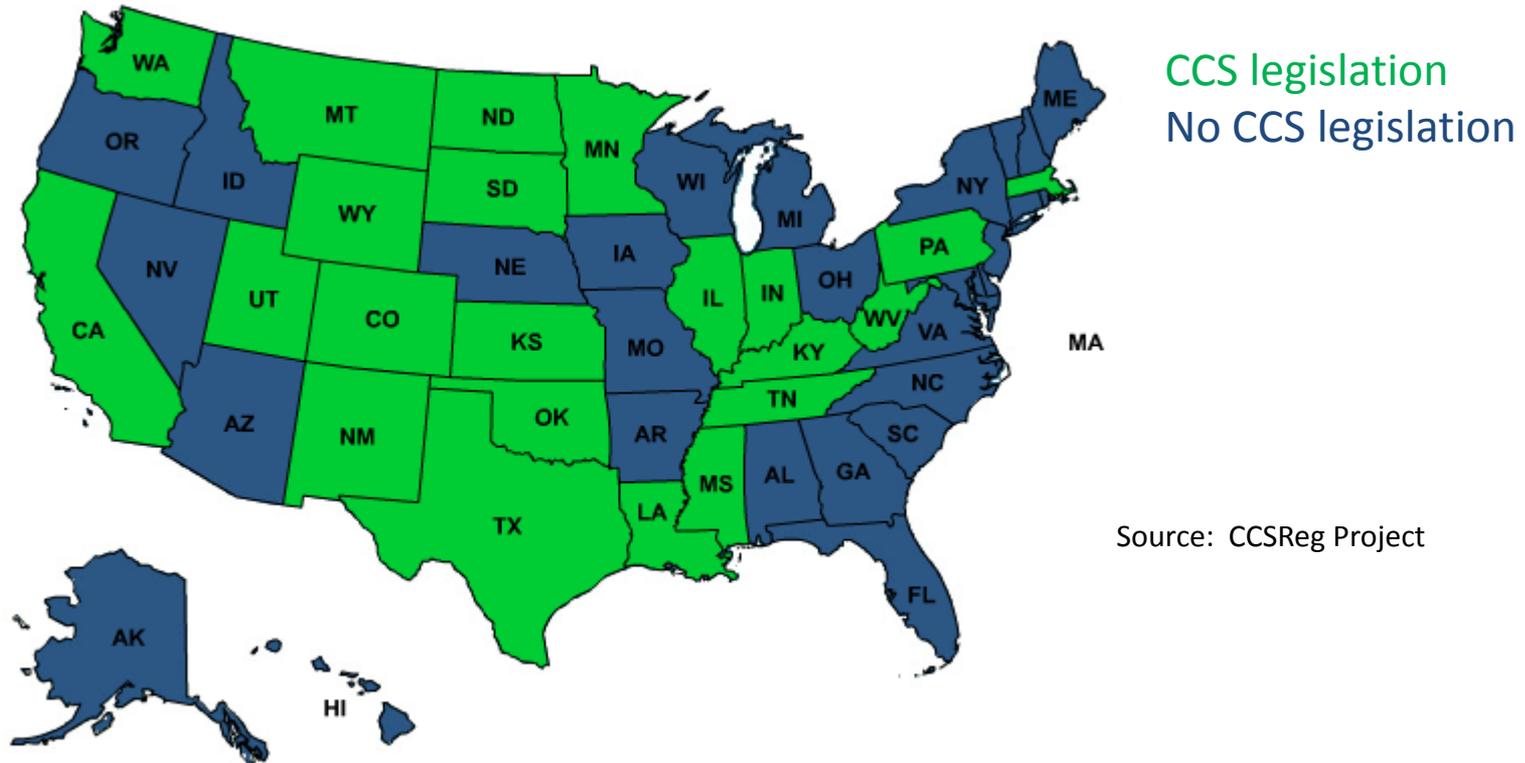


# Marcellus Play



# State Level Activity Advancing

# EOR Projects Are Helping To Form A CCS Legal Framework, Too



# Mississippi

- **Feb 15<sup>th</sup>** Mississippi, the House and Senate both passed legislation (SB 2723 and HB 1093). The bills to allow and regulate long-term underground carbon dioxide storage, a practice proponents say will help increase the state's oil production while reducing greenhouse gas emissions. Senate passed a bill to set up a regulatory structure giving the state Department of Environmental Quality the authority to oversee the process. Two oil producers - Denbury Resources, Inc., of Plano, Texas, and Tellus Operating Group LLC based in Ridgeland - supported House Bill 1098 and Senate Bill 2723.

