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"Pic du pétrole et autres pics"
Translation by Colin Campbell

Peak Oil and Other Peaks

by Jean Laherrère ASPO France

Introduction

Several scientific reports on peak oil have been published between 1994 and 1996 including those by Laherrère, Perrodon, Demaison published by Petroconsultants, using confidential data. They include *The End of Cheap Oil* in March 1998 by Campbell and Laherrère (Scientific American), which was translated into *Le Fin du Pétrole bon Marché* (Pour la Science in May 1998).

ASPO – *The Association for the Study of Peak Oil and Gas* - was founded in 2001 by Colin Campbell under the presidency of Prof. Kjell Aleklett of Uppsala University. It is an informal network of European geoscientists, having held international annual conferences at Uppsala 2002, Paris 2003, Berlin 2004, Lisbon 2005, Pisa 2006, Cork 2007, Barcelona 2008, Brussels 2011 and Vienna 2012. As many as thirty national organisations were established after 2005, with ASPO-USA being the most active. Colin Campbell published a monthly newsletter from January 2001 to April 2009, but closed it on the hundredth edition.

ASPO FRANCE was founded in 2005 under Law No 1901 with a budget of €80. It is made up of about twenty members who meet two to three times a year. It has studied the evolution of the resources and production of liquid hydrocarbons and gases, and in particular the possibility of substitution by other energy sources. Its Website *aspofrance.org* publishes articles at the request of its members, including my annual lectures at Mastere OSE (Optimisation des Systèmes Energétiques) Centre de Mathématiques Appliquées, Ecole des Mines de Paris at Sophia Antipolis.

The best way by which to judge a forecast by an author is to relate earlier studies to new data. It is up to you to judge the value of my 2004 forecasts.

See The Graphs of Toulouse 2004 - http://aspofrance.viabloga.com/files/JL_Toulouse2004.pdf.

These graphs have been updated and compared with the originals. The 2004 text is shown in italics.

The Evaluation of Natural Patterns

In the words of Napoleon, a graph is worth a thousand words.

Where is the truth? It is made up of facts and observations but the data are unfortunately often subject to manipulation and imprecise definitions. The eye sees in two dimensions on the retina, but the brain converts the image into three dimensions by comparing what is seen from two eyes. I do not see the same as you because the viewpoint is different.

Paul Valery said "*all that is simple is wrong, and all that is not is useless*".

For the economist, 1000 plus 1 gives 1001, but in the uncertain world of reserve reporting with an accuracy of less than 10%, 1000 plus 1 gives 1000.

One of the great changes of earlier years was in terms of migration: when one region became overpopulated, people headed west to America and from eastern America to California to find new lands, but now with the considerable increase in population there are no more fertile lands to exploit. Current migrations are for economic reasons. Climate warming could facilitate a new move to the north as the lands of Siberia and Canada become more fertile, but unfortunately relatively few people are now employed in agriculture.

It is the same with resources. We are close to the peak or plateau of many essential supplies. The great changes mean that we face the end of the world we have known.

Paul Valery said in 1931 in a book entitled Looks to the Present World": *the time of the finite world begins*.

Everything in Nature can be modelled with simple cycles.

It is well said that everything that is born, grows, reaches a peak and then declines. There are no exceptions save for protons: the Universe, the Sun, the Earth, Species, or Civilisations.

What goes up must come down.

Fig 1: Example of the North Atlantic cod, now extinct,

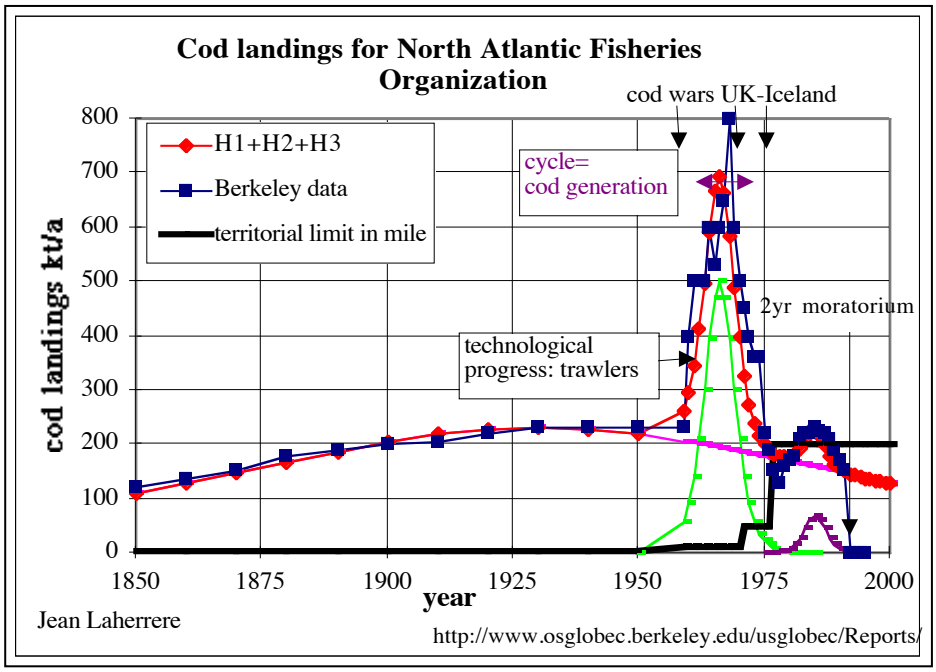
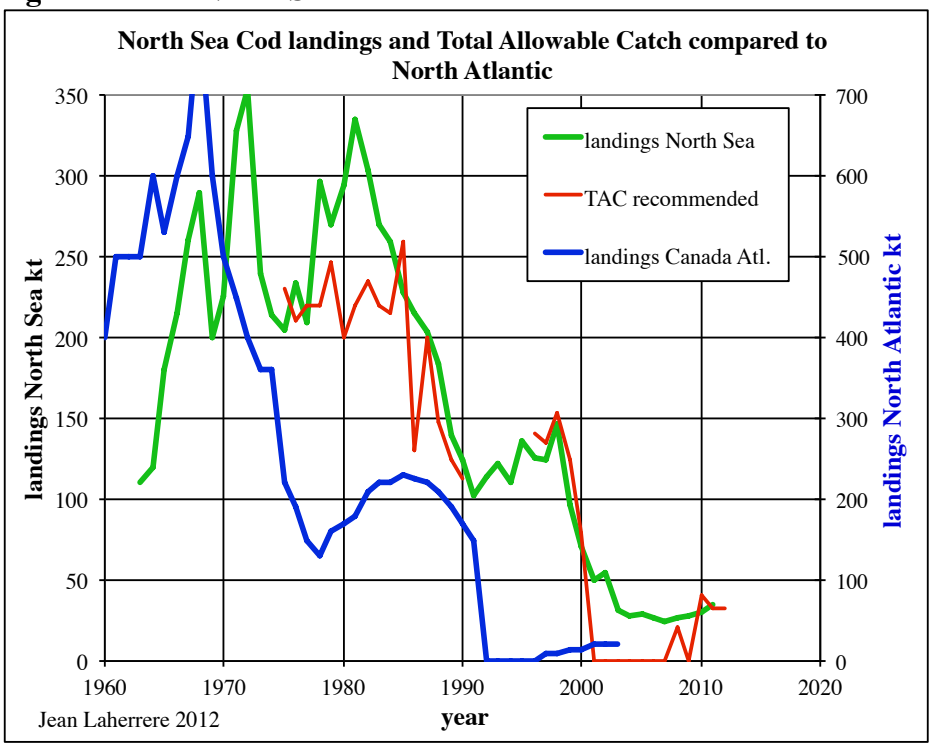


