Interview with Jean Laherrère

Posted by Luís de Sousa on July 31, 2007 - 6:12pm [Edit this story]
Topic: Supply/Production
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Jean Laherrère kindly agreed to give an interview to TOD:E by e-mail. For several years he was virtually the sole researcher modelling Coal depletion in the same vein it is done for Oil and Gas. Despite being considerably different from the common sense of limitless Coal, his forecasts were this year confirmed by several studies and reports. TOD:E got some comments on this matter as so on the general Fossil Fuels depletion picture and our future beyond them.

TOD:E : *You have been calling for a thorough assessment of future Coal production for some time, claiming that Coal has been wrongly regarded as a virtually infinite resource, and that it will likely peak circa 2050. Since the beginning of the year we had several studies made public, that not only confirm your views on Coal, but show a peak even sooner. Remarkably, two different studies, one by the Energy Watch Group (EWG), another by David Rutledge (California Institute of Technology) point to a Coal peak by 2025. What do you think of these studies?*

JL : Both studies are good and rely on BGR (German Federal Institute for Geosciences and Natural Resources) reserves and resources presently known, but it is hard from BGR data to estimate the coal ultimate recovery, because most of coal resources will stay as resources in the ground without being converted into reserves. The Zittel group (EWG) is right to say that data is of poor quality, because contrary to oil and gas there is no scout company collecting technical coal data and compiling a homogeneous world coal inventory. IEA, WEC just give the list of what national agencies report and these data are heterogeneous because nations usually report very optimistic values and there are no strict rules of coal reserves (and resources) definitions. There is always confusion between reserves and resources.

Furthermore in oil and gas fields, pressure gives an indication of the decline, there is not such thing in coal production. Also the conversion of hard and brown coal into barrels of oil equivalent (boe) is difficult and usually a wild guess.

My coal ultimate is 1000 Gt (or 600 Gtoe), because in front of uncertainty I prefer to choose a round number than an accurate wrong one. Using the Hubbert Linearization can lead to wrong estimate when the plot displays several linear parts.

Zittel, and also Rutledge, rightly emphasize the large decreases of coal reserves in countries as Germany and the UK and they use a world ultimate close to mine, taking mainly only BGR reserves. Their coal peak is in the same range.
I always say that my plot of ultimate by a bell-shaped curve with a smooth peak is what the geology can offer, but constraints from the demand and investment may

change it into a bumpy plateau.

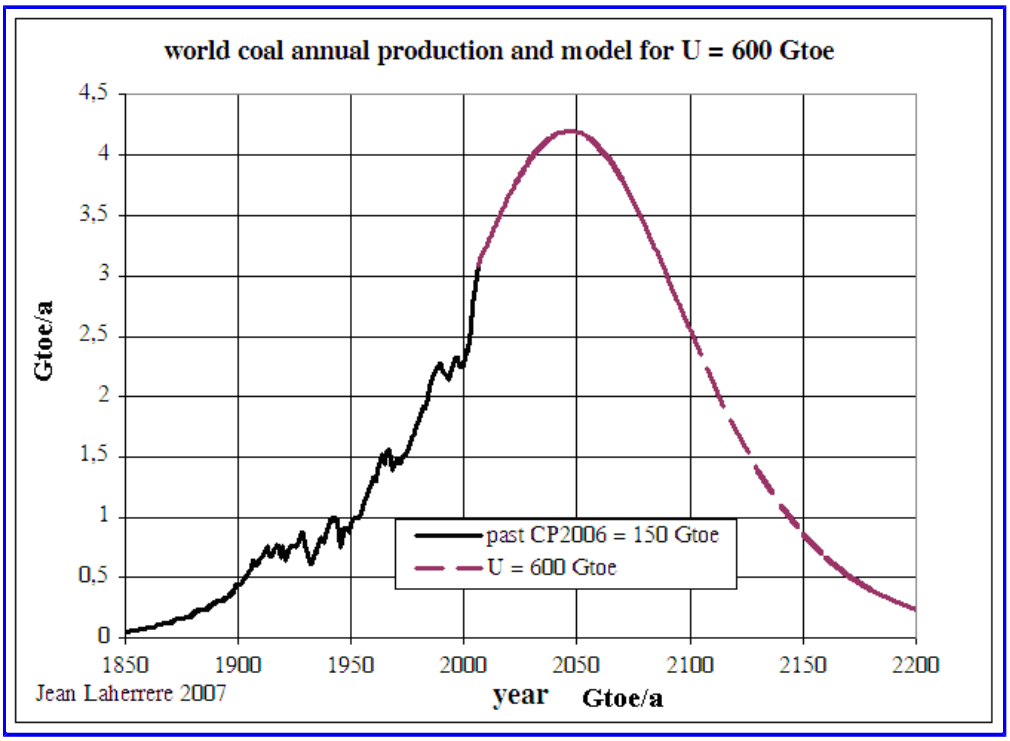

Figure 1 - World Coal production with an ultimate of 600 Gtoe. Click to enlarge.

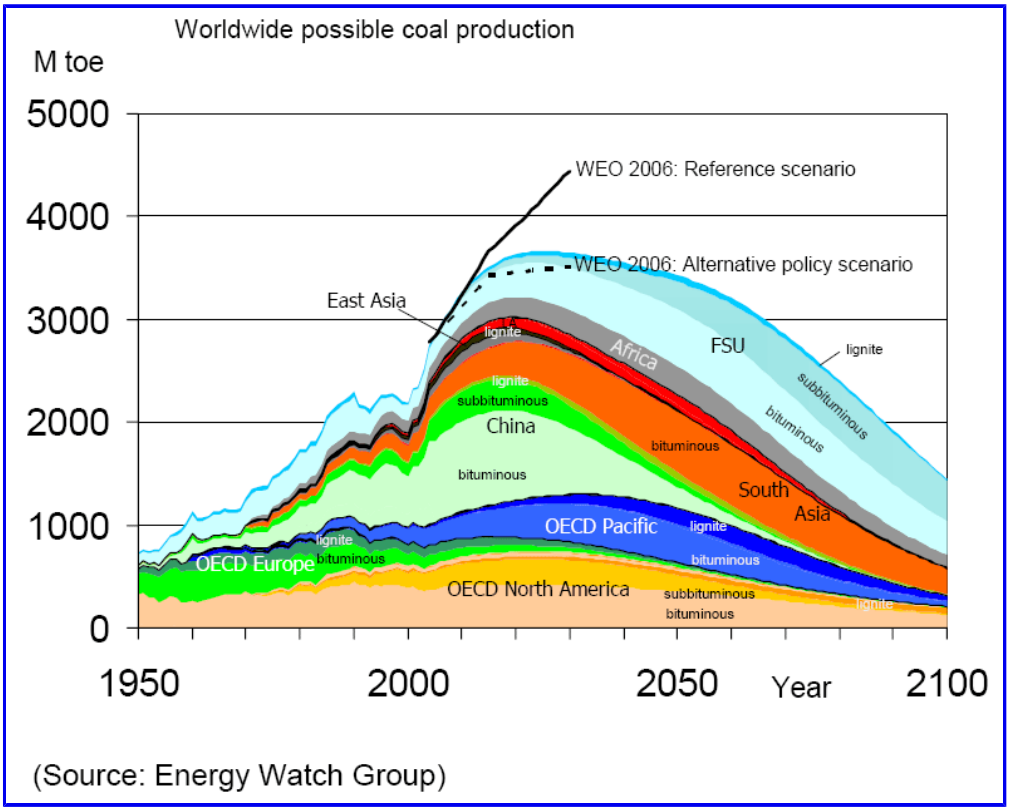

Figure 2 - World Coal production as forecasted by the Energy Watch Group. Click to enlarge.

