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The Myth of Peak Oil and Reality

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Abstract

Each time there is a short-term shortage of oil or hike in oil price, we talk of running out of affordable oil, an idea captured by the Peak Oil concept. Peak Oil is the theoretical point when oil production reaches at maximum followed by a terminal decline. A lot of debate surrounding the Peak Oil theory is in place, with some observers predicting rapid decline in oil production with serious implications for the entire economy and society. The geological view is that the oil production will reach at peak when half of the total ultimate recoverable resources have been produced. "Peak oil" theory relies on proven reserves and it does not represent the total available oil which can be produced over time. Problem lies in the estimation of total recoverable conventional oil reserves. Recovery factor and uncertainty play big roles here. With technological developments and advancements, discoveries are being made in virgin areas as well as some of the old fields have lengthened production with enhanced recoveries, which ultimately are adding to the recoverable resources. Though total oil production has been more or less plateaued, production from the older fields is in decline. To balance the gap, production from unconventional resources, i.e. tight oil, tar sand, shale gas has ramped up. Peak oil is about peak/maxima in oil production, not about running out of oil. Production is affected by price and price is controlled by the demand and supply economics, i.e. global oil markets. From economic perspective, peak production will occur when marginal customer will no longer intend to pay the price of marginal barrel. With plateaued conventional oil production and high cost unconventional resource development, global energy scenario is a bit in dilemma. However, the peak in production can be just an apparent one – "spike", and does not confidently indicate peak oil availability.

Introduction

Peak oil, according to economists, is the point at which oil production maxes out: the easily available reserves are gone, and the cost of extracting and refining the remaining stuff exceeds the price it fetches on the open market. After the peak, production starts to fall. There is a lot of debate surrounding the Peak Oil theory, with some observers predicting rapid decline in oil production with serious implications for entire human economy and society. Experts worry that if such a decline in production happens too rapidly, it could outpace the development of viable energy alternatives, resulting in a drastic spike in prices. Others believe that peak oil is a myth, that we could never drain the world's oil supply to the point of such a crisis.

Here we discuss and review the available theories, logic-counter logic regarding the issue, status of global oil production over recent time, uncertainty and recovery of proven oil producers, upcoming energy alternatives to manage the demand-supply gap, economic consequences of high oil prices to shed some light upon the grey area.

Experts' opinions

No name is more closely associated with the concept of Peak Oil than geologist Marion King Hubbert, a research geologist for Shell Oil Company and later the US Geological Service. Hubbert is credited with developing a quantitative technique (Logistic Growth Curve) now commonly referred to as the Hubbert Curve, which he suggested could be used to predict the remaining oil supplies (or any other finite resource like gas, copper, etc.) and the time of eventual depletion. In the 1956 meeting of the American Petroleum Institute in San Antonio, Texas, Hubbert presented a paper titled Nuclear Energy and Fossil Fuels where he suggested that overall petroleum production would peak in the United States between the late 1960s and the early 1970s. Since US oil production did indeed appear to peak in 1970, many Peak Oil advocates acclaim Hubbert as a prophet.

Another point of confusion in the debate over the ultimate availability of oil and gas supplies is the question of “unconventional” fossil fuel sources like tar sands, oil shales, heavy oils, and shale oil. Hubbert did not include these other energy types in his estimates and many of the proponents of Peak Oil today tend to ignore these hydro-carbon sources. However, since there is vastly more oil (and gas) found in these “unconventional” sources compared to “conventional” crude oil and traditional gas sources, the exclusion of them from any policy debate over oil’s demise leads to serious misrepresentation of our ultimate fossil fuel availability. As Hubbert wrote in his paper, “if we knew the quantity (of some resource) initially present, we could draw a family of possible production curves, all of which would exhibit the common property of beginning and ending at zero, and encompassing an area equal to or less than the initial quantity.” In theory, Hubbert’s basic concept is sound. As a way of thinking about and approaching the issue of declining finite resources, Hubbert was a pioneer. But that does not mean his predictions were accurate.

The problem for anyone trying to predict future resource availability is discerning the initial starting amount of a resource such as oil when one cannot readily see or gauge accurately the resource. This lack of transparency presents huge opportunities for error, in particular, erring on the side of under estimation of the total resource. And time has consistently shown that under estimation of total resource is the most common error, and as we shall see this is exactly the error that Hubbert made with regards to his estimates of our remaining oil and gas reserves. Hubbert can be forgiven because new technology can make previously unavailable resources accessible, even less expensive to exploit. In fact, he even anticipated this to a degree in his paper, another point that Hubbert’s admirers today tend to overlook.