Fig 2: Same diagram on the North Sea cod

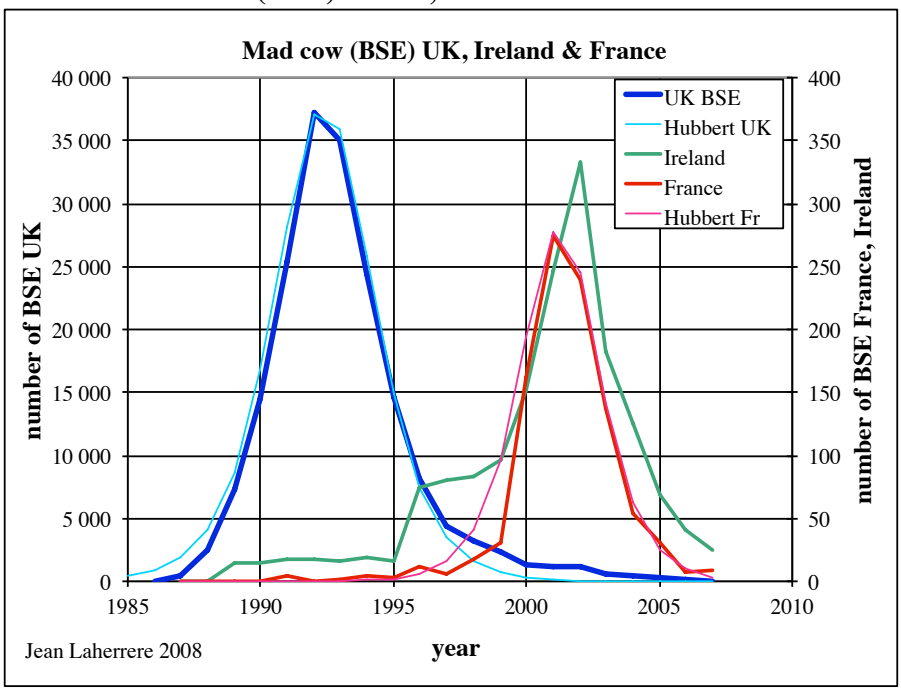


The Total Allowable Catch (TAC) of fish is often exceeded, leading to the disappearance of species: advances in the technology of trawlers and floating fish-factories have killed off the fish, and have also not paid attention to the rules.

If the TAC continues to be exceeded, the cod of the North Sea will virtually disappear, as have those in the New World across the Atlantic.

So-called Mad Cow Disease appeared in 1985 when the cows were fed with meat and bone meals. The decline has been rapid as the increase.

Fig 3: The number of mad cows (BSE) in UK, Ireland & France

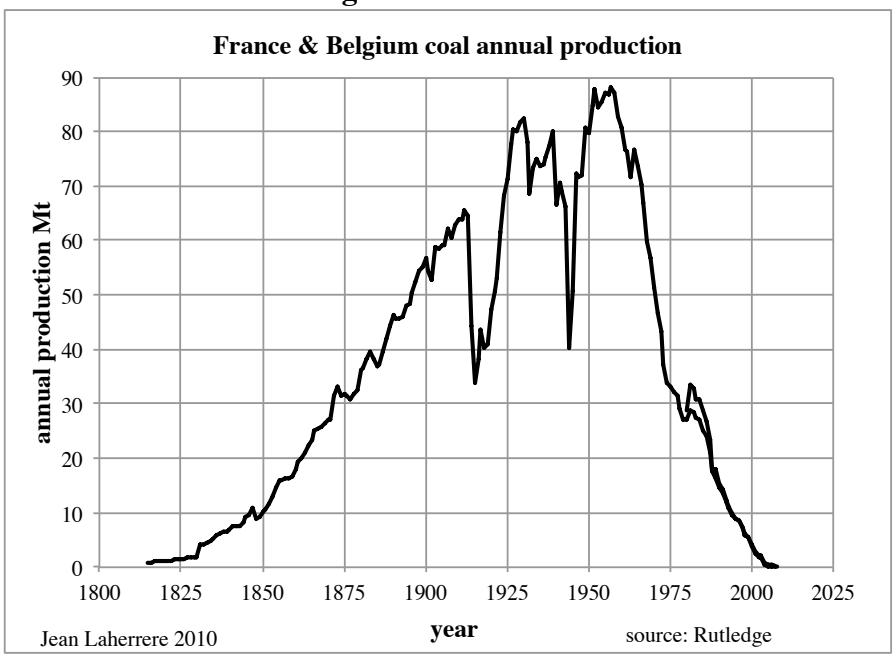


Nature is far from equality. There is equality at the starting line, but only one winner at the finishing line. Individually, we were created when near 300 million spermatozoa were released, but only one reached its goal. The Universe is made up of space and plasma with solid components which are very irregular. The French people, who are said to value equality, play Loto in order to be "*the richest of the rich*", and accept that there are taxes on salaries but not on Loto wins.

It is very unfair as pointed out by Calimero!

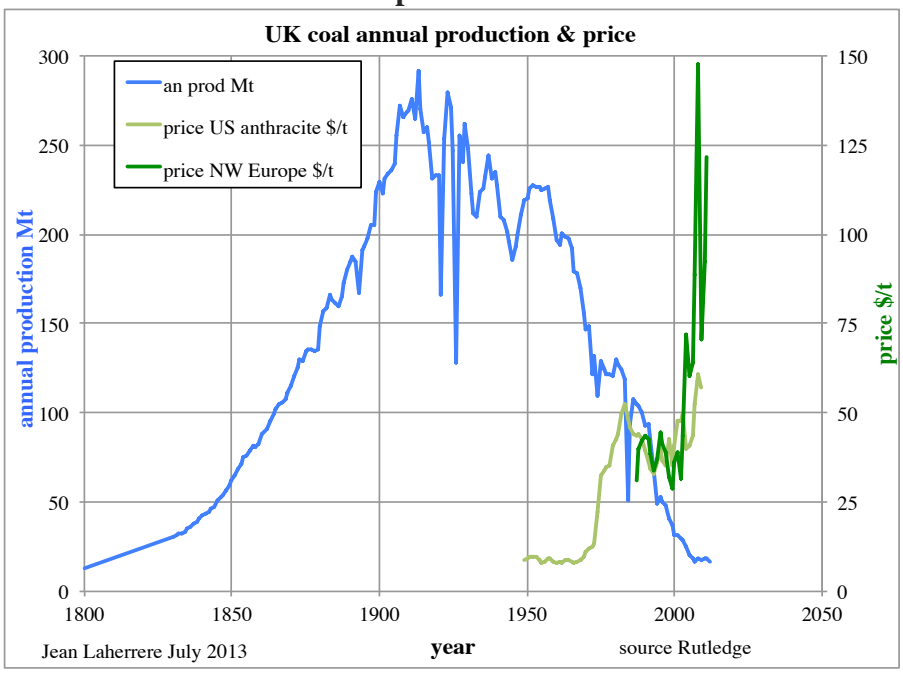
Coal production in France & Belgium (ended in 2004) displays an asymmetrical bell curve, only disturbed by the two international wars.

Fig 4: Coal production in France & Belgium



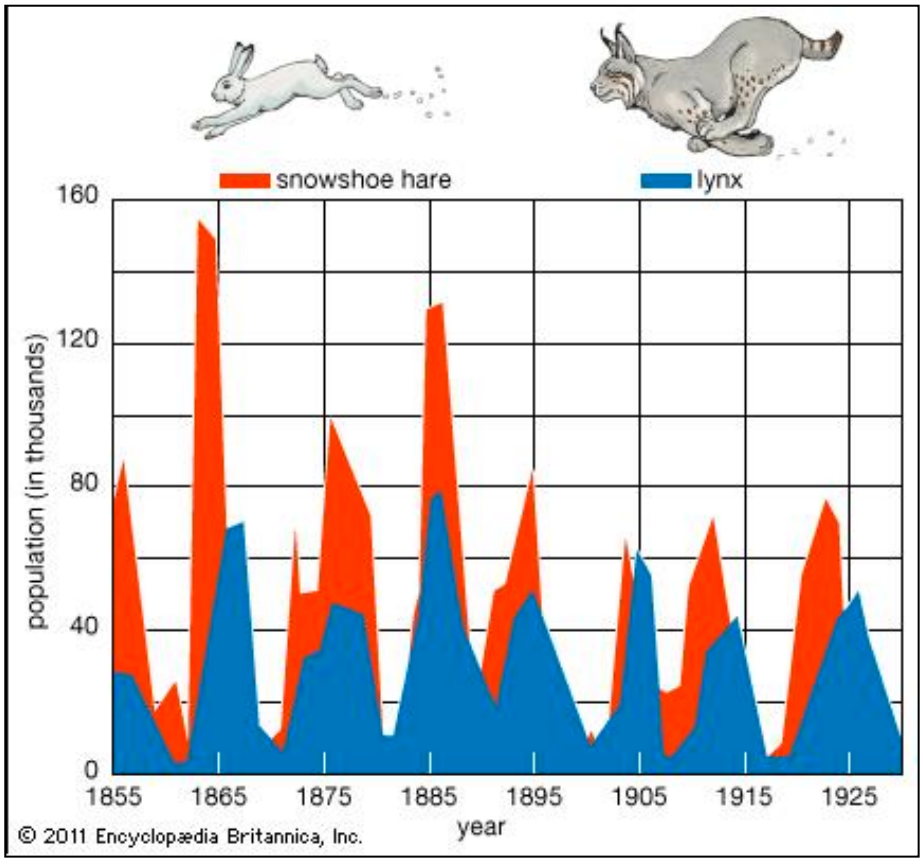
The British Empire was built on coal from the United Kingdom that provided the energy needed for its fleet and industry. But coal production in Britain now stands at less than 10% of its peak level in 1910, despite a doubling of price. As in France, the decline is steeper than the rise.

