The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Is "shale oil" the answer to "peak oil"?

Posted by Gail the Actuary on March 4, 2011 - 10:56am

Readers have been asking questions about a couple of shale oil articles recently. One is an AP article called New drilling method opens vast oil fields in US. A similar article is a CNBC article titled Massive New US Oil Supply – 'Peak Oil' Fears Overblown? Both of these articles talk about the extraction of shale oil in the Bakken and other locations, using horizontal wells and hydraulic fracturing.

According to the AP article:

> Companies are investing billions of dollars to get at oil deposits scattered across North Dakota, Colorado, Texas and California. By 2015, oil executives and analysts say, the new fields could yield as much as 2 million barrels of oil a day — more than the entire Gulf of Mexico produces now.
>
> This new drilling is expected to raise U.S. production by at least 20 percent over the next five years. And within 10 years, it could help reduce oil imports by more than half, advancing a goal that has long eluded policymakers.

There are several questions that might be asked:

1. Is this really a new drilling technique?

2. How likely is the 2 million barrels a day of new production, and the 20% increase in US production, by 2015?

3. Can this additional oil supply really reduce the US's imports by over half?

4. How much of a difference will this oil make to "peak oil"?

Let's take the questions in order.

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1. Is this really a new drilling technique?

No., this is not really a new drilling technique. According to Wikipedia, hydraulic fracturing was first used in the United States for stimulating oil and gas wells in 1947. It was first used commercially in 1949. Directional drilling, including horizontal drilling is almost as old, but it was not widely used until down-hole motors and semicontinuous surveying became possible. The techniques have gradually been refined, as oil and gas companies have used them more and supporting technologies have been better developed.

A major reason we are using these techniques is because much of the easy-to-extract oil has already been extracted. Horizontal drilling and hydraulic fracturing are more expensive, but can

be used to get out oil that would be inaccessible otherwise. The hope is that oil prices will be high enough to make these techniques profitable.

2. How likely is the 2 million barrels a day of new production, and the 20% increase in US production, by 2015?

That is a good question. There is certainly a lot of drilling for oil being done now. According to Baker Hughes, 805 rigs are now involved in oil drilling. This is above the oil rig high point in 1987. (Natural gas rig counts are down recently, so much of this rig count increase seems to represent a re-purposing of rigs.)

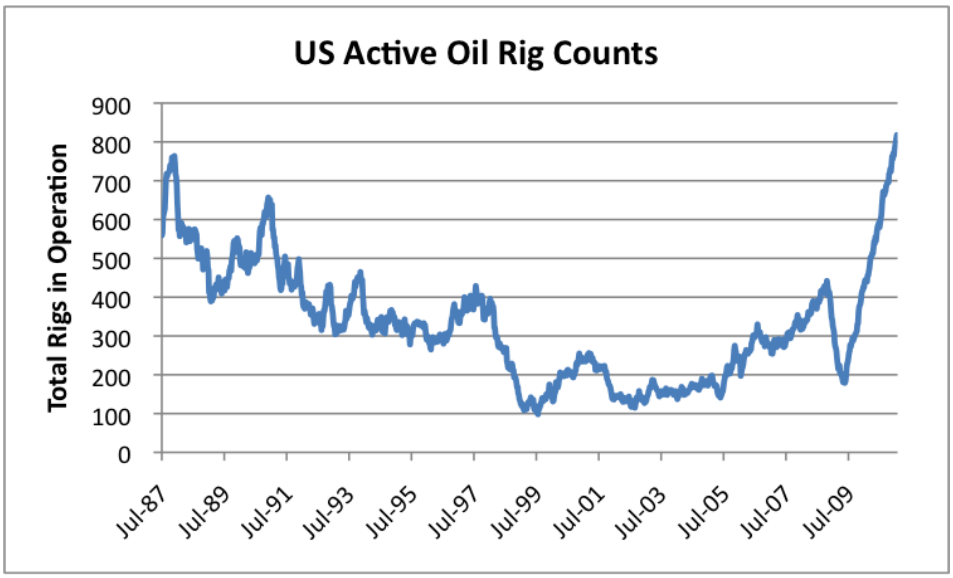

Figure 1. US Active rigs engaged in oil drilling, according to Baker Hughes.