The main coal producer China is difficult to forecast because of the unreliability of data, but using an ultimate of 150 Gt (past production 40 Gt plus the 114 Gt EIA estimate) the peak is around 2,5 Gt (2,2 in 2005) in 2020, in agreement with Zittel. This explains why China is already importing coal. But BGR reports for China

remaining reserves of 115 Gt but also 975 Gt of resources. How much of those resources will be converted into reserves?

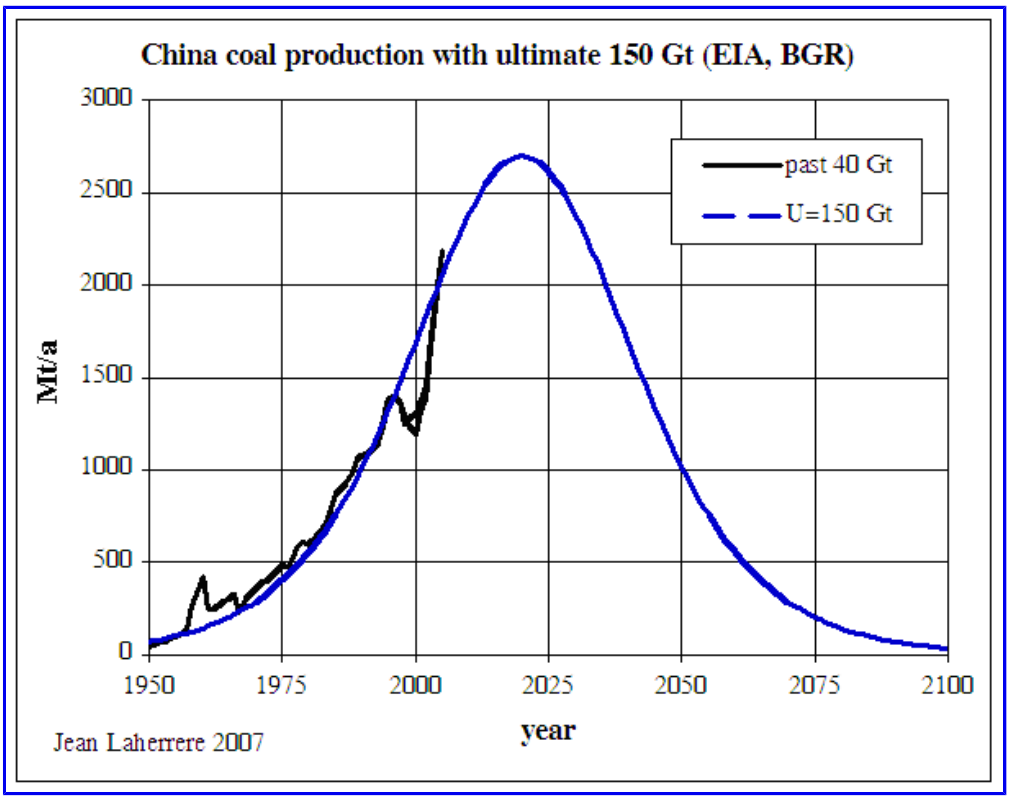

Figure 3 - Chinese Coal production with an ultimate of 150 Gt. Click to enlarge.

But BGR (Thielemann, Schmidt and Gerling) has just published in the International Journal of Geology 2007 an article «Lignite and hard coal : Energy suppliers for world needs until the year 2100 –an outlook» which is much more optimistic, forecasting no bottleneck in coal supplies and a large potential for CTL.

So, the same data can lead to completely different views.

TOD:E : *Do you think we can have a new Coal cycle here in Europe, by re-activating old mines?*

JL : I am an oil explorer that knows nothing about coal mining, but I see that France has closed in 2004 the last coal mine and has rejected a Scottish proposal to open a surface mine. France more likely will never produce anymore coal, while the BP Statistical Review 2007 is reporting reserves of 15 Mt (hard coal) with an R/P of 30 years. France has no more coal reserves, only coal resources!

France can do so because 80% of its electricity is nuclear, but other European countries cannot refuse nuclear and stop coal mining when oil and gas production is in decline in Europe. Germany is reported by BP as having 183 Mt of hard coal and 6556 Mt of brown coal; the BGR reports 161 Mt reserves + 8384 Mt resources of hard coal and 6556 Mt reserves plus 76 396 Mt resources of soft coal.

So you have to ask Peter Gerling about re-activating old mines in Germany.

TOD:E : *Can off-shore Coal exploration be important in the future?*

JL : As far as I know, offshore coal exploration is done by oil and gas explorers because they log coal measures when drilling. And they found plenty of coal in the North Sea (some being the source-rocks of oil and gas). But offshore coal is considered as uneconomic at the present and the BGR does not count offshore as deep coal because of EROI.

But Underground Coal Gasification (UCG) may change the problem, if successful. I do not know too much on UCG except that many experiments have been carried out, but nothing commercial is in operation now, despite some claims by Ergo Exergy: all onshore.

UCG has a long history. The first UCG patent is from 1909, the Soviets were keen about UCG and had commercial plants in 1937, but dropped them in the 60s after the large natural gas discovery in Western Siberia. See the paper by A.Beath & B.Davis «UCG history» 14 Nov. 2006 Kolkata. It is for deep or thin coal onshore and not a word on offshore coal.

TOD:E : *You have been issuing serious warnings on the Natural Gas (NG) situation, both here in Europe as in North America. How far are we from having trouble?*

JL : I did warn first on North America natural gas peaking few years ago and my graph was in the WEC programme of studies 2002-2004 report «Drivers of the energy scene».

