North American CO$_2$ Supply and Developments

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Phil DiPietro, NETL

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Disclaimer and Acknowledgements

All data and information contained within this presentation are from public sources. Furthermore, all analyses and interpretations have been conducted with publically available data, unless otherwise stated.

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Agenda

• CO₂ Supply and EOR Projects
  • North American Status and Developments
  • Regional Developments

• Forecasting CO₂ EOR
  • Scheduled CO₂ supply developments
  • Using UR as a forecasting metric

• Natural Sources
  • NETL Catalogue
CO$_2$ Supply and EOR Projects
Project Development

4 projects started in 2013: East Seminole (Permian), Bell Creek and Greive (RM), and Burbank
CO2 Sales

Average Daily CO2 Sales - North America

- Other
- Dakota Gasification
- MS/Gulf Coast
- Rocky Mountains
- Permian Basin

CO2 Sales (MMcfpd)

0 500 1,000 1,500 2,000 2,500 3,000 3,500

CO2 EOR Incremental Recovery

North American CO2 EOR Production

- Midale
- Weyburn
- Mid-continent
- MS/Gulf Coast
- Rocky Mountains
- Permian basin

Oil production (Million barrels per year)

Year:
- 1972
- 1977
- 1982
- 1987
- 1992
- 1997
- 2002
- 2007
- 2012

Jackson Dome Area

- 6.1 TCF Proved Reserves estimated at 9/30/12
- 3Q 2012 Average Daily Production – 1,036 MMcf/d
- 4 wells drilled in 2012

**Historical Gross CO₂ Production**
Wyoming Oil Production by Type

- Incremental CO₂ Oil
- Pindeale/Jonah Condensate
- Stimulated Horizontal Plays
- “Conventional” Oil
## Current CO₂ Supply

<table>
<thead>
<tr>
<th>Process</th>
<th>Project Name</th>
<th>Operator</th>
<th>Location</th>
<th>Stated Supply Capacity (MMcfpd) 2012</th>
<th>Actual Supply (MMcfpd) 2012</th>
<th>CO₂ Concentration, vol %</th>
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</thead>
<tbody>
<tr>
<td>Natural Resources</td>
<td>Jackson Dome</td>
<td>Denbury</td>
<td>MS</td>
<td>1,000</td>
<td>1,025 (933 for EOR)</td>
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<td></td>
<td>McElmo Dome</td>
<td>Kinder Morgan, ExxonMobil</td>
<td>CO</td>
<td>1,150</td>
<td>1,150</td>
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<td>Bravo Dome</td>
<td>KM, Occidental, Amerada Hess</td>
<td>NM</td>
<td>445</td>
<td>300</td>
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<td></td>
<td>Sheep Mountain</td>
<td>Occidental</td>
<td>CO</td>
<td>50</td>
<td>25</td>
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<td></td>
<td>Doe Canyon</td>
<td>Kinder Morgan</td>
<td>CO</td>
<td>105</td>
<td>50</td>
<td>97</td>
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<td>Natural Gas Processing</td>
<td>L琦arge</td>
<td>ExxonMobil</td>
<td>WY</td>
<td>340</td>
<td>210</td>
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<tr>
<td></td>
<td>Lost Cabin</td>
<td>ConocoPhillips</td>
<td>WY</td>
<td>50</td>
<td>0</td>
<td>20</td>
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<td></td>
<td>Val Verde Natural Gas Plants</td>
<td>Occidental, Sandridge Energy Inc.</td>
<td>Terrell and Pecos Counties, TX</td>
<td>450</td>
<td>135 (65-75)</td>
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<tr>
<td></td>
<td>Turtle Lake</td>
<td>DTE Energy</td>
<td>MI</td>
<td>11</td>
<td>11</td>
<td>97</td>
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<tr>
<td></td>
<td>Lula</td>
<td>Petrobras</td>
<td>Brazil</td>
<td>35</td>
<td>?</td>
<td>8-15</td>
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<td>Conversion</td>
<td>Agrium Fertilizer</td>
<td>Agrium, Inc.</td>
<td>Borger, TX</td>
<td>26</td>
<td>26</td>
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<td>Koch Fertilizer</td>
<td>Koch Nitrogen Company, LLC</td>
<td>Enid, OK</td>
<td>35</td>
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<td>Arkalon Ethanol</td>
<td>Conestoga Energy Partners</td>
<td>Liberal, KS</td>
<td>14</td>
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<td>Boundary Dam</td>
<td>SaskPower</td>
<td>Estevan, SK</td>
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<td>Bonanza BioEnergy Ethanol</td>
<td>Conestoga Energy Partners</td>
<td>Garden City, KS</td>
<td>8</td>
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<td></td>
<td>Coffeyville Pet. Coke to Ammonia</td>
<td>CVR</td>
<td>Coffeyville, KS</td>
<td>42.5</td>
<td>42.5</td>
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<td>PCS Nitrogen Ammonia</td>
<td>PCS Nitrogen - Denbury Resources</td>
<td>Geisma, LA</td>
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<td>Valero Refinery - Steam Methane Reforming</td>
<td>Air Products - Denbury Resources</td>
<td>Port Arthur, TX</td>
<td>51</td>
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<td></td>
<td>Great Plains Synfuels Plant</td>
<td>Dakota Gasification</td>
<td>Beulah, ND</td>
<td>150</td>
<td>150</td>
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</table>
CO2 EOR Supply in 2013

