Methane to Markets Partnership Expo
30 October – 1 November 2007
Beijing, China

J. Michael Onifer
Senior Vice President Established Business Units
CBM/CMM Extraction:
A Winning Proposition for both Gas and Coal
• Engaged in the exploration, development, and production of natural gas in the Appalachian Basin
• Leading developer of coalbed methane (CBM)
• WWW.CNXGAS.COM
• Safety is our Top Priority

• CNX GAS employees have worked 2,374,604 hours without a lost-time accident
• Last lost-time 06-94
• Contractor I.R. 0.30
• Calendar year 2006 0.20
• One ten month period the contractors worked over 1 million hours without a LTA
Firefighting training
Geographical Location

[Map showing geographical locations with labels for "Exploratory" and "Producing" in the specified region.]
CNX Gas Profile – Oakwood Field

DOE Lists CXG’s Oakwood Field as the 21st largest gas field in the U.S.
• First priority is mine safety
• Key element is open communication between Mine Management and CNX GAS personnel
• Strategic location of frac wells and gob wells
• Continuous monitoring of the bleeder check points underground
Advance degasification of coal seams has the following benefits:

– Improved mine safety
– Improved mine productivity
– Generates additional revenue
– Significantly reduces methane emissions (greenhouse gas) into the environment
CBM Production Methods

- Frac Wells – Vertical Degasification
- Horizontal “short holes”
- Horizontal “long holes”
- Gob Wells
- Sealed Gob Wells
Mix of Production

• Frac Production – 1,459 wells 70%
• In-mine Horizontal 2%
• Active Gob – 184 wells 12%
• Sealed Gob – 552 wells 16%
Southwest Virginia Stratigraphic Section

- Up to 51 Completable Coals Seams or Stringers
- Individual Coal Thickness: 0.5 - 5.5 ft
- Total Completable Coal Thickness: 15 - 40+ ft.
Stratigraphy vs. Average Gas Content
TYPICAL LONGWALL PANEL DEVELOPMENT

- Gob Wells
- Longwall Extraction
- Frac Wells
- Gate Development
- Mining Projections
- Horizontal Drilling (Short Holes)
Vertical Degasification Techniques

GOB Well

Blower

13-3/8” Casing

12-1/4” Open Hole

FRAC Well

7” Casing

4-1/2” Production Casing with Fiberglass Joint

Longwall Mining Equipment

Overlying Coals

Pumping Unit

Pumping Unit
Horizontal Drilling In-Seam Long Holes

- Long hole drilling contracted with REI Drilling
- Drilled depths up to 5,148 feet (1,569 meters)
- 13 producing holes
- 75,327 feet (22,960 meters) drilled
- 1,114,285 mcf produced.
- No negative impact on frac well volumes.
Hole #10 - 4,557’
Hole #9 - 5,148’
Hole #2 - 2,313 ft
Hole #3 - 2,510 ft
Hole #5 - 5,040 ft
Hole #6 - 3,665’
Hole #7 - 4,744’
Hole #8 - 4,112’
Hole #4 - 4,842 ft

VENT SHAFT 9
Surface Elev. 2281.7
Bottom Elev. 462.9
22 ft Diameter
Split Shaft

VENT SHAFT 8
Surface Elev. 1910.0
Bottom Elev. 375.6
28 ft Diameter
Split Shaft

EP CLOSED

Surface Elev. 2494.14
SUR LOC
N 336345.55
E 1010468.67
s. elev. 2489.64
SUR LOC
N 336239.83
E 1008893.47
s. elev. 2489.77
SUR LOC
N 336889.04
E 1007184.94
s. elev. 2294.34
SUR LOC
N 337077.61
E 1002050.81
s. elev. SUR LOC
N 337177.33
E 1003097.07
s. elev. SUR LOC
Typical underground horizontal well set-up
Typical Gob well site

• Booster blower
• Compressor
• Ability to flow into a gathering line or go to vent
• Oxygen measured and relayed back to a command center
• Command center can remotely start and stop blower/compressors and regulate volumes
• Water – gas separator and storage tank on site with high level alarms to command center
• 6-7 holes in the first 1000’ and then 500’ spacing on the panel
• Not uncommon to have 4-5 million per day from the lead gob well.
Gob well blowers and compressors
## Typical Active Gob Quality

