OPPORTUNITIES FOR PRODUCING THE "STRANDED" HYDROCARBON RESOURCES OF LOUISIANA

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LSU Center for Energy Studies Workshop

ALTERNATIVE ENERGY: The Future of Louisiana's Energy Industry?

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PERSPECTIVES ON LOUISIANA HYDROCARBON RESOURCES

- Louisiana's oil fields are mature and in decline.
- However, the problem of declining oil production is not due to a lack of resources:
  - Billions of barrels are being left behind, or "stranded," in Louisiana oil fields.
  - Current primary and secondary recovery methods recover only about 40-45% of the original oil in-place from these fields.
- While hydrocarbon resources in Louisiana may not be traditionally considered an "alternative" source of energy, this substantial resource should not be ignored.
  - Since it can provide substantial economic benefits to Louisiana
  - Continued viability of offshore oil and gas infrastructure can help **support the development of other alternative energy resources.**

PRESENTATION OUTLINE

- Background – U.S. “Stranded” Oil
- Stranded Oil Resources of Louisiana
  - Volume of Stranded Resources
  - Analysis Methodology
  - Economic Potential
- Stranded Gas Resources of Louisiana
  - Discovered Reservoirs
  - Deep Formations
- Conclusions

BACKGROUND -- U.S. "STRANDED" OIL

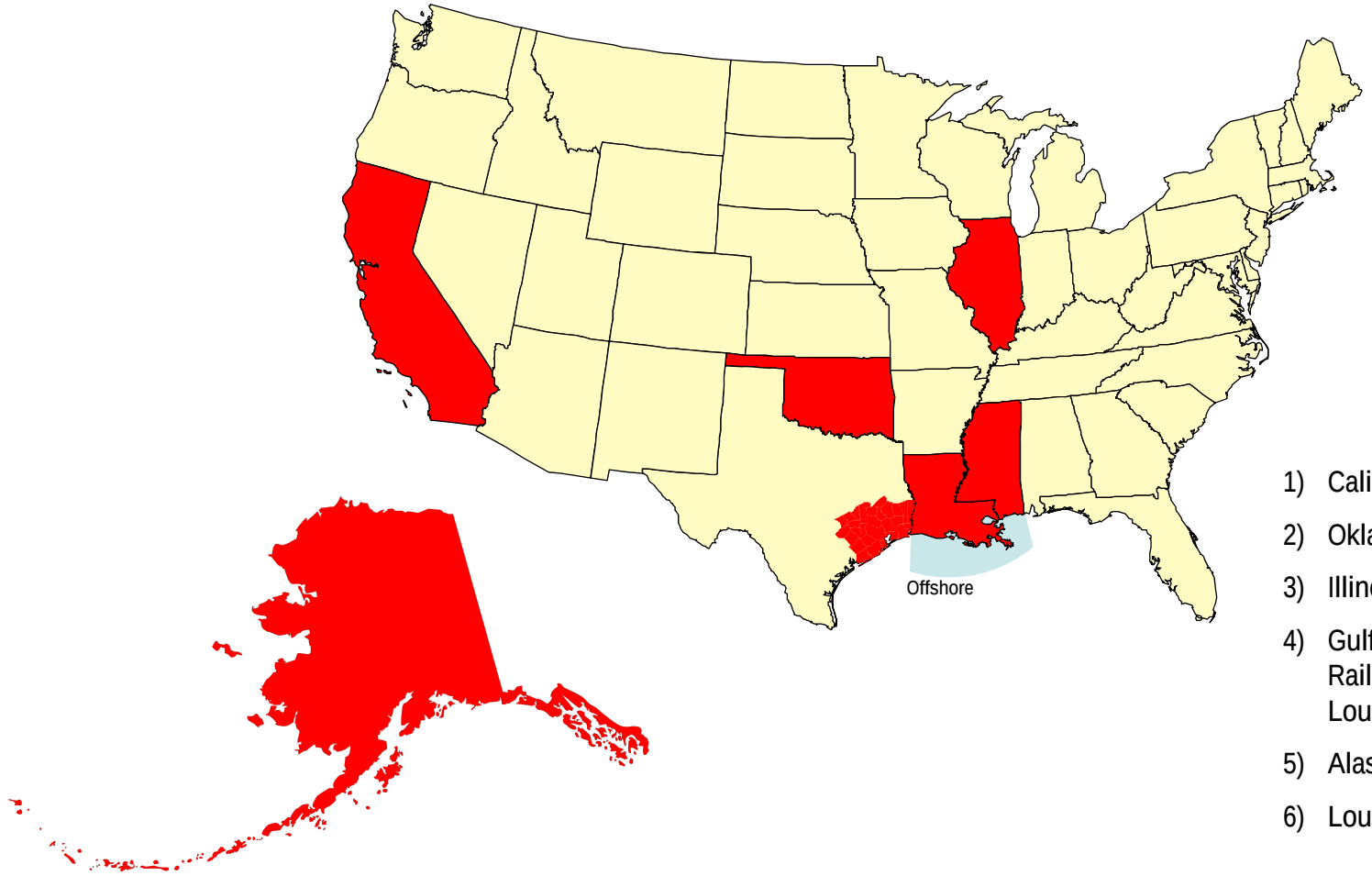
DOE's BASIN-ORIENTED STRANDED OIL STUDIES

A series of DOE-sponsored studies has been launched to examine the potential for adding domestic oil reserves and production using CO_2-EOR

- Establish the size of the CO_2-EOR potential in selected oil basins, assuming sufficient volumes of "EOR-Ready" CO_2 supplies become available
- Examine the set of State and Federal "risk sharing" incentives that would help make this resource economic.