**CO2 EOR Supply in 2013**

- **2.5 MMscf/d**
- **150 MMscf/d**
- **390 MMscf/d**
- **10.5 MMscf/d**
- **150 MMscf/d**
- **1,800 MMscf/d**
- **950 MMscf/d**

**TOTAL 3,453 MMScfd**

## Supply Developments

<table>
<thead>
<tr>
<th>Sink Location</th>
<th>Project Description</th>
<th>Status</th>
<th>Online date</th>
<th>Incremental CO₂ Rate (MMcfpd)</th>
<th>Total</th>
<th>% inc.</th>
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</thead>
<tbody>
<tr>
<td>Rockies</td>
<td>DKRW Medicine Bow Fuel &amp; Power Coal to Liquids (WY)</td>
<td>In Financing</td>
<td>2018?</td>
<td>100 initially (Phase II conditional but would add 100)</td>
<td>536-766</td>
<td>135% - 195%</td>
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<td></td>
<td>Linc Energy UCG (WY)</td>
<td>Planning</td>
<td>?</td>
<td>115</td>
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<tr>
<td></td>
<td>Carbon Energy (WY)</td>
<td>Planning</td>
<td>?</td>
<td>?</td>
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<tr>
<td></td>
<td>Riley Ridge (WY)</td>
<td>Plant w/o CO₂ Capture Currently Under Construction</td>
<td>2019</td>
<td>130 initially, phasing up to 260</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Quintana South Heart Project</td>
<td>Permitting</td>
<td>2017?</td>
<td>110</td>
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<td></td>
<td>Antelope Valley AVS CO₂ Demo</td>
<td>on-hold (Cancelled)</td>
<td>?</td>
<td>51</td>
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<tr>
<td>Permian Basin</td>
<td>Summit - Texas Clean Energy Project (TX)</td>
<td>Air Permit Approved, Near Closing.</td>
<td>2016</td>
<td>140</td>
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<td></td>
<td>St. Johns Dome (NM)</td>
<td>Under Development</td>
<td>2016-2017</td>
<td>200-450</td>
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<td>McElmo Dome (CO)</td>
<td>Upgrade AFE’d</td>
<td>2015</td>
<td>200</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Doe Canyon (CO)</td>
<td>Upgrade AFE’d</td>
<td>2014</td>
<td>65</td>
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<td>Gulf Coast</td>
<td>Faustina Petroleum Coke Gasification Project, St. James Parrish (LA)</td>
<td>Under Study</td>
<td>2020</td>
<td>200</td>
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<td></td>
<td>NRG W.A. Parish Plant, Houston (TX)</td>
<td>Status uncertain</td>
<td>2016</td>
<td>85</td>
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<td>Mississippi Power (Southern Company) - IGCC Kemper County (MS)</td>
<td>Under Construction</td>
<td>2014</td>
<td>115</td>
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<td></td>
<td>Indiana Gasification, LLC (IA)</td>
<td>Permitting, future uncertain</td>
<td>?</td>
<td>205</td>
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<td>Cash Creek IGCC (KY)</td>
<td>Planning, Permitted, Future Indeterminate</td>
<td>?</td>
<td>100</td>
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<td></td>
<td>&quot;Chemical Plant&quot; near Green Pipeline</td>
<td>Planning</td>
<td>~2020</td>
<td>150</td>
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<td></td>
<td>&quot;Other Plants&quot; near Green Pipeline</td>
<td>?</td>
<td>2016</td>
<td>85</td>
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<td></td>
<td>Power Holdings of Illinois (IL)</td>
<td>Planning</td>
<td>?</td>
<td>250-300</td>
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<td>California</td>
<td>HECA (Elk Hills, CA) - Pet-coke to Hydrogen</td>
<td>Permitting</td>
<td>2017</td>
<td>135</td>
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<td>Alberta CO2 Trunkline Project -ACTL (AB, Ca) with Agrium</td>
<td>Capture facility under retrofit</td>
<td>2014</td>
<td>25</td>
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<td>Alberta CO2 Trunkline Project -ACTL (AB, Ca) with Northwest Upgrading</td>
<td>Capture facility under construction</td>
<td>2015</td>
<td>62</td>
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<td></td>
<td>Bow City (AB)</td>
<td>Planning</td>
<td>2017</td>
<td>51</td>
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<td></td>
<td>Shell Quest Project (AB, Ca.)</td>
<td>Construction underway</td>
<td>2015</td>
<td>60 (currently for storage, but potential for EOR)</td>
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<td>Middle East</td>
<td>ESI CCS, Abu Dhabi, UAE</td>
<td>Planning</td>
<td>2015</td>
<td>41</td>
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<td>Emirates Aluminium CCS Project, Abu Dhabi, UAE</td>
<td>Planning</td>
<td>2018</td>
<td>100</td>
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<td>Europe</td>
<td>Don Valley Power Project, UK</td>
<td>Planning, construction planned 2014</td>
<td>2016 or later</td>
<td>250</td>
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<td>Nuon Magnum, NL</td>
<td>Planning</td>
<td>2020</td>
<td>250</td>
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<td>Dongying CCS Project, Dongying, Shandong Province</td>
<td>Planning</td>
<td>2020</td>
<td>51</td>
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<td>HuaNeng GreenGen IGCC Project, Binhai New Area, Tianjin</td>
<td>Planning</td>
<td>2020</td>
<td>100</td>
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<td>Jinli Oil Field EOR Project, Songyuan, Jilin Province</td>
<td>Planning</td>
<td>2015</td>
<td>45</td>
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<td>Lianyungang IGCC with CCS Project, Lianyungang, Jiangsu Province</td>
<td>Planning</td>
<td>2015</td>
<td>51</td>
<td></td>
<td></td>
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</tbody>
</table>

