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Natural Gas: The Squeeze at the Bottom of the Resource Triangle

Posted by Gail the Actuary on August 29, 2011 - 10:00am
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Tags: natural gas, natural gas price, shale gas [list all tags]

Theoretically, we have a very large amount of resources of many kinds available–oil, natural gas, coal, uranium, gold, fresh water. There is a relatively small amount of high quality, inexpensive-to-extract resources, and we tend to extract those first. From there, we move to lower quality resources that are more expensive to extract. The question comes: How do we reach limits for the extraction of any of the resources?

For oil, I have shown this chart:

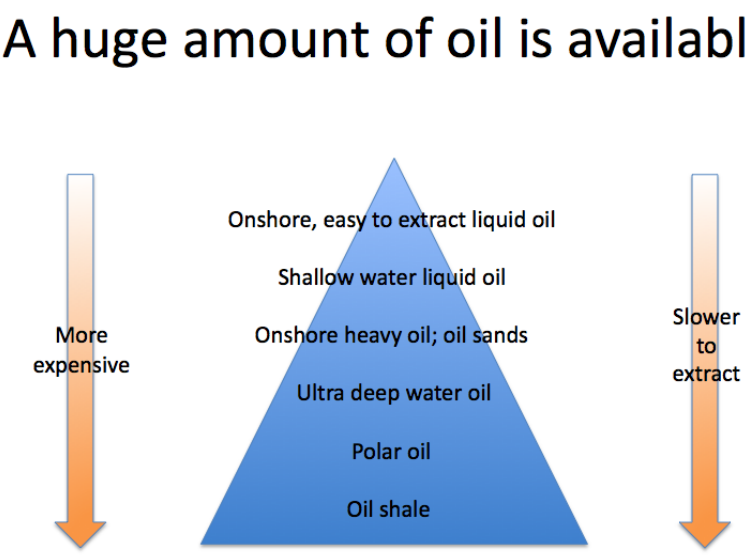

Figure 1. My version of the oil resource triangle.

I recently explained what I think is happening with oil, as we are extracting lower and lower quality resources, in my article Oil Limits, Recession, and Bumping Against the Growth Ceiling. High oil prices are squeezing the economy, leading to recession. I think this squeeze may ultimately lead to serious financial problems and reduced oil production.

In this post, I want to discuss natural gas, instead of oil. Here we are also moving down the resource triangle, getting to lower quality, more difficult to extract resources as well.

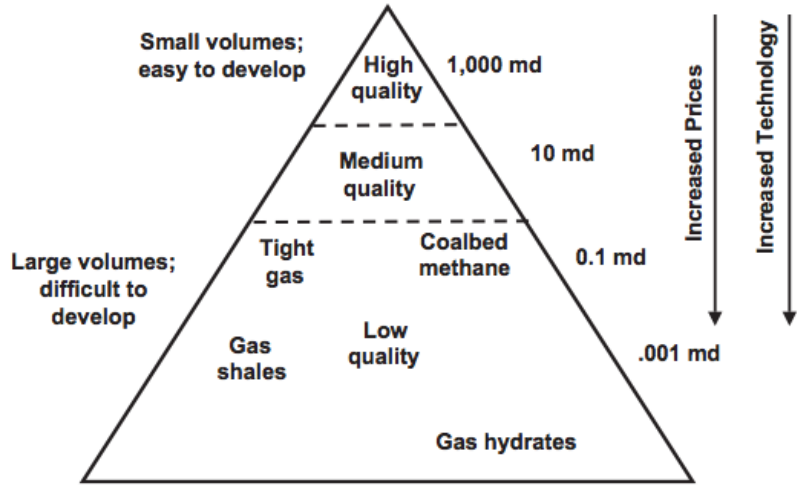

Figure 2. Stephen Holdritch's resource triangle for natural gas

Shale gas is very low on the resource triangle for natural gas, at least according to Stephen Holditch, in a paper authored under the Distinguished Author Series of the Society of Petroleum Engineers. It has even lower permeability (measured in millidarcies or md) than tight gas or coal bed methane.

It seems to me that in the United States we are, or will soon be, reaching a different kind of squeeze at the bottom of the triangle for natural gas–the squeeze of too low prices for shale gas producers to be profitable. If, somehow, natural gas prices do manage to rise sufficiently for the majority of shale gas producers to be profitable, the higher prices are likely to add to the oil's high price squeeze on the economy that I noted in my earlier post.