DOE's BASIN-ORIENTED STRANDED OIL STUDIES

States/Regions Assessed To-Date

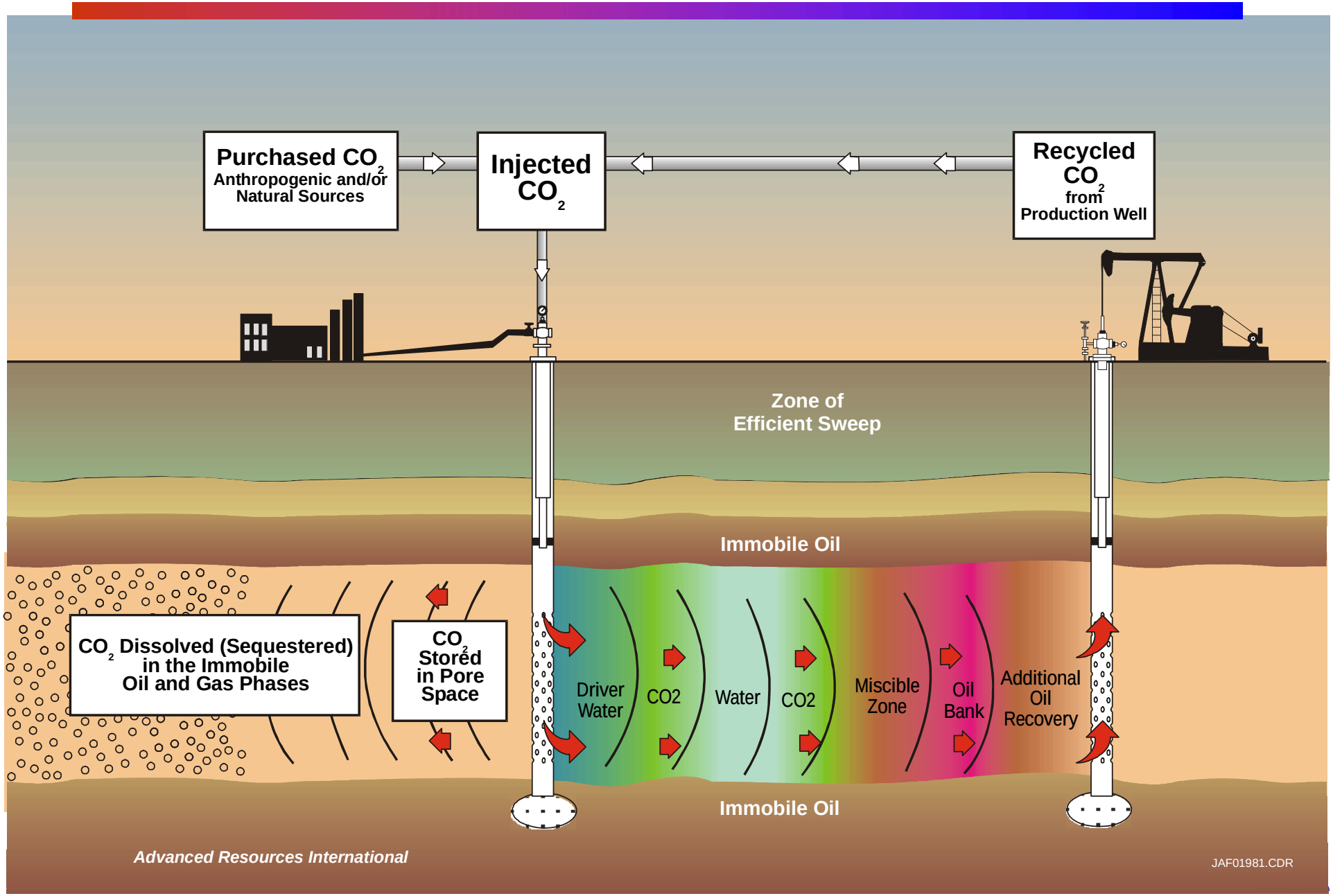


1) California
2) Oklahoma
3) Illinois
4) Gulf Coast (Texas Railroad District 3, Louisiana, Mississippi_
5) Alaska
6) Louisiana Offshore

