U.S. Shale Gas: Magical Thinking & The Denial of Uncertainty

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January 9, 2012
Shale Magical Thinking

All difficulties arise from what seems easy. All great things arise from what is minute. One who thinks that everything is easy will encounter much difficulty.

Tao Te Ching

• Less is more: we can produce more oil and gas from shale than was produced from better reservoirs over the past century.
• The United States has enough natural gas to last at least 100 years.
• A shale business model with no barriers to entry except capital, with an infinite supply of cheap gas, and somehow everyone makes a big profit.
• Shale plays can make a profit at less than $5/kcf gas price.
• Gas prices will be low forever because of abundance and low break-even price.
• If shale didn’t make sense, big companies would not be involved.
• Big production volumes prove success.
Natural gas is not as abundant or as inexpensive as commonly believed

- The United States does not have 100 years of natural gas.
- We have less than 22 years of possible reserves.
- Resources are not reserves, and reserves are not supply.
- Shale gas reserves are over-stated by at least 100%.
- The true break-even cost of shale gas is $7/mcf. The price must rise above this cost for companies to survive.
- Production is impressive but most wells are not profitable.
- All plays have contracted to core areas a fraction of the size of the play as originally advertised.
- The shift to liquid-rich shale plays will deflate the gas over-supply and cause prices to rise.
- Environmental problems will limit the contribution of the Marcellus Shale.
The United States has 22 Years of Natural Gas, not 100 Years

<table>
<thead>
<tr>
<th>Potential Gas Committee Category</th>
<th>Tcf Gas</th>
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</thead>
<tbody>
<tr>
<td>Probable resources (current fields)</td>
<td>537</td>
</tr>
<tr>
<td>Probable resources (coal-bed methane)</td>
<td>13</td>
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<tr>
<td>Total Probable</td>
<td>550</td>
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<tr>
<td>Optimistic reserve fraction (50%)</td>
<td>225</td>
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<tr>
<td>Years of supply when drilled &amp; developed</td>
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<tr>
<td>Proved reserves</td>
<td>273</td>
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<tr>
<td>Years of supply when drilled &amp; developed</td>
<td>12</td>
</tr>
<tr>
<td>Maximum years of supply when drilled &amp; developed</td>
<td>22</td>
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</tbody>
</table>

The myth that the U.S. has 100 years of natural gas comes from confusing resources with reserves.
Resources $\neq$ Reserves $\neq$ Supply

- Reserves are a very small sub-set of resources.
- Reserves take years of development drilling to become supply.
- Proved undeveloped reserves may never be developed.
Why Reserves are Over-stated—Decline Rates are Higher than Anticipated

• Annual decline is 44 percent.
• This means that to keep production flat, new wells must be continually drilled.
Cost is Understated: The True Break-Even Price is $7.00/mcf

- Claims of profitability at less than $5.00 /mcfg are based largely on point-forward economics at odds with costs reported to the Securities and Exchange Commission in 10-K filings—all sunk costs written off.
- Price must rise to meet the true break-even cost.
- Several executives have recently said that $6/mcf is a minimum threshold to justify more drilling.
Shale plays have contracted to a fairway or core area: Haynesville Shale example

- The emerging core area includes ~110,000 acres or about 5 Townships.
- This represents approximately 10% of the play area in Louisiana defined by limits of drilling (1.5 million acres or 65 Townships).
- A few years ago, this was promoted as the 4th largest gas field in the world, and the largest in North America.
- It will be approximately 10-15% of what was promised in 2007.

First 6-month cumulative production for Haynesville Shale horizontal wells (with contours). Data source: HPDI
Environmental Concerns

- Regardless of the merit of environmental concerns, perception is everything. Environmental issues will be an obstacle that adds cost and time to shale development.
- The oil & gas industry has always done a poor job of public relations.
- Much of the debate is fueled by other energy interests struggling for market share.
- Earthquakes don’t help.
Can natural gas reduce dependence on foreign oil?

- Natural gas was 25% of U.S. primary energy mix in 2010.
- Shale gas was ~4% of total energy mix—is this really a game-changer?
- Will natural gas eliminate U.S. dependence on foreign oil (Pickens, etc.)?
- 3% of natural gas used for transportation.
- 72% of liquids used for transportation.
- Natural gas and crude oil are used differently & are not interchangeable without massive, long-term equipment changes.
U.S. Shale Gas Magical Thinking: What It Means

• A tremendous amount of capital has been bet on shale and much of this is in the form of debt.
• A new paradigm in land and completion costs has forever changed the domestic E&P business.
• There is very little shale production history so the outcome is uncertain.
• It is unclear that shale gas production will support even short-term expectations of abundance.
• Capital expenditures exceed cash flow for most companies.
• Full-cost and off-book accounting mask the weak performance of most shale-dominated companies.
• There is great uncertainty about reserves, and most are undeveloped.
• Yet, the prevailing view is that success is certain.
• There are considerable risks in magical thinking.
Acknowledgments

• Mike Bodell
• Allen Brooks
• Robert Gray
• Jim Halloran
• Lynn Pittinger
• Keith Shanley
• Shale Gas Producers for Low Heating Bills
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