Shale Gas Is Not A Revolution

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Shale gas is not a revolution. It's just another play with a somewhat higher cost structure but larger resource base than conventional gas.

The marginal cost of shale gas production is $4/mmBtu despite popular but incorrect narratives that it is lower. The average spot price of gas has been $3.77 since shale gas became the sustaining factor in U.S. supply (2009-2017). Medium-term prices should logically average about $4/mmBtu.

A crucial consideration going forward, however, will be the availability of capital. Credit markets have been willing to support unprofitable shale gas drilling since the 2008 Financial Collapse. If that support continues, medium-term prices for gas may be lower, perhaps in the $3.25/mmBtu range. The average spot price for the last seven months has been $3.13.

Gas supply models over the last 50 years have been consistently wrong. Over that period, experts all agreed that existing conditions of abundance or scarcity would define the foreseeable future. That led to billions of dollars of wasted investment on LNG import facilities.

Today, most experts assume that gas abundance and low price will define the next several decades because of shale gas. This had led to massive investment in LNG export facilities. Both the assumption and its investment corollary should be carefully examined through the lens of history.

The Lens of History

The last 40 years have been characterized by two periods of normal gas supply, and two periods of gas-resource scarcity. Supply was tight from 1980 through 1986, and gas prices averaged $5.57/mmBtu (all values in this report are in April 2017 dollars). Normal supply was restored from 1987 through 1999, and gas prices averaged $3.24/mmBtu (Figure 1).

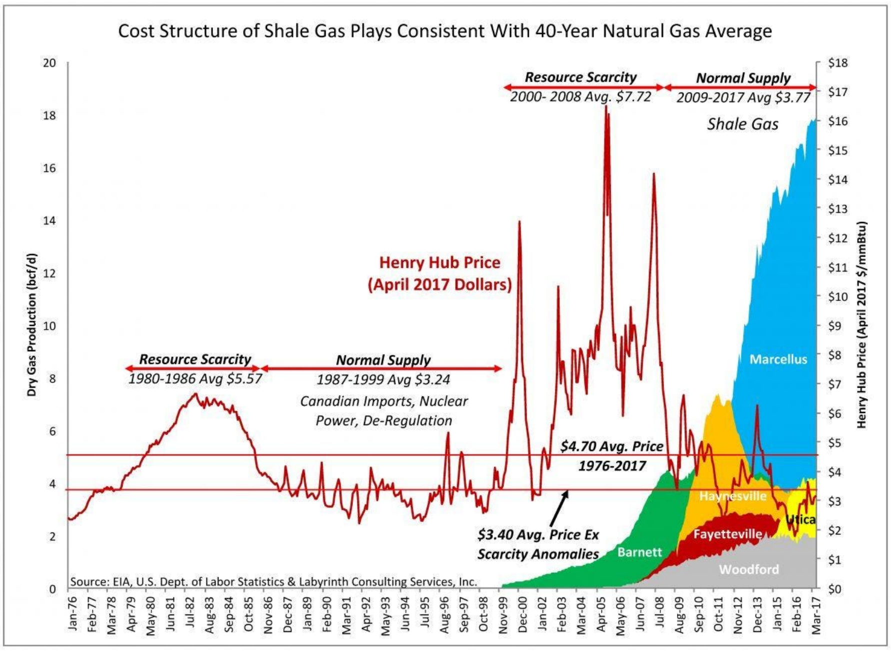

Figure 1. Cost Structure of Shale Gas Plays Consistent With 40-Year Natural Gas Average. Source:... [+]

Scarcity returned from 2000 through 2008, and prices averaged $7.72/mmBtu. Shale gas production began with the Barnett Shale in the 1990s. Development of other shale gas plays culminating in the giant Marcellus completed the return to normal supply. Prices since 2009 have averaged $3.77/mmBtu.

Because prices fell about 50% with growth of shale gas production, many assume that shale gas is low-cost. That is only true compared with the preceding period of high prices that resulted from resource scarcity, but not compared with conventional gas prices during periods of normal supply.

The 40-year average gas price since 1976 has been $4.70/mmBtu. Excluding periods of resource scarcity, it has been $3.40. The average cost of conventional gas from 1987-2000 was $3.42/mmBtu. During the period of shale gas supply dominance (2009-2017), prices have averaged $3.77 (Figure 2).

