

Peak Oil Overview - June 2007

The message that “peak oil” may be a problem is now reaching respected publications like **Business Week**. But how can a person learn more? Information about peak oil is often fragmented, and the quality of the sources is questionable. The purpose of this article is to document some of what is known about peak oil, so that readers have a better framework for understanding our current situation. Many links are provided, so that readers can dig deeper if they like.

1. What is peak oil?

“Peak oil” is the term used to describe the situation when the amount of oil that can be extracted from the earth in a given year begins to decline, because geological limitations are reached. Extracting oil becomes more and more difficult, so that costs escalate and the amount of oil produced begins to decline. The term peak oil is generally relates to *worldwide* production, but a similar phenomenon exists for *individual countries* and other smaller areas.

2. Why would oil production begin to decline? Can't we extract oil as fast as we want to, until it finally runs out, many years from now?

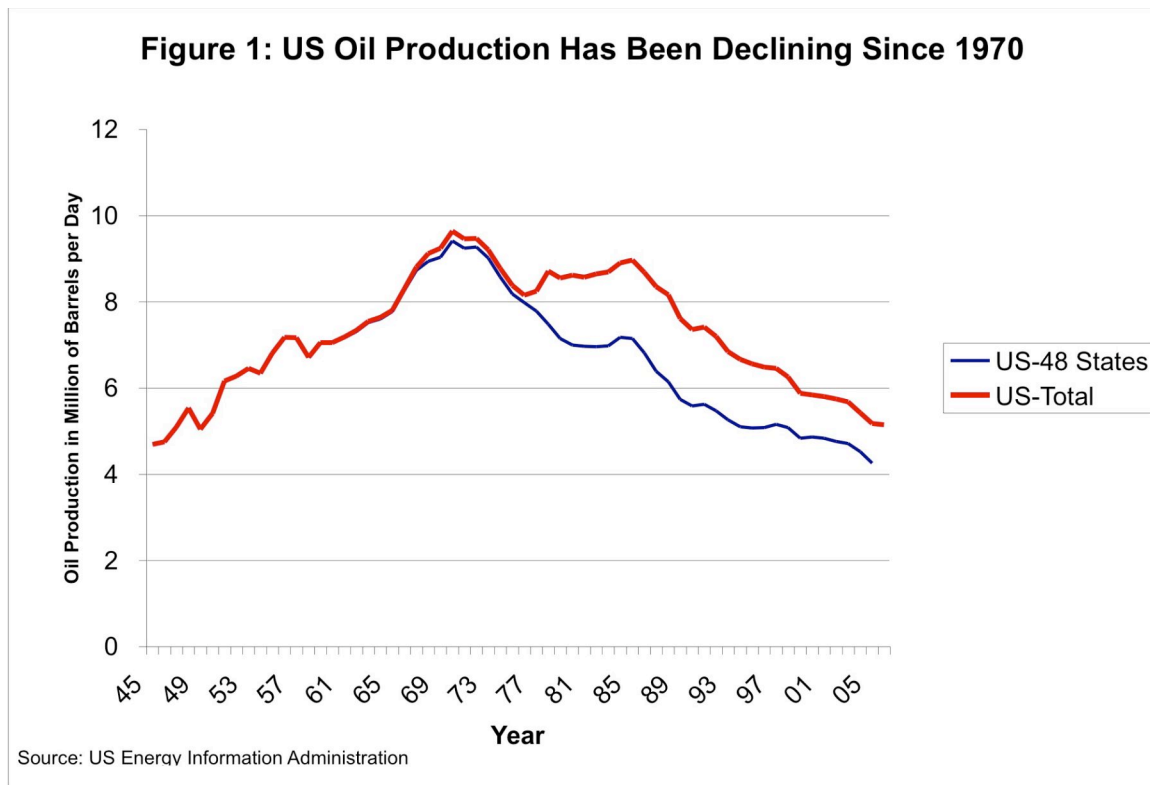
What happens isn't quite as simple as “running out”. Instead of running out, oil gets progressively more difficult to extract. When a well is first drilled, the oil is often under pressure, so comes out quickly with virtually no effort. Later, pressure drops, and it becomes necessary to inject one of several gasses to repressurize the wells. Finally, when even this ceases to keep production up, the remaining oil is pumped out at a slow rate.