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Incremental Supplies (2013 – 2018)
- Summit (140)
- St. Johns (200-450)
- McElmo (200)
- Bravo (80)
- Doe Canyon (65)
- Century (170)
Permian Basin / Mid-Continent – 2018

Incremental Supplies (2013 – 2018)
- Chaparral Burbank (145)
- Bravo Dome (35)
Doe Canyon Field Expansion
$255 MM, 65 MMcf/d CO₂ increase

- 170 MMcf/d (from 105 MMcf/d)
  - Adds 750 Bcf reserves

- Timing: 2nd Quarter 2014
  - Drilling underway
  - Parallel Compression Q4 2013
  - 170 MMCFD YE 2013
  - Booster Compression Q2 2014

- Project delivers attractive returns based on contracts recently executed and currently being negotiated
St. John’s CO₂ Source Opportunity
Assessment drilling and testing ongoing

- Evaluating pipeline & field development options
  - 200 MMCFD ~$0.6 B
  - 450 MMCFD ~$1.3 B
- Drilled/Recompleted 14 wells
- Established good deliverability in Granite Wash
- Deliverability in Amos Wash is being evaluated
  - Testing completion strategies
- Core analysis, log evaluation, geological/reservoir characterization and mapping is ongoing
- Target in service date 2016-17
Chaparral – Potential EOR Production Growth

Net Oil Production

- Additional production from non Business Plan projects meeting corporate economic hurdles
- Additional CO2 Plan w/ +100 mmcfpd in 2015
- Business Plan w/ 95 mmcfpd in 2015 at Burbank

2010 2015 2020 2025 2030 2035 2040
0 5,000 10,000 15,000 20,000 25,000 30,000 35,000 40,000

