ASPO-USA 2014 UPDATE

Oil Abundance?—Not So Fast

DRILLING HOLES IN THE ENERGY BOOM STORY

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The story of America's new energy abundance has been accepted uncritically by too many people. A closer look at the realities of today and the last decade, coupled with a better understanding of our energy and oil systems, reveals risks that must be discussed and included in planning for the years ahead.

Based on ASPO-USA's cumulative work to date, this brief paper reviews key information regarding the state of global oil supplies and the role of oil in the economy including: the fact that the global rate of crude oil extraction has not increased meaningfully since 2005, the failure of high prices to create new supplies, limits to oil being produced through fracking, the global challenges to oil supplies, and the likelihood that the United States will never again be a net oil exporter or even "energy independent" in terms of oil.

People who are part of the energy or economic debate - whether as policy makers, journalists, academics, community planners, conference organizers, or citizens who will be living through the consequences of decisions being made – should be sure to consider all the facts, uncertainties, and choices involved in assessing the future of oil supplies.

The **Association for the Study of Peak Oil USA** is a network of active and retired experts in the oil business, scholars, journalists, and other interested individuals. No one, including us, has all the answers, but we believe that a full and open conversation is critical to finding the best path ahead.

WHY IT IS IMPORTANT TO KNOW ABOUT OIL SUPPLIES

Whether we will have adequate supplies of affordable oil and other energy supplies is one of the critical questions of our time. Ultimately this question will not be answered by our wishes, but by the realities of the physical world. In this report, we show why we believe there is a substantial risk that the United States and the world will **not** have the abundant supplies of inexpensive energy that many people assume. Planning by individuals, communities, businesses, and governments should take that risk into account.

There is a tight relationship between energy supplies generally, especially affordable quantities of oil, and the level of overall economic activity. Simply put, economies stop growing when their use of energy stops growing. The world moves with oil, and petroleum lubricates the global economy. It is not simply a natural resource, but the substance that allows all other systems – from food to cities to (unfortunately) war – to exist at the massive scales of today.

For most of the 20th Century, the world's supply of oil grew steadily, while the price generally declined and remained low. This enabled the world's GDP to expand by a factor of 15, a rate vastly greater than at any time in human history. The opening years of the 21st century have broken with these trends. The price of oil is higher (even adjusted for inflation) than it has been since the opening days of the oil age, but supplies of oil are growing very slowly, if at all, and economic growth is stalling all over the world.

A debate rages: can we return to "business as usual" relying on abundant, affordable oil supplies? Is oil going to become increasingly scarce and dear? Will new technologies blunt the impact of oil declines? If the net rate of oil extraction cannot be increased as it was throughout the 20th Century, what might happen to the overall economy? What responses are available?

Every big decision we make is shaped by our expectations for the world to come, the world in which the impacts of that decision will play out. We build new highways and airports assuming that there will be sufficient demand in the future to justify the investment today. We undertake commitments around health care, education, housing, corporate debt, or retirement plans with the assumption that incomes and jobs will be sufficient to satisfy the obligations in the future when they become due.

When it comes to energy, the investments and time frames are substantial. It can take billions of dollars and a decade or more to turn a newly discovered oil field into a flow of actual oil. Refineries and pipelines, export terminals, and new technologies similarly require major commitments, not just by the companies making the investment, but by the communities affected and all of society.

ASPO-USA wants to help decision-makers make informed judgments regarding these large-scale commitments based on the best available information on energy supplies, especially oil. Overly optimistic projections and talk of "energy independence" by people whose economic and political interests *require* assumptions of plenty can lead to terrible long-term impacts that the rest of us will have to pay for in years to come if the hoped-for cheap energy never appears.

A FRAMEWORK FOR UNDERSTANDING NET OIL SUPPLIES

We – society, "the economy" – need energy to get anything done, and we especially need oil to move people and things. The framework below is intended to help readers understand how much "oil energy" the non-energy part of the economy and society will have to work with. It also shows why ASPO is concerned that future supplies are likely to be tighter and more expensive than many think today.