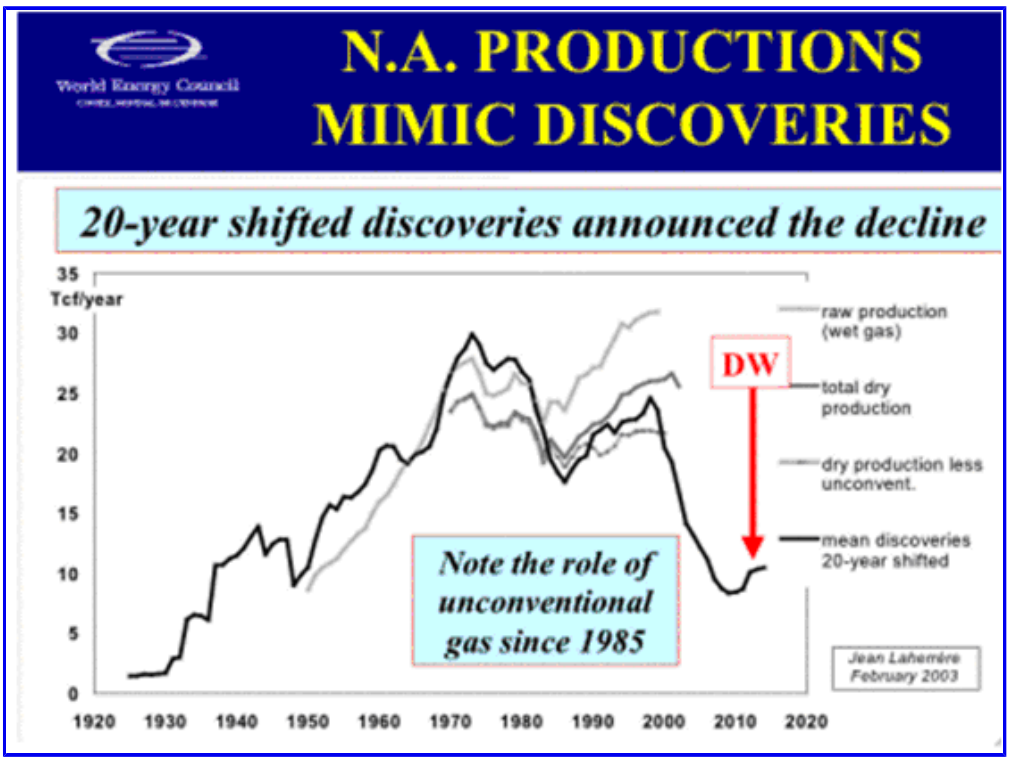

Figure 4 - Jean Laherrère's North American Natural Gas graph as published In the WEC programme of studies 2002-2004. Click to enlarge.

The US was counting too much on Canadian gas supply but they changed completely from increasing NG imports in AEO 2003 to decreasing imports in AEO 2004 (Laherrère, J.H. 2004 «Future of natural gas supply» ASPO Berlin May 25-26 - pdf).

Then I issued a similar warning for Europe because European NG production is peaking and the overestimation of NG reserves in the FSU (due mainly to a Russian classification based on maximum theoretical recovery giving 3P reserves and underinvestment in the Yamal Peninsula)

TOD:E : *To what extent can Coal Bed Methane (CBM) help ameliorate the situation?*

JL : The US has the largest coal reserves but the USDOE is forecasting a peak in CBM, despite heavy drilling. CBM production needs frac operations and to get rid of a large quantity of water, before and during production.

US NG production is declining despite a large increase in the number of producing gaswells (many being CBM). The US NG peak was at 22 Tcf/a in 1973 with about 100 000 gaswells, 2005 production was at 19 Tcf/a with 400 000 gaswells.

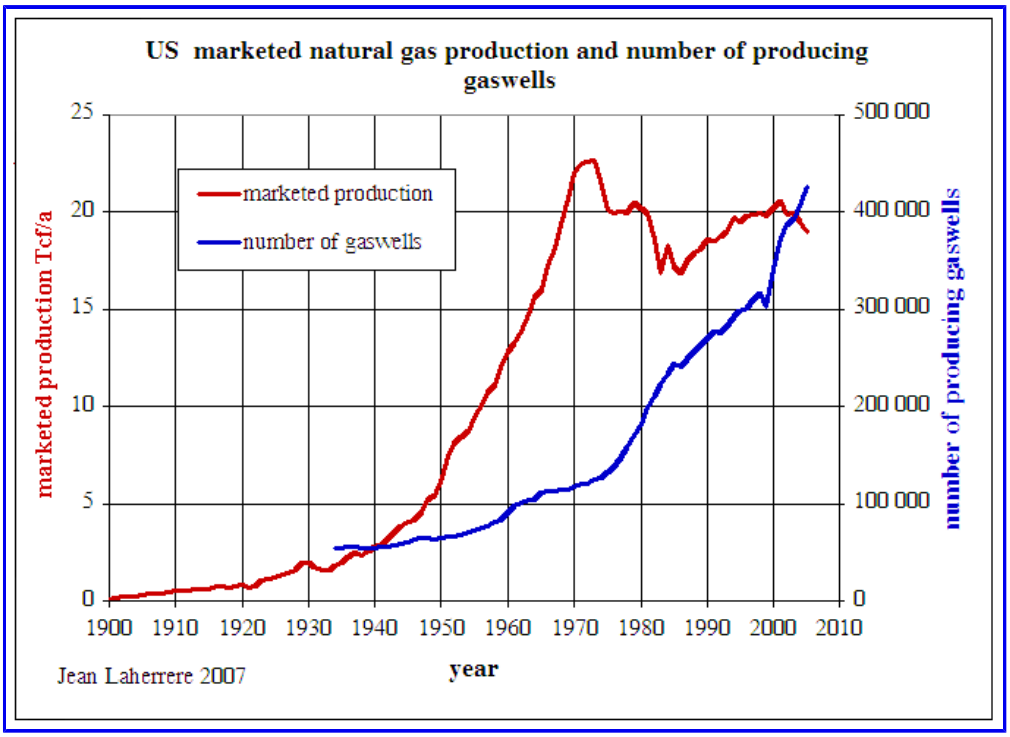

Figure 5 - US Natural Gas production and producing gaswells. Click to enlarge.

US CBM is a small part (tight reservoir is larger) of unconventional gas and the USDOE AEO 2005 forecasts a plateau in 2010 when the conventional production will be in sharp decline.

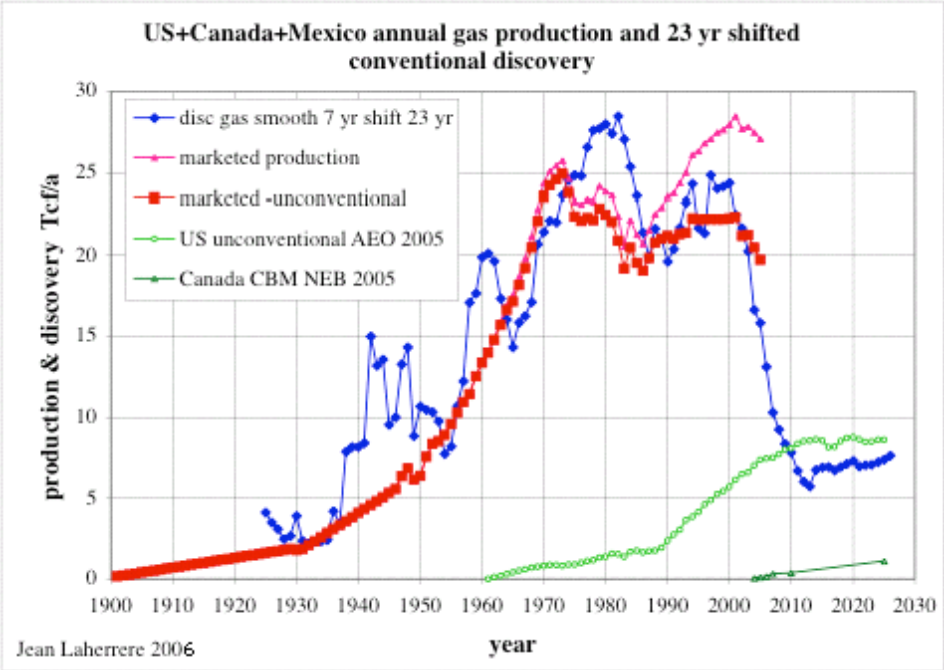

Figure 6 - North American Natural Gas production and shifted discovery.