Active rigs in North Dakota have also increased greatly. (These rigs are include both oil and natural gas, but with the Bakken and Three Forks-Sanish plays in North Dakota, it seems as though most would be oil rigs.)

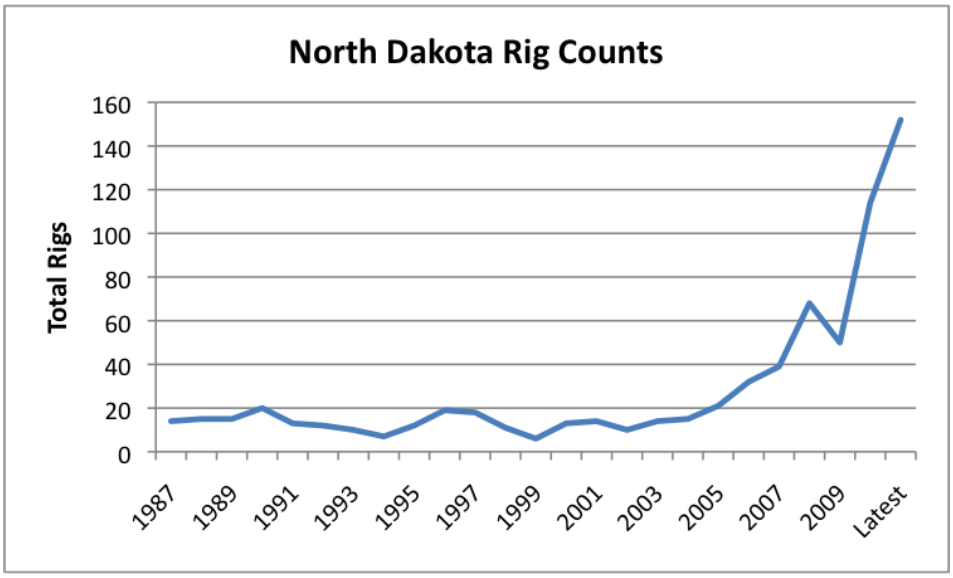

Figure 2. Active drilling rigs in North Dakota, according to Baker Hughes.

There are several reasons why the hoped for increase might not be realized, however. These

include:

Inadequate infrastructure. One question is whether inadequate infrastructure will prove to be a roadblock to meeting ambitious production goals in five to 10 years. The AP article quoted above mentions that currently oil is being transported to market by rail and truck, and drilling companies have erected camps for workers. If infrastructure problems are already being reached, before the ramp-up really takes place, a person wonders how much of an obstacle these considerations will be in the future.

Inadequate price. What tends to happen when there isn't adequate transportation for the oil is the selling price of the oil tends to be depressed, relative to other types. As of February 8, the spot price for Brent was $99.25; the spot price for West Texas Intermediate (WTI) was $85.85, and the spot price for North Dakota Sweet was $65.61. The target discount rate relative to WTI is quoted as being 10% (because it is a light oil), but the actual price seems to be much lower.

It is easy for operators to assume that the price differential will get better, and also that the prices of other types of oil will continue to rise. But all of these things are by no means certain. High oil prices tend to send the economy into recession, so world prices may not rise as much as hoped–they may oscillate instead, rising, then putting the economy into recession and falling again. Also the differential of North Dakota types of crude to Brent may stay low for an extended period, if infrastructure issues cannot be worked out.

Optimism before drilling. There are many unknowns before drilling including how quickly oil production from individual wells will decline, how long wells will prove to be economic, what proportion of wells will have high production, and the level of oil and gas prices in the future. It is natural for those who are trying to get others to invest in these ventures to base their assumptions on an optimistic view of the future. If experience with **shale gas** in Texas is any clue, once realities start setting in, the level of drilling may decline, and overall production, after an initial run-up, may decline. If this happens, it will be very difficult to meet the ambitious goals presented.