In this post, I will explain what I see as happening with US natural gas supply and prices, and how this fits in with the natural gas supply controversy we have been reading about in the press recently.

1. The cost of extraction seems likely to increase as we move down the natural gas resource triangle, toward shale gas.

As we move toward more and more difficult to extract natural gas, located in less advantageous locations (next to cities, for example, as compared to in a location with few neighbors) I would expect the cost of extraction to get higher. This higher cost may relate to indirect costs related to extra precautions for protecting the environment in sensitive locations as well as direct costs of extraction.

We know that if we look at US natural gas extraction, the cost per foot drilled rose more than four-fold between 2000 and 2007 (Figure 3), based on EIA data. At least part of the reason for this increase in cost is the greater use of fracking, which is very expensive.

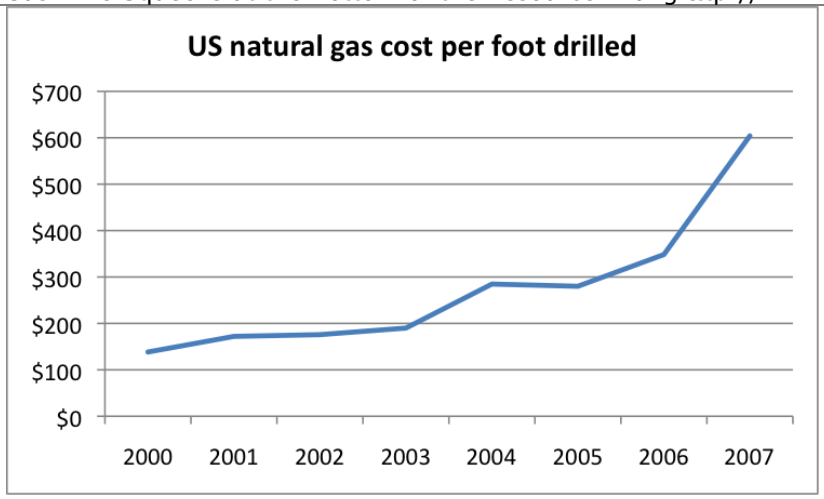

Figure 3. US natural gas cost per foot drilled, based on EIA data.

In Figure 3, the amounts shown are averages for all types of natural gas wells drilled, including those that use little fracking as well as those that use a lot. Shale gas wells use a great deal of fracking, so would be expected to have higher costs than the average per foot drilled. (This is not complete proof that shale gas costs are higher, of course. If the fracked shale gas wells are extremely efficient, the benefit of the new wells could theoretically offset their higher cost.)

2. Part of the current shale gas controversy relates to how high the price of natural gas needs to be for shale gas to be profitable; part of the controversy relates to how much natural gas can be extracted from a given acreage.

There is a great deal of estimation that goes into figuring how profitable shale gas production will be. When a well is drilled, the producer hopes it will continue to produce natural gas for a very long time–30 or 40 years. One question is whether wells will really last that long, and continue to produce enough natural gas to remain economic. Another is whether it is possible to extrapolate favorable results for a few small areas to the entire acreage. It could be that the shale gas is concentrated in sweet spots, and these are drilled first.

A recent analysis by Art Berman and Lynn Pittinger is given in this recent Oil Drum post. According to their calculations, reserves in the aggregate appear to be overstated by more than 100% (suggesting that there is less than half as much natural gas per acre recoverable as what most operators are expecting), and the price needs to be more than double today's price, for shale gas to be profitable.

3. In the US, natural gas prices have been unstable. Current natural gas prices are low (around $4/mcf) in comparison to historical prices.

With oil prices, we are used to oil prices rising, as oil gets harder and harder to extract. This occurs because there is an international market for oil, and so a shortage of oil leads to higher prices for oil, enabling the extraction of lower quality resources (at least until recession sets in, and lowers price, in my view).

With natural gas, in the United States, the situation seems to be different (Figure 4).