There is a big gap between the gross number of barrels of oil the world takes out of the ground and the amount of oil available to operate society. Here's how it works:

1. **Merely defining "oil" turns out to be difficult**. Crude oil is a liquid made up mostly of a mixture of molecules of carbon and hydrogen (hence, "hydrocarbons"), once any water and contaminants are removed. Some "oil" is so thick – like the bitumen from the Canadian tar sands – that it doesn't flow freely and even sinks in water. Other "oil" is so light that it evaporates easily and can't be turned into motor fuel. Biofuels like ethanol are substitutes for oil, but are manufactured from plants that require energy inputs to grow and be processed. Different kinds of liquid fuels have different amounts of energy per gallon, even though we measure oil in barrels (42 gallons), not by the energy provided.

2. People commonly discuss oil production, but **oil is not "produced" by nations or oil companies; it is "extracted."** The actual creation of oil takes millions of years, starting with algae trapped underwater and subjected to massive pressure and just the right geology. We extract oil from the ground, and that phrase reminds us that we are draining a fixed and limited resource.

3. The total volume of oil extracted is usually reported, but **energy is used to extract, move, and process the oil. The useful remainder is called "net energy"** or "energy profit." We tend to extract the most accessible oil with the most net energy first, and then pursue harder-to-get sources. Thus, the energy cost of extraction goes up over time, and the "energy profit" goes down.

4. **"Conventional oil" is what most of us think of as oil, a liquid coming out of wells** drilled into the earth, either on land or in relatively shallow water. The oil flows to the well pipe. These wells are typically productive for many years, or even decades.

5. "**Unconventional oil" comes in two basic forms,** but what they have in common is typically **much higher costs** per barrel than conventional oil. One form is stuff that is **not quite oil, like the bitumen in the tar sands,** which requires lots of expensive processing before it can be used. **The other is hard-to-get oil**. Some of that is in shale or other rocks that have to be fractured to release the oil. Other oil fields are deep in the ocean, under a mile or more of water and miles more of rock, where everything required to extract this oil is more expensive and more difficult to employ. There is potential for oil extraction in the Arctic, either on- or off-shore, but the temperatures are bitterly cold, support facilities are far away, the environment is dangerous, and any extracted oil must be moved thousands of miles over difficult terrain. **It is a measure of the oil situation that most new sources of oil are in one of the "unconventional" categories, and the extraction efforts require high oil prices to be economically feasible.**

6. **Oil is traded globally, but only a dozen or so countries export significant amounts of oil.** When considering the supply of oil available to major importing economies – including the US, Europe, Japan, China, and India – we cannot look at total world extraction amounts, or even the amounts after expenses, but we also have to subtract the amount the exporting countries use for their own people, and see what the "net exports" are. Since Saudi Arabia and the Gulf States have rapidly growing economies and populations, **the amount of oil available for the rest of the world has been declining steadily since about 2005.**

7. **The price of oil is initially set by the cost of extracting and processing it, subject to production limits set by producing cartels,** whether Rockefeller's Standard Oil of long ago or OPEC more recently. **The value of the energy in oil to users has historically been much greater than the price, with the difference propelling economic growth.** As oil has become harder to find and extract, the cost of new oil has risen to approach the value to buyers, reducing the benefit to the economy. **There can come a time when the price needed for extraction exceeds the price users are willing to pay, so new investment in extraction will slow or stop.**

8. **There is another potentially important "source" of oil: fuel switching**. Most of the energy use of oil in the US is for transportation. Oil was once used in the US to generate electricity, but that mostly ended with the 1970's oil shocks. More recently, the share of oil used for fuel oil, heating oil, asphalt, and power generation has declined sharply again, protecting the supply of gasoline and diesel fuel. Similarly, increased efficiency and new technologies in the transportation sector in the US and Europe can move more goods and people further on the same amount of oil.

9. Ten years ago, most oil statistics applied only to oil, or "crude and condensate." More recently, the numbers include "all liquids," adding natural gas liquids (NGLs) and biofuels to the mix. However, while NGLs have value, they cannot be used for most transportation applications, so should be considered on their own, not as part of a total.

The key question about oil is whether we will have enough oil available at prices that will allow us to operate and grow the economy and society. We will never run out of oil, but rather soon the rate of extraction of oil priced to support rapid economic growth will decline, and the energy profit we enjoy will shrink from current levels.

