Impact of Shale Gas

Anchorage, AK
August 5-9, 2013
North Slope Gas & LNG Symposium
Conventional versus Unconventional Resources

1. Unconventional oil and gas are down the resource pyramid – more difficult and expensive
2. Very few, if any, outright dry holes, but many disappointing wells that fail to break even
3. Within an unconventional play, there is enormous variability between winners from losers
4. Operational competence is important but rarely a source of long-term comparative advantage as best practices and technology spread easily
5. Value creation is mostly captured in the initial de-risking phases
6. Unconventional assets are extremely modular – companies can stop and start without impacting project economics
What Is Unconventional Gas?

Cows 520 MMtons
Sheep and Goats 105 MMtons
Chickens 48 MMtons

Resource Pyramid (for minerals)
- Highly concentrated
- Easy extraction/access

Ants 5,000 MMtons

Increasing cost of extraction (including MORE ENERGY)
- Low concentration
- Difficult extraction/access

Better quality resource
Better Technology to the Rescue

The Problem with Ants (and Unconventional Resources):

If you pick them up and eat them one at a time, energy output is greater than input.

The Solution

Horizontal Drilling
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Life Stage and Value Creation Framework
Ingredients of Successful Plays
Skill Sets
Play Reviews
 Plays pass through distinct life stages as they mature.
 Pace of maturation varies tremendously

Life Stages of Unconventional Plays

- **Prove It** (Infancy) ~100 wells
- **Optimize It** (Adolescence) ~1000-1500 wells
- **Standardize It** (Adulthood)
- **Re-invent It** (2nd Career)

**Oily**
- Monterey
- Uinta Tight Oil
- Tuscaloosa
- Cline
- Wolfcamp
- PRB Niobrara
- Smackover
- DJ Niobrara
- Mississippian
- Utica

**Gassy**
- Eagleford Gas
- Marcellus
- Haynesville
- Fayetteville
- Marcellus
- Haynesville

**Bakken**
- Eagleford Oil
- Granite Wash

**Pinedale/ Jonah**
The Game and Its Players

- **Low** Risk
- **High** Risk

- **Low Risk and Cum $$**
- **Value**
- **Cumulative Capex**

- **Window of Max Profits**

- **Prove It**
- **Optimize It**
- **Standardize It**
- **Re-invent It**

- **Private & PE Companies**
- **Small/Mid-Cap Growth Companies**
- **Mid/Large-Cap Independents**
- **Majors and Large Foreign Companies**
- **Mature Field Privates**
- **MLPs**
The Game and Its Players

- Companies have 4 primary levers to pull to improve individual well results.
- When companies achieve these, in early stages, these gains compound, but each tends to reach a plateau eventually.
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Life Stage and Value Creation Framework

Ingredients of Successful Plays

Skill Sets

Play Reviews
Characteristics of Shale/Tight Gas Plays

- Petrophysics means that production is front-loaded
  - Enhances NPV significantly by reducing payout time
- Profile creates treadmill effect, forcing constant reinvestment to avoid decline

- **There is debate about industry estimates of well reserves and life**
- **PFC analysis suggests**
  - Core areas volumes are in line with company claims
  - Different areas within play can diverge sharply
  - Well life should be measured in decades
Three Kinds of Factors Seem Necessary for Success

Macro Enablers

Geo-technical Potential

Pace Accelerants / Retardants
The Top Ten Countries with Largest Shale Gas Resources

While there is a large range in the distribution of shale gas resources among the top ten, no single country is overwhelmingly dominant.
Countries identified by the EIA with the largest unconventional resources vary widely in terms of overall above-ground risk – but those in the top ten for both shale gas and shale oil are mostly found in the top half of the risk range.
Shale gas resources are concentrated in the countries with the most manageable above-ground risk as well as strong infrastructure/service sector capacity. The two main outliers are Argentina and South Africa.
Unconventional Success Has Resulted from a Complex System of Favorable Factors