MAJOR ASPECTS OF DOE-SPONSORED STUDIES

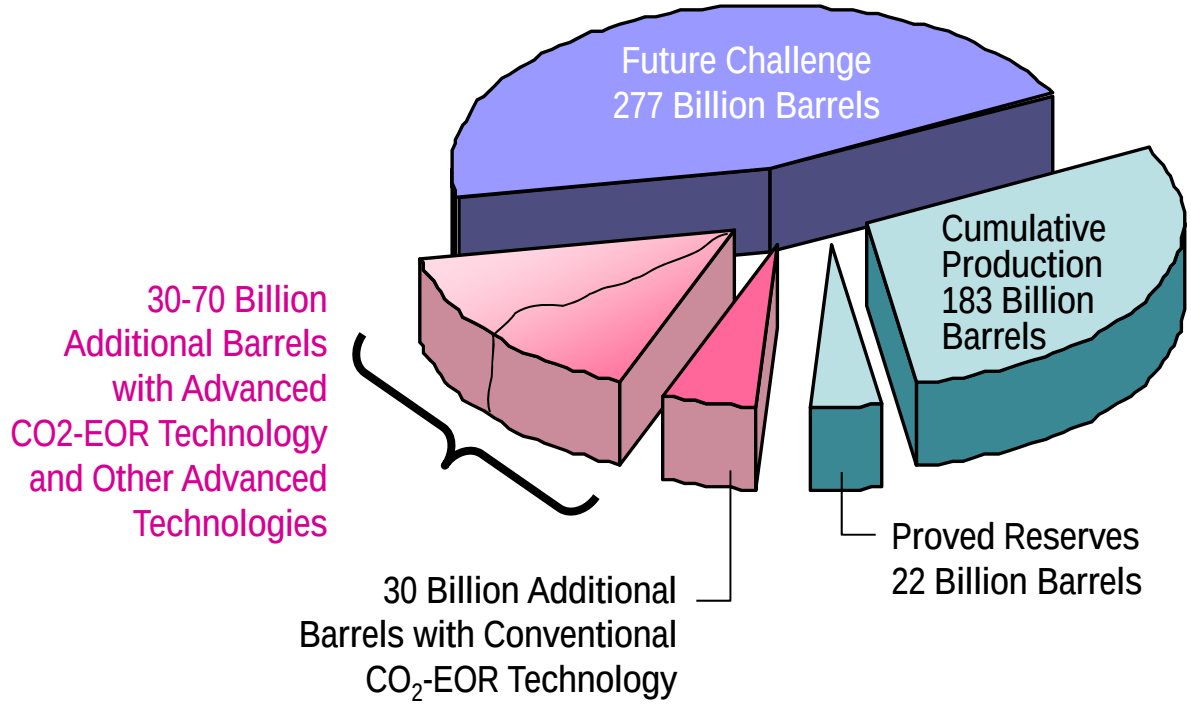
- Establish the geological characteristics of major oil fields in the state/region
- Examine available CO_2 sources, volumes and costs
- Estimate technical oil recovery potential
- Estimate economic feasibility, under alternative CO_2 supply and "risk mitigation" scenarios

WHAT IS CO_2-EOR?



DISCOVERED "STRANDED" DOMESTIC OIL RESOURCES

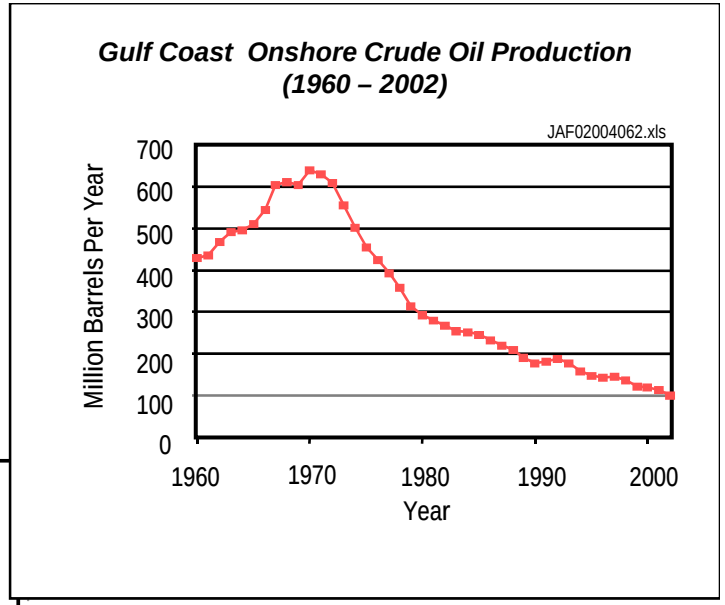
Total Original Oil In-Place (OOIP):	**582 B Barrels**
"Stranded" Oil - - Residual Oil In-Place (ROIP):	**377 B Barrels**

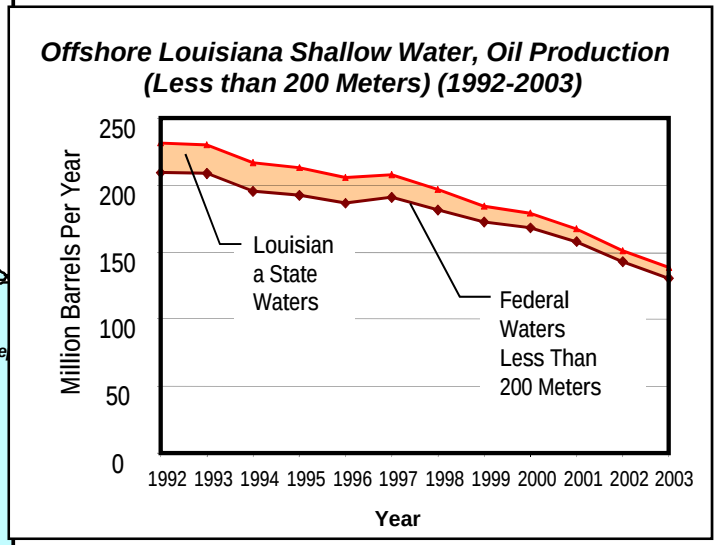


**Does not include undiscovered crude oil resources.*

STRANDED OIL RESOURCES OF LOUISIANA

Major Gulf Coast Oil Basins and Fields





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ESTIMATES OF "STRANDED" OIL RESOURCES OF LOUISIANA

	Estimates of Stranded Oil Resources of Louisiana (All values in billion barrels)			
	Onshore Louisiana	Offshore State Waters	Offshore Federal Waters	Total
Original Oil in Place	19.2	3.6	24.5	47.3
Produced to Date	7.0	1.4	10.0	18.4
Remaining Proved	0.4	0.1	0.9	1.4
"Stranded" Resource	11.8	2.2	13.5	27.5
% Recovery, Traditional Practices	39%	42%	44%	42%