Another reason for production tapering off is that oil companies tend to develop the fields which are expected to have the highest return first, and save the smaller fields and fields with more challenging production profiles (such as deep sea oil, very viscous oil, and oil combined with

toxic chemicals) until later.

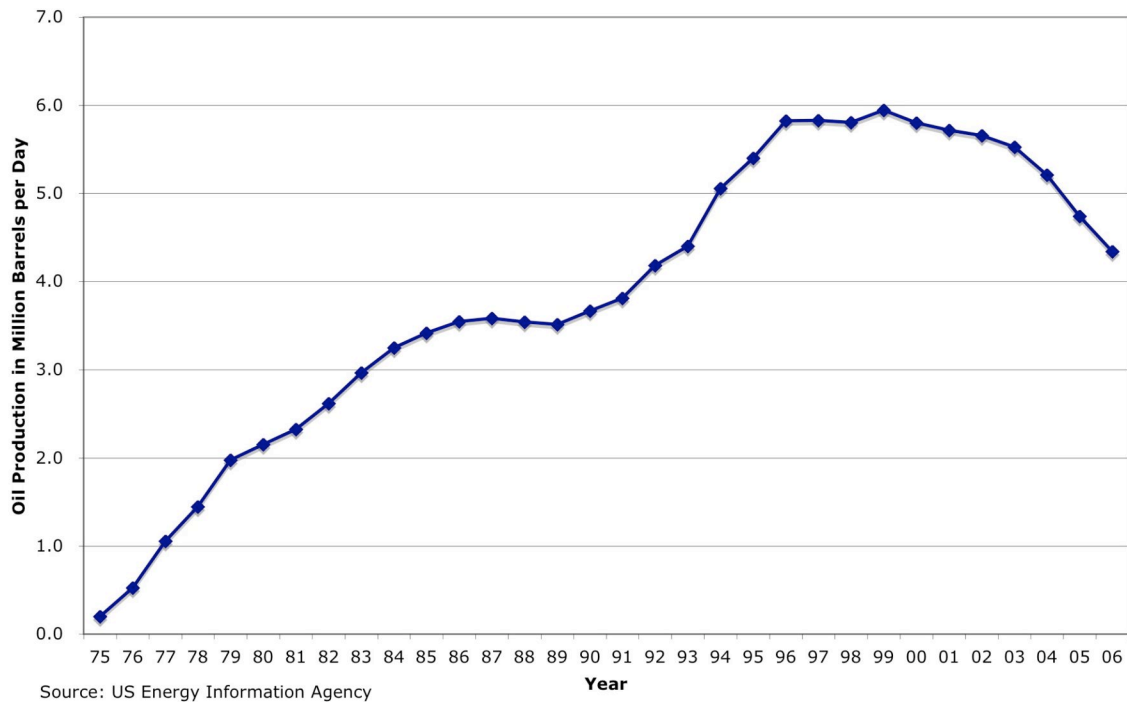
3. Do we have any historical reason to expect that oil production will begin to decline at some point?

When we look at oil production in any given area, the production tends to rise until approximately 50% of the oil that will eventually be extracted is gone, and then begins to decline. For example, Figure 1 shows oil production of the United States.



A similar pattern holds for North Sea oil production (Figure 2).