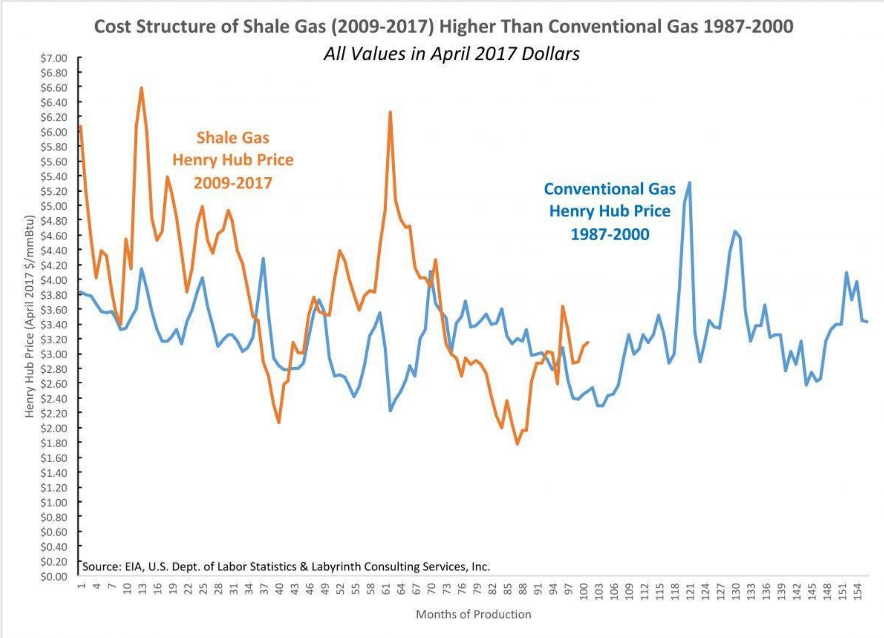

Figure 2. Cost Structure of Shale Gas (2009-2017) Higher Than Conventional Gas 1987-2000. Source:... [+]

Gas Supply Models Consistently Wrong and LNG The Wrong Solution

The lesson from history is that U.S. gas supply is highly uncertain. Normal supply characterized 60% of the period since 1976, but scarcity characterized the remaining 40%. During each episode of either normal or tight supply, experts agreed that existing conditions would define the long-term. They were consistently wrong.

Cheap, regulated natural gas was abundant in the 1950s and 1960s, and most analysts believed that this would be the case for decades. Abundance and low price led to demand growth of 283% (45 bcf/d) between 1950 and 1972 (Figure 3).

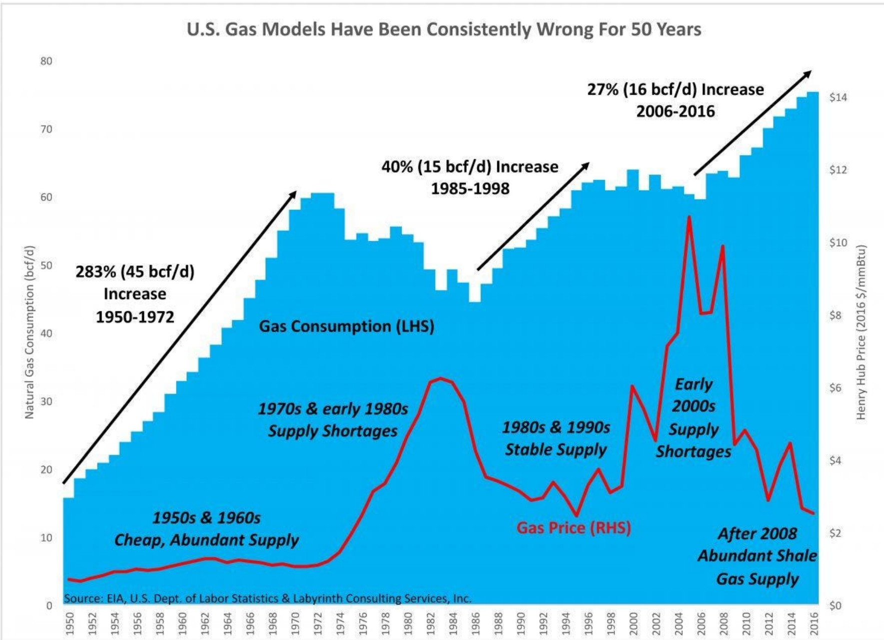

Figure 3. U.S. Gas Models Have Been Consistently Wrong For 50 Years. Source: EIA, U.S. Dept. of... [+]

Supply could not keep pace and there were acute shortages of gas during the winter of 1970. By 1977, shortages had grown to crisis proportions. Few saw this coming partly because of incorrect reserve estimates.

