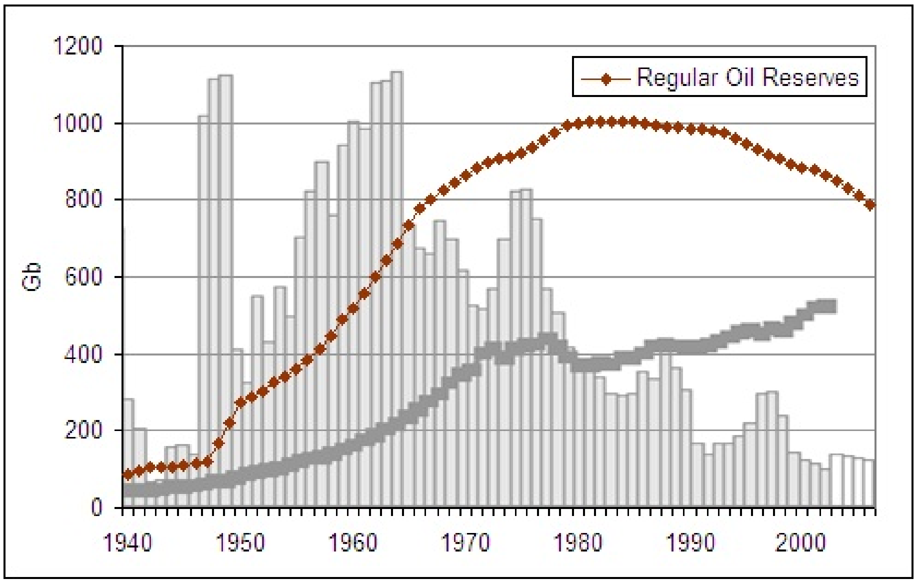
How to address Contrarian Arguments - part II

Posted by Luis de Sousa on December 24, 2006 - 12:40pm in The Oil Drum: Europe
Topic: Supply/Production
Tags: cera, non-conventionl oil, oil reserves, oil ultimate, reserves assessment, ultimate assessment [list all tags]

On this second installment of the Contrarian Arguments series we'll look into the **We have huge reserves** rhetoric.
The first part can be found here: Part I : Fundamentals

We have huge reserves, but I have bad news for you, they've been huger:



Regular Oil Reserves, as computed from Colin Campbell's "Growing Gap" graph. Data source: Exxon-Mobil backdated to year of discovery.

Warm Up

The "Huge Reserves" kind of argument is probably the most important one to address, beyond all the madness and delusional arguments like infinite oil, this one can be used be serious geologists and researchers. It is the kind of argument you can get from people that have seriously (or close to it) studied the stuff, but came up to slightly different conclusions of those got by the regular peak researcher.

At the head of the serious people taking this kind of argument is CERA, our nemesis. So we'll look closer to CERA's work and understand what differentiates our conclusions.

Before digging in to it I'd like to make one thing clear first: this argument cannot be used against the Hubbert Method, or the Hubbert way of thinking. Advocating for larger Reserves numbers will only let you put the epoch of Peak later in time, never to dismiss it. Remember the sweet chestnuts? It's like buying 150 instead of 100, the peak will come, only a bit later. Like seen below even in CERA's graph there's a peak.

A Tale of two tales

Studying Reserves is not an easy task. When doing it we are in some way looking in to the future, because they tell us in what point of depletion are we, projecting a picture of how we'll fare.

Declaring reserves is a political act, one must never forget about it, and that's why it is so hard to get a clear picture of the real situation. When declaring reserves companies have two worries:

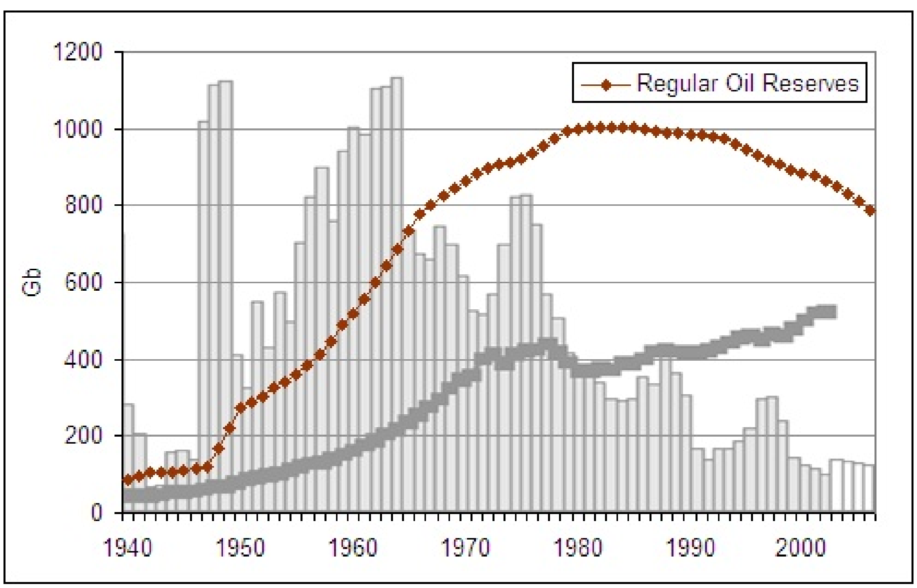
- Avoid taxes, in the case of Private Owned Oil Companies;
- Take hold of a good share of production, in the case of OPEC's State Owned Oil Companies.

So current reported Reserves suffer from both these evils: over-reporting and under-reporting. As we'll see ahead the later was stronger in the past, whilst the former has taken over during the last two decades. This means that public declared reserves by both private owned and state owned companies have never matched to the physical reality.

In order to correctly access the amount of remaining Reseves it is imperative to compensate for both these artifacts. Chris has already linked us to a very important article on this subject by Roger Bentley, I recommend it too.

Above all Reserves are dwindling

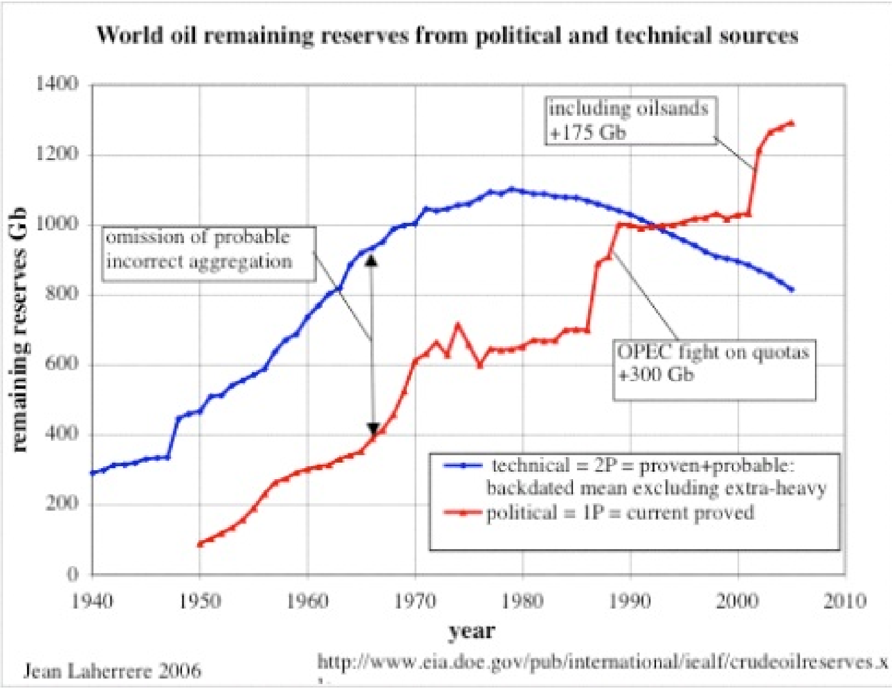
The graph shown on epigraph was obtained by computing existing reserves on each year using the Growing Gap graph published every month on the bulletins compiled by ASPO-Ireland (Colin Campbell & Uppsala). This graph depicts discovery backdated to the original year of first successful drill, and not to the year of reporting. This technique eliminates the artifacts of under-reporting used by private owned Oil Companies in order to avoid taxing. The data reports to Regular Conventional Oil, defined as light liquid hydrocarbons found on land and on sea above 500 meters deep, using Exxon-Mobil's data. Current Reserves are estimated at 790 Gb, computing it backwards in time we get this:



Regular Oil Reserves, as computed from Colin Campbell's "Growing Gap" graph. Data source: Exxon-Mobil backdated to year of discovery.

