Enhanced Oil Recovery in a Carbon-Constrained World

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Outline

Introduction

How big is the CO_2-EOR opportunity?

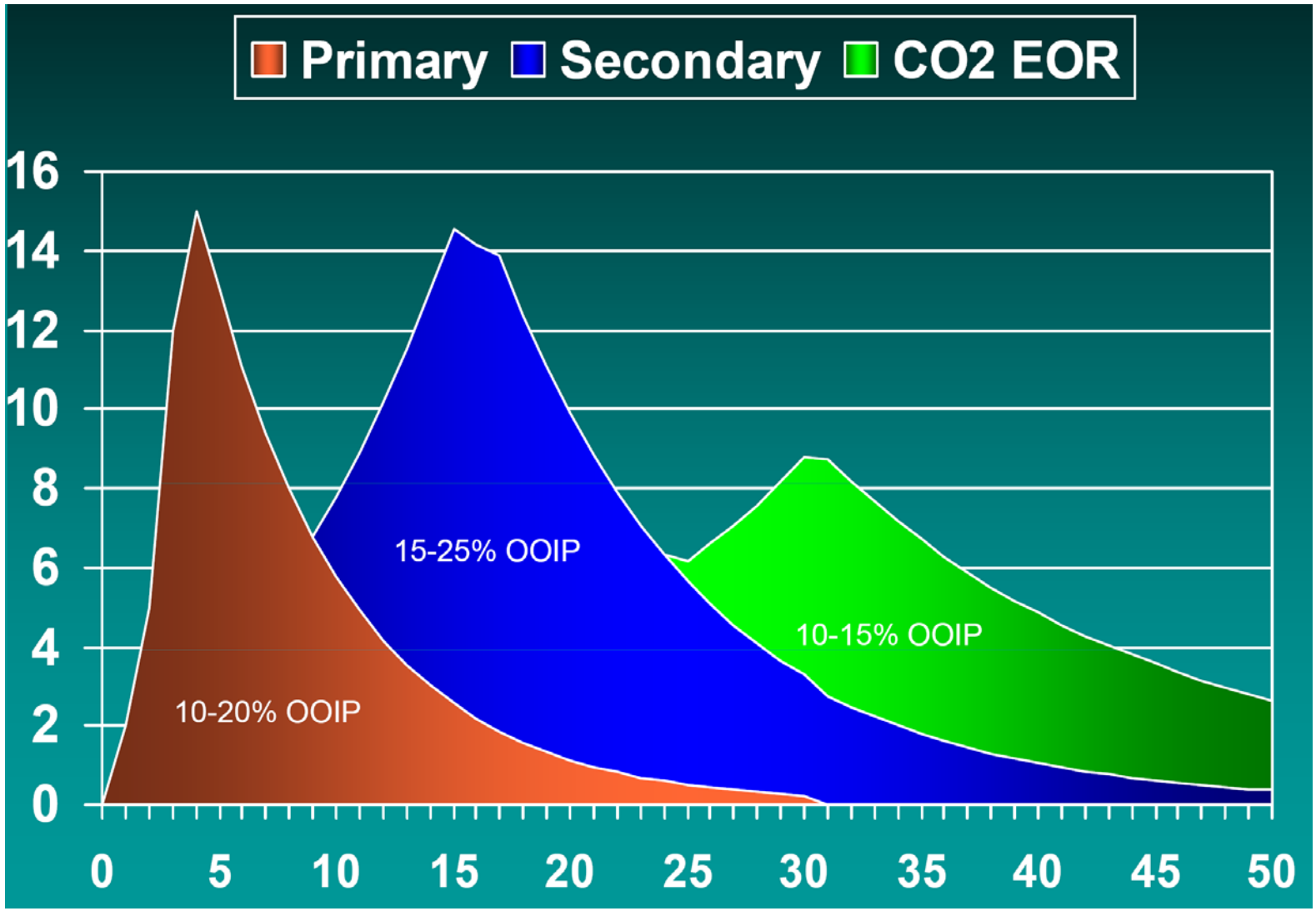
How large could the (captured) CO_2 supply be?

How could CO_2 supplies meet EOR demand?

