

TxCCSA Conference on

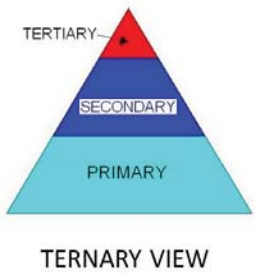
The Future of Texas CCS: 2011 and Beyond

AT&T Center
Austin, Texas

February 8, 2011



CONVENTIONAL VIEW OF RECOVERABLE OIL RESOURCES

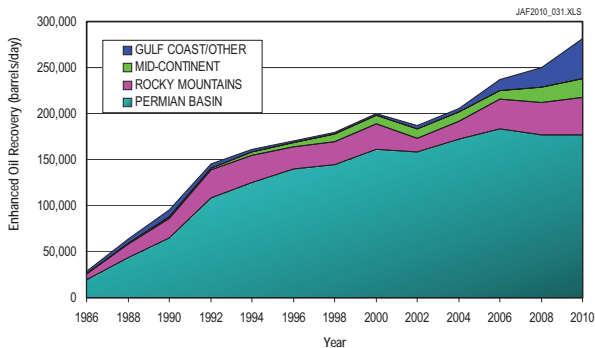


- Primary Production: Wells Penetrate the Reservoir and Fluids are Produced with the Reservoir's Internal Energy
- Secondary Production : Injection Wells are added; Reservoir is Re pressured and Oil is "Swept" to Producing Wells (Injectant Doesn't Mix with the Oil)
- Tertiary Production: Injectant Changes the Properties of the Oil to Make it More Mobile in the Reservoir

Also Referred to as Enhanced Oil Recovery (Steam, Chemical, and CO₂ Flooding are all Applicable)



Growth Of CO₂-EOR Production In The U.S.



Part 1: CO₂ EOR Potential

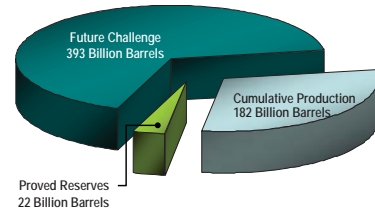
Advanced Resources International
(<http://www.adv-res.com/>)



Large Volumes Of Domestic Oil Remain "Stranded" After Primary/Secondary Oil Recovery

The U.S. has a bountiful oil resource in-place; only about one-third of this resource is recoverable with traditional technologies.

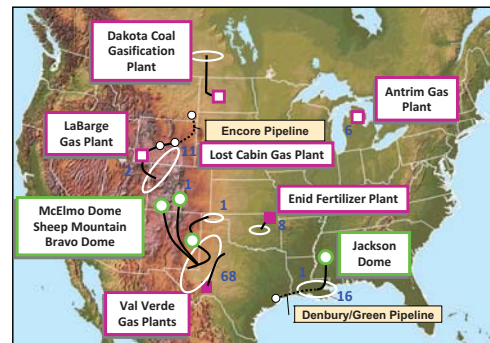
Original Oil In-Place: 597 B Barrels*
"Stranded" Oil In-Place: 393 B Barrels*



Source: Advanced Resources Int'l. (2009)



U.S. CO₂-EOR Activity



114 Number of CO₂-EOR Projects

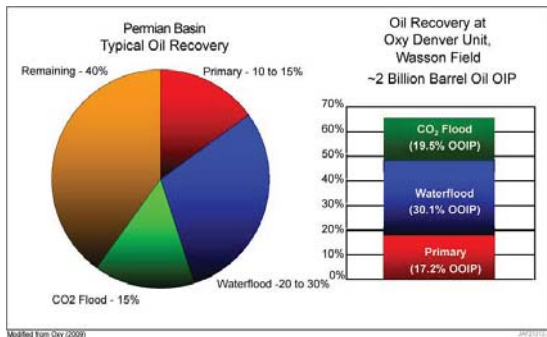
- Natural CO₂ Source
- Industrial CO₂ Source
- Existing CO₂ Pipeline
- CO₂ Pipeline Under Development

- Currently, 114 CO₂-EOR projects provide 281,000 B/D.
- New CO₂ pipelines - - the 320 mile Green Pipeline and the 226 mile Encore Pipeline - - are expanding CO₂-EOR to new oil fields and basins.
- The single largest constraint to increased use of CO₂-EOR is the lack of available, affordable CO₂ supplies.