HISTORY OF CO_2-EOR IN LOUISIANA

- While no CO_2-EOR projects are ongoing in the Louisiana onshore, several pilots have been conducted
  - Paradis (Lower 9000' sand RM)
  - South Pass Block 24 (8,800' RD)
  - West Bay 5 A' B"
  - Weeks Island gravity stable CO_2 flood
- Two small offshore pilots underway by ExxonMobil
  - South Pass Block 89 (X & Y sands)
  - South Pass Block 89 (X series)

NEED FOR ECONOMIC CO_2 SUPPLIES

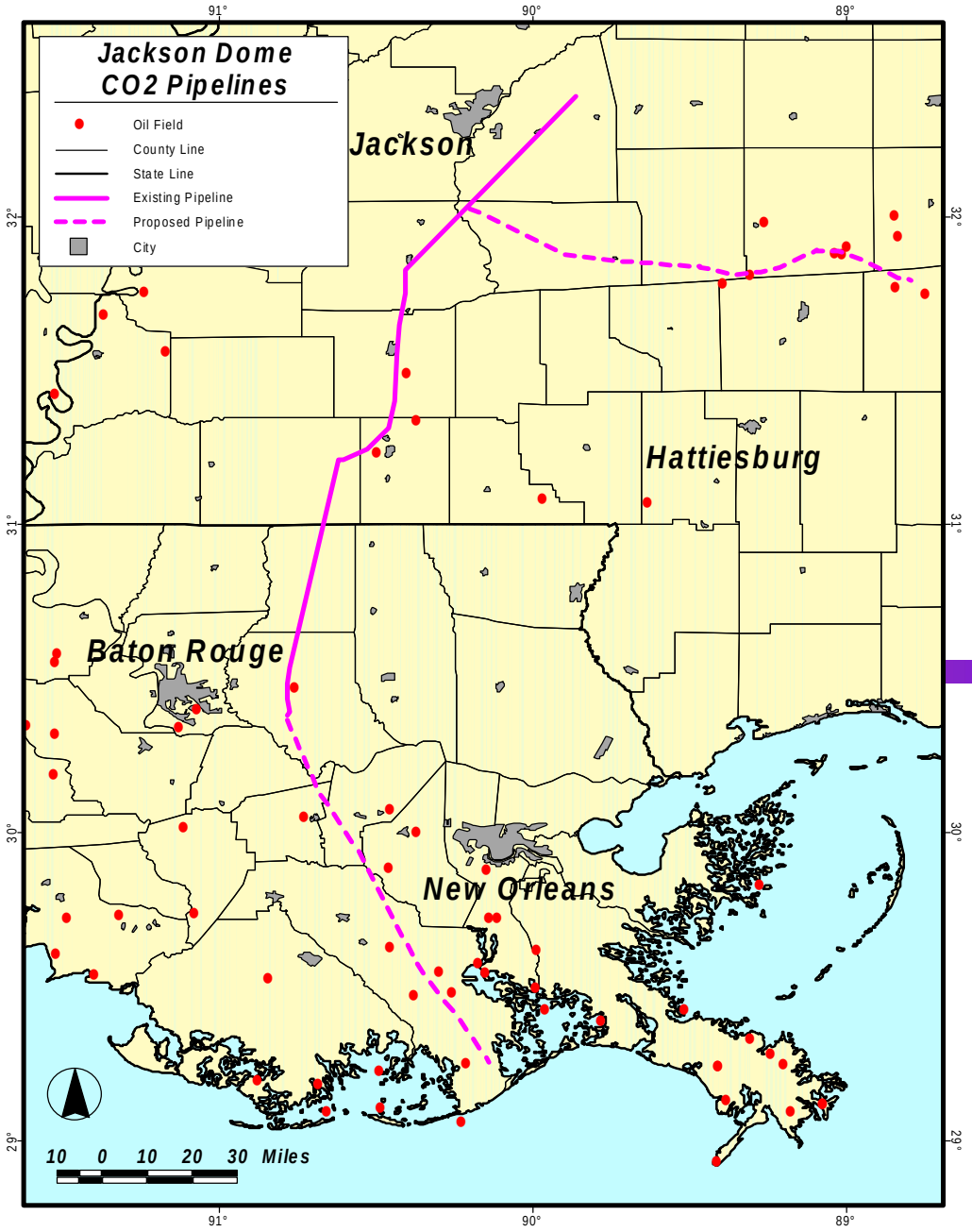
Lack of "EOR Ready", affordably priced CO_2 supplies is one of the major constraints for aggressively applying CO_2 EOR.

The Jackson Dome CO_2 reservoir, along with the existing pipeline system transporting the CO_2, is currently the source for several CO_2-EOR projects in central Mississippi and NE Louisiana

New new hydrogen plants at oil refineries could provide new sources of "EOR Ready" CO_2.

Centralized collection of high concentration CO_2 from cement plants, fertilizer complexes, ethanol plants and coal gasification facilities could add to the total.

In the longer term, capture of CO_2 from power plants, as part of CO_2 emissions management, could bring massive volumes of "EOR Ready" CO_2 into the market.



Location of Existing and Planned CO_2 Supply Pipelines in Mississippi and Louisiana

Source: Adapted from Denbury Resources, 2004.

CO_2 Emissions from Refinery H_2

Refinery	Operator	Annual Volume H_2 (MMcfd)	Estimated CO_2 Emissions (MMcfd)	(MMt/yr)
LOUISIANA				
• Convert	Motiva Enterprises	63		
• Norco	Motiva Enterprises	60		
• Baton Rouge	Exxon/Mobil	24		
• Others	Various	17		
Sub-Total		198	80	1.5
MISSISSIPPI				
• Pascagoula	Chevron	230		
• Others		8		
Sub-Total		238	100	2.0
EAST TEXAS				
• Texas City	BP	210		
• Baytown	Exxon/Mobil	143		
• Beaumont	Exxon/Mobil	55		
• Others	Valero/Other	5		
Sub-total		415	170	3.4

Other installations of hydrogen plants at refineries are due to come on stream in the next five years.