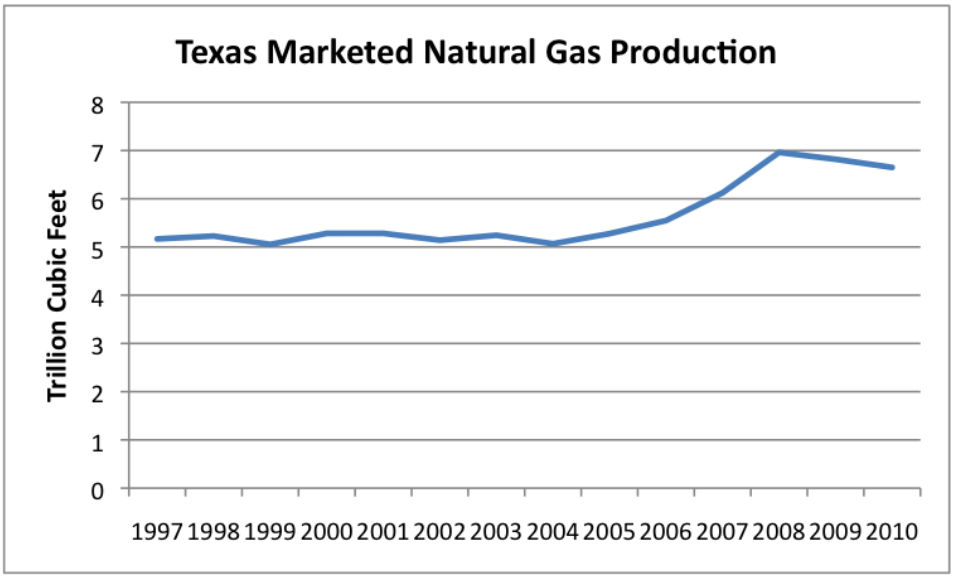

Figure 3. Texas natural gas marketed production based on EIA data. 2010 estimated based on Jan-Nov actual data.

Large amount of increase required. If we look at a graph of countrywide US oil production, it has been decreasing prior to an uptick in 2009 and 2010. Bakken oil production (in ND +MT) is shown near the bottom of Figure 4. It appears as a thin blue line that was a bit thicker back in the

late 1980s, became thinner for many years, and now is a bit thicker (reaching an average of about 370,000 barrels a day in 2010). Getting that line, or that line plus some other areas that are only starting up, to increase by 2 million barrels a day, to 2,370,000 per day by 2015, would be a tall order.

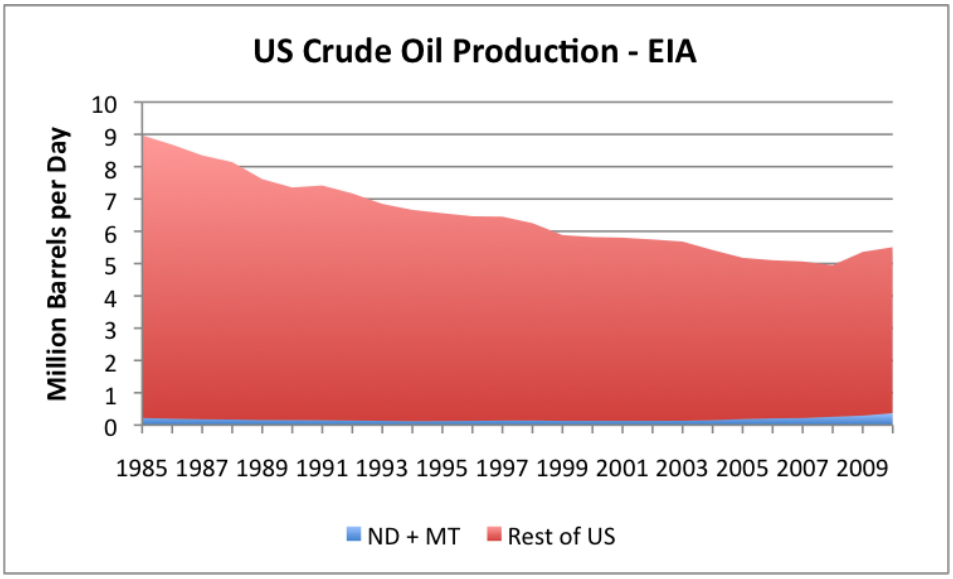

Figure 4. US crude oil production, with North Dakota and Montana production separated out.

