UNCONVENTIONAL NATURAL GAS: INDUSTRY SAVIOR OR BRIDGE?

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UNCONVENTIONAL NATURAL GAS: INDUSTRY SAVIOR OR BRIDGE?

**Not That Kind Of Bridge!**

**Maybe If We Turn Into Wood Chips?**

**Now, That’s More Like It!**
INTRODUCTION

The presentation draws on 30 years of experience in unconventional gas, including a host of resource studies and numerous “on the ground” development projects.

“We were working on unconventional gas before it was respectable to do so.”

The presentation also captures insights from our recent update of the recoverable resources, performance and technology status of significant U.S. unconventional gas plays.
1. BACKGROUND AND PERSPECTIVE

- Why is “unconventional gas” unconventional?
- What is the status of and outlook for unconventional gas in the U.S.?
UNCONVENTIONAL GAS AND RESOURCE PLAYS

TIGHT GAS SANDS
• Continuous Deposition
• Low Permeability
• Both Traditional and "Basin-Center" Settings

COALBED METHANE
• Self-Sourcing Reservoir
• Gas Adsorbed in Coal
• Requires Depressuring and Usually Dewatering

GAS SHALES
• Self-Sourcing Plus Traditional Porosity Reservoirs
• Gas Adsorbed in Organic Matter
• Requires Pervasive Natural Fracture Network

RESOURCE PLAYS
WORKING DEFINITION OF UNCONVENTIONAL RESOURCES

- A Volume of Hydrocarbons Trapped by a Convergence of Several Geologic/Physical Mechanisms
  - Low Matrix Permeabilities (<0.1 md)
  - Abnormal Pressure
- Adsorption Mechanisms
- No Obvious Reservoir Seal

- They Require Changes in Standard Operating Practices
  - Favorable Reservoir Paradigm
  - Wellbore and Completion Designs
  - Well and Formation Testing Procedures

- They Must be Made Economic Through the Efforts of the Operator
OVERTON FIELD, EAST TEXAS
(COTTON VALLEY TIGHT GAS SANDS)

- Reduced drilling time by 50%.
- Increased initial production by three fold.
- Increased EUR per/well by 60%.
UNCONVENTIONAL GAS NOW ACCOUNTS FOR 40% OF U.S. NATURAL GAS PRODUCTION

Source: Conventional/Offshore – EIA Annual Reserve Reports; Unconventional – Advanced Resources International data base.
ALL THREE UNCONVENTIONAL GAS RESOURCES HAVE EXPERIENCED INCREASED PRODUCTION

Source: Advanced Resources International data base.

U.S. Natural Gas Production (Tcf)

<table>
<thead>
<tr>
<th>Resource</th>
<th>2000</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tight Gas Sands</td>
<td>3.5</td>
<td>5.1</td>
</tr>
<tr>
<td>Coalbed Methane</td>
<td>1.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Gas Shales</td>
<td>0.3</td>
<td>0.7</td>
</tr>
</tbody>
</table>
EIGHT OF THE TOP TWELVE U.S. NATURAL GAS FIELDS ARE UNCONVENTIONAL GAS FIELDS

<table>
<thead>
<tr>
<th>Rank (in 2002)</th>
<th>Field Name</th>
<th>Basin/State</th>
<th>Type of Resource</th>
<th>Production (Bcf/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Year 2002</td>
</tr>
<tr>
<td>1</td>
<td>San Juan Gas Area</td>
<td>San Juan, NM/CO</td>
<td>CBM/Tight Gas Sands</td>
<td>3.9</td>
</tr>
<tr>
<td>3</td>
<td>Newark East</td>
<td>Ft. Worth, TX</td>
<td>Gas Shale</td>
<td>0.6</td>
</tr>
<tr>
<td>4</td>
<td>Wyodak/Big George</td>
<td>Powder River, WY</td>
<td>CBM</td>
<td>0.9</td>
</tr>
<tr>
<td>5</td>
<td>Jonah</td>
<td>GGRB, WY</td>
<td>Tight Gas Sands</td>
<td>0.6</td>
</tr>
<tr>
<td>7</td>
<td>Wattenberg/DJ Basin</td>
<td>Denver, CO</td>
<td>Tight Gas Sands</td>
<td>0.5</td>
</tr>
<tr>
<td>9</td>
<td>Carthage</td>
<td>East Texas, TX</td>
<td>Tight Gas Sands</td>
<td>0.5</td>
</tr>
<tr>
<td>10</td>
<td>Antrim</td>
<td>Michigan, MI</td>
<td>Gas Shale</td>
<td>0.5</td>
</tr>
<tr>
<td>11</td>
<td>S. Piceance Gas Area*</td>
<td>Piceance, CO</td>
<td>Tight Gas Sands/CBM</td>
<td>0.3</td>
</tr>
</tbody>
</table>

*Includes Mamm Creek, Rulison, and Grand Valley/Parachute.