ASSESSMENT METHODOLOGY

A five part methodology was used to assess the CO_2-EOR potential of Louisiana oil reservoirs.

(1) Assemble oil reservoirs data base

(2) Screen reservoirs for CO_2-EOR

- Minimum size (>50 million barrels, OOIP)
- Minimum miscibility pressure (miscible floods)
- Depth and oil gravity (immiscible floods)

(3) Calculate oil recovery

(4) Assemble detailed costs and cash flow economics

(5) Perform analyses of "risk sharing" incentives

ECONOMIC CRUDE OIL RESOURCE POTENTIAL

ESTIMATES OF TECHNICALLY RECOVERABLE OIL RESOURCES IN LOUISANA

Basin	No. of Fields/Reservoirs	OOIP (MMBbls)	Technically Recoverable (MMBbls)
State Onshore	128	16,035	3,244
State Offshore	12	1,100	237
Federal Offshore	87	20,950	4,213
TOTAL	**227**	**38,085**	**7,694**

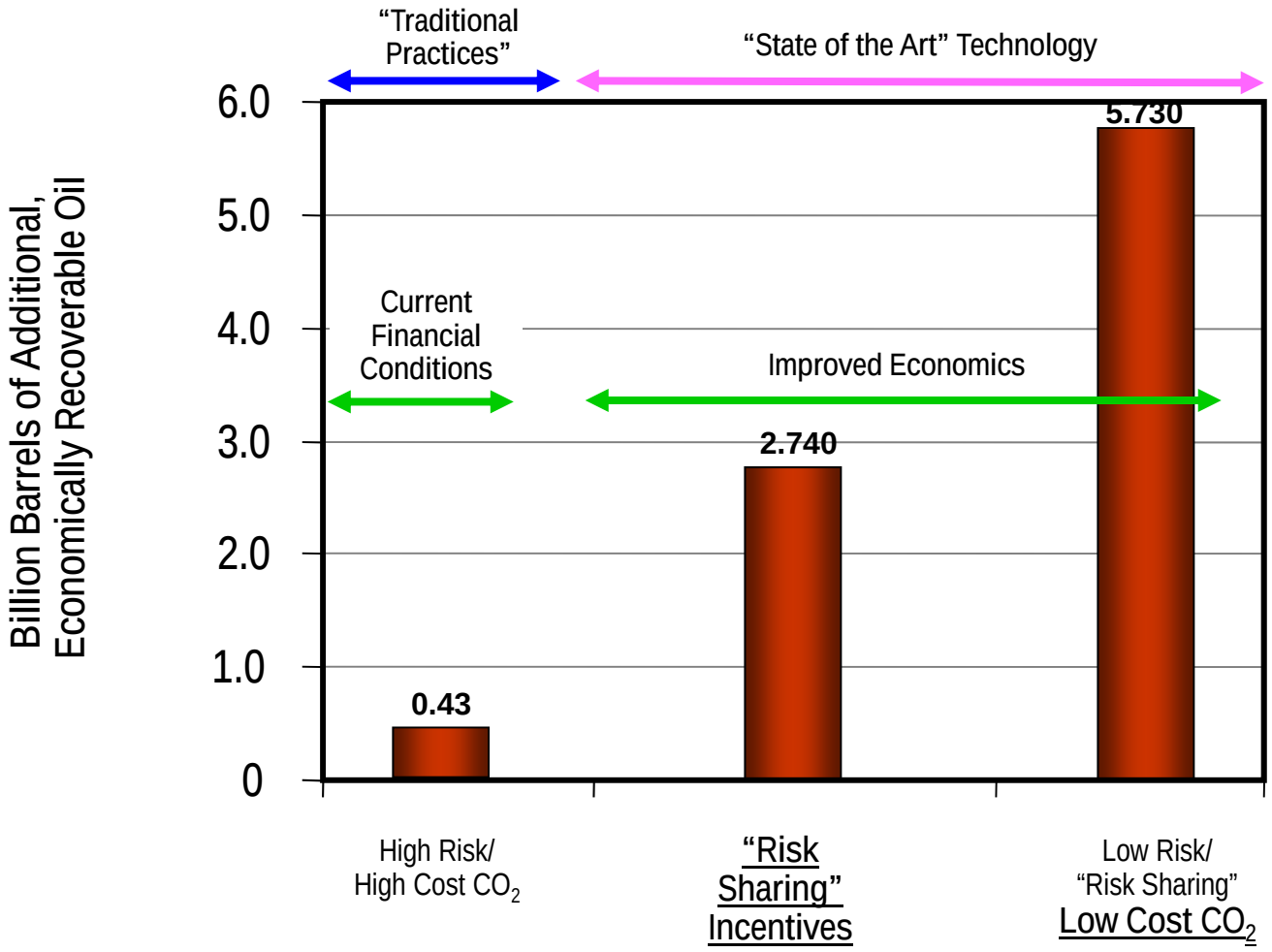
TECHNOLOGY AND "RISK SHARING" MATTERS

"State-of-the-art" CO_2-EOR technology, when combined with lower CO_2 costs and "risk sharing" incentives, could enable a significant portion of the technical potential to become economically recoverable:

- Under "traditional practices" (small volumes of CO_2 injection, no immiscible CO_2-EOR) only a modest portion (430 MMB) of the resource is economic
- "State-of-the-art" technology (large volumes of CO_2 injection, immiscible CO_2 - EOR, lower risk) would enable nearly 3 billion barrels to become economic (at oil price of $25 per barrel and CO_2 cost of 5% of oil price).
- Providing lower cost CO_2 (at 2% of the oil price) and "risk sharing" incentives (such as royalty and/or production tax relief, investment tax credits, etc.) could raise the economic potential to almost 6 billion barrels.