Likely other declines at same time. US crude oil production has been headed downward for a long time–actually since 1970, not just since 1985 shown on the graph Figure 4. If overall production is to be increases by 2 million barrels a day by 2015, it will be necessary to overcome these declines, as well as add 2 million barrels a day of new production. What happens is that each year, more and more oil fields and oil wells within oil fields become non-economic. These are closed. Also, what is extracted is an oil-water mix, and the proportion of oil tends to fall over time. This means that if a given volume of oil-water mix is processed from a well, each year the well will yield less oil and more water.

There has been discussion of raising taxes on oil companies. Raising taxes on oil companies tends to raise the number of wells that are non-economic.

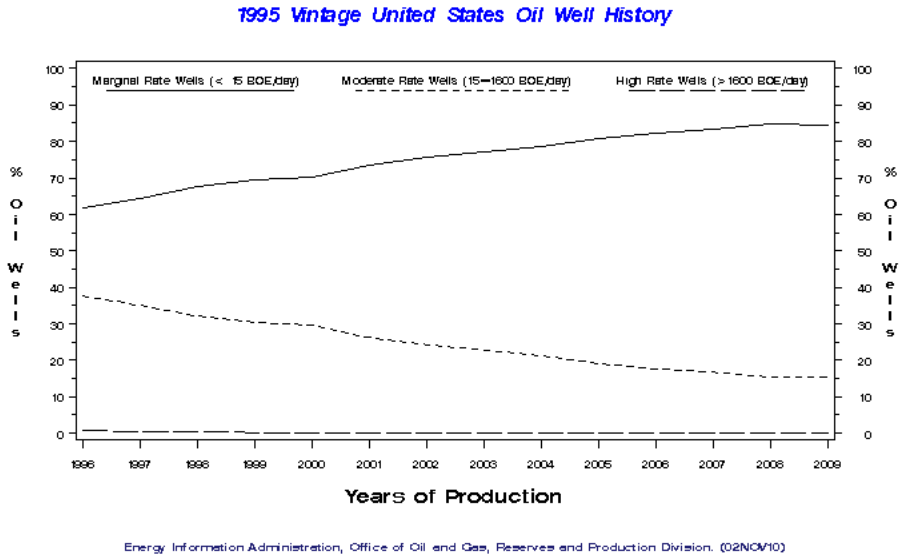

Figure 5. EIA graph of US wells by production grouping.

According to Figure 5, about 85% of US wells are now producing less than 15 barrels a day, and about 15% of wells are moderate rate wells, producing 15 to 1,600 barrels of oil equivalent a day. Only a small percentage are high rate wells. If tax rates increase, some of them will be closed. New wells will also become less economic, and some wells will not be drilled that would otherwise be drilled. So a person would expect an increase in taxes on oil companies to result in a step down in existing production. Many of the oil companies affected will be small–their only business may be a few wells producing less than 15 barrels a day. The amount of oil produced by so-called stripper wells is about 900,000 barrels a day.

Another area where there is risk of decline is Alaska. The Trans-Alaska Pipeline System is suffering from issues related to low flow and corrosion. Major upgrades to the system may be needed, including heating the line, to keep it operational. At some point, the amount of "fixes" to the Alaska pipeline will exceed the value to be gained from shipping the oil, and the whole system may need to be closed because of low flow. The current flow through the pipeline is 640,000 barrels a day.

3. Can this additional oil supply really reduce the US's imports by over half, in ten years?

US oil consumption reached its maximum level in 2005. Figure 5 shows a breakdown into its major components.

