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The end of the peak oil myth

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This long paper gathers the data and work, which is the base of the presentation, which will be reduced for a talk of 30 minutes.

Introduction

The term "peak oil" was created by Colin Campbell in 2000 after our joint March 1998 article in Scientific American "The end of cheap oil" ("La fin du pétrole bon marché" Pour la Science Mai 1998).
This paper was ignored until 2005 when oil price passed 50 $/b and fully accepted in 2008 when 140 $/b (a spike! when the Chinese filled up their tanks for the opening of the Olympic Games) was reached.
But with the recent burst of "shale oil" (now called "light tight oil"), many papers have been published on the "Peak Oil Myth" or "The end of the Peak Oil"
The peak of oil production is a fact in many basins like the North Sea (2000) and in the Paris Basin (1988).
Chevron (2005-2011) www.willyoujoinus.com: 33 of the 48 largest producing countries are in decline

The problem is that about 99% of the oil generated in the oil kitchen at depth (resources) is still in the sediments, with only 1% produced in fields (reserves).
Toreador claims in 2009 that they are prepared to extract 40 billions barrels under the Eiffel Tower from "les schistes cartons" similar to the Bakken.
In the US, 2 Mb/d are produced today from shale oil (Bakken North Dakota & Eagle Ford Texas) and some people think it will bring energy independence to US.

Many confuses resources (volume in the ground) and reserves (volume to be produced)
But before producing oil it is necessary to find it!

How is the distribution of oil reserves and how is life

-Life is cycles

Life is one cycle: we are all mortal (the Sun also will die): “what goes up must come down”!

Extraction usually is one cycle

UK coal peak was in 1910 (leading to the English Empire), at 270 Mt/a, when France & Belgium coal peak was in 1960 at 88 Mt/a.

The profile was obvious: production increase until the peak and then a decline despite sharp price increases.

France coal is dead since 2004, despite some proposals refused because NIMBY (not in my back yard)

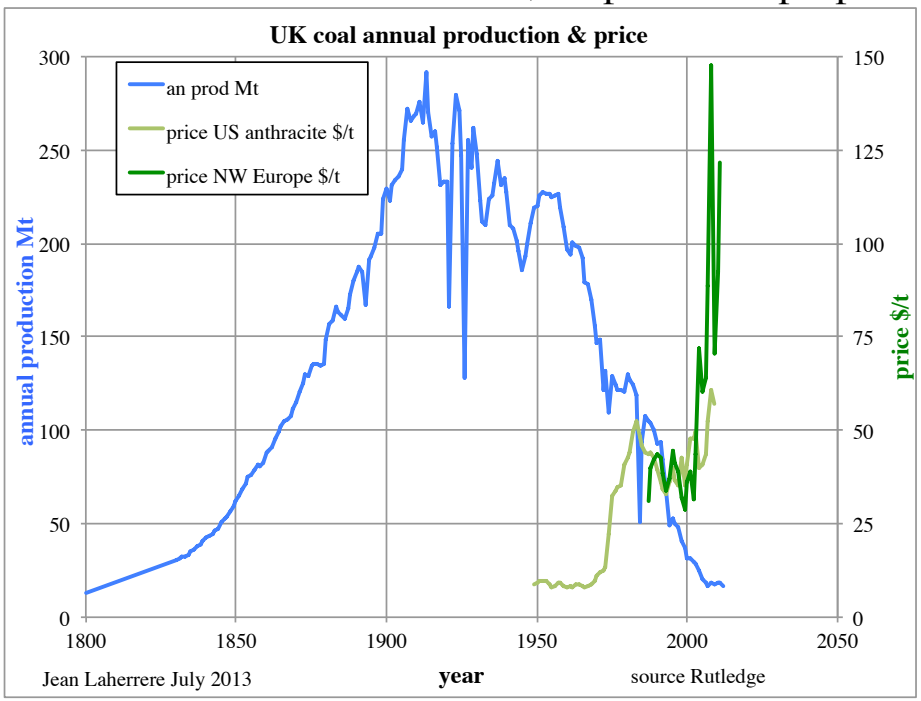


Fig 1: UK coal production & price

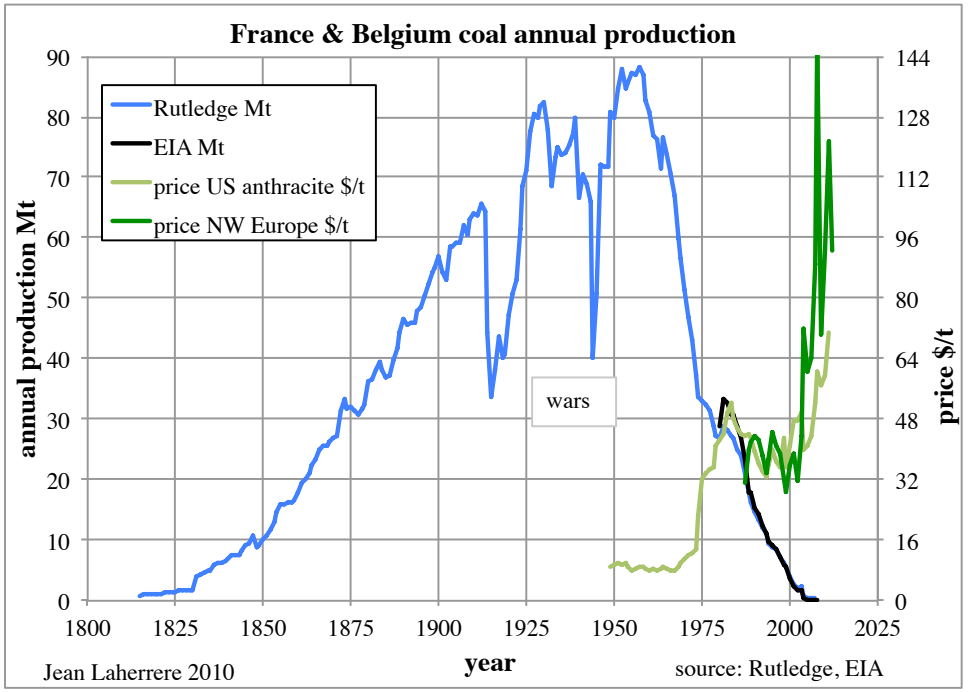


Fig 2: France & Belgium coal production

Life is also multicycles.
Repetitive cycles are astronomical related to the sun: day, year, 11 years (sun activity), 20 000 years (equinoxes precession, 40 000 years (earth obliquity), 100 000 years (earth ellipse).
The 20 000 years cycle is found in Vostok temperature (blue = data, red = model with 21 cycles) and in Vaca Muerta (Argentina) which is a very prolific source rock.

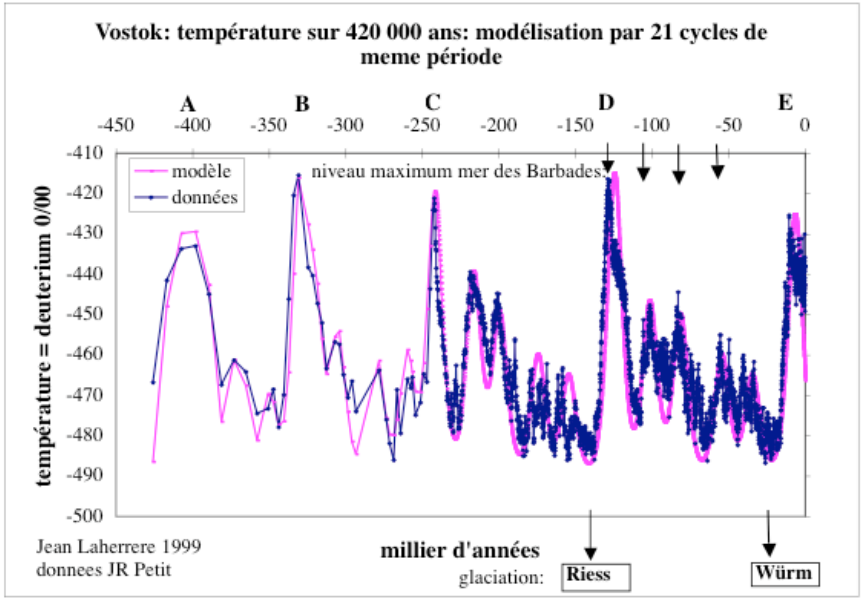


Fig 3: temperature model Vostok 420 000 yr 21 cycles = 20 000 yr

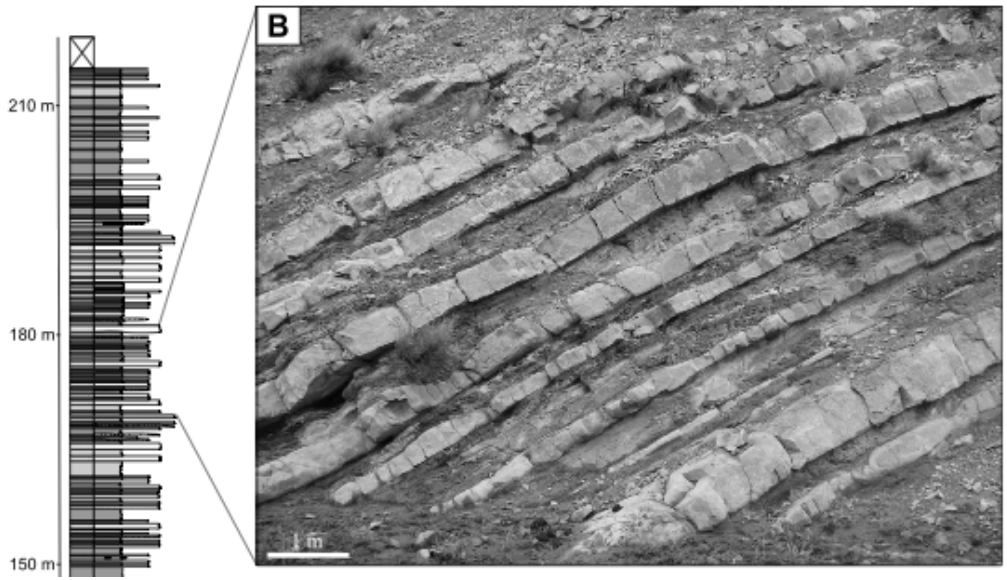


Fig 4: Argentina Vaca Muerta 20 000 yr = equinoxes precession

Cycles can be the race predators/preys: hare and lynx in Canada (number of furs by Hudson Bay Company)

Oil is produced after been found, oil discovery can displays several cycles followed by production cycles like in France or UK

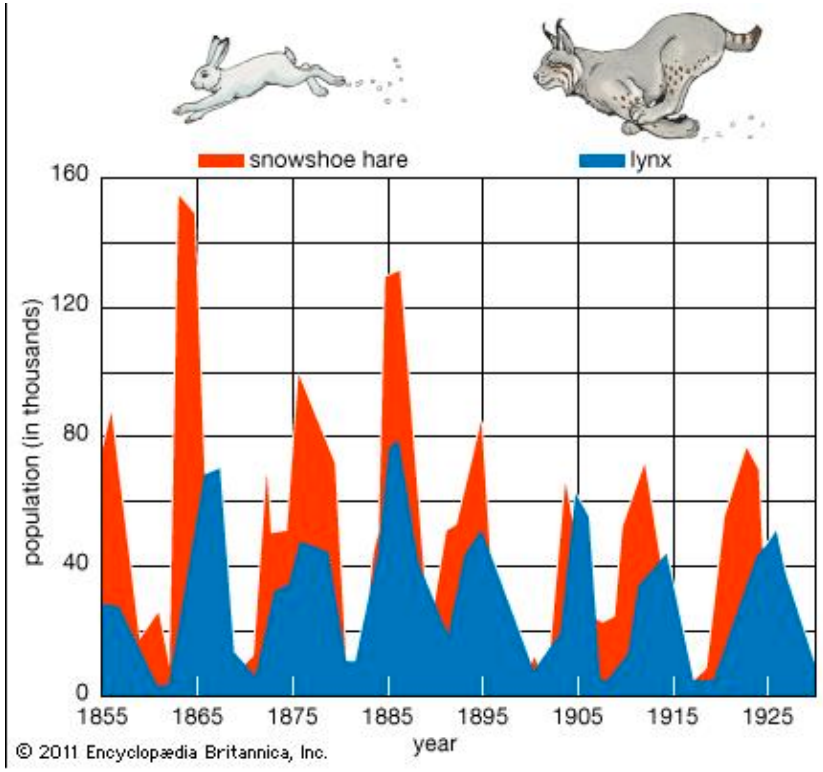


Fig 5: Hudson Bay number of hare/lynx furs

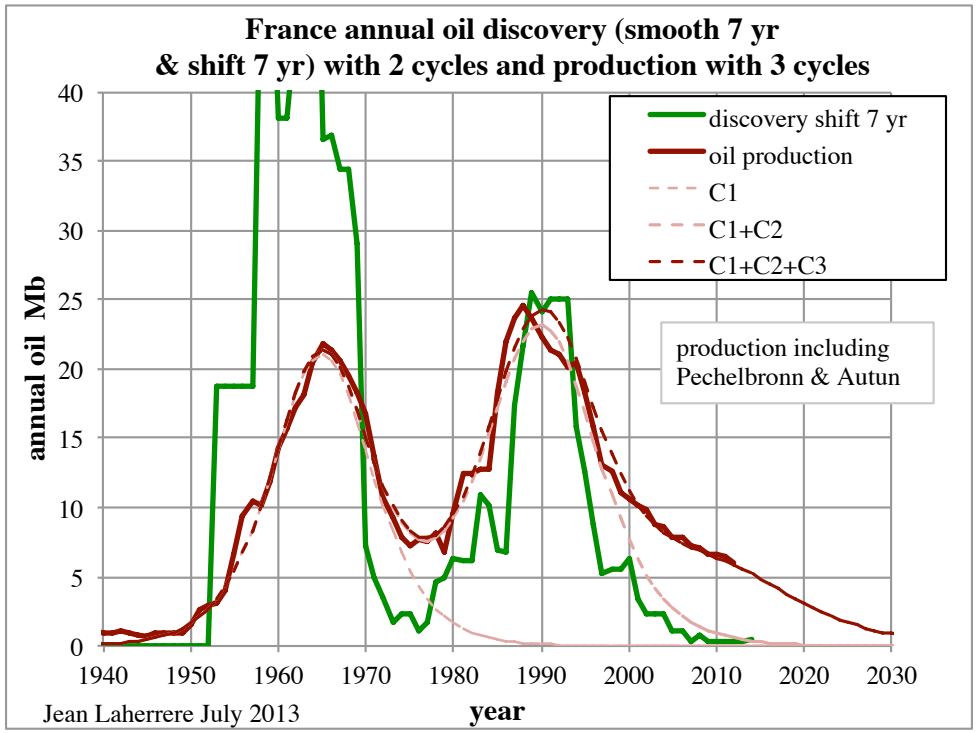


Fig 6: France 3 oil production cycles & 2 discovery cycles 7 yr shift

Life is fractal: human gather in urban agglomeration the same way as for galaxy, earthquake, oil reserves: fractal = a small part behaves as the whole. Pareto 80/20 law based on incomes is a fractal distribution: 80 % of the incomes come from 20% of the people, 80 % of health expenditures come from 20% of the patients. Fractal display is the plot of the size versus the rank (by size decrease) in a log-log scale. Any power law, like the Gutenberg Richter law on earthquakes, display a linear plot in fractal display. But Nature is not linear but curved and a parabolic fractal is a better representation of the Nature : see figure 18 (-Laherrère J.H. 1996 "Distributions de type

fractal parabolique dans la Nature"-Comptes Rendus de l'Académie des Sciences- T.322 -Série IIa n°7-4 Avril p535-541
http://www.oilcrisis.com/laherrere/fractal.htm)

-Peak oil (and not "oil peak", because ASPO sounds better, but for me "peak oil" is oil with a peak)
Four reports were written on the oil & gas distribution of reserves and production by retired oil geologists Alain Perrodon, Gerard Demaison, Colin Campbell & Jean Laherrere from 1994 to 1998 (1356 pages!) using the world reserves database of Petroconsultants (oil & gas database company in Geneva)

-**reserves definitions**

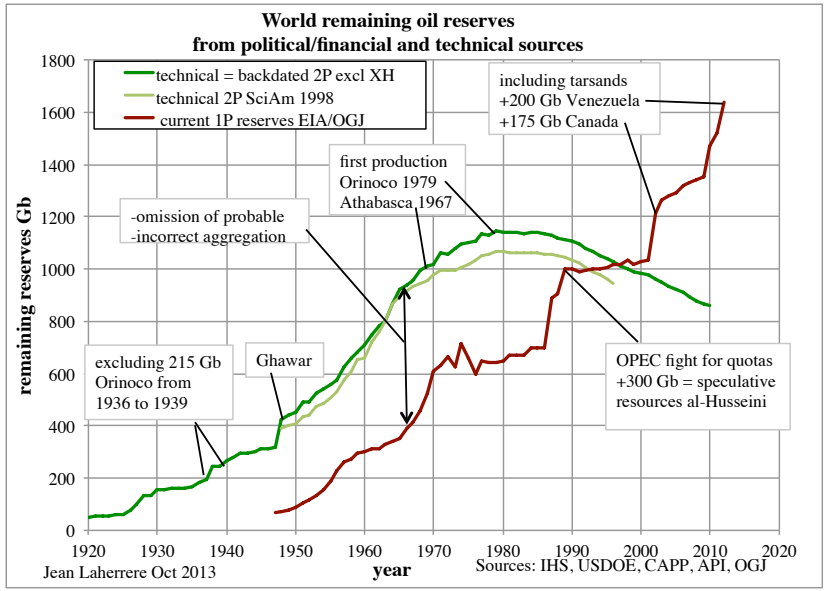
no consensus on reserves classification, but local practices
-OPEC unaudited proved reserves = fight for quotas = political = 300 Gb speculative resources al-Husseini
-SEC audited proved reserves, forbidding to report probable reserves = financial to please the bankers
-SPE/WPC/AAPG PRMS: 1P =P90, 2P = P50, 3P = P10, arithmetic addition is only correct for 2P
-Russian ABC1 grossly exaggerated (Khalimov 1959 & 1993) = 3P
-Norwegian classification = mean value
It is incorrect to add arithmetically proved field reserves to get world proved reserves, giving an underestimation, leading to artificial reserves growth (= bad practice of reserves reporting)

-**confusion of probable with 2P, of possible with 3P**

IEA, UK DECC, IFP, BP confuse probable with P50 which is the definition of 2P = proved + probable, without asking why probable = 2P

-**reserves data**

There are two sources for world oil reserves:
-published political/financial current proved reserves by OGJ = USDOE/EIA, OPEC, BP
-technical backdated 2P database from scout companies as IHS & Rystad



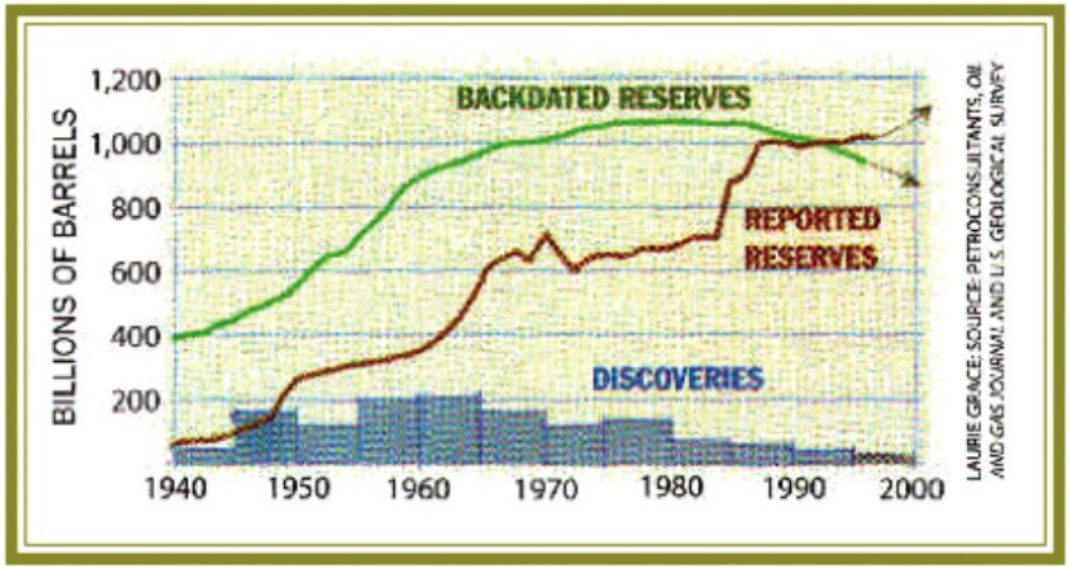


Fig 7: the contrast between world remaining oil reserves from political/financial and technical sources in 2013

Fig 8: same graph in 1998 Scientific American "the end of cheap oil"

The technical oil reserves in green has peaked in 1980, when the political/financial oil reserves has increased since 1945 with jumps when adding 300 Gb during the fight for quotas by OPEC or the extra-heavy oil of Canada in 2002 (in production since 1967) and of Venezuela in 2012.

This graph is the most important one, because it explains why economists, who have only access to political data (brown curve), do not believe in peak oil. They do not think wrong, they think on wrong data.

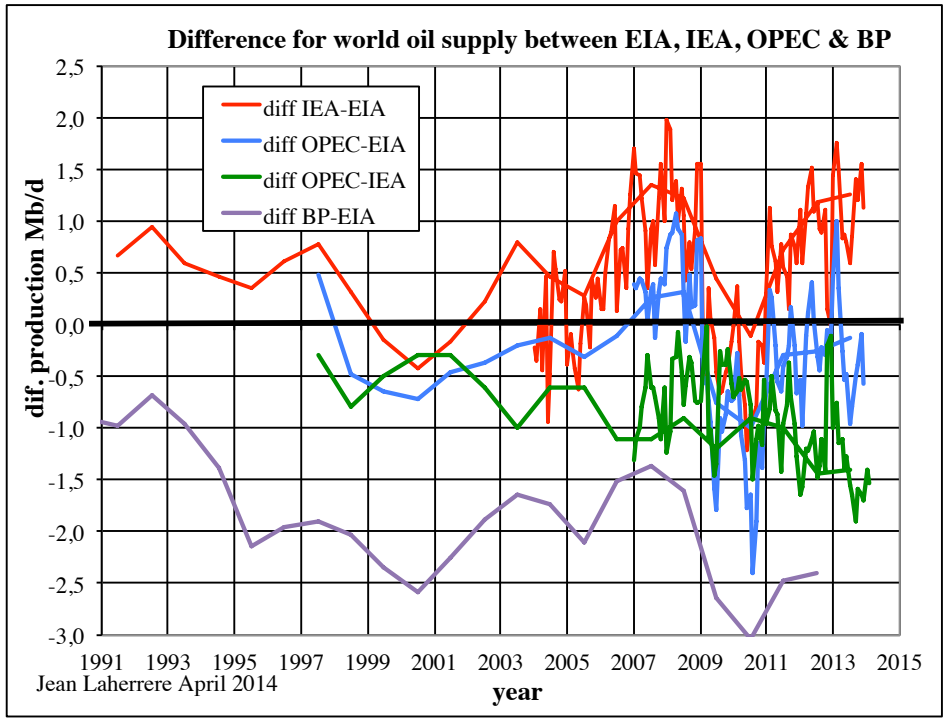
-**production data**

There are many sources available on Internet: USDOE/EIA, IEA, BP, OPEC

Their data for world oil supply vary chaotically and within plus or minus 2 Mb/d.