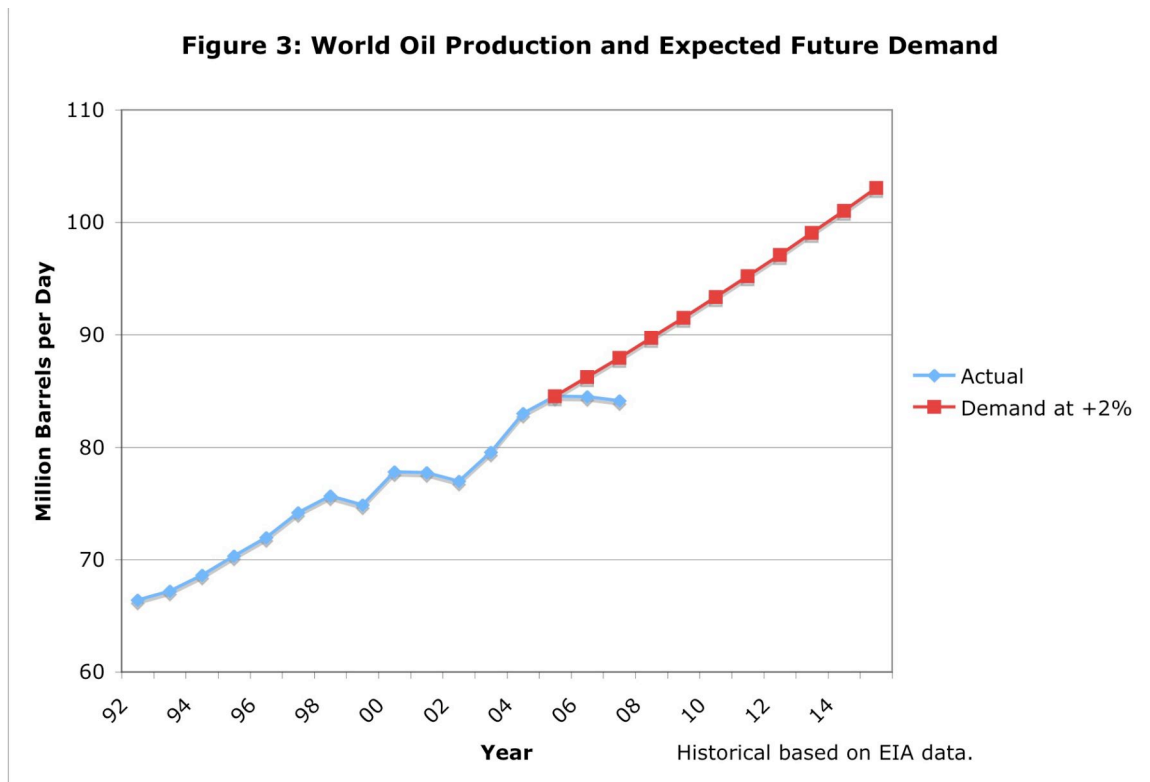
Figure 2: North Seas Oil Production Has Declined Since 1999



We have now reached the point where oil production is declining, apparently for geological reasons, in the majority of oil-producing countries. It logical to expect that world oil production will eventually begin to decline.

4. What does world oil production look like?

Figure 3 shows recent world oil production (blue line), plus a rough estimate of future demand for oil (red line), assuming world oil desired usage continues to grow at 2% per year.



On this graph, a person can see that world oil production was rising fairly steadily, but recently has “stalled out”. Based on data of the United States Energy Information Agency (EIA), oil production for 2005 was a little higher than that for 2006. Partial 2007 data suggests that 2007 production may be a little lower than that for 2006.

Because of this “stalled out” condition, there is a growing gap between what the world would like for petroleum production, and what is actually being produced. At this point, the countries that are suffering a shortfall because the current price is too expensive are mostly third world countries from Africa and Asia. The International Energy Agency (IEA) has **expressed concern** that oil production is not high enough, and believes that Organization of Petroleum Exporting Countries (OPEC) should produce more.

5. Can OPEC raise its production of petroleum?

Many people suspect that the answer to this question may be no.

Some publications **report** that Saudi Arabia is having production difficulties, as are several other OPEC countries (Kuwait, Iran, Nigeria and Venezuela). Saudi Arabia does not admit to any production problems. EIA data indicates declining oil production for Saudi Arabia, even before OPEC production cuts were announced in the fall of 2006.

It is likely that we will learn the truth about OPEC's ability to raise production this winter. OPEC has its next planned meeting in September. Unless something very unusual happens, there will be a need for significantly higher oil production. OPEC's actions at that time will tell what the real situation is.