Fig 5: Coal production in Great Britain & price



In the case of renewable elements, the cycle is driven so to speak by the hunters, as for example the hares and lynx in the Hudson Bay region where there was a ten year cycle from 1845 to 1935.

Fig 6: Number of furs from hare-lynx at Hudson Bay Company



The temperature curves as estimated from the Vostok ice cores (Petit 1999) can be readily modelled over 420 000 years into 21 cycles of 20 000 year periods reflecting the Milankovitch Cycles of the precession of the equinoxes. There is also a cycle of 40 000 years for the Earth's axis obliquity and a cycle of 100 000 years for Earth's ellipse around the sun. This cycle of 20 000 years

has been recorded in the alternations of the Vaca Muerta oil source-rocks in Argentina (Kietzman 2011). Each time you see an outcrop of rocks with alternating layers of about 20 cm thickness, think of the precession of the equinoxes every 20 000 years with deposition of 1 mm per century. The sediments were laid down slowly. But over the past 600 million years since the Cambrian, one mm per century gives 6 km, which is in accord with the thickness of most sedimentary basins.

Fig 7: Temperature Vostok 420 000 yr & model 21 cycles 20 000 yr

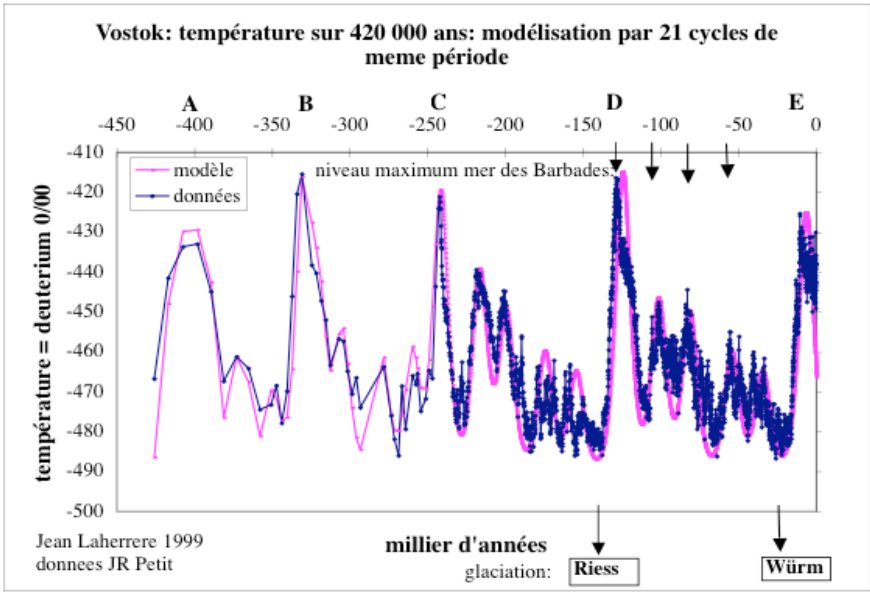
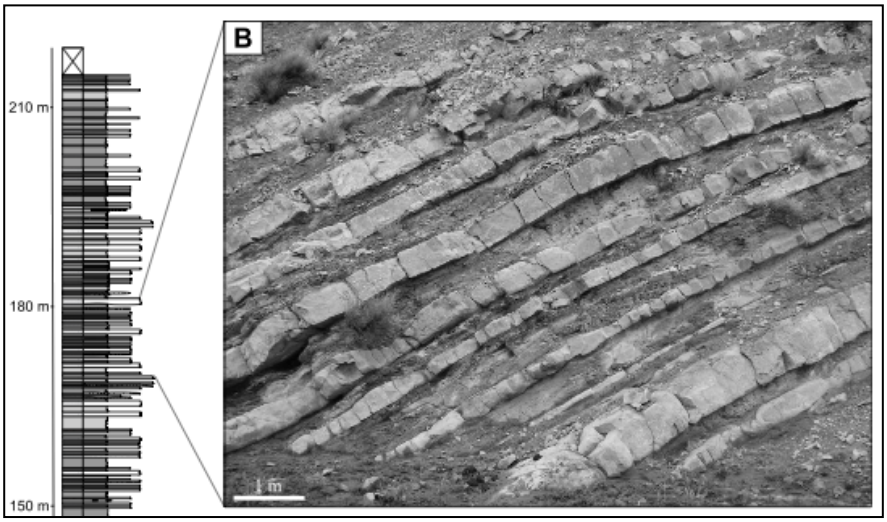


Fig 8: Argentina Vaca Muerta outcrop 20 000 yr = equinoxes precession



All geoscientists recognise that the cause of the Vostok temperatures are Milankovitch Cycles and that the amount of carbon dioxide measured in the bubbles of gas shows a good correlation with a delay of about 1000 years (Jouzel has written about it). The driver is the temperature and the carbon dioxide, of which the level of solubility in the oceans diminishes when the temperature rises, follows by going into the atmosphere. The measurement of carbon dioxide is valid only in the Antarctic because there is much pollution elsewhere. But at Vostok the bubbles of gas are only sealed when trapped into ice being compacted by about 100 m (it needs 5000 years to reach 100 m because snow fall is only 2 cm per year: South Pole is a desert). Before in the firn the gases are in communication with the atmosphere during 5000 years. The level of carbon dioxide is accordingly a five thousand year average, and it is wrong to compare it with the current annual value. It is therefore wrong to claim that the present 400 ppm has not been attained over the last thousand years based on Vostok data.

But in the Cretaceous period (as measured by stomates) the level of carbon dioxide was twice the present and in the Cambrian it was ten times higher. Carbon dioxide is accordingly a false enemy as it is the source of life. The 2010 report of the Academy of Sciences speaks of the effect of

greenhouse gas on the rise in temperature from 1975 to 2003, but not carbon dioxide. The main greenhouse gas is water!

A good example of the symmetrical cycle is the production of oil in the United States excluding Alaska (USL48) that I showed in 2004.

It is necessary to find oil before it can be produced. The shifted discovery matches production and forecast future production.