For Texas oil production, the sources are API, Railroad Commission, EIA, OGJ and the discrepancy bad definition (condensate & federal waters) & bad reporting can reach 60%. RRC underreports recent production

data by lack of accurate reports from the 4700 operators. On December 2012 Texas July 2012 production was reported as 1564 kb/d but it was 1961 kb/d in the report of March 2014 it means a correction of 25 %.
In contrary EIA presently over reports Texas production by extrapolating past data when in lack of information.
In fact it is necessary to wait one year to get reliable production data!



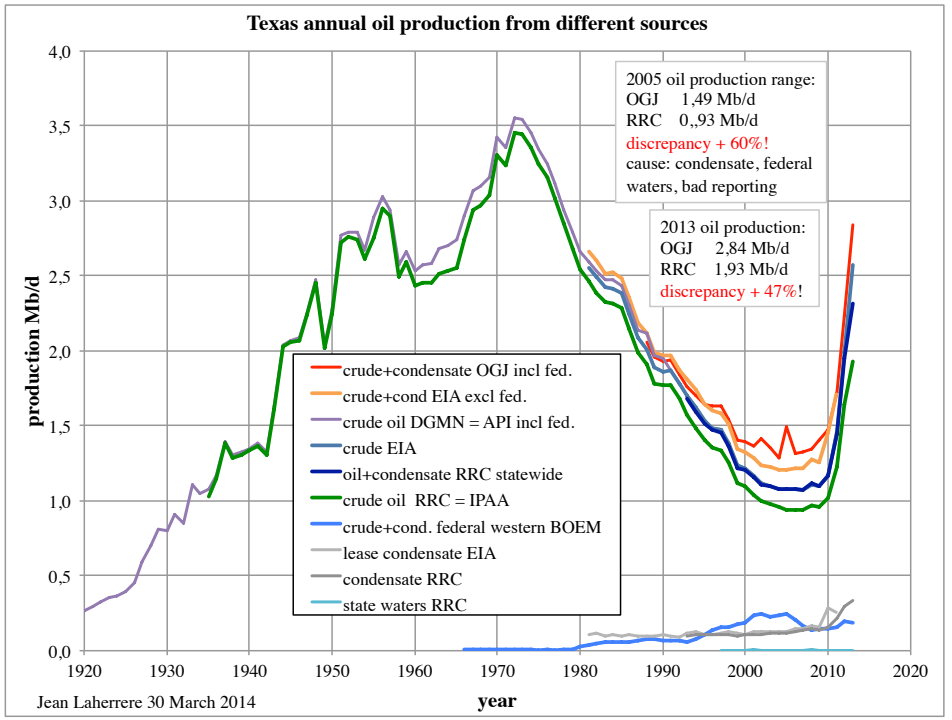


Fig 9: Showing the difference, for world oil supply, between EIA, IEA, OPEC & BP data

Fig 10: discrepancy on Texas oil production from different sources

Oil production data varies widely within sources mainly because bad definitions and then its trend should be studied from one source.
The world excluding US oil production from EIA is on a bumpy plateau since 2005.

On the graph 1900-2020 the "Thirty Glorious" 1945-1975 displays an exponential growth stopped by the oil shock of 1973/1979, with the oil counter shock of 1986 followed by the "twenty less glorious " 1986- 2005
Since 2005 it is a bumpy plateau with a range equal to the accuracy of the data.

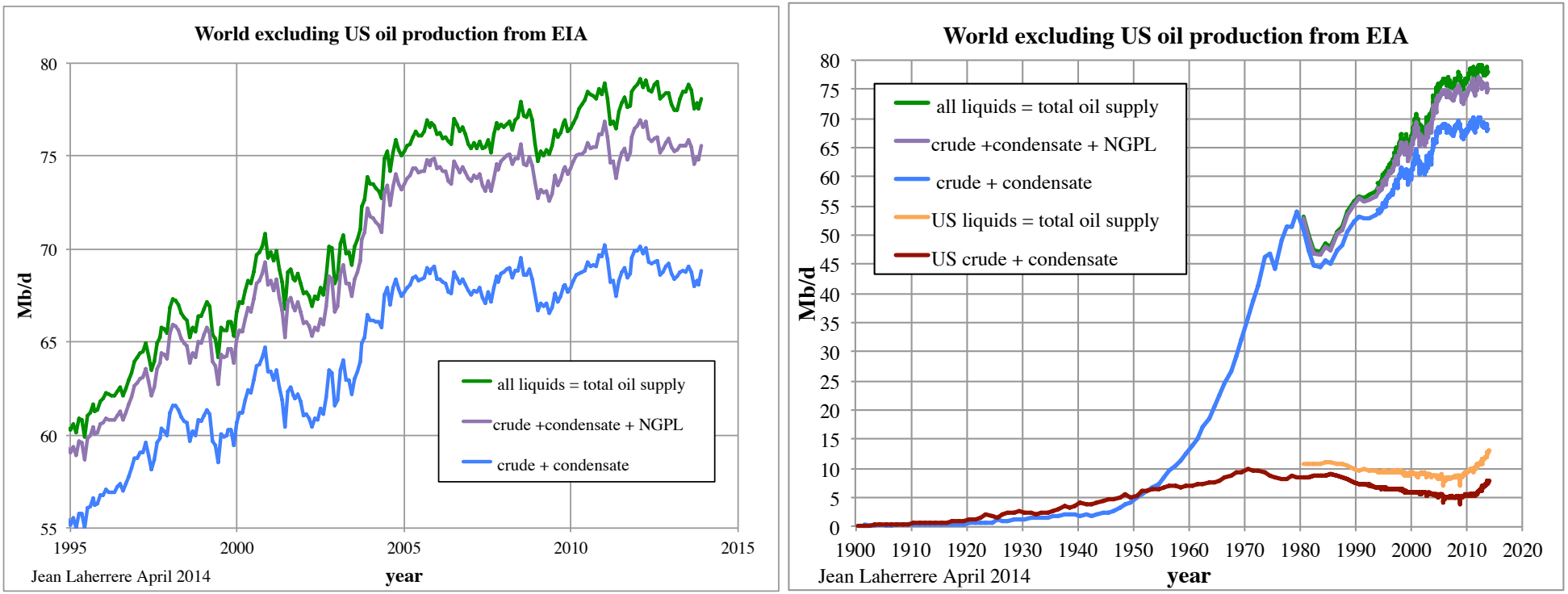


Fig 11: World excluding US oil production from EIA 1995-2013 and 1900-2013

US oil production decline is disturbed since 2008 by the sharp increase of shale oil (now light tight oil = LTO), in particular in North Dakota and Texas, following the increase in deepwater of the Gulf of Mexico.
The oil production of the US lower 48 excluding Texas, North Dakota and deepwater (in purple) is peaking in 1970 and symmetrical. Future oil production is forecasted using ultimates of 225 Gb for the USL48, 135 Gb for USL48 less Texas, ND & deep, 75 Gb for Texas (with 3 Gb for Eagle Ford), 10 Gb for deepwater and 5 Gb for North Dakota (with 2.5 Gb for Bakken)

The recent oil boom since 2010 is really a boom with short life. The USL48 crude oil production has peaked in 1970 with 3.5 Gb per year and it will peak again this year or next at 2.5 Gb, with a sharp decline down to 1 Gb in 2025 and to 0.3 Gb in 2040 and to 0.15 Gb in 2050.

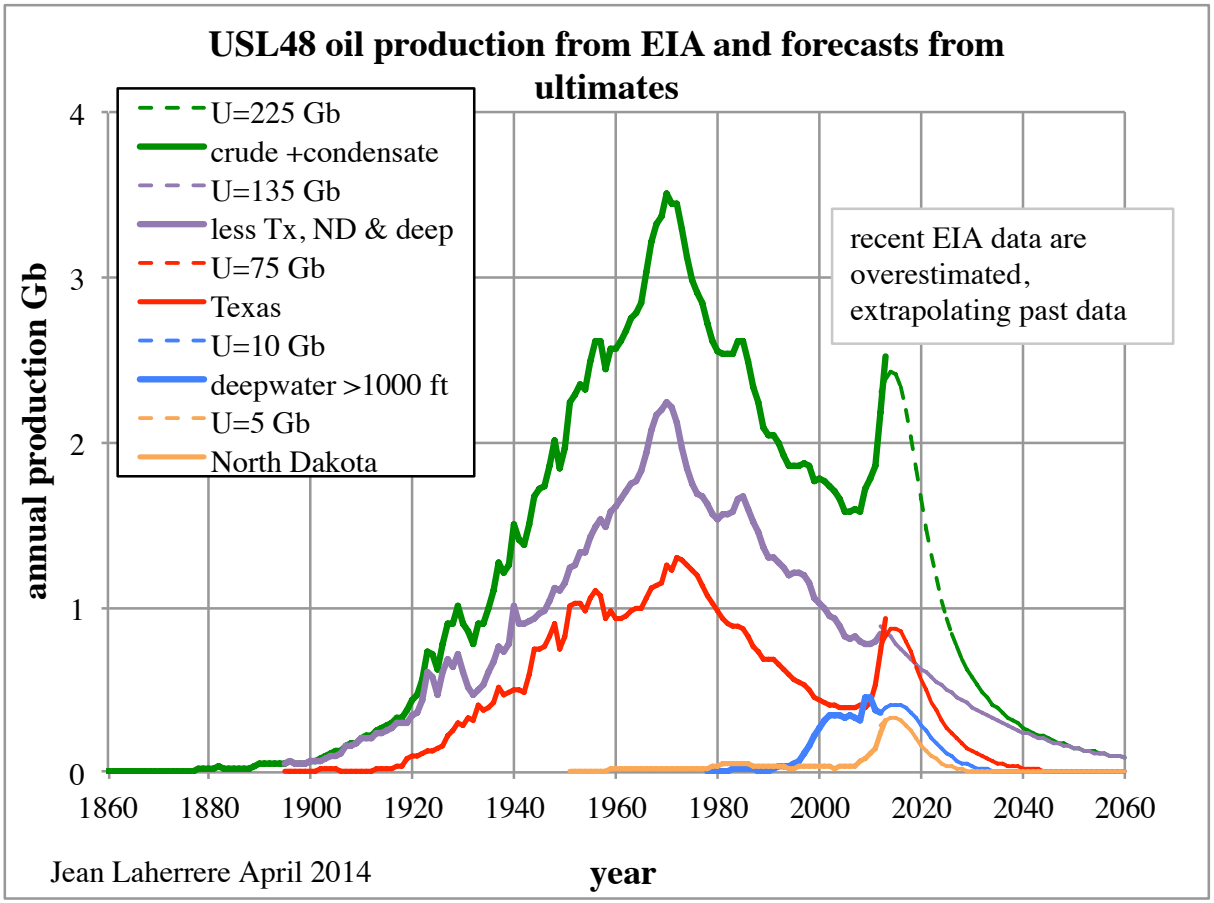


Fig 12: USL48 oil production from EIA and forecasts from ultimates
The dream of North America oil independence will soon disappear.

-oil ultimates

The ultimates were estimated using the creaming curve from backdated discovery 2P (proved +probable) data (extrapolation of the cumulative discoveries versus cumulative number of fields) or Hubbert linearization of oil production growth percentage versus cumulative production).

-US forecasts

-GOM

The Gulf of Mexico (GOM), being federal beyond the state waters, is the only place in the world with UK and Norway where the field reserves are reported in detail by field (unfortunately it takes time: the last report is at end 2009). Unfortunately the list of fields is incomplete when looking at past reports (32 fields (0.9 Gb) missing in 2006 compared to 2009).

For the all GOM the creaming curve in Gboe (in US 1 kcf = 5.6 boe) is modeled with one or several cycles using hyperbolas and the ultimate is taken from the model at a future cumulative number of fields double of the present: it is 25 Gb for oil and 200 Tcf for gas. For deepwater (>1000 ft) the curve is a little bumpy and the ultimate is 10 Gb for oil ands 26 Tcf for gas

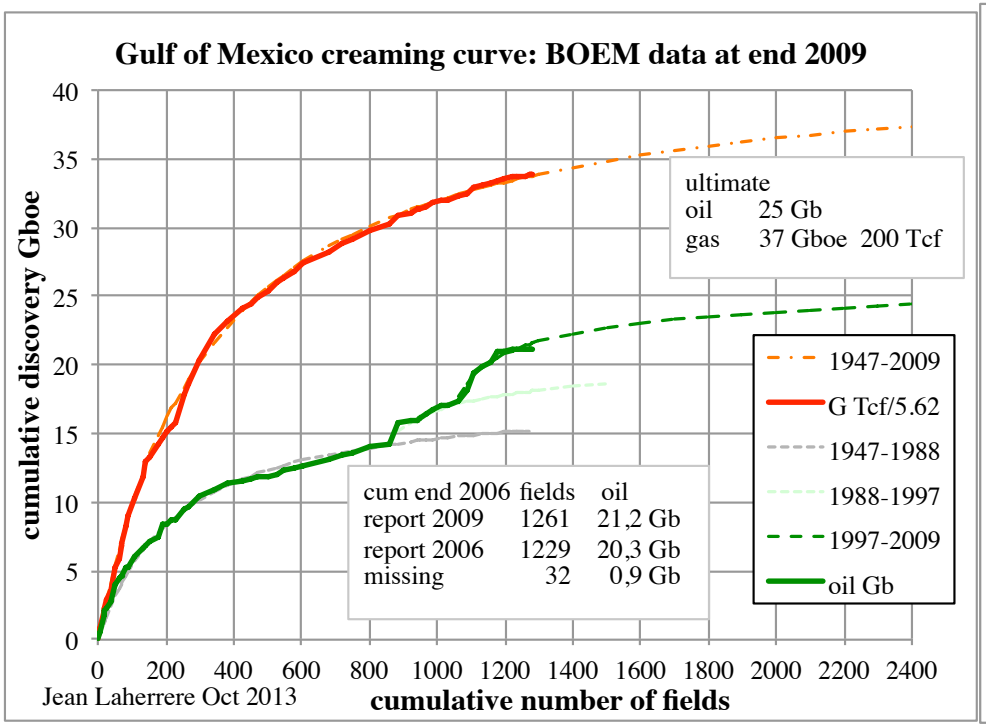


Fig 13: US GOM oil & gas creaming curve

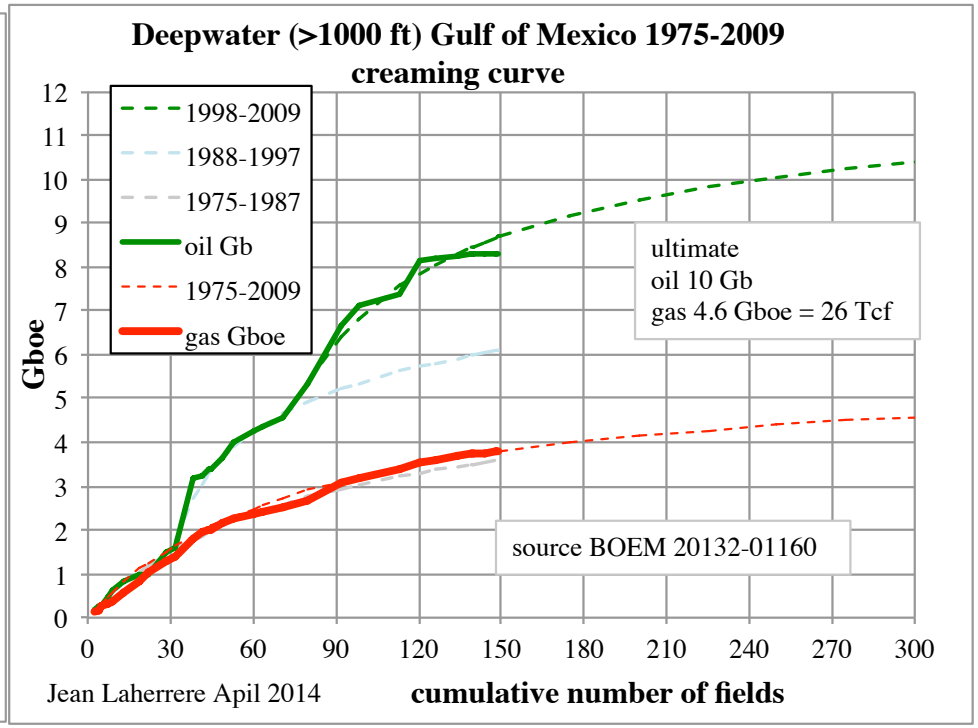


Fig 14: US GOM deepwater (>1000 ft) creaming curve

For the shallow waters the model is simple and the ultimate for oil is 14 Gb.

The Hubbert linearization (percentage annual production divided by cumulative production plotted versus cumulative production) is extrapolated for the last linear plot (1984-2012) towards also 14 Gb.

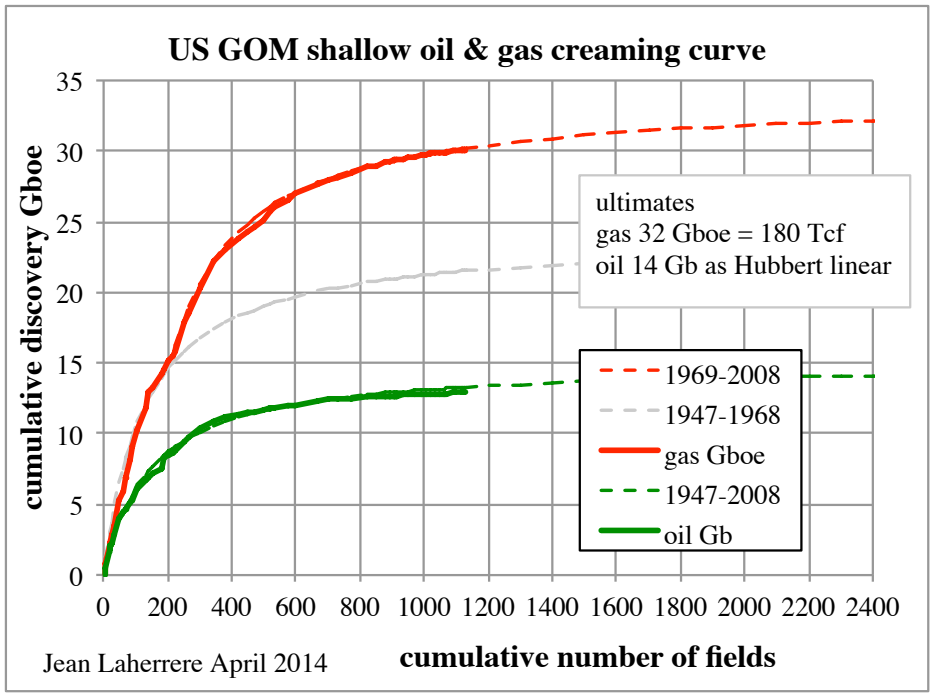


Fig 15: US GOM shallow creaming curve

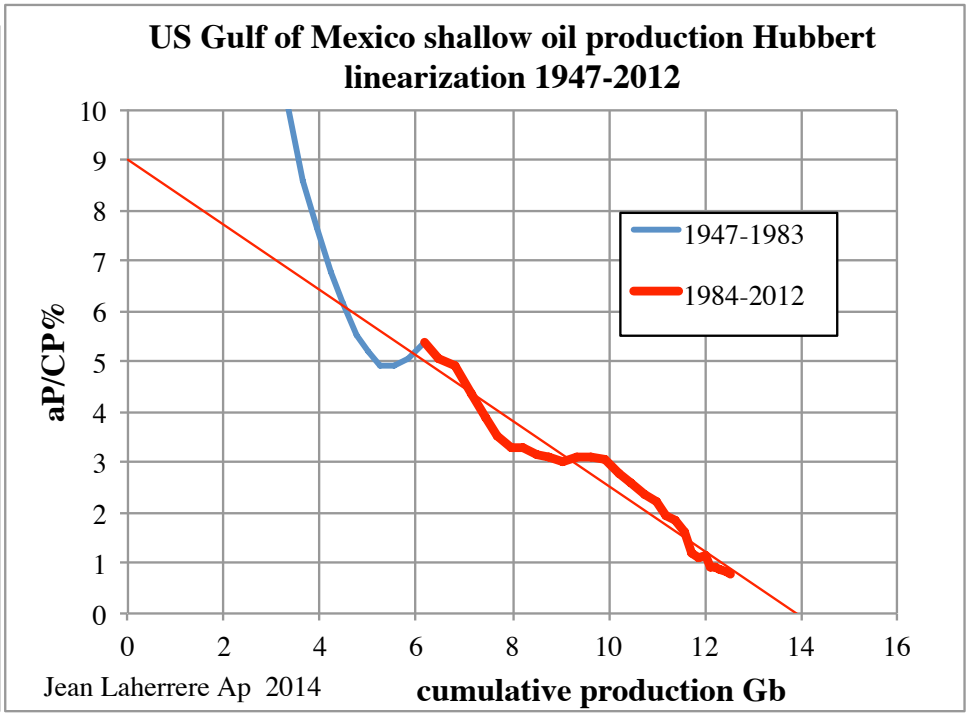
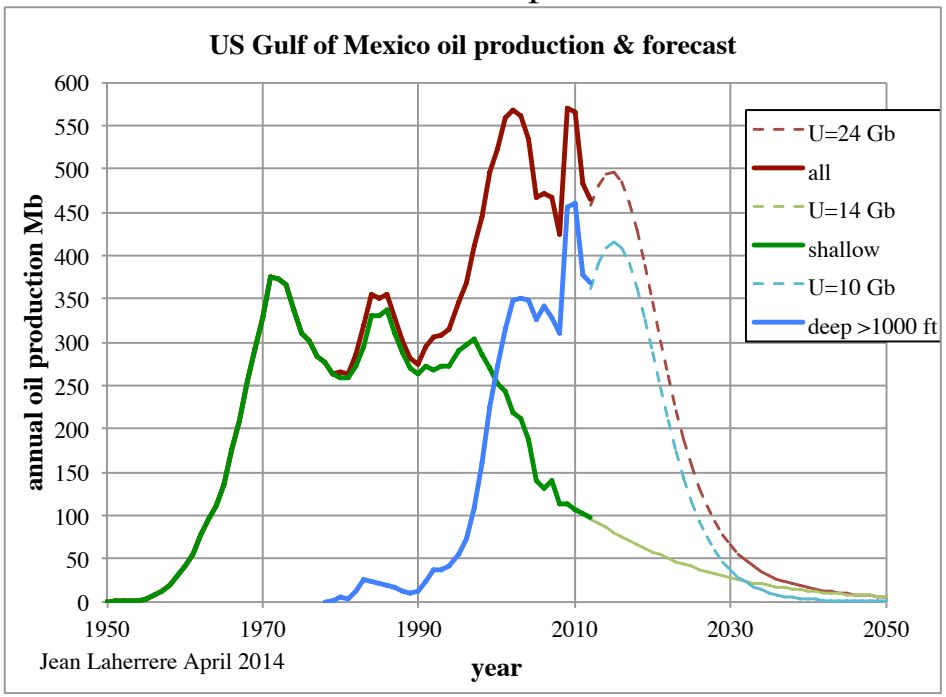


Fig 16: US GOM shallow oil production Hubbert linearization

Using these two (shallow & deep) ultimates the US federal Gulf of Mexico oil (including condensate) production is extrapolated towards its end (2050). Shallow production with an ultimate of 14 Gb and 12 Gb already produced at end 2012 is declining slowly from now 100 000 b/d production to zero in 2050.
The deepwater (ultimate 10 Gb with 5.5 Gb produced end 2012) has peaked in 2010 because the BP Macondo blow out. The sharp decline is due to the lack of drilling production wells at the large deepwater fields (Mars, Thunder Horse,) due to government moratorium. It is likely that with drilling now allowed production, a new peak will be reached at 400 000 b/d in few years followed by a sharp decline.
The GOM peak is likely to be in 2001 & 2009 at 560 000 b/d with a sharp decline after 2020

The fractal distribution of oil and gas discoveries is displayed with the evolution every ten years. It is obvious that the distribution is close to parabolic and that the new discoveries are mainly small discoveries.