The picture is clear; a plateau circa 1000 Gb was reached in the early 1980s followed by a decline that set in from 1984 onwards. A clear downward trend is being felt for more than 20 years, and the rate of decline is accelerating.

A view from another angle can be taken from Jean Laherrère's multiple works. Jean uses two databases, one from IHS Energy and another from Wood-Mackenzie, and he also compensates for the reporting artifacts, computing what he calls Technical Reserves (Proven + Probable), opposing to the Political Reserves:

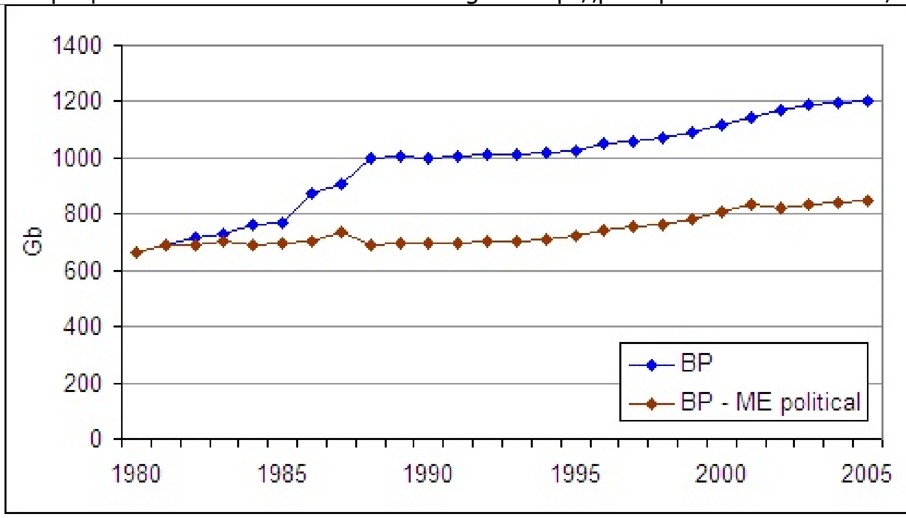


Conventional Oil Reserves from Political and Technical sources. Compiled by Jean Laherrère using data bases from IHS Energy and Wood-Mackenzie.

This graph reports to Conventional Oil, defined as light liquid hydrocarbons no matter were found. A peak in 1979 circa 1100 Gb is quite clear followed by a decline up to today's 800 Gb of remaining Reserves. Again a downward trend has clearly set in, a steady decline of more than 25 years.

In Jean's graph the artifacts of under- and over-reporting are very clear. In 1950 declared Reserves were around 100 Gb, in 1960 stood around 300 Gb and in 1970 even after the Middle East discovery galore they were just above 600 Gb. This was the time of private Oil Companies. Reserves remained pretty much unchanged for over a decade (in spite of major discoveries in the 1970s) until the mid-1980s. Then an oil price collapse brought some restrains on production, triggering a fight between OPEC countries for production quotas. The National Oil Companies became the most important elements in the market. A slow end for the private owned companies unfold, with mergers covering the fact of rapidly dwindling reserves on private hands.

To complete this section I'll give a view from another angle still. The handy BP Statistical Review shows "proved" Reserves of 1200 Gb at the end of 2005. BP has been sane enough not to include heavy tar sands on the final accounting, meaning that by compensating solely for OPEC's political additions we can get close to physical figures. Using Middle East Reserves as assessed by Ali Samsam Bakhtiari (Peak Oil Review Vol.1 No.7) we get this:



Conventional Oil plus NGL Reserves from BP's Statistical Review. Blue - raw data. Red - corrected for over-reporting in the Middle East using Samsam Bakhtiari's estimates.

We don't get a declining curve, but computed like this the figure for 2005 is 850 Gb. This figure also contains Condensate and Natural Gas Liquids and it still includes political reserves for Venezuela. If a backdating process was used a declining curve would be a likely outcome.

