

# NEW MARKETS FOR CO<sub>2</sub>

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# INTRODUCTION

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**The President's Global Climate Change Initiative (GCCCI) and pending Senate bills (S. 556 and S. 3135) have raised the stakes on greenhouse gas emissions:**

- ***GCCCI set forth the goal of an 18% reduction in GHG intensity (tGHG/\$GDP) by 2012***

**Other proposed legislation and international pressures would lead to deeper reductions in CO<sub>2</sub>.**



# HOW TO ACHIEVE GOALS?

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**A portfolio of emission reduction actions (beyond those in the Reference Case) will be required to achieve the GHG intensity goal for 2012:**

	Million Metric Tons (MMt)
	Carbon
Efficiency & Renewables	25 – 30
Forestry & Agriculture	15 – 20
Non-CO2 GHG Mitigation	15 – 20
<b>Carbon Sequestration</b>	<b>30 – 45</b>
<b>TOTAL REQUIRED REDUCTIONS</b>	<b>100</b>



# STRATEGIES FOR ACHIEVING EMISSION REDUCTION GOALS

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- 1. “Value added” CO<sub>2</sub> markets**
  - Depleting oil fields
  - Deep coal seams
  - Other
- 2. Low cost CO<sub>2</sub> sources**
- 3. Technology and Incentives**