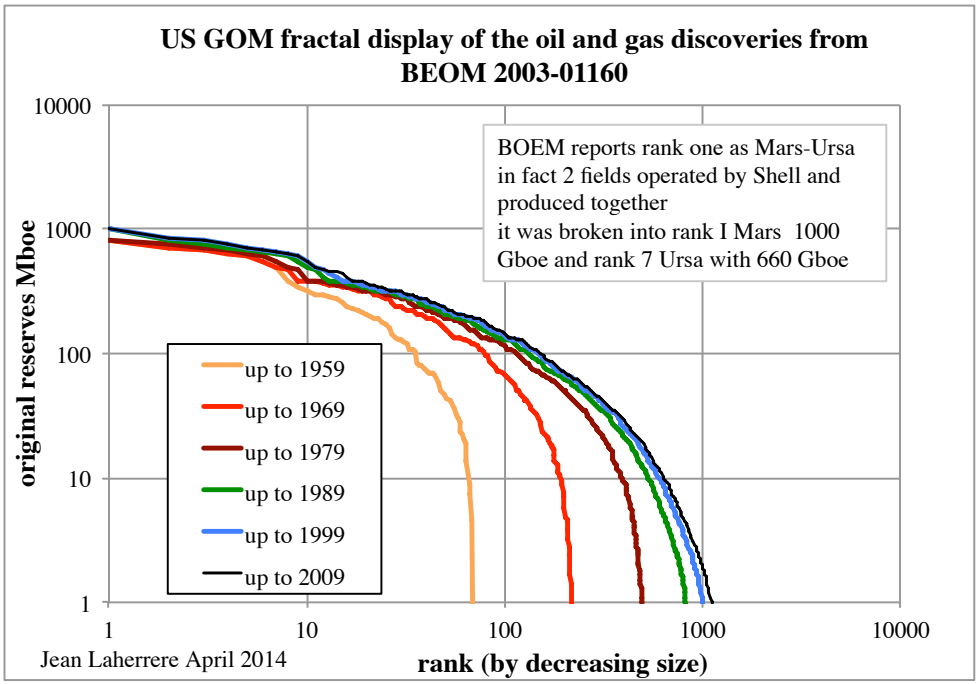


Fig 17: US GOM oil production forecast for ultimates 14 Gb shallow & 10 Gb deepwater

Fig 18: US GOM fractal display of oil & gas discoveries

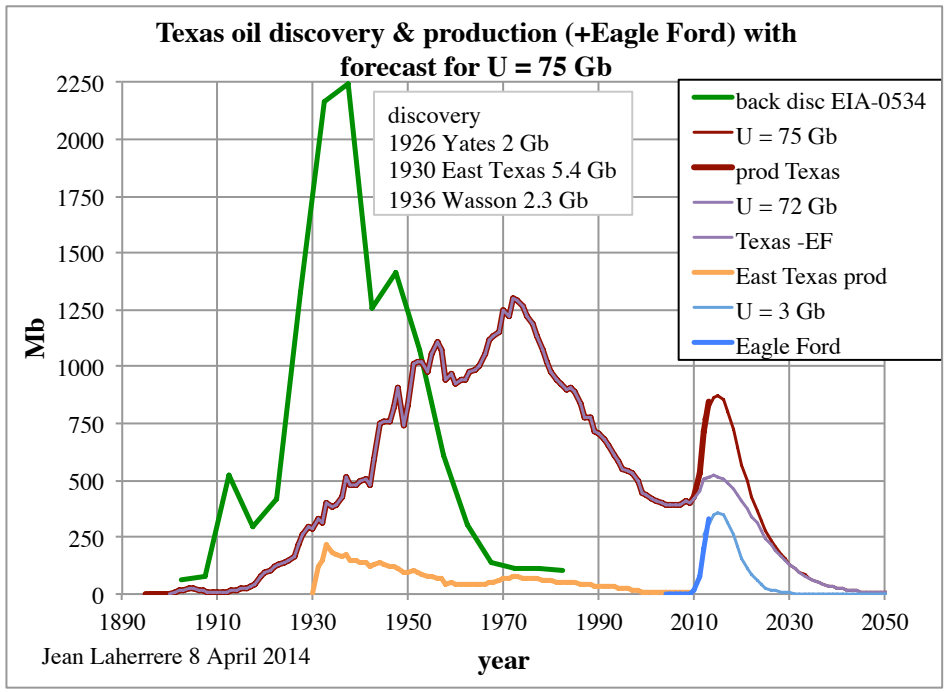
It is amazing to see that most peaks of the GOM oil production display symmetrical increases and decreases! This confirms our model of symmetrical curve (logistic derivative) for future production.

-Texas and Permian Basin (Texas & New Mexico)

Texas started oil production on 1892 and has peaked in 1972. The peak of oil backdated discoveries (from USDOE/EIA-0534 open file US oil and reserves by year of field discovery, which was scheduled to be the first of a series but also the last and presently not anymore available on EIA site) was centered around 1930 with Yates 2 Gb 1936, East Texas 5,4 Gb 1930 and Wasson 2,3 Gb 1936.

At end 2011 (IPAA report) Texas has drilled more than 1 100 000 wells (600 000 oil wells, 200 000 gas wells and 300 000 dry wells), and produces with 4700 operators 170 000 oil wells (150 000 marginal) and 100 000 gas wells (65 000 marginal)

The State Railroad Commission (RRC) and USDOE/EIA reports monthly production excluding the federal waters when OGJ and DGMN reports production including federal waters. Most reports crude oil but sometimes they includes condensate. The confusion on federal waters and condensate leads that for 2013 RRC reports 1.93 Mb/d when OGJ reports 2.84 Mb/d a discrepancy of 47% (see Fig 10): it is a shame to find such confusion on the largest oil producing state!



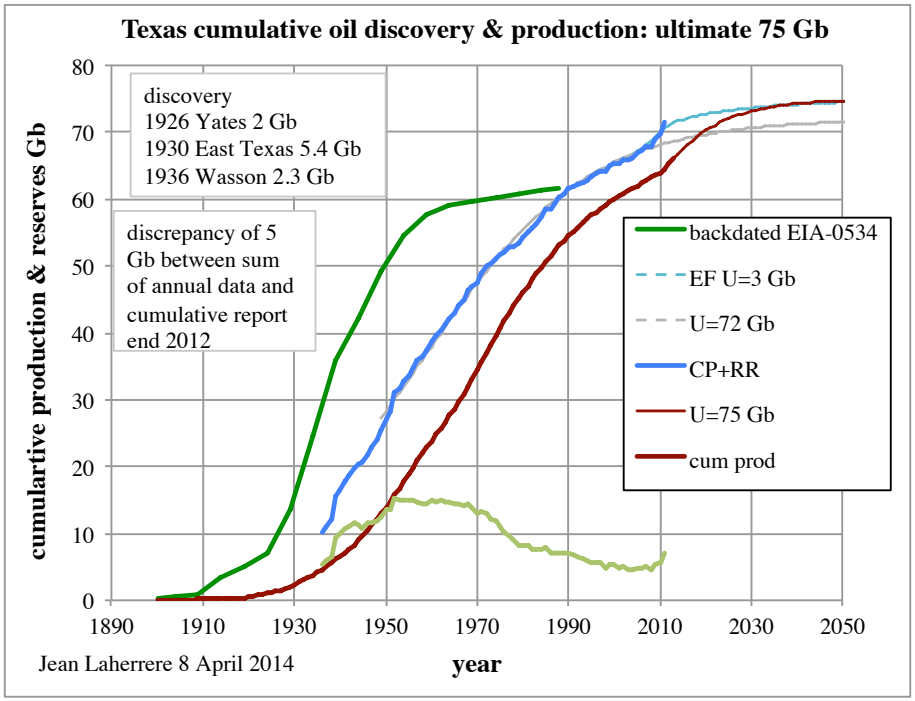


Fig 19: Texas oil discovery and production with forecast U= 75 Gb

Fig 20: Texas oil cumulative discovery (backdated and current) and cumulative production U=75 Gb

The Eagle Ford crude oil production started in 2009 as the condensate production and both they climb to 0,9 Mb/d in 2013, likely peaking in 2014/2015 around 1 Mb/d.
The Permian Basin (Texas & New Mexico) has produced oil since 1923 to 2013 about 35 Gb and its ultimate is about 40 Gb as shown by figure 22. The Permian Basin represents more half of the Texas ultimate. Oil production peaked in 1973 at 2 Mb/d but declined in 2005 at 0,8 Mb/d, but was boosted since thanks to oil price by the use of more horizontal drilling (like Shell in Gabon and Oman figure 53 & 54) but it is likely to peak in 2016 around 1.5 Mb/d. The oil ultimate is estimated at 40 Gb thanks to production Hubbert linearization. But Rystad newsletter (April 2014) forecasts that the Permian Basin production will peak around 2020 at 1.8 Mb/d.
The "Spraberry trend " discovered in 1943 was reported in mid 1950 as the world's largest unrecoverable oil reserve. In 1949 production was improved after being shot with nitroglycerin, but very rapid decline. More than 50% of the CO2 EOR present projets are in the Permian Basin.
Scotiabank estimates Permian break-even cost at 81 $/b when Bakken at 69 $/b and Eagle Ford at 64 $/b.

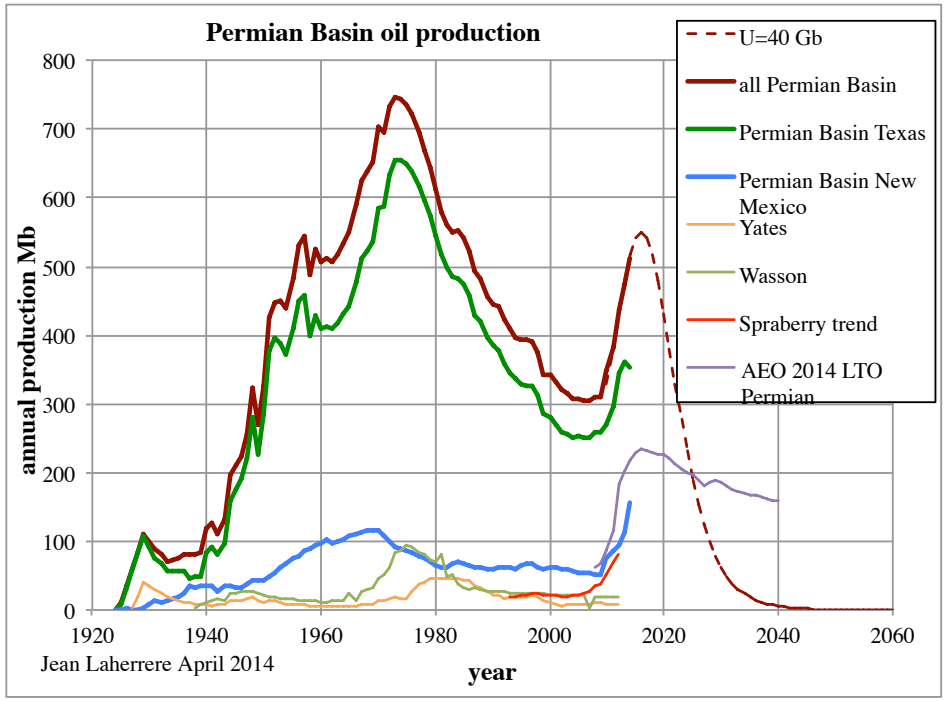


Fig 21: Permian Basin oil production U= 40 Gb

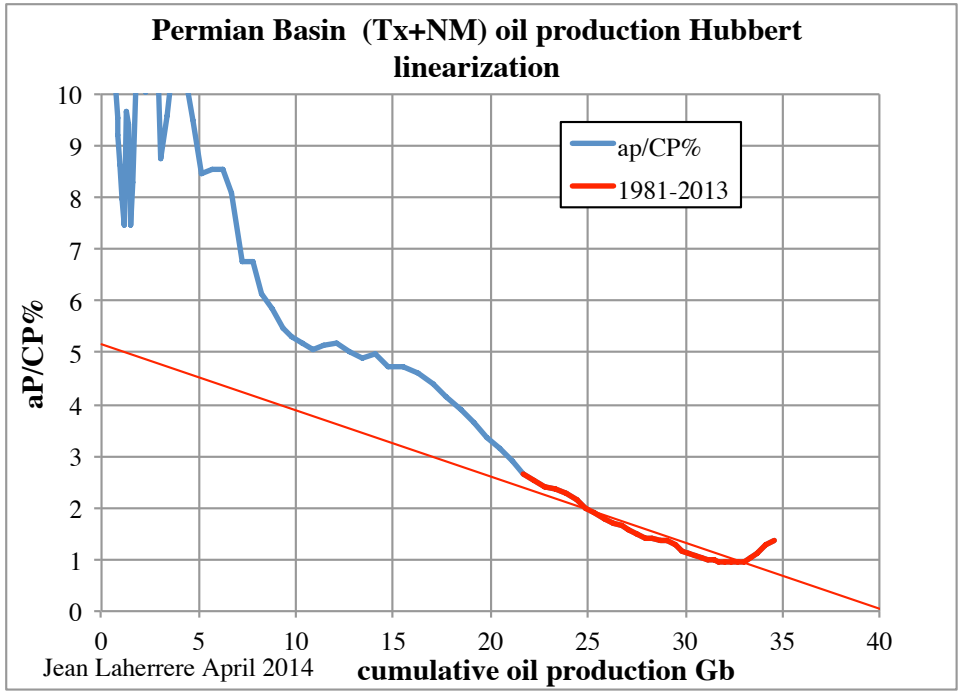


Fig 22: Permian Basin oil production Hubbert linearization

-North Dakota

North Dakota oil production started in 1951 and Bakken in 1953 but was the largest part only from 2005. Bakken oil ultimate is estimated at 2500 Mb (like the non-Bakken) from the production Hubbert linearization With an oil ultimate of 5 Gb, ND oil production will likely peak this year, but there is still a large number of wells (>500) waiting for hydraulic fracturation?

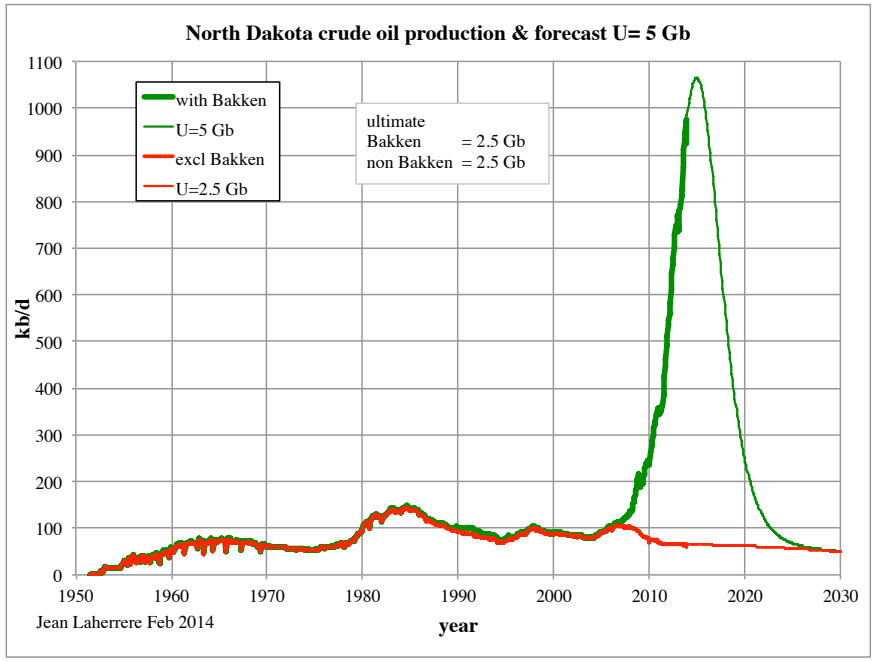


Fig 23: North Dakota oil production 1950-2030

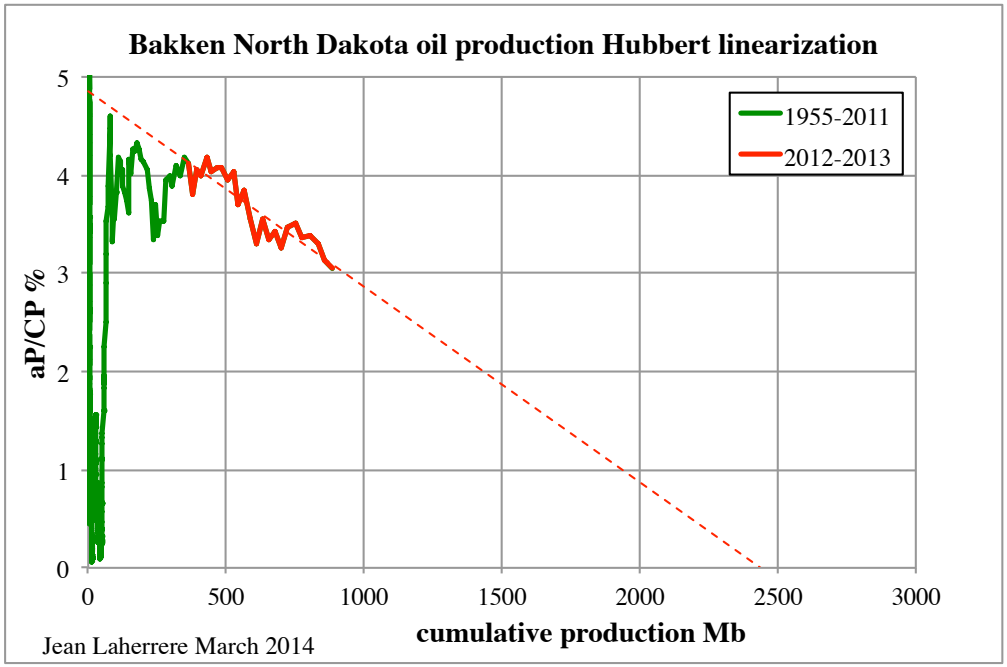


Fig 24: Bakken ND monthly production Hubbert linearization

The plot of Bakken oil production in log scale for the period 1985-2025 shows that the future peak will be similar to the past smaller peak in 1991.
The correlation of ND oil production with the number of rigs leads to a oil peak now, suggesting that this Bakken bubble will lower widely EIA forecasts

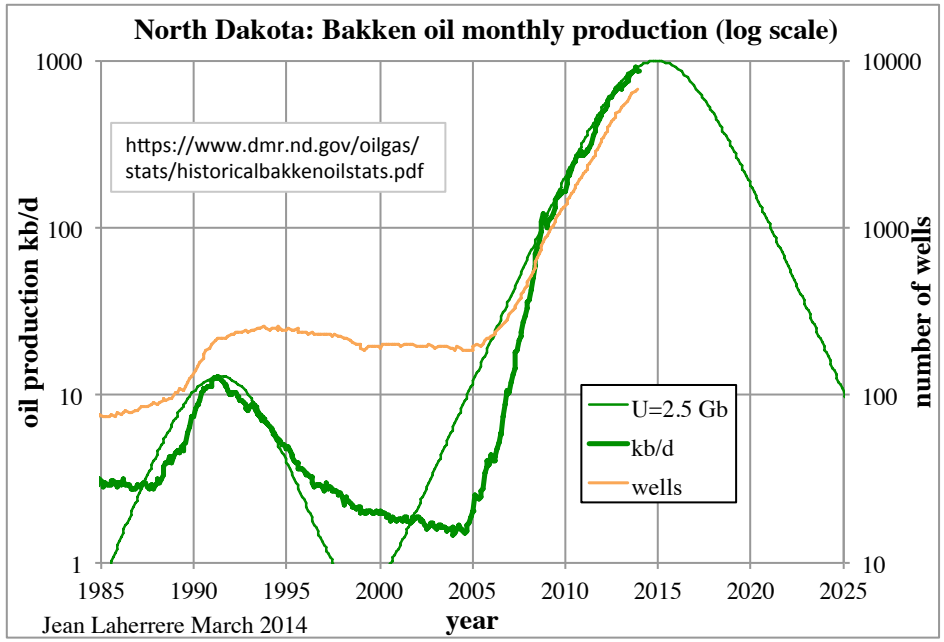


Fig 25: Bakken ND monthly oil production 1985-2025 in log scale

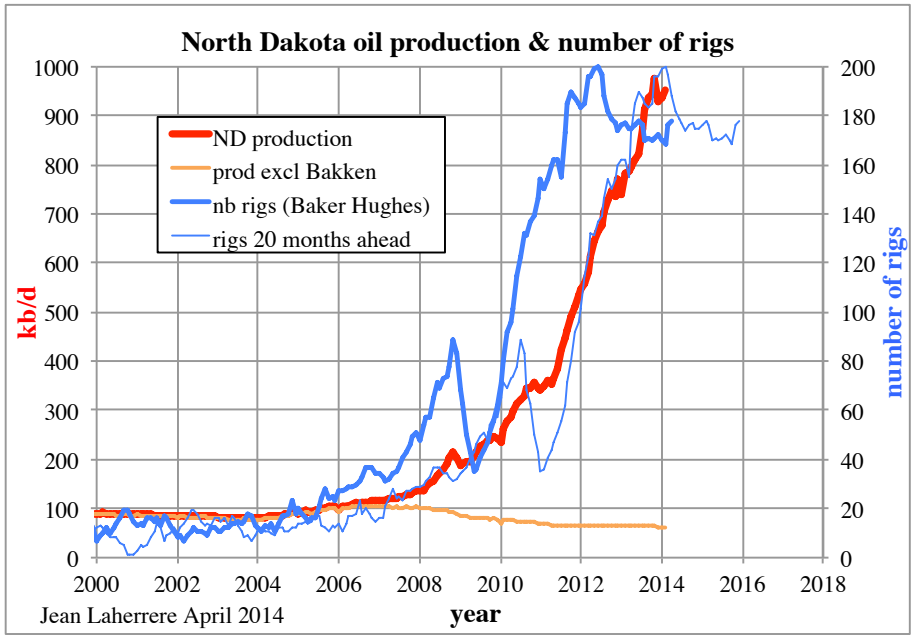


Fig 26: North Dakota oil production and number of rigs

-USL48 less Texas, North Dakota and deepwater

The recent US oil production increase comes mainly from Texas, North Dakota and deepwater. The Hubbert linearization of the production of the USL48 excluding Texas, North Dakota and deepwater is far to be linear, but the period 1989-2012 could be extrapolated towards 135 Gb (only 20 Gb remaining to produce), in agreement to the separate estimate of 225 Gb for USL48, Texas 75 Gb, deepwater 10 Gb & North Dakota 5 Gb.
Using these ultimates the plot of future production for USL48 (from EIA data which is overestimated for the last monthly data because of optimistic guesses) is easy and forecast a likely peak, contrary to the optimistic EIA forecast.