<table>
<thead>
<tr>
<th>Critical Ingredients of the System</th>
<th>Lwr-48</th>
<th>China</th>
<th>Alaska</th>
<th>Geo-tech</th>
<th>Macro Enabler</th>
<th>Pace Governor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock characteristics/ resource base quality</td>
<td>X</td>
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<td></td>
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<td>X</td>
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<tr>
<td>Resource base quantity</td>
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<tr>
<td>Responsiveness to frack</td>
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<td>Well control</td>
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<tr>
<td>Land Tenure/Parcel Size</td>
<td></td>
<td>X</td>
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<tr>
<td>Local advocates and beneficiaries</td>
<td></td>
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<td>X</td>
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<tr>
<td>Lease structure forcing establishment of production</td>
<td></td>
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<tr>
<td>High number of operators/dispersion</td>
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<tr>
<td>Company ability /willingness to spend significant capital quickly</td>
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<tr>
<td>High company risk appetite for trial and error</td>
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<tr>
<td>Service sector availability</td>
<td></td>
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<tr>
<td>Rapid transmission of learnings via leaky service sector and external company orientation</td>
<td></td>
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<tr>
<td>Pipes, Gathering to allow processing/delivery</td>
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<tr>
<td>Water and other essential frac materials</td>
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<tr>
<td>Skilled oil and gas labor pool</td>
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<tr>
<td>Favorable natural gas prices and available markets</td>
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<tr>
<td>Cooperative governments and incentives</td>
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</tbody>
</table>
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Life Stage and Value Creation Framework
Ingredients of Successful Plays

Skill Sets

Play Reviews
Stage 1: Prove It

- **What is Happening?**
  - Companies proving the reservoir will flow in likely commercial quantities.

- **Major Activities**
  - Geoscience/Basin studies
  - Land acquisition
  - Pilot wells

- **Strategies for Success: Violate the Usual Rules of Oil and Gas**
  - Run a **Science Experiment**
  - Attract other operators
  - Capture acreage even where geo scientists don’t suspect sweet spot
  - Select service sector partner based on science/experience, not cost

- **Key Metrics to Evaluate**
  - $/acre of land acquired
  - Quantity and distribution of leasehold
  - Reservoir information derived from each drilling dollar
Stage 2: Optimize It

- **What is Happening?**
  - Derive the optimal recipe for drilling and fracing wells in this particular play
  - Establish the limits and quality map of the play

- **Major Activities**
  - Try everything
  - Gain scale & scope
  - Ramp drilling/create hubs

- **Strategies for Success: Creative Engineering for Peak Efficiency**
  - Integrate diverse data streams and draw correct conclusions
  - Orient externally: collect and share information and scout heavily
  - Choose multiple service sector companies to maximize creativity

- **Key Metrics to Evaluate**
  - $/acre paid during consolidation of companies w/ weaker results
  - Change in standard deviation of frac techniques and results
  - Slope of IP evolution
Stage 3: Industrialize It

• What is Happening?
  – Play is turned from potential into cash flow by massive investment with cookie cutter approach

• Major Activities
  – Large, steady programs
  – Focus on above ground efficiencies

• Strategies for Success: Standardize to Grind Down Unit Costs
  – Coordinate chain of resources and companies flawlessly
  – Ensure ancillary infrastructure such as midstream and transport
  – Apply no-frills approach to service partners & seek volume discount

• Key Metrics to Evaluate
  – Cost of capital and free cash flow at bottom of cycle
  – Spud to market timing efficiency
  – Speed of convergence vs. peers and predictability of well results
  – Sequential unit cost reduction (opex and capex)
Stage 4: Rethink It

• What is Happening?
  – Rejuvenate the play and manage its operations

• Major Activities
  – Transfer of ownership
  – Choose between three paths
    ▪ Downspace further
    ▪ Rework and refrac
    ▪ Expansion

• Strategies for Success: Sweat the Small Stuff… and Bring Imagination
  – Keep it cheap and focus
  – Leverage existing well bores, infrastructure, and field personnel
  – Find new zones and new technology

• Key Metrics for Investors to Evaluate
  – $/boe attributed to probables and possibles
  – Use of existing wellbores and infrastructure
  – Success rate in finding overlooked sweet spots
  – Change in rate of base decline
What Does It Take to Win?