6. Doesn't OPEC report very large oil reserves? It seems like those high reserves would assure us that OPEC can increase its production at will.

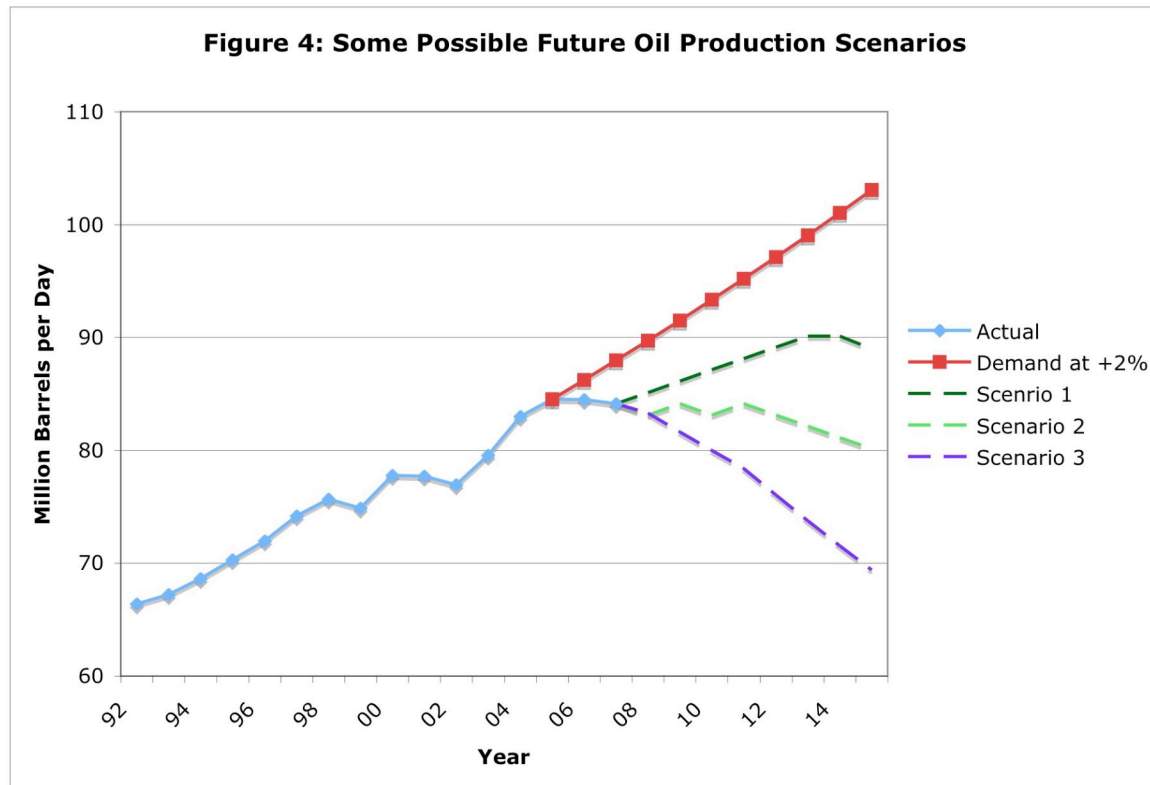
No, the high reserves aren't all that helpful. First, there are serious doubts about the accuracy of OPEC's oil reserves. The reserves are not audited numbers. Countries may be motivated to exaggerate them, so as to increase their OPEC production allocations. Analyses such as **this one** suggest that the reserves are likely overstated.

Second, even if OPEC reserves are accurate, the reserves tell us nothing about the flow rate. If the reserves include much very viscous oil, it may take years and large amounts of other resources to produce a relatively small flow of oil.

One important piece of detective work regarding Saudi oil reserves was done a couple of years ago. Matt Simmons analyzed published scientific papers relating to Saudi oil wells, and determined that Saudi wells were reaching a serious state of depletion. He documented his findings in the book **Twilight in the Desert**. This book is now available in paperback, and has been translated into German and Chinese.

