Extreme Production Measures

Posted by Dave Cohen on July 23, 2006 - 3:55pm
Topic: Supply/Production
Tags: chris skrebowski, deepwater, eor, horizontal drilling, peak oil, robert hirsch, saudi arabia, tar sands, ultra deepwater, yibal [list all tags]

Looking at the ASPO Blog, I read these statements by some prominent members of the peak oil community.

> [Robert] Hirsch doubts that the world can keep increasing oil flows for much longer. "CERA sees a long plateau ahead," he said. "But I can't find a plateau in the data I'm looking at." The downturn, when it comes, could take the world by surprise. "Peaking could come with little warning and sharp declines," he said....
>
> "We have 1,500 days until peak and tomorrow we'll have one day less," Chris Skrebowski, the editor of Petroleum Review, told the ASPO-5 crowd today. Skrebowski's projections, which focus on oil flows instead of reserves, has the world peaking at between 92 and 94 million barrels per day. Unfortunately, he said, "collectively we're still in denial."

Hirsch is the principal author of the now famous Hirsch Report (large pdf). Skrebowski maintains the Megaprojects Database of future oil production. These quotes got me thinking about the shape of the peak in world oil production which Skrebowski projects as occurring in the fall of 2010.

Writers here at TOD like Stuart and Khebab have provided us with many *top down* approaches to oil depletion using Hubbert Linearizations. Often we forget that there is a complementary data-driven *bottom up* methodology.

> Skrebowski's analysis has provided one of the most important independent methodologies supporting the 'imminent peak oil' hypothesis proposed by Hubbert inspired modelers such as Colin Campbell, Jean Laherrere, Ken Deffeyes, Stuart Staniford and GraphOilogy. His most recent studies conclude that, should no major disruptions take place, global peak oil should be delayed until at least 2010, “but shortly thereafter production is more likely to decrease than increase.” ... Skrebowski's latest figures also include deepwater oil, Athabasca tar sands, as well as natural gas liquids and condensate production....
>
> Over the last year or two there has been a great deal of discussion about depletion rates within certain countries. **Usually what is described is the loss of capacity in existing fields that would occur if no remedial or offsetting action is taken and sometimes referred to as ‘natural decline rates’**. Typically this is assessed

> at around 5% but an increasing number of reports now cite even higher decline rates. For Example the IEA's 'World Energy Outlook 2005' which provided a detailed analysis of prospects for the Middle East and North African producers (all Opec members except Egypt) noted current natural decline rates of 600,000 b/d per year for Saudi Arabia and 270,000 b/d per year for Iran....
>
> This information indicates that these two countries and any other with similar declines face considerable challenges in maintaining or expanding their capacity. However, this **information on natural decline rates is of limited value unless the volumes that can be offset by infill and infield work are known**....

One "poster child" of field depletion is Yibal in Oman.

> Oman's Yibal field, which began production in 1968, is an excellent example of a field that has responded nicely to **MRC** [Maximum Reservoir Contact] **wells combined with water flooding**. After many years of **infill drilling and the use of water injection wells**, PDO made the decision in 1994 to use **horizontal wells**. Today, the Yibal field contains nearly 500 horizontal wells, which helped the field reach peak production at more than 250,000 bbl/d in the late 1990's. **Horizontal drilling has led to a dramatic increase in water production and an equally impressive decline in oil production**. In 2003, Yibal produced approximately 80,000 bbl/d and approximately 700,000 barrels of water per day. Such a high water cut speaks volumes about the maturity of the field and portends a field approaching the end of its productive life. It is estimated that PDO has already recovered approximately 42% of Yibal's oil in place, although it hopes to get the field's recovery factor close to 55%.