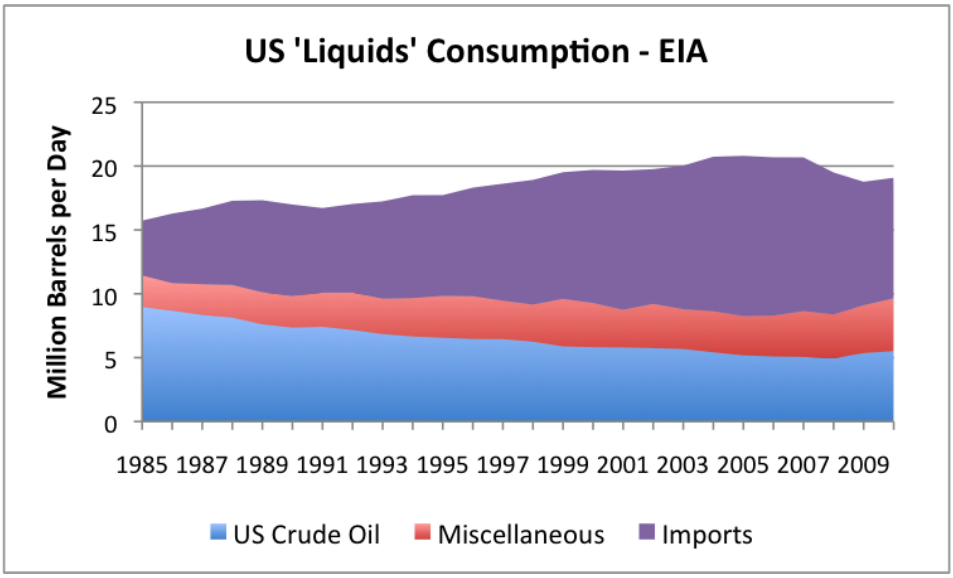

Figure 6. US liquids consumed, divided into crude oil, net imports, and miscellaneous

The crude layer in blue is the same countrywide crude oil production as shown in Figure 4. The purple layer on the top is imports (minus exports), so net imports, based on EIA data. The layer I have called miscellaneous is everything else that goes into what is reported as "liquids." Recently, the miscellaneous category has been about one-half natural gas liquids, one-quarter ethanol, and one-quarter "refinery gain"–that is the expansion that occurs when the US refines crude oil. The "miscellaneous" items are products that provide less energy per barrel than oil. Many people believe that these additional items have been included in "liquids" figures to make US oil production look like it is performing better than it really is.

Natural gas liquids. I am suspicious that quite a bit of the 2 million barrels a day of additional production by 2015 that is being forecast is not really oil. Instead, I expect it will be natural gas liquids. This currently represents about half of the "miscellaneous" layer in Figure 6. Natural gas liquids (NGLs) include propane, butane, and other gasses. It may very well that much of the

recent increase in "oil" drilling rigs is, in fact, primarily for NGLs, since there has been a great deal of recent interest in liquids-rich gasses. In fact, some articles talk about the possibility of falling prices for NGLs, because of a possible supply-demand imbalance, if production of these ramps up.

An increase in NGLs would be of lesser benefit than oil, because it is not directly substitutable for oil, and is a cheaper product. Initially, it would mostly make home heating for those using propane cheaper, but then tend to drive NGL developers out of the market. Unless NGLs can cheaply be converted to higher priced oil products (and refinery capacity can be added quickly to accomplish this), it would seem like a drop in prices would quickly put an end to the NGL ramp-up.

Imports. Figure 7 shows a graph of US net imports–that is the top layer on Figure 6–by themselves. (On all of these graphs, the data for 2010 is through November, but I have estimated December, to give an approximate 2010 value.)