"Peak Oil" will occur when society is using – or the nations of the earth are extracting – oil at the highest rate ever, and at a higher rate than can be sustained in the future. High prices can have an impact on the economy even before the "peak" is reached, and the "peak" is likely to look more like a plateau than a sharp rise and decline. For "peak oil" to be "dead," as some optimists claim, the supply of affordable oil would have to continue to grow for decades to come. The following section outlines why we think that is unlikely.

THE OIL SUPPLY STORY IN BRIEF

Understanding how we use oil and where it comes from provides many reasons why Americans should be concerned about the future of oil supplies. The outline below presents the most essential of these reasons.

A. ENERGY, ESPECIALLY OIL, IS KEY TO THE ECONOMY

1. **Nothing gets done without energy**. The economy as a measure of real-world activity is based on energy and natural resource use, not finance. Whenever oil prices have risen sharply since the 1940's, a recession has almost always followed. Attempts to manipulate the economy with fiscal and monetary policy cannot succeed if affordable real resources are not available. In particular, our water supplies and agricultural economy are very dependent on oil and other fossil fuels, while energy production requires a lot of water.

2. **We have two energy systems, not one. Nearly all transportation around the world is powered by petroleum**, and most petroleum is used for "transportation energy." Other sources – coal, natural gas, nuclear, hydropower, wind, and solar – are mostly used for "process energy," meaning electricity, heat, and manufacturing. Advances in the non-oil sector have done little to satisfy the demand for transportation energy.

3. **High-priced oil tends to reduce other economic activity before slowing oil consumption directly, because there are few substitutes for oil.** People do not drive 85% of the way to work, so they have to cut other spending to pay for expensive gas. The economic benefit from a gallon of gasoline or diesel is often greater in China and other developing economies than in the US and Europe, so they can afford to pay more than we can. Our economic growth has slowed when prices have risen rapidly, especially as oil prices exceed $100 per barrel.

4. **Despite large increases in the price of gasoline, American consumption has remained nearly level at about 9 million barrels per day for the last ten years**. Diesel consumption, the second largest use of oil, dropped briefly due to the economic slowdown, but has now fully recovered, growing since 2009.

B. THE COST OF OBTAINING OIL IS RISING

5. **"Energy Return on Energy Invested" (EROEI) is an important concept showing how much energy (not just money) we get for the energy used in the extraction process**. During much of the twentieth century, US oil extraction enjoyed an EROEI ratio of 50 or more, which meant that only 2% of the energy was consumed in the production process. Current estimates of oil from fracking and tar sands show an EROEI well below 10, which means we use 10% or more of the energy from that oil simply getting it out of the ground.

6. **Low oil prices tend to reduce oil extraction, because the newest oil sources tend to be the most expensive** – tar sands, tight oil, deepwater fields, and so on. If oil prices fall too far, investors will not get the return they need justify new drilling efforts, so many new projects will be abandoned or delayed.

7. **The rate of growth in conventional oil extraction around the world has slowed markedly since 2005, despite massive ongoing investments** by oil companies in exploration and production efforts, because new oil is hard to find and hard to extract. Global oil extraction rates outside of the US grew only 3% in the eight years between 2004 and 2012, even though oil prices tripled during that period.

8. Another factor has reduced the amount of net exports of oil in world trade and thus contributed to higher prices: **oil exporting countries often increase their consumption levels faster than extraction rates,** and consumption may continue to rise even if extraction falls. China, Indonesia, Great Britain, Egypt, Vietnam, Argentina, and Malaysia have all changed from exporters to importers in the last twenty years. increasing the competition for oil in world trade.

C. NEW SOURCES OF AFFORDABLE OIL ARE NOT AS ABUNDANT AS IS COMMONLY CLAIMED

9. In the last decade, two substantial new sources of oil have emerged in North America. One is **the Canadian Tar Sands in Alberta, which currently yields about 1.5 million barrels per day of bitumen, a product that can be refined into oil. However, the growth rate of extraction has been slower than forecast as costs are rising,** the environmental impact of tar sands oil production are substantial, and transportation and pipeline decisions could affect the economics of future production.

