

**National Enhanced
Oil Recovery Initiative**

Accelerating Commercial Deployment of CCS:

***Developing Incentives to Expand Anthropogenic CO2
Supply for Enhanced Oil Recovery Commercial***

**Brad Crabtree
Great Plains Institute**

From a Bridge to a Destination: Gas-Fired Power after 2020

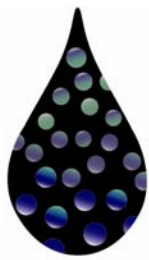
November 4th, 2011

Washington, DC



Great Plains Institute

Working on tomorrow's energy solutions with today's leaders



Commercial carbon management is here and now—and bigger than most realize—thanks to CO2 Enhanced Oil Recovery:

- 40 years of commercial operational experience (began in West Texas in 1972).
- Nearly 300,000 barrels of oil produced daily, or about 6 percent of U.S. domestic production.
- U.S. EOR industry manages pipeline transport and injection of roughly 65 million tons of CO2 annually—profitably and without serious reported injuries, accidents or environmental harm.



Some of that CO₂ to produce oil already comes from industrial sources . . .

Current CO₂ Supply for EOR

Source Type (Location)	CO ₂ Supply (Mt/year)	
	<i>Natural</i>	<i>Anthropogenic</i>
Colorado, New Mexico (Geologic)	33	-
Texas (Gas Processing)	-	6.4
Wyoming (Gas Processing)	-	6.6
Mississippi (Geologic)	22	-
Oklahoma (Fertilizer Plant)	-	0.7
Michigan (Gas Processing)	-	0.3
North Dakota (Coal Gasification)	-	3
Total	55	17

U.S. Department of Energy (2011), *Improving Domestic Energy Security and Lowering CO₂ Emissions with “Next Generation” CO₂-Enhanced Oil Recovery (CO₂-EOR)*, DOE/NETL-2011/1504, citing Advanced Resources International (2011).

And the potential is truly vast . . .

NETL/ARI Projected CO₂-EOR Resources

	Incremental Technically Recoverable Oil (Billion Barrels)		Incremental Economically Recoverable Oil (Billion Barrels)	
	<i>Best Practices</i>	<i>Next Generation</i>	<i>Best Practices</i>	<i>Next Generation</i>
Lower 48 Onshore	55.7	104.4	24.3	60.3
Total	61.5	136.6	29.6	67.2

¹ U.S. Department of Energy (2011), *Improving Domestic Energy Security and Lowering CO₂ Emissions with “Next Generation” CO₂-Enhanced Oil Recovery (CO₂-EOR)*, DOE/NETL-2011/1504.

² Incremental technically recoverable after subtracting 2.3 billion barrels already being developed by CO₂-EOR.

³ “Best practices” assumes “state of the art” technology characteristics used in DOE’s 2008 NETL study, *Storing CO₂ with Enhanced Oil Recovery*, Report DOE/NETL-402/1312/02-07-08 and DOE NETL (2011).

⁴ “Next generation” assumes technology characteristics used in DOE’s 2009 NETL study, *Storing CO₂ and Producing Domestic Crude Oil with Next Generation CO₂-EOR Technology*, Report DOE/NETL-2009/1350 and DOE NETL (2011).

⁵ Estimates for incremental economically recoverable oil assumes an oil price of \$85/bbl , a CO₂ price of \$40/ton and a project rate of return of at least 20%.

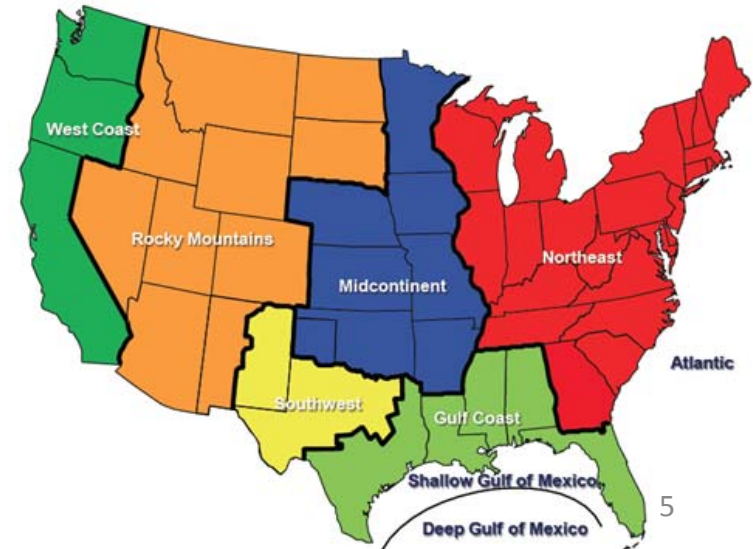
But, we need more CO₂ . . . and natural gas has a major role.