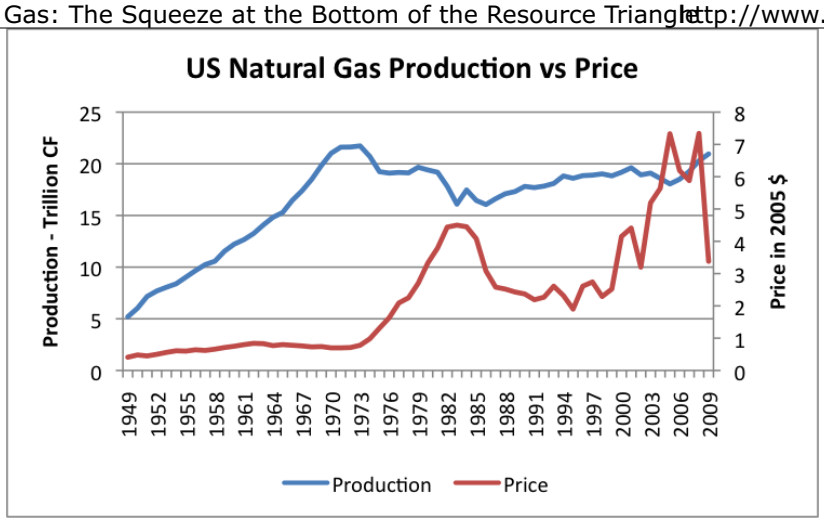

Figure 4. Production versus annual average Henry Hub wellhead price per thousand cubic feet, in 2005$, based on EIA data.

Natural gas prices rise when there is a local shortage (1973-1983 and 2000-2008). But once the amount of gas extracted exceeds the amount that the market requires, prices drop sharply. Prices have been low, roughly in the $4 per thousand cubic feet (abbreviated mcf, where M is the Roman numeral for thousand) range, for about three years now–since late 2008. These low prices are what one would expect when there is an oversupply of natural gas.

The reason why prices drop when there is even a small oversupply of natural gas is because natural gas is difficult to store and transport. Once available storage space is full, there is no place to put the extra natural gas, and so prices can go to $0. Also, it is impossible to ship natural gas to buyers elsewhere in the world unless pipelines or liquified natural gas (LNG) facilities have been built in advance.

Furthermore, shipping natural gas is expensive. For example, one estimate for shipping natural gas by pipeline from Alaska to the 48 states was $2/mcf. If the selling price in the $48 states is only $4/mcf, the high shipping cost means that a producer in Alaska must produce gas for less than $2 /mcf, in order to make a profit, something that would be virtually impossible for most producers to do. Thus, high shipping costs can make long-distrance transport not feasible, unless a high price can be guaranteed in the receiving location, over the long term.

4. There is an un-level playing field in the cost of production of natural gas. The way costs are allocated, some producers can produce natural gas for practically nothing, while the cost of production is much higher for producers who must fully cover their true costs of production.

With oil, where there is a well-developed international market, we often hear, “The Easy Oil is Gone.” Oil companies sought out the cheap-to-extract oil first, and it is generally not available for new extraction. There may be some oil companies that are still extracting “cheap oil,” but if those companies want to find new resources, they pretty much have to go after expensive-to-extract oil.

With natural gas, the situation is different. Natural gas can be produced (1) virtually on its own, as with most shale gas production, or (2) almost as a bi-product of the extraction of oil in an oil field, or of natural gas liquids, in “liquids-rich fields”. When natural gas is produced as a bi-product, producers are often happy with a very low price, since the high price of the oil or natural gas liquids makes extraction profitable overall. Thus, some of today’s natural gas producers are happy with a $4/ mcf price.

The significant difference in the cost structure of production puts high-cost producers at a distinct disadvantage. While others can make an overall profit at a low price, they cannot.

5. Compared to the price of oil, the current price of natural gas in the United States is extremely low.

The price of natural gas now is around $4 /mcf, which is low in relationship to the price of oil. The usual conversion factor (based on equivalent heat energy) makes $ 4 /mcf gas is equivalent to $24 barrel oil, but in my view this is too low. Natural gas is harder to transport and has more distribution costs after it is extracted, so $4 gas is probably more equivalent to $40 barrel oil. But if West Teas Intermediate oil is at $85 a barrel and Brent is at $110 / barrel, the US natural gas price is still very low in comparison, no matter what conversion is used.

6. There is growing uncertainty about the volume of natural gas that is technically recoverable.

The United States Geological Surveys (USGS) recently issued a report on the Marcellus Shale (covering a large part of Pennsylvania, New York, West Virginia, and Tennessee). The USGS said that based on its evaluation, the Marcellus Shale has 89 trillion cubic feet of mean undiscovered natural gas resources. These resources are estimated to be technically recoverable, using currently available technology, but without consideration of price or accessibility or regulatory issues. Actual recoveries are expected to be lower, because some gas will be inaccessible, and because prices may not rise to a high enough level for some extraction.