Note: Fourteen of the twenty largest gas fields, based on proved reserves, hold unconventional gas.

Sources: EIA 2002/2004 Annual Reserve Reports, Advanced Resources Data Base.
UNCONVENTIONAL GAS RESOURCES

Eight of the top 10 U.S. onshore giant gas discoveries are unconventional

<table>
<thead>
<tr>
<th>Name</th>
<th>EUR (Tcf)</th>
<th>Play Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newark East – Barnett Shale</td>
<td>26.2</td>
<td>Continuous Shale Gas</td>
</tr>
<tr>
<td>Powder River CBM</td>
<td>24.0</td>
<td>Coalbed Methane</td>
</tr>
<tr>
<td>Jonah</td>
<td>3.3</td>
<td>Basin Centered Gas</td>
</tr>
<tr>
<td>Pinedale</td>
<td>2.0</td>
<td>Tight Sands</td>
</tr>
<tr>
<td>Madden Deep (Mostly Conventional)</td>
<td>2.0</td>
<td>Structural</td>
</tr>
<tr>
<td>Vernon</td>
<td>1.8</td>
<td>Tight Sands</td>
</tr>
<tr>
<td>Ferron Coal Play Utah</td>
<td>1.5</td>
<td>Coalbed Methane</td>
</tr>
<tr>
<td>Freshwater Bayou (Conventional)</td>
<td>1.5</td>
<td>Structural</td>
</tr>
<tr>
<td>Dew – Mimms</td>
<td>1.2</td>
<td>Tight Sands</td>
</tr>
<tr>
<td>Bob West</td>
<td>1.1</td>
<td>Structural/Tight Sands</td>
</tr>
</tbody>
</table>

Source: Anadarko, Howard Weil 33rd Annual Energy Conference, April 2005
Currently, unconventional gas, the single largest source of U.S. natural gas production, provides 21 Bcfd (7.5 Tcf per year); its role is expected to grow.
2. UNCONVENTIONAL GAS RESOURCES

- How large is the U.S. recoverable “unconventional gas” resource base?
- Why do resource estimates for unconventional gas change and differ so much?
- Where are the new unconventional gas plays?
HOW LARGE IS THE UNCONVENTIONAL GAS RESOURCE BASE?

We do not yet know the ultimate size or productivity of the unconventional gas resource base.

- Improved geologic knowledge continues to expand its size and add new gas plays.
- Technology progress helps increase recovery from already defined plays.
MAKING UNCONVENTIONAL GAS RESOURCE ESTIMATES IS DIFFICULT

Assessing the size and quality of unconventional gas is a challenge:

- Does not lend itself to finding-rate models
- Does not follow rules of field size distribution or discovery process models
- Requires prudent incorporation of “technology progress” for drilling efficiencies, well costs and reserves per well
- Requires considerable data, acceptance of geologic variability, and numerous “expert judgment” calls.
THE OUTLOOK FOR UNCONVENTIONAL GAS PLAYS CAN CHANGE RAPIDLY

Unconventional gas plays require frequent assessments.

- Some plays, where resource depletion exceeds technology progress, are in decline (e.g., San Juan, Mesaverde tight gas).
- Some plays, where technology progress exceeds resource depletion, are improving in performance and size, (e.g., Piceance Basin, Mesaverde tight gas).
- The plays are prone to rapid and large changes in outlook, performance and costs (e.g., Barnett/Fayetteville gas shales).