EIA's Projected CO₂ Supply for EOR (tons annually)

	Natural Gas Processing	Hydrogen	Refineries (Hydrogen)	Ammonia	Ethanol	Cement	Power Plants
Gulf Coast	6,031,746	-	6,031,746	4,126,984	-	4,550,265	207,936,508
West Coast	2,116,402	-	4,920,635	-	211,640	2,539,683	60,000,000
Southwest	-	-	-	-	3,597,884	3,915,344	-
Rocky Mountains	634,921	-	3,280,423	158,730	1,216,931	1,851,852	153,809,524
Northern Great Plains	317,460	-	846,561	-	476,190	158,730	3,174,603
Midcontinent	-	-	52,910	-	9,259,259	2,539,683	39,788,360
East Coast	1,216,931	158,730	899,471	-	2,751,323	4,973,545	686,772,487

¹U.S. Energy Information Administration, Office of Energy Analysis (2011). Assumptions to the Annual Energy Outlook, Oil & Gas Supply Module.

²EIA notes that technology and market constraints prevent the total volumes of CO₂ from becoming immediately available.



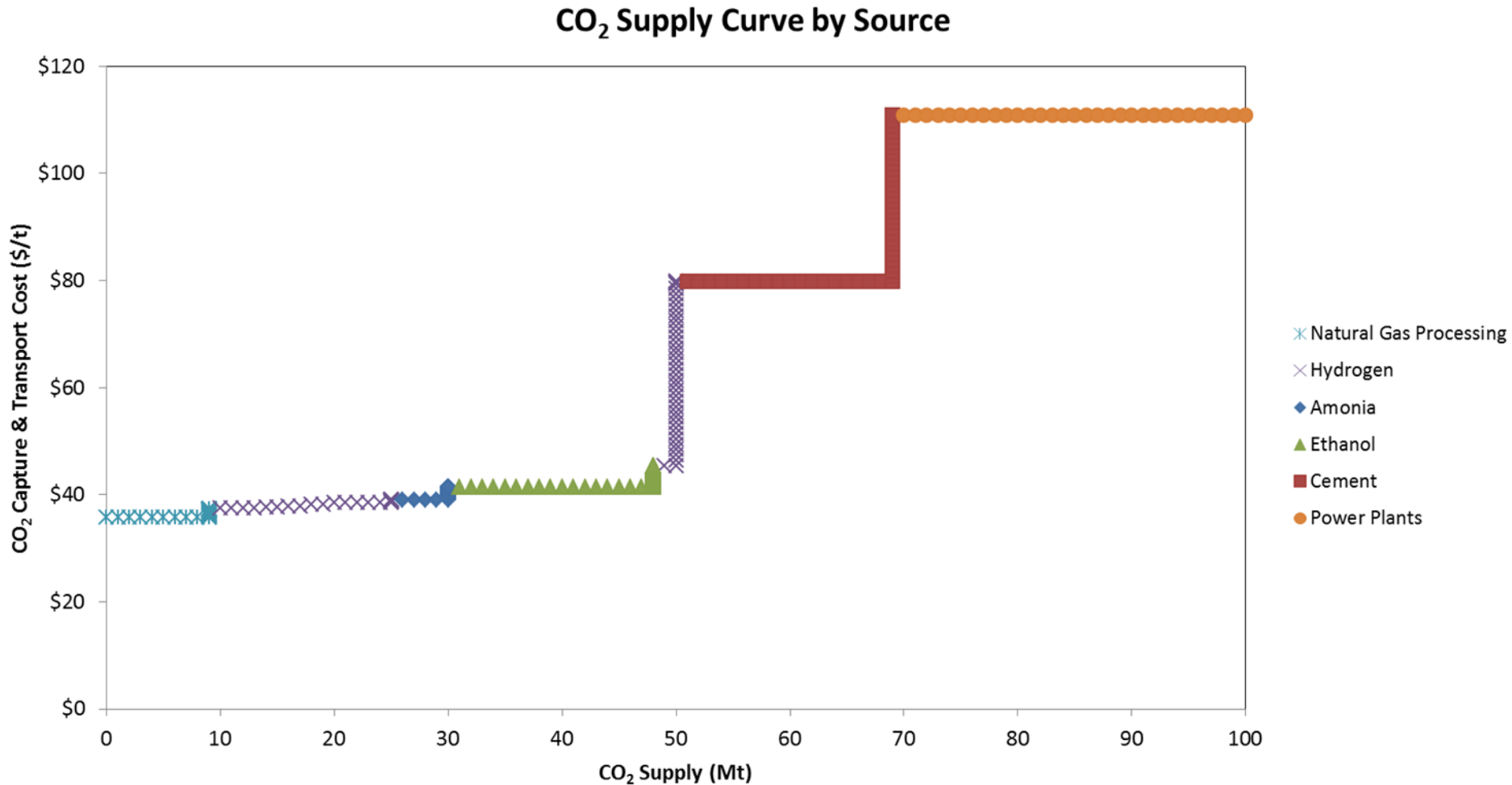
Natural gas CO2 supply comes in at both ends of the cost spectrum . . .