Some economists predict the peak has already occurred; Princeton's Kenneth Deffeyes says it happened in 2005. Other experts, like Matthew Simmons, chairman of Simmons & Company International, an energy investment company, estimate that the world is peaking right now. Exxon Mobil and other oil companies have projected a peak at 2030 or beyond. Tim Considine, formerly professor of natural resource economics in the College of Earth and Mineral Sciences, University of Wyoming says. "Peak oil is a moving target," he notes. "As demand increases, prices increase. And when prices increase, companies develop and produce more oil, which can slow the peak. We're getting better at finding oil and more efficient at drilling it."

Peak Oil advocates continuously point to the rise in oil prices during the latter part of the 2000s and suggest that an apparent lack of significant new oil production is due to depletion. However, there is a time lag before higher prices result in a noteworthy increase in oil production. Given the huge investments needed to bring on line new oil production, companies have to first wait for quite a number of years after an oil price hike before they start any new development to make sure that higher prices are going to stabilize, not rise and then fall suddenly as happened in 2008 when oil reached $145 a barrel then crashed to $30 a barrel. Such volatility does not lead to greater oil production.

Status of oil production over recent time

Implications for Unconventional Sources Global production of crude oil and condensates (hydrocarbons with 3 to 12 carbon atoms per molecule), which generally can be used as transport fuels has essentially remained on a plateau of about 75 million barrels per day (mb/d) since 2005 in spite of a large increase in the price of oil (Figure 1a). Even more important, the global net oil exports from oil- exporting countries (oil production minus internal consumption) have peaked and are in decline. Though total oil production has plateaued, production of oil from older existing fields has been in decline, dropping roughly 5% annually, corresponding to a loss of 3–4 mb/d.

To balance that decline, production from all new sources, including unconventional ones, has ramped up. Yet despite a steady stream of emphatic claims that production from unconventional sources will make up for declining production from existing conventional fields and meet growing demands for more supply, production from these unconventional sources is difficult and expensive and has very low energy return on investment (EROI) (Hall et al., 1986). Simply stated, it takes energy to get energy, and more is required to produce energy from unconventional sources. With conventional oil production facing production decline rates, the debate about "peak oil" comes down to the prospects for production rate from low- EROI—and thus expensive—unconventional sources to balance the declines.

Proven Reserves vs. Total Reserves

Part of the confusion in the Peak Oil debate is that people, agencies and organizations use different definitions and accounting methods of reserve calculation, that are often not explicitly acknowledged. For instance, most Peak Oil advocates rely upon "proven reserve" numbers to argue we have limited oil supplies remaining. However, it is important to note the term "proven reserves" has a very precise meaning that only includes oil that has a 90% certainty that the oil can be extracted using current technology at current price. It does not represent total oil that may over time be produced. The total estimated amount of oil in an oil reservoir, including both producible and non-producible oil, is called various terms including oil in place. Due to technological, political and other limitations, only a small percentage of the total "in place" oil can be extracted at the present time. However, proven reserves are the bare minimum amount of oil that reasonably can be expected to be extracted over time.

One of the wild cards in predicting oil reserves is the Recovery Factor (RF). Recovery factors vary greatly among oil fields. Most oil fields to this point have only given up a fraction of their potential oil holdings—between 20-40%. By 2009 the average Texas oil field had only about a third of its oil extracted, leaving two-thirds still in the ground. Using Enhanced Oil Recovery (EOR) techniques, recovery can often be boosted to 40-60%. If EOR were applied to many of the larger US oil fields, we could effectively double the oil extracted, hence "proven reserves." While no one realistically believes it's possible to get every last drop of oil from an oil reservoir, new technologies are often able to get significantly more oil from existing fields than was possible in the past. The important fact is that the recovery factor often changes over time due to changes in technology and economics. Since the bulk of global oil still remains in the ground, and any shift upward in price and improvement in technology suddenly makes it profitable to exploit reserves that were previously not included in the "proven reserves" estimate. Thus proven reserve estimates are a minimum, not the maximum amount of oil available.

To demonstrate how technology and price can affect "proven reserves" estimates, just a few years ago Canada's "proven reserves" of oil were only 5 billion barrels. Today, due to higher prices and improved technology that makes tar sands production economically feasible; Canada now has "proven" reserves of 175 billion barrels of oil. Nothing changed other than the price of oil and the technology used to extract it. Oil companies knew there was a lot of oil in the tar sands, but it took a change in technology and price to move it into the "proven reserves" category. People knew all along there were tremendous amounts of oil locked in Alberta's tar sands. But it took a change in price, along with some technological innovation to make it profitable for extraction. So proven reserves are not a static figure based on geology, rather it reflects economics and technology. Unfortunately too many writing about the presumed Peak of oil in the United States appear to ignore the distinction, and regularly use the "proven reserves" figure as if it were the ultimate geological limit on oil and/or gas supplies. With unconventional oils like tar sands, oil shales, heavy oils, etc. included, it seems we have huge amounts of potential energy–even acknowledging that much of that oil may not be extracted until some future date due to cost and/or lack of technology.