Experts agreed that scarcity would be the case for decades and that imported LNG was the only solution. Four LNG import terminals were built between 1971 and 1980. Limited gas supply led to a golden age of nuclear and coal-fired power plants that largely re-balanced the electricity market. Government subsidies and tax credits provided incentives to evaluate shale gas and coal-bed methane as alternative sources of natural gas.

The 1980s and 1990s were a period of great stability in natural gas prices. Increased pipeline imports from Canada gave the false impression that, once again, there was cheap and abundant natural gas for decades to come. All LNG plants were closed and some were used for gas storage.

Amendments to the Clean Air Act in 1990 caused many power plants to switch to natural gas to replace coal. Demand for natural gas increased 40% (15 bcf/d) but production did not keep pace with demand growth despite increased gas-directed drilling.

Canadian and U.S. gas production peaked in 2001 and by 2003, LNG import terminals were re-opened and capacity was expanded. More than 42 additional import facilities were proposed between 2001-2006. Seven were built. Experts agreed that LNG import was, once again, the only solution to the gas-supply problem.

The first long-lateral horizontal wells were drilled in the Barnett Shale in 2003. By late 2006, shale gas production in the Barnett, Fayetteville and other shale gas plays exceeded 4 bcf/d and confounded not only the U.S. LNG import market but also the global LNG industry that had planned on the U.S. being the market of last resort.

In every supply cycle, major investments in LNG were either undertaken or abandoned. Total installed LNG import capacity reached 18.7 bcf/d but imports averaged only 1.3 bcf/d from 2000-2008 and never exceeded 2.1 bcf/d. That's an average utilization of 7% and a maximum of 11%. The original cost for the terminals was approximately $18 billion. How could industry analysts, company executives and investors get things so wrong?

Now, experts agree that, because of production from shale, gas will be abundant and cheap forever. LNG exports began in early 2016, and the U.S. became a net exporter of gas in April 2017. Seven previously failed import facilities are being converted for LNG export at an anticipated cost of approximately $48 billion. Three other export terminals have been approved by the Department of Energy (Figure 4) and applications for a total of 42 export terminals and capacity expansions have been approved.

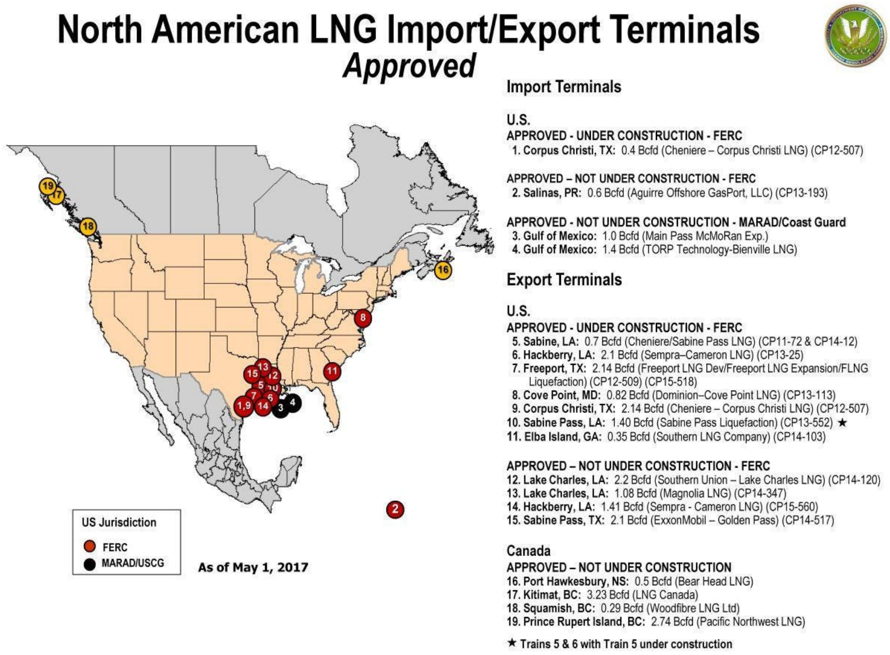

Figure 4. North American LNG Import/Export Terminals Approved.
Source: FERC.