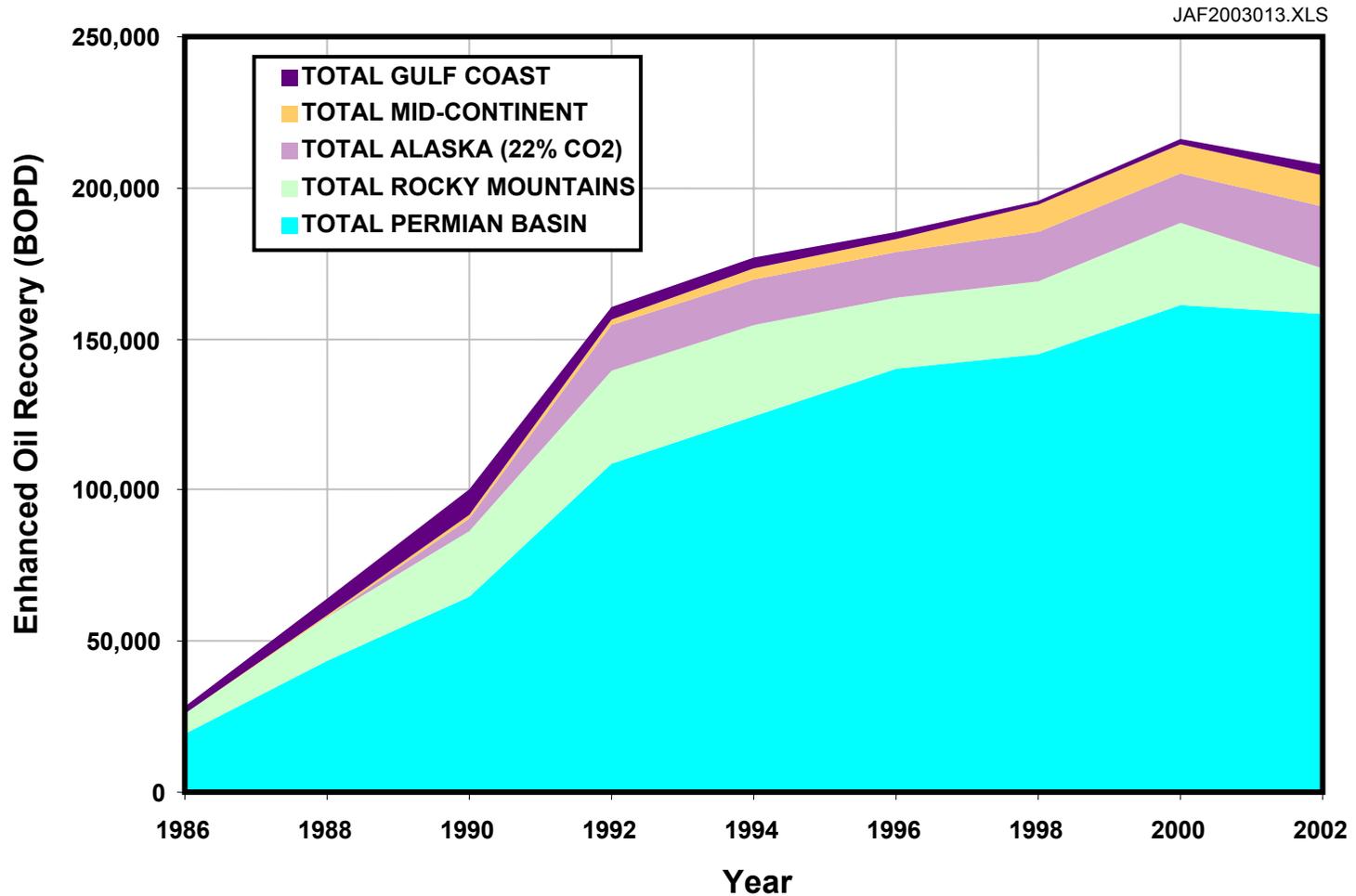
# DEPLETING OIL FIELDS

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- **Competes with natural source CO<sub>2</sub>, priced at \$10 to \$15/Ton, delivered at pressure.**
- **High purity (95+%) CO<sub>2</sub> preferred.**
- **Costs of CO<sub>2</sub> compression and transportation (to sinks) are significant.**
- **Reservoir and economic models exist to examine markets and feasibility of this “value added” option.**



# CO2-EOR PRODUCTION IN THE U.S.



# CONVERTING CURRENT EOR PRACTICES TO CO<sub>2</sub> STORAGE

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1. **Assess and configure reservoir for long-term (~1,000 year) storage of CO<sub>2</sub>.**
2. **Maintain CO<sub>2</sub> in reservoir (at pressure) rather than “blow down” reservoir and reuse the CO<sub>2</sub>.**
3. **Install long-term monitoring, verification and safety systems.**