Three models, four databases and the Reserves numbers dist 60 Gb between them. As for Conventional Oil the time of increasing Reserves is long past.

Using Mathematics to see the Future

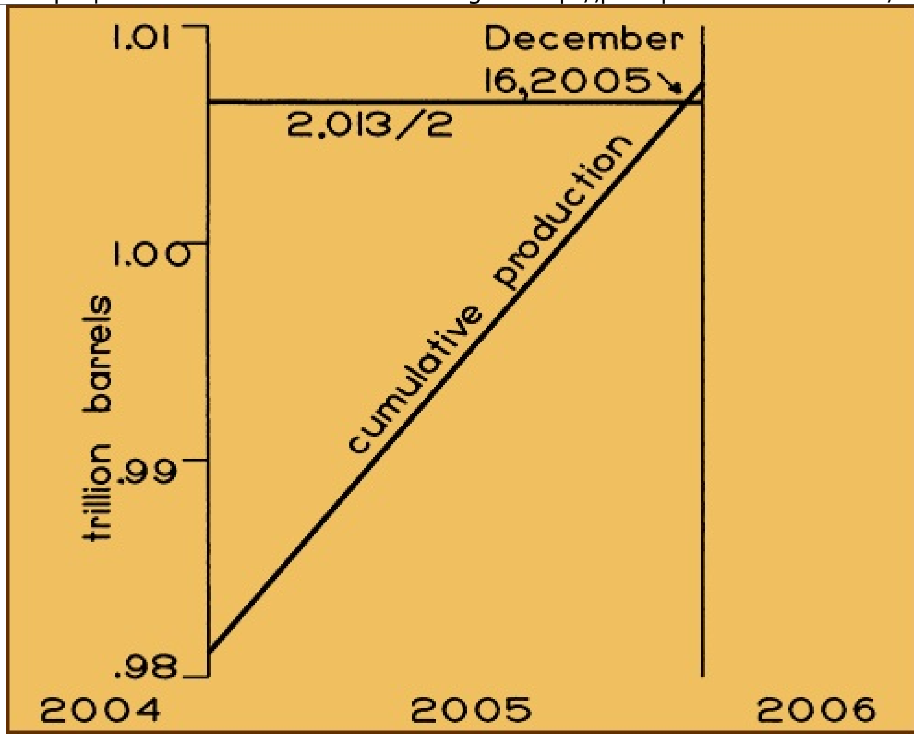
Beyond these techniques of looking at reported Reserves and compensating for bad reporting habits, several mathematical tools are available for assessment of Ultimate Reserves.

Ultimate Reserves can be defined like this:

- all the oil that we've already used plus
- all the oil we know to exist plus
- all the oil that we still don't know to exist but will be sometime in the future found and used as well.

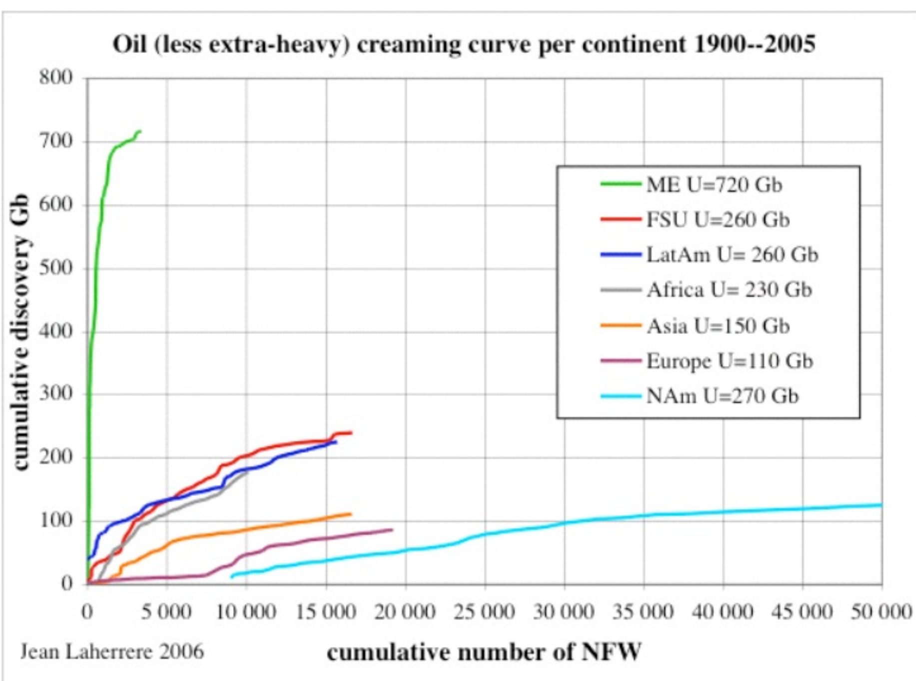
First of all: dear old Hubbert's Method. A simple technique that has a single magic step of assuming that the plot of P/Q versus Q follows a straight line (P - production at each year, Q - cumulative production at each year). See how Stuart Staniford introduced it for All Liquids to TOD here.