Economic Consequences of High Oil Prices

There are serious economic consequences of continuing high oil prices—high oil prices make expensive extraction from unconventional sources more affordable. For example, shale formations (with low permeability) were formerly considered source rocks too costly to develop. The shale revolution began not because producing oil and gas from shale was a good idea but because more attractive opportunities were exhausted and market prices climbed to support the higher cost of extraction. But let's take a step back. Since 2005, the supply of oil has been essentially unresponsive to price (Figure 1b) - though the price has increased, production has plateaued. This inelastic response suggests that supply is no longer able to match demand. The economic consequences of this inelastic oil production are likely to be significant (Tverberg, 2012). For example, the United States and Europe each spend $1 billion per day on oil imports even as the import volumes decline due to higher crude prices.

The inelastic supply of oil logically results in a price- production buffer against increasing economic growth (Murphy and Hall, 2011). This negative- feedback buffer works as follows: Increased global demand for oil is driven significantly by economic growth in China and India. The demand leads to an increase in the price of oil, which is set by the global markets. As the price of oil increases, more unconventional resources become economically viable for development. Oil production increases due to increased production from unconventional sources. However, because an increase in the price of oil set this cycle in motion, the potential for recession increases. Of the 11 recessions in the United States since World War II, 10 were preceded by a spike in oil prices (Hamilton, 2009). The increased price of oil leads to a sudden loss of demand (demand destruction) followed by a decrease in the price of oil (countering the initial increase that set this cycle in motion). If the price decreases enough, production of the expensive unconventional resources is no longer profitable.

This feedback induces a drag on the economy, and consistent economic growth is difficult against this price- production buffer. This buffer can be seen in the recent price history—the price of oil increased to about $110 and then stopped rising. This appears to be the threshold at which consumers would rather reduce oil consumption than pay more.

Historically, there has been a strong correlation between global economic growth (measured by an average of gross domestic product (GDP)) and oil production (International Monetary Fund, 2011). A 4% growth in GDP would require an annual increase in oil supply of 3%, and that would amount to an increase in oil production of 17 mb/d over the next 5 years. Because production of conventional oil appears stuck on a plateau of 75 mb/d, it is likely that economic growth may be difficult unless there is a transformation away from the historical relationship between energy use and economic growth.

Myth versus Reality

Peak oil is not about oil reserves or resources, neither of which translates directly into production rate. Peak oil is not about running out of oil but about its peak in production. Production is the key metric because price is controlled by the balance between supply and demand. So the question is if the ideas of peak oil a myth. If readers are expecting an abrupt decrease in oil production, then it is. But if they understand that the manifestation of peak oil is a struggle between supply and demand that is resolved through global oil markets, they will understand that the data show that peak oil can originate from economic as well as geological factors.

However, an apparent peak in production does not necessarily represent a peak in oil availability, especially in a global market - something that Peak Oil advocates tend to overlook. In fact, a "peak" may just be one of many "spikes".

With conventional oil production on a plateau and with expensive unconventional sources the only means by which oil production may be increased in the short term, it is clear that societies face a major dilemma. Will the price remain high enough to develop unconventional sources and, in doing so, limit economic growth? Even so, can the production rate of unconventional oil ever be enough to support the concept of an "energy revolution," much less "oil energy independence"? The grey areas remain grey still as well.

Discussions and Conclusions

There is no doubt that a finite resource such as oil will continue to decline, and demand will likely grow at least into the foreseeable future, both of which should lead to higher fuel costs. But whether this leads to a long term chronic shortages that cause major economic disruption or even the collapse of civilization as some predict is subject to more uncertainty than perhaps some like to admit. For one thing there is far more oil on the planet than most people recognize, and new technologies combined with rising price for fuels is spurring development of new oil supplies. Rising prices also spurs shifts to other energy sources, as well as greater efficiency and conservation of energy.

Rather than running out of oil and/or gas any time soon, the bigger danger is that we have more than enough oil and other fossil fuel energy resources to sustain us for quite a few decades if not centuries. Any efficiency and/or conservation of energy, combined with some replacement of fossil fuel energy with renewable energy options than these finite resources, will extend hydrocarbon resources quite a few additional decades.

The real problem for the planet and human society is not the imminent danger of running out of hydrocarbon fuels, but that an abundance of these energy sources will permit population and economic growth that will gradually diminish the planet's biodiversity, degrade ecosystems, and disrupt global climate and other systems.

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Figure 1. (a) World crude oil and lease condensate production plotted with price (of Brent crude, sourced from the North Sea) from 1998 to 2013. Lease condensates are hydrocarbons heavier than pentanes that are recovered as a liquid during natural gas production. The Brent price is a representative price used to reflect the prices of crude oil sold around the world. The solid line represents an increase in price of 14% per year. While production has grown by nearly 2 million barrels per day since 2005, this represents an annualized growth rate for the past 8 years of only 0.25% per year. After Murray and King (2012), updated to 2013. (b) Since 2005, world crude oil production has been unresponsive to price.