Sharp Decline at Yibal

At the top, Hirsch makes the conjecture that "Peaking could come with little warning and sharp declines". Skrebowski tells us that the world will peak at between 92 and 94/mbd in 2010. Together, these two statements suggest that what happened at Yibal could happen to the world. Let's use an analogy to explore Hirsh's conjecture. Enhanced Oil Recovery (EOR) is used to increase recovery rates in an oil field and usually refers to applied *secondary* and *tertiary* techniques. Among the former are use water flooding (to maintain reservoir pressure). Among the latter are the injection of other gases (eg. nitrogen at Cantarell, carbon dioxide or steam in other fields). Either technique can be accompanied by drilling of horizontal (deviated) wells to stimulate oil flow. Use of EOR often results in a recovery pattern that looks like this -- detailed in Technology and Petroleum Exhaustion: Evidence from Two Mega-Oilfields for the Forties field in the North Sea and the Yates field in West Texas.

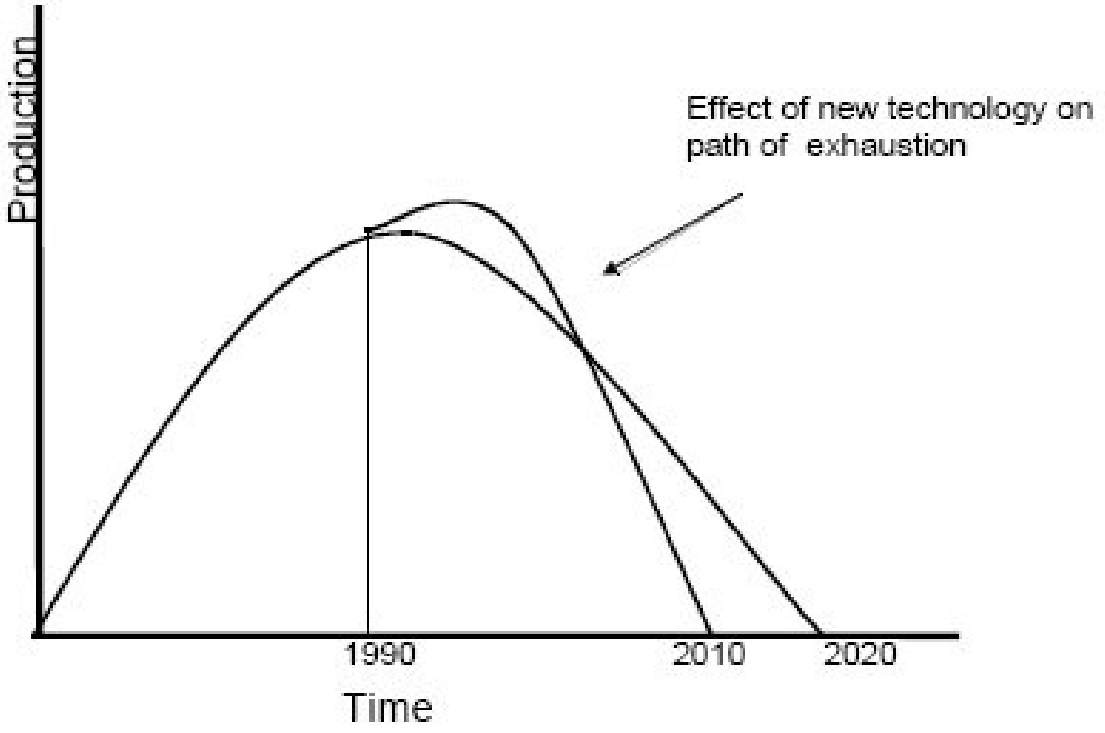


Fig. 2. Technological advance masks impending production declines

To pursue my analogy, I will invent a term *Extreme Production Measures* (EPM) which applies to various aspects of global oil production just as EOR applies to individual fields. As you see in the graph just above, the use of EOR often (but not always) has the effect of pushing the production curve higher and to the left followed by a steep decline and perhaps some *reduction* in the URR (ultimately recoverable reserves). This reduction is entirely hypothetical because it is presumed that declines in the field in question would have followed a bell curve, the *natural decline* rate as cited by Skrebowski above.

The net effect then is to compress the recovery in time -- recover more oil now perhaps at the expense of future production. So let's define our new term as follows.

Extreme Production Measures (def)

- Any aggressive production technique or approach that is meant to increase short-term recovery rates or efficiency. Such techniques or approachs may also decrease longer term yields had these not been applied but that can not be known with any certainty after the fact.