- All of these athletes won gold medals in London. Guess the sport.

100m Sprint
Marathon
Weightlifting

- If the London gold medal decathllete had entered all the event finals, he would have placed last in 8 and in the bottom half of the other two.
- Retraining is difficult (think Michael Jordan in baseball or Lance Armstrong in the NYC marathon).

Deep excellence comes from thorough-going specialization, but that also shapes the entity in a way that makes it difficult to succeed in a different contest.
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Life Stage and Value Creation Framework
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Play Reviews
Lower 48 Shale Gas is Primary Contributor to Growth

- Marcellus production, primarily in Pennsylvania, is projected to be a key driver of growth in domestic natural gas through 2020.

![Graph showing Lwr-48 Gross Natural Gas Production Estimate](image)
Shales Projected to Grow Market Share Substantially

- By 2020, Shales are projected to source over half of Lower-48 production.
Haynesville Shale Play
### Haynesville: Key Facts

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Life Cycle</strong></td>
<td>Though the Haynesville has a large inventory of wells still to be drilled, low gas prices are not incentivizing operators to return to the play. Thus, though it has quite mature technologically, it may never reach its full potential.</td>
</tr>
<tr>
<td><strong>Well Count</strong></td>
<td>By March of 2013, nearly 3,500 wells were producing from the Haynesville.</td>
</tr>
<tr>
<td><strong>Competitive Landscape</strong></td>
<td>Over 40 operators have producing assets, though the largest six operators hold nearly 50% of the wells</td>
</tr>
<tr>
<td><strong>Oil vs. Gas</strong></td>
<td>Haynesville production is more than 98% gas.</td>
</tr>
<tr>
<td><strong>Sweet Spot</strong></td>
<td>Activity in the sweet spot of the play has nearly exhausted the inventory of best acreage. Given the current pricing environment, focused activity is expected to continue.</td>
</tr>
<tr>
<td><strong>Productivity Distribution</strong></td>
<td>$1^{st}$ quintile wells are 1.5 times as productive as $2^{nd}$ quintile wells and 4.3 times more productive than $5^{th}$ quintile.</td>
</tr>
<tr>
<td><strong>Type Curve Trends</strong></td>
<td>Minor improvements in peak production are still observed, while newer vintage wells outperform older wells nearly 7-to-1 after 12 months (2011 vs. 2007).</td>
</tr>
</tbody>
</table>
Highly Concentrated Area of Peak Productivity
Centralized Activity

- Most efficient wells are concentrated geographically in a very small area in LA. Rock productivity decreases significantly in a radial manner as operators have delineated the expanses of the play.
Peak Gas Production Has Hit Plateau

- Productivity in the play is at best stagnant being that it has not improved and operator results are converging on the plays inherent average. Additionally recent trends have shown operators are high-grading within their individual portfolios which further supports a bearish outlook.

![Diagrams showing average peak mcf/d over years from 2008 to 2012]
Despite operators having determined an optimal lateral length for the play during attractive gas prices. The decline in pricing has seen operators attempt multilaterals as an effort to buoy economic results.
Well Productivity per Lateral Foot is Highly Predictable

- Resulting from longer laterals and stagnant peak rates, peak productivity has slightly declined. Operators are drilling more lower quintile assets showing possible exhaustion of higher quintile sites.
Marcellus Shale Play
## Marcellus: Play Conclusions