ECONOMIC RECOVERY POTENTIAL

Impact of Improved Technology and Financial Conditions on Economically Recoverable Oil from Large Louisiana Reservoirs Using CO_2-EOR (Million Barrels)



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ECONOMIC RECOVERY POTENTIAL

Basin	"State of the Art" Technology* (Bbls)	Plus "Risk Sharing" Incentives** (Bbls)	Plus Ample Supplies of Low-Cost CO_2*** (Bbls)
Louisiana Onshore	430	1,440	2,130
State Offshore	--	--	200
Federal Offshore****	--	1,300	3,400
TOTAL	**430**	**2,740**	**5,730**

**This case assumes an oil price of $25 per barrel, a CO_2 cost of 5% of the oil price, and a low-risk financial hurdle rate (15% BT).*
***This case assumes "risk sharing" incentives provide improved economics equal to an additional $10 per barrel; CO2 costs are $1.25/Mcf.*
****This case assumes an oil price of $35 per barrel and a CO_2 cost of 2% of the oil price, or $0.70/Mcf.*
*****LA Offshore assumes a CO_2 cost of 3% of the oil price.*

ENHANCED OIL RECOVERY CREDIT UPDATE ACT OF 2005 (Proposed)

- Increases the tax credit from 15% to 25% for qualified EOR projects.
- Removes the current restrictions against applicability against the alternative minimum tax (AMT)
- Allows “transferability” of the credit
- Fully indexes the phase out formula for the credit for inflation

DISTRIBUTION OF REVENUES CO_2-EOR IN SAMPLE LA ONSHORE OIL FIELD

			Producer	Private Minerals	State Treasury	Federal Treasury
1	Net Wellhead Oil Price ($/B)		$35.50 (1)			
	Less: Royalties		(4.40) (2)	4.40		
2	Operating Revenues		$31.10			
3	Operating Expenses					
	a. Production Taxes		(3.50) (3)	(0.60)	4.10	
	b. CO_2 Purchase/Recycle		(8.40) (4)			
	c. Other Operating Expenses		(6.80) (5)			
	d. DD&A (Capital Investment)		(1.20) (6)			
4	Income, Before Tax		$11.20	$3.80	$4.10	-
5	Income Taxes	a. Oil Industry	(5.70) (7)		0.90	4.80
		b. Private Minerals	-	(2.40)	0.60	1.60
6	Net Income ($/B)		$5.50	$1.40	$5.60	$6.40
7	Sec. 43 Tax Credit	a. Current Tax Credit (@15%)	1.70	-	-	(1.70)
		b. Increased Tax Credit (+10%)	1.20	-	-	(1.20)
8	Net Income (after Sec. 43 Tax Credit)		$8.40	$1.40	$5.60	$3.50

(1) Assumes AEO 2005 oil price track in nominal dollars with reductions for oil quality and transportation costs.
(2) Royalties are assumed at 12.5% for private minerals.
(3) Production tax (including ad valorem tax) of 13.5%.
(4) CO_2 purchase cost of 5% of oil price ($/Mcf) and recycle cost of 1% of oil price ($/Mcf).
(5) Other operating expenses include well O&M, lifting costs and G&A, based on model cost data.
(6) Capital investment includes costs for wells, well rework and CO_2 recycle plant, based on model cost data.
(7) Federal and State income taxes of 35% and 6%.

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DISTRIBUTION OF REVENUES CO_2-EOR IN SAMPLE FEDERAL OFFSHORE OIL FIELD

			Producer	Private Minerals	State Treasury	Federal Treasury
1	Net Wellhead Oil Price ($/B)		$29.10 (1)			
	Less: Royalties		(4.80) (2)	-	-	4.80
2	Operating Revenues		$24.30			
3	Operating Expenses					
	a. Production Taxes		-	-	-	
	b. CO_2 Purchase/Recycle		(9.60) (3)			
	c. Other Operating Expenses		(4.50) (4)			
	d. DD&A (Capital Investment)		(2.00) (5)			
4	Income, Before Tax		$8.20	-	-	$4.80
5	Income Taxes	a. Oil Industry	(4.10) (6)			4.10
		b. Private Minerals	-	-	-	-
6	Net Income ($/B)		$4.10	-	-	$8.90
7	Sec. 43 Tax Credit	a. Current Tax Credit (@15%)	1.90	-	-	(1.90)
		b. Increased Tax Credit (+10%)	1.30	-	-	(1.30)
8	Net Income (after Sec. 43 Tax Credit)		$7.30	-	-	$5.70

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(1) Assumes AEO 2005 oil price track in nominal dollars with reductions for oil quality and transportation costs.
(2) Royalties are assumed at 16.67% for the federal offshore.
(3) CO_2 purchase cost of 5% of oil price ($/Mcf) and recycle cost of 1% of oil price ($/Mcf).
(4) Other operating expenses include well O&M, lifting costs and G&A, based on model cost data.
(5) Capital investment includes costs for wells, well rework and CO_2 recycle plant, based on model cost data.
(6) Federal income taxes of 35%.