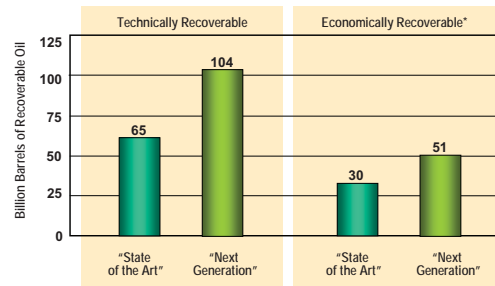
Source: Advanced Resources International, Inc., based on Oil and Gas Journal, 2010 and other sources.



Oil Recovery Performance From Permian Basin San Andres Formation



New Domestic Oil Supplies From CO₂-EOR



*At an oil price of \$75/B, CO₂ costs of \$40/mt and 20% (BT) financial return.
Source: Advanced Resources Intl (2010).



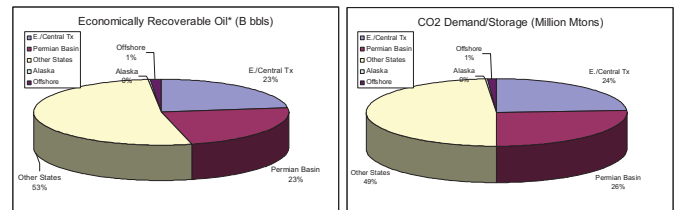
Impact of "Next Generation" CO₂-EOR Technology on Oil Recovery and CO₂ Storage

Reservoir Setting	Oil Recovery (Billion Barrels)		CO ₂ Demand/Storage*** (Million Metric Tons)	
	Technical	Economic**	Technical	Economic
Lower-48 Onshore				
• East/Central Texas	22.5	11.7	8,160	4,500
• Permian Basin*	19.2	11.9	7,430	4,750
• Other	50.6	26.6	17,150	9,020
Sub-Total	92.3	50.2	32,740	18,270
Alaska	6.0	0.2	3,190	80
Offshore	6.0	0.7	1,770	200
TOTAL	104.3	51.1	37,700	18,550

*Includes New Mexico portion of the Permian Basin. JAP2011.008.XLS
**At \$75 per barrel oil price and \$40 per metric ton of CO₂.
***Includes 2,100 million metric tons of CO₂ provided from natural sources.



Texas is a Big, Big Player in Concurrent CO₂ EOR and CCS



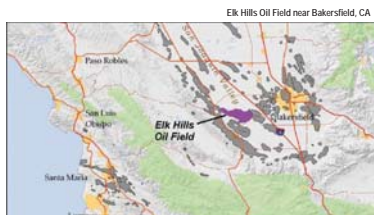
But other States can be Huge Players too.....



Advanced Power Plants Plan to Use EOR for CO₂ Storage

Hydrogen Energy's (Rio Tinto/BP) Gasification Plant

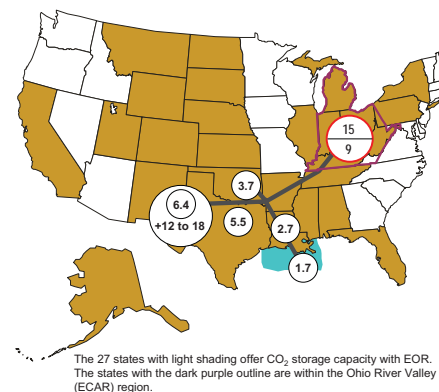
- 250MW gasification of pet-coke
- Capture 90% of CO₂; over 2 million tons of CO₂ per year
- Oxy will take CO₂ for EOR at Elk Hills oil field
- Operational by 2015



Source: Hydrogen Energy



Integrating CO₂ Capture and Storage Using CO₂-EOR



With three long distance (800 mile), large capacity (5 Bcf/d) pipelines, plus shorter distance CO₂ distribution lines, CO₂-EOR could store all of the CO₂ captured in 30 years from Ohio River Valley (ECAR) coal-fired power plants.

Total and captured CO₂ emissions* from coal-fired power plants in 30 years (Gt).
CO₂ storage capacity provided by "traditional" CO₂-EOR (Gt) in each market region.
+12 to 18 CO₂ storage capacity (Gt) provided by EOR in the Residual Oil Zone in the Permian Basin.

*Captured CO₂ assumes retirement of inefficient coal-fired capacity equal to 1/3 of today's CO₂ emissions and 90% CO₂ capture from the remaining coal-fired plants.

Source: Advanced Resources Intl (2010).



Benefits of Using CO₂ for EOR with Storage

- Improving Energy Security.** The productive use of captured CO₂ emissions from coal-fired power (and other) plants could provide up to 3 million barrels per day of domestic oil production by 2030.
- Additional Revenues.** The sale and use of captured CO₂ for EOR would provide revenues to the capturer of the CO₂ plus at least \$200 billion of revenues to Federal, state and local governments.
- Accelerating the Implementation of CCS.** Using EOR as the CO₂ storage option would enable CCS projects to be implemented while the “thorny issues” surrounding using saline formations are resolved.