10. **The other new source has been "light tight oil," extracted from shale deposits with fracking technologies, mostly in a few counties in North Dakota and Texas**. While this oil has reversed the long trend of declining American extraction rates, studies analyzing the histories of individual wells show **rapid decline rates** (often 40-60% per year, compared to a few percent with traditional wells) and relatively small areas (or "sweet spots") where fracking efforts are economic, leading to the prediction that the shale oil "boom" will be short-lived**. More money is being spent on new wells than is being generated by cash flow from the oil, requiring a steady flow on outside capital** to keep development going. Efforts to use fracking technologies for oil extraction in other states and countries have not yet been economically successful on a substantial scale, and government estimates of the size of the Monterey Shale in California have been cut by 96%. We agree with the International Energy Agency in expecting growth in US "tight oil" to end during this decade, while conventional extraction amounts will continue to decline.

11. **Oil extraction from deep water sources, especially in the Atlantic Ocean near Brazil, and from the Arctic is proving to be more difficult, more expensive, and slower to happen than many expected (or promised).** The Macando (Deepwater Horizon) blowout in the Gulf of Mexico in 2010 was the result of the complexities that are a necessary part of pursuing difficult oil. The cost of cleanup and damages from that event has been almost equal to the total revenue from all Gulf of Mexico extraction in 2010. It now looks doubtful that Brazil

will ever become a net exporter of oil. After Shell's bad experience off Alaska, no major public oil company is currently drilling for oil in Arctic waters.

12. **While oil extraction rates have increased in the United States, this growth has been largely offset by declines in extraction and exports in other nations**. Mexico's oil extraction is one-fourth lower today than in 2005. Brazil and Kazakhstan are having great trouble starting major new projects. Nigeria, Libya, Venezuela, Sudan, and Iraq are all facing domestic unrest that challenges export levels.

13. Fracking is also a major technology for the extraction of natural gas, and has reversed a long-term decline in American gas production. It appears that this growth and "abundance" may be limited, as the initial fields in Texas and Louisiana went into decline after only a few years of drilling. American gas production has increased less than 4% over the last two years. Fracking also creates many environmental concerns around water use and costs to communities. This paper deals primarily with oil supplies, but **we are also concerned with predictions about future natural gas production that we feel are overly optimistic, particularly those that suggest natural gas could be a major substitute for oil** as a transportation fuel. Reports published by Art Berman and David Hughes with the Post Carbon Institute, and others have dealt with these issues in detail, and we must simply refer readers to those sources for now.

D. THE IMPACTS OF HIGH OIL PRICES AND LIMITED SUPPLIES ARE ALREADY CLEARLY VISIBLE

14. **High oil prices contributed significantly to high food prices and the global financial crisis**. The effects are still being felt, resisting central bank efforts to boost the economy:

    a. US employment did not return to pre-2007 levels until May 2014.

    b. Europe seems stuck in a long-term recession. The countries most dependent on oil for energy were the hardest hit in the recent crisis.

    c. Pakistan (which generates much of its electricity from oil) now has only a few hours of electricity per day in its cities.

    d. The Arab world is full of unrest and conflict partially traceable to the end of Egyptian oil exports, as well as the worst drought in Syria in over 2000 years, record high wheat prices, growing populations, and other environmental factors.

    e. China's economy is subject to challenges from high energy prices, water problems, and the need to combat pollution caused in large part by the combustion of fossil fuels.

15. The large international oil companies are faced with major challenges, despite their resources and technological strength. **The total oil extraction by the seven "majors" has declined by over 10% since 2009, even though they have raised their capital expenditure levels by 40-70% during that time**. Their share of global production has fallen from 12.7% to 10.4%.

16. **In the face of claims of oil abundance, the world (Brent) price of oil has remained stubbornly higher than $100 per barrel since 2011.** Since the US still imports almost half its daily usage of oil, those prices directly affect us.

E. HIGH PRICES AND DIFFICULTY IN INCREASING EXTRACTION RATES CALL FOR CREATIVE RESPONSES

17. **Conventional oil extraction has been generally flat or declining since 2005, and current unconventional extraction methods are more difficult, growing more slowly (US tight oil excepted), and more expensive than expected**. Any significant future growth in oil availability – and therefore, growth in the global economy – depends on sources that are not currently identified or under development. Existing oil fields deplete by more than 5% per year, so new sources are constantly required.