POTENTIAL BENEFITS TO FEDERAL TREASURY ASSOCIATED WITH THE ACT

	Offshore*	Onshore	Total
Federal Tax Revenues (10 Years)			
1. Tax Revenues from 67 Fields	4.35	2.52	6.87
2. Royalties from 67 Fields	6.6	-	6.6
(less State share of 8g royalties)	(0.6)	-	(0.6)
Total	10.35	2.52	12.87
Federal Tax Credit Costs (10 Years)			
1. Tax Credit Costs for 67 Fields from Modified Sec. 43 (@ 25%)	6.47	2.42	8.89
2. Less: Tax Credit Costs for 67 Fields from Current Sec. 43 (@ 15%)	(3.88)	(1.45)	(5.33)
Incremental Tax Credit Costs	2.59	0.97	3.56
Net Federal Revenue	7.76	1.55	9.31

Notes:

*Includes state and federal waters.

1. Assumes tax revenues from 67 additional Louisiana Offshore fields and 36 onshore Louisiana fields developed with enhanced oil recovery. These fields provide an incremental 4.79 billion barrels of economically recoverable domestic oil resource.
2. Assumes tax credit costs for all Louisiana onshore and offshore fields due to the changes to Sec. 43.

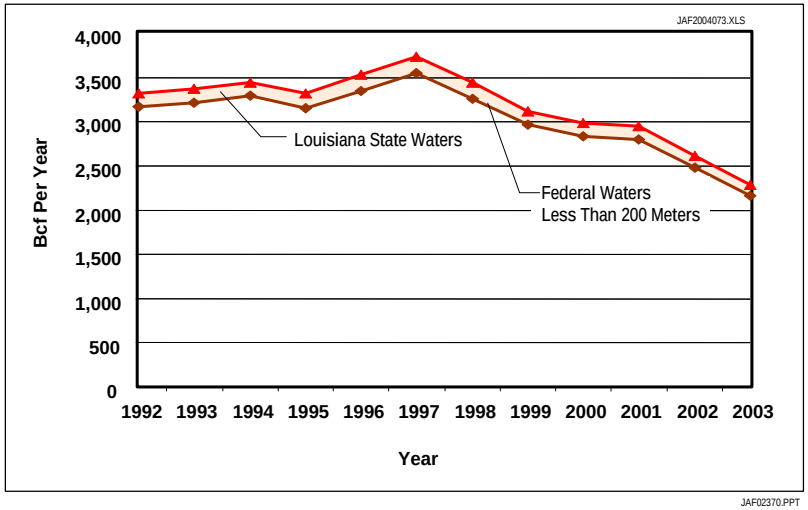
POTENTIAL BENEFITS TO STATE TREASURY ASSOCIATED WITH THE ACT

	Onshore	Offshore*	TOTAL
Production Taxes (Industry)	$5.2 Billion	$0.8 Billion	$6.0 Billion
State Corporate Income Tax	1.0	0.2	1.2
State Royalty (from fields in the state waters)	0.4	0.9	1.3
Federal 8g Royalties to State	-	0.6	0.6
Total	$6.6 Billion	$2.5 Billion	$9.1 Billion
*Includes state and federal waters			

STRANDED NATURAL GAS RESOURCES OF LOUISIANA

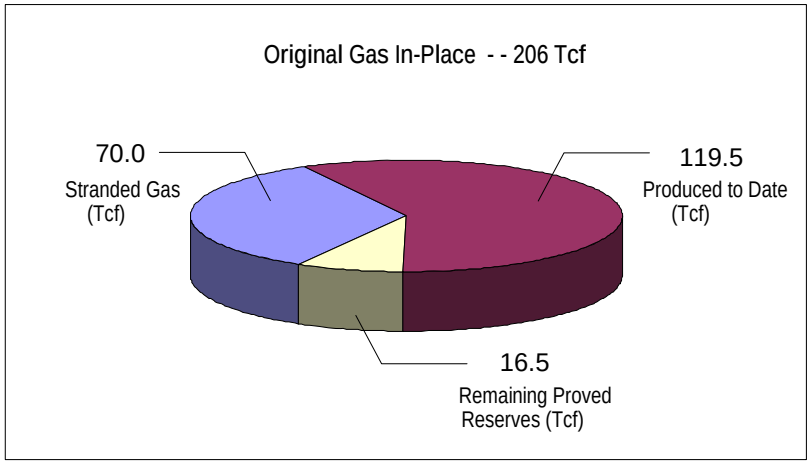
STRANDED GAS IN THE SHALLOW WATER OFFSHORE

- In the shallow waters of offshore Louisiana, gas production has declined from 3.3 Tcf to to 2.3 Tcf per year in last decade
- Reservoir flow conditions, primarily a strong natural bottom water drive, preclude efficient recovery, and could “strand” a third of the gas in-place
- An estimated 70 Tcf is stranded, with 42 Tcf in large attractive fields
- No assessment has been performed of the economic potential of these stranded resources



Natural Gas Production in Offshore Louisiana Shallow Water (< 200 Meters) (1992-2003)

Source: U.S. Dept. of Interior, Minerals Management Service and the Louisiana Dept. of Natural Resources