The total of approved export applications amounts to more than 54 bcf/d---75% of U.S. dry gas production. Daily U.S. dry gas production in 2016 was 72 bcf/d. Are we repeating the mistakes of LNG import in reverse?

The Natural Gas Act (1938) states that the Department of Energy should approve an application unless "the proposed exportation or importation will not be consistent with the public interest." It is, therefore, not a question of whether or not to regulate but rather, how to regulate in the public interest. Approving LNG export applications for 75% of U.S. production does not seem to be in the public interest from either a supply security or gas price standpoint.

Shale Gas Marginal Cost

Shale gas producers have been making exaggerated claims about low-cost supply for so long that markets now believe them. Sell-side analysts routinely gush about sub-$3 break-even prices despite corporate income statements and balance sheets that show otherwise. Marcellus leaders Cabot, Range and Antero spent an average of $1.43 for every dollar they earned in 2016; Chesapeake had negative earnings for the year---it couldn't even pay for operating expenses out of revenues *before* capital expenditures and other costs.

Rig count is a direct indicator of how oil and gas producers choose to allocate capital. It is, therefore, a simple way to judge marginal costs by how companies "vote with their feet." Horizontal shale gas rig counts remained fairly flat in 2014 when gas prices fell from more than $6/mmBtu to $4 (Figure 5). Rig counts collapsed, however, when prices fell below $4.

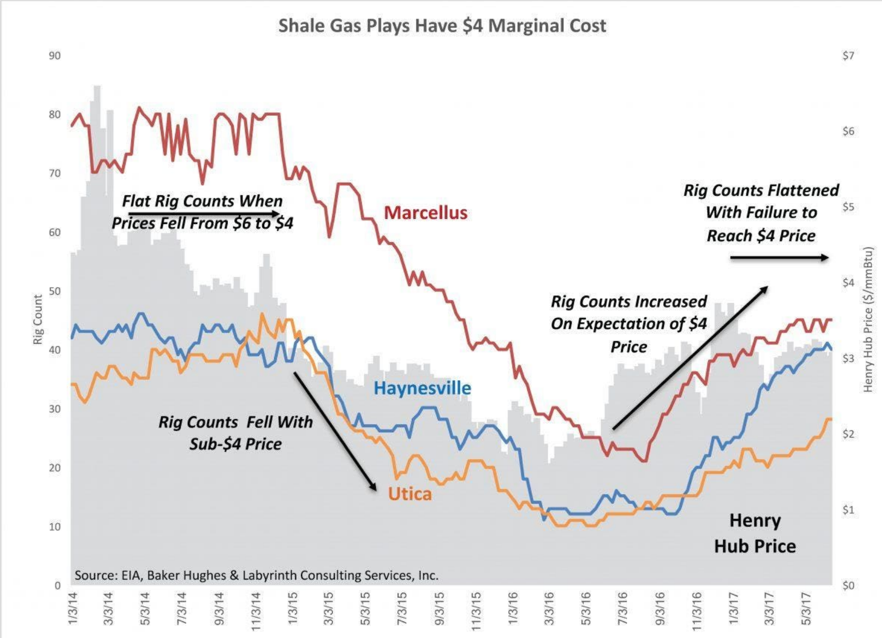

Figure 5. Shale Gas Plays Have $4 Marginal Cost. Source: EIA, Baker Hughes and Labyrinth Consulting... [+]

Gas prices reached a weekly average low price of $1.57/mmBtu in February 2016 and then, rose consistently through the end of 2016. Shale gas rig counts doubled on expectation of $4 gas prices but flattened when prices failed to reach that threshold. The implication is that the marginal cost of shale gas is approximately $4/mmBtu.

The Bearish Scenario

Most gas-market observers anticipate a supply glut and gas-price collapse beginning late in 2017 because of new pipeline take-away capacity from the Marcellus-Utica plays. Associated gas from tight oil plays---the Permian basin in particular---is expected to extend this bearish view some years into the future.