Canada CBM with large coal reserves will not help much either, because CBM drilling in 2007 is down (lower price) and the CAPP 2007 forecast is less than 1 Tcf/a in 2020.

TOD:E : *Regarding Oil, last year you were saying that a bumpy plateau was more*

likely than a peak. Looking back, the past 3 years look very much like a plateau; is this it, the final plateau? How long do you think it will last?

JL : When showing forecasts with bell-shaped curves, I have since several years warned that because of constraints the peak would be in fact a bumpy plateau.
World oil liquids is indeed presently in a plateau between 84 and 85 Mb/d since May 2005, when it went over 85 Mb/d; the last April production was 84.3 Mb/d, from table 1.4 of EIA. But the present two years step can be as the one in 2001 and 2002.

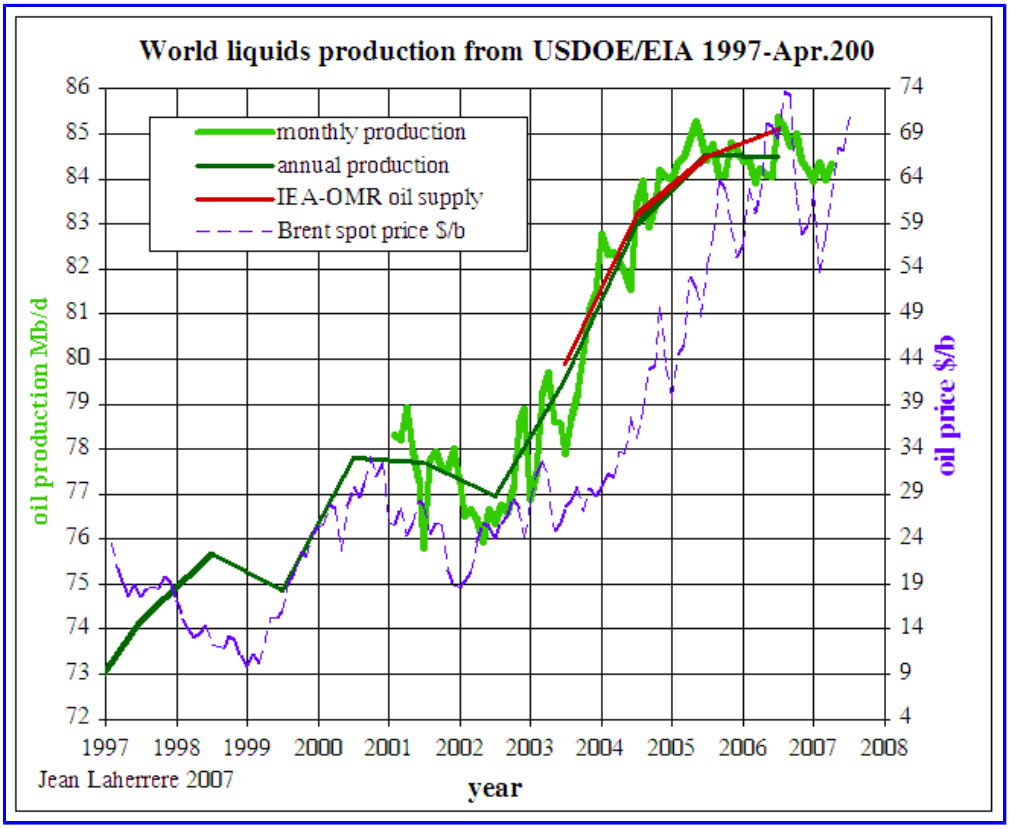

Figure 7 - World Liquids production 1997 - 2007. Click to enlarge.

For short term the problem is not the size of the tank (reserves and ultimate) but the size of the tap and the way the tap is partly closed by political constraints as insecurity in Iraq, Nigeria or nationalisation (Venezuela, Bolivia, Russia). Also the demand may decrease if there is a world recession and the US housing bubble is a bad sign for a country that has negative savings when borrowing 80% of the world savings!

The best approach for knowing what will be the world production of the next ten years is to look at all the megaprojects, as did Chris Skebowski. After a few revisions where he corrected the optimistic statements in volume and timing, he now forecasts a peak in 2011 at 91 Mb/d. Skrebowski is right to expect time delays (well illustrated by the MacNamara law where the ratio for frontier projects between initial and final is about “pi” for costs and “e” for time) because most megaprojets are late by several years, as Kashagan in the Caspian, Thunder Horse in the Gulf of Mexico, Athabasca new plants, etc.

I trust his forecast for oil, but he is not counting the BTL (biofuels) (large increase in volume, but small in global %) included in the oil supply of 85 Mb/d in 2006 and he has to guess what will be the decline of the present production.
CERA did the same approach and arrived to a completely different result with supply in 2010 being around 100 Mb/d. The difference is mainly due to CERA believing in the optimistic statements of future production but also of decline of present production.

It is hard to say what will be the decline of present world producing fields, because of

the lack of data in the Middle East and also quotas. Production mimics discovery with a certain lag and R/P trends towards an asymptote (Broto E. 2006 «General method to set up infinite limit of R/P» poster ASPO 5 Pisa).
R/P is a very poor parameter for forecasting, but it is often used by many.

So at the end of production R/P is constant as:

$R=kP$

If there is no new discovery:

$\Delta R=-P$ and $\Delta R=k\Delta P$

The depletion is:

$\Delta P/P = \Delta P/-\Delta R = -1/k$

The depletion is the inverse of R/P. In Pisa I modelled world R/P trending towards 20 years.