NRDC and CCS

- Investigated capture technologies and geologic sequestration since the late 90s
- Concluded CCS is viable and critical to the *political and technical* ability of achieving deep emission reductions by 2050
- Now designing, analyzing and advocating *effective policies to deploy CCS at scale* (USCAP, Waxman-Markey, Kerry-Boxer)

The CO_2-EOR Wave: How Big?

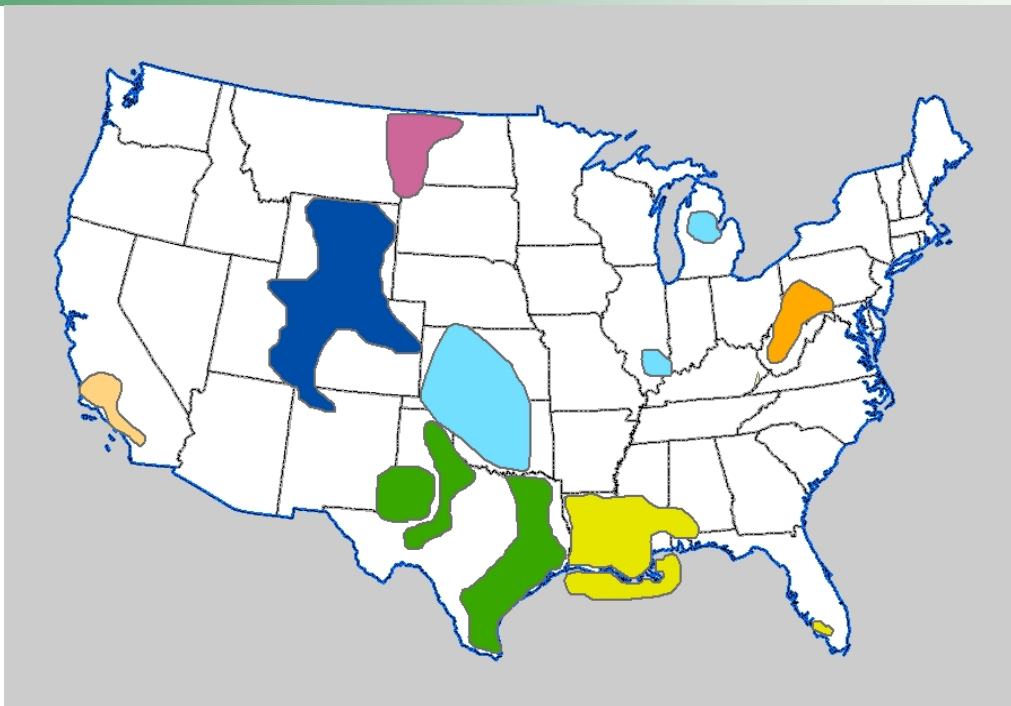


Source: Kinder Morgan

The CO_2-EOR Wave: How Big?

- The majority of US oil fields have the attributes needed for CO_2-EOR (EIA, ARI)
- Advanced flooding with higher CO_2 volumes can recover more of the oil in place
- Additional EOR potential in the residual oil zone (ROZ) below oil reservoir
- Total US economic potential: ***45 to 64 billion barrels*** in eleven basins (DOE/ARI, not including ROZ potential)

EOR and CO_2 demand in lower 48



- Economic potential between 35-55 bn bbl, at \$70/bbl and \$35/t CO_2
- CO_2 demand between 9.7-11.7 bn tons
- 75% of lower-48 potential in four basins in Gulf, Texas, Mid-Continent

ACES: How much CCS, CO_2?

- ACES (Waxman-Markey) incentivizes CCS for up to 72GW of power plants ($150-200bn)
- 15% of CCS incentives (up to $30bn) for industrial applications
- Additional deployment later when costs are lower and carbon prices higher
- A huge opportunity for the CO_2-EOR business