Forward curves reflect this perspective. Their term structure is inverted meaning that near-term futures prices are higher than longer-term prices (Figure 6). Market traders are betting that winter gas prices will peak between $3.25 and $3.50/mmBtu and fall below $3 in early 2018. The volume of contracts beyond May 2018 approaches zero so the picture of worsening prices is speculative even a year into the future.

henry-hub-forward-curves-are-currently-in-the-2-70-3-30-range

Figure 6. Henry Hub Forward Curves Are Currently in the $2.70 to $3.30/mmBtu Range. Source: CME and... [+]

The bearish scenario will be disastrous for producers whose share prices have fallen nearly 30% already in 2017 (Figure 7). Although investors have been willing to fund the unprofitable efforts of these companies for many years, I suspect that their patience is wearing about as thin as it has lately for tight oil.

natural-gas-equity-shares-have-fallen-29-since-january-2017

Figure 7. Natural Gas Equity Shares Have Fallen 29% Since January 2017. Source: Google Finance and... [+]

Some analysts incorrectly believe that shale gas producers have already pushed costs so low through technology and efficiency innovation that sub-$3 gas prices will become the new normal. Although it is true that costs have fallen substantially, this is more because of deflationary pricing by the service industry than because of technology and innovation.

In fact, the technology that enables unconventional oil and gas production resulted in a 4-fold increase in oil and gas drilling costs from 2003 to 2014 (Figure 8). Depressed demand since 2014 has resulted in a 45% reduction in drilling costs and this accounts for most savings.

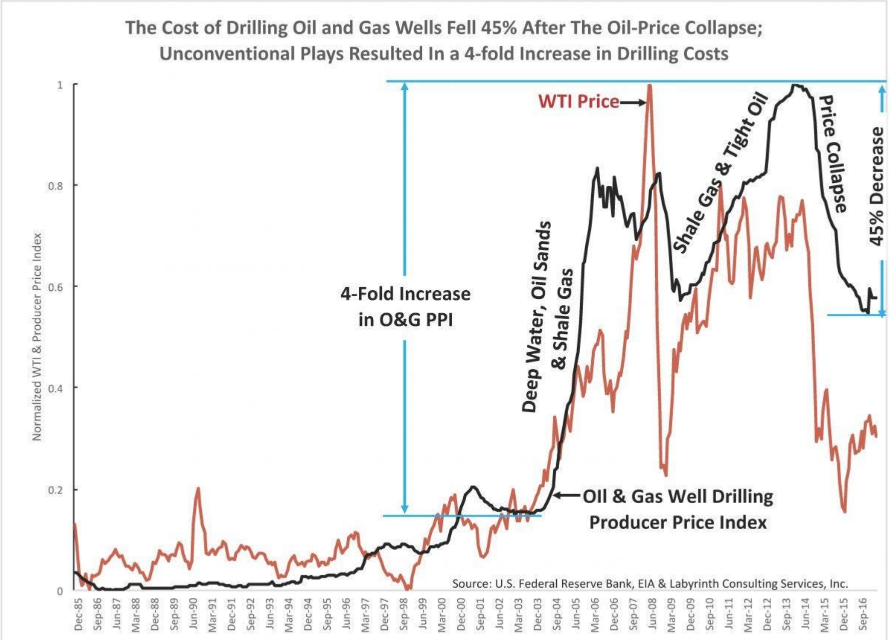

Figure 8. The Cost of Drilling Oil and Gas Wells Fell 45% After The Oil-Price Collapse.... [+]

I have little doubt that there will be downward pressure on gas prices in the near term but do not see how sub-$3 prices *can* become the new normal. Producers have send-or-pay agreements with the pipelines that will carry new supply from the Marcellus and Utica plays. Some of these projects will probably deliver gas to Canada and LNG export markets having limited effect on domestic supply. Similarly, much future Permian basin gas will likely go to Mexico. New supply from the Marcellus and Utica plays will inevitably force gas from higher cost plays out of the market.

New volumes that enter the domestic market must first overcome the present supply deficit (Figure 9). Gas production fell more than 4 bcf/d from February 2016 to January 2017. EIA forecasts that production will increase 4.7 bcf/d in 2017 but only 1.9 bcf/d in 2018. EIA anticipates monthly average prices above $3.00 in 2018 ending the year at $3.66/mmBtu.