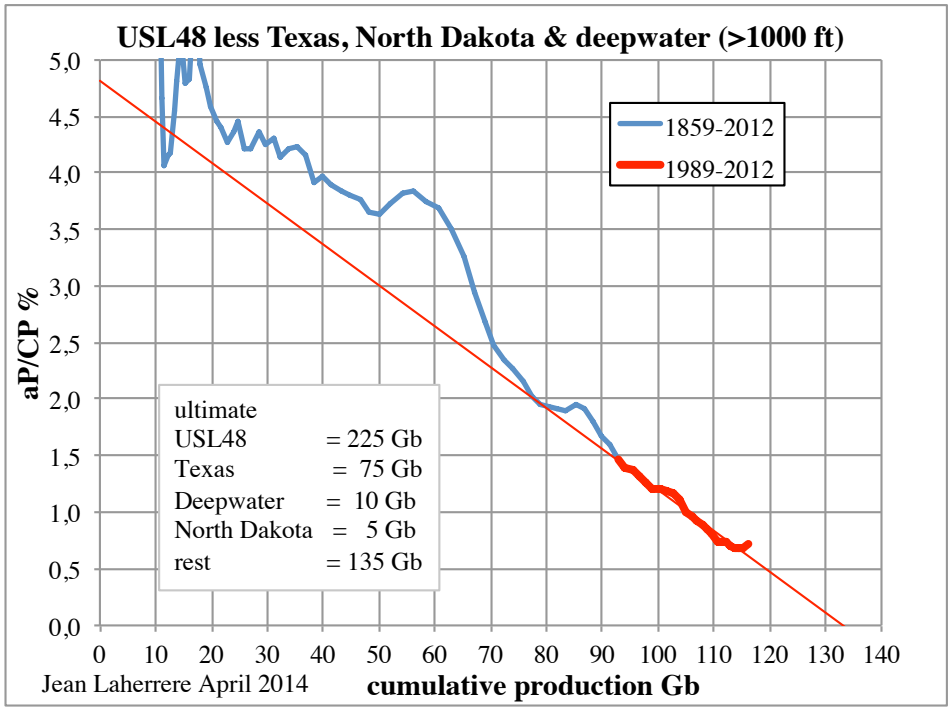


Fig 27: US less Texas, North Dakota and deepwater Hubbert linearization

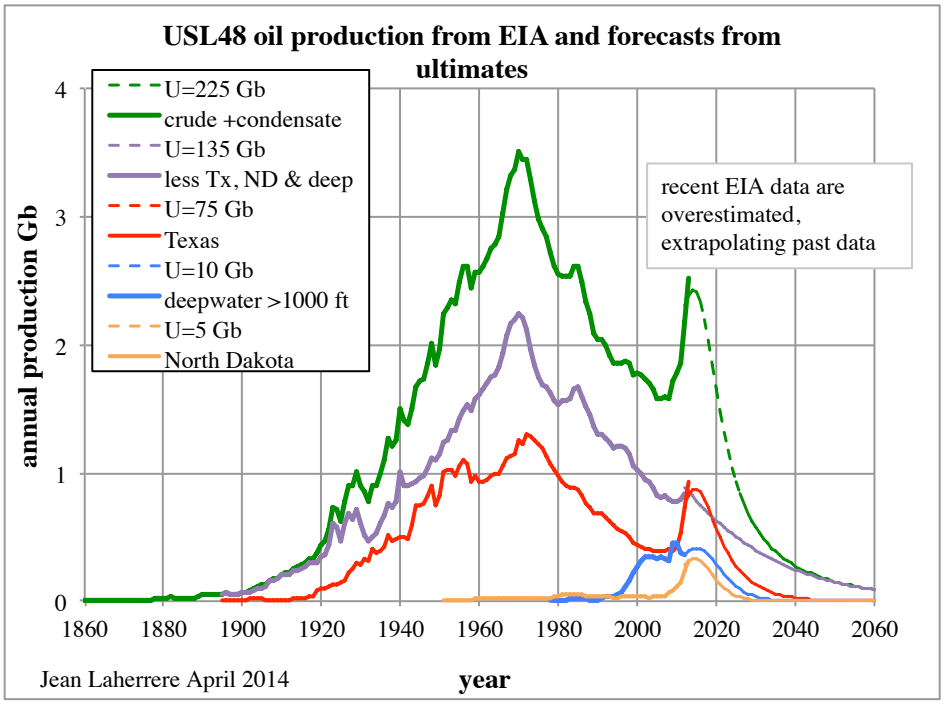


Fig 28: US oil production forecast 1860-2060

-**Cycles of activity**

Human behave with cycles (depending upon their moods and constraints) and the US number of wells displays several cycles of different width, different level if all wells or only exploration wells.

It is amazing to see that most of the time the cycles are symmetrical

"what goes up declines with similar rate"

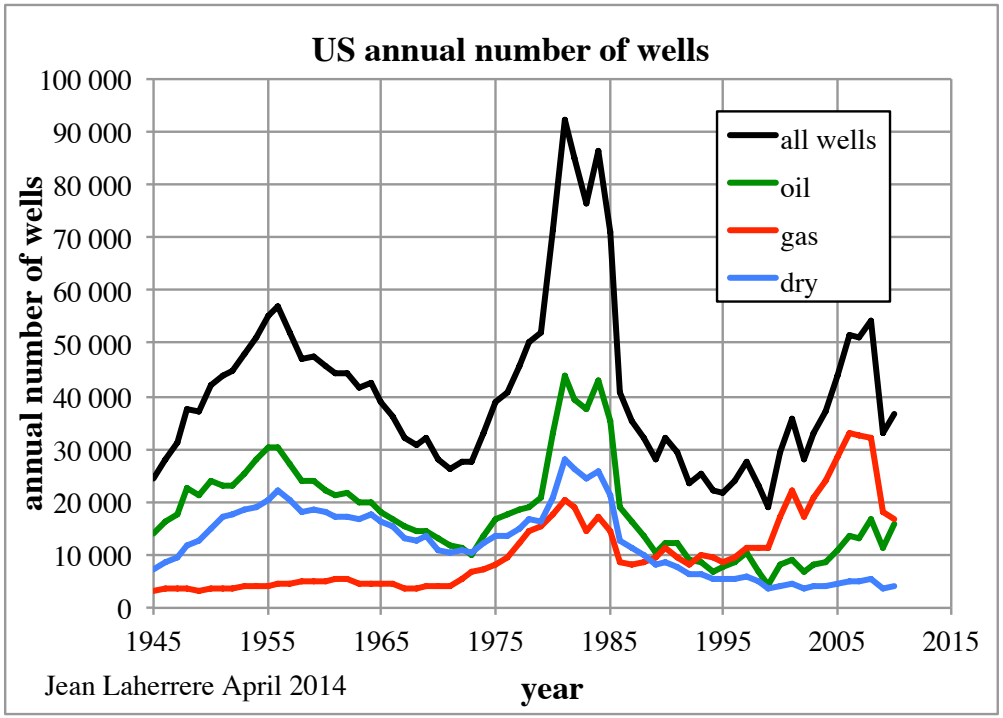


Fig 29: US annual number of wells 1945-2012

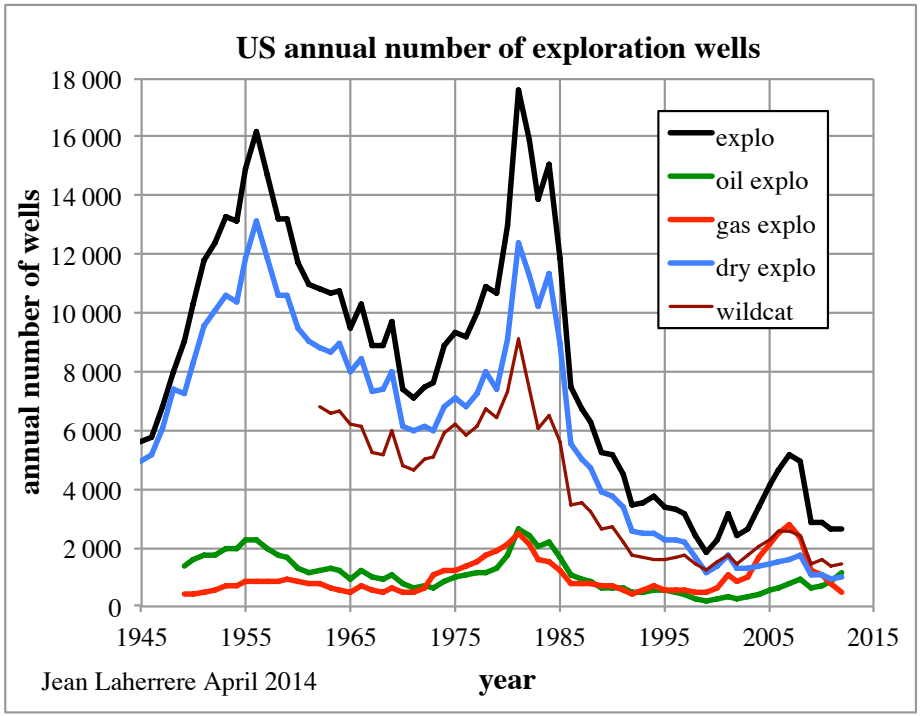


Fig 30: US annual number of exploration wells

The US number of producing wells is now about one million (50% oil and 50% gas), when in 1960 it was 0,7 million (85% oil and 15 % gas). The number of marginal wells (IPAA) is important, about 70%.

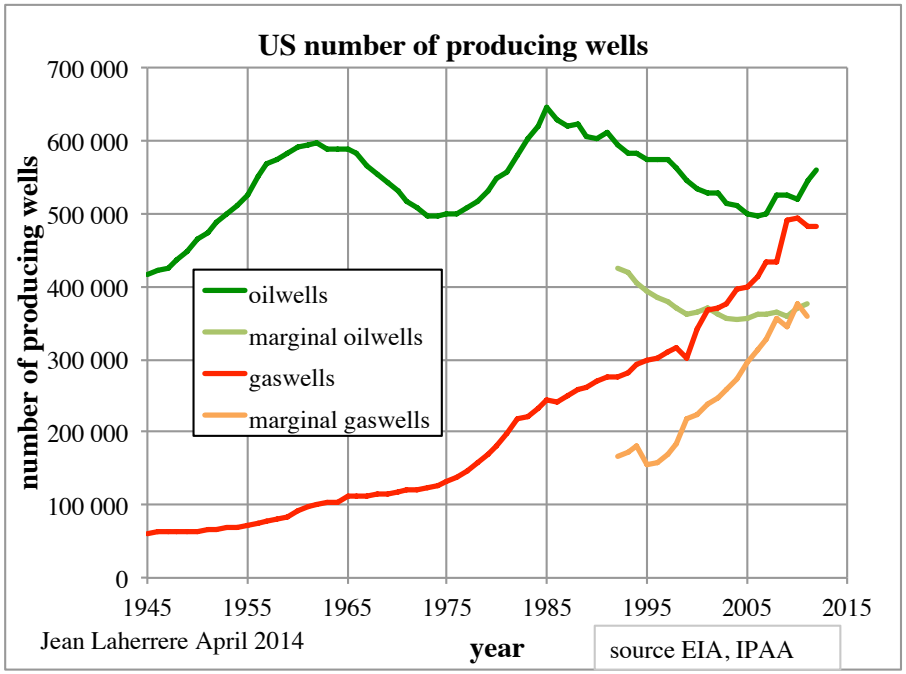


Fig 31: US number of producing wells 1945-2012

-World all liquids production & forecast

As already mentioned, oil databases are a mess, varying with sources, because poor collection of data and poor definitions. Furthermore to be wrong they are incomplete, unfriendly. And nobody cares.

Only three countries report reserves and production by field: UK, Norway and US federal lands.

Because there is no consensus on the definition of the products there are no rules, no referees and no red cards.

To display reliable graphs for showing the trends it is necessary to choose only one source and the "least worse" source is EIA. EIA database is friendly and often corrected, but often confusing condensate and for recent data using extrapolations instead of real data. Unfortunately EIA database reports too short historical series.

Production data have to be displayed from the start.

Many forecasts display more future estimates than past data: it is a must to show at least twice more past data than future data.
World all liquids graph displays different items: the crude including the condensate but excluding the extra-heavy (green), then natural gas plant liquids NGPL (red when added purple) and other liquids beings extra-heavy XH (black), refinery gain (brown) (3% of crude less XH) and other liquids including biofuels (yellow) which contrary to other is not limited by an ultimate but an asymptote at 5 Mb/d.
The ultimates are estimated to be 2200 Gb for crude -XH, 500 Gb for XH (peak around 2070), 300 Gb for NGPL (peak in 2030).
All liquids peak is likely to occur around 2020 and to be a bumpy plateau because above grounds constraints.
Official forecasts by EIA, IEA, BP and OPEC up to 2035 do not foresee any peak: their goal is to deny oil peak to please their government and shareholders. They are “Business as Usual “forecasts. The conventional oil decline is assumed to be compensated by the shale oil boom, which, like any boom, will soon decline as quick as it appears.

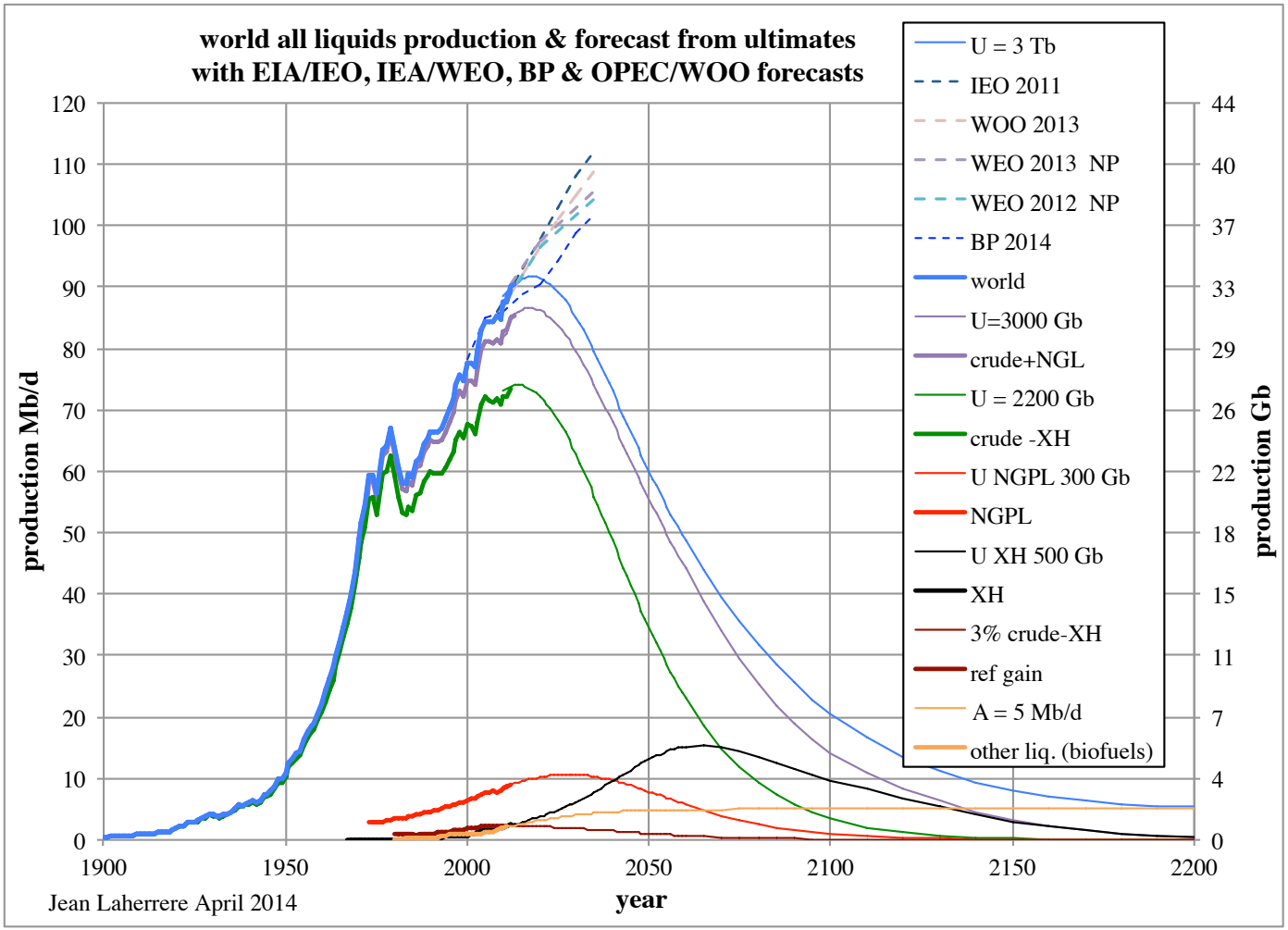


Fig 32: world all liquids production and forecasts from ultimates assumed no constraints above ground and official forecasts from EIA, IEA, BP and OPEC

-United States and European Union financial situation: which is the worst?

Everyone in Europe claims that the US is in good shape and Europe in bad condition except Germany, but why is the euro so high. The explanation is that the Fed is printing too much money (80 G$/month) but it is hard to forecast the value of euro next year. US official inflation (CPI) is reported to be low about 2%/a but John Williams site (Shadow Government Statistics) reports a real value close to 9%/a: who is right?
In the past spot FOB oil price in US (WTI) was very close to the price in Europe (Brent, despite that Brent oil field is depleted), because it cost few dollars per barrel to transport oil from US to Europe, but since 2010 WTI is about 20 $/b lower because the lack of enough oil pipeline to transport shale oil.

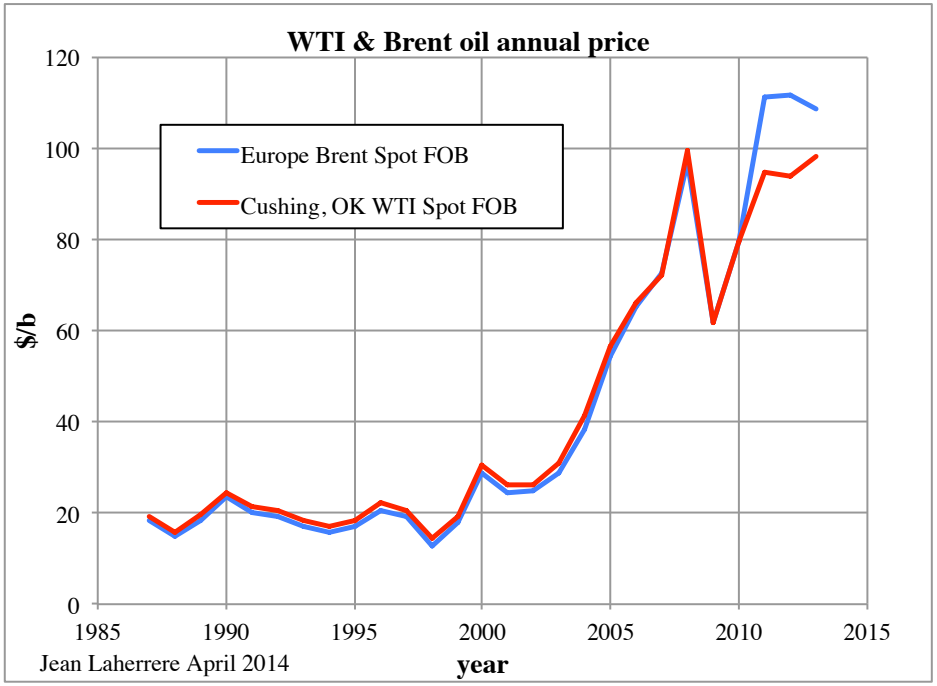


Fig 33: WTI & Brent spot FOB oil annual price

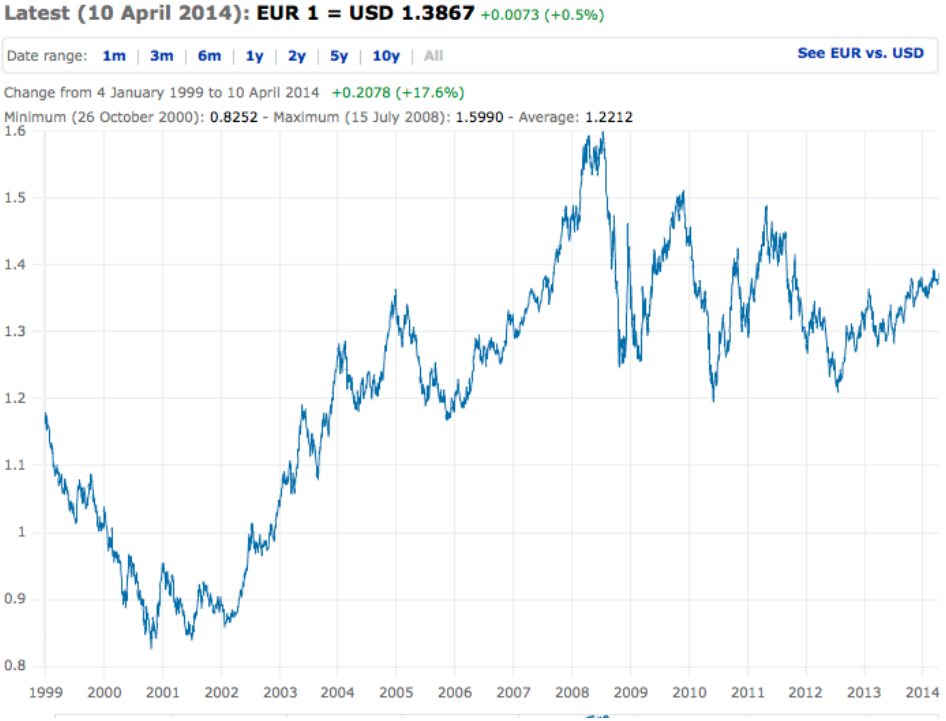


Fig 34: euro over US dollar 1999-2014

The gap WTI/Brent seems to be on the decrease and is likely that it will decrease to zero when Bakken and Eagle Ford will decline.