Distribution of Economic Value of Incremental Oil Production from CO₂-EOR

Notes		Oil Industry	Private Minerals	Federal/ State	Power Plant	U.S. Economy
1	Domestic Oil Price (\$/B)	\$75.00				
2	Less: Royalties	(\$13.10)	\$10.90	\$2.20		
3	• Production Taxes	(\$3.10)	(\$0.50)	\$3.60		
4	• CO ₂ Purchase Costs	(\$14.00)			\$14.00	
5	• CO ₂ Recycle Costs	(\$9.00)				\$9.00
6	• Other O&M Costs	(\$8.00)				\$8.00
7	• Amortized CAPEX	(\$4.00)				\$4.00
	Total Costs	(\$51.20)				
	Net Cash Margin	\$23.80	\$10.40	\$5.80	\$14.00	\$21.00
8	Income Taxes	(\$8.30)	(\$3.60)	\$11.90	?	?
	Net Income (\$/B)	\$15.50	\$6.80	\$17.70		

- Assumes \$75 per barrel of oil.
- Royalties are 17.5%; 1 of 6 barrels produced are from federal and state lands.
- Production and ad valorem taxes of 5%, from FRS data.
- CO₂ cost of \$40/metric ton, including transport; 0.35 tonne of purchased CO₂ per barrel of oil.
- CO₂ recycle cost of \$15/ metric ton; 0.6 tonne of recycled CO₂ per barrel of oil.
- Other O&M/G&A expenses from ARI CO₂-EOR cost models.
- CAPEX from ARI CO₂-EOR cost models.
- Combined federal and state income taxes of 35%, from FRS data.

JP 011.00.XLS



Major Observations

- CO₂-EOR Needs CCS.** Large-scale implementation of CO₂ enhanced oil recovery (CO₂-EOR) is highly dependent on the CO₂ capture portion of CCS.
- CCS Benefits from CO₂-EOR.** CO₂ capture will benefit, in many ways, from the purchase and offtake of CO₂ by EOR.
- CO₂-EOR Can Provide Enhanced Energy Security.** The use of captured CO₂ emissions could enable EOR to provide up to 3 million barrels per day of domestic oil production by year 2030, reducing oil imports by nearly 30%.
- CO₂-EOR Offers Large CO₂ Storage Capacity.** CO₂-EOR in oil fields and residual oil (ROZ) fairways can accommodate the majority of CO₂ captured from coal-fired power plants to year 2050.
- CCS and CO₂-EOR Need Supportive Policies and Actions.** Supportive policies and pre-built CO₂ pipelines would greatly accelerate the integrated use of CO₂-EOR and CCS.



Part 2: The Excitement Around Residual Oil Zones: The Science and On-going Reservoir Exploitation

Melzer Consulting

(<http://www.melzerconsulting.com/>)

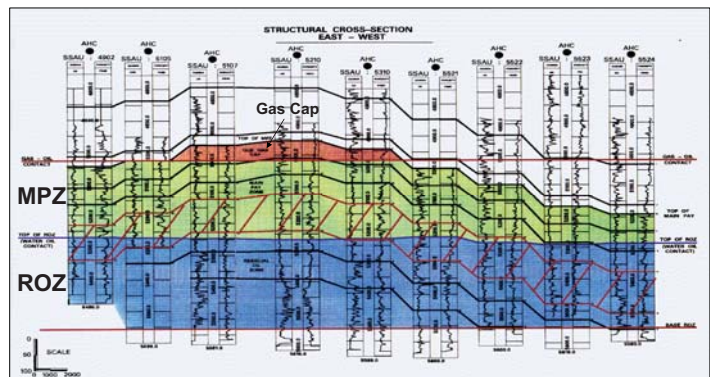


The Science

ROZs as a Residual of Mother Nature's Waterflooding

Seminole Field MPZ & ROZ Cross-section

(Re: Bush, Hess Corp., CO₂ Flooding Conference, 12/01)