What are some EPMs in the current world of oil production? Here's a short list, you may think of others.

- Tar Sands Development in Alberta. If we look at Of Oilsands and Caviar and Malthus, we learn that "Shell Canada and Western Oil Sands announced that the price tag of their

Athabasca oilsands expansion won't be $7.3 billion (Canadian dollars) as initially projected, but rather $11 billion – or 50% higher! If that's not inflation folks, then we don't know what is.... It would appear that this purveyor of abundant energy is on its way to ignominity due to spiraling costs". These spiraling capital costs are due to various factors including commodity prices (eg. steel), lack of trained workers and infrastructure in the producing region and higher energy prices (oil and natural gas) affecting the EROEI.

The attempt to ramp up the tar sands production quickly has resulted in an unsustainable development subject to radical inflation. Shell's phase 1 expansion is supposed to add 150/kbd to tar sands production but they have overreached. Read Tar Sands Sanity Check for some background. It gets worse. Consider the Globe & Mail's article Cost of Athabasca could hit $20-billion.

> The cost of the full three-stage expansion, pegged at about $13.5-billion last year, now might come in at more than $20-billion.
>
> "Intense demand for construction labour, material and supplies . . . have resulted in unprecedented increases in capital costs. This demand is further intensified in Alberta by the development of multiple oil sands projects," said Western Oil Sands Inc. in a press release late yesterday. Western, along with Chevron Corp., is a minority partner in Shell's Athabasca operation.
>
> The announcement is **the loudest statement yet that development in the oil sands north of Fort McMurray in northeastern Alberta is coming unhinged** and that the demand for steel and workers is reaching untenable levels.

Future production is now in doubt due to investor uncertainty, unprofitable economics and logistical impossibilities. One can wonder whether a slower, smaller phased development would have been better but that is The Road Not Taken.

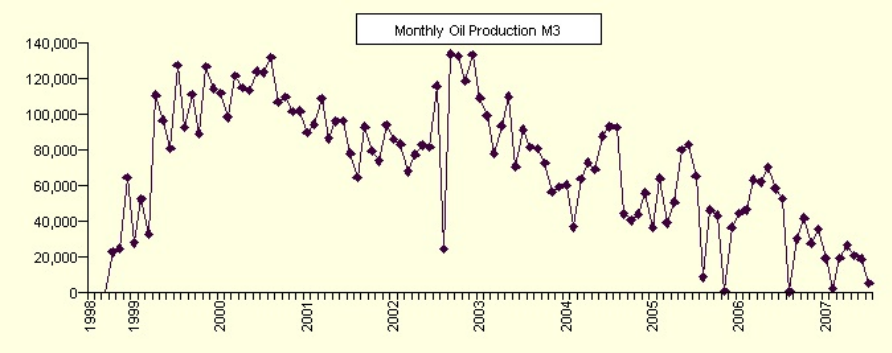
- Ultra Deepwater Drilling. If you read Byrant Urstadt's The Oil Frontier, you will see that Chevron is using a single rig to drill six scheduled wells in the Tahiti field in the Gulf of Mexico. All six wells will be put into production and are being drilled to maximize flow rates. Initial production of an anticipated total of 125/kbd is supposed to come onstream in 2008.

  From Urstadt's article.

  > "We don't want a straw down there," says [Senior drilling superintendent Curt] Newhouse. "We want to see a good 30,000 barrels a day." Stick with the bigger casing too long, and the deepest part of the well may collapse before it can be cased....
  >
  > Newhouse, though, isn't convinced the bit is close enough to the M17 sands to change the casing yet. He's thinking about the future of the well, 10 years down the road, and he wants to see a good flow, not an overly conservative casing decision.