Resource estimates for emerging, “high risk-high potential” unconventional gas plays need to be updated every two to three years, not once a decade.
THE ADVANCED RESOURCES’ UNCONVENTIONAL GAS SUPPLY AND TECHNOLOGY MODEL (MUGS)

INTEGRATED ASSESSMENTS OF SUPPLY AND PRODUCTION

Resource Base and Productivity Module

Activity, Production and Reserves Module

Technology Impacts and Timing Module

Drilling and Capital Allocation Module

Costs and Economic Module

Production, Reserve Additions and Reserves Accounting Module

Note: Tracks performance of 84 major unconventional gas plays.
Advanced Resources’ assessments of major unconventional gas basins and plays show twice as much tight gas sands resource and somewhat more CBM and gas shales resource than the NPC or the USGS.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>Proved Reserves (Tcf)</td>
<td>Undeveloped Reserves (Tcf)</td>
<td></td>
</tr>
<tr>
<td>Tight Gas Sands</td>
<td>61</td>
<td>341</td>
<td>175</td>
</tr>
<tr>
<td>Coalbed Methane</td>
<td>19</td>
<td>83</td>
<td>58</td>
</tr>
<tr>
<td>Gas Shales</td>
<td>8</td>
<td>77</td>
<td>35</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>88</strong></td>
<td><strong>501</strong></td>
<td><strong>268</strong></td>
</tr>
</tbody>
</table>

Technically Recoverable Unconventional Gas Resources (U.S. Lower-48)
A significant portion of the unconventional gas reserve and resource is in the Rocky Mountain basins. However, the Gulf Coast and East/Central Texas area, with the Barnett Shale and Bossier tight gas sand plays, has been the fastest growing.

<table>
<thead>
<tr>
<th>Basins/Areas</th>
<th>Tight Gas Sands (Tcf)</th>
<th>Coalbed Methane (Tcf)</th>
<th>Gas Shales (Tcf)</th>
<th>Total (Tcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Rocky Mountain</td>
<td>191</td>
<td>63</td>
<td>12</td>
<td>266</td>
</tr>
<tr>
<td>2 Gulf Coast/E&amp;C Texas</td>
<td>60</td>
<td>5</td>
<td>39</td>
<td>104</td>
</tr>
<tr>
<td>3 Mid-Continent</td>
<td>17</td>
<td>6</td>
<td>-</td>
<td>23</td>
</tr>
<tr>
<td>4 Southwest</td>
<td>9</td>
<td>1</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>5 Other</td>
<td>64</td>
<td>8</td>
<td>26</td>
<td>98</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>341</strong></td>
<td><strong>83</strong></td>
<td><strong>77</strong></td>
<td><strong>501</strong></td>
</tr>
</tbody>
</table>
WHY DO RESOURCE ESTIMATES FOR UNCONVENTIONAL GAS DIFFER?

The Williams Fork/Mesaverde tight gas play in the southern Piceance Basin serves as a “case study” to illustrate why unconventional gas resource assessments differ.

- Grand Valley: 233 Bcfe, 130 MMcfed
- Parachute: 139 Bcfe, 99 MMcfed
- Rulison: 275 Bcfe, 128 MMcfed
- Mamm Creek: 259 Bcfe, 271 MMcfed
- Divide Creek: 65 Bcfe, 2 MMcfed

Source: Petrie Parkman & Co./Bill Barrett Corporation
WHY UNCONVENTIONAL GAS RESOURCE ESTIMATES DIFFER!

Given their “continuous” nature, the size of an unconventional gas play (recoverable resource) is determined by: (1) play area; (2) well spacing; (3) well performance; and, (4) expectations for success.

The Williams Fork (Mesaverde) tight gas play illustrates how moderate differences in assumptions can lead to widely different estimates.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Play Area (mi²)</td>
<td>1,989</td>
<td>1,008</td>
</tr>
<tr>
<td>Developed (%)</td>
<td>3%</td>
<td>4%</td>
</tr>
<tr>
<td>Well Spacing (acres/well)</td>
<td>73</td>
<td>20</td>
</tr>
<tr>
<td>EUR/Well (Bcf)</td>
<td>0.91</td>
<td>1.21</td>
</tr>
<tr>
<td>Success/Availability Factors (%)</td>
<td>20%</td>
<td>83%</td>
</tr>
</tbody>
</table>

RESULTS

| Recoverable Resource (Tcf) | 3.1 | 31.3 |

Advanced Resources International, Inc.
Twenty eight townships (1,008 square miles) exist within the 50+ Bcf per section gas in-place contour for Williams Fork/Mesaverde gas play. The gas in-place is estimated at 100 Tcf inside this contour area.