Incentives for CCS in Federal Climate Legislation

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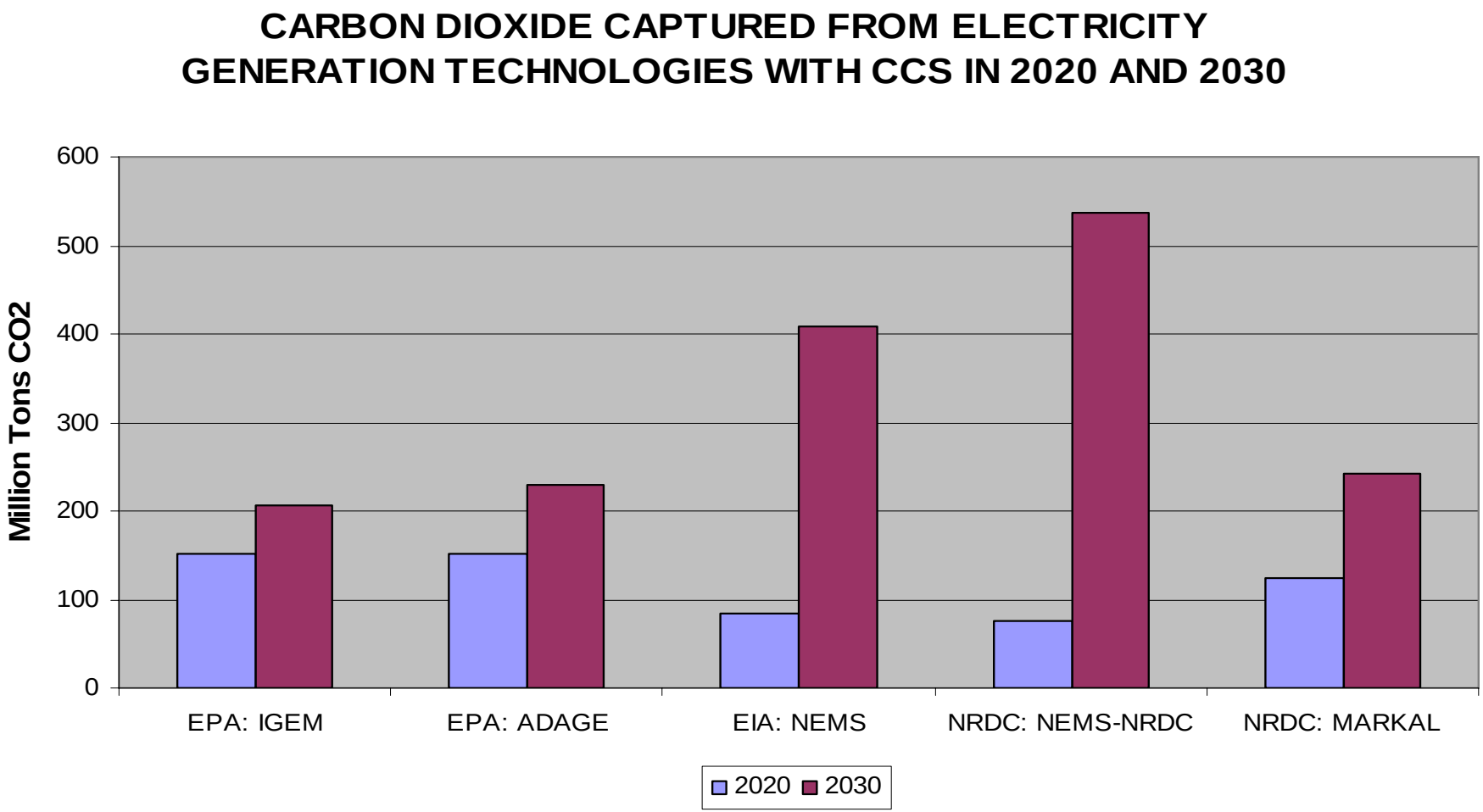
THE EARTH'S BEST DEFENSE

Fixed 10-year subsidy for up to 72 GW of generation

	H.R. 2454	S. 1733
Early Deployment	$1 billion annually for 10 years	$1 billion annually for 10 years
Total Bonus Pool	5.32 Billion	4.19 Billion
1st Tranche[15]	$90/ton for first 6 GW + $10/ton built before 2017	$96/ton for first 10 GW + $10/ton built before 2017
2nd Tranche	Reverse Auction	$85/ton for next 10 GW
3rd Tranche	N/A	Reverse Auction

ACES: How much CCS, CO_2?