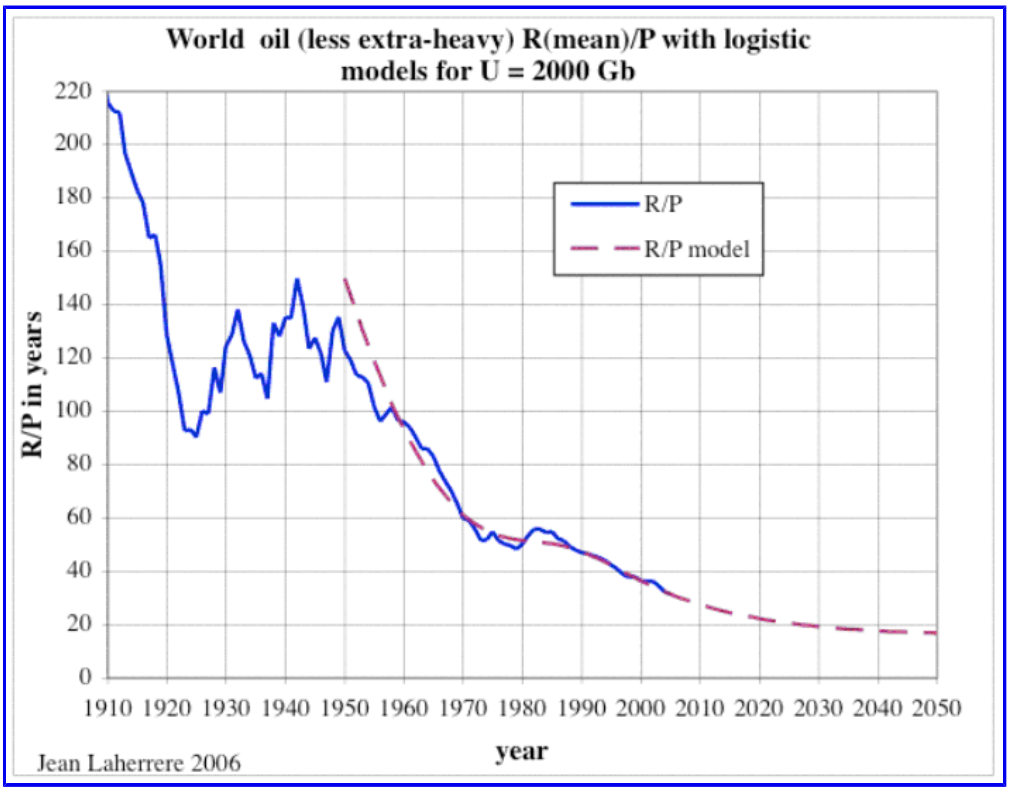

Figure 8 - World R/P trend for Oil. Click to enlarge.

So world depletion should be trending towards 5% (1/20).

In 2005 I plotted for several European countries (France, UK, Norway, Netherlands, Germany) R/P and R/P/depletion. R/P being at the end the inverse of depletion, the ratio is trending towards 1. In Europe oil depletion seems to trend towards 10%.

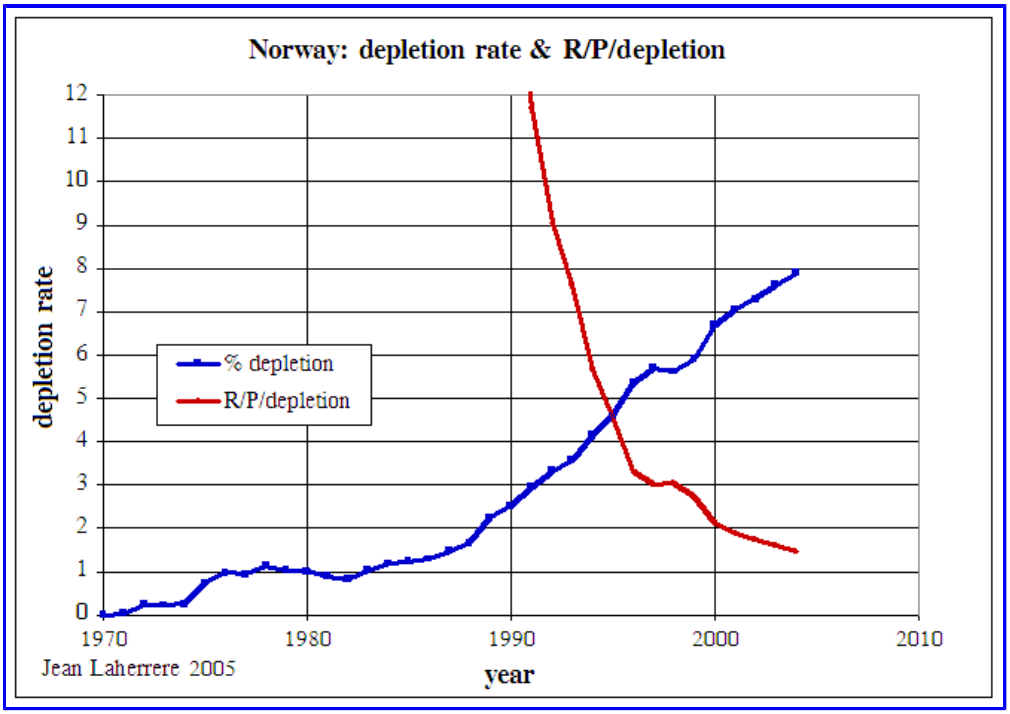

Figure 9 - Depletion rate and R/P/depletion for Norway. Click to enlarge.

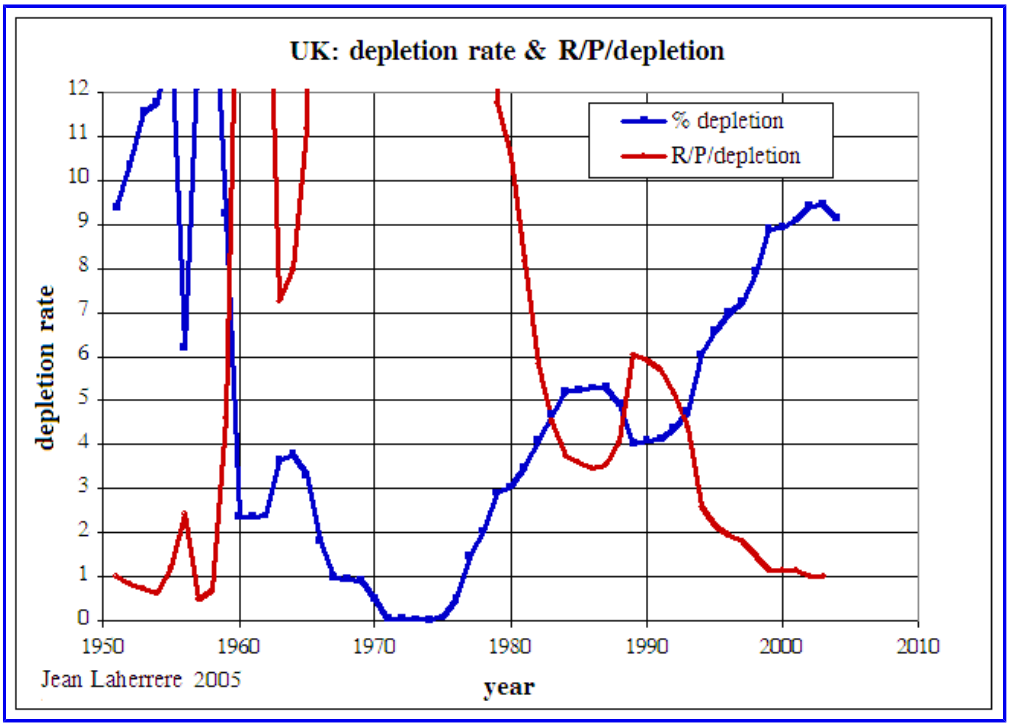

Figure 10 - Depletion rate and R/P/depletion for the UK. Click to enlarge.