Business Plan  Add CO2  Others
Estimated Net Reserves from CO₂ Flood – North Ward Estes

Total Net Proved, Probable & Possible CO₂ Reserves at 12/31/08 = 80 MMBOE
Total Net Proved, Probable & Possible Reserves from All Sources at 12/31/08 = 150 MMBOE

Total Net CO₂ Related Reserves = 80 MMBOE
+23 MMBOE

Total Proved = 72.8
+19 MMBOE

Probable¹ = 32.5
(including CO₂)
Possible¹ = 45.1
(including CO₂)

Total 3P = 150.4

Cumulative Oil Recovery (% hcpv)

Cumulative Total Injection (% hcpv)

hcpv = hydrocarbon pore volume

¹ Please refer to Slide #1 for disclosures regarding “probable” and “possible” reserves.
Rocky Mountain / Northern Plains – 2013
Incremental Supplies (2013 – 2018)

- LaBarge (130)
- Lost Cabin (30)
- CES (50)
- Linc/carbon energy (100)

Or maybe a little later...
Incremental Supplies (2013 – 2018)

- Jackson Dome (120)
- Mississippi Power (140)
- Lake Charles (200)
- Ammonia (85)
- NRG (85)
- Air Products (40)
- PCS Nitrogen (20)
- Leucadia (200)
- Other (355)
CO₂ Supply to Support Gulf Coast Growth

**Additional CO₂ Potential (not reflected in graph)**
- Probable & Possible Reserves: ~3 TCF
- Improved Recovery of Proved Reserves: ~0.8 TCF
- Recycle: ~3 TCF

**Gulf Coast CO₂ Demand**

**Jackson Dome Risked Drilling Program**
- Executed Agreements with Future Construction

**Jackson Dome Proved Reserves**
- ~6.1 TCF
- Estimated as of 12/31/2012

Note: Forecast based on internal management estimates and includes fields currently owned. Actual results may vary.
Gulf Coast Industrial Partners

Currently Producing or Under Construction

<table>
<thead>
<tr>
<th>Air Products</th>
<th>PCS Nitrogen</th>
<th>Mississippi Power – (Under Construction)</th>
</tr>
</thead>
</table>
| - Port Arthur, Texas
- Hydrogen Plant
- Capture Date: 1Q 2013
- Quantity: ~50 MMcf/d | - Geismar, Louisiana
- Ammonia Products
- Capture Date: 2Q 2013
- Quantity: ~20 MMcf/d | - Kemper County, MS
- Gasifier
- Capture Date: ~2014
- Quantity: ~115 MMcf/d |

Future Construction (currently planned or proposed)

<table>
<thead>
<tr>
<th>Lake Charles Cogeneration</th>
<th>Ammonia Plant</th>
<th>Chemical Plant</th>
</tr>
</thead>
</table>
| - Lake Charles, Louisiana
- Petroleum Coke to Methanol Plant
- Capture Date: ~2018
- Quantity: >200 MMcf/d | - Near Green Pipeline
- Capture Date: ~1Q 2016
- Quantity: ~85 MMcf/d | - Near Green Pipeline
- Capture Date: ~2020
- Quantity: ~200 MMcf/d |
E N H A N C E D  O I L  R E C O V E R Y  I N S T I T U T E

CO2 EOR Supply in 2018?

CO2 EOR Supply in 2018?

2,200 MMscf/d

2,900 MMscf/d

10.5 MMscf/d

330 MMscf/d

700 MMscf/d

75 MMscf/d

200 MMscf/d

25 MMscf/d

Key
- Potential Natural CO2 Source
- Natural CO2 Source
- NG Processing Source
- Conversion Source
- CO2 Pipeline
- CO2 Pipeline planned
CO₂ Supply Trends, MMScfd

- Conversion
- Gas Processing
- Natural Sources
CO$_2$ Supply Trends, MMscfd

- 2013:
  - Canada
  - Mid Continent
  - Rockies
  - Gulf Coast
  - Permian

- 2018:
  - Canada
  - Mid Continent
  - Rockies
  - Gulf Coast
  - Permian
Supply Developments

- Rockies:
  - CO₂ Supply in the Rockies will increase by as much as 1 Bcfpd over next 5-10 years. Mostly by development of Riley Ridge but also through several conversion projects. Supply, and CO₂ EOR industry, could quadruple in 5-10 years. Implications for oil industry in the region in general and consequent state economics.