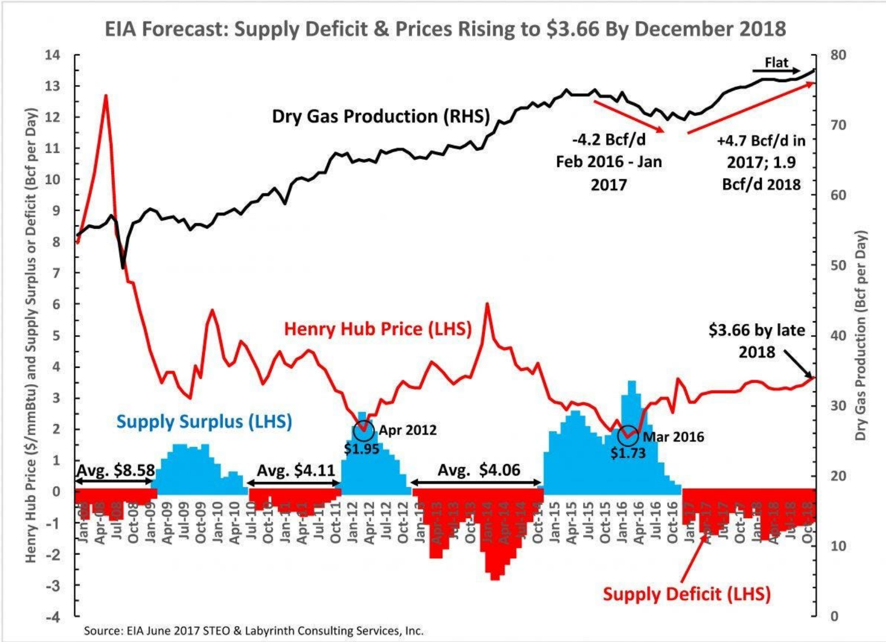

Figure 9. EIA Forecast: Supply Deficit & Prices Rising to $3.66 By December 2018. Source: EIA June... [+]

This is only a forecast and certainly incorrect in its details but EIA's domestic gas forecasts have been notionally reliable over the past several years. Increased consumption and exports should keep supplies relatively tight, and prices reasonably strong.

Broadcast The Boom Boom Boom and Make 'Em All Dance To It

Since the early 2000s, producers and analysts have proclaimed that shale gas is a "game-changing," end of history-type phenomenon. From now on, natural gas will be abundant and cheap. The United States was running out of natural gas before 2009 but now can afford to export to the world. We were lost but now are found.

In late March, Morgan Stanley analysts wrote that Haynesville Shale "break-evens now sit comfortably below $3/MMBtu" and Marcellus-Utica "break-evens range from $1.50 to $2.50/MMBtu." Yet, with average gas prices above $3 for the last 7 months, none of that good news can be found in the balance sheets and income statements of the main producers in those plays.

Shale gas companies spent an average of $1.42 for every dollar they earned in the first quarter of 2017 (Figure 10). That average excludes Gulfport and Chesapeake whose capital expenditure-to-cash flow ratio was 10.7 and 5.4, respectively. *Including* those two operators, companies spent $2.12 for every dollar they earned. It doesn't seem like even $3 gas is working very well.

shale-gas-companies-spent-1-42-for-every-dollar-earned-in-q1-2017

Figure 10. Shale Gas Companies Spent $1.42 For Every Dollar Earned in Q1 2017 Excluding Gulfport and... [+]

Bernstein Research published a report in May ("Inventory a plenty in Appalachia- we estimate at least 20 years of drilling remain") that predicted 19-37 years of Marcellus-Utica "inventory at a steady-state production profile of 36 Bcfd"---current production is about 24 bcf/d. I know of no other oil or gas field in the history of the world with a trajectory of increasing production for so long.

That's because Bernstein has made a technically recoverable *resource estimate* with quite optimistic spacing assumptions.* The report does not tell us anything about gas volumes that are commercial to produce at a some gas price.

To place this and other sell-side reports in context, I re-visited the Bureau of Economic Geology's (BEG) production forecast for the Barnett Shale published in 2013. The BEG study determined individual well *reserves* and economics for 15,000 Barnett wells at $4 gas prices.

Figure 11 shows that actual Barnett production (from Drilling Info) has fallen far short of the BEG forecast and will probably result in much-reduced ultimate recoveries. That is *not* because the BEG study was flawed but because gas prices have been lower than the $4/mmBtu price assumed in their forecast.