EIA's CO2 Capture & Transport Cost Assumptions (\$/ton)

	Natural Gas Processing	Hydrogen	Refineries (Hydrogen)	Ammonia	Ethanol	Cement	Power Plants
Gulf Coast	\$36.29	\$36.67	\$36.67	\$39.69	\$42.15	\$81.08	\$112.64
West Coast	\$36.29	\$37.99	\$37.99	\$39.69	\$42.15	\$81.08	\$112.64
Southwest	\$36.29	\$38.18	\$38.18	\$39.69	\$42.15	\$81.08	\$112.64
Rocky Mountains	\$36.29	\$38.37	\$38.37	\$39.69	\$42.15	\$81.08	\$112.64
Northern Great Plains	\$36.29	\$38.75	\$38.75	\$39.69	\$42.15	\$81.08	\$112.64
Midcontinent	\$36.29	\$39.12	\$39.12	\$39.69	\$42.15	\$81.08	\$112.64
East Coast	\$36.29	\$46.12	\$46.12	\$39.69	\$42.15	\$81.08	\$112.64

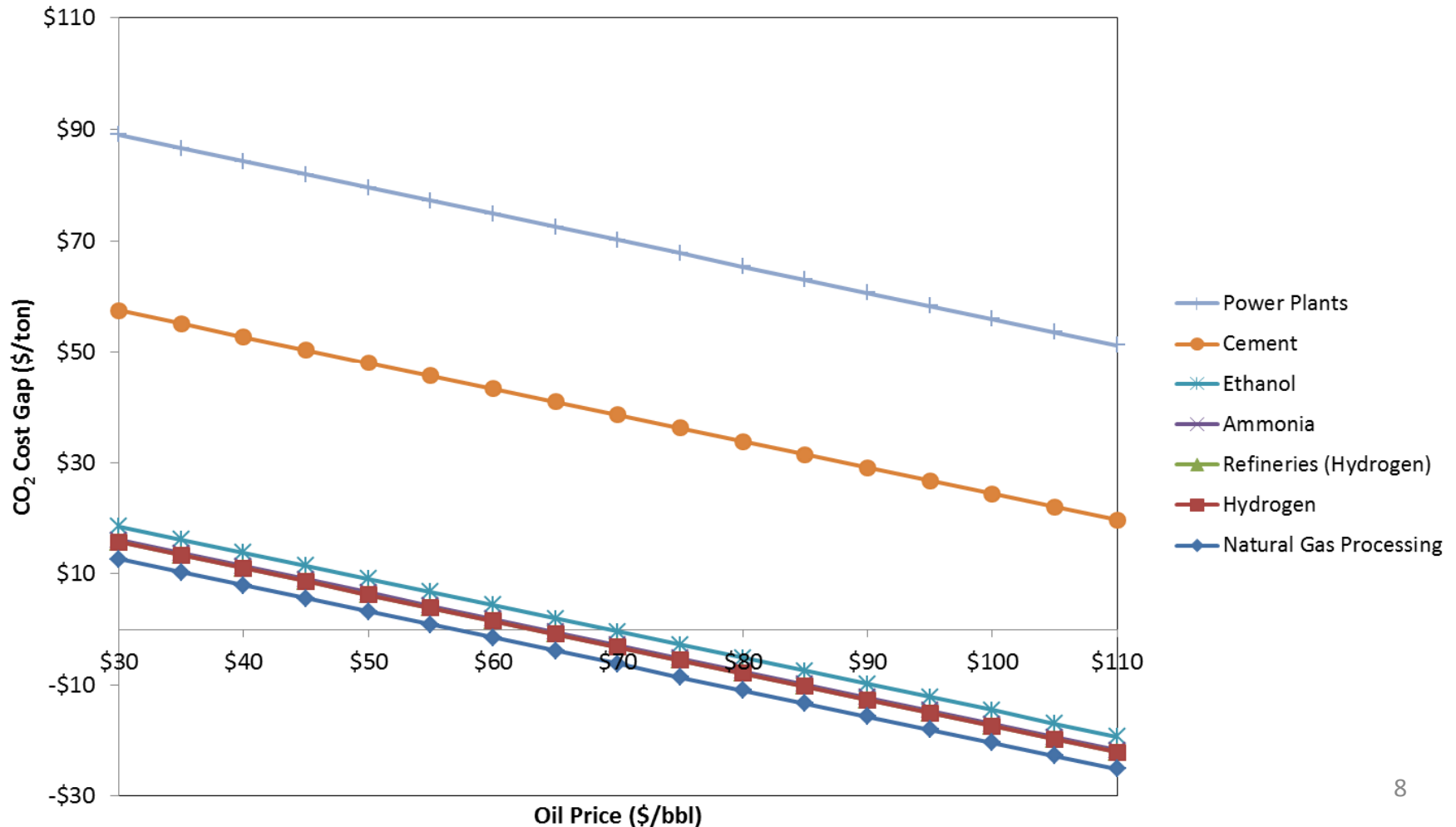
U.S. Energy Information Administration, Office of Energy Analysis (2011). Assumptions to the Annual Energy Outlook, Oil & Gas Supply Module.

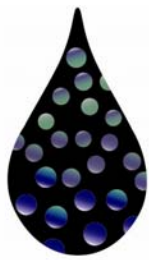
Natural gas processing has and will continue to be an early target for CO2 supply to the EOR industry . . .



CO₂ from post-combustion capture off natural gas power generation can come later, but only with significant incentives to lower capture costs. . .