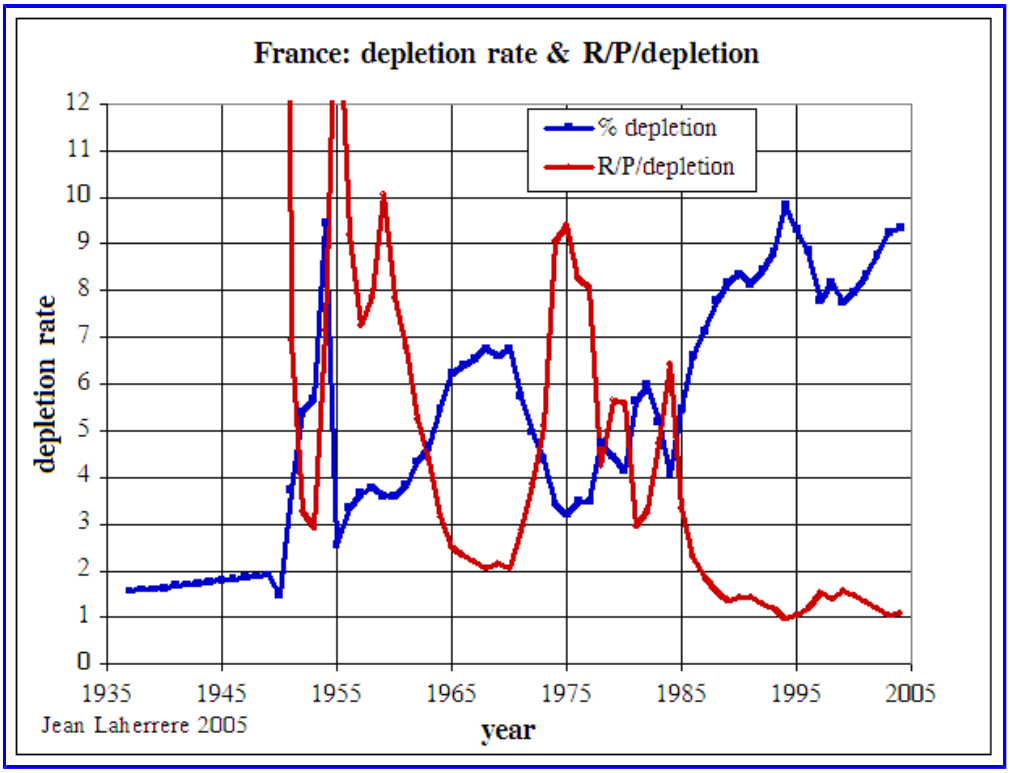

Figure 11 - Depletion rate and R/P/depletion for France. Click to enlarge.

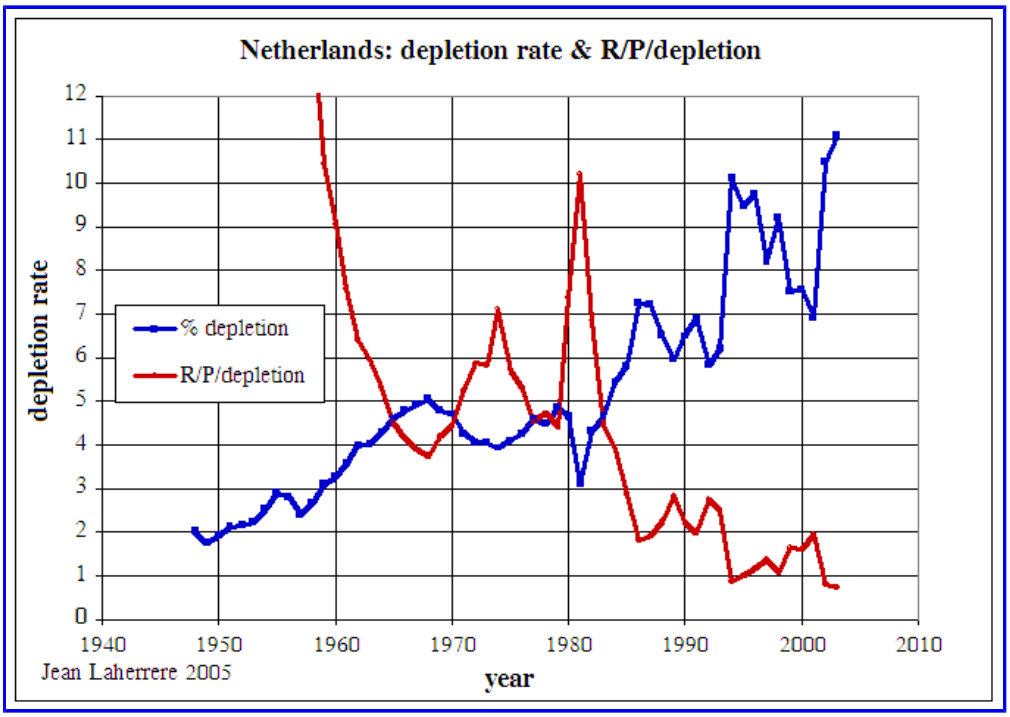

Figure 12 - Depletion rate and R/P/depletion for the Netherlands. Click to enlarge.

If European countries have a depletion rate trending towards 10% and the world towards 5% it means that OPEC countries will have a lower rate.

TOD:E : *Like other researchers (e.g. Hubbert, Marchetti) you use extensively the Logistic analysis as a predictive method, even though not everyone appreciate it as much. What makes you rely so much on the Logistic curve?*

JL : Contrary to many researchers I use a several cycles model, I do not trust the Hubbert Linearization if the plot is not linear for decades. I use the derivative of the logistic function as model for each cycle because it is the simplest to plot using the peak value of the cycle, the peak date and the width of the cycle in years. Any other

bell-shaped curve, as the Gauss (normal) curve, will work as well. I fit the last cycle to the last production value with the last trend (slope).

But I add in the text that this curve is to show simply what the geology can offer with the ultimate being the surface below the curve. But the supply has constraints from investment, politics, wars, insecurity and other constraints of the demand (high prices or recession). Any curve with the same surface below can fit depending the constraints. This is why I was also the first one to speak about a bumpy plateau instead of a peak.

What is important is to give the reader a production curve which has a surface below the curve equal to the ultimate. The curve can be modified to satisfy the constraints as long as the surface is conserved: any area below the model should be compensated by an equal area above the model. Most of forecasts are showing short periods before and after present, when mine are from the beginning to the end.