Using this method for Conventional Oil (the same definition used by Jean Laherrère) Kenneth Deffeyes arrived at an Ultimate Reserves number of 2000 Gb.



Kenneth Deffeyes' graph showing the mid-point of depletion crossed in late 2005. Deffeyes arrived at an Ultimate of 2000 Gb using Hubbert's Method; in 2005 Cumulative Production went over 1000 Gb.

Secondly, the Creaming Curve. This was a technique invented at Shell, and is defined by Jean Laherrère as being "the plot of cumulative mean discovery versus the cumulative number of exploratory wells". This plot follows a hyperbolic curve (or a sum off hyperbolic curves), and can be modeled that way. The magic step is this: with time discoveries go down in volume, and although you drill more the total volume of your findings is less. Experience from mature regions has been showing this assumption a correct one, the low hanging fruit goes first. Here's Jean's data for each global region:

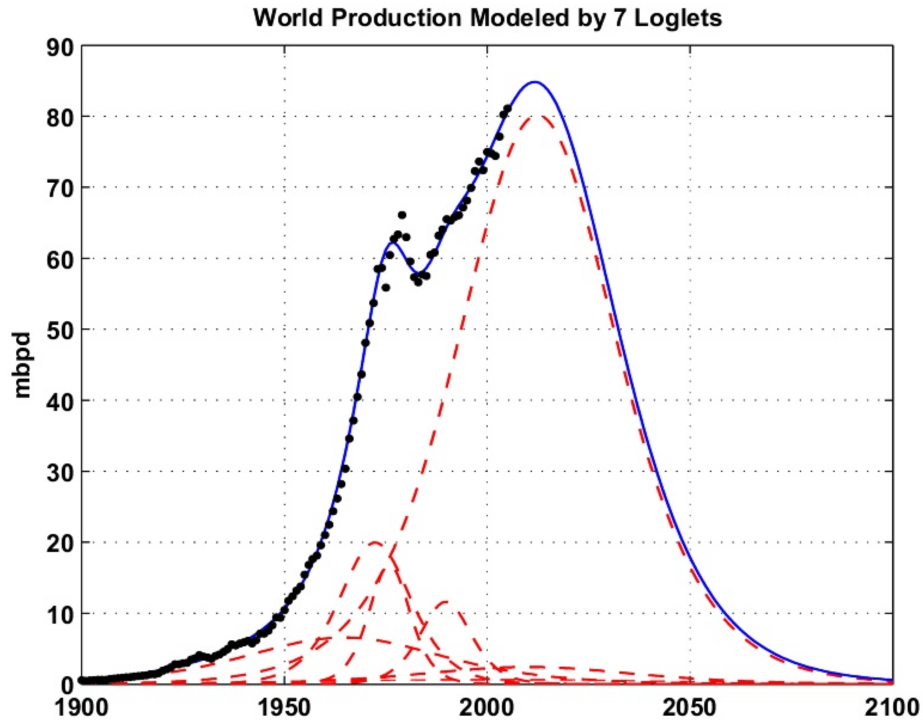


Creaming curves for several different global oil regions. Adjusting hyperbolic curves to these data Jaean Laherrère arrived at a global Ultimate of 2000 Gb (note the geographic dispersion).

Click to enlarge.