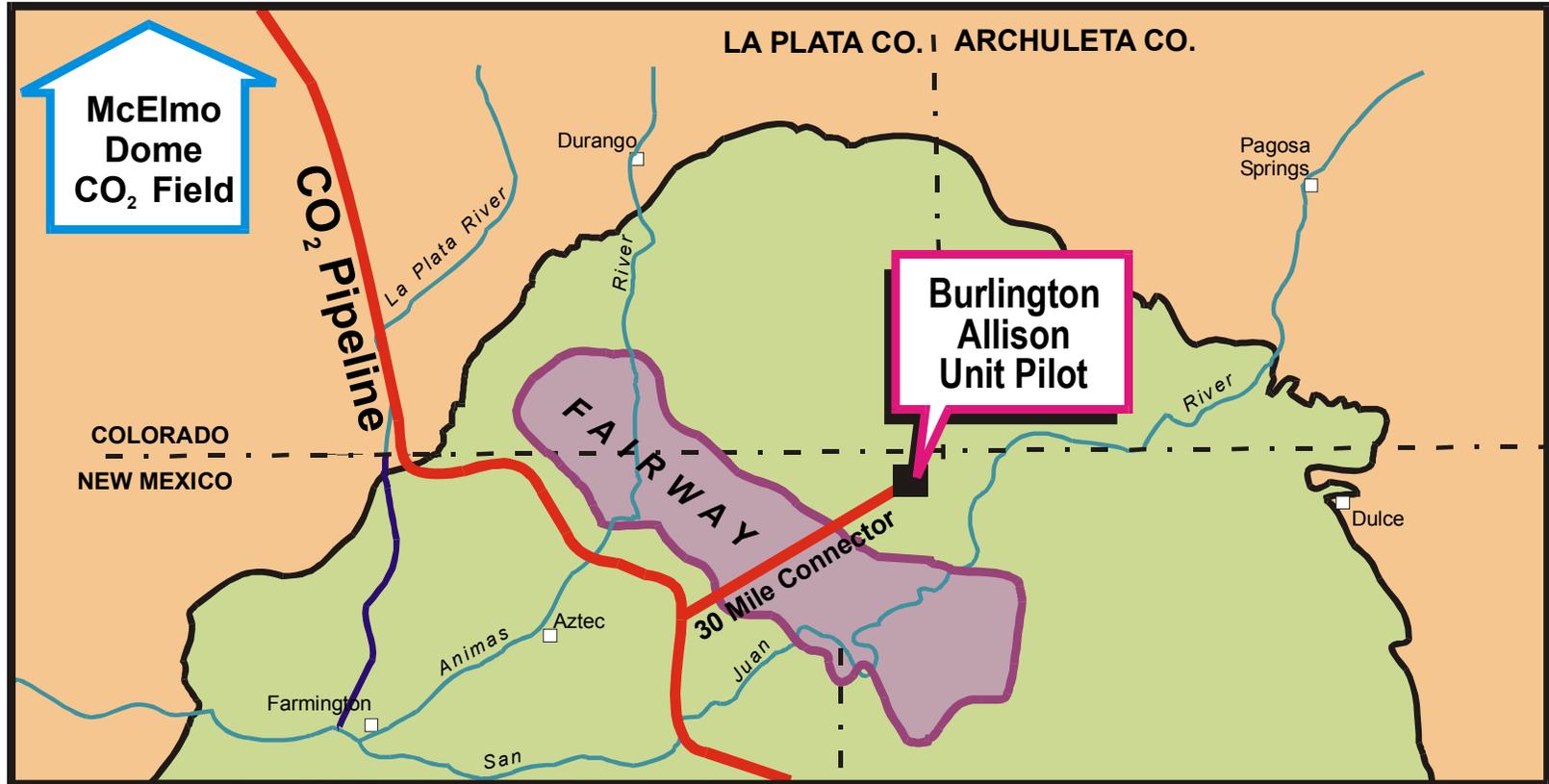
# DEEP COAL SEAMS

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- **Coalbed methane (CBM) is a growing industry; production can be enhanced with CO<sub>2</sub> injection.**
- **Considerable flexibility in injectant (CO<sub>2</sub>/N<sub>2</sub>) composition.**
- **Higher CO<sub>2</sub>/MMBTU ratio (than for oil) reduces “value-added” component.**
- **Coal basins geographically widespread, shorter transportation and less compression.**
- **Requires further R&D/field testing.**



# LOCATION OF ECBM PILOTS, SAN JUAN BASIN, USA



JAF01941.CDR



## 2. LOW COST CO<sub>2</sub> SOURCES

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**Certain industrial processes generate high concentration CO<sub>2</sub> emissions, offering near-term opportunities for low cost capture and geologic sequestration.**



# HIGH CO2 CONCENTRATION VENTS IN THE U.S.

Type of CO2 Vent	Aggregate CO2 Emissions (MMtC)	
	Actual 2000	Projected 2020
Oxygen-blown Gasification	15	30
Natural Gas Processing	5	15
Cement Production	11	15
Hydrogen (Production in Refineries)	4	10
Other	5	10
<b>TOTAL</b>	<b>40</b>	<b>80</b>