# Kentucky

- **March 15<sup>th</sup> & 16<sup>th</sup>** Kentucky Governor Steve Beshear signed SB 50 and HB 259 legislation that could help pave the way for a series of coal gasification projects that would capture carbon dioxide and either store the greenhouse gas or send it through a proposed Denbury Resources pipeline for use in enhanced oil extraction on the Gulf Coast. S.B. 50 gives the right of eminent domain to CO2 pipeline developers such as Denbury. The bill, which easily passed both the Republican-controlled Senate and House of Representatives, where Democrats hold a majority. Denbury, a Plano, Texas-based independent oil and natural gas company, is evaluating building a 700-mile-long pipeline to transport CO2 from several proposed coal gasification plants in Illinois, Indiana and Kentucky to an existing Denbury pipeline near Tinsley, Miss. H.B. 259, meanwhile, empowers Kentucky to pursue a demonstration project to store CO2 from a project such as Kentucky NewGas, a Peabody Energy/ConocoPhillips joint venture in Muhlenberg County that would produce synthetic natural gas.

# Indiana

- **April 21<sup>st</sup>** Indiana House passes bill SB 251 an energy incentives bill that includes eminent domain for CO2 pipelines. “It will ensure Indiana will be able to provide clean reliable energy (using) the coal resources that are under our feet,” said Rep. Sue Ellspermann, R-Ferdinand. The measure allows needed right away to be acquired through eminent domain to make way for a carbon dioxide pipeline, which would take away the gas from Indiana Gasification LLC, a subsidiary of Leucadia National Corporation gasification project. The project, on the Ohio River at Rockport, about 30 miles south of Ferdinand, would turn local coal into natural gas. Denbury Resources sought the eminent domain measure this winter after it made plans to buy all of the future carbon dioxide from the coal gasification plant. Construction of the plant can begin only after federal environmental officials accept its plan to sequester of tons of carbon dioxide given off in the gasification process. The bill now goes to the Indiana Senate.

# Texas

- **June 17<sup>th</sup> Texas** HB 82 Unitization bill was filed. Covers both hydrocarbons and CO<sub>2</sub> storage.
- **June 27<sup>th</sup> Texas TRRC** New rules adopted at the RRC's June 27, 2011, open meeting. The Commission adopted new rules in Chapter 5, new Subchapter C, §§5.301-5.308, relating to Certification of Geologic Storage of Anthropogenic Carbon Dioxide (CO<sub>2</sub>) Incidental to Enhanced Recovery of Oil, Gas, or Geothermal Resources. The adopted new rules will be published in the July 8, 2011, issue of the Texas Register with an effective date of July 17, 2011.  
<http://www.rrc.state.tx.us/rules/proposed.php>