- Permian Basin:
  - Natural source supply will be lifted incrementally, but significant volume of additional supply will come from NG processing plants and conversion technologies.

- Midwest/Mississippi/ Gulf Coast:
  - Natural source supply will be lifted incrementally, but supply will be supplemented massively by conversion project supply going forward. Ultimately, as Jackson Dome enters decline, majority of supply will be from anthropogenic sources.

- Mid-continent:
  - Possible tie-in to Permian Basin system. Additional supply provided by conversion projects.

- Canada:
  - Initiation of CO₂ Transport and Utilization system. CO₂ supply from upgrading processes.
$\text{CO}_2$ EOR Forecasting
Forecasting CO2 EOR Incremental production

- Collaboration with Phil DiPietro from NETL
- Normally need a dimensionless curve
  - Can be difficult, and at least very time consuming, to compile data.
- On a system and sub-system basis, we can use $UR_{Net}$
- Use sensitivity analysis on historic data to determine best model (nominal, cumulative, average, SLM) and forecast system of $UR_{Net}$ in each system (e.g. Rockies, Permian, GC/MS)
- Assume ‘perfect’ knowledge of supply capacity past and future.
- Use probabilistic methods to forecast actual sales.
- Use $UR_{Net}$ to calculate production from forecast sales.
- Not perfect but much better than resource based models currently used.
Permian Basin CO2 EOR: CO2 sales, Crude oil Production, and CO2 net utilization
Permian Basin

Incremental Supplies (2013 – 2018)

- Summit (140)
- St. Johns (200-450)
- McElmo (200)
- Bravo (80)
- Doe Canyon (65)
- Century (170)

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2018</th>
</tr>
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<tbody>
<tr>
<td>CO₂ Supply (MMscfd)</td>
<td>1,800</td>
<td>2,900</td>
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<tr>
<td>Crude oil Prodn</td>
<td>196</td>
<td>315</td>
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<tr>
<td>(Mbpd)</td>
<td></td>
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<tr>
<td>CO₂ Utilization Eff</td>
<td>9,200</td>
<td>9,200</td>
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Rocky Mountain

Incremental Supplies (2013 – 2018)

- LaBarge (130)
- Lost Cabin (30)
- CES (50)
- Linc/carbon energy (100)

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 Supply (MMscfd)</td>
<td>390</td>
<td>700</td>
</tr>
<tr>
<td>Crude oil Prodn (Mbpd)</td>
<td>44</td>
<td>80</td>
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<tr>
<td>CO2 Utilization Eff (scf/bbl)</td>
<td>8,800</td>
<td>8,800</td>
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Mississippi / Gulf Coast CO2 EOR: CO2 sales, Crude oil Production, and CO2 net utilization

- CO2 use, MMcfd
- Crude oil production, MM bbls/yr
- CO2 Net Utilization, Mscf/bbl
Gulf Coast

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2018</th>
</tr>
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<tbody>
<tr>
<td>CO₂ Supply (MMscfd)</td>
<td>950*</td>
<td>2,200</td>
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<tr>
<td>Crude oil Prodn (Mbpd)</td>
<td>36.5</td>
<td>110</td>
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<tr>
<td>CO₂ Utilization Eff (scf/bbl)</td>
<td>26,000</td>
<td>20,000</td>
</tr>
</tbody>
</table>

*supply for EOR only

Incremental Supplies (2013 – 2018)
- Jackson Dome (120)
- Mississippi Power (140)
- Lake Charles (200)
- Ammonia (85)
- NRG (85)
- Air Products (40)
- PCS Nitrogen (20)
- Leucadia (200)
- Other (355)
Mid Continent

Incremental Supplies (2013 – 2018)
- Chaparral Burbank (100)
- Bravo Dome (35)
- Coffeyville (30)
- Enid, Borger, Garden City (15)

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2018</th>
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</thead>
<tbody>
<tr>
<td>CO₂ Supply (MMscfd)</td>
<td>150</td>
<td>330</td>
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<tr>
<td>Crude oil Prodn (Mbpd)</td>
<td>21</td>
<td>47</td>
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<tr>
<td>CO₂ Utilization Eff (scf/bbl)</td>
<td>7,100</td>
<td>7,100</td>
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## Near Term CO₂ EOR Forecast