-Evolution of oil supply forecasts

Official oil supply forecasts by IEA/WEO reports are displayed from 1998 to 2012. For 2030 forecast was 120 Mb/d in 2002, but 98 Mb/d in 2012 for New Policies. The discrepancy from past forecasts

IPCC 40 energy scenarios are used by IPCC climate modelers to forecast temperature up to 2100. But their energy scenarios (SRES) were designed in 1998: they are not energy forecasts but just 40 storylines from economists (for the period 1990 to 2100) and the 40 primary energy scenarios are completely out of range from reality and from recent official forecasts. IPCC models are just GIGO: Garbage In Garbage Out

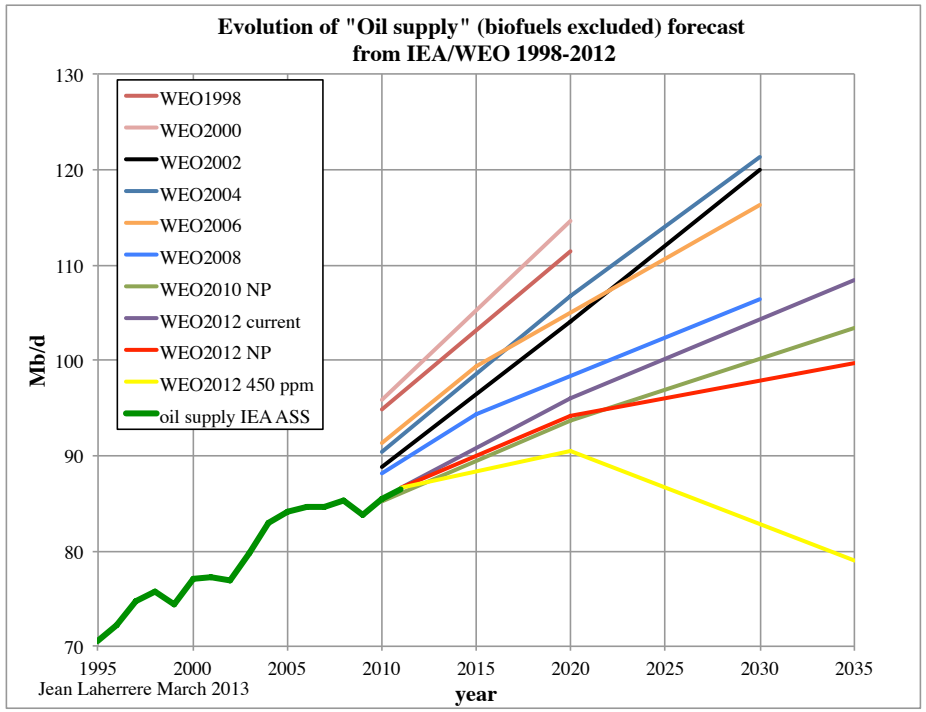


Fig 35: Evolution of oil supply forecasts from IEA/WEO

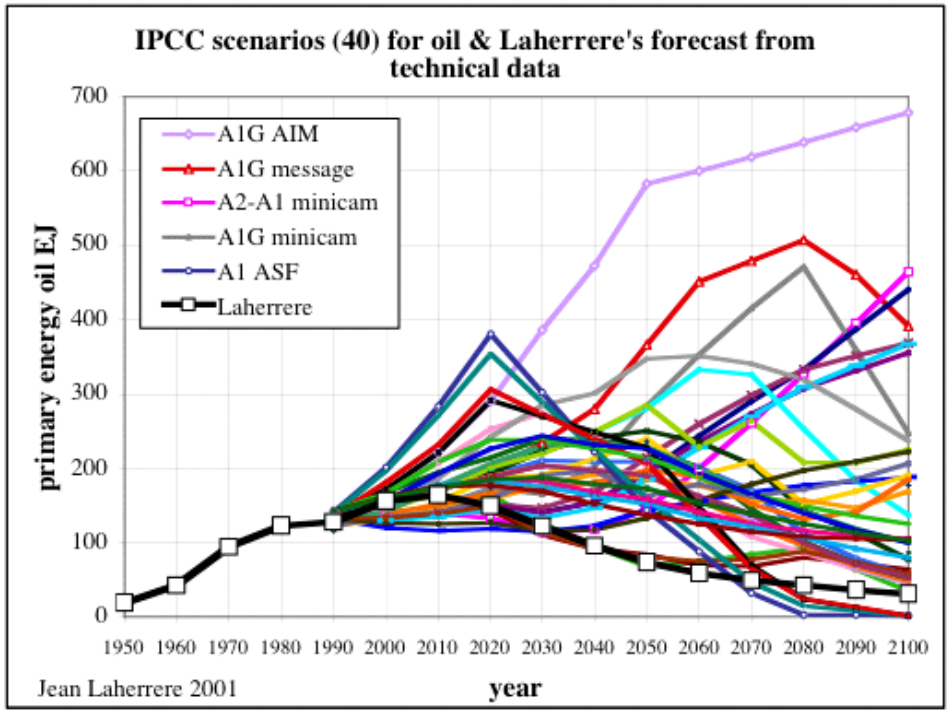


Fig 36: IPCC oil scenarios (1998)

-Evolution of oil price forecasts

The evolution of past USDOE/EIA/AEO forecasts on oil price shows that they were completely wrong: 20 $/b in 2020 forecasted in 2000! In 2014 WTI is forecasted 140$/b in 2040!

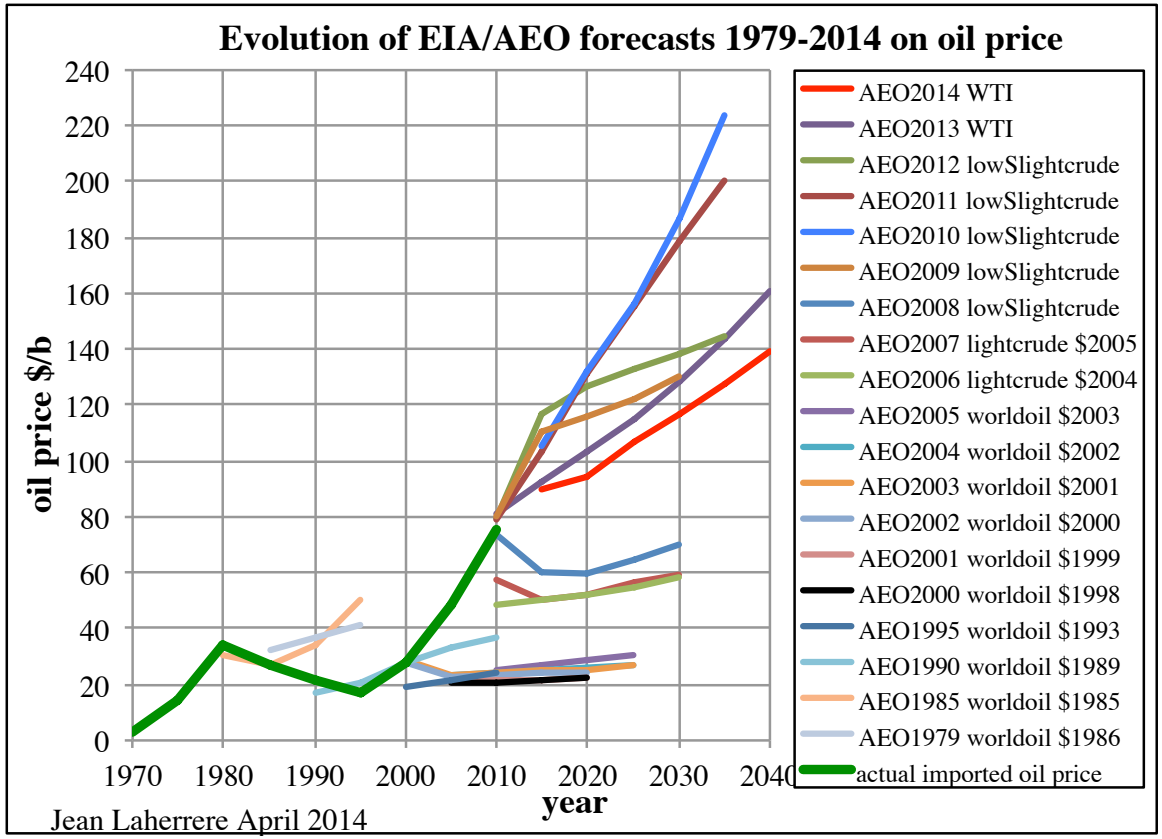
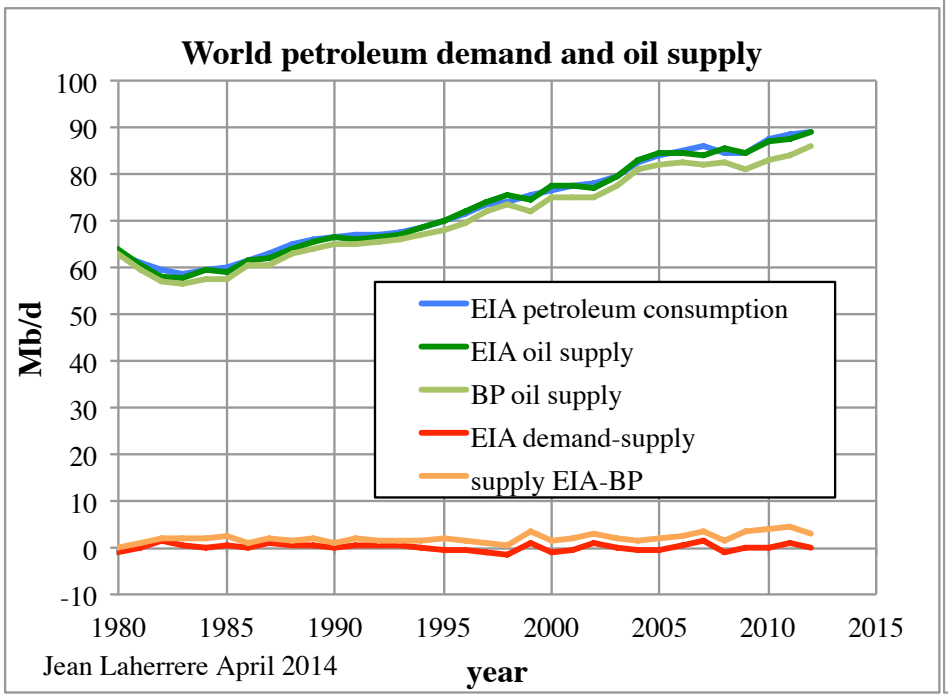


Fig 37: evolution of EIA/AEO forecasts 1979-2014 on oil price

I never forecast oil price because oil price is subject to irrational human behaviour (like the stock market). I only forecasted in 1998 with Colin Campbell "The end of cheap oil" when oil price was 13 $/b. In 1999 it went down to 10 $/b and it was only in 2005 when oil price was over 50 $:b that our work was recognized.

-Peak oil or peak demand

Some (Olivier Appert) claim that peak oil is of no interest and that only peak demand should be considered. But for the world petroleum demand equals oil supply neglecting the storage and losses. EIA petroleum demand less oil supply is less than 1 Mb/d since 1980 and much less than the difference on oil supply between EIA and BP!
As oil is very cheap to transport there is only one market for oil (except since 2010 with WTI cheaper than Brent).
As world demand equals supply it is difficult to say which is the egg and which is the chicken. But if demand is the driver and there is plenty of oil as some claim, the oil price should drop. Oil price is now about 100 $/b
The big questions are:
-why is the oil price not rising?
-why is the oil price not falling?
But oil price cannot drop below cost and estimates on cost (breakeven) from Goldman Sachs 2012 and Scotiabank 2014 where Kashagan (Caspian Sea 50 G$) at 125 $/b and Bakken at 70 $/b



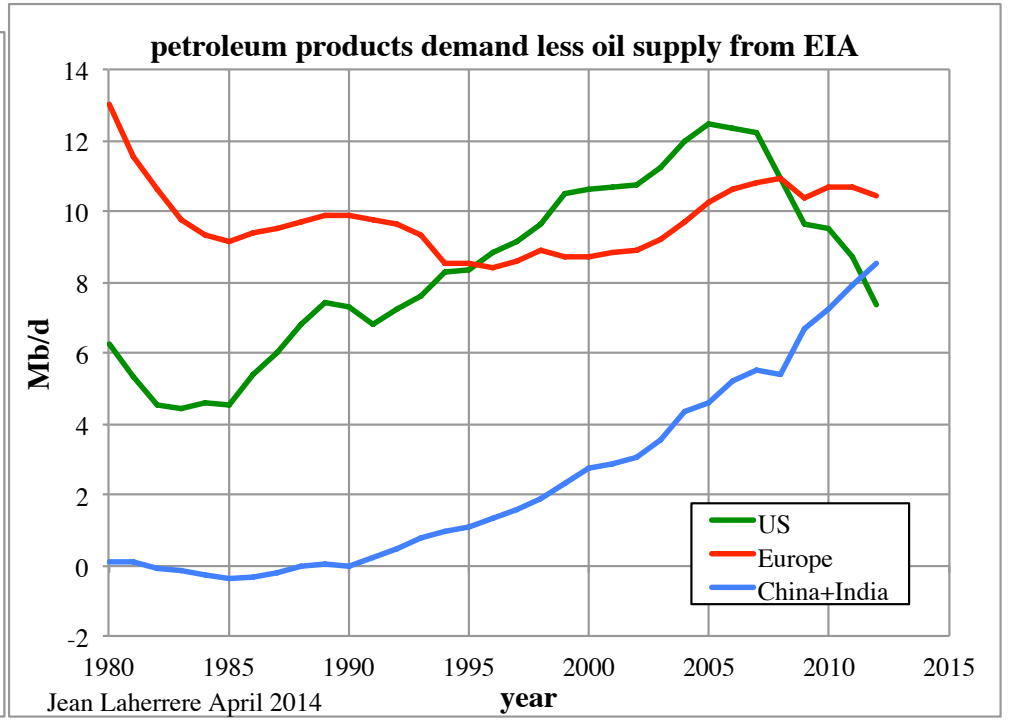


Fig 38: World petroleum demand and oil supply

Fig 39: petroleum demand less oil supply in US, Europe & China/India

The plot of demand less supply in US is dropping since 2007 by 5 Mb/d, Europe is a bumpy plateau since 1985, but China/India has increased since 1990 by more than 8 Mb/d and since 2007 by 4 Mb/d.

The Brent oil price was over 100 $2011/b in 1980 like in 2008 and in 2013 at 111 $2011/b

The plot of oil price ($2011/b) versus oil (crude + condensate) production from 1965 displays up and down but it seems that they behave as there is a ceiling at 120 $2011/b and a wall at 77 Mb/d

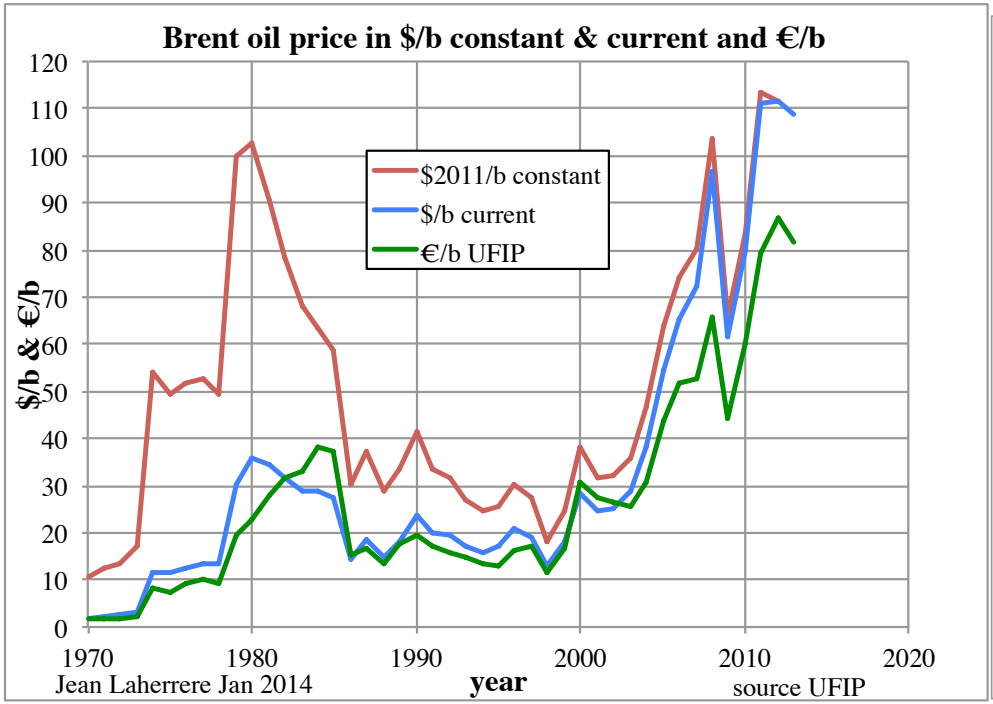


Fig 40: Brent oil constant and current price

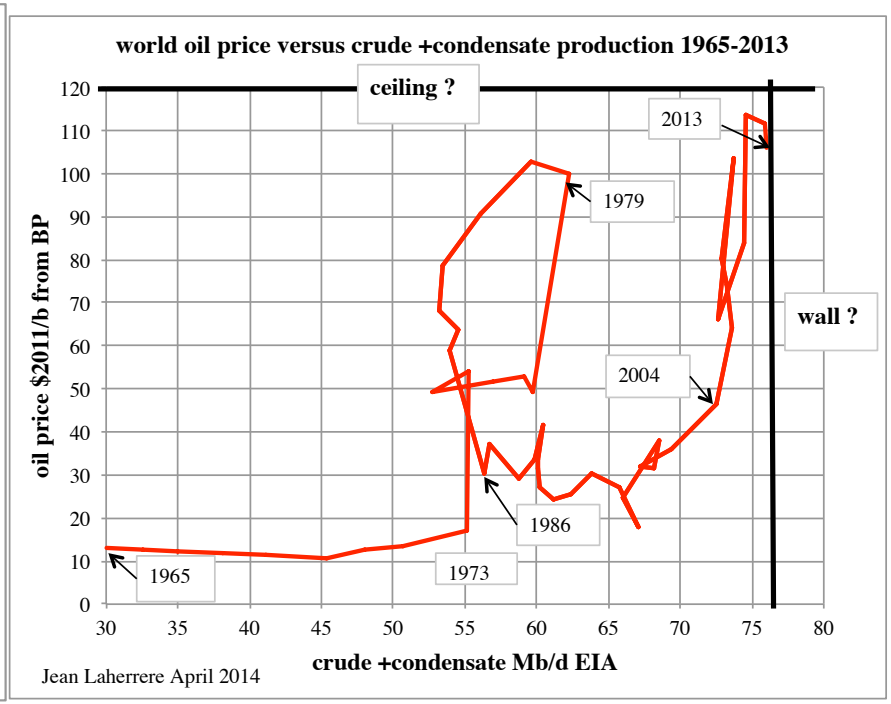


Fig 41: world oil price versus oil production

see:

-Aymeric de Villaret newsletter February 2014
http://aymericdevillaret.files.wordpress.com/2014/01/lettre-n11-fevrier-2014-pic-doffre-ou-de-demande.pdf
-Steven Kopits Douglas-Westwood "Global Oil Market Forecasting: Main Approaches & Key Drivers" Feb 2014
http://energypolicy.columbia.edu/events-calendar/global-oil-market-forecasting-main-approaches-key-drivers
-video "le petrole une histoire sans fin" LCP 19 avril 2014 http://www.youtube.com/watch?v=o7WBcxtgvro

The problem of oil price is about inflation on US drilling. USDOE/EIA has stopped reporting drilling cost after 2007. The cost of drilling per foot increased sharply since 2002 but it is difficult to know the cost in 2014 and the conditions have changed with the large increase in horizontal drilling. The cost has increased because the goals more complex.

-US natural gas production and price

It is amazing in the US that the ratio oil price over natural gas price in Mbtu was 7 in 1950 declining slowly to between 1 and 2 from 1985 to 2005 and rising sharply to over 5 in 2012 because the shale gas boom and the lack of gas pipelines. US NG flaring was over 7% in the 1950s and c declines to 1% from 1973 to now except 1992-1998. But in North Dakota NG flaring went from 12% in 2005 to over 33% since 2008.
The boom of shale gas led to the fall of gas price and immediately the fall of number of gas rigs. The correlation between NG monthly production and numberrof gas rigs is very good since 1987 until mid 2012 where
US NG price needs to go over 6 $/Mbtu (February 2014 price with only 341 rigs) to see the number of rigs rising.