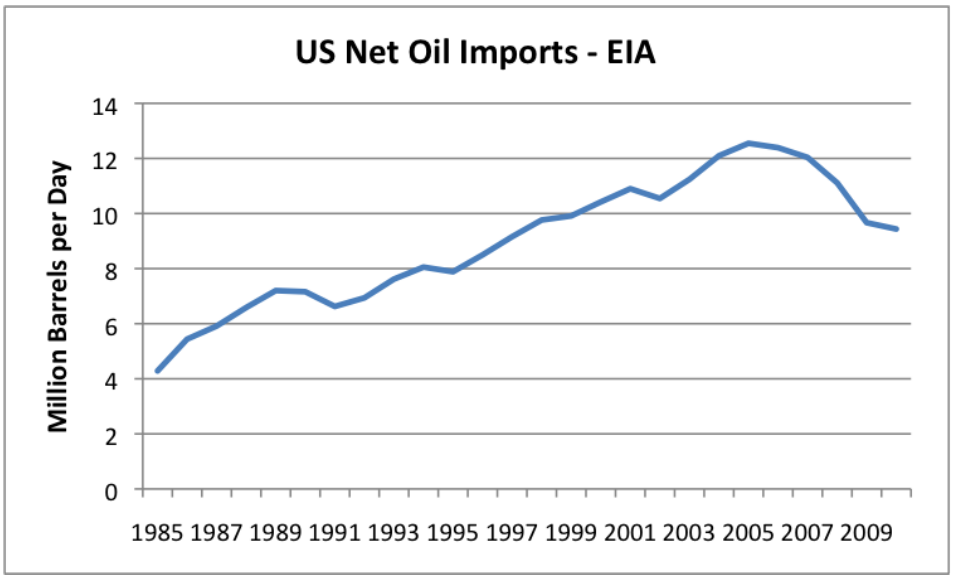

Figure 7. US net oil imports, based on EIA data.

It seems to me that oil imports really depend on what the US can afford for imports–how high the price is, how much oil for export is on the world market (which helps determine the price), and whether the US is in recession because of high oil prices. Oil imports were increasing up until 2005; now they are decreasing. This decrease in oil imports reflects the fact that oil in the world export market peaked in 2005, as much as anything else. High oil prices (and layoffs indirectly related to high oil prices) have made it difficult for people to afford goods and services that require oil in their production (vacation trips, new homes, new cars, many other types of goods). As a result, US demand for oil products has dropped to the point where our imports have dropped each year since 2005.

In my view, if additional US oil is produced, **it actually helps increase US demand for oil products**–in fact for all products. More people are employed, and this puts more money into the economy. It also helps keep world oil prices from escalating as fast as they would otherwise. The net effect is that I would expect higher US oil production to increase US imports (or maybe, keep imports from falling as fast), because they will help keep the US out of recession. I am sure some will disagree with me on this, however.

US oil imports have declined about 25% in the five years since 2005. In the next ten years, I would expect oil imports to continue to decline, regardless of what we do, because the amount of oil on the world market will continue to drop, and oil importers will tend more and more to be in recession. It is not clear how much US oil imports will drop, but a 50% drop in the next 10 years

would not seem all that unlikely, regardless of what we what we produce, because of oil exporting countries will tend to consume more, and more countries will shift from being exporters to importers. We are currently importing 9.4 million barrels a day, so a reduction by half by 2020 would be a reduction of 4.7 million barrels a day.

Responding to the initial assertion that the oil ramp-up will permit a reduction by half of oil imports by 2020. If somehow over the next ten years, we could really produce 4.7 million barrels of *oil* to offset the decline in oil imports that we will likely be losing because of declines in the world export market, that would be wonderful. But at most, what it looks like the author of the AP article is looking for is a mixture of *NGLs and crude oil* that might ramp up to 2 million barrels a day by 2015, and 4.7 million barrels a day by 2020, in addition to compensating for whatever other declines we might be encountering.

If the mixture is heavily NGLs, it seems as though refineries will need to be reconfigured to adjust the NGLs to permit reformation into longer-length chains, to make the NGLs truly substitutable for oil. I do not know how feasible such a step would be, or what the "energy cost" would be. It would really be the net oil addition, after the conversion process, that would be of interest.

4. How much of a difference will this oil make to "peak oil"?

It seems to me that whatever additional oil and NGLs are produced will have a much bigger impact on the US economy than it will have on "peak oil." Adding more energy, if it can be done at a price that is affordable, will be help keep the US out of recession, and thus keep employment up and demand for energy products up.