ATTRIBUTES OF AN EXAMPLE FIELD: THE SEMINOLE FIELD MAIN PAY AND ROZ ZONES

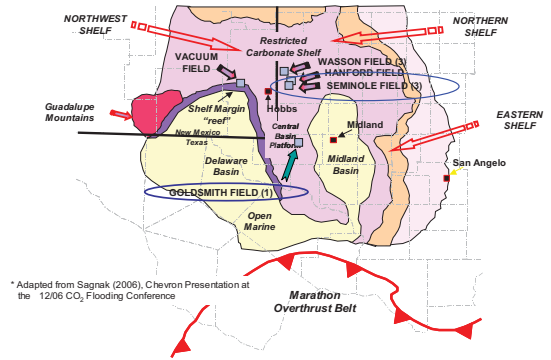
	Gross Thickness	Net Thickness	Porosity	Permeability Range	OOP	Initial Oil Saturation
Main Pay Zone (MPZ):	160'	126'	12%	0.8-120 md	1 billion stbo	0.84
Residual Oil Zone (ROZ):	246'	197'	12.6%	0.5-270 md	960 Million stbo	0.32



Re: Biagiotti, Hess Corp., CO₂ Flooding Conference, 12/08

COMMERCIALIZING CO₂ EOR OF THE ROZ ACTIVE RESIDUAL OIL ZONE CO₂ EOR PROJECTS IN THE PERMIAN BASIN

MIDDLE SAN ANDRES PALEOGEOGRAPHY with Location of Industry Documented ROZ Zones/Fields*



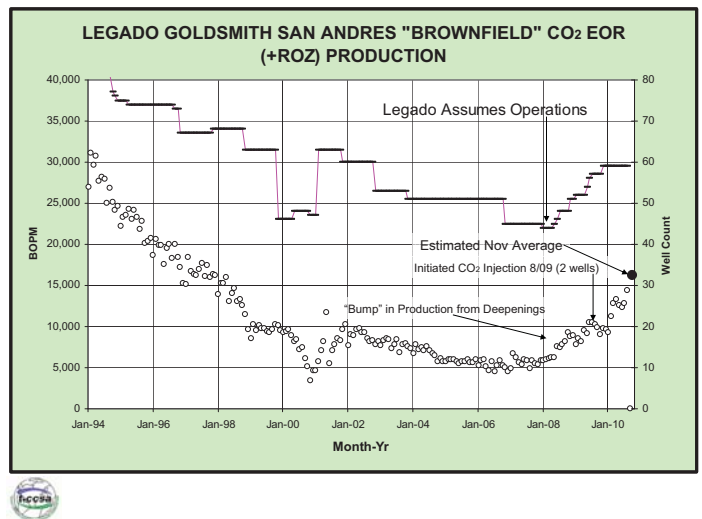
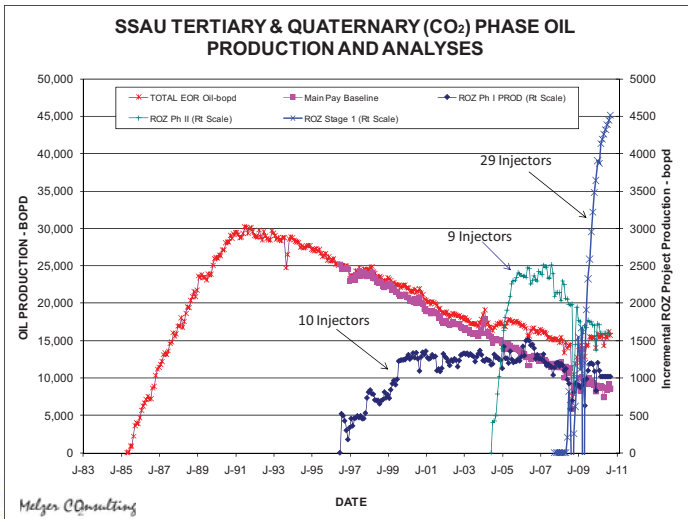
CO₂ FLOODING THE ROZ

AN UPDATE ON HESS' SEMINOLE SAN ANDRES UNIT AND LEGADO'S GOLDSMITH LANDRETH UNIT

Melzer Consulting
NOVEMBER 2010

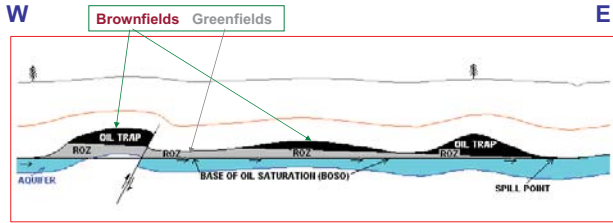


Type and operator	Field	State	County	Top MPZ Depth, ft	Pay zone
Active CO₂ miscible					
Chevron	Vacuum San Andres Grayburg Unit	NM	Lea Co.	4,550	San Andres/Grayburg
Fasken	Hanford	Tex	Gaines	5,500	San Andres
Hess	Seminole Unit-ROZ Phase 1	Tex	Gaines	5,500	San Andres
Hess	Seminole Unit-ROZ Phase 2	Tex	Gaines	5,500	San Andres
Hess	Seminole Unit-ROZ Stage 1 Full Field Dev	Tex	Gaines	5,500	San Andres
Legado	Goldsmith-Landreth Unit	Tex	Ector	4,200	San Andres
Occidental	Wasson Bennett Ranch Unit	Tex	Yoakum	5,250	San Andres
Occidental	Wasson Denver Unit	Tex	Yoakum	5,200	San Andres
Occidental	Wasson ODC	Tex	& Gaines	5,200	San Andres