Fig 9: USL48: oil annual production & shifted discovery by 33 yr

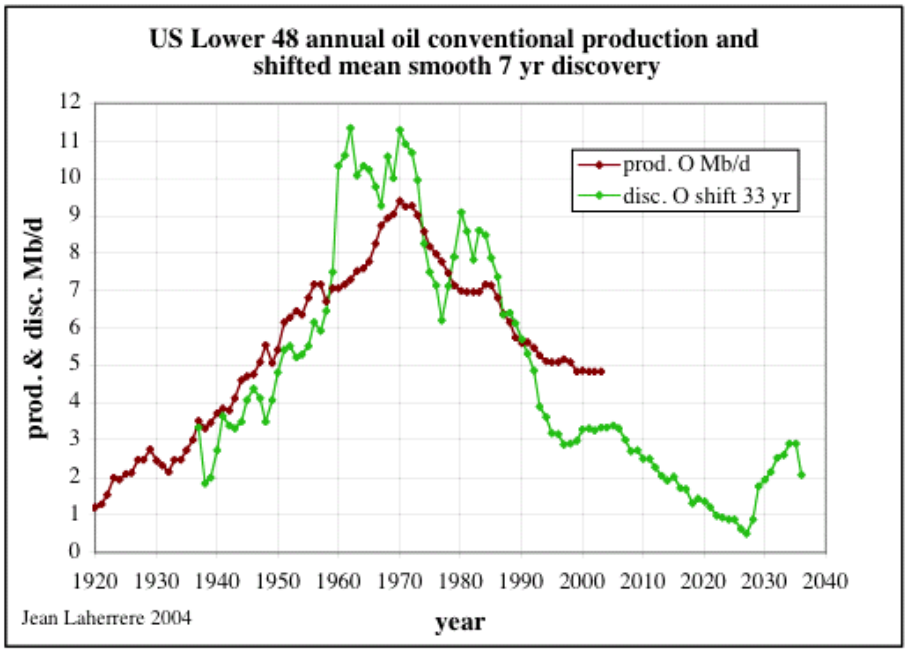
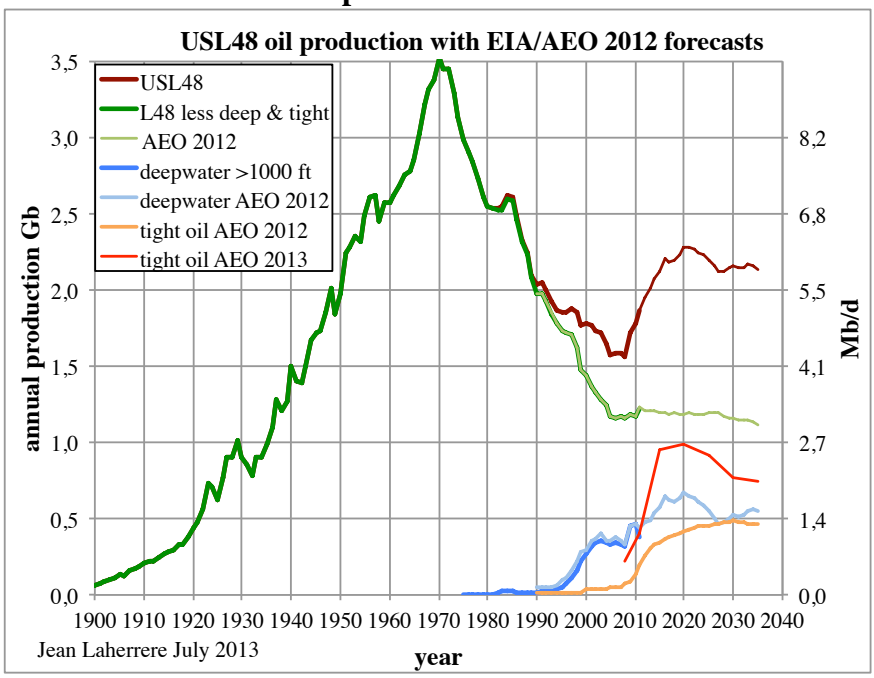


Fig 10: USL48: oil & non conventional oil production



The United States is the only country where the landowner also has mineral rights to the subsoil. There are more than 20 000 oil companies, 45 000 oilfields and 500 000 producing wells (out of more than 2 million drilled) and more than 500 000 producing gas wells. The oil production from source-rocks ("Shale Oil" which is now called Light Tight Oil) is forecast by the AEO in 2012 to reach a platform by 2030 at 1.4 Mb/d but in 2013 the AEO forecast (in red) a platform of 2.7 Mb/d, although its decline can occur soon, notably in the Bakken. Hess has started the search for such oil in the Paris Basin with a vertical well at Chateau Thierry on the Toreador Prospect (Banc

du Roc). The reservoir is supposed to be similar to the Bakken. The well gave rise to passions, but this year Hess managed to drill two vertical wells without difficulty (Mary and Leudon in Brie). The objective is to obtain cores in the expected reservoirs. The problems of production and possible fracturation will follow but first it is essential to know the potential of the tight reservoir.

The Bakken (a carbonate reservoir in the midst of shale source rock) is the beacon for shale oil production in the USA (now termed "*light tight oil*"). Production in Montana reached a peak in 2006 (Elm Coulee = Bakken) following the number of rigs shifted by one year. But there has been a rebound with the discovery of a new field, the Elm Coulee Northeast, which might peak in 2014. The peak of production in North Dakota (also giving a house price boom with unemployment down to 3%) will likely occur this summer at about 800 000 b/d because the number of rigs which increased from 20 in 2005 to 200 in 2012, has now reduced to 171.

Fig 11: Montana oil production & number of rigs

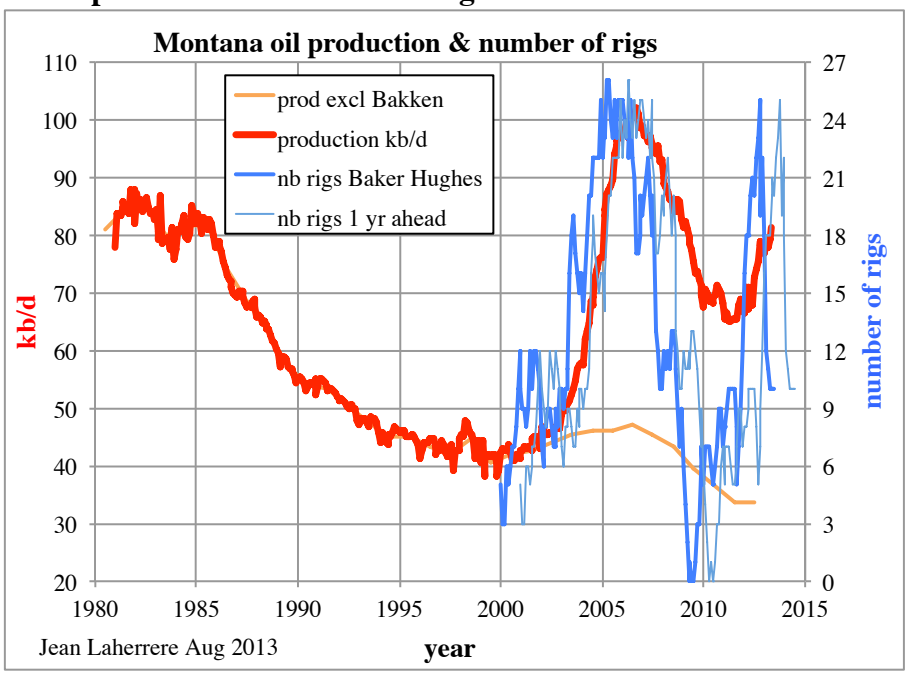
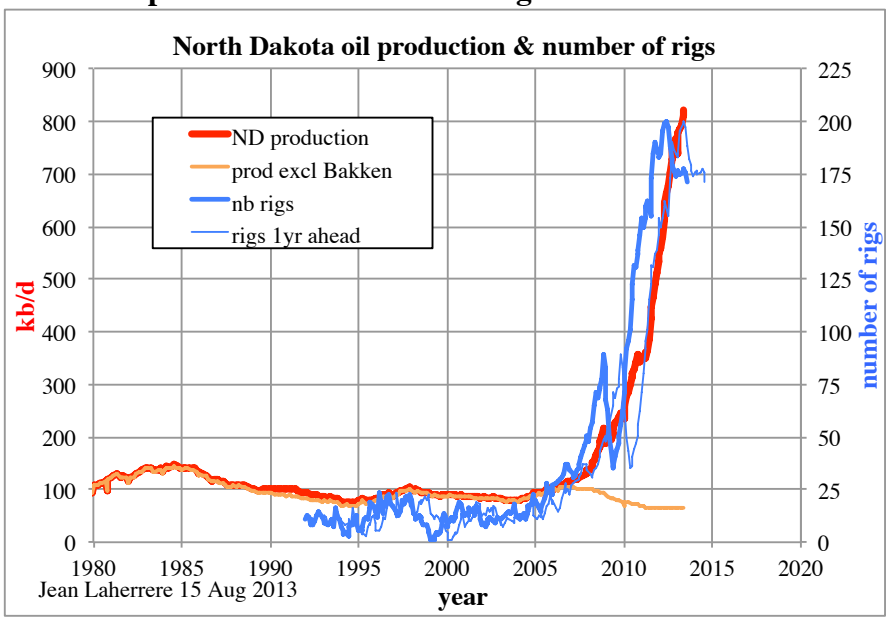


Fig 12: North Dakota oil production & number of rigs



Bakken production was forecast by the EIA – AEO in 2013 to reach a peak of 0.9 Mb/d in 2020 and remain on a plateau until 2030.

That of the Eagle Ford is forecast to reach a peak of 0.8 Mb/d in 2016 and start to decline from 2025. The Sprayberry (Permian Basin), which started in 2000, cannot pass 0.4 Mb/d.