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Life Cycle</td>
<td>Developing in two main sub-regions, operators have found their best results in the northeast and southwest extents of Pennsylvania. Though much of the geographical footprint remains undeveloped, the core areas are clearly seeing standardized operations.</td>
</tr>
<tr>
<td>Well Count</td>
<td>The latest data, capturing the majority of the play through the end of 2012, accounted for over 5,600 producing wells.</td>
</tr>
<tr>
<td>Competitive Landscape</td>
<td>130 operators generate volumes from the Marcellus, though only seven operators have more than 200 wells</td>
</tr>
<tr>
<td>Oil vs. Gas</td>
<td>Though some operators have found substantial NGL volumes, Marcellus production is more than 96% gas at the wellhead.</td>
</tr>
<tr>
<td>Sweet Spot</td>
<td>Operators have found the most economic production in the northeast and southwest portions of Pennsylvania.</td>
</tr>
<tr>
<td>Productivity Distribution</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; quintile wells are 2 times as productive as 2&lt;sup&gt;nd&lt;/sup&gt; quintile wells and 8 times more productive than 5&lt;sup&gt;th&lt;/sup&gt; quintile.</td>
</tr>
<tr>
<td>Type Curve Trends</td>
<td>Type curves have shown no meaningful improvements in the past 3 years.</td>
</tr>
</tbody>
</table>
Despite the large areal extent of the play, high quality wells are concentrated in the northeast and southwest regions of the play. Operators continue to delineate the most productive areas of the play, leaving the middle portion of Pennsylvania largely undeveloped.
Marcellus: Peak Gas

- Peak rates have shown incredible consistency since early 2012, though the variance in peaks has increased. Omitting the “super wells”, mainly drilled by Cabot and EQT, the play’s average peak has slightly declined.
Marcellus: Lateral Length

- Though the average lateral length in the play is holding steady, there is still a large variance throughout the play. In northeastern Pennsylvania, lateral lengths average approximately 1,000 feet longer than in the southwestern portion of the play.
Marcellus: Peak/Latft Gas

- The natural result of peak production rates and lateral lengths both holding steady is that peak per lateral foot has been flat as well. Operators have largely delineated and held quality acreage and are content to develop those areas and hope for higher gas prices to justify more exploration.

![Graph showing average peak mcf/d per 1000 lateral feet over years 2009 to 2012.](image-url)
Barnett Shale Play
Barnett: Key Facts

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Life Cycle</td>
<td>The Barnett is well into the optimization phase, and may be experiencing some sweet spot exhaustion. Liquids production in the northern portion counties have breathed new life into the play.</td>
</tr>
<tr>
<td>Well Count</td>
<td>Since 2001, over 17,000 wells have begun production in the play.</td>
</tr>
<tr>
<td>Competitive Landscape</td>
<td>Since 2008, over 130 operators have drilled at least one active well. However, of the 9,000 wells drilled since 2008, Chesapeake, Devon, EOG, and ExxonMobil combine to account for 6,000 of them.</td>
</tr>
<tr>
<td>Oil vs. Gas</td>
<td>Over 91% of the wells in the Barnett produce dry gas (wellhead volumes &gt;90% gas at 6-1 conversion). However, in the northern reaches of the play, liquids production has been increasing.</td>
</tr>
<tr>
<td>Sweet Spot</td>
<td>The sweet spot in parts of Wise, Johnson, and Tarrant counties have seen the most activity, though activity in all three has been decreasing from the peak in 2008.</td>
</tr>
<tr>
<td>Productivity Distribution</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; quintile wells in the Barnett are nearly twice as productive as 2&lt;sup&gt;nd&lt;/sup&gt; quintile wells, and are 8 times as productive as 5&lt;sup&gt;th&lt;/sup&gt; quintile wells.</td>
</tr>
<tr>
<td>Type Curve Trends</td>
<td>2012 was the first year the Barnett type curves did not improve.</td>
</tr>
</tbody>
</table>
Core Located on Eastern Edge of Play, With Productivity Delineations Clearly Visible to the West

- As the oldest unconventional play in the US, the Barnett has seen over 18,000 wells produce volumes. Though overall production has grown, an exhaustion of best drill sites and a reduction in activity point to a possible decline in production.
Peak Production Rates Still Holding Steady

- As operators are unable to drill top producing wells, overall gas productivity has experienced a significant decline in recent years.
Lateral Lengths Continue to Grow, Despite Play’s Age

- Lateral lengths in the play have been trending upwards, as operators seek to generate more production per well bore by drilling larger wells. The current average is nearly 4,000 feet, though some operators have clearly experimented with multi-laterals.
Production per Lateral Foot Falling, Partly Driven by Longer Lateral Lengths

