CCUS in Unconventional Reservoirs

Wayne Rowe | Schlumberger Low Carbon Projects
March 29, 2019
A Reuters* survey of the top 10 U.S. power companies showed eight have no plans to purchase and install carbon capture and storage (CCS) equipment, citing high costs and uncertain demand, while the other two declined to comment.

*Reuters “U.S. Companies Balk At Expanded Carbon-Capture Subsidy” Timothy Gardner, August 2, 2018
CCUS in Unconventional Reservoirs
It’s all in the west!

- Demand for $\text{CO}_2$ in the eastern US is minimal at best
- Little potential for $\text{CO}_2$ EOR in the east
- $\text{CO}_2$ storage potential in the east is not significant
- Power sector capture cost is still too high
- 10 out of 10 power companies can’t be wrong…
U.S. CO₂ EOR Infrastructure

All roads lead to the Permian
U.S. Shale Gas Production (2005 – 2040)
Nearly half comes from the east coast

U.S. Energy Information service
U.S. Shale Gas Production March – April 2019

Most prolific shale gas play in the U.S. is the Marcellus

<table>
<thead>
<tr>
<th>Region</th>
<th>Oil production</th>
<th>Gas production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>March 2019</td>
<td>April 2019</td>
</tr>
<tr>
<td>Anadarko</td>
<td>586 (thousand barrels/day)</td>
<td>581 (thousand barrels/day)</td>
</tr>
<tr>
<td>Appalachia</td>
<td>134 (thousand barrels/day)</td>
<td>138 (thousand barrels/day)</td>
</tr>
<tr>
<td>Bakken</td>
<td>1,441 (thousand barrels/day)</td>
<td>1,458 (thousand barrels/day)</td>
</tr>
<tr>
<td>Eagle Ford</td>
<td>1,434 (thousand barrels/day)</td>
<td>1,442 (thousand barrels/day)</td>
</tr>
<tr>
<td>Haynesville</td>
<td>43 (thousand barrels/day)</td>
<td>43 (thousand barrels/day)</td>
</tr>
<tr>
<td>Niobrara</td>
<td>732 (thousand barrels/day)</td>
<td>753 (thousand barrels/day)</td>
</tr>
<tr>
<td>Permian</td>
<td>4,137 (thousand barrels/day)</td>
<td>4,177 (thousand barrels/day)</td>
</tr>
<tr>
<td>Total</td>
<td>8,507 (thousand barrels/day)</td>
<td>8,592 (thousand barrels/day)</td>
</tr>
</tbody>
</table>

U.S. Energy Information service
Why Does the Marcellus Matter to Utilities?

The Adsorption Phenomenon

- Organics in Shale have a higher affinity for CO$_2$ than Methane
- Selectivity of CO$_2$ over methane 2 to 5 times higher
- Organics in shales exchange methane for CO$_2$

The Appalachia Region Marcellus Shale
The Sleeping Giant for CO$_2$ Enhanced Gas Recovery

- Decades of Storage Capacity while increasing production by as much as 24%
- *The Permian Basin of the East?*

Shale Gas Formations and Their Potential for Carbon Storage: Opportunities and Outlook
Roozbeh Khosrokhavar & Steve Griffiths & Karl-Heinz Wolf
What about CO\textsubscript{2} for the initial completion too?

Stimulation with carbon dioxide instead of water – A trifecta of benefits

- Saves Millions of gallons of water per well
- Eliminates Millions of gallons of waste water
- Could Improve initial production 20%

Plus….

- Uses 30,000 tonnes of CO\textsubscript{2} per well

Modelling the adsorption-desorption behavior of CO\textsubscript{2} in shales for permanent storage of CO\textsubscript{2} and enhanced hydrocarbon extraction Solomon Browna*

*Schlumberger Private
Who can supply this massive volume of CO$_2$ for Marcellus EGR?
Carbon capture and the future of power generation

Petra Nova*

- $1,000M Project
- $ 190M U.S. DOE
- $ 250M Japan
- 240 MW WA Parrish Unit 8
- 1.8M TPY Captured
- 80 Mile Pipeline
- Hilcorp West Ranch Oil Field
- 300 BOPD to 4,000 BOPD

- Second of a kind – 20% less according to Petra Nova
- Petra Nova subsidies - $440,000
- 1.8M TPY (12 Years) 45Q Tax Credit for Utilization - $756M

*https://www.nrg.com/case-studies/petra-nova.html
CCUS in Unconventional Reservoirs
It’s **NOT** all in the western U.S.

- Demand for CO₂ in the eastern U.S. is *a sleeping giant*
- Little potential for CO₂ EOR in the eastern US. True, but…
- **EGR potential in the eastern US is enormous!**
- CO₂ storage potential in eastern shales is *enormous!*
- Power sector capture is *closing the gap*