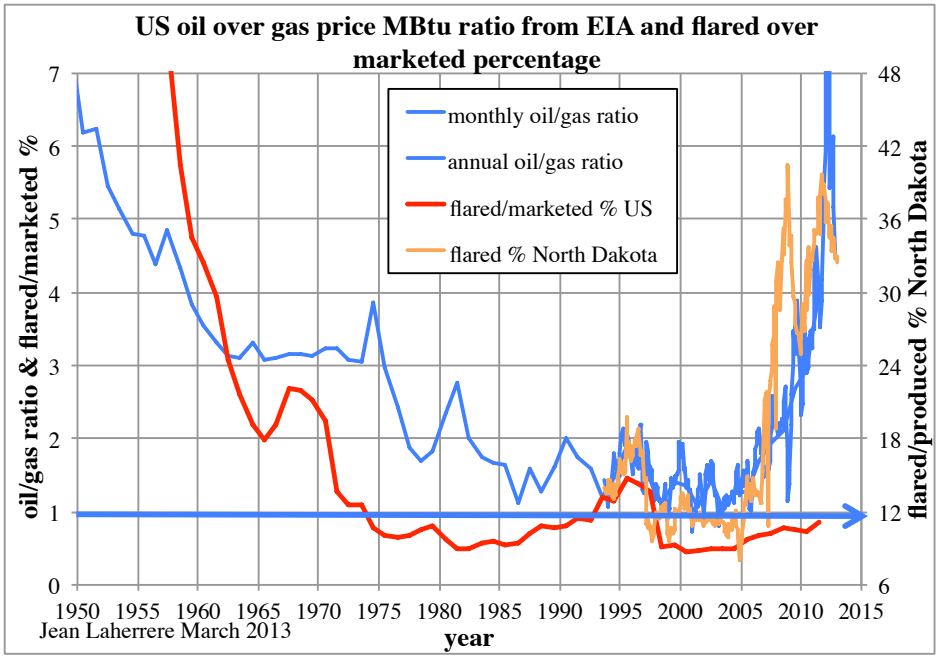


Fig 42: US: oil versus gas price ratio & % gas flaring over production

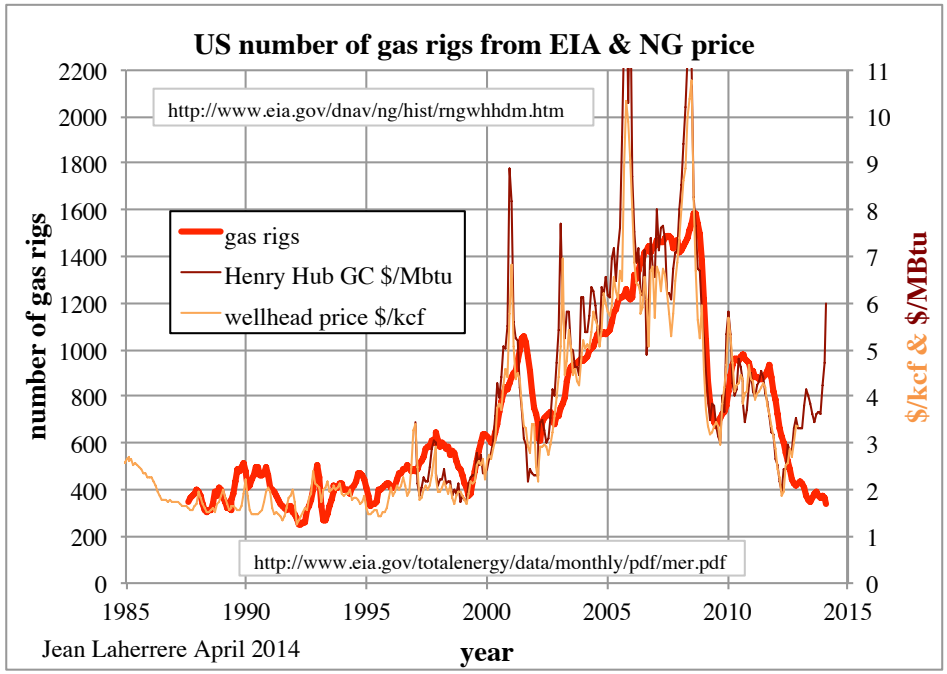


Fig 43: US monthly number of gas rigs and NG price

The US NG production is displayed from 1900 to 2060 with the breakdown with conventional (peak in 170 at 22 Tcf and at less than 9 Tcf in 2011) and unconventional with likely peak in 2020 at 22 Tcf (18 Tcf in 2012). Like the shale oil, the shale gas production (gross less reinjected to account loss and flaring) will peak soon and the decline is sharp. NG production is likely to fall to 10 Tcf in 2040 when EIA/AEO2013 forecasts 33 Tcf in dry: more than three times more!

I am amazed to see the number of US LNG export projects (like Cameron with GDF Suez) with contracts for 20 years based on the shale gas boom! A boom is like an explosion: very strong during a short time

It is a boom not a revolution!

The shale gas boom is not due to a technical change but to an economical change.

Unfortunately the hectic drilling by promoters led to a drastic decrease in NG price (from over 10 $/Mbtu in 2008 to 2 $/Mbtu in 2013).
Unconventional NG reached 17 Tcf/a in 40 years, when it took 70 years for conventional NG !
Such hectic drilling occurs in the East Texas oil field (>1700 operators) after its discovery in 1930, oil production increased sharply in 1931 with 1300 wells producing open flow 1.4 Mb/d and oil price dropped from 1 $/b to 0.1 $/b. The State Governor issued a martial law on August 1931 and sent the military forces to close wells and restrict the production below 0,4 Mb/d. The oil price went back to 1 $/b. At the end over 30 000 wells were drilled on the field, ten times too many for such good reservoir. But at the times there were no rules on drilling location except the law of capture, making possible to produce neighbor oil by drilling on his limit.

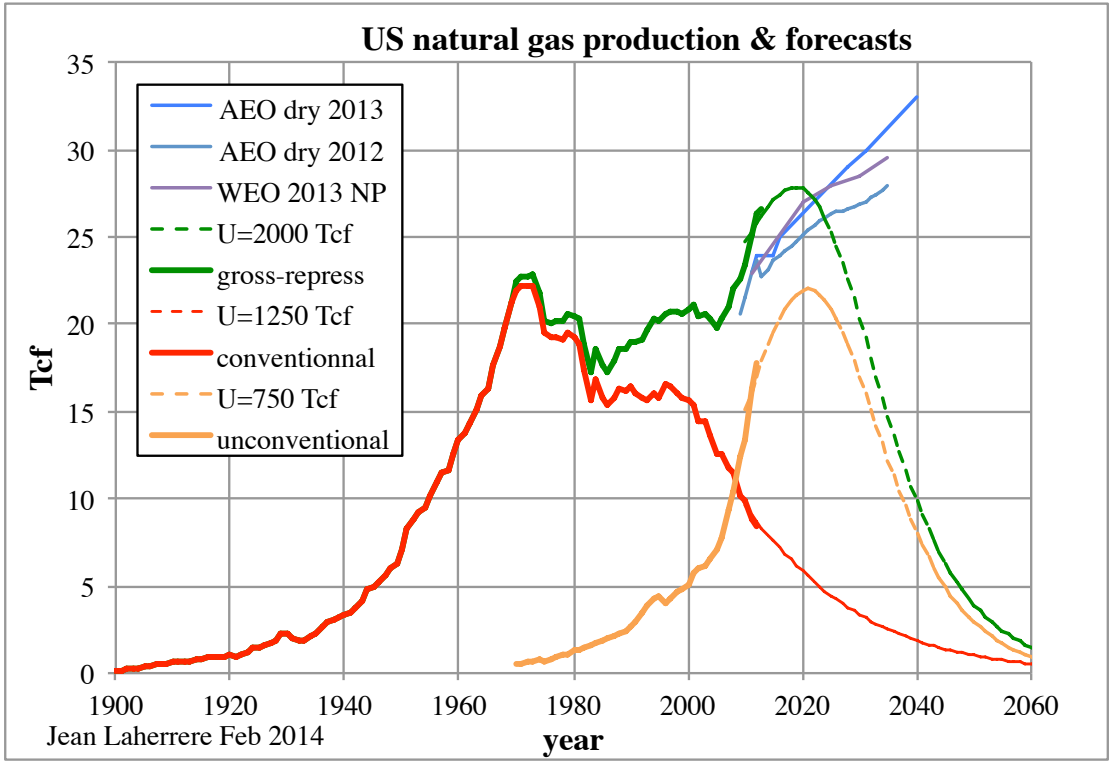


Fig 44: US conventional & unconventional natural gas production & forecasts

The US shale gas looks like a Madoff scheme and the best is to see the present debt of Chesapeake (after the firing of its chairman) after selling more than 20 G$ assets to majors and the write off of majors on shale gas acquisitions.

-Fossil fuels production

If the oil production will decline after 2020 with an ultimate of 3000 Gb, the natural gas production will decline after 2030 with an ultimate of 2200 Gboe (13 000 Tcf) and the big unknown is about coal with an ultimate of 5400 Gboe (750 Gtoe). the fossil fuels will peak about 2025.

But the fossil fuels production per capita which rises from 5 boe in 1950 has been on a bumpy plateau between 10 and 11 boe since 1970: it will peak around 2020 and will be down to 4 boe in 2100.

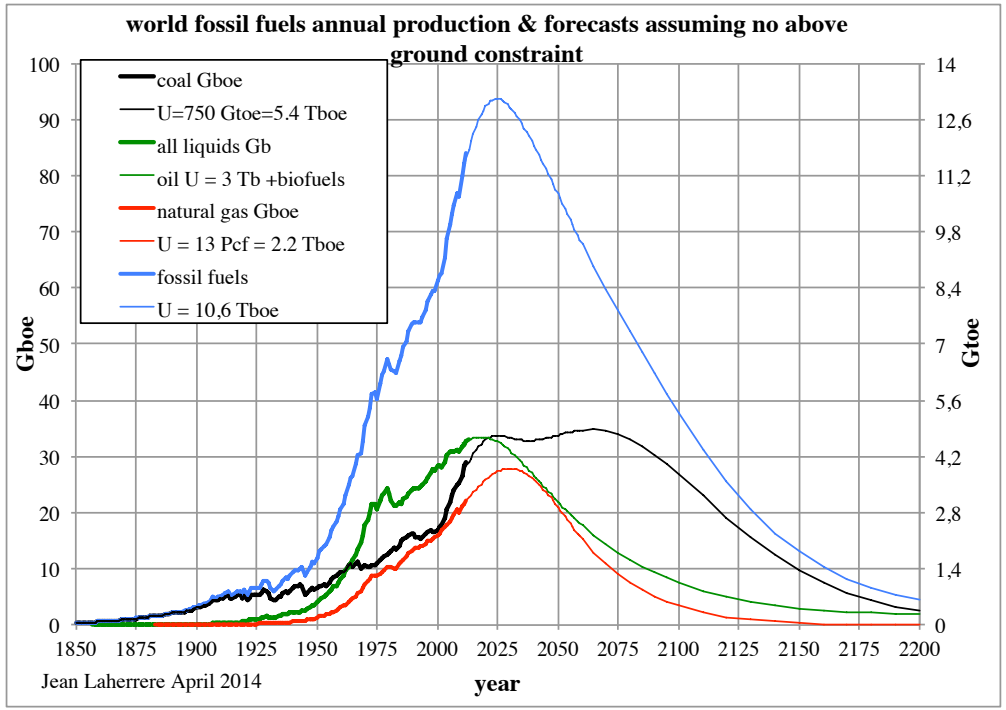


Fig 45: world fossils fuels production 1850-2200

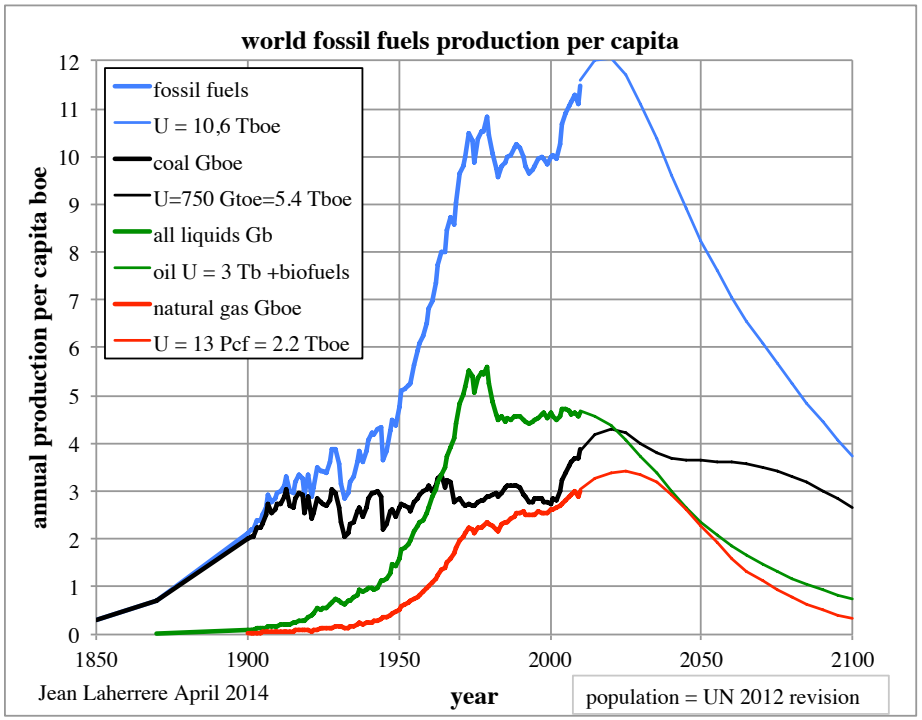


Fig 46: world fossils fuels production per capita

-Diesel scandal in France : fiscal inequality

France is assumed to be “special” “being one exception” in many ways: cheese, nuclear, diesel cars.

For several years I denounce the French diesel scandal. France claims equality but taxes on diesel is much less than gasoline and diesel is sold much cheaper than gasoline in contrary to US, UK, Switzerland. Diesel is sold by volume and diesel is heavier than gasoline and in fact 7.3% higher in energy by volume.

In France, the number of diesel cars represents 60 % of the 31 millions cars, gasoline consumption peaked in 1987 and diesel consumption is rising sharply, being 4 times on 2012 than gasoline in volume

In fact diesel should be sold 7% higher than gasoline to be energy equivalent.

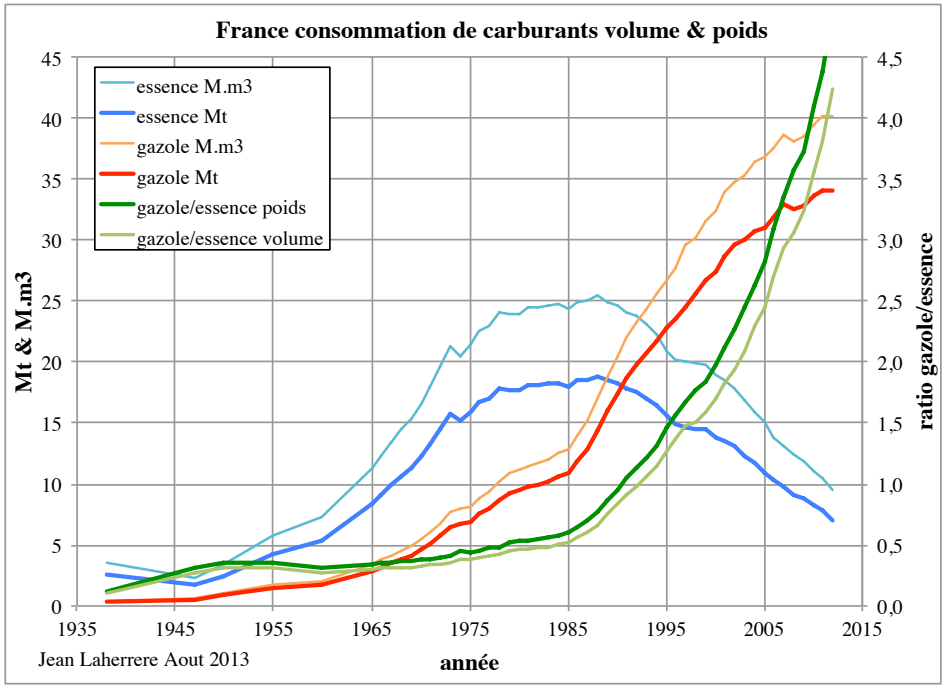


Fig 47: France: fuels consumption 1947-2011

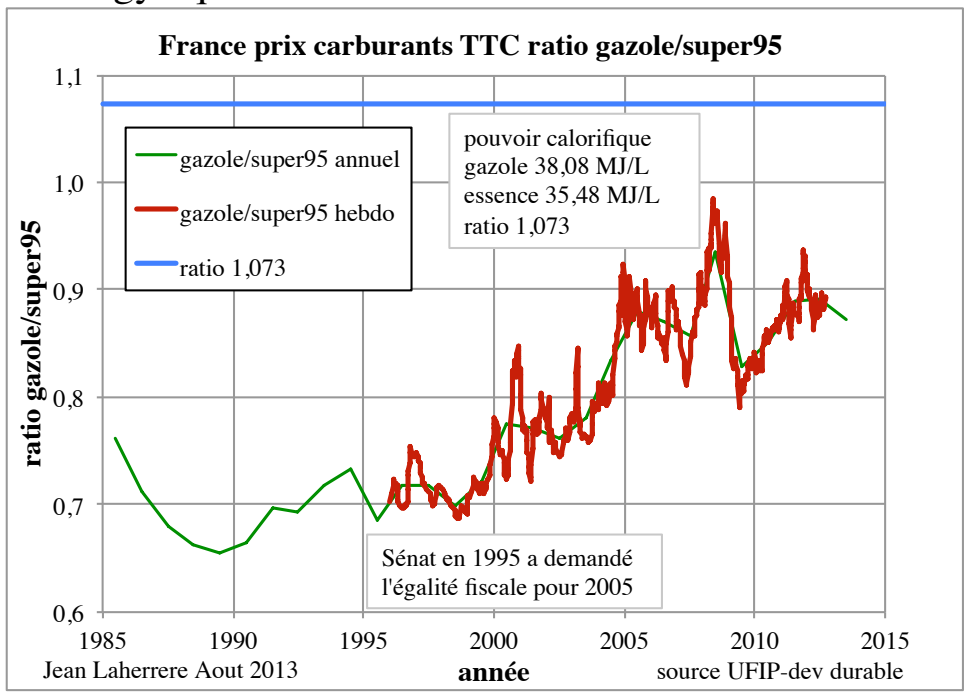


Fig 48: France: price ratio TTC diesel/gasoline

In 1995 where diesel was sold 70% of gasoline, the French senate asked for fiscal equality in 2005, the ratio climbed to close to 1 in 2008 but feel in 2012 to 0.9.

In 2014 in France diesel is sold 2,3 time the price in Rotterdam when gasoline is sold 2.8 times, when in 2009 it was over 3 and 5 times.
French refineries produce not enough diesel and too much gasoline and they are obliged to import diesel from Russia and to sell gasoline to the US (they do not want it anymore). In 2012 the consumption of diesel was 34 Mt and the consumption of gasoline was 7 Mt. The fiscal loss (compared to calorific equality in sale TTC) was over 11 G€ per year. The cumulative loss due to diesel inequality for the period 1990 to 2012 is about 200 G€.
No one is telling this truth, when the government is looking for tens of G€!