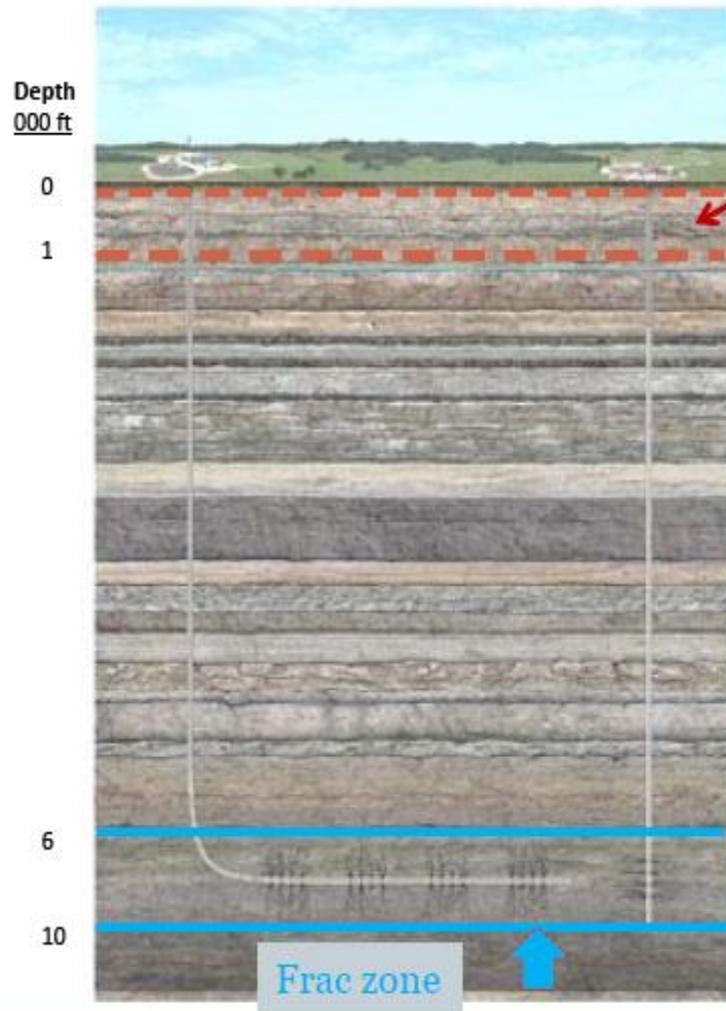
# Illinois

- **June 24<sup>th</sup> Illinois** S.B. 1821 creates the Carbon Dioxide Transportation and Sequestration Act. Has passed the Senate and House and sent to the Governor for signature. It empowers the Illinois Commerce Commission to issue a certificate “for the limited grant of authority for construction and operation of a carbon dioxide pipeline”.  
<http://www.ilga.gov/legislation/BillStatus.asp?DocTypeID=SB&DocNum=1821&GAID=11&SessionID=84&LegID=57876>

# Market Mechanisms

- California under AB 32 Cap and Trade Program
- Regional Greenhouse Gas Initiative
- State RPS programs
- Federal CES?
- Voluntary reductions/Offsets
- Commodity value of CO<sub>2</sub> from EOR and beneficial uses
- Tax credits, grants and loan guarantees

# Food for Thought-Hydraulic Fracturing vs. Raw Sewage...



Water for human consumption is taken from top 1000 feet of the earth.

EPA says **20 Billion\*** barrels of sewage (containing toxins and diseases) leak annually from US sewage systems. Leaks are into top of water supply zone and can go down through entire zone. (Daily volume = more than 10 times the *total* BP Macondo well spill.)

Which is the greater threat?

Typical frac job 50-100k barrels—thousands of feet below water supply

# Questions & Thank You!

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# Extra

# EPA RCRA Title for Geologic Sequestration

- “Hazardous Waste Management System: Identification and Listing of Hazardous Waste: Carbon Dioxide (CO<sub>2</sub>) Streams in Geologic Sequestration Activities”; 76 Fed. Reg. 48073 (Aug. 8, 2011); docket ID no. EPA-HQ-RCRA-2010-0695.

# Additional Points CO<sub>2</sub>

- Mississippi tax
- Nd land use subsurface rights
- NARUC EOR resolution
- NEORI
- PEW method
- CCS CDM implications

# Lugar-Conrad

- Sen. Lugar (R-IN) will introduce his “Practical Energy Plan,” CO2-EOR is a key part of the plan.
- According to the Senator’s office, the plan is expected to displace the need for more than 5 million barrels per day of foreign oil by 2030 – again, via CO2-EOR.
- S. 1220, which Sen. Conrad introduced
  - + Section 402 includes the energy committee’s prior language re indemnification for up to ten federally funded CCS projects.
  - + Section 412 implements a new investment tax credit for qualifying carbon dioxide capture, transport and storage equipment that is part of a qualifying clean coal project. 30%
  - + Section 413 includes modifications to the current 45Q CCS tax credit to encompass, in part, non-EOR beneficial uses of CO2, credit transferability, and a 10-year credit eligibility period.
- Clean energy bonds \$5bln

# CCS Related Papers

- Four recent CCS papers that may be of interest.
- “Potential Impacts of CCS on CDM” (CATO2, May 2011). This paper examines early “carbon credit” opportunities in the developed world.
- “Role of CCS in the International Climate Regime” (CATO2, May 2011). This paper suggests non-UNFCCC/non-Kyoto Protocol international mechanisms to fund and otherwise advance CCS.
- “CCS In Industrial Applications” (UN Industrial Development Organization, Nov 2010). Although dated last November, we understand that this is a working draft that has not yet been formally published. This paper looks at CO2 capture considerations, including costs, in the following sectors: “high-purity CO2 sources,” cement, iron & steel, refineries, and biofuels. It also discusses EOR (p. 48).
- H. Coninck, “An International Relations Perspective on the Global Politics of Carbon Capture and Storage” (Global Environmental Change, 2011). This paper makes the stunning conclusion that “CCS enthusiasts often are under the influence or representatives [sic] of energy, industry and fossil fuel interests ....” (p. 8). (We’ve also heard that astronomers are driving most of the demand for telescopes, but we’re trying to confirm that.) From this paper we conclude that parents should think long and hard before encouraging their children to pursue postdoctoral work in international relations.