4-6 bcf/day by 2020; 12-27 bcf/day by 2030

CCS and EOR under ACES (lower 48)

MARKAL model looks at optimal technology deployment nationally over full policy period.

- By 2050:
  - 201GW of CCS plants
  - 20 billion tons of captured CO_2
  - 37 billion barrels from CCS/EOR
- Assumes:
  - $58/bbl<oil prices<$89/bbl
  - CO_2 priced at $15/t or less
- Assumes “best practices” at that oil price range
- Up to 60 billion barrels become economical at higher oil prices (>$90/bbl) and using “next generation” techniques

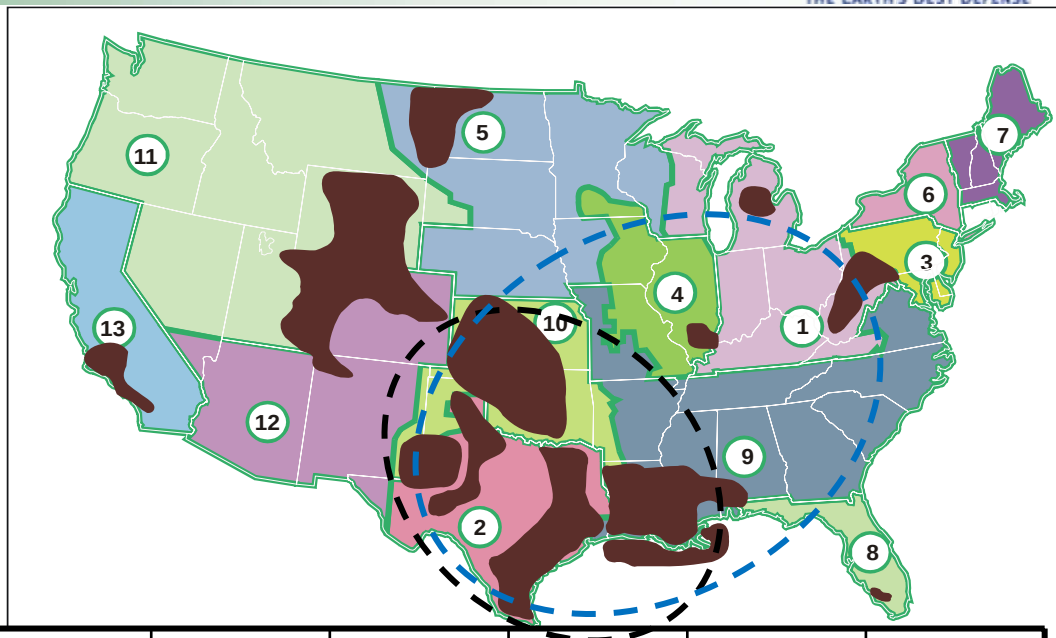
Regional results (lower 48)

NEMS model is more predictive, looks at technology costs and decisions by power region, but only out to 2030.

- By 2030:
  - 108 GW of CCS plants deployed
  - 500 million tons of CO_2 captured per year
  - $114/bbl projected, down from $130/bbl BAU
- CO_2 EOR included but not linked to CCS deployment
- Geologic reservoir data not included
- As early as 2026, however, enough CCS is deployed to meet the total CO_2 demand for EOR in the lower-48.

Regional results

- Regional imbalances in CO_2 supply/demand
- 75% of CO_2 supply within economic distance of 75% of EOR potential



Power region	CA	NW	MAPP	SPP	ERCOT	SERC	MAIN	ECAR	MAAC
GW by 2030	1.6	0.9	5.8	4.8	2.7	23.9	6.1	19.8	8.7
CO_2 captured over 30 yrs	301	169	1090	902	508	4493	1147	3722	1636
Oil basin	CA	WY, UT, CO	MT, ND, SD	NE, KS, OK	NM, W.TX	E. TX	LA, MS, AL	MI, IL	OH, KY, PA
CO_2 demand	1556	683	122	1825	3028	2099	2059	329	18