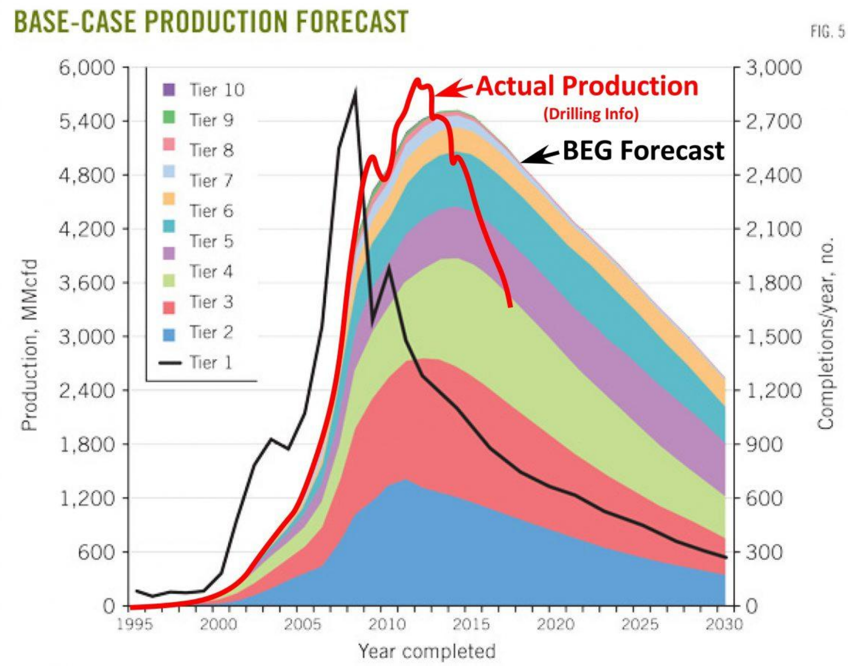

Figure 11. Comparison of Bureau of Economic Geology (BEG) Barnett Shale Production Forecast and... [+]

If Barnett production varies so much from the BEG's scrupulous analysis and forecast, how can we have confidence in less rigorous analyst reports that call for for decades of cheap, abundant shale-gas supply?

The Barnett and Fayetteville shale plays are dead at current prices because their core areas have been fully developed. Rig counts reflect this unavoidable reality (Figure 12). Considerable resources remain but not at sub-$4 gas prices. The Marcellus and Utica will inevitably meet the same fate--all fields do. Higher marginal cost of production outside the core will result in more supply but will also require higher gas prices to develop and produce.

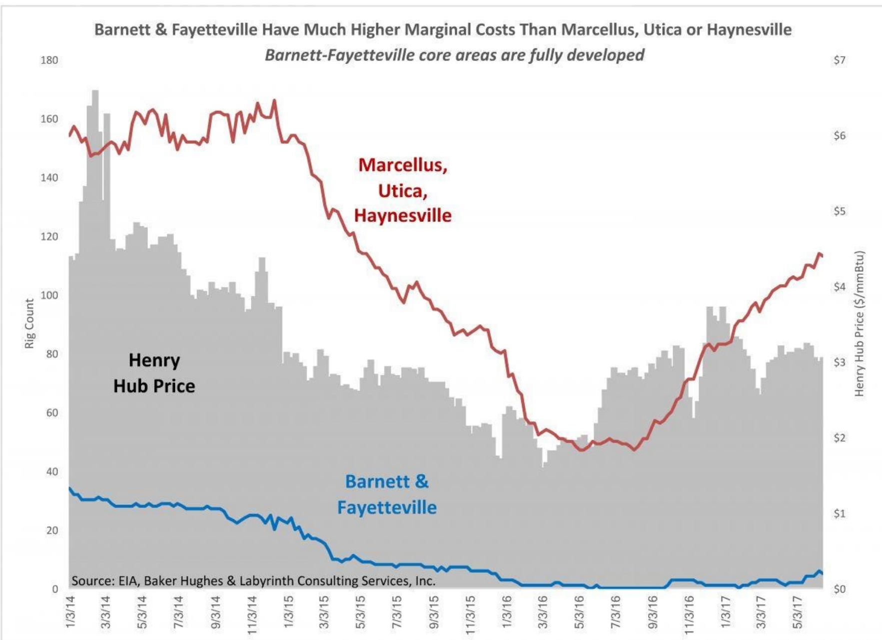

Figure 12. Barnett & Fayetteville Have Much Higher Marginal Costs Than Marcellus, Utica or... [+]

Few analysts seem to consider the economics of shale gas as a limiting factor to output and, therefore, to supply. Perhaps they actually believe the phony economics that lead to supposed break-even prices for the Marcellus and Utica in the $1.50 to $2.00 range.