Again 2000 Gb for the Ultimate Reserves. Jean usually calls our attention to the evenly geographic distributed pattern that this graph shows. Some regions, like Europe were not privileged by Fortune in what comes to hydrocarbon endowment.

And thirdly a recent technique introduced to us by our Canadian peer Khebab, the Loglets Transform. This technique comes from the Hubbert Method family, but it looks at the data considering the hypothesis of several curves being concurrently driving events. Instead of using a single Logistic Curve we use several to see if it gets closer to the data. Here's Khebab's graph:



The seven logistic curves identified by the Loglets Transform for World Conventional Oil + NGL production. The net Ultimate is 2100 Gb. Click to enlarge.

2100 Gb, a slightly different number but this one includes NGL, which the previous models did not; taking out this extra the result is essentially the same. Using the Loglets Transform seven different curves can be identified, but we get a number for Ultimate Reserves pretty close to that got with a single curve. The Loglets Transform allows us to get a clear picture of how production evolves over time, but interestingly it confirms the result got from the Hubbert Method.

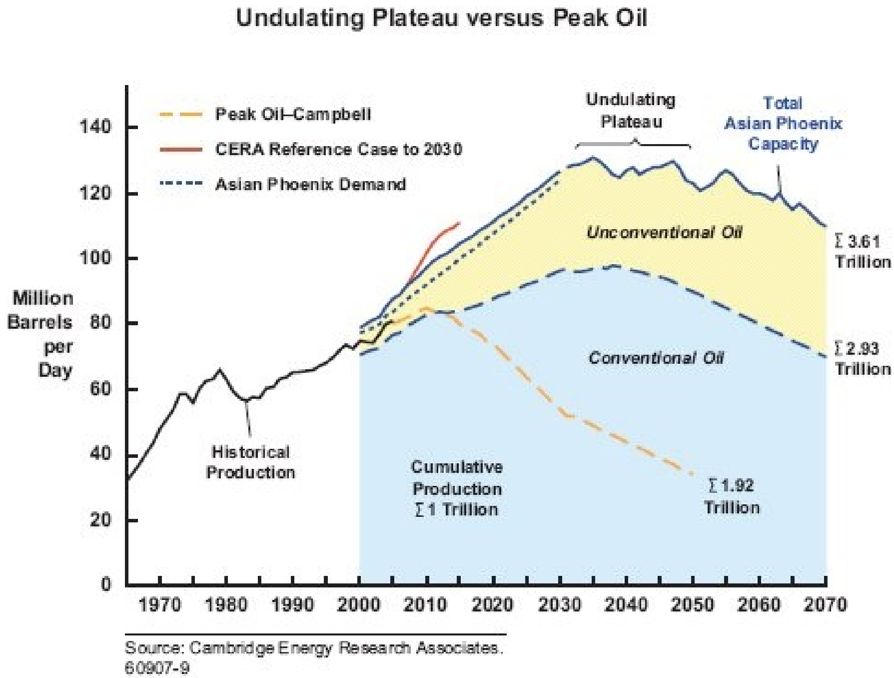
Three different mathematical techniques, one result.

From the previous section we got that current Reserves stay somewhere circa 800 Gb, the 2000 Gb figure given by the math models for the Ultimate confirms this number, with around 200 Gb yet to be found in a slow, declining, expensive, discovery process.

Kenneth Deffeyes' projection of the mid-point of depletion in 2005 was labeled as bold and pessimistic. It isn't, it is a sound result from a sound mathematical method. Passing the mid-point of depletion doesn't mean exactly that a production decline sets in immediately, it just means that the oil used up to that moment is equal to that left to use. But it means that a decline is at hand (like 2010-2012 when deep offshore production peaks).

And what about CERA's ?

Let's have a look into the figures that support the argument that Peak Oil is still a bit further in the future. We'll use CERA's numbers, for they seem to be the best paid of this bundle, but the following words apply broadly. Here's CERA's graph:



CERA's outlook for Conventional and Non-Conventional Oil production. Up to 2070 the Ultimate for Conventional Oil is already 50% larger than that given by mathematical methods.