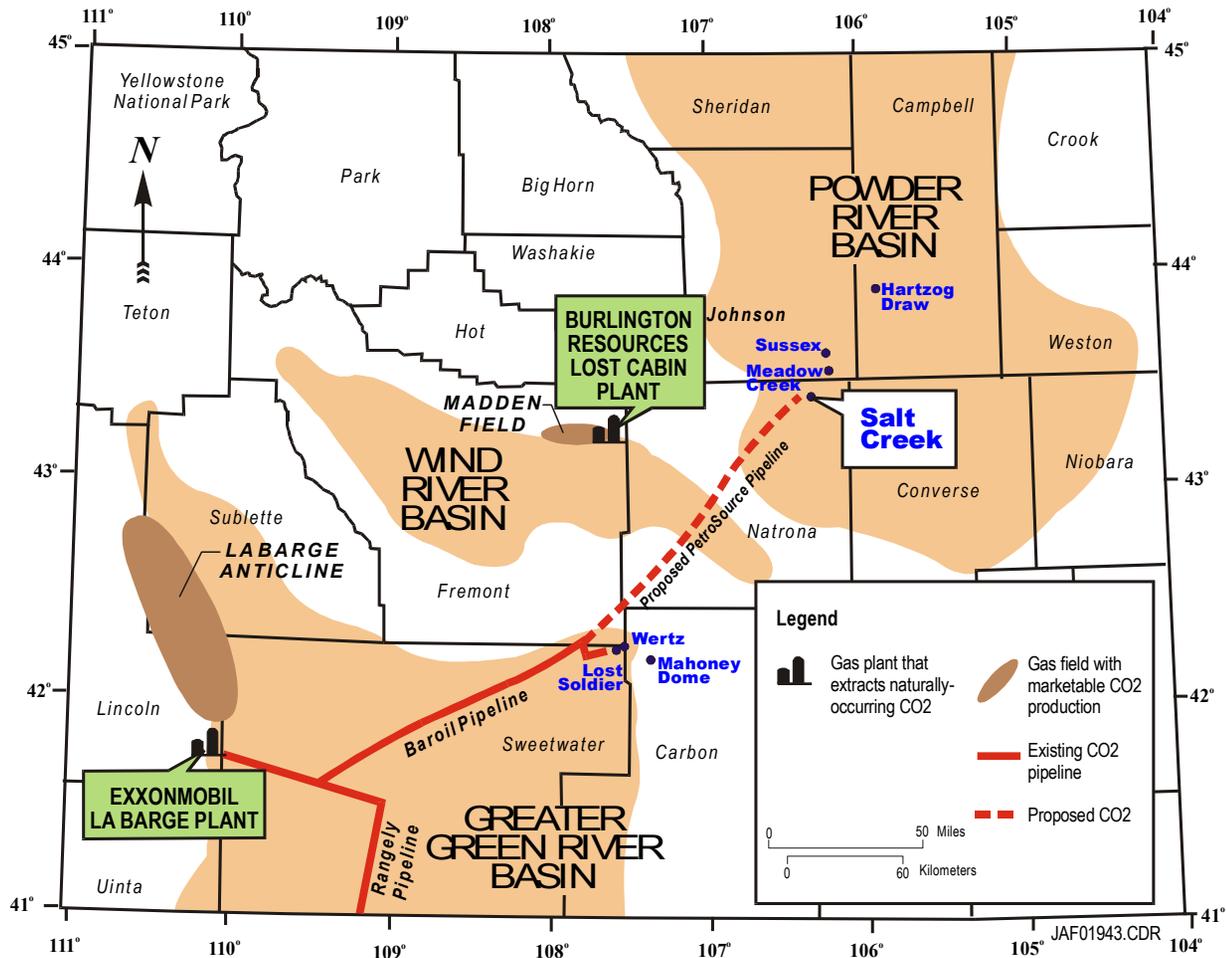
# CASE STUDY: ROCKY MOUNTAIN GAS PROCESSING PLANT

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- Existing LaBarge (western Wyoming) gas processing plant generates 435 MMcfd (2.3 million tC/yr) of CO<sub>2</sub> of which 250 MMcfd is already sold for EOR.
- A pipeline expansion is underway to take additional CO<sub>2</sub> to the Powder River Basin oilfields (northeastern Wyoming) for EOR.
- Estimated “value added” sequestration capacity is 300 to 400 million tons CO<sub>2</sub>.