<table>
<thead>
<tr>
<th>Component</th>
<th>Mole %</th>
<th>BTU</th>
<th>GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide</td>
<td>0.8267</td>
<td>0.00</td>
<td>0.0000</td>
</tr>
<tr>
<td>Oxygen</td>
<td>1.8806</td>
<td>0.00</td>
<td>0.0000</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>9.2462</td>
<td>0.00</td>
<td>0.0000</td>
</tr>
<tr>
<td>Methane</td>
<td>85.2429</td>
<td>862.95</td>
<td>0.0000</td>
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<tr>
<td>Ethane</td>
<td>2.3527</td>
<td>41.73</td>
<td>0.6288</td>
</tr>
<tr>
<td>Propane</td>
<td>0.4510</td>
<td>11.37</td>
<td>0.1242</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>100.0000</td>
<td>917.78</td>
<td>0.7530</td>
</tr>
</tbody>
</table>

Specific Gravity from Composition  
0.6272

BTUs @ 14.73 Saturated  
901.81

BTUs @ 14.73 Dry  
917.78

Compressibility  
0.99812
Gathering system above the mine
Sealed Gob Well

- Wells found in sealed mines or sealed areas of an active mine
- Physically the same as active gob well
- No wellhead equipment necessary to produce
- A sealed gob well typically produces anywhere from 50,000 cf/day – 70,000 cf/day
- Gas is contaminated primarily with nitrogen and carbon dioxide
# Typical Sealed Gob Quality

<table>
<thead>
<tr>
<th>Component</th>
<th>Mola %</th>
<th>BTU</th>
<th>GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide</td>
<td>2.6134</td>
<td>0.00</td>
<td>0.0000</td>
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<tr>
<td>Oxygen</td>
<td>0.2414</td>
<td>0.00</td>
<td>0.0000</td>
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<tr>
<td>Nitrogen</td>
<td>7.8179</td>
<td>0.00</td>
<td>0.0000</td>
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<tr>
<td>Methane</td>
<td>88.8364</td>
<td>899.32</td>
<td>0.0000</td>
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<tr>
<td>Ethane</td>
<td>0.4122</td>
<td>7.31</td>
<td>0.1102</td>
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<tr>
<td>Propane</td>
<td>0.0788</td>
<td>1.99</td>
<td>0.0217</td>
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<tr>
<td><strong>Totals</strong></td>
<td><strong>100.0000</strong></td>
<td><strong>910.34</strong></td>
<td><strong>0.1319</strong></td>
</tr>
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</table>

Specific Gravity from Composition: 0.6165

BTUs @ 14.73 Saturated: 894.49

BTUs @ 14.73 Dry: 910.34

Compressibility: 0.99812
Remote controlled valves operated from the command center
Gathering System

• Low pressure pipeline – HDPE pipe 4” to 8” in conjunction with 2” water line operating 8 to 22 psi

• Intermediate pressure pipeline – Steel lines with operating pressure of 150 psi

• High Pressure pipeline – Steel lines operating at 650 to 1250 psi
Gathering System

- Cardinal 1 line
  50 miles 16”
  Frac, Horizontal,
  Sealed and Active
  Gob gas

- Cardinal 2 line
  30 miles 20”
  Frac Gas

- Jewell Ridge Line
  30 miles 20”
  Frac Gas
Command Center

- 24/7 operation
- Monitor bleeders in the mine
- Monitor shearer amps on the longwall
- Start and stop compressors remotely
- Monitor gas quality
- Monitor barometric pressure
**Command center control screen**

<table>
<thead>
<tr>
<th>MINE STATION</th>
<th>HOG RIDGE</th>
<th>STATION 1</th>
<th>Station 3</th>
<th>Station 5</th>
<th>Station 7</th>
<th>Thermal Dryer</th>
<th>Geometric RT.83</th>
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<tbody>
<tr>
<td>Flow</td>
<td>44066</td>
<td>3108.91</td>
<td>36923</td>
<td>14305.69</td>
<td>1391.61</td>
<td>3973.43</td>
<td>2581.01</td>
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<tr>
<td>PSIG</td>
<td>703.31</td>
<td>705.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NIT</td>
<td>4.56</td>
<td>6.81</td>
<td>2.48</td>
<td></td>
<td></td>
<td></td>
<td>NIT 5.08</td>
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<tr>
<td>CO2</td>
<td>1.31</td>
<td>1.54</td>
<td>1.03</td>
<td></td>
<td></td>
<td></td>
<td>CO2 1.35</td>
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<tr>
<td>CH4</td>
<td>92.76</td>
<td>88.93</td>
<td>94.19</td>
<td></td>
<td></td>
<td></td>
<td>CH4 91.65</td>
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<tr>
<td>O2</td>
<td>0.39</td>
<td>0.86</td>
<td>0.45</td>
<td></td>
<td></td>
<td></td>
<td>O2 0.4995</td>
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<tr>
<td>H2O</td>
<td>4.71</td>
<td>3.49</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>H2O 2.25</td>
</tr>
</tbody>
</table>