7. What is the pattern of world oil production in the next few years expected to look like?

We can't know for certain, but Figure 4 shows three possible oil production scenarios as dotted lines.



If OPEC production is now falling, it is likely that we are at “peak oil” now, because production for the rest of the world is flat. If we are at peak oil, we might expect future oil production to follow a pattern similar to Scenario 3 (the lowest dotted line, with production falling immediately) or possibly Scenario 2 (the middle dotted line, with production falling after a plateau). Several respected energy industry insiders, including **Matt Simmons**, energy investment banker and author of *Twilight in the Desert*, and **Samsam Bahktiari**, retired Iranian oil executive, believe that we are at peak oil now.

Scenario 1 (the top dotted line) shows a scenario in which peak oil is still a few years off. Some scientists believe that this is a more likely

scenario. The Association for the Study of Peak Oil and Gas **Newsletter** forecasts peak oil in 2011, four years from now. The **PhD thesis** of Fredrik Robelius showed that peak oil is expected to occur between 2008 and 2018. Chris Skrebowski, author of the **Megaprojects** analysis **forecasts** a worldwide peak in 2011/2012.

8. Does everyone forecast peak oil within approximately the next 10 years?

No. The US Energy Information Administration's **model** is based on an approach that does not consider geological constraints. Instead, it is based more on expected demand. In Figures 3 and 4, expected demand is the red top line. Forecasts on this basis tend to be higher than those considering geological constraints. Forecasts of the IEA appear to use similar logic, since IEA also assumes that OPEC can meet supply shortfalls.

Another organization that is known for its rosy **production forecasts** is Cambridge Energy Research Associates (CERA). CERA's production forecasts are widely quoted in the news media, but it is not clear that they are particularly accurate. Some concerns:

- CERA's clients are companies in the energy field. One would expect that these companies would like to hear "good news" about future growth prospects. Thus, CERA is likely to be under more pressure to produce favorable forecasts than are independent scientists.
- CERA's forecasts do not appear to be reproducible by independent scientists. Chris Skrebowski and Fredrik Robelius (see Question 7) both use field-by-field analyses that are in many ways similar to CERA's approach, but come to very different conclusions.
- Where it is possible to test actual production against forecasts, CERA's forecasts seem high. Euan Mears **notes** that in March 2006 CERA presented a model for UK 2006 oil production capacity showing around 2,350,000 barrels per day — around 700,000 barrels per day

higher than the actual production figure.

9. When was peak oil first predicted?

M. King Hubbert, in 1956, first predicted that US oil production for the 48 states would peak in 1970. This prediction turned out to be correct, to everyone's surprise. He also predicted a world-wide peak around 2000.

10. Will alternative energy sources be able to make up for the shortfall in petroleum production?

At this point, it seems **unlikely** that they will make up the shortfall.

On Exhibit 4, the gap that needs to be filled is the gap between future demand (the top line) and actual future production (something in the vicinity of the dotted lines). Clearly, the sooner production begins to drop and the steeper the decline in oil production, the bigger the gap that needs to be filled. Even if production stays level, there can be a gap because demand continues to increase.

At this point, there does not seem to be any "silver bullet" for replacing the lost oil production. Oil is unique in its abundance, its high energy density, and its portability. There do appear to be a number of possible silver bee-bees, however. These include:

- ethanol from corn,
- ethanol from sugar (generally imported),
- biodiesel,
- cellulosic ethanol from biomass, and
- coal-to-liquid.

None of these appears to be very scalable, especially in a short time frame. In addition, there are other drawbacks — cost, environmental damage, and for coal-to-liquid, climate change issues. Indirect approaches to circumventing the shortage, like using battery operated cars, may be part of the picture as well. If these are used, they will probably need to be phased in slowly, as existing cars are retired. It is likely that conservation will need to be part of the mix.

11. What is “Energy Returned on Energy Invested” or “EROEI”?

This is a concept that a person runs into frequently, if one reads any of the more advanced articles about peak oil on the internet. Analysis based on EROEI helps to explain why many scientists are discouraged about the newer energy prospects - both alternatives like ethanol and “unconventional” oil like oil sands.