Difference Between EOR Operators' Willingness to Pay for CO₂ and CO₂ Capture + Transport Cost



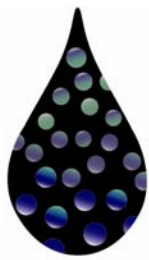


Collaborative national policy and outreach effort: oil and gas companies, industries supplying CO₂; state officials, legislators and regulators; and state and national environmental NGOs.

Mission: Accelerate commercial deployment of enhanced oil recovery using CO₂ from fossil, renewable and industrial sources.

Convening organizations: Pew Center on Global Climate Change and Great Plains Institute.





National Enhanced Oil Recovery Initiative

Overview of the Initiative

Who's Involved

Oil and Gas

- Chaparral Energy
- Chevron Corporation
- Continental Resources
- Core Energy
- Denbury Resources
- Encana
- Occidental Petroleum

Coal and Coal-Based Generation

- Arch Coal
- Basin Electric Power Cooperative
- Leucadia
- Southern Company
- Summit Power Group
- Tenaska Energy

Industrial Suppliers of CO₂/Technology Vendors

- Air Products
- Archer Daniels Midland
- GE Energy

Environmental NGOs

- Clean Air Task Force
- Natural Resources Defense Council
- Ohio Environmental Council
- Wyoming Outdoor Council