**GAS IN PLACE AND BASIN /PLAY AREA**

Gas In-Place (Bcf per Section), Williams Fork/Mesaverde, Southern Piceance Basin.
WELL DRAINAGE AND SPACING

Estimates of well drainage (and ultimate well spacing) can be developed from type-curve matching of early time production data once key reservoir properties are established.

RMV 58-20 Log-Log Type Curve Plot.

RMV 58-20 Semilog Type Curve Match.
DEVELOPING UNCONVENTIONAL GAS RESOURCES

Rulison Field Case Study: Piceance Basin, Colorado

Traditional Practices

- 80 Acres/Well Spacing
- 8 Wells/Section, with Old Technology (0.9 Bcf/well)
- 7% Recovery of GIP
- 7 Bcf

Intensive Development

- 20 Acres/Well Spacing
- 32 Wells/Section, with New Technology (1.5 Bcf/well)
- 48% Recovery of GIP
- 48 Bcf

100 Bcf of GIP

93 Bcf (“Stranded”)

52 Bcf (“Stranded”)

Source: Modified from Williams, 2003
TECHNOLOGY PROGRESS AND IMPROVED WELL PERFORMANCE (MAMM CREEK)

Williams Fork Basin-Center Gas Cell

2000’

EUR/Well 0.8 Bcfe 0.6 Bcfe 1.2 Bcfe

Top of Gas Saturation

1994-1999 (Snyder) 1999-2000 (Ballard) Present (EnCana)

Frac Stages

Paludal

Rollins

Modified by Advanced Resources from EnCana, 2005
WHERE ARE THE NEW UNCONVENTIONAL GAS PLAYS?

Gas Shales. Gas shales are currently the “hot new play.” In addition to dramatic growth of the Barnett Shale, Fort Worth Basin, new plays include:

- Fayetteville (Caney), Arkoma Basin
- Woodford, Arkoma/Anadarko Basin
- Mississippian/Devonian, Palo Duro Basin
- Barnett, Permian Basin

Tight Gas Sands. In addition to continued growth in the Rocky Mountains, expanding tight gas plays include:

- Cotton Valley/Bossier, East Texas Basin/North LA
- Red Fork/Cherokee/Atoka, Anadarko Basin

Coalbed Methane. While Powder River and San Juan basins still dominate, new CBM plays include:

- Mid-Continent, Arkoma/Cherokee Basins
- Atlantic Rim, Greater Green River Basin
1. Recently announced Arkoma Basin Mississippian-age gas shale accumulation.

2. Southwestern Energy, the dominant producer in the play, has drilled, completed and placed on production 54 wells (end of 2005) including 13 horizontal wells. Average IP for first 13 horizontal wells is 2.5 MMcfd.

3. Numerous other companies (e.g., Chesapeake, XTO) have established large acreage positions in this play.

Source: Southwest Energy, 2005
BARNETT SHALE, FORT WORTH BASIN

- Assessments of “technically recoverable” resources have grown steadily:
  - 3 Tcf (USGS, 1996)
  - 26 Tcf (USGS, 2004)
  - 39 Tcf (Advanced Resources, 2005)

- Reserves per well in “core” area have steadily improved

- Wells are being drilled on closer and “smarter” spacing

- Micro-seismic mapping providing insights on interactions of hydraulic fracturing with natural fracture systems and stress regimes
In less than five years, Anadarko has established the Bossier tight gas sand play in N. Louisiana as a major “success story”.

**Before (January 2000)**
- 17 Wells
- 7,400 Net Acres
- 8 MMcf/d (Gross)
- 6 MMcf/d (Net)
- 50 Bcf EUR (Gross)

**After (May 2004)**
- 164 Wells
- 116,000 Net Acres
- 250 MMcf/d (Gross)
- 180 MMcf/d (Net)
- 1.4 Tcf EUR (Gross)

Source: Anadarko, 2004
UNCONVENTIONAL NATURAL GAS: INDUSTRY SAVIOR OR BRIDGE?

For some companies, such as Anadarko, EnCana and Southwestern Energy, unconventional gas is more than a bridge, it is their future.

For other companies, such as ExxonMobil and Chevron, for whom this is not a core business, unconventional natural gas is “a bridge to nowhere”.

The unconventional gas resource base is large (+500 Tcf). However, significant advances in E&P technology will be essential for converting this resource into economic reserves, thus building a “Golden Gate” type of bridge.