The new USGS estimate is much higher than its previous estimate of 2 trillion cubic feet of mean undiscoverable resources, but it is not as high as the US Energy Information Administration (EIA) has been using in its estimates of resources available. The EIA had been using information from industry sources to base it future production estimates on. It is now saying that it will use the new USGS estimates in its model, and will sharply downgrade its estimates.

Some estimates in newspapers have claimed that the United States has 100 years of natural gas available. These estimates are based on reports of the Potential Gas Committee and the American Clean Skies Foundation. The Potential Gas Committee gives an estimate of recoverable resources for the Atlantic Region of 353 trillion cubic feet. This is about four times as much as the current USGS estimates for the Marcellus Shale, which would appear to cover a similar region.

We can't know without actually doing the extraction how the amounts will actually work out, but this comparison indicates the range of estimates that researchers evaluating resources are coming up with.

7. A major part of the problem in getting demand for US natural gas to rise (so prices will rise) is the fact that US industrial use of natural gas has been declining for years.

If we look at US natural gas consumption, it has been close to level for many years (Figure 5).

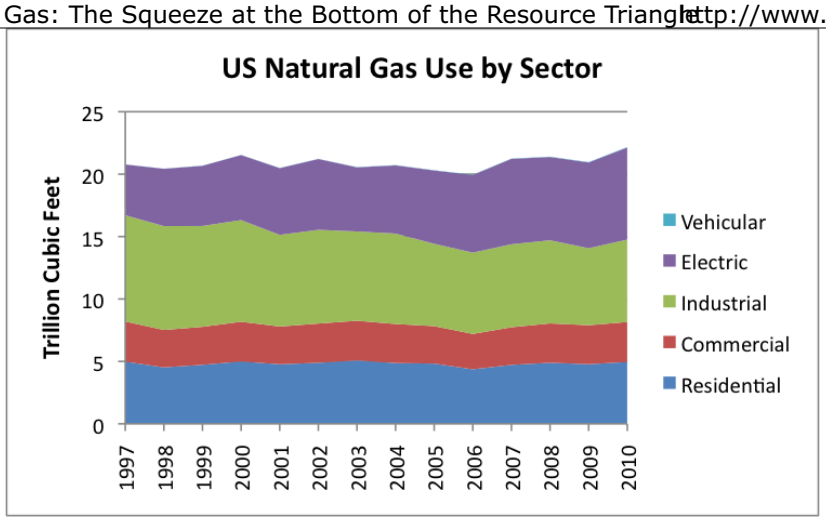

Figure 5. US natural gas use by sector (stacked chart) based on EIA data

What has happened is that over time, industrial use has dropped, partly because of the high price of natural gas in this country, and partly because manufacturing has been moving overseas, where labor is cheaper. Electrical use has risen to offset declining industrial use. Residential and commercial use (both of which are mostly space heating and water heating) have remained virtually flat. Vehicular use of natural gas is so small as to be invisible.

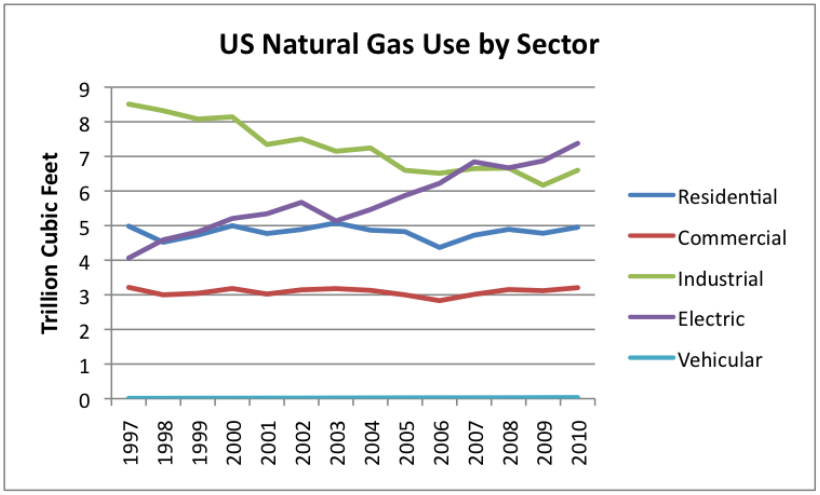

Figure 6. US natural gas use by sector (line graph) based on EIA data.

Figure 6 shows the same data as Figure 5, but as separate lines for the individual components. It may be easier to see the relative sizes and the extent of growth from Figure 6.