18. America's current optimistic oil policy seems based on the hope that "somebody will come up with something," and that what has worked in a few areas can be extended to many others. **A more realistic policy would be based on assuming that we are at or near the maximum rate of production of affordable oil for a modern economy, and develop responses appropriate to that future.** If we find marginal new supplies equivalent to shale oil, we should treat them as a one-time bonus to be used to pay for the transition to whatever is next.

19. **Many opportunities exist for creative responses to these challenges**. Some responses, like more efficient automobiles, support our current way of life, while others, like localization of food production, community building, and information technology, help transition to a new economy.

20. **Since high oil prices make transportation more expensive, there are advantages to changing our transportation systems and functions, including electrification, mass transit, and transit-oriented development**. These actions require capital, vision, and lots of time to have their fullest impact.

21. Contrary to some claims**, there is little evidence that the demand for oil is declining for reasons unrelated to price, or that we are moving away from oil.** The need for moving people and goods remains active, as shown by the number of new airports around the world, the increase in car sales in China, India, and the Middle East, and the doubling of the size of the Panama Canal. There has been much discussion but little action toward electric cars and natural gas-powered trucks and trains, and those technologies remain more expensive than gasoline and diesel-powered vehicles.

22. **We should create a standby mechanism in the US for protecting society while rapidly reducing the use of gasoline and diesel fuels if an absolute shortage should appear**. As noted above, high prices have had a very minor direct effect on oil demand, but impacts spill over into other parts of the economy. The Strategic Petroleum Reserve could help cushion a crisis, but It is not clear how the US would deal with the need to reduce the use of gasoline and diesel by 5 to 15% that seemed likely to persist for a long time without major impacts on the economy and society.

F. OIL SUPPLIES ISSUES ARE CRITICAL, AND INTERACT WITH OTHER RESOURCE CONCERNS

23. The expertise of ASPO-USA centers on energy issues, especially those relating to supplies of oil and natural gas. Our nation faces many other issues from the use or availability of natural resources, and many of these are related to the availability or past use of cheap and plentiful energy or expectations of endless economic growth. Among these are:

    a. Climate change

    b. Availability of water for people and agriculture

    c. Population growth

    d. Soil quality

    e. Ocean acidification

    f. Phosphorus for agriculture

    g. Biodiversity

    h. Debt levels and other financial concerns

As we develop responses to energy constraints, we need to assure that we are not making other problems even worse. Notably, efforts to accelerate fossil fuel development could adversely impact climate change and the availability of water.

G. WE CONTINUE TO LEARN ABOUT THESE ISSUES

Over the last two years, presentations and conferences discussing energy constraints have included:

- "Oil Wildcards" conference, New York City, June 2012
- ASPO-USA annual conference, Austin TX, November 2012
- American Geophysical Union conference, San Francisco, December 2012
- U.S. Society for Ecological Economics conference, Burlington VT, June 2013
- Geological Society of America "Geoscience" conference, Denver, October 2013

In addition, major articles have appeared in Scientific American, Science, and Nature magazines, as well as more specialized scientific journals.

ABOUT ASPO-USA

ASPO-USA's mission is to help America understand and adapt to a new energy reality

More than a decade ago, a group of energy experts and interested people from a number of different countries formed the Association for the Study of Peak Oil (ASPO) to investigate questions about the future of oil. A few years later, ASPO-USA was created as a U.S. forum for discussion of this. The initial focus was on gathering data, understanding concepts like depletion and energy return on energy invested, and developing projections based mostly on physical constraints to oil extraction.

More recently, the discussion has broadened into the sensitivity of supplies and demand to prices, the impact of energy prices on the overall economy, the role of "above ground" (including political) factors on oil supplies, the role of new kinds of "oil" (like the Canadian tar sands) and new methods of extraction (like fracking for gas and tight or shale oil), the development of alternative sources of energy and ways to substitute for the use of oil, and the interaction between climate change and the use of oil and other fossil fuels.

ASPO-USA publishes a daily and weekly online newsletter, and engages in other public education efforts. For more information: www.peak-oil.org | info@aspousa.org | 202-470-4809

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