Hubbert in 1956 was modelling bell-shaped oil production by hand without any equation (he adopted the logistic curve much later) and he was saying that the production curve mimics discovery curve with a certain lag. He was right and often I do not model production, I just show production and shifted discovery to guess the future production by looking at the discovery curve which is ahead of the production time, as for example the natural gas of North America in the above graph in the NG chapter.

TOD:E : *Looking to the future, what do you think will happen to our Society and Civilization in the next decades? Will we sort our way through the crisis? What technologies/energy sources do you foresee us using in the future?*

JL : I was also one of the first ones to say that, despite knowing little on economy being an oil explorer, I was more worried by a possible coming recession (following 2004 Paul Wolcker's forecast) than by a peak from supply. I am also adding that geology is rational, when human behaviour is often irrational and this is why I refuse always to make any forecast on oil and gas prices.

I am convinced that the only way to leave to our grandchildren an earth with enough resources and not much pollution and debt is to change our way of life. Our consumption society is based on growth and our politicians and managers are judged on growth of GDP or stock market. Constant growth is impossible in a limited earth. In the past, our growth was possible because there was open space (go west) and large resources. Now we have to constraint our consumption to the limited reserves.

I do not trust a protocol which involves only governments; I believe that the constraint has to be on the consumer. I feel that Fleming's approach on TEQ (Tradable Energy Quota) is better because each will decide if he wants to consume more than his share by paying much more his excess.

CO2 is the wrong enemy; it is wasting energy which must be reduced. Sequestration of CO2 will consume more energy and it is better not to emit CO2 which can be avoided.

Technology is very good to produce quicker and cheaper conventional fields, but cannot change the geology of the reservoir which determines mainly the recovery of oil and gas - for oil, 3% in a fractured tight reservoir to over 80% in very porous sand (East Texas field) or reef (Leduc, Rainbow in Canada or Intisar in Libya). Horizontal drilling manages to produce quicker (as using several straws to drink a glass of orange juice) but no more (examples that I have shown in my papers for giant fields as Yibal in Yemen, Rabi-Kounga in Gabon).

In fact technology allows to produce fields with a decline which gives false hope of ultimate recovery and in fact leads to negative reserve growth; East Texas is a good example because from 1969 to 1990 ultimate reserves were reported as 6 Gb but the collapse of the decline from 1993 to now (almost depletion) leads to a final recovery

of about 5.4 Gb (negative growth of 600 Mb!). In fact, water injection (about 15 Gb of salt water) and too many wells (over 30 000 wells = 4 acres/well, because 1715 operators = too many straws) succeed to produce 86% of the oil in place (very well known because the large number of wells).

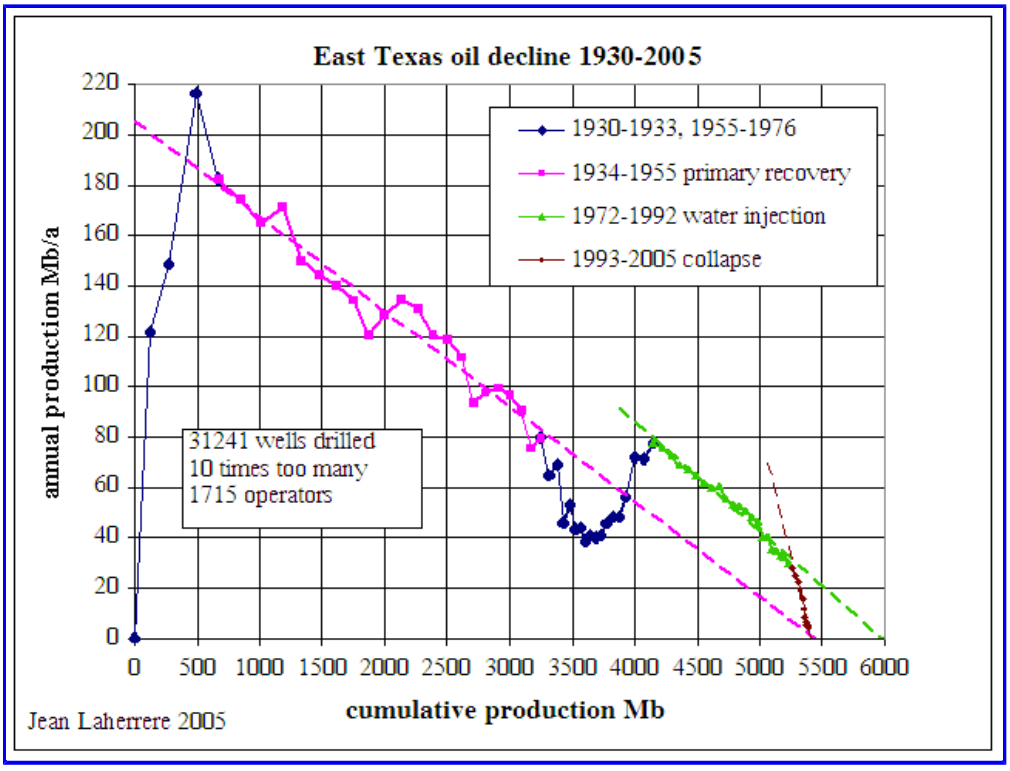

Figure 13 - East Texas decline 1930 - 2005. Click to enlarge.

It is amazing to find about the same story for the Brent oil field in the North Sea, where official estimates are higher than the cumulative production of the field, which is almost depleted after the collapse started in 1998 that doubled the decline. Brent is now producing mainly gas and the so called Brent marker is not anymore with Brent oil, but from other fields as the new Buzzard which is of less quality.

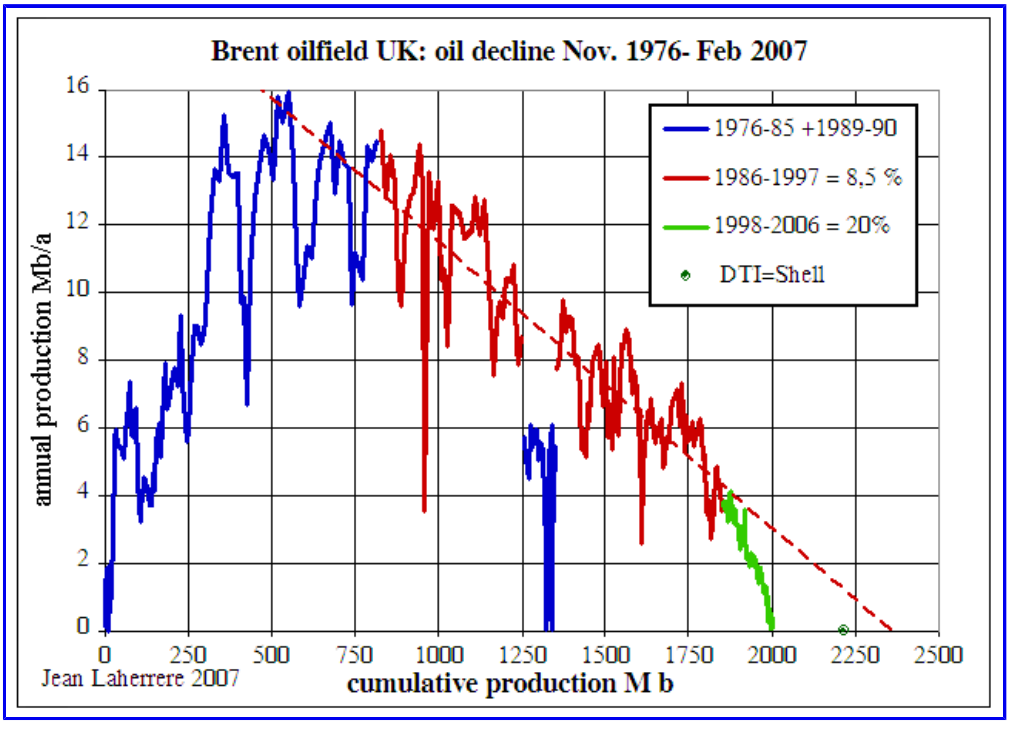

Figure 14 - Brent decline 1976 - 2007. Click to enlarge.