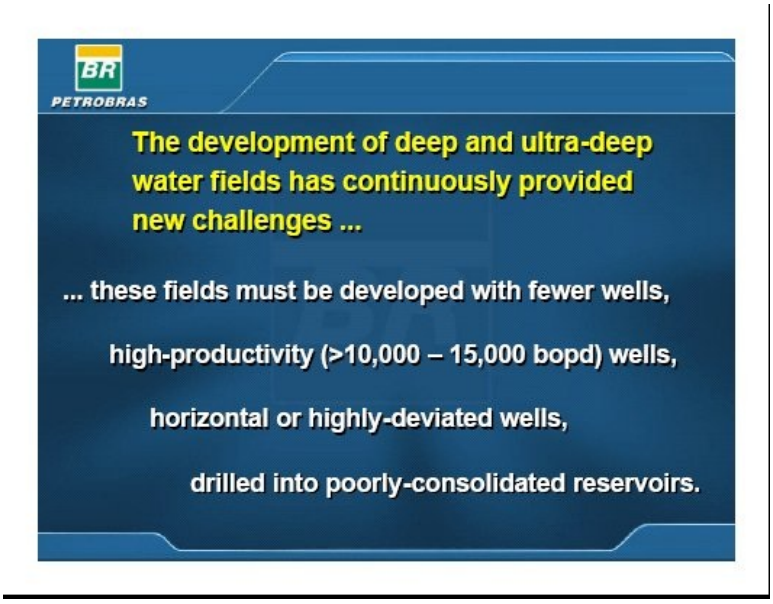
  The view here is that Chevon's Tahiti will eventually be subject to "natural declines" in the

future which mirror the experience in the UK's older Magnus field in the North Sea in which EOR was first applied (gas injection) in 1996 after a severe production decline. Note that this has not stopped the drop-off in production.

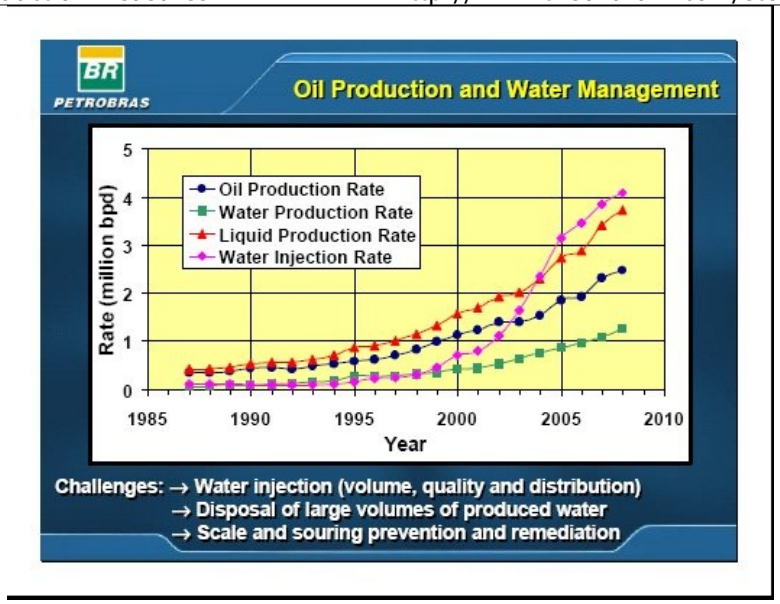


Magnus Production (1983 to 2006)
Click to Enlarge

The Magnus field had high flow rates for about 12 years before starting its precipitous decline. The field's production pattern looks little like a bell curve. Now consider these slides from How Much Oil and Gas from Deepwater? -- The Brazilian Experience by Carlos H.L. Bruhn of Petrobras E&P at ASPO 2005.



Slide 1 -- Click to Enlarge



Slide 2 -- Click to Enlarge

Slide 2 is the aggregate of production from Brazilian deepwater and ultra-deepwater fields. After you've had a chance to review both slides, consider that in this kind of production, a few horizontal wells are drilled using water injection to achieve high flow rates. The effects on recovery of deviated wells are well known from onshore areas. As you can see in *Slide 2*, the water injection rate is soaring, increasing by about 366% between the years 2000 and 2006. This has resulted in productivity gains that are substantially lower than the water injection rate. Water production, which is pacing oil production, can't be far behind. Though things may look rosy now, the pictures strongly suggest that these fields will be used up sooner rather than later followed by a Yibal-style sharp decline. Only by adding new fields will production be sustained.