EROEI is a measure of how much energy an investor gets out, compared to how much energy the investor puts in. Some of the energy invested is not in fuel directly, but in things that are made using fuel, like oil rigs and refining equipment.

In the early days of oil, much of the oil extracted came from highly pressurized wells, so little effort was required to get the oil out. At that time, the typical EROEI was about 100. As those wells became depleted, more and more effort was required to get the oil out. A typical EROEI for oil is now about 15, considering additional costs like repressurization of wells and drilling in underwater locations.

One problem that we are running into with “unconventional oil” and alternatives is that it takes a huge amount of effort (in terms of energy expended) to get the energy out. EROEI is in the low single digits for oil sands, and is barely above 1 for ethanol from corn. Oil in very deep sea locations is also expected to have a low energy return (assuming it can be extracted at all), because of all the very fancy equipment required.

If we had a huge amount of other energy from a readily available source that we could use for producing oil and oil alternatives, such as natural gas or coal, a low EROEI would not necessarily be a big issue. But it is now becoming clear that natural gas is in nearly as short supply as oil, at least in North America. And coal has a lot of issues as well — it is implicated in climate change, is mixed with toxic pollutants, is not as easy to transport, and is not in as unlimited supply as most believe.

When we have energy sources with a low EROEI, we are using a lot of fuel to get oil or oil alternative. The energy we have left to do everything else we do — build roads, build shopping malls, produce food — is less. I once heard an estimate that it takes an average EROEI of 6 to have enough energy left over to fuel today's society. If new energy sources all have EROEIs of 3 or less, we are likely to

- Need a large share of workers to work in energy-related occupations
- Have less energy left over for other uses
- Experience a significant fall in our standard of living

12. What are the indirect impacts of peak oil likely to be?

We don't know for certain. Some issues that have been raised include:

- Will the food supply be adequate, if farmers are not able to get fuel for their equipment and transportation is disrupted?
- Will it be possible to supply all of the products that are currently made with petroleum, including asphalt, many chemicals, fabrics, and building supplies?
- If there is a shortage of oil, will the new alternative energy sources really be sustainable? For example, will it be possible to service windmills adequately, if there is a severe shortage of oil? Will it

possible to produce enough corn for ethanol?

- Will people be able to repay their debt, if standards of living fall? Will lenders be willing to provide more long-term loans, if it appears likely that future transportation will be disrupted?
- Will there be problems with the monetary system, if there are major debt defaults?
- Will the many economic concepts that we hear so frequently continue to apply, such as “globalization”, “companies should grow”, “fungible oil supply”, and “increased price will lead to greater supply or substitution”?
- Will countries fight about the remaining oil supply?

13. If the peak oil story is really this important, why haven't we been reading about it in the newspapers for years? Are you claiming there has been some sort of conspiracy?

No conspiracy. Just of a lot of things that seem to work together:

- Oil = Power. A country with lots of oil (and other fossil fuels) has great power. It can manufacture what it wants, outfit big armies, and generally be at the top of the pecking order. For this reason, government officials may be tempted to exaggerate strengths and gloss over weaknesses on the energy front. This is true for almost every country with oil — US, Saudi Arabia, Russia, Venezuela, and others.
- Embarrassment about the drop in US oil production. Prior to 1970, the US was the world leader in oil production. It was the undisputed world leader in manufacturing, and the economy was growing rapidly. In 1970, oil production started to drop. This was a shock, because very few believed the prediction Hubbert had made in 1956. The drop in oil production meant a changing world role - to more of a service

economy, and relatively less power. This whole discussion was left out of textbooks. If it had been included, people would have realized that a decline in world oil production would be coming some day, just like the decline in US production.

- Faith in OPEC oil reserves. The Saudi oil company Aramco was taken over by Saudi Arabia in 1980. Shortly thereafter, the amount of oil reserves was doubled, without finding any more oil. Other OPEC countries soon followed suit, since higher reserves meant higher oil production targets under OPEC rules. Current OPEC reserves appear to be seriously overstated, but they are repeated endlessly as fact, in news media and textbooks.