- As operators drill longer laterals with lower peak gas rates, the compounding effect has eroded overall productivity in the play. As sweet-spot exhaustion becomes more of an issue in the play, operators will have to drill a larger number of wells to compensate for lower productivity.
Fayetteville Shale Play
### Fayetteville: Key Facts

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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<tbody>
<tr>
<td>Life Cycle</td>
<td>With the play dominated by one operator, Southwestern, standardized operations have been seen for several years. However, Southwestern appears to have recently ceased acreage holding activities and is now focusing on infill drilling.</td>
</tr>
<tr>
<td>Well Count</td>
<td>5,500 wells currently generate production in the Fayetteville.</td>
</tr>
<tr>
<td>Competitive Landscape</td>
<td>Southwestern rules the play with nearly 60% of producing assets.</td>
</tr>
<tr>
<td>Oil vs. Gas</td>
<td>No liquids are found in the Fayetteville.</td>
</tr>
<tr>
<td>Sweet Spot</td>
<td>Several areas of highly productive rock have been identified, though no core sweet spot has been determined.</td>
</tr>
<tr>
<td>Productivity Distribution</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; quintile wells are 1.5 times more productive than 2&lt;sup&gt;nd&lt;/sup&gt; quintile wells and five times as productive as 5&lt;sup&gt;th&lt;/sup&gt; quintile.</td>
</tr>
<tr>
<td>Type Curve Trends</td>
<td>Type curves have shown no significant improvements since 2010, though if Southwestern’s acreage holding is complete, high-grading is expected.</td>
</tr>
</tbody>
</table>
Fayetteville: Map of Peak/Latft Gas Quintiles

- Southwestern is the dominant asset holder in this play, having actively developed acreage since 2006. As acreage holding activities have largely subsided, Southwestern has been completing infill drilling in their most productive areas.
Fayetteville: Peak Gas

- Operators have shown small but steady improvements in peak gas rates. Additionally, the variance in peak rate is decreasing, implying operators have been at least modestly successful in high-grading efforts.
Fayetteville: Lateral Length

- Given regulatory hurdles to drill across section lines (one square mile), lateral lengths are likely to remain below 5,000’. Operators have pushed that limit and have shown minimal deviations, indicating that under the current regulations, the technical limits of the play have largely been realized.
Fayetteville: Peak/Latft Gas

- Peak productivity has remained predictable, and in much the same as peak rates and lateral lengths, the variability in results has decreased. As Southwestern continues a methodological development of the play, results will maintain their predictability.
Pinedale-Jonah Play
### Pinedale-Jonah: Key Facts

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Life Cycle</td>
<td>The Pinedale has shown steady cumulative growth from 2001. This play is in the re-invent stage of life as operators are testing the limits of infill activity.</td>
</tr>
<tr>
<td>Well Count</td>
<td>3900 wells are currently producing from the Pinedale-Jonah.</td>
</tr>
<tr>
<td>Competitive Landscape</td>
<td>Ultra Petroleum rules the competitive landscape with 40% of 1st quintile wells with premium acreage in the northern part of the play.</td>
</tr>
<tr>
<td>Oil vs. Gas</td>
<td>There is essentially no liquid production from the Pinedale-Jonah.</td>
</tr>
<tr>
<td>Sweet Spot</td>
<td>The northern part of the play encompassing a 90 square mile area is the clear sweet spot in this play with almost ¾ of the 1st quintile wells.</td>
</tr>
<tr>
<td>Productivity Distribution</td>
<td>1st quintile wells are two times more productive than 3rd quintile and 5 times as productive as 5th quintile.</td>
</tr>
<tr>
<td>Type Curve Trends</td>
<td>Decline trends have shown slight increases over the last few years as operators test the technological limits of infill drilling.</td>
</tr>
</tbody>
</table>
The Pinedale field dominates this play with almost 75% of the 1st quintile wells. Ultra Petroleum operates the majority of the Pinedale wells, while Encana is the dominant operator in the Jonah.
Pinedale-Jonah: Peak Gas

- As the play has been experiencing infill drilling, peak rates have slightly declined due to communication and interference between wells. This, combined with low gas prices, has led to a significant reduction in activity in the play.