**TOTAL INERTS (ST1 & MINESITE) 7.66**

**COLUMBIA 1 FLOW MMBTU 94899**

**COLUMBIA 2 FLOW MMBTU 52211**

**TOTAL SENT TO GRANT C2 CNX**

\[
\frac{99864.16}{52054.56} = \frac{154499.73}{98984}
\]

**GRANT DISCHARGE TO COLUMBIA FLOW MCF**

**GRANT DISCHARGE TO COLUMBIA PSI**

**GRANT SUCTION PSI**

**CARDINAL LINE VALUE PSI:** 692

**CARDINAL LINE SHUTDOWN:** 715

**TOTAL PRODUCTION**

**NETWORK STATION 1:** NORMAL

**6/24/2004 4:37:59 PM**
Production

- Producing approximately 170 mmcf/d
- Treating 100 mmcf/d
Types of Treatment

- Dehydration
- Oxygen Removal (Platinum Catalyst)
- Carbon Dioxide Removal (Amine)
- Mole Sieve (Nitrogen Rejection)
Gas processing site
Oxygen Removal

- CH4 + O2 + platinum catalyst = CO2 + 2H2O
- 100 MMCFD
- 5,500 ppm inlet oxygen
- 20 – 30 ppm outlet oxygen
- 0.2% increase in CO2
- Exothermic process
- Exchanger used to raise inlet gas to 700 degrees along with a gas heater
- Product gas is saturated after O2 removal
Amine Process

- Method of removing Carbon Dioxide from sealed gob (inactive areas)
- Amine is an alkaline solution that absorbs acidic gas (carbon dioxide)
- Results in increased production from the sealed units without negatively impacting the quality of the product.
- 100 mmcfd capacity unit located at the Grant Process Facility
- On-line January 5th 2004
- System allows collection of future sealed areas
Amine Process

- Inlet CO2 – 1.60%
- After oxygen removal – 1.80%
- Capability to reduce CO2 levels to 3 ppm
- Typical discharge of 0.9%
Nitrogen Rejection Unit

- Englehard Molecular Sieve
- Primary purpose is to remove excess nitrogen
- Nitrogen is an inert gas that needs to be removed from the final product.
- Also removes oxygen and carbon dioxide
- Inlet gas must be dry
### Molecular Gate® Design Material Balance

<table>
<thead>
<tr>
<th></th>
<th>Raw Feed</th>
<th>MG Product</th>
<th>Tail Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow, MM SCFD</td>
<td>1.50</td>
<td>1.13</td>
<td>0.37</td>
</tr>
<tr>
<td>Pressure, psig</td>
<td>110</td>
<td>95</td>
<td>5</td>
</tr>
<tr>
<td>Temperature, F</td>
<td>80</td>
<td>80</td>
<td>150</td>
</tr>
<tr>
<td>Composition, Mole %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>78.60</td>
<td>94.84</td>
<td>28.77</td>
</tr>
<tr>
<td>N2</td>
<td>16.19</td>
<td>4.00</td>
<td>53.58</td>
</tr>
<tr>
<td>CO2</td>
<td>3.20</td>
<td>-</td>
<td>13.03</td>
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<tr>
<td>C2</td>
<td>0.91</td>
<td>0.89</td>
<td>0.98</td>
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<tr>
<td>C3</td>
<td>0.07</td>
<td>0.02</td>
<td>0.23</td>
</tr>
<tr>
<td>O2</td>
<td>1.03</td>
<td>0.25</td>
<td>3.41</td>
</tr>
<tr>
<td>H2O</td>
<td>Dehydrated</td>
<td>Dry</td>
<td>Dry</td>
</tr>
</tbody>
</table>

Product heating value = 974 BTU/ft³
Tail gas heating value = 314 BTU/ft³
The methane recovery rate is 91%.
88 Megawatt Peaker Power Plant