The length of the AEO2013 plateau seems very optimistic although it is too soon to know if my forecast will prove correct. The problem lies with the number of Bakken wells waiting for hydraulic fracturing (500), especially in winter. It takes more than 700 truck deliveries to supply the water needed for the fracturing.

The potential for the Shale Plays is based on the assumption that the oil and gas extend throughout the source-rock basin. But in reality only a small proportion of the well locations are economic. In reality, the accumulations are in stratigraphic traps having adequate porosity and permeability and the number and quality of the fractures.

Reserves and Resources are being confused, with recovery being only a few per cent. The operators are always too optimistic.

On the maps for the Bakken and Eagle Ford in Texas (see Hughes May 2013) the good wells (sweet spots shown in red) are concentrated in well-defined zones, which do not cover more than a small part of the source-rock area (shown in grey). The distribution is not random, but controlled by geology. The volume produced initially is good compared with conventional wells, but the decline rate is very high reaching 50% in the first year. The life of these wells will also be short but one lacks an historical record to determine the exact rate.

Fig 13: Quality of Bakken wells (Montana North Dakota) Hughes 2013

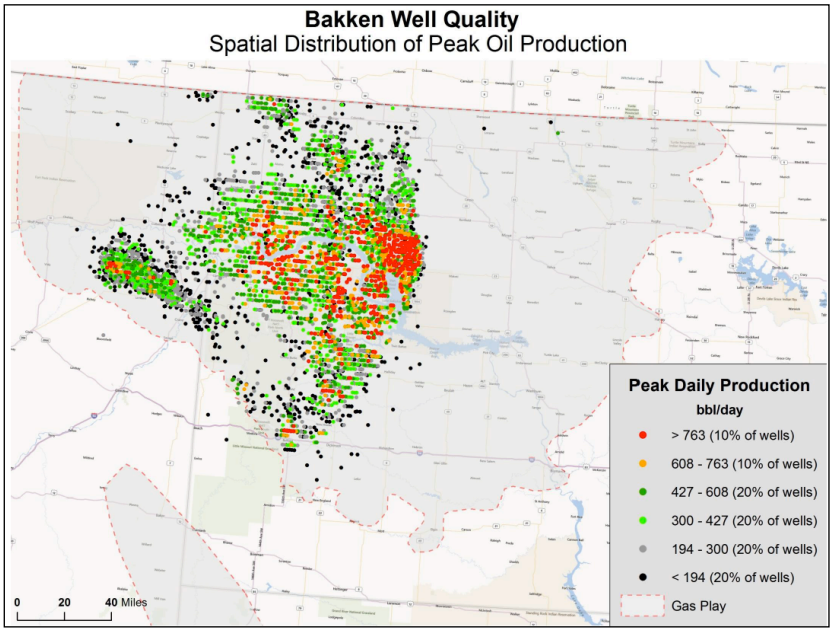
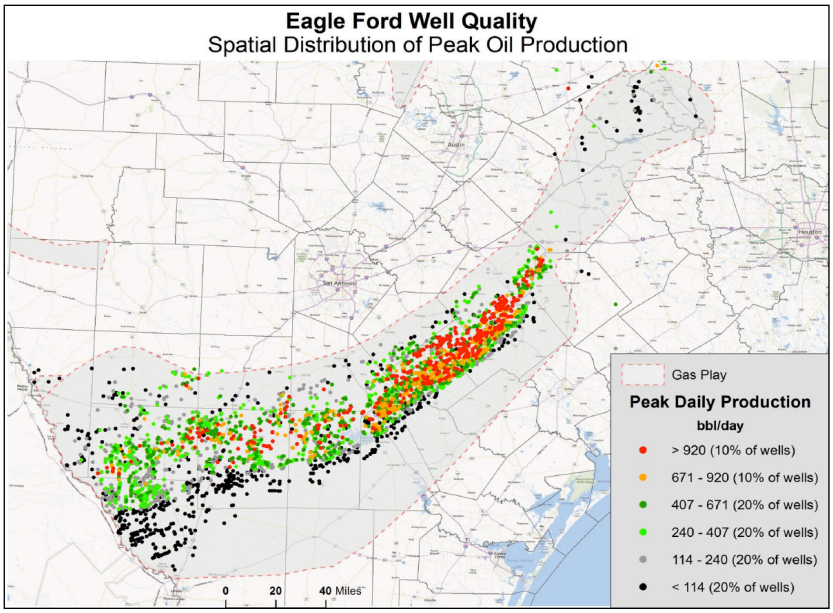


Fig 14: Quality of Eagle Ford (Texas) Hughes 2013

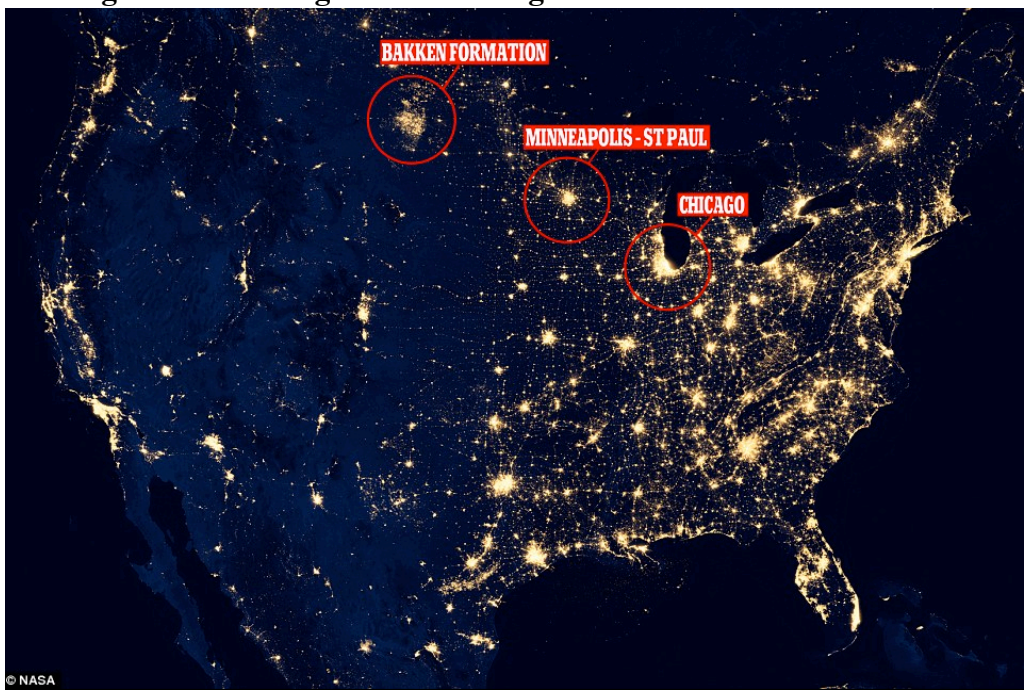


The US Shale Oil boom started in 2004 in the Bakken (Williston Basin). It supported 182 rigs in August 2013 compared with 224 in February 2012. It was followed in 2011 by the Eagle Ford boom of oil and condensate in Texas with 229 rigs in August 2013 compared with 258 in May 2012. Certainly, there are other tight oil plays such as in the Permian Basin of Texas where conventional wells have produced 40 Gb (including the Yates giant field), but there is often confusion between conventional and non-conventional, with no standard definition. The Bakken does not produce from the source-rock but from a porous carbonate interval within the source-rock, and is therefore to be considered as a conventional stratigraphic trap. It is for that reason that Shale Oil has become Light Tight Oil, increasing the confusion.

In North Dakota, the gas associated with the Bakken is flared (about 100 M$/a) because there is neither a pipeline to transport it, nor a reservoir for reinjection. There are also 150 companies in competition with each other, and naturally have to produce at the maximum rate possible for the benefit of their shareholders or future buyers.

One can see the extent of flaring on a satellite photograph of the United States where the Bakken flares give as much light as Minneapolis.

Fig 15: Satellite night shot showing Bakken flaring



The gas flaring, justified by the low price of gas and the high costs, is the result of competition and the short-term attitude of the operators and politicians, who have failed to forbid large scale flaring. But it can't last long.

The tragedy is that the whole world has come to believe that the low price of gas in the United States is long-lasting, permitting the repatriation of fertiliser plants, the replacement of coal by gas, and the self-sufficiency of North America in gas.

Cycles of discovery & production

Discovery and production cycles often follow the same pattern.