My conclusion is that deepwater and ultra-deepwater production meet the criteria for *extreme production measures*. When global deepwater production peaks in the period 2010 to 2015, mostly due to diminishing discoveries, the declines may be sharp and rapid.

- Tertiary EOR and horizontal wells. This is the baseline example of an extreme production measure. Critiquing CERA's 2005 report, EconBrowser reports

> The issue seems to be that modern methods of oil extraction appear to keep production high for longer, but then it falls fast on the back side. Eg, horizontal multilateral wells at the top of the oil layer keep up much higher production than vertical wells, until the oil is pretty much gone, and then it starts to fall very fast. Similarly, regular seismic imaging of the oil in place allows rapid exploitation of pockets of left behind oil until there are none, then it's over.
>
> As far as I'm able to tell, the use of this kind of technology is now widespread. So there is an argument that global depletion will be much faster than Hubbert, Campbell, Deffeyes et al have predicted. This is the basis for Matt Simmons saying things like "If we don't address this, no scenario is too dark".

As far as tertiary recovery goes, nitrogen injection at Cantarell is fast becoming the exemplary case.

- Saudi oil production -- The current issues with Saudi Arabia are nicely summed up in Saudi Arabia's Oil A Huge Question.

> "When the price is high, that's when you want to take out your oil and sell it," said economist Ujjayant Chakravorty of the University of Central Florida. "I am wondering if they have some production issues."
>
> In the past, the Saudis have repeatedly passed up the chance to maximize short-term profits. Instead, they have seen high prices as a threat to global economies and an incentive for development of alternative energies that would threaten their cash cow.
>
> **When prices have been high, they have pumped more**.
>
> "If your concern were energy market stability and not your income level, you'd put more oil out in the market," said Amy M. Jaffe, energy fellow at Rice University's Baker Institute. "Why do they see something different now? It doesn't make sense to me."

I would like to de-mystify the question for Amy but unfortunately I can not. A standard view here at TOD is that Saudi production is peaking. For the sake of argument, I will take another stance. In this view, the Saudi's have engaged in *extreme production measures* in the past and are now realizing the folly of their ways, that time marches on. Saudi Arabia has been under a great deal of pressure from the OECD countries and their energy vehicle, the IEA, to invest more in new production. Subsequently, they have drilled more wells and put the newest Haradh-3 extension to Ghawar onstream. However, the Saudis have apparently starting restraining their production. Perhaps there has been a change in policy and the Saudis, knowing that they can not control prices or risk damage to old existing fields, have settled on a policy of preserving longer term yields. This thesis is not inconsistent with the view that their production is peaking but does not imply it. They can no longer pump like there's no tomorrow.

Skrebowski takes a data-driven *bottom-up* approach to global oil depletion while modellers like Stuart use a *top-down* view based on Hubbert Linearizations. When we consider the shape of the global oil peak, Skrebowski believes we will get to the 92 to 94/mbd range before peaking. Taken together with Hirsch, who is probably looking at the same or similar anticipated production data, it would seem that they believe that there is no "undulating plateau" as CERA envisions. Rather, there is the possibility of a sharp drop-off. Hirsch has examined various peaks at Shaping the peak of world oil production. On the other hand, Stuart believes that Hubbert Theory says Peak is Slow Squeeze.

Here I have taken another approach considering what I defined as *extreme production measures* as they apply to various aspects of world oil production, which may or may not contain an element of truthiness. Even as an artifice, this has forced me to look at things in a different way. The four examples I used all point to an intuitively obvious common element: the rush is on to get to Skrebowski's production levels without heeding the future consequences of such actions. What are the combined effects of 1) failed tar sands development, 2) likely rapid depletion in deep and ultra-deepwater production, 3) diminishing returns for applications of EOR and horizontal drilling and 4) the Saudi production history for Ghawar and it's other older fields? I don't know the future

but my intuition tells me that

- We will never see 94/mbd.
- Real declines, when they begin to occur, will be sharp, not gradual.

Only time will tell.