Labor

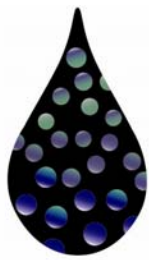
- AFL-CIO
- United Transportation Union

Other Institutions

- Enhanced Oil Recovery Institute (University of WY)
- Interstate Oil and Gas Compact Commission
- North American Carbon Capture and Storage Association
- Southern States Energy Board

State Officials

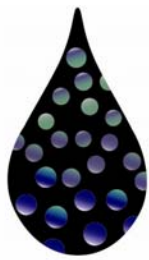
- California, Illinois, Indiana, Michigan, Mississippi, Montana, New Mexico, Texas and West Virginia



Sponsors

- **Charitable Foundations:** Joyce Foundation, Edgerton Foundation, Energy Foundation
- **Private Industry:** Arch Coal, Chaparral Energy, Chevron, Continental Resources, Core Energy, Encana, Southern Company, Summit Power, Tenaska



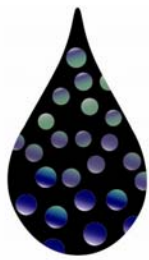


Bipartisan Congressional Support

Initiative launched in July with participation and endorsements from:

- Sen. John Barrasso (R-WY)
- Rep. Mike Conaway (R-TX)
- Sen. Kent Conrad (D-ND)
- Sen. John Hoeven (R-ND)
- Sen. Richard Lugar (R-IN)

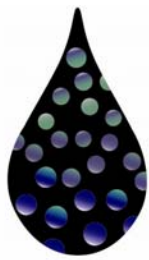




Three-Part Agenda

- Prepare key analyses to inform and support incentive policies for anthropogenic CO₂-EOR
- Recommend and advocate for incentives and other policies to support commercial CO₂-EOR deployment that are fully or largely self-financing through revenues from additional incremental oil production.
- Increase policy-maker, media and public awareness of the CO₂-EOR, its benefits and need for deployment incentives.





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Objectives for Policy

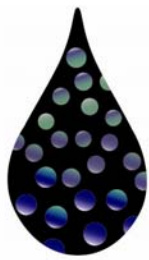
The EOR Initiative will develop, recommend and encourage the implementation of federal and state incentives that:

- Accelerate commercial deployment of CO₂-EOR using anthropogenic CO₂ captured from fossil, renewable and industrial sources;
- Encompass a broad range of CO₂ source industries, projects and capture technologies;
- Bridge the gap between what oil companies can pay for CO₂ and the cost of capturing CO₂ and transporting it to oil fields.
- Ensure net fiscal benefit and sustainability of incentives over time by increasing production of oil without new or additional taxes; and
- Produce more American oil to displace imports, while reducing net CO₂ emissions through oilfield storage of captured anthropogenic CO₂.



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The EOR Initiative's federal and state incentive recommendations shall:

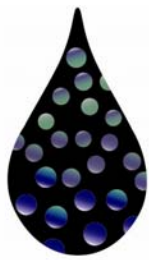
- **Reduce the net cost of anthropogenic CO₂ delivered** by directing incentive value toward commercial-scale capture projects and development of pipeline networks that makes CO₂ attractive for purchase and use in oilfields;
- **Provide for revenue-neutrality** for federal and state governments over the lifespan of the projects;
- **Ensure financial continuity and certainty** over a defined and limited time period to support commercial capture and pipeline project development, secure private sector investment and reduce capital and O&M costs.
- **Address three priorities simultaneously:** low-cost targets of early opportunity to increase anthropogenic CO₂ supply, competitive commercial-scale development and deployment of critical long-term capture technologies, and build-out of new pipeline capacity.





- **“Cost gap” analysis:** (difference between willingness to pay by EOR operators and cost of carbon capture, storage and transportation)
 - GOAL: Determine the level of incentive needed for incremental new CO₂-EOR.
 - Methodology and spreadsheet tool complete; working to improve data.
- **“Revenue neutrality” analysis:**
 - GOAL: Determine the fiscal impact of new CO₂-EOR incentives.
 - Compare the cost of new CO₂-EOR incentives with new federal revenues from increases in oil royalties, corporate income tax, and person income tax directly and indirectly resulting from incremental new CO₂-EOR production.
 - Analysis now underway in preparation for engaging members of Congress and staff regarding budget scoring.