France

Fig 16: France: oil production & discovery shifted by 7 yr

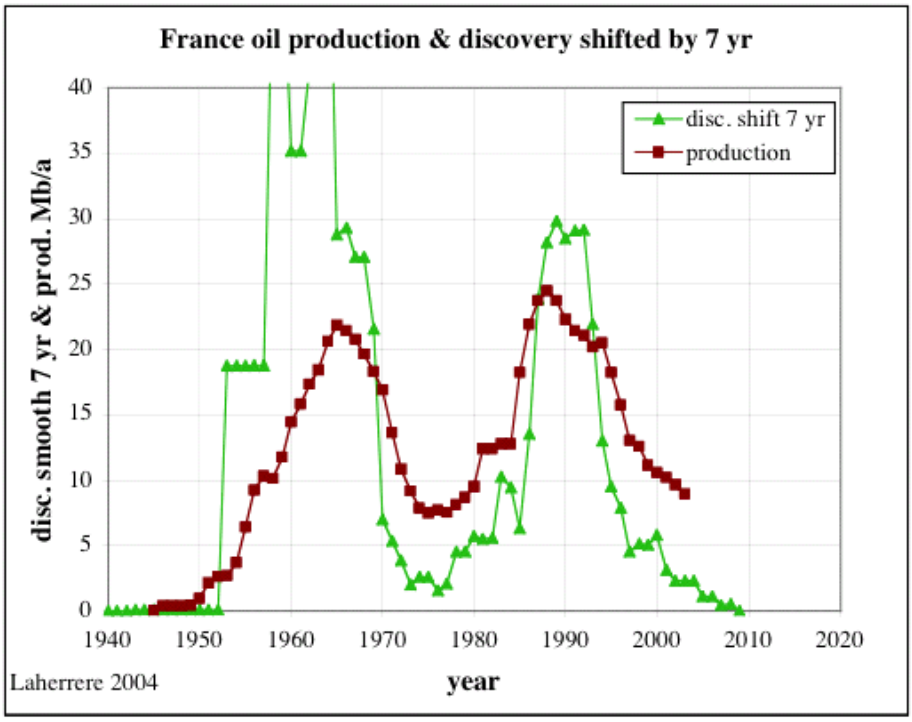
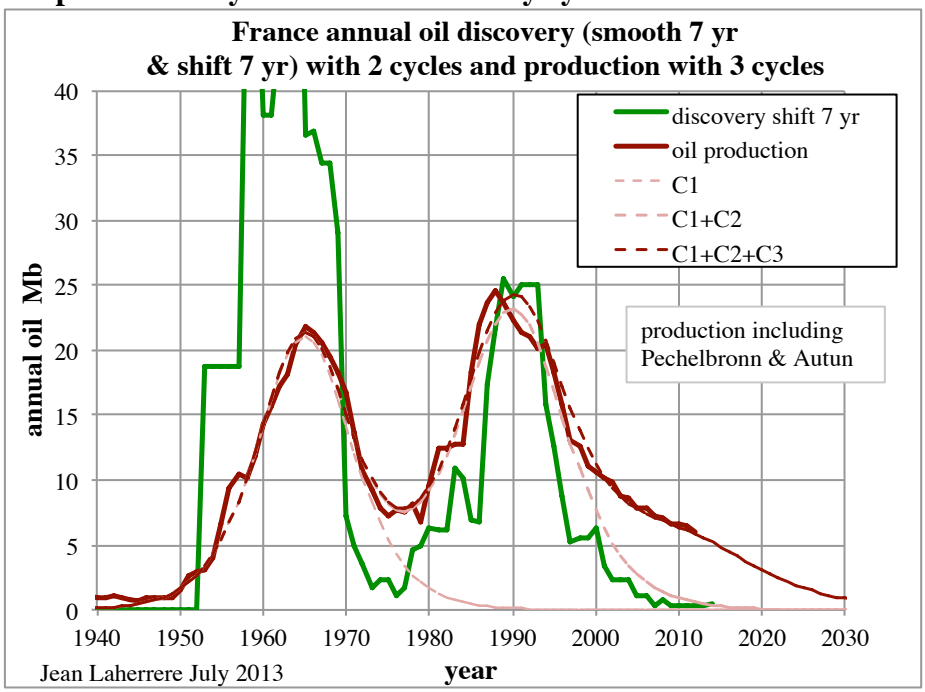


Fig 17: France: 3 production cycles for two discovery cycles



In France there are two discovery cycles (shown in green) and three production cycles (shown in brown), but the first discovery cycle was produced for more than forty years, and later sold to small companies who could develop at minimum cost.

Almost 8000 wells have been drilled in France, of which 2000 were exploration wells and 4400 producers (4200 of oil and 200 of gas). In 2006, there were 470 oil-producing wells (321 in the Paris Basin, 136 in the Aquitaine Basin and 13 elsewhere), and 41 gas-producing wells (all in the Aquitaine Basin).

Historical data are weak, as French Energy Ministry does not practice the transparency or simplicity of the United Kingdom or Norway.

World

Fig 18: World annual oil (outside extra-heavy) & gas production, as discovery shifted by 40 & 45 years

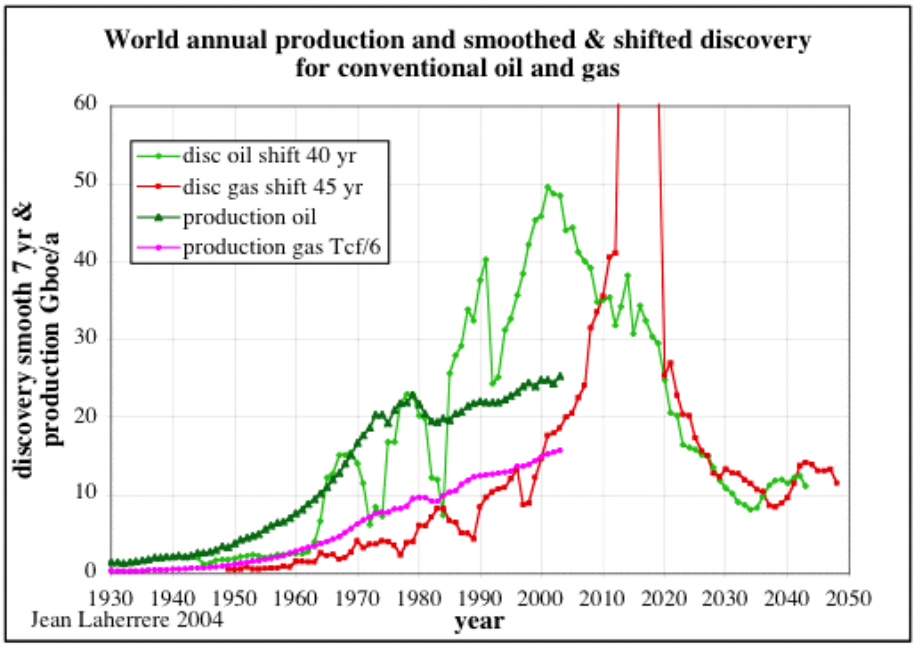
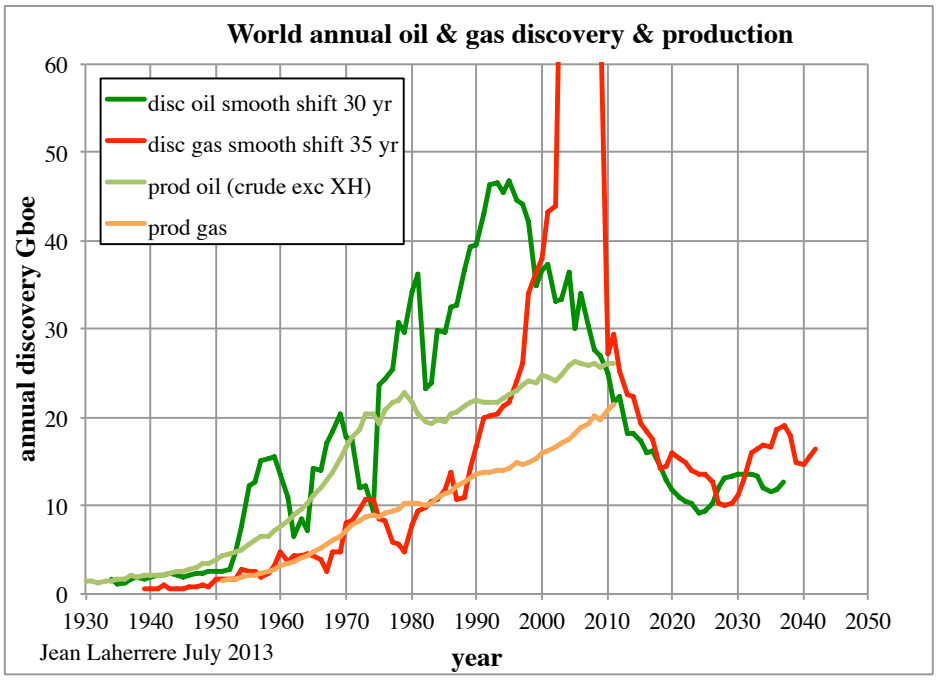