The Concept of Brownfields and Greenfields

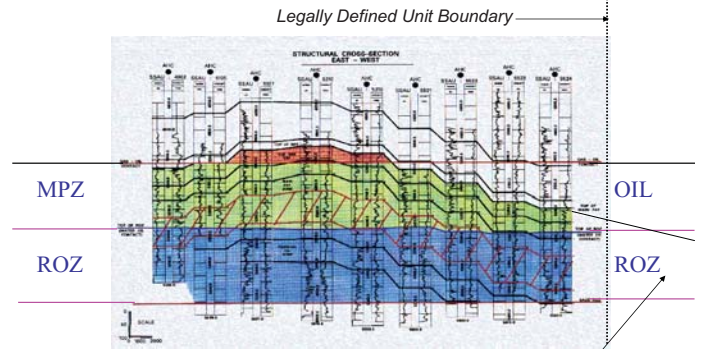
Change in Hydrodynamic Conditions, Sweep of the Lower Oil Column, Oil/water Contact Tilt, and Development Of The Residual Oil Zone



TYPE 3 ROZ



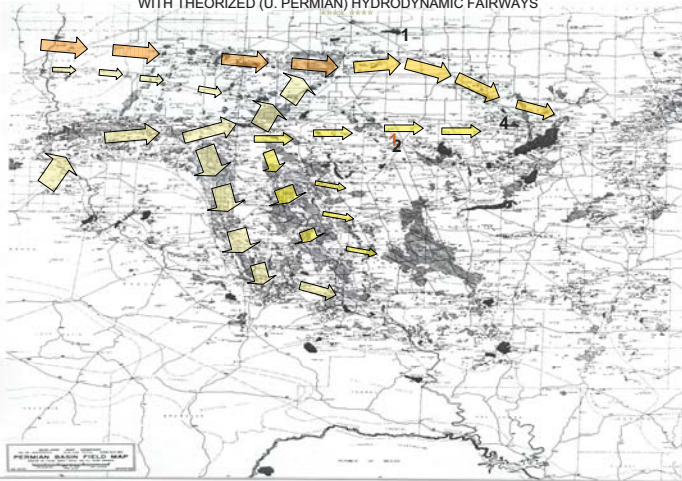
SCHEMATIC CROSSSECTION OF A ROZ AT A WEST TEXAS SAN ANDRES FIELD



Undeveloped and ROZ Productive Acreage ('Greenfield')



PERMIAN BASIN FIELD MAP WITH THEORIZED (U. PERMIAN) HYDRODYNAMIC FAIRWAYS



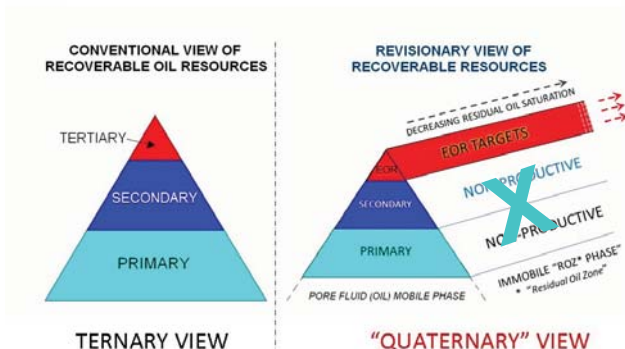
Conclusions

- The ARI Work Suggests CO₂ EOR provides Immense Targets for Producing Oil and Storing CO₂
- Texas has a Huge Share of them
- ARI Work has not Included the Spectrum of ROZ Targets (56 Brownfields Only)
- Ongoing Demonstration Projects in the Permian Basin Suggest both Commerciality and Enormous Potential in Brownfields
- Greenfields are More Challenged Economically but Provide Vast New Targets

And.....One Last Concept to Consider



AN EMERGING NEW APPROACH FOR OIL RESOURCE DEVELOPMENT WITH CARBON CAPTURE & STORAGE



"QUATERNARY" VIEW

Melger Consulting