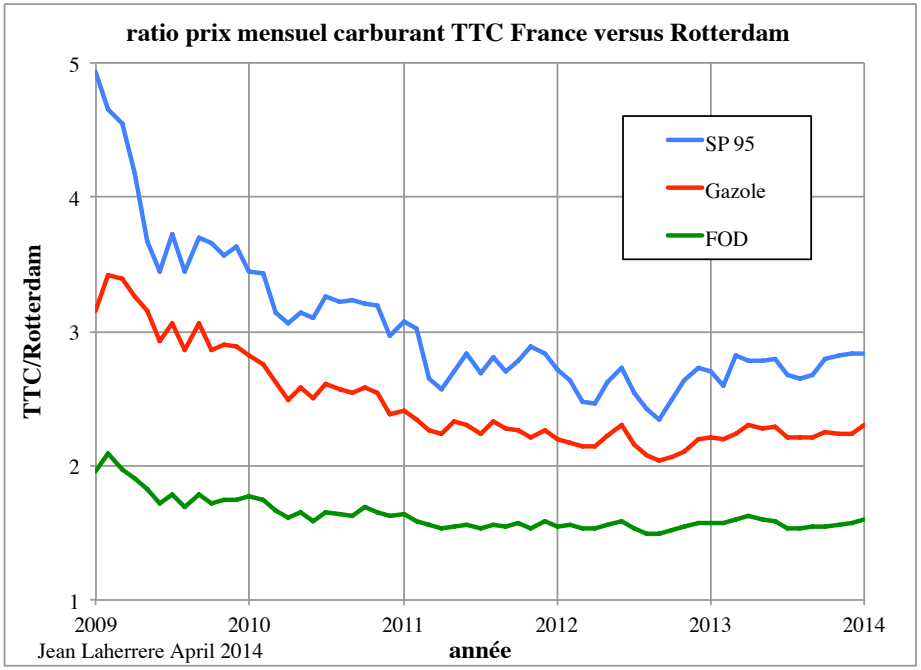


Fig 49: France: ratio price TTC SP95, diesel, FOD versus Rotterdam

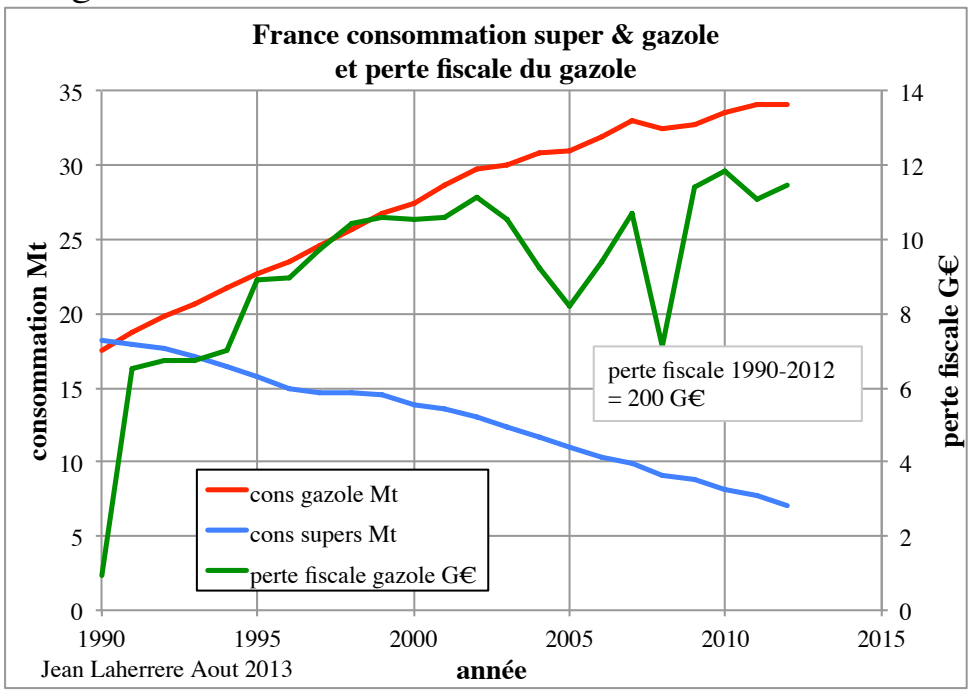


Fig 50: France diesel & gasoline consumption and fiscal loss

Further to the diesel fiscal inequality, diesel exhaust produces nanoparticles which are carcinogenic. New particles filter in cars stops mainly the large particles PM10, but little the nanoparticles PM0.1, which are in great number. Furthermore volatile exhaust leaving the filter are quickly turned into nanoparticles.
Aphekom study on 25 European towns founds that on Paris

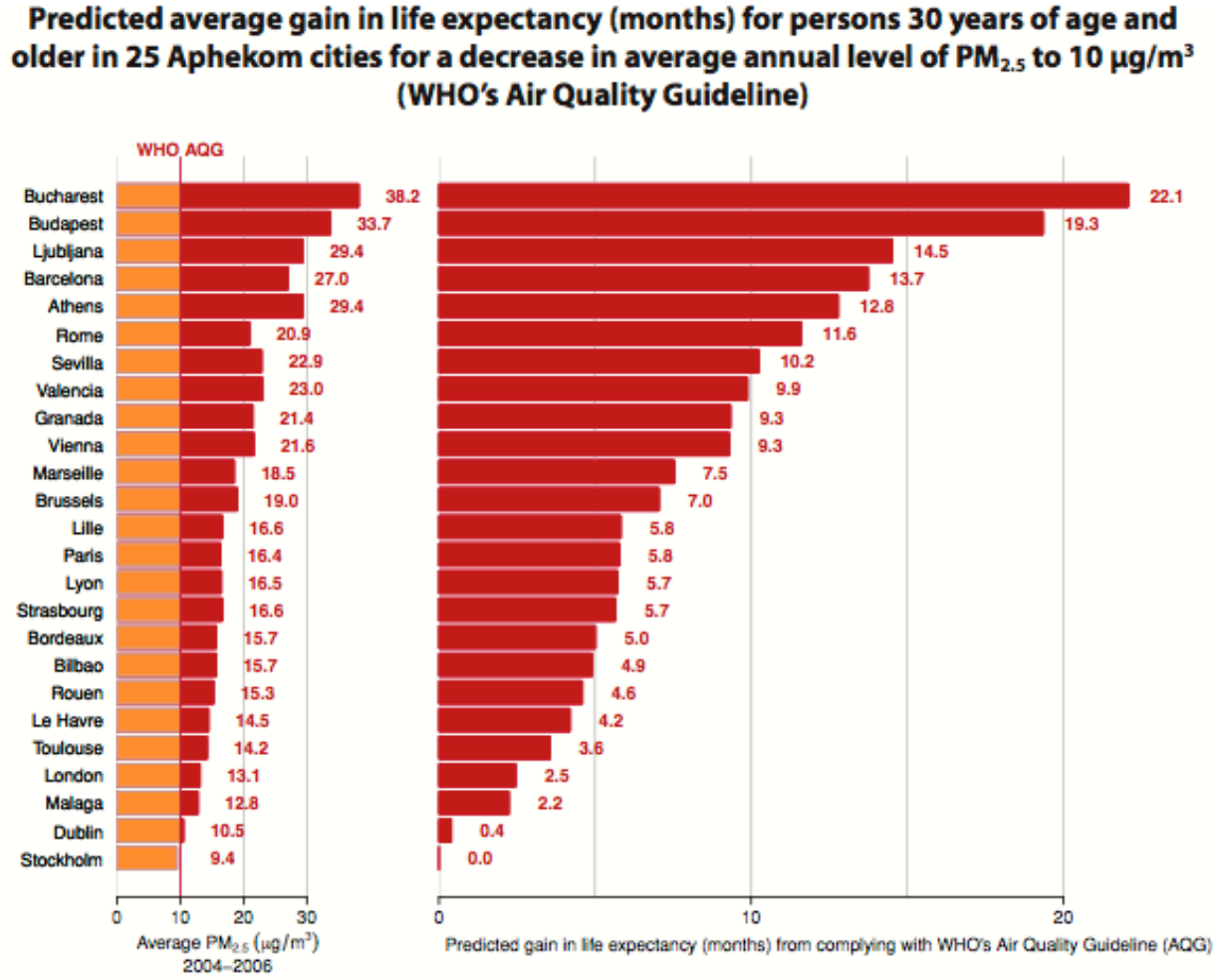
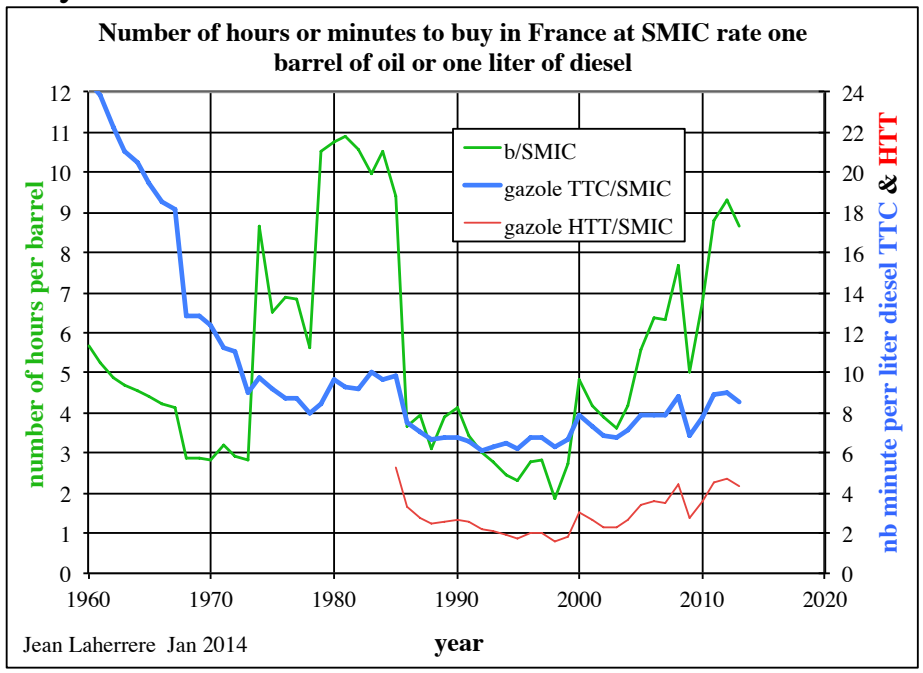


Fig 51: Aphekom study: loss in life expectancy in 25 towns

On 10 April 2014 in north Paris AI Airparif has recorded since 1 January 44 days above the limit of PM10 of 50 microgramme per cubic meter, when the rule is less than 35 days per year. The limit was overpassed 176 days in 2010, 164 in 2011 and 192 in 2012.
CO2 and OGM do not kill anybody in France, but diesel particles kill an estimated 40 000 people a year (http://oecdinsights.org/2013/06/19/avoiding-death-by-diesel/).
Who cares? Not the Greens!

-Energy expenditures in France

Many complain that energy expenditures increases in France and in particular diesel fuel.
In 1960 it was necessary to work 24 minutes at French minimum wages (SMIC) to buy one liter of diesel, but only 10 minutes in 1972, 7 minutes from 1986 to 1999 and less than 9 minutes in 2013



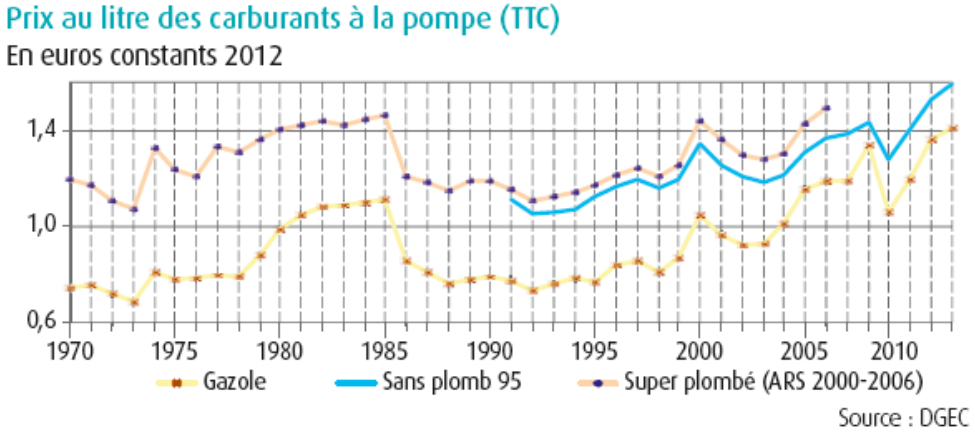
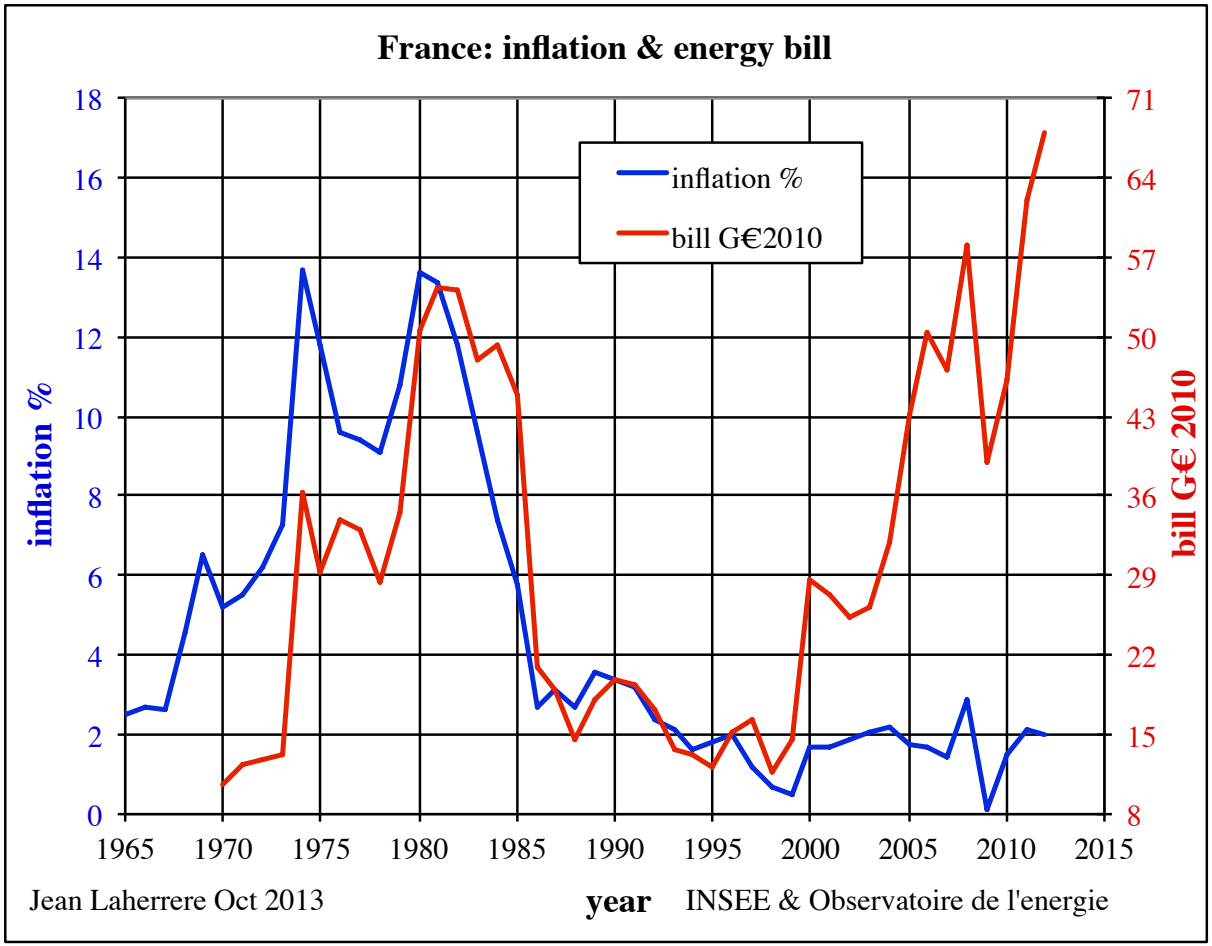


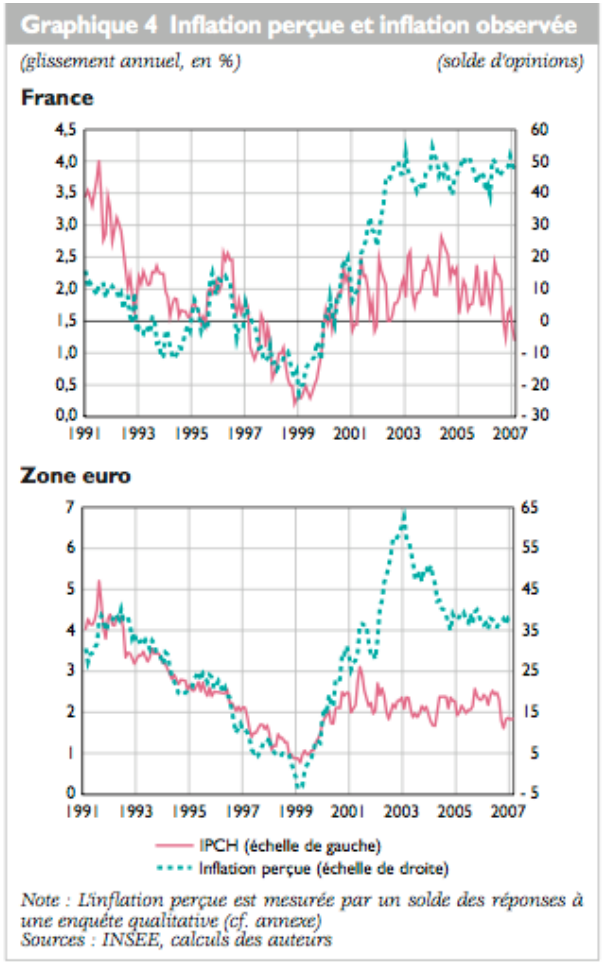
Fig 52: time to work at France minimum wage to buy one barrel and one diesel liter

Fig 53: fuel 2012 euro price at service stations 1970-2012

The price at petrol stations in 2012 euro shows a different trend because inflation and SMIC do not correlate.
Diesel in €2012 is 1.4 in 2012 and only 0,7 in 1970.
Statistics can be changed: it depends in finding the right index!
Nature is never linear, but multi-solution.
When you find one solution, it is not the only one, keep finding another one

France energy bill is displayed in €2010 and compared to official inflation. There is a good agreement from 1965 to 1986 (oil counter-shock) but beyond where official inflation is about 2%/a. But enquiry about perceived inflation displays a different pattern from official inflation since 2000
France energy bill is on the increase with no peak in view!





-Fig 54: France: inflation & energy bill

-Fig 55: official inflation & perceived inflation Chauvin & LeBihan BdF

In Reperes 2013 the percentage of energy expenditures for a French household is reported with a bumpy plateau between 8 et 9% since 1987 and a peak in 1984 of 12%, but in 2009 the same graph was reporting plateau between 7 et 8% and the 1984 peak is only 10% and in 2006 the bumpy plateau was between 5 and 6% and the 1984 peak was at 8%

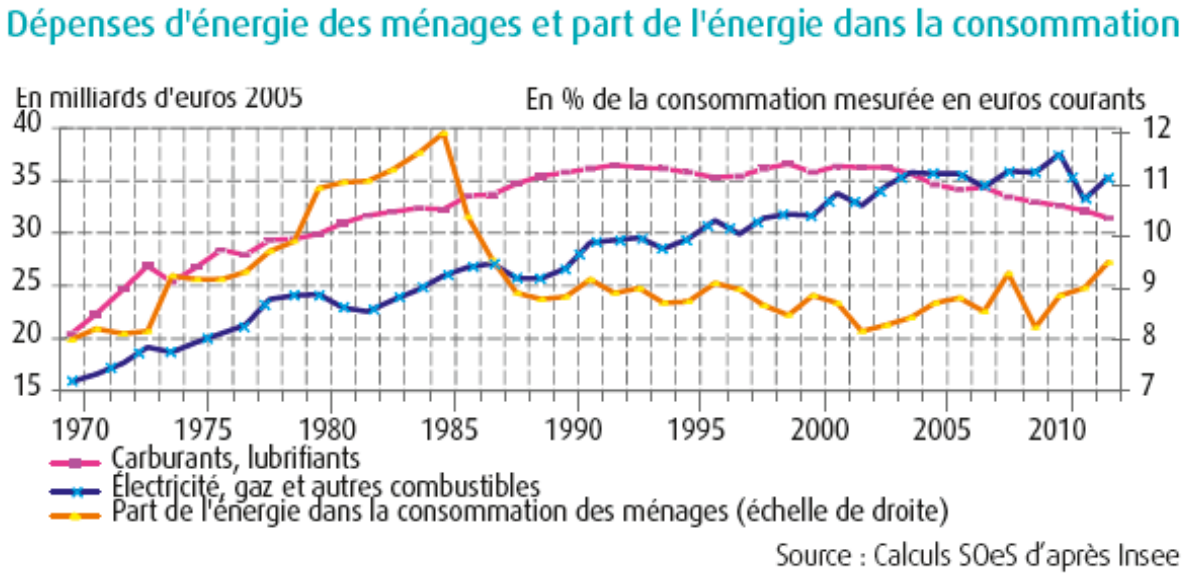
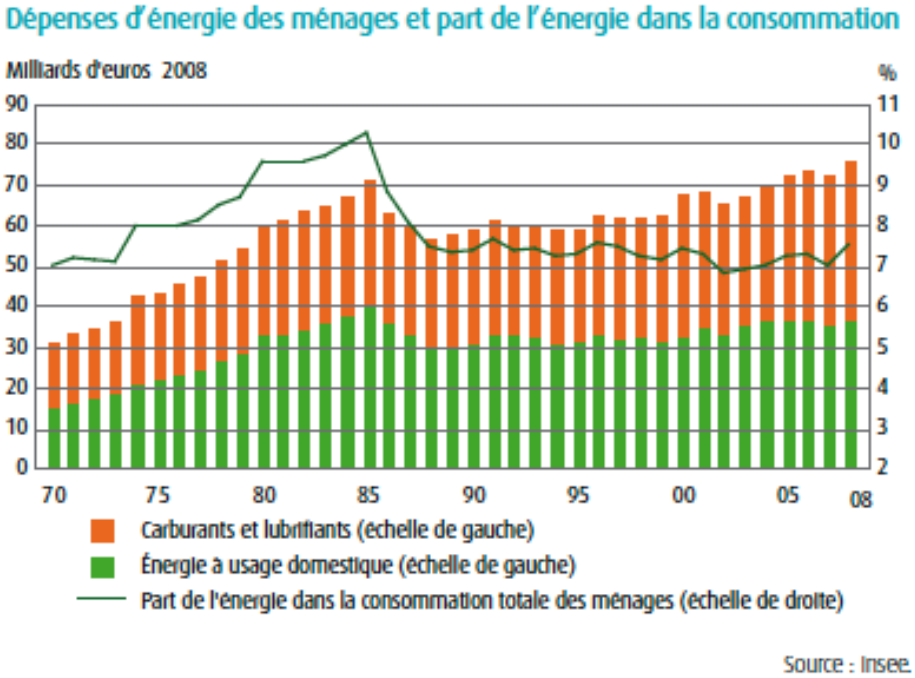


Fig 56a: France Reperes 2013: household energy expenditures & percentage consumption
In 2013 the expenditures are reported in 2005 euros, when in 2009 in 2008 euros and in 2006 in 2005 euros!
Why such change? What is the motive?
Data are either badly reported or manipulated, in particular on inflation



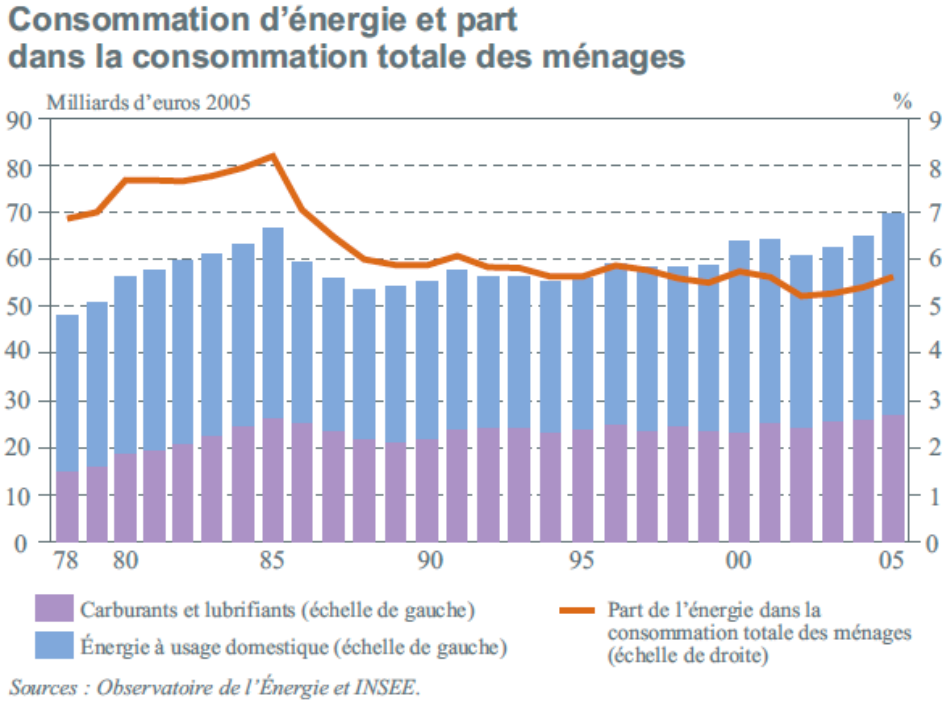


Fig 56b: France Répéres 2009: household energy expenditures & percentage consumption

Fig 56c: same in Répéres 2006

-GDP growth and oil production growth

Energy intensity is calculated as units of energy per unit of GDP. Oil intensity is the oil consumption per GDP unit, and it peaked in 1973 for US, Japan, UK.