Fig 19: Oil & gas production & discoveries shifted by 30 and 35 years



The discovery record is based on current estimated Proved & Probable (2P) Reserves duly backdated to the discovery year. This *Creaming Curve* is based on the plotting the cumulative discovery by field against the cumulative number of fields. Previously, it was based on cumulative discovery against cumulative exploration wells (New Field Wildcats), but the data are weak in some countries, notably China. The extrapolation of this curve, modelled with several cycles, makes it possible to estimate the ultimate recovery for a country (for a certain number of fields) and for the world as a whole. The confidential industry database refers to 2P Reserves but it must be corrected for the Middle East where reserves were evidently over-stated by 300 Gb for OPEC quota fights in 1986-89 (see al-Husseini, VP ARAMCO 2007) and reduced by 30% for the former Communist countries which report so-called ABC1 Reserves under their classification.

The Creaming Curve for the world outside non frontier US/Canada is made up of several cycles and gives an Ultimate of 2000 Gb for oil and 10 000 Tcf for gas,

Fig 20: World outside onshore US/Canada Creaming Curve

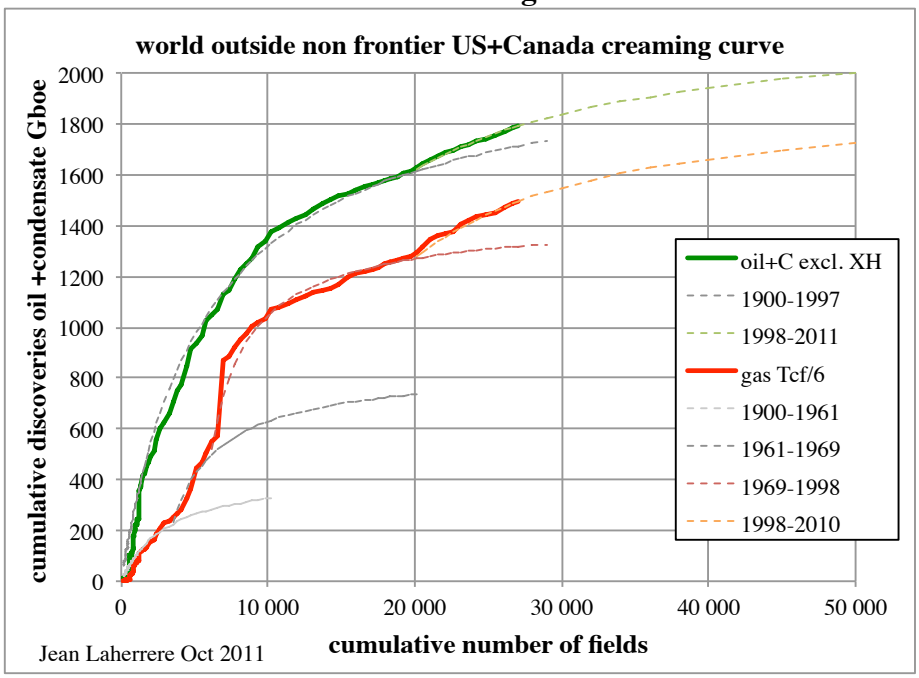
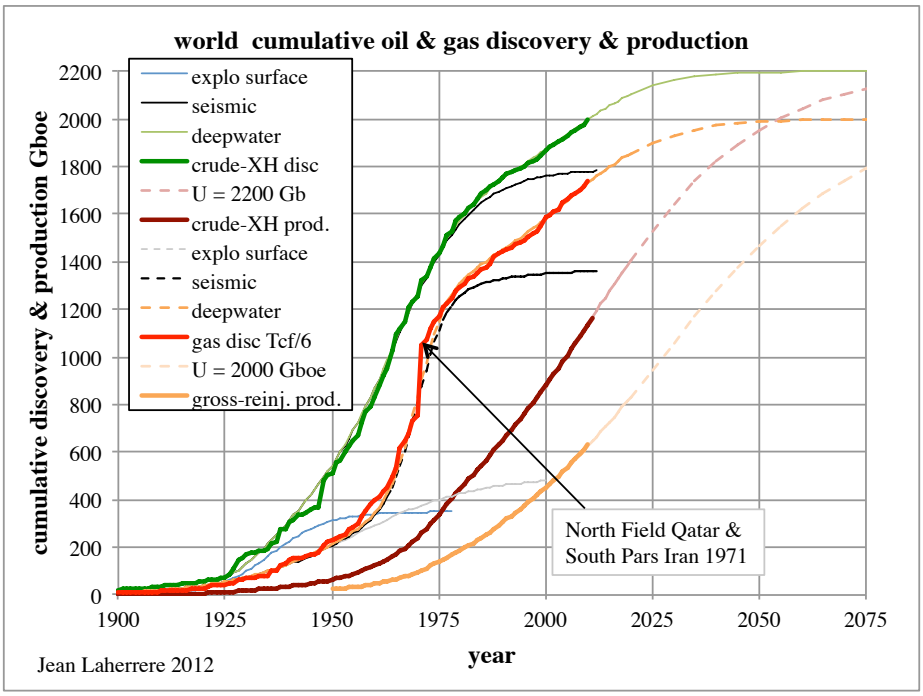


Fig 21: World cumulative 2P discoveries U = 2200 Gb & 12 Pcf



The cumulative world (2P) reserves as a function of the discovery dates are extrapolated in several cycles

1900-1945 – Surface exploration

1945-1990 – Seismic exploration

1990-2011 – Deepwater and sub-salt

The *Extra Heavy* found before 1940 is excluded, because it is the size of the tap rather than the reserves that is relevant. The question is if Shale Oil (Tight Oil) gives a new cycle. I think not because current production (2 Mb/d) is in the same order of magnitude as the uncertainty of the data on All Liquids (Fig 26), the amount of refinery gain, and the confusion between reserves and resources. The volume of oil reserves in source-rocks is small relative to the overestimation of OPEC reserves (300 Gb).

Reserves

There are in effect four different reserves definitions:

-OPEC Reserves are said to be *Proved*, but they are without audit. In fact, they are essentially political reserves with an addition of 300 Gb in the quota wars of 1986-1989.

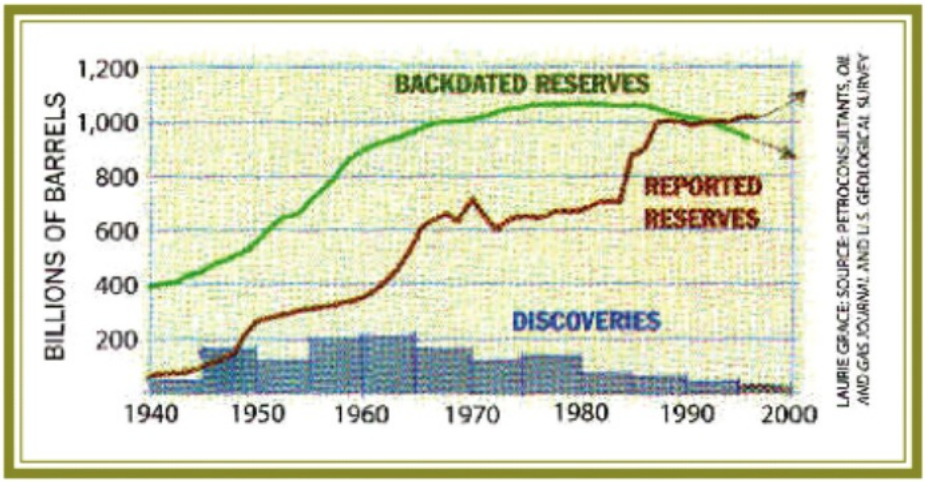
-The SEC rules, used by major companies quoted on the New York Stock Exchange, are only so-called Proved audited Reserves, having *reasonable certainty*, which itself is not defined.