<table>
<thead>
<tr>
<th>Region</th>
<th>CO₂ Supply</th>
<th>Crude Oil</th>
<th>CO₂ UR net</th>
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<tbody>
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<td></td>
<td>2013</td>
<td>2018</td>
<td>2013</td>
</tr>
<tr>
<td>Permian</td>
<td>1,800</td>
<td>2,900</td>
<td>196</td>
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<tr>
<td>Rockies</td>
<td>390</td>
<td>700</td>
<td>45</td>
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<tr>
<td>Gulf Coast</td>
<td>950</td>
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<tr>
<td>Mid Continent</td>
<td>150</td>
<td>330</td>
<td>21</td>
</tr>
<tr>
<td>Canada</td>
<td>153</td>
<td>275</td>
<td>20</td>
</tr>
<tr>
<td>California</td>
<td></td>
<td>25</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3,443</td>
<td>6,430</td>
<td>318</td>
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</tbody>
</table>
Growth in CO$_2$ EOR by Region, bpd

Source: draft report prepared by Advanced Resources International for NETL
# The U.S. DOE Energy Information Administration’s Forecast for CO₂ EOR

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2016</th>
<th>2018</th>
<th>2030</th>
<th>2040</th>
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<tr>
<td>CO₂ EOR (MMbpd)</td>
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<td>0.22</td>
<td>0.26</td>
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<td>Tight oil (MMbpd)</td>
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<td>2.6</td>
<td>2.8</td>
<td>2.2</td>
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<td>WTI price ($/bbl)</td>
<td>93</td>
<td>91</td>
<td>99</td>
<td>129</td>
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</table>

Source: Annual Energy Outlook 2013, Reference Case
Natural Source Catalogue
Catalogue of Subsurface CO$_2$ Accumulations

- Work performed by Tom Heidrick, Jeff Eppink and Michael Marquis of Enegis LLC
- Assess the tectonics and genesis of subsurface CO$_2$ systems
- Compile data and develop volumetric estimates of CO$_2$ initially-in-place
- Derive estimates of TRR and ERR
Subsurface Sources CO$_2$ in the Contiguous United States

- A. McElmo
- B. Bravo
- C. St. John
- D. Val Verde
- E. Sheep
- F. Doe Canyon
- G. Oakdale
- H. Big Piney LaBarge
- I. Kevin
- J. Jackson
- K. Escalante
- L. McCallum
- M. Gordon Creek

- Discovered, producing
- Discovered, not producing

- Cretaceous
- Laramide
- Mid Tertiary
- Late Tertiary
<table>
<thead>
<tr>
<th>Field Name</th>
<th>State</th>
<th>Status</th>
<th>Depth k ft</th>
<th>Area k acres</th>
<th>Pay ft</th>
<th>Por %</th>
<th>GIIP 10^6 mt</th>
<th>Rec %</th>
<th>Access 10^6 mt</th>
<th>TRR volume %</th>
<th>Cumm 10^6 mt</th>
<th>ERR 10^6 mt</th>
</tr>
</thead>
<tbody>
<tr>
<td>McElmo Dome</td>
<td>CO, UT</td>
<td>P</td>
<td>8.0</td>
<td>202</td>
<td>95</td>
<td>12</td>
<td>30,095</td>
<td>70</td>
<td>60</td>
<td>12,640</td>
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<td>1,000</td>
<td>40</td>
<td>20</td>
<td>24,584</td>
<td>65</td>
<td>90</td>
<td>14,381</td>
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<td>1.5</td>
<td>220</td>
<td>75</td>
<td>15</td>
<td>8,917</td>
<td>70</td>
<td>80</td>
<td>4,994</td>
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<td>14</td>
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<td>4</td>
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<td>75</td>
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<td>80</td>
<td>600</td>
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<td>65</td>
<td>90</td>
<td>587</td>
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<td>75</td>
<td>12</td>
<td>238</td>
<td>70</td>
<td>85</td>
<td>141</td>
<td>90</td>
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**Subtotal** 1,400