- Faith in technology. The fact that oil production would eventually decline has been known for about 50 years. But many people who were aware of this problem assumed that technology would somehow overcome the problem. If peak oil is viewed as an easily solvable problem, there is no reason to tell the public about it.

- Faith in economic theory. Economic theory says that if there is a shortage, higher prices will encourage greater production or substitution. Therefore, there should be no reason to worry.

14. Even with all of these things going on, it seems like the peak oil story would be better publicized than it has been. What else has kept the story off the front page?

There are number of other things:

- The people who have discovered the peak oil story are by and large technical people — people working in academia, people working for oil companies, and scientists who are close enough to the situation to say:

Wait a minute. We see a huge change coming. Oil is near the point where worldwide production will drop and we aren't

finding any major technological solutions. All we are finding is some little things that together don't look like they will cover more than a small percentage of the problem. The economy cannot continue to grow the way it has grown. In fact, it looks like a major cutback is in store.

- Peak oil people are not well funded. Their organizations are volunteer organizations. Some of their work is done on internet blogs. It is hard for them to match well-funded organizations like CERA.
- Peak oil does not mix well with standard economic theory. Economic theory is repeated so often that everyone nearly everyone takes it as *science* or *fact*. It is only when people step back and realize that economic theory is just a theory, and that it does not necessarily apply in a resource constrained world, that they can understand the peak oil situation.
- Newspapers have a happy story to tell — one of growth, entertainment, selling lots of SUVs. It is hard for a news organization to publish the peak oil story when it is so much at odds with the main message of the paper.

15. So who are the people who know the peak oil story?

In Washington D. C., Representative **Roscoe Bartlett** (R - MD) is the leader on the issue of peak oil.

There are many others who are peak oil aware. The Association for the Study of Peak Oil and Gas (ASPO) now has organizations in **11 countries**. There are also quite a number of local peak oil organizations.

There are quite a few people involved with internet sites that publish peak oil information and discuss the peak oil story. A few of note:

- TheOilDrum.com - "Discussions about energy and our future"

Features well-researched articles written by its staff. 40% of its readers have postgraduate degrees.

- EnergyBulletin.net - Publishes peak oil and related articles that others submit. Has good indexing features. No discussion.
- Globalpublicmedia.com - Publishes speeches and other audio media related to "a postcarbon world".
- **Speeches by Matt Simmons** Slides for the speeches by the author of "Twilight in the Desert" can be found at this site.
- aspo-usa.com - The web site of the US version of the Association for the Study of Peak Oil and Gas. Offers a weekly and daily newsletter.

There are also many others web sites dealing with peak oil. Many of these can be found by searching for the words "Peak Oil".

16. Are governmental leaders aware of peak oil?

Many of them seem to be.

We know that the leaders of OPEC are aware of peak oil because OPEC's magazine talks about the issue. A speech by one of their members on peak oil is printed on page 58 of the November 2006 **OPEC Bulletin**.

We strongly suspect that Russian and Venezuelan leaders are peak oil aware, because of their aggressive recent actions. They know that because of peak oil, they have more power, and are acting accordingly.

Representative Roscoe Bartlett (R-MD) **reports** that based on his meetings in China, Chinese leaders are very peak oil aware. He reports that they have a five point plan for dealing with peak oil and are buying up all of the oil assets they can.

George W. Bush and Dick Cheney do not talk about peak oil, but there are many governmental reports relating to peak oil. Some of these include

- **Uncertainty About Future Supply Makes it Important to Develop a Strategy for a Peak and Decline in Oil Production.** US

Government Accountability Office, February 2007.

- **Energy Trends and Implications for U. S. Army Installations** E.

T. Westervelt and D. F. Fournier, September 2005.

- **Peaking of World Oil Production, Impacts, Mitigation, and Risk Management** R. L. Hirsch, R. Bezdek, and R. Wending, February

2005. For US Department of Energy.

A number of people have noted that both Iraq and Iran report significant oil reserves. The question has been raised whether the US involvement in these countries is more than coincidence, given peak oil concerns.