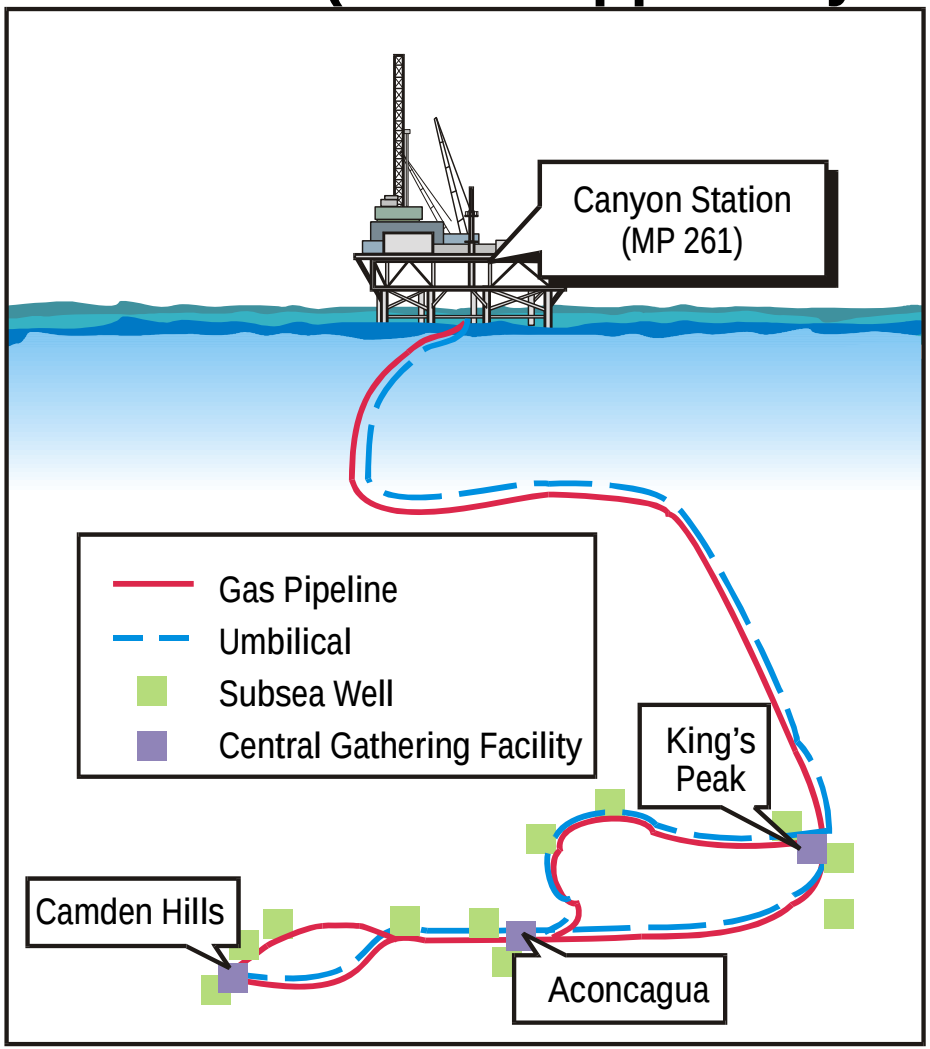
Stranded Natural Gas Resources In Offshore Louisiana

DEEP GAS IN THE SHALLOW OFFSHORE IS A LARGE UNKNOWN

- **> 15,000‘ drilled depth, in < 200 m water depth**
  - Only 5% of drilled wells are deeper than 15,000 ‘
- **Substantial potential possible**
  - High flow rates (10 – 50 MMcf/d)
    - One well peaked at 350 MMcf/d (ST204 – El Paso)
  - Financial incentives available
    - Royalty suspension on first 20 Bcf
  - As much as 55 Tcf of potential (5% probability)
    - Mean resource estimate of approximately 30 Tcf
    - At today’s prices, roughly 25 Tcf could be economic
- **Uses existing shallow water infrastructure**

Sub-Sea Wells and Tiebacks Make Marginal Deepwater Fields Economic

(Mississippi Canyon, Gulf of Mexico)



"Canyon Express" Project

	Sub-Sea Wells (#)	Field Size (Bcfe)	Water Depth (ft)
Aconcagua (MC 305)	3-4	300	7,070'
Camden Hills (MC 348)	2	500	7,200'
King's Peak (MC 217)	4	100	6,500'

CONCLUSIONS

CONCLUSIONS

1. **CO_2-EOR could significantly increase Louisiana oil production:**
   - An economically recoverable resource of 0.4 to 5.7 billion barrels (depending on technology and "risk mitigation" incentives) is sufficient to support one million barrels per day of additional oil production by 2020
     - o 400,000 B/day in state onshore and offshore
     - o 600,000 B/day in the Federal offshore

2. **The CO_2-EOR potential will, most likely, prove to be higher than defined by this study.**
   - More "advanced" CO_2-EOR technologies (gravity stable CO_2 injection, horizontal wells) could increase recovery.
   - Miscibility enhancers, conformance control agents, and next-generation immiscible technology could extend the application of CO_2-EOR.

CONCLUSIONS

3. **Large volumes of "EOR-ready" CO_2 supplies will be required.**
   - The overall market for purchased CO_2 in these fields could be up to 25 Tcf (1.5 billion tons). Advanced CO_2-EOR flooding would increase this amount, particularly if CO_2 is stored and sequestered, rather than recycled.

4. **A series of "risk sharing" actions and incentives will be essential for overcoming barriers to large scale use of CO_2-EOR.**
   - Field projects to reduce technical and geological risks.
   - Incentives for capturing and storing CO_2 emissions, to provide affordable "EOR-ready" CO_2.
   - State production tax reductions, enhanced Sec. 43 investment tax credits. and Federal royalty relief.

CONCLUSIONS

5. Large volumes of "stranded" natural gas resources may also exist in Louisiana

- Approximately 42 Tcf of stranded gas resources in large attractive discovered fields
- Approximately 30 Tcf in deep formations in the Louisiana offshore shelf
- However, the extent of this potential has yet to be comprehensively evaluated

6. Offshore oil and gas infrastructure (if not abandoned) could help facilitate other alternative energy and environmentally beneficial activities

- Wind energy
- LNG
- Ocean energy (thermal, wave, current, salinity gradient)
- Large scale carbon sequestration industry

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