Electrical use is probably the easiest way to add use of natural gas, since building gas-fired power plants is relatively quick and inexpensive, and since coal has serious pollution issues. But historically, growth in the use of natural gas for electricity production has not been enough to raise total natural gas use because of the offsetting contraction of industrial use.

One advantage natural gas has had in the recent past has been its low price. At $4 /mcf, natural gas has also been cheaper than coal or wind for producing electricity. If the price of natural gas should double, there would likely be a price incentive to switch from natural gas back to coal.

Creating an increase in the industrial use of natural gas is likely to be difficult, unless the US economy is growing more than it is now, and unless potential users can be convinced that natural gas prices are likely to stay low for an extended period. There is also the wage difference, relative

to emerging markets, to overcome.

Adding more commercial and residential use of natural gas would require changing things in such a way that some people who are currently using heating oil or propane could substitute natural gas for their current fuel source. In order for this to happen, three things would have to take place:

1. Additional pipelines to homes and businesses would need to be built, and as well as pipelines connecting these lines to major pipelines.
2. Additional caverns for storage of natural gas would need to be added, so as to have to be able to store natural gas pumped in summer for winter use.
3. The people who currently have propane or heating oil furnaces would need to replace them with natural gas furnaces.

Given the cost and difficulties involved in making such a change, such a change is likely to take place slowly, if at all. More efficient furnaces and greater use of insulation are likely to have an offsetting impact, keeping total demand growth low for residential and commercial users in the future.

One possible source of growth in the use of natural gas would seem to be in the use of natural gas for vehicles, especially for vehicles like delivery vans and city busses that operate from a central location where they always do their refueling. Adding individual automobiles running on natural gas would be more difficult, since it would require adding a refueling network as well.

If we do convert many vehicles to natural gas, we will want to keep a close eye on the total amount of natural gas that is truly available. If in a few years we start running short of natural gas, we could find ourselves with a shortfall of natural gas both for electricity production and for vehicle fuel use.

8. Another situation which contributes to the oversupply of natural gas relative to demand is use-it-or-lose-it drilling rules.

The way natural gas leases work is that companies pay upfront fees, plus ongoing rental fees for leases of a specified term. Once companies have a lease, they effectively have no choice but to produce natural gas immediately from the property (or lose their initial investment, with no return). This means that companies tend to produce natural gas, even when prices are too low to cover their up front cost of investment.

Instead of looking at total profitability, what companies tend to look at when making a go/ non go decision regarding whether to drill (or to keep producing) is simply a comparison of future revenue compared to future costs (ignoring their sunk costs). Because many costs are front-ended, this means that low natural gas prices do not lead to a shut down in production of shale gas production, or for that matter, most any other kind of natural gas production, unless prices are extremely low. Thus, natural gas supply tends not to respond very quickly to low demand expressed as low price.

9. The way natural gas reserves are counted seems overly generous in oil company financial statements.

Oil and gas companies are concerned with "replacing their reserves" each year. In recent years, it has been getting more and more difficult to find locations where oil might be produced in the future, at reasonable cost, so companies are finding it more difficult to replace their oil reserves.

The way oil companies recently seem to be getting around this difficulty is by buying natural gas-producing companies, so that new reserves include a higher proportion of natural gas reserves,

instead of oil reserves. The way that reserves are calculated is in terms of "barrels of oil equivalent," using a conversion in which 6000 cubic feet of natural gas is equivalent to one barrel of oil.

The thing that seems strange to me about this conversion is that value of the natural gas reserves is far lower than the value of the oil reserves they replace. An mcf of gas produces roughly 1/6 of the heating value of oil, so 6,000 cubic feet of natural gas are worth about 6 x $4 = $24, while a barrel of oil is worth something in the $85 to $110 range. Even if natural gas prices were not at their current very low level, the conversion factor would seem to be overly generous.

10. The situation in other countries is likely to be different.

The situation I have described relates to the United States. Eurasia is different, because Russia is a major producer, and a major trans-shipper, so can hold back natural gas (and not import gas) to produce the price it desires. The Far East is different, because rising demand from China and other emerging market nations tends to keep demand very high. Also, other countries of the world have not yet begun producing shale gas, to nearly the extent the United States does, so differences in cost levels may not be as much of an issue.

Over time, international trade may even out differences between countries. But for right now, the United States seems to have a tendency toward too low a natural gas price, relative to what appears to be the cost of production for some producers.

This article originally appeared on Our Finite World.