Reserve growth occurs in the US because of the obsolete SEC rules which prevents the report of probable reserves as in the rest of the world. Canada dropped such bad practice in 2003. US reserve growth is mainly due to the omission of probable reserves and also to wrong unscientific arithmetic aggregation (a Monte Carlo should be run to be correct).

There are many examples of negative reserve growth and few examples of positive reserve growth where decline improves with time, all that I found are due to exceptional geological conditions as Eugene Island 330 or Ekofisk (compaction of the reservoir with 8 meter seafloor subsidence). These examples cannot be extrapolated to the normal field conditions. But technology can change the viscosity of oil with steam or chemicals or fire in unconventional fields.

We will need all energy that we can produce and no energy can be rejected for irrational reactions, but the best solution is to first save energy. It is obvious that Americans consume twice more energy than Europeans for a similar income, but the big difference is that energy is much more expensive in Europe because of taxes. Americans went to compact cars in 1979 because they feared the tripling gasoline future price (which was completely wrong with the arrival of the counter shock!).

Energy is too cheap everywhere because for the last 40 years world energy cost about 5% of the GDP when experts (Kummel, Ayers) have shown that the contribution of energy to the GDP is about 50%. Everyone knows that an electricity blackout stops immediately all activity in the industrial world. It is a joke to read that the US core inflation excludes food and energy, as if American consumers can live with a car without gas, a house, TV and computer without electricity and meals with only water.

Agriculture uses most of the useful soil and using more will diminish the lungs of Gaia, being the forests. World grain production is flattening and stocks have been reduced from 120 days to less than 60 days. Agriculture cannot feed the world and fill the tanks of the cars.

There is not substitute to oil for transports except synthetic oil. All unconventional oil, as extra-heavy oil (Athabasca and Orinoco) needs time to be produced in large quantity. Lack of workers and infrastructure (as water and cheap energy for steam) leads to peak oil occurring well before they can reach a large volume. It is not possible to have a baby in a month with nine women. It is the same with Gaia.

Oil shale has an EROI and such environment problems which condemn any mining operation after many failures, the last one being in Australia. The *in situ* Shell experiment (which heats the kerogen with electricity for years in several wells to generate oil and gas when freezing around) is likely to have also a poor EROI, because Shell after many years of research has not yet decided to build a commercial pilot. The USDOE is not counting to any shale oil before 2030, if any.

Oceanic methane hydrates are too dispersed and limited horizontally - to few meters - and vertically - to few millimetres - to be ever produced.

Wind and Solar are intermittent and need back up thermal plants. It is in Germany and Denmark that more windmills are found because they have many coal plants that they can use as backup. This is not possible in France because nuclear is used mainly on a base level. In France we pollute much less than in Germany.

World coal is reported with a R/P of 250 years, with US being the Saudi Arabia of coal. But the US National Academy of Sciences has recently estimated that 100 years is more likely. Global warming is now well considered as a threat and will soon replace nuclear fears. So constraints on coal will increase.

Nuclear is the least dangerous energy, but there are limited uranium 235 (0.7% of mined uranium) reserves with present reactors techniques, fast breeders are needed

to use uranium 238 and thorium. In France 80% of the electricity is produced since decades from nuclear plants and no one was killed, but when during the same time hundreds of people were killed by natural gas explosions in their houses. Coal is killing tens of thousands of people in the world mines. Wood fires are killing also many in developing countries because of smokes.

Technology can be a big help in developing new energy if succeeding in the following research fields, which have started decades ago:

- cheap photovoltaic
- light, cheap and powerful batteries to store renewable intermittent energy
- cellulosic ethanol (miracle enzymes to be found)
- in situ coal gasification
- fast breeders (fourth generation) and accelerator driven systems (ADS) proposed by Rubbia to use uranium 238, thorium's large reserves and also nuclear wastes
- fusion

Let us hope than at least one of them will succeed. Simple techniques to save energy are well known but need motivation and change of live to be carried out.

Information on the energy future problems is the first and best technique to convince people to save energy. I feel that The Oil Drum is doing a good job for that.

Biography

Born May 30, 1931. After graduation from Ecole Polytechnique and Ecole Nationale du Pétrole in Paris, he participated with Compagnie Francaise des Pétroles (now TOTAL) in the Sahara exploration with the discoveries of two supergiant fields: Hassi Messaoud and Hassi R'Mel. He went to explore Central, Southern and Western Australia. He was in charge of exploration in Canada for TOTAL in Calgary where he started exploring Labrador Sea and Michigan. After 15 years overseas, he went to TOTAL headquarters in Paris where he was in charge successively of the new ventures negotiation, technical services and research, basin exploration departments and finally deputy exploration manager. He was member of the Safety Panel of the Ocean Drilling Program (JOIDES). He was President of the Exploration Commission of the Comité des Techniciens of the Union Française de l'Industrie Pétrolière where he directed the publication of a dozen of manuals. He was director of Compagnie Génerale de Geophysique, Petrosystems and various TOTAL subsidiaries. After 37 years of worldwide exploration with TOTAL, he retired in 1991. He is now writing articles and giving lectures. He has written several reports with Petroconsultants and Petroleum Economist on world's oil and gas potential and future production. He was a member of the "Society of Petroleum Engineers/World Petroleum Congress ad hoc Committee on joint definitions of petroleum reserves" and also a member of the task force on "Perspectives Energie 2010-2020" for the "Commissariat Général du Plan". His graphs are used in the International Energy Agency 1998 report "World International Outlook" and in the World Energy Council reports 2000 "Energy for tomorrow's world - Acting Now" & 2004 "Drivers of the energy scene". He chaired the 2002 World Petroleum Congress (Rio of Janeiro) panel on hydrates (RFP9 "Economic Use of Hydrates: Dream or Reality?"). He is a member of ASPO (Association for the Study of Peak Oil and gas).

On behalf of the TheOilDrum:Europe team I'm glad to thank Jean Laherrère for taking this interview and fully committing to it, even updating his graphs and providing them for publication.

Luís de Sousa

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