But price matters and production growth lags price change by approximately 10 months. Gas prices fell below $4 in late 2014, and about 10 months later, production growth slowed from almost 7% to 1% (Figure 13). Gas supply is fairly tight today because year-over-year production growth has been negative for 14 consecutive months.

production-response-lags-price-change-by-10-months

Figure 13. Production Response Lags Price Change by ~10 months.
Source: EIA, U.S. Dept. of Labor... [+]

Gas production has increased since January, and the EIA forecasts that this will continue through 2018. Yet, EIA data also indicates continuing tight supply. That is because demand is increasing while pipeline and LNG exports are increasing.

Most analysts believe that gas prices will collapse in early 2018 as new Marcellus and Utica pipelines bring new supply to market. That may be for the short term but evidence suggests that gas prices will recover and remain fairly strong over the medium term. After one of the mildest winters in history, gas prices remain in the $3.00/mmBtu range and comparative inventories have fallen for 3 consecutive weeks.

Production growth, rig count data and company balance sheets all indicate that the marginal cost of shale gas production is about $4/mmBtu. Yet, most analysts say it isn't so. Gas supply and price models have been consistently wrong for 5 decades. Yet, this time it will be different. LNG import terminals were investment fiascos but LNG export will be a great success.

All ruling theories falter and are replaced by new paradigms. It is unlikely that shale gas will be an exception.

There are wildcards that might prolong the shale gas phenomenon. Increased associated gas from tight oil plays particularly in the Permian basin might provide a few more years of proxy shale gas supply. Today, much of that gas is flared to avoid tie-in and processing expenses. Almost 40% of current Permian gas goes to Mexico, and it is reasonable that more future Permian gas will be exported than face gas-on-gas competition in other regions of the U.S. In addition, optimistic forecasts for Permian gas assume $60/barrel oil prices that now seem increasingly unlikely.

Credit markets are another wildcard. Investors have been willing to look past evidence that shale gas is unprofitable. This is based largely on the expectation that negative cash flow is normal during field development and that profits will come later. The problem with this is that shale gas decline rates average about 30% and capital expenditures never end.

The lens of history places shale gas in its proper perspective. The plays are not lower-cost than conventional gas plays. They are only low-cost compared with higher prices that resulted from depletion of conventional gas plays in the early 2000s.

Shale gas is not a revolution but it bought the U.S. a decade or so of normal supply before facing another period of gas scarcity.

The plays are large but finite, and price matters. The industry has abandoned the early shale gas plays---the Barnett and Fayetteville---because their core areas are fully developed, and the cost to develop marginal resources is higher than it is in the the core areas of the Marcellus and Utica plays.

Those newer plays will follow the same pattern of growth, peak and slow decline as the Barnett and Fayetteville, as all plays have in the long history of the oil and gas industry. The idea that shale plays are somehow different defies the well-established laws of earth physics and depletion.

The shale gas story claims success based on resource size but not reserves. It emphasizes production volumes but not the cost of that production. Its champions focus on the technology that makes the plays possible but not the cost of that technology. Break-even prices are discussed rather than profits because the plays are not profitable. No smart investor puts his money in break-even projects anyway. When economics are addressed, analysts and industry exclude important expenses that we are told are sunk and can, therefore, be ignored.

The shale gas story is accepted because it paints a picture that fulfills aspirations of American energy independence, re-emerging political strength, and economic growth.

If the story is repeated enough, maybe it will become true.

Broadcast the boom, boom, boom and make 'em all dance to it.*

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*Bernstein considers 100-acre spacing *conservative*. Assumed average-well EUR of 17 bcf suggests a much larger drainage area to me and, therefore, full development at a much lower well density than 100-acres per well.

*Lorde, "At The Louvre."

I do not have any investments that are affected by the outcome of shale gas plays.

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Art Berman

I am a petroleum geologist with 42 years of oil and gas industry experience. I am an expert on U.S. shale plays and