Moving CO_2 from source to sink

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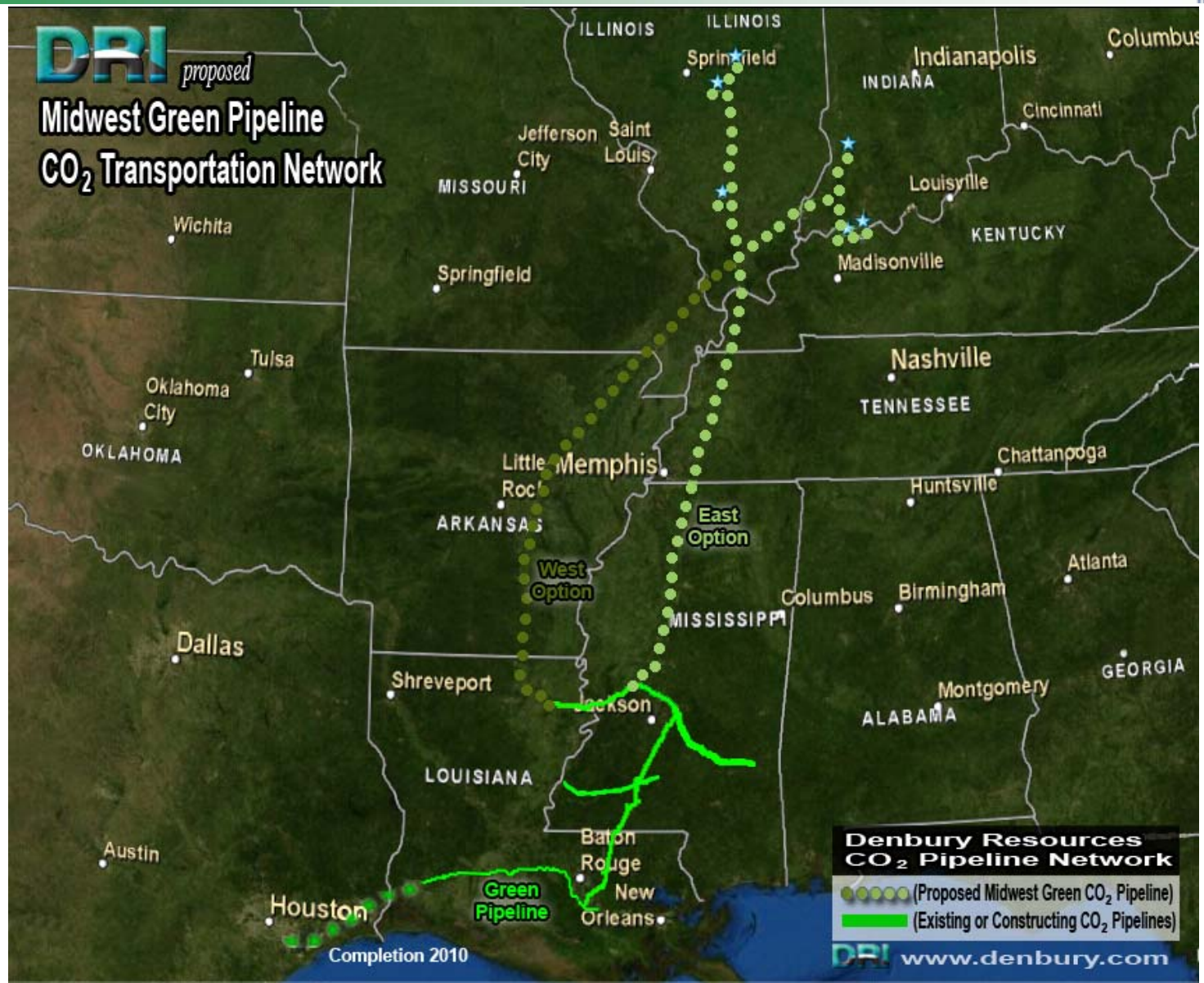
THE EARTH'S BEST DEFENSE



Conclusions

- CO_2-EOR has the potential to grow substantially under climate policies, using anthropogenic CO_2
- CO_2-EOR can meaningfully reduce oil imports
- It provides a viable pathway for CO_2 sequestration, potentially at a lower cost and faster timeframes
- Regulatory gaps need to be addressed, and adequate institutional capacity ensured for wider deployment

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