We have known for a long time that a huge amount of oil is available, in forms that are increasingly difficult to extract. The question, in my view, is how much of this huge amount of oil is economic to extract. This is closely related to Energy Return on Energy Invested (EROEI). At some point, oil becomes too expensive to extract; it just puts the economy into recession, or worse. A schematic diagram of what happens is shown in Figure 8:

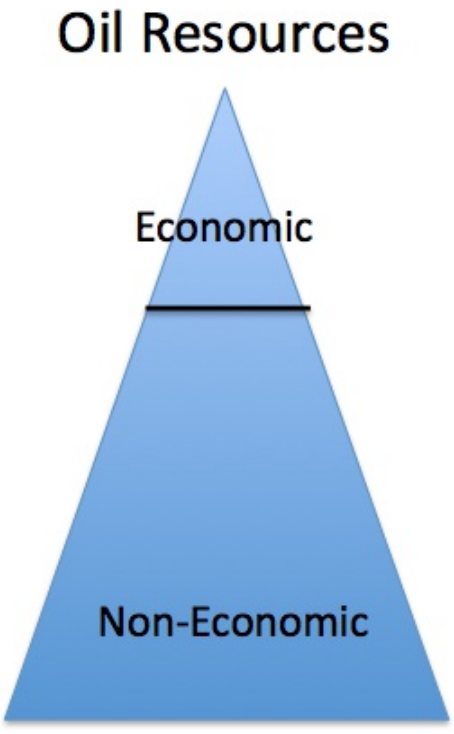

Figure 8. Schematic diagram of economic and non-economic resources

We have known about the Bakken oil shale and the many other shales that have NGLs for a long time. There are also many other types of oil that we know about (such as ultra-deepwater, polar, oil-shale) that are quite expensive to extract, both in terms of price in dollars and in terms of resources required. The resources required are not just the direct resources of drilling–they also include pipelines that might not be used for very many years, and even local refineries, which again might not be used for many years, and training for workers. With respect to NGLs, if they are to be used as "regular" oil, they will need unification, perhaps with catalytic reforming, if they are to be used as longer-chain hydrocarbons, which are the higher-priced, more desirable, product. The big question is whether these processes can be made to be economic. If we ever get to the point where more energy is consumed in these processes than we get out at the end, the processes are clearly losers.

To me, each decision to drill a new well, or to start a new field, or even to continue pumping from an existing well, is based on the economics of the day. Some fields or potential wells or new wells drop below the "Non-economic" line on Figure 8, as tax rates rise. Others rise about the non-economic line, as technology improves. But by and large, the vast majority of oil resources that we know about will forever lie below the non-economic line. The assumption that oil prices will rise high enough to allow us to extract all of these oil sources is based on an incomplete understanding of the situation. At some point, the costs (and energy demands) of extraction and processing just become too high, relative to the benefits. Demand can never rise high enough to produce the high prices required for extraction. Ultimately, production will fall, not from a lack of resources, but from inadequate demand for high-priced oil from low quality resources.

The manner in which Figure 8 fits in with Hubbert's Curve is not directly obvious. Most "liquid" oil will tend to be in the upper "economic" triangle. Most "solid" forms of oil will tend to be in the bottom portion of the triangle. (Hubbert's Curve is usually applied only to the liquid portion of oil resources.)

But within this general breakdown, the edges will be determined by economics–does it make financial sense to use a particular tertiary recovery method on a particular liquid-oil field? Is it economic to extract something that is not quite liquid oil (like NGLs) and transform it to something that might operate vehicles?

One thing that is definitely different about Figure 8, compared to Hubbert's Curve, is a different implication regarding how much is left, when the non-economic line is reached. Hubbert's Curve discussion talks about half of the oil being gone, when decline starts. There is no such implication with Figure 8. Operators will continue to extract oil that can be extracted at low price (high EROI), even as more and more new types of extraction fall below the non-economic line. But it seems quite likely that much less than half of the low-priced (high EROEI) oil will be left, when we start running into difficulties with new oil types falling below the non-economic line.

To me, the big question is whether Bakken oil shale, other oil shales, and all of the additional NGLs can really be made economic. If they can, and the amount of oil extracted raised to the hoped-for 2+ million barrels a day by 2015 and 4.7+ million barrels a day by 2020, the new oil sources may help to keep recession away for a while longer. But if not, we are likely nearing the point where limited oil supply will push us more and more into recession. I am doubtful that the new oil shale sources can ramp up as quickly as hoped, but there is at least some glimmer of hope that these fuels will help keep the day of reckoning away a bit longer.

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