Peak Oil is a myth to CERA, but not for their graphs, Conventional Oil is projected as clearly peaking circa 2040; on top of that is a convenient All Liquids plateau. What really demarks the mathematical results from CERA`s is the Ultimate: for CERA cumulative production will go over 2900 Gb in 2070 implying an even greater Ultimate.

From the above it is clear that CERA isn't using a mathematical approach to Ultimate estimation. CERA uses a Bottom Up analysis to forecast future production, adding up the flows from fields currently in production to fields in development or with perspectives of development. Euan as looked closer to the way they do it in his [assessment of UK production].

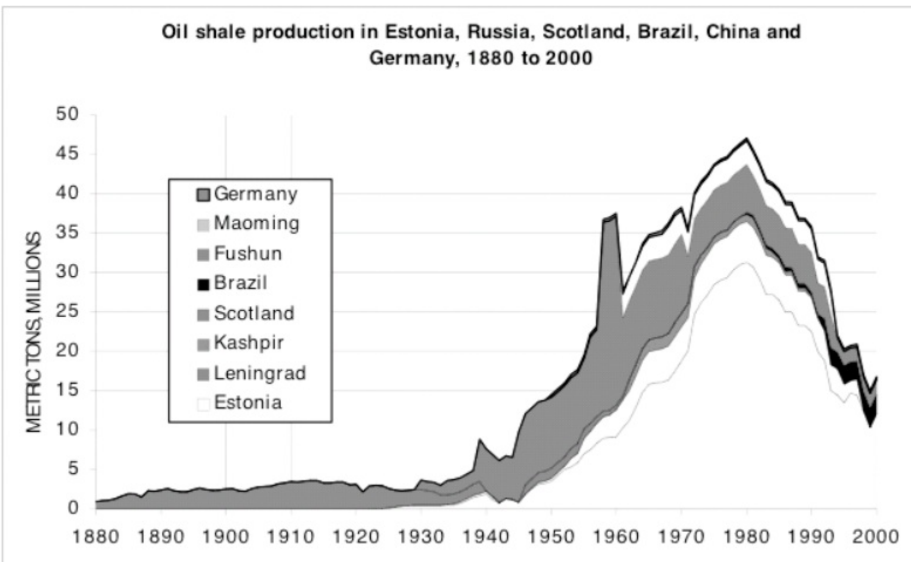
There's one thing that makes me wonder, how can such analysis predict a peak in 2040? Moreover, how can you forecast Ultimate Reserves with such analysis? You can't forecast Ultimate Reserves with a Bottom Up technique because you can only account for currently known fields. So how can CERA's projection be at least 50% above that given by three different mathematic techniques? Even counting with political reserves the Ultimate from BP for instance would be 2300 Gb, where will almost another 1000 Gb come from?

In the end this can amount to a "my model is better than yours" discussion. I don't' like CERA's, CERA don't like mathematics. But one thing is for sure, CERA is waiting for a new cycle of discovery that will amount to more than 1000 Gb, meaning that at least four new Saudi Arabias will be discovered in the near future. Yes near future, because with current known Reserves and depletion rates, decline will surely set in before 2015. Take for instance the Lower Tertiary in the Gulf of Mexico, it was discovered in the early 2000s, but will come on stream by 2013 (all things going right) a gap of more than 10 years. So CERA's implicit new discovery cycle will have to come really fast and against all current trends.

Non-Conventional Reserves

Non-Conventional Oil Reserves have to be considered separately for a simple reason, the EROEI of these energy sources is lower than that of Conventional Oil. Resource numbers can be huge but Reserves are considerably lower, production rates will never get close to those we get for Conventional sources today.