Oil production growth is often compared to GDP growth and I did it in the past.

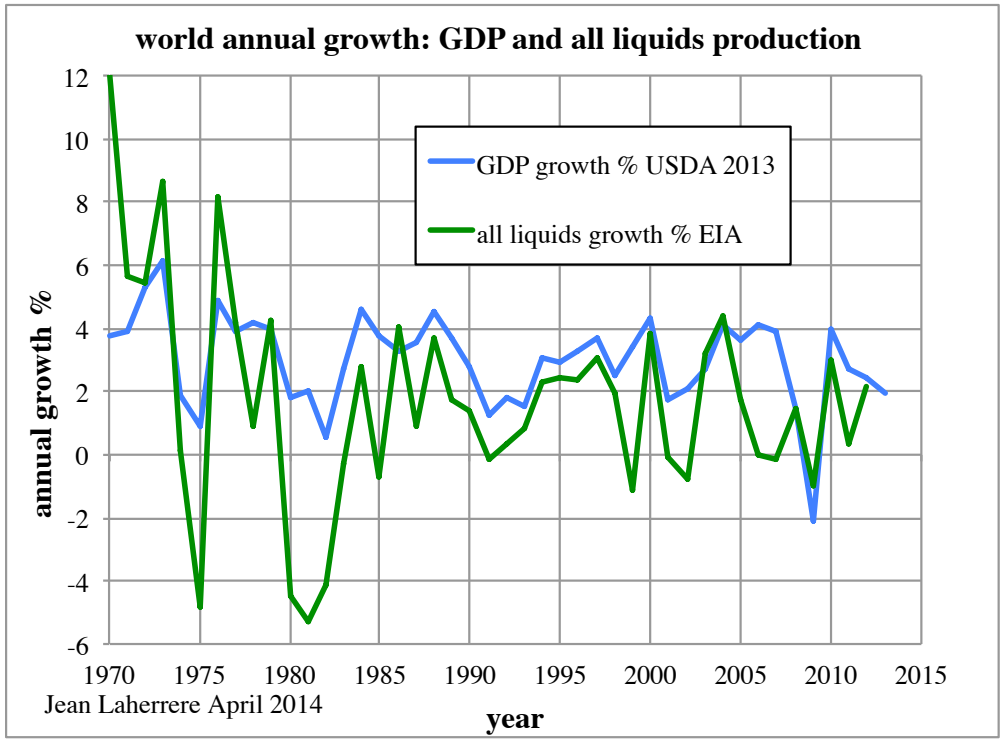


Fig 57: world annual growth GDP & all liquids production

Many believes that GDP growth drives oil growth.

But GDP is manipulated. The US government decided in 1998 to change computer expenditures into investments using a hedonic factor adding hundred of G$, and in July 2013 artistic expenditures into investments. But such change in definition is applied to the all world by USDA.

World GDP is plotted from different sources and the variation is large, depending the unit. Taking 1990 as 100, GDP value for 1970 varies between 31 and 50.

Taking the same source being USDA which reports GDP per country, the world GDP in $2005 displays in edition 2010 and edition 2013 a large increase of 1500 G$ (in green = 3%) for 2010 when the annual growth in 2010 was 2000 G$, but for 2009 the variation was 1250 G$ and the growth -1000 G$.

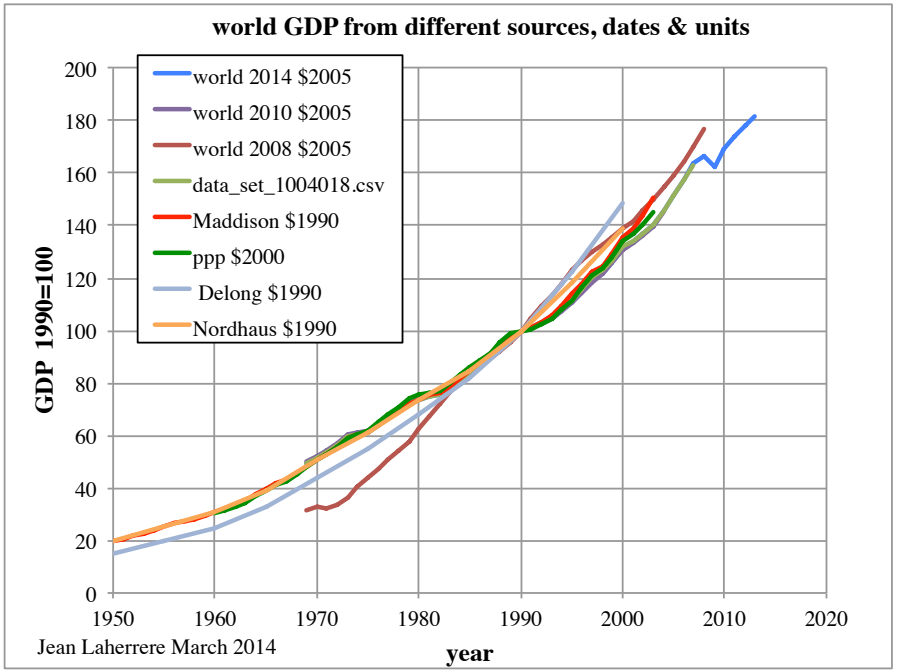


Fig 58: world GDP 1990=100 from different sources

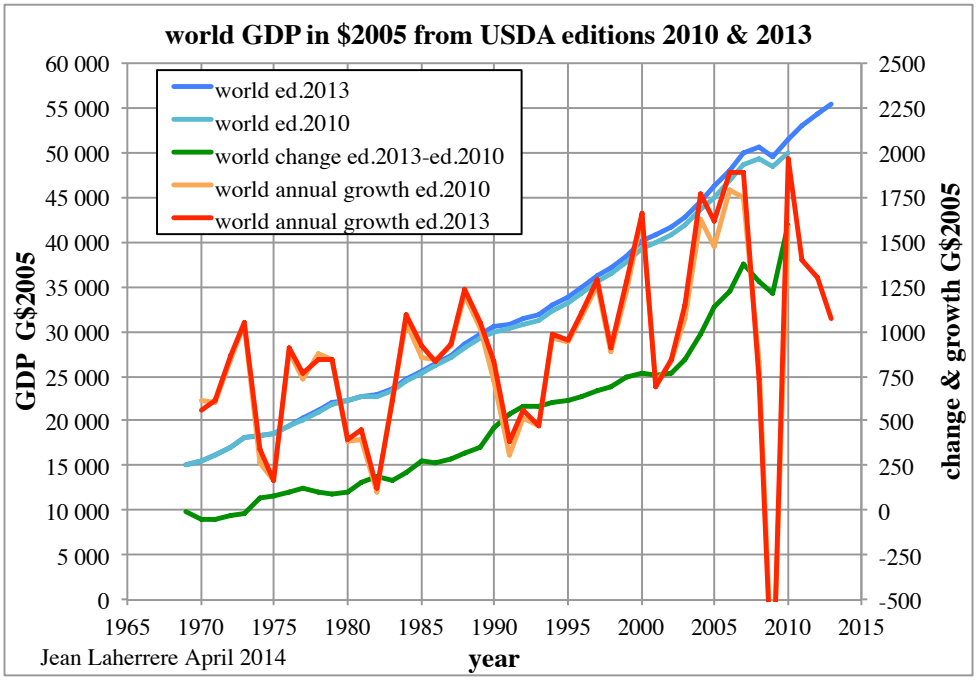


Fig 59: world GDP from USDA editions 2013 & 2010

In fact the annual growth of the world GDP is about the accuracy of the estimate and therefore unreliable!

-Technology and "peak oil"

Technology will save the world, say the economists, but they are not technician. I am a technician with over 50 years experience in geology and geophysics and I have seen most of the break-through in exploration. I participated in the drilling of hundreds of dry holes but also in the discovery of several giant oil and gas fields, in particular Hassi Messaoud and Hassi R'Mel, largest oil and gas fields in Africa (which supply presently half of Algerian revenues).

Now, like one hundred years ago, no one can predict if a prospect will find oil or gas, only drilling will tell. Technology like horizontal wells may improve the flow of production, allowing to produce faster, but often it is at the detriment of the ultimate: the two giants fields (Yibal and Rabi-Kounga) in Oman and Gabon operated by

Shell were produced with horizontal wells increasing the peak but also the decline to 12 % and decreasing the total recovery, despite the statement in 2000 by Sir Watts that "major advances in drilling were enabling the company to extract more from such mature fields".

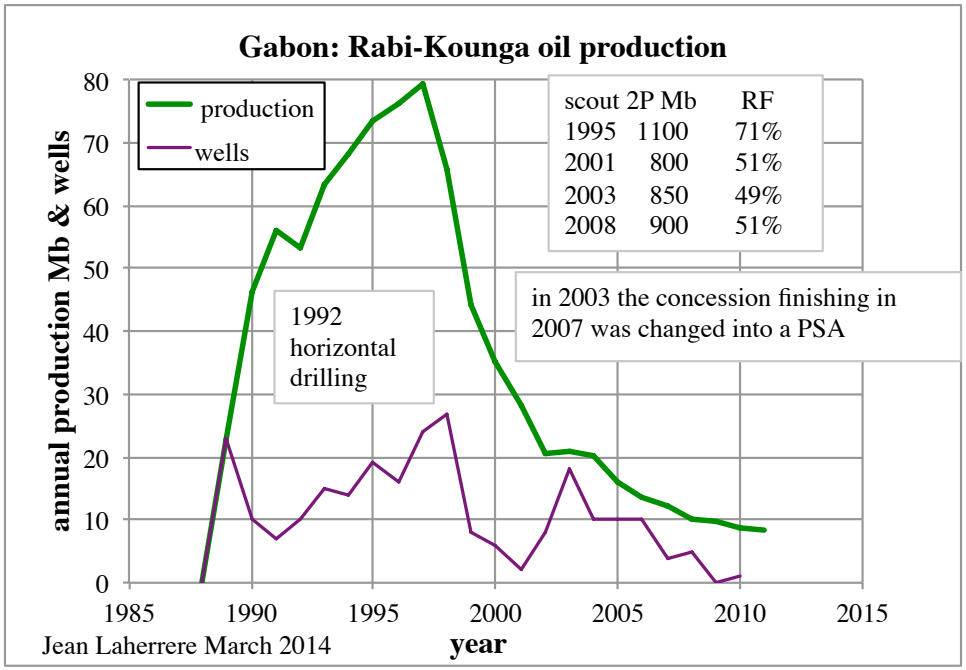


Fig 60: Gabon Rabi-Kounga oil production

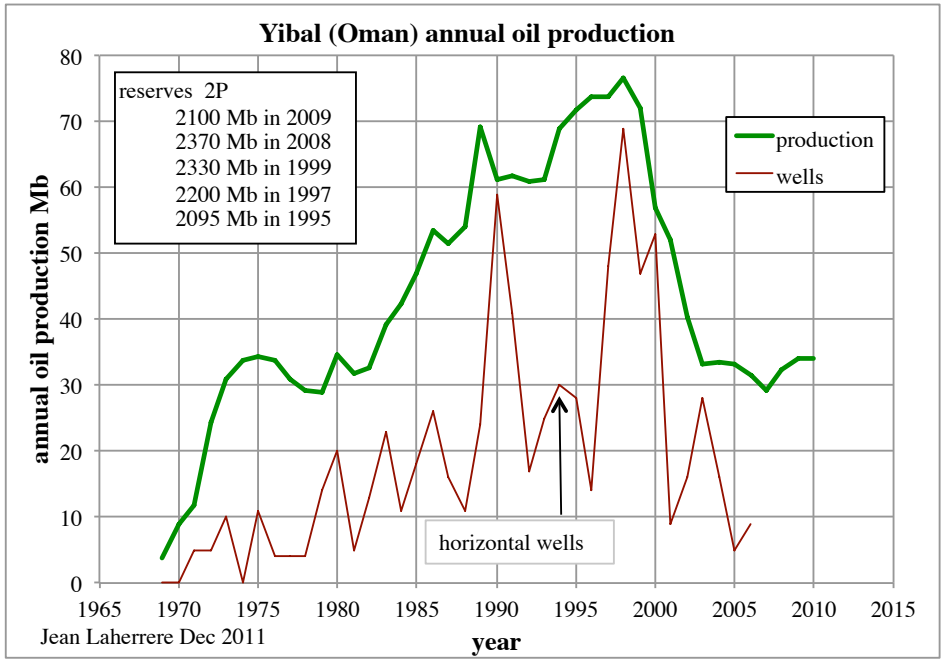


Fig 61: Oman Yibal oil production

-Science and accuracy

Many believe that Universe is better known than one century ago: presently from what we see, astronomers say that only less than 5% of the universe is known, the rest being an unknown dark matter (22-25%) and an unknown dark energy (70-74%). These unknown dark matter or dark energy are not needed when changing slightly Newton equation (Milgrom MOND)

The standard model of particles physics is incompatible with the quantum mechanics. Nobody knows the size of the electron, discovered more than a century ago. But nobody seems to bother to tell the truth!
"The most I know, the most I know that I do not know and the others neither"
The period after the Big Bang was cool enough for particles to form atoms and for matter to be separated from light was estimated by Gamov around 240 million years (Ma) in the 50 s, showing a simple graph with two curves crossing. Later on, without any explanation, this time was estimated at 1 Ma, then 0.1 Ma and now at 0.38 Ma, every time without giving the way it is estimated and the accuracy of the measure.
In the old days where engineers were using slide rules to make computations the result was given with few decimals. The discovery of Hassi Messaoud field was based on refraction seismic surveys, most of computations were made with slide rules. My discovery on parabolic fractal distribution was not with computers, but with plots on millimeter and probability papers (that I have converted in my computer to plot probability).
Now with computers data are given with a ridiculous number of significant digits. The BP Statistical Review is now reporting oil supply of the world in a excel format both in volume and in weight, when in fact it should be reported in energy (Joule). The 2012 world oil supply in BP 2013 is reported at 86 152 204, 854 026 4 b/d in volume and 4 118 887 886,332 96 t/a in weight: it means that BP reports the daily volume being accurate down to 0,000 000 1 b and the annual weight down to 10 g. It is ridiculous, country production is usually measured either in thousands barrels or in tonnes. The stupid number of digits comes from the conversion of c volume in weight or the contrary using a computer and not a slide rules. In oil data any value reported with more than 3 significant digits should be considered done by someone without any understanding of the accuracy of the measure and it should be considered as sure that the second digit is wrong and likely also the first digit.
Most of scientists are unable to estimate accuracy and to deal with probability.

-Human Stupidity
Einstein said that there were two examples of infinity: "the Universe and Human stupidity, but I am not sure about the first".

Gross errors that have been made could have been avoided with simple common sense and observance of the rules.

Examples:

1600 – climatic catastrophes were attributed to the Devil and more than 60 000 sorcerers and witches were burnt at the stake. Now, it is carbon dioxide that is held responsible, and it is deemed a pollutant although being the source of food, it means life. Efforts are being made to store it although no one can guarantee the results. The main greenhouse gas is in fact water (60%) with only 20% (clear sky) being carbon dioxide.

1974 – the sinking of the Frigg Oil Platform in the North Sea which was due to an error in the conversion of units and cost 300 M$.

1986 – Tchernobyl: the safety rules must never be ignored; in a test, all the alarms were shut.

1998 – Loss of the Mars Orbitor: NASA sent the instructions in metric units (SI), but the probe was constructed in pound units. The mistake cost 150 M$.

Official organizations violate the Systeme International (SI) of units (which is the law in every country except Liberia, Myanmar and the US non federal) in using incorrect symbols for million (m, mm, MM) and confusing km^3 (being a billion of cubic meter = 10^9 m^3) and Gm^3 (being a cubic gigameter or 10^{27} m^3)

1999 – The Tokai nuclear accident in Japan with two deaths happened because in order to gain time the uranium container was filled with 16 kg when the safe limit was 2.4 kg.

2005 – Katrina and New Orleans: a large part of the town, but not the old quarter, was flooded by rising water levels. The seawalls were designed to resist a cyclone of no more than Force 3 and the Army Corps of Engineers was in Iraq. Most of the deaths, numbering 1750, were from flooding due to inadequate sea walls, not the winds.

2008 – Subprime debt in the USA: the price of housing cannot rise indefinitely, but loans made to the unemployed based on the assumption that property prices must rise and fill the pockets of the promoters. There was the example of Japan where property prices peaked in 1990 after 20 years of increase, but then declined by like amount.

2009 – US EPA considers CO2 as a danger for human health, but CO2 is the base of vegetation growth, which is the food of grass-eaters, which is the food of meat-eaters and at least of human beings. Grains production has increased because of fertilizers but also because of CO2 increase. Greenhouses in Holland are boosted with CO2!
2010 – The Xynthia Storm at Faute-sur-Mer: the rule for houses of only one level in a area subject to flooding below sea-level cost 57 lives.
2010 – The Macondo oil leak in the Gulf of Mexico: to finish in haste the delayed well, the cementation was badly managed. The six Fireboats of the US Coast Guard sprayed the submersible platform with six tons of water per minute and sunk it, leading to a bad sea pollution instead of a less severe air pollution!
2011 – Fukushima: the safety facilities should have been placed at a level above millennial tsunamis (>30m) but the site being 30 m high, 20 m were removed leaving the reactors at 10m in order to economize on pumping costs. The management of TEPCO have been acquitted on the grounds that they did not know the impact of tsunamis, yet the Internet shows that there have been many above 30 m in the area: those greater than 30 m were in 1605, 1771, 1792, 1896, 1993 and those at 10m in 1923, 1933 and 1983.
2011 – Spanish Property collapse and airports without aircraft: the Spanish boom of building more houses than France, Germany and Britain was based on the expectation that many people would retire to Spain but it did not take into account the crisis forecast by Paul Volcker in 2004 with a 75% probability that it would come in five years. Spain has 3 million empty houses and two unused airports.
2012 – The sinking of the Concordia: a pretentious Captain trying to impress tourists passed very close to land against every rule, causing 32 deaths; it was not the first time without any reaction from the management.
2013 – The railway accidents of Lake Megantic in Quebec and Santiago de Compostela in Spain were the inexcusable actions of the drivers and cost 130 deaths.
2014 – The Chinese Housing bubble: this crisis is yet to come with China having 70 million unoccupied apartments.

-Conclusions

Production data in the world are very poor, unfriendly, incomplete with very poor definition of the products. Reserves data is worse, public proved reserves are political/financial data (which should not be used for forecasting future production) and the real technical proved +probable reserves are confidential and unknown by economists.

There are no rules in the world oil industry, no referees and no red cards for bad reporting!

The peak oil theory was introduced in 1956 by King Hubbert forecasting the US oil peak either in 1965 or 1970. US oil peak occurs in 1970 and triggers the 1973 & 1979 world oil shocks. North Sea oil production peaked in 2000 and peak oil was then not a theory but a fact. Campbell and Laherrere in 1998 forecasted the end of cheap oil, but it was rejected as poor forecast. It was only in 2005 with oil price reaching 50 $/b that the peak oil was accepted but many disagree on the date and the level.

IEA recognized in 2010 that the world conventional crude oil has peaked in 2006, but since 2005 all liquids display a bumpy plateau within a range being the same order that the accuracy of the oil supply data which varies from sources at plus or minus 2 Mb/d.

The boom of the shale oil (now called light tight oil) in the US with the dream of oil independence for North America led some economists to claim that the peak oil theory is dead (the end of peak oil, peak oil myth).

But shale oil boom is not due to new technology (horizontal drilling and hydraulic fracturation are 50 years old practice), but to high oil price. It is true that huge amount of oil was generated in most mature Petroleum Systems and that 99% is still within the sediments, but resources should not be confused with reserves. Shale plays were reported as continuous type accumulations covering huge areas, but quickly it was found that only sweet spots were economical and 80% of the wells uneconomical.

Estimating ultimate for US shale oil leads to forecast that the US tight oil boom will peak soon (EIA forecasts the peak for 2017 to 2020) in and will decline faster than forecasted by EIA.

The big difference between my shale oil forecasts and EIA forecasts is not for the date or for the level of the shale oil peak, but the rate of decline: I foresee (as many examples in the past) similar increase and decline when they see sharp increase and very slow decline.

Some claims that the oil peak will be due to demand reduction with abundance of oil supply. But oil price over 100 $/b proves that the problem is oil supply.
Many dreams that peak oil will never occur by lack of supply, but by lack of demand, because the renewable will take over.
But it is likely that oil (all liquids) peak will occur soon and because there is no sufficient substitute to oil for transport, Nicolas has to find the solution.

Citations Paul Valery
"Le temps du monde fini commence" 1931 Regards sur le monde actuel
«Ce qui se dit partout, par tous et toujours a toutes les chances d'etre faux »
"Tout ce qui est simple est faux, mais tout ce qui ne l'est pas est inutilisable"

Glossary of abbreviations
AEO: Annual Energy Outlook (USDOE/EIA)
boe: barrels of oil equivalent
DGEMP: Direction Generale Energie & Matieres Premieres
EIA: Energy Information agency (USDOE)
INSEE: Institut National de la Statistique et des Etudes Economiques
FOD: domestic fuel oil
Gb: gigabarrel = 10^9 b = billion (US) barrels (billion SI = square million = 10^{12} = trillion US
G$: billion (US) US dollar
GMO: genetically modified organism
GOM: Gulf of Mexico
Gtoe: gigatonne oil equivalent = billion tonnes of oil equivalent
Gtoe/a: gigatonne oil equivalent a year

IEA: International Energy Agency
IFP: Institut Francais du Petrole
IHS: Information Handling Services, which acquired Petroconsultants in 1996
IPCC: Intergouvernmental Panel on Climate Change
kb/d: thousand barrels a day
Mb/d: megabarrel a day = million barrels a day
Mt: megatonne = million tonnes
NG: natural gas
OPEC: Organisation of Petroleum Exporting Countries
SEC: Securities and Exchange Commission
SMIC: guaranteed minimum wage in France
Tcf: tera cubic feet = trillion (US) cubic feet = 10^{12} cf (trillion SI = cubic million = 10^{18})
TTC: all taxes included
USDOE: United States Department of Energy

Older papers from Jean Laherrere and other ASPO France members can be found at http://www.aspofrance.org

NB
-sorry for my broken English
-if you want more explanation you may write to me at jean.laherrere@alsatis.net