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<tr>
<th>Field Name</th>
<th>State</th>
<th>Status</th>
<th>Depth k ft</th>
<th>Area k acres</th>
<th>Pay ft</th>
<th>Por %</th>
<th>GIIP 10^6 mt</th>
<th>Rec %</th>
<th>Access 10^6 mt</th>
<th>TRR volume %</th>
<th>Cumm 10^6 mt</th>
<th>ERR 10^6 mt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Piney LaBarge</td>
<td>MY</td>
<td>P</td>
<td>16 - 18</td>
<td>79</td>
<td>275</td>
<td>9</td>
<td>173,021</td>
<td>70</td>
<td>74</td>
<td>90,213</td>
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<td>Kevin Dome</td>
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<td>9</td>
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<td>Madden</td>
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**Subtotal** 2,974

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<th>Por %</th>
<th>GIIP 10^6 mt</th>
<th>Rec %</th>
<th>Access 10^6 mt</th>
<th>TRR volume %</th>
<th>Cumm 10^6 mt</th>
<th>ERR 10^6 mt</th>
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<tbody>
<tr>
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<td>MS</td>
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<td>15.5</td>
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<td>16,123</td>
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**Not within a major CO2-EOR System**

<table>
<thead>
<tr>
<th>Field Name</th>
<th>State</th>
<th>Status</th>
<th>Depth k ft</th>
<th>Area k acres</th>
<th>Pay ft</th>
<th>Por %</th>
<th>GIIP 10^6 mt</th>
<th>Rec %</th>
<th>Access 10^6 mt</th>
<th>TRR volume %</th>
<th>Cumm 10^6 mt</th>
<th>ERR 10^6 mt</th>
</tr>
</thead>
<tbody>
<tr>
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<td>37</td>
<td>172</td>
<td>7</td>
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<td>55</td>
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<td>2,495</td>
<td>95</td>
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<tr>
<td>McCallum</td>
<td>CO</td>
<td>P</td>
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<td>15</td>
<td>100</td>
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<tr>
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<td>82</td>
<td>95</td>
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</tr>
<tr>
<td>Indian Creek</td>
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<td>18</td>
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<td>10</td>
<td>85</td>
<td>70</td>
<td>95</td>
<td>57</td>
<td>66</td>
<td>30 - 4</td>
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<tr>
<td>Woodside</td>
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<td>13</td>
<td>45</td>
<td>9</td>
<td>111</td>
<td>60</td>
<td>90</td>
<td>32</td>
<td>62</td>
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</tbody>
</table>

**Subtotal** 202

Region Coding: Colorado Plateau, Rocky Mountains, Permian Basin, Other

Notes: GIIP = Gas Initially in Place, TRR = Technically Rec. Resources, ERR = Economically Rec. Resources, CO2 = Carbon Dioxide. Tcf = Trillion cubic feet. Bcf = Billion cubic feet. ERR is inclusive of estimated cumulative production through 2012. ERR based on CO2 price of $20 per tonne at the field gate at pipeline pressure and purity.

Conversion factor = 53 million tonnes CO₂ per Tcf
Discovered Subsurface Sources of CO$_2$ in the Contiguous United States
Economically Recoverable Resource (Total 5,100 BmtCO$_2$)
Un-discovered Subsurface Sources of CO$_2$

- A. McElmo
- B. Bravo
- C. St. John
- D. Val Verde
- E. Sheep
- F. Doe Canyon
- G. Oakdale
- H. Big Piney LaBarge
- I. Kevin
- J. Jackson
- K. Escalante
- L. McCallum
- M. Gordon Creek
- N. Valverde thrust
- O. Lincoln County
- P. San Juan
- Q. North Park
- R. Sweetgrass
Figure 3.1.3-20. Map of the Val Verde subbasin specifies the direction of increase in CO$_2$/$^3$He Ratios toward the Marathon fold-thrust belt (black arrows). CO$_2$ gas emplacement precedes CH$_4$ generation according to Ballentine et al., 2001. Contours (4, 30, 50 of 75 percent) added by Enegis, LLC.
Un-discovered Lead: San Juan Basin

Figure 3.3.1-11. Map of CO₂ content in gases from Mississippian reservoirs in the San Juan basin, New Mexico shows the progressive basinward increase in contained CO₂ and He gases (0.1→95.3% CO₂). Figure adapted from Broadhead et al., 2009 (used with permission).
Questions?

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Joseph.dipietro@netl.doe.gov
412 386 5853