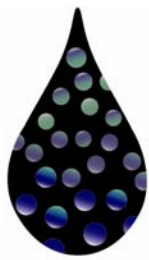
Economic/jobs impacts of CO₂-EOR incentives

- High-level estimates for incentive impacts based on existing literature for economic and job benefits of domestic oil production.
- Literature review underway.

CO₂ storage benefits

- Commissioned paper outlining:
 - History and experience with CO₂ management and storage in context of BAU commercial EOR;
 - What can be claimed for storage to date based on that operational experience; and
 - Recommendations going forward for demonstrating and verifying CO₂ storage as part of commercial EOR.





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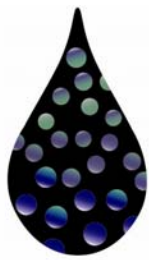
***Policy Recommendations
Forthcoming***

- **Design of a major revenue-neutral federal domestic energy security incentive for EOR using CO2 from fossil, renewable and industrial sources**
 - Participants working on key design attributes of a federal incentive that will incorporate pending analyses regarding cost gaps and revenue neutrality



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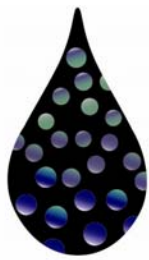
***Policy Recommendations
Forthcoming***

- **Proposed revisions to existing 45 Q CO2 capture and storage tax credit**
 - Participants developing consensus comments on how to reform 45Q
 - Working through overlapping members to try and harmonize recommendations with other associations and organizations submitting comments



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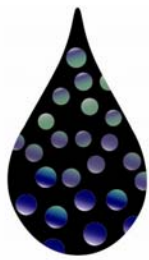
Policy Recommendations Forthcoming

- **Input on current legislation**
 - Participants developing consensus comments regarding proposed revisions to:
 - EOR component of Senator Lugar's Practical Energy Plan
 - Relevant provisions in Senator Conrad's recent FUEL Act



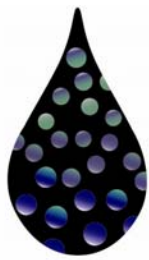
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- **Recommendations regarding CO₂-EOR on public lands with existing oil and gas development**
 - Recommendations for how BLM, the Bureau of Mines and other federal agencies can encourage CO₂-EOR on federal lands already impacted by oil and gas development.
 - Wyoming participants preparing draft recommendations based on experience with BLM in Big Horn Basin and analysis highlighting economic, energy security and environmental benefits of expanded CO₂-EOR on public lands.

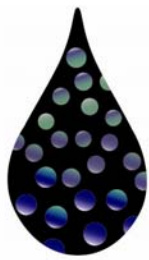




Materials for policy-makers, media and public:

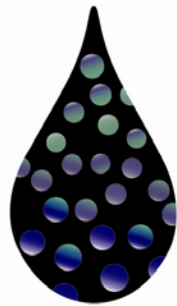
- Address lack of awareness of commercial CO₂-EOR and its economic, energy security and environmental benefits:
 - Newspaper op-ed making case for CO₂-EOR to be submitted around the country;
 - Two pagers on: overview of CO₂-EOR, economic benefits, environmental benefits and safety; and
 - Forthcoming: two-pagers on importance and benefits of CO₂-EOR to the coal industry, natural gas industry, agriculture, and potentially other sectors.





COMMERCIAL CO₂-EOR SUPPORTS URGENT NATIONAL PRIORITIES:

- **Increase U.S. oil production** from existing mature oil fields at lower risk and impact than drilling in new areas;
 - **Strengthen America's national security** by reducing dangerous dependence on unstable and/or hostile regimes supplying the world oil market;
 - **Reduce trade deficits** by keeping petroleum expenditures at home and at work in the American economy;
 - **Create new, high-paying American jobs** and retain and attract private sector investment in the U.S. economy;
 - **Enable commercial deployment of CCS industry** to the long-term benefit of coal, natural gas, ethanol and other domestic industrial sectors;
 - **Facilitate compliance and participation in low-carbon fuels markets** by oil, natural gas and ethanol producers; and
 - **Achieve significant net carbon reductions** through CCS.
- **Potential for viable agenda and coalition in challenging economic and political times!**



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THANK YOU!

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