CO₂ Utilization and Storage from CO₂ Enhanced Oil Recovery for the U.S. DOE/NETL Carbon Sequestration Atlas

Prepared by:
Vello A. Kuuskraa
vkkuuskraa@adv-res.com
President
ADVANCED RESOURCES INTERNATIONAL, INC.
Arlington, VA USA

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Introduction

The storage of CO$_2$ with Enhanced Oil Recovery (CO$_2$-EOR), a key aspect of CCUS (Carbon Capture, Utilization and Storage), is receiving increasing interest.

A number of the current CO$_2$ capture projects are using CO$_2$-EOR for CO$_2$ storage and for revenues to help defray the costs of capturing CO$_2$.

- Southern Company’s Kemper County IGCC Plant
- Summit Power’s Texas Clean Energy Project
- Others (e.g., North Dakota Coal Gasification, Boundary Dam Integrated CCUS Project, etc.)
### Southern Company’s Kemper County IGCC Plant
- 582 MW fueled by Mississippi Lignite
- Will Capture 65% of CO₂
- Negotiating agreement to sell 1.1 to 1.5 million tons of CO₂ per year for EOR (170-225 MMcfd)
- Project expected to cost $2.4 B and be operational by 2014.

*Source: Mississippi Power, Denbury Resources*

### Summit’s Texas Clean Energy IGCC Project
- 400 MW IGCC with 90% capture
- Located near Odessa in Permian Basin
- Sell 2.5 million tons of CO₂ per year to EOR market
- Expected cost $1.75 B; $350 MM award under CCPI Round 3.

*Source: Siemens Energy*

- Two methods are currently used to estimate the CO₂ storage volume: (1) a volumetrics-based CO₂ storage estimate and (2) a production-based CO₂ storage estimate. The method selected by each RCSP is based on available data.
- The CO₂ storage volumes in the “Atlas” represent technical storage capacity and not the economically viable market demand for CO₂ by the EOR industry.
Key Study Topics

The purpose of this study is to work with the Regional Partnerships to address the following topics:

1. How large of a CO₂ utilization and storage market does CO₂ enhanced oil recovery (CO₂-EOR) offer in each Partnership region?

2. How would the size of the CO₂ utilization and storage market offered by CO₂-EOR match the available sources of CO₂ in the Partnership regions?

3. How would the demand for CO₂ utilization and storage by the CO₂-EOR market vary as a function of oil prices?

4. How would the CO₂-EOR based utilization and storage of CO₂ compare with the volumetrics or production-based estimates of CO₂ storage currently prepared by each Partnership?
Work Plan and Scope

The work is being performed as part of a joint effort by ARI, MGSC, SSEB and the U.S. DOE’s RCSPs.

Phase I of the study is developing and testing an updated CO$_2$ utilization and storage methodology for CO$_2$-EOR. This work involves project management by SSEB and joint technical work between ARI and the Midwest Geological Sequestration Consortium (MGSC).

Phase II of the study will apply the CO$_2$ utilization and storage methodology developed in Phase I to assess CO2 storage from CO$_2$-EOR with participation of each of the RCSPs.
Phase I Work Plan

Subtask 1. Develop Methodology for Estimating CO$_2$ Utilization and Storage Offered by CO$_2$ Enhanced Oil Recovery with Midwest Geological Sequestration Consortium (MGSC).

- Geologic and Reservoir Data
- Screening Criteria Oil Reservoirs Technically Viable for CO$_2$-EOR
- Cost and Economic Data and Model

Subtask 2. Work on CO$_2$ Storage and Oil Recovery Methodology with MGSC.


Progress to Date

**Atlas IV.** DOE’s RCSPs have estimated 226 billion metric tons of CO₂ storage capacity.

### Previous MGSC Study Results

<table>
<thead>
<tr>
<th>State</th>
<th>CO₂ Storage Resource (million metric tons)</th>
<th>Estimated EOR* (million barrels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>106 to 358</td>
<td>632 to 979</td>
</tr>
<tr>
<td>Indiana</td>
<td>20 to 47</td>
<td>124 to 162</td>
</tr>
<tr>
<td>Kentucky</td>
<td>14 to 35</td>
<td>104 to 138</td>
</tr>
<tr>
<td>Total</td>
<td>140 million to 440 million metric tons</td>
<td>860 million to 1.3 billion barrels</td>
</tr>
</tbody>
</table>

*EOR volume was estimated using oil recovery factors for specific geologic units and miscibility type, applied to the original oil in-place per oil field.

**New MGSC Study.** Develop dimensionless CO₂-EOR performance curves for Illinois Basin geologic formations, calibrate curves via rigorous geologic and reservoir models, and incorporate results into an economic model.
The Master Input Data Sheet enables the model user to:

- Select a representative performance ("type") curve.
- Enter appropriate fluid injection rates.
- Generate oil recovery and CO2 utilization projections
  - Graphics
  - Tables
Performance ("Type") Curves: Oil Recovery vs. CO$_2$ Injection (Three Grades of Reservoir Heterogeneity)
Performance (“Type”) Curves: Oil Recovery vs. CO\textsubscript{2} Injection (Two Types of CO2-EOR)

Oil Recovery (% HCPV)

HCPV of Injected CO\textsubscript{2}
Performance ("Type") Curves: Oil Recovery vs. CO₂ Injection (Three Types of CO2-EOR Process)
The work by the MGSC, particularly by Mr. Scott Frailey, has established an improved approach for calculating CO$_2$ storage and oil recovery and Trimeric has provided capital and operating costs for CO$_2$-EOR.

Advanced Resources, drawing on this valuable work, is in the process of integrating the MGSC developed performance (“type”) curves with the economic model.

In Phase II, we will work with each of the Regional Partnerships to test and incorporate this methodology for strengthening this information on CO$_2$ utilization and storage in each Partnership Region.
Advanced Resources International
www.adv-res.com

Office Locations
Washington, DC
4501 Fairfax Drive, Suite 910
Arlington, VA 22203
Phone: (703) 528-8420
Fax: (703) 528-0439

Houston, Texas
11931 Wickcheater Ln., Suite 200
Houston, TX 77043-4574
Phone: (281) 558-6569
Fax: (281) 558-9202