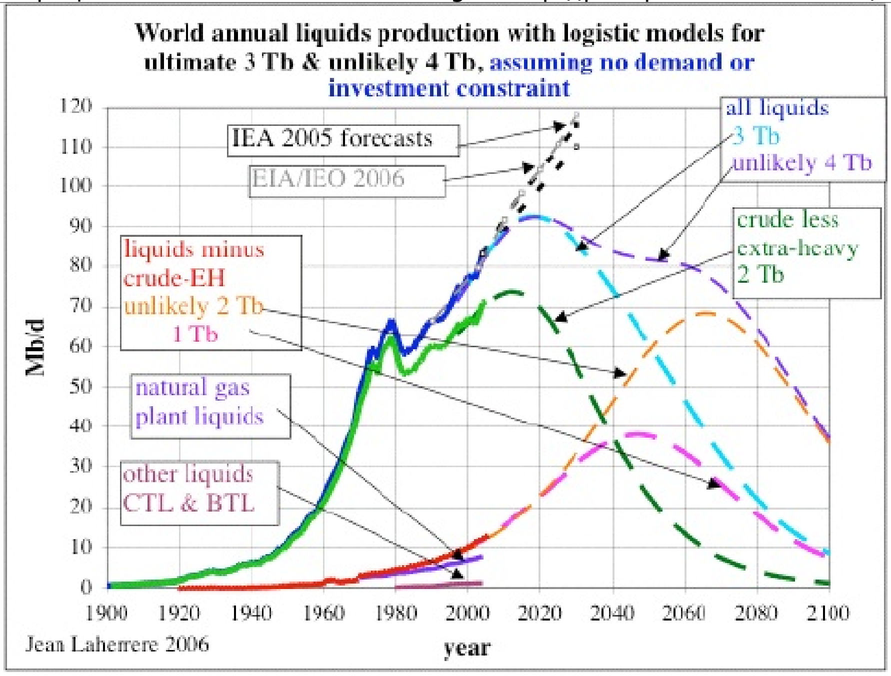
Oil Sands suffer not only from a very low EROEI (negative?) but also from spatial constraints that limit the amount of final liquids produced. Heavy Oils also have to be pre-refined at the production site in order to facilitate its transportation using Conventional Oil infrastructures. A good example is that of the Orinoco basin which also yields an immense Resource, but production stands at 650 kb/d and will probably never go over 2 Mb/d. Shale Oil Reserves are also huge, but production is marginal, and peaked in 1980:



source: Illustration #21 from paper: Origin and resources of some world oil shale deposits, by John R. Dyni, U.S. Geological Survey, Denver, CO, USA, presented at the Estonian Oil Shale Symposium, Tallinn, Nov. 18-20, 2002.

World Oil Shale production breakdown by country of origin. Click to enlarge.

Even CERA acknowledges these lower prospects for Non-Conventional Oil in spite of the Resource numbers. In CERA's graph the cumulative production from Non-Conventional sources is 700 Gb, peaking at a rate circa 40 Mb/d. This is very close to Jean Laherrère's lower assessment of an Ultimate of 1000 Gb with a peak rate of 40 Mb/d:



Jean Laherrère's outlook for Conventional and Non-Conventional Oil production. The lower case for Non-Conventional Oil is very close to CERA's.

In sum, Non-Conventional Reserves are yet to be mater of disagreement between early peakers and late peakers.

Conclusions

Knowing the Ultimate Reserves accurately can give a clear picture of where the mid-point of depletion stands in time, and in tandem the unfolding of production decline. It's not easy to assess correctly Reserves numbers for exiting bad practices of Oil Companies in reporting.

Looking at four different databases for Conventional Oil Reserves (Proven + Probable) and correcting the numbers for reporting artifacts we get a number around 800 Gb. The decline in oil discoveries means that this value is dwindling for at least 20 years.

Using three different mathematical methods we can estimate the Ultimate Reserves, which in all cases stays around 2000 Gb, of which roughly 1000 Gb have been consumed. This is in line with the Reserves number of 800 Gb, and the decline trend of discovery, meaning that 200 Gb of producible Conventional Oil is left to find.

In light of this it is hard to support Ultimate Reserves numbers in excess of 3000 Gb for Conventional Oil, like CERA and others put forward. There's no indication at present of any region in the world that could have such amount of unknown Reserves. If existent this(these) region(s) have to be found in the short term to avoid the final Peak in Conventional Oil production.

As for Non-Conventional Oil, there seems to be a general view that in spite of large Resource numbers, the producible Reserves are much lower. There also seems to be consensual that these Reserves can never be tapped at the same rates that Conventional Oil is today.

Advocating larger Reserves can not be an argument against Hubbert's Peak and seems a weak one in pushing the Peak date further in to the future.

Previously on the Adressing Contrarian Arguments series:

Part I : Fundamentals

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