

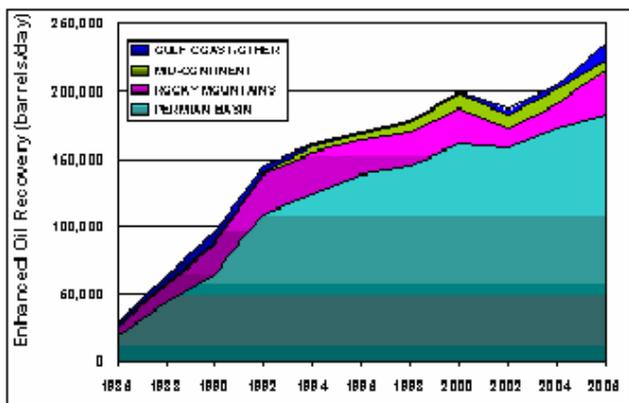
DOE Office of Petroleum Reserves – Strategic Unconventional Fuels

Fact Sheet: CO₂ Enhanced Oil Recovery

Background

- Significant volumes of conventional oil remaining in known U.S. oil reservoirs could be produced by injection of carbon dioxide (CO₂).
- CO₂ enhanced oil recovery (CO₂ EOR) has been constrained by economics, technology, CO₂ supply, and pipeline infrastructure.
- Use of CO₂ EOR in additional basins and reservoirs could increase domestic oil supply and provide effective storage of CO₂ produced from unconventional fuels production.
- Current (2005) oil production from CO₂ EOR is approximately 237,000 Bbls/day.¹ (Figure 1)

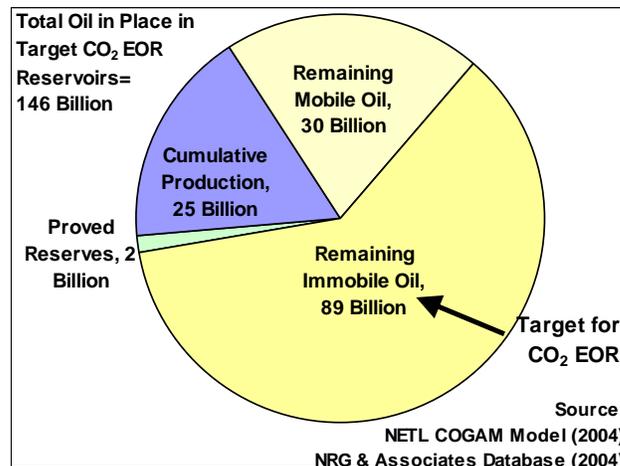
Figure 1 - U.S. CO₂-EOR Production is growing Most Production Comes from the Permian Basin



U.S. CO₂ EOR Resources

- Based on the information available in the DOE/NETL Comprehensive Oil and Gas Analysis Model (COGAM), a total of 1,673 fields/reservoirs have been identified as candidates for CO₂-miscible flooding in the United States.
- These fields and reservoirs collectively account for 146 billion barrels of OOIP, with 65 billion barrels of remaining immobile oil as the target resource for CO₂-miscible flooding. (Figure 2)
- Application of CO₂ EOR in candidate reservoirs in other basins depends on the economic availability of CO₂ from natural or industrial sources.

Figure 2 – Potential Target for CO₂ EOR



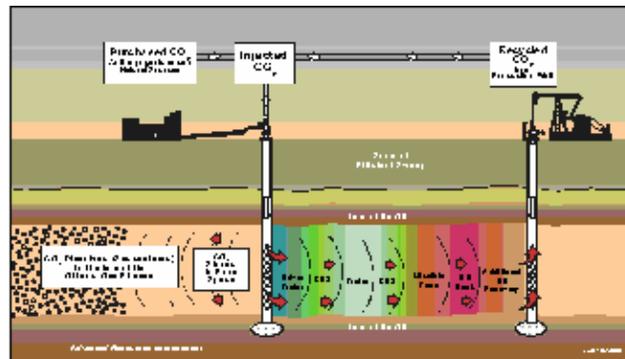
CO₂ EOR Economics

- Construction of new pipelines from CO₂ sources to target basins requires significant capital investments that must be supported by the long-term oil production potential of the target basin and by expectations of future oil prices.
- Oil price volatility is a significant deterrent to CO₂ pipeline and project investment by industry, particularly for smaller independent producers.

CO₂ EOR Technology

- CO₂ injection in conventional oil reservoirs can produce oil unrecovered by primary production or secondary water-flooding. CO₂ acts as a solvent that reduces viscosity and enables the oil to flow to the production well. (Figure 3)²

Figure 3 – What is CO₂ Enhanced Oil Recovery?



- Significant volumes of injected CO₂ can be recovered from producing wells and recycled by reinjection.
- When production is complete, the depleted reservoir may act as a CO₂ storage site.

CO₂ Sources and EOR Markets

- Natural sources of CO₂ now supply about 950 billion cubic feet (Bcf)/ yr (2.6Bcf/d) for CO₂ EOR projects. Approximately 75 percent is used in projects in West Texas (the Permian Basin). Other states with CO₂ EOR projects include Colorado, Wyoming, and Mississippi. (Figure 4)³

Figure 4 - Natural CO₂ Sources and Pipelines



- CO₂ EOR can provide a significant market for “EOR-ready CO₂”, from industrial sources,

including unconventional fuels projects such as shale oil, oil sands, and coal-to-liquids.

- The potential market is about 380 trillion cubic feet (Tcf,) or about 20 billion metric tons of CO₂. Future oil prices and CO₂ cost will determine how much of this market may be economically captured.⁴

CO₂ EOR Environmental Factors

Environmental concerns associated with CO₂-EOR development differ from those of other unconventional oil resources.

- Most production potential exists in already producing oil fields. So, many environmental concerns are already addressed within the existing regulatory oversight framework for these fields.
- Emissions are generally limited to gases from compressors used for CO₂ injection.
- CO₂ is captured from the production well and recycled, so CO₂ emissions are negligible if injected CO₂ is stored in the reservoir when production is complete, not vented.
- CO₂-EOR projects require significant amounts of water in order to pursue a “water-alternating-gas,” or WAG, injection processes. Much of this water will come from the oil formation itself, as it is produced with the oil.

References

- 1 Oil & Gas Journal Vol. 105.15, April 17 2006 p.40.
- 2 Advanced Resources International, 2006.
- 3 Oil and Gas Journal, April 2006.
- 4 U.S. DOE Office of Fossil Energy,