# CO<sub>2</sub> FACILITIES AND EOR FIELD SITES, WYOMING



Source: Carbon Dioxide in Wyoming, WY State Geological Survey, Info Pamphlet 9, 2001



# 3. TECHNOLOGY AND INCENTIVES

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**Market-based incentives could be structured to encourage industry to capture high CO2 concentration emissions for enhanced oil, natural gas and coalbed methane recovery:**

- **Capture of CO2 emissions from high concentration vents**
- **Production of additional domestic energy**
  - **1 million barrels per day of oil production by 2020**
  - **Substantial potential for additional natural gas reserves**
- **A \$50/tonne carbon (\$13 to 14/tonne CO2) sequestration credit would be revenue neutral or revenue positive.**



# “REVENUE NEUTRAL” CARBON SEQUESTRATION/OIL PRODUCTION INCENTIVE

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		Based on Tonnes Carbon
1	<b>Sequestration Tax Credit, \$50/Tonne Carbon (\$0.72/Mcf CO<sub>2</sub>)</b>	<b>\$50/Tonne C</b>
2	<b>CO<sub>2</sub>/Additional Oil Recovery Ratio (4 to 7 Mcf/BO)</b>	<b>0.06 to 0.1 TC/BO</b>
3	<b>Tax Credit per Barrel of Additional Oil Production</b>	<b>\$3 to 5/BO</b>
4	<b>Public Benefits from Additional Domestic Oil Production (@ \$25/BO)</b>	<b>\$5.50/BO</b>



# SIMPLE MODEL OF PUBLIC BENEFITS

		Oil Company	Private Mineral Owners	Federal/State Mineral Owners
<b>1</b>	<b>Domestic Oil Price</b>	\$25.00 <sup>(1)</sup>		
	Less: Royalties (@ 15%)	(3.70) <sup>(2)</sup>	\$1.90 <sup>(3)</sup>	<b>\$1.80 <sup>(3)</sup></b>
<b>2</b>	<b>Operating Revenues</b>	\$21.30		
<b>3</b>	<b>Operating Expenses</b>			
	a. Production Taxes (@4%, net of royalties)	(0.90) <sup>(4)</sup>	(0.10) <sup>(4)</sup>	<b>1.00</b>
	b. Lease Bonus and Rentals (@ 1%, net of royalties)	(0.20) <sup>(5)</sup>		<b>0.20</b>
	c. Other Operating Expenses	(14.00) <sup>(6)</sup>		
	d. Total Operating Expenses	(15.10)	(0.10)	
<b>4</b>	<b>Before Tax Income</b>	\$6.20	\$1.80	<b>\$3.00</b>
<b>5</b>	<b>Income Taxes (@ 31.5%)</b>	(2.00) <sup>(7)</sup>	(0.50)	<b>2.50</b>
<b>6</b>	<b>Net Income (per Barrel of Oil)</b>	\$4.20	\$1.30	<b>\$5.50</b>

(1) Assumed.

(2) Royalties are 15% and include 12.5% to 16.7% Federal and State royalties and 15% to 17.5% private royalties.

(3) Royalty distribution of 52% private and 48% Federal/State based on Alaska, OCS and onshore (Federal, Indian and State lands) from MMS and State of Alaska.

(4) Production tax data includes ad valorem taxes and is 4% from FRS data. Private royalty owners assumed to pay production taxes of 4%, or \$0.10 on their share of royalty income.

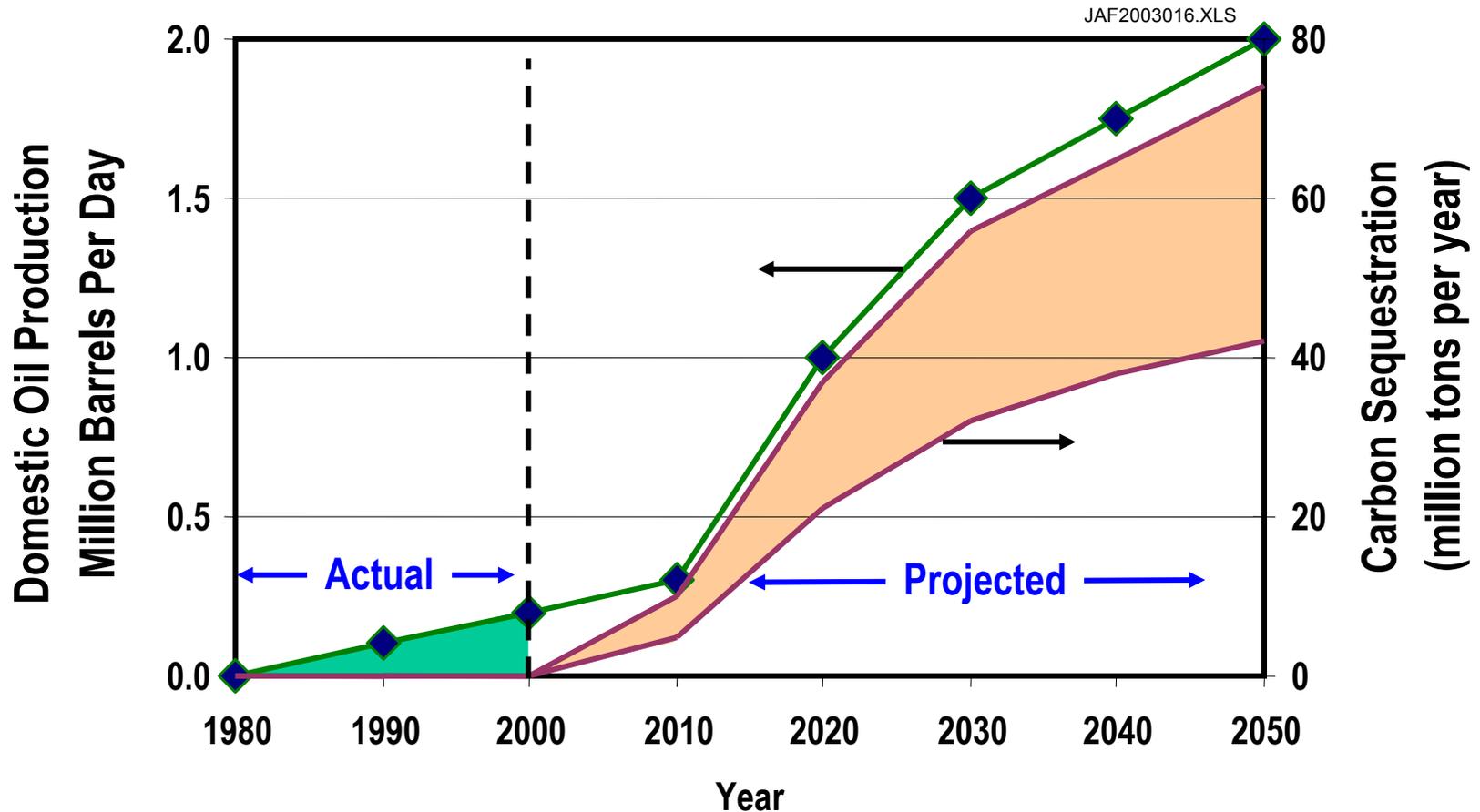
(5) Lease bonus and rentals data is 1% of revenues from MMS data.

(6) Production and other expenses based on FRS data, adjusted for effects of domestic oil price.

(7) Federal and State income taxes on domestic production of 31.5% based on FRS data. Private royalty owners assumed to pay about 30% Federal and State income tax on their net royalty income.



# SEQUESTRATION OF CO2 IN DEPLETED OIL FIELDS



# CONCLUDING COMMENTS

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**Assuming aggressive R&D/demonstrations plus performance-based incentives, significant “value added” carbon sequestration markets will exist for CO<sub>2</sub>:**

- **About 20 to 40 MM tonnes of carbon in 2020.**
- **Two times as much in 2050.**

**This would provide an additional one million barrels per day of domestic oil production (and potentially significant volumes of additional natural gas production) in 2020.**





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