-The countries of the former Soviet bloc report ABC1 reserves, with a "maximum theoretical recovery", or in other words = 3P (Proved + Probable + Possible).

-Confidential estimates by operators deciding on the development of a field are based on 2P Reserves, using a Mean value. Such data can be purchased by industrial intelligence companies such as IHS or Rystad.

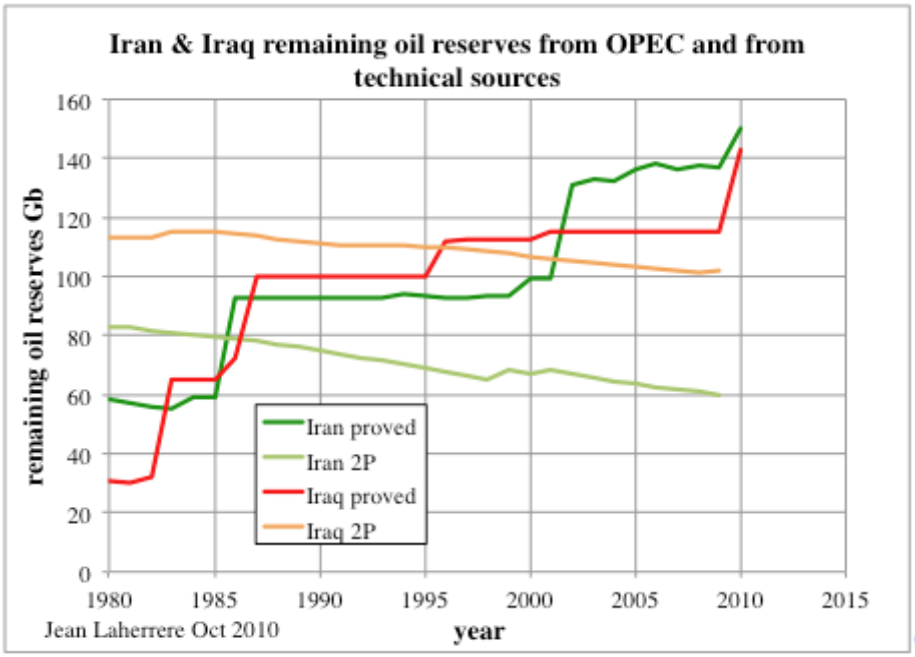
Only three countries publish reserves by field: Norway, the United Kingdom and the United States for federal lands (as also some US States like California).

Fig 22: World remaining oil reserves from political/financial sources in Scientific American 1998



The 1P political reserves of one country can be higher than the 2P technical reserves = Iran & Iraq

Fig 23: Iraq-Iran political & technical remaining oil reserves



The peak of the world remaining 2P reserves was in 1980.

Fig 24: World remaining conventional oil reserves from political & technical sources in 2004

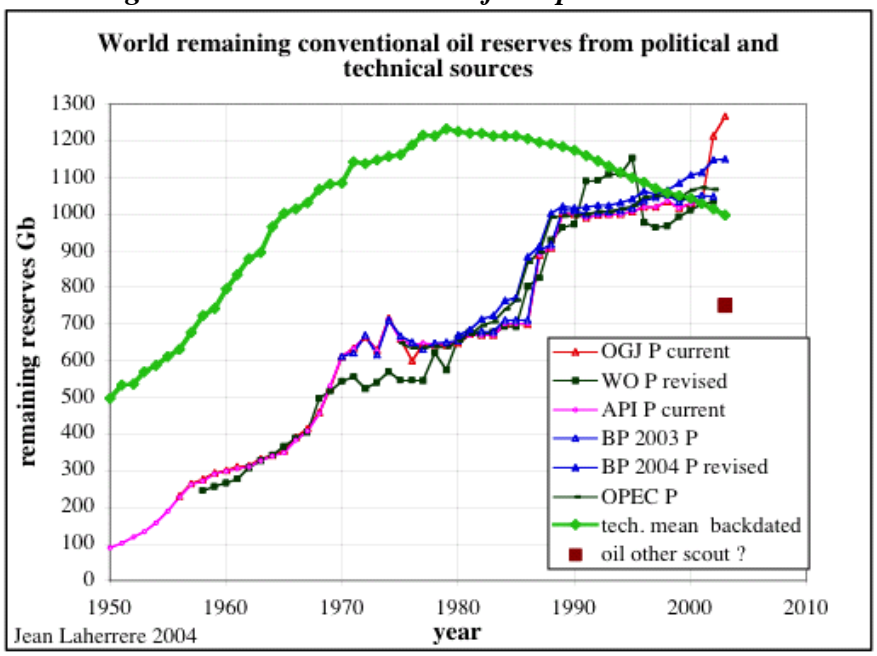


Fig 25: World remaining oil reserves from political & technical sources in 2013

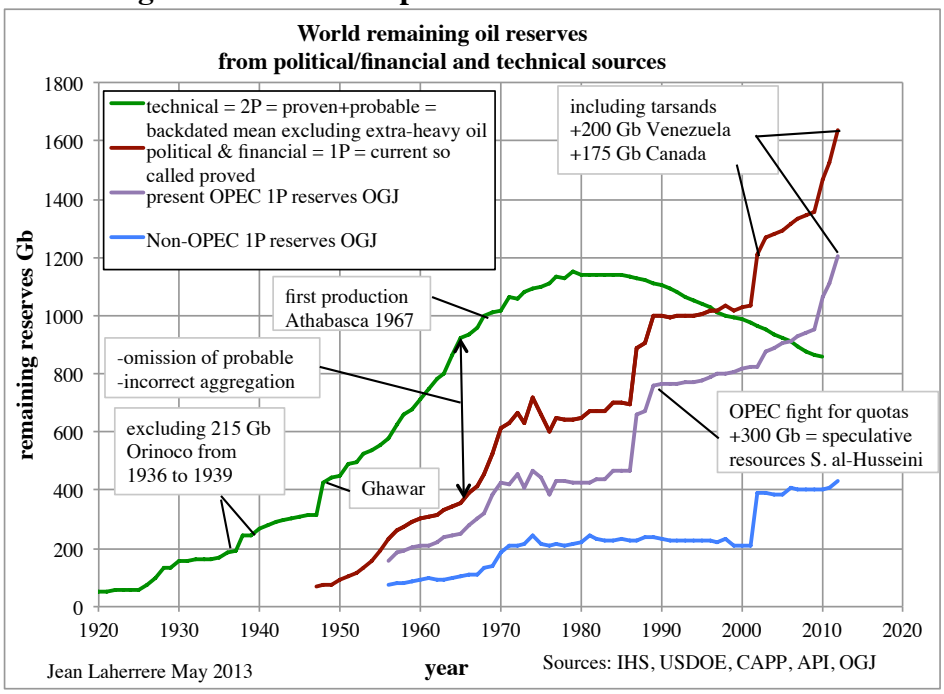


Figure 25 illustrates the divergence between geologists, who know that the discovery curve, shown in green, has been in decline since 1980, and the economists who have access only to the brown curve which has grown for fifty years due to political factors and changing definitions.The Extra-Heavy oil reserves of Athabaska in Canada and the Orinoco in Venezuela must be added separately, the resource having been known (and produced) for many years. The profile of Non Conventional Reserves is of little significance because it is size of the tap, which is both costly and slow to install, that matters more than the size of resource itself.

Reserves and Resources must not be confused

The term Reserves refer to estimates of future production until it ends, whereas the term Resources refers to the amount of hydrocarbons in the ground. Reserves must be commercially viable. In France, we still have large resources of coal, which several foreign companies wish to

produce, but the French are opposed, meaning accordingly we currently have no coal reserves. That could change tomorrow.

The world's resources of coal, representing what is in the ground, are enormous but Reserves are limited to that lying in beds thicker than 50 centimetres and at less than 1500 m depth. The net energy return on the balance is negative. The coal Resources of the North Sea are enormous but there are no coal Reserves.

Thanks to progress in geochemistry since 1990, notably the Rock Eval of the IPF, it is possible to estimate the volume of oil or gas generated in the source rock of a mature basin, which has both an oil window and a gas window.

In a 1994 report, *Undiscovered Petroleum Potential* by Laherrere, Perrodon & Demaison, we estimated the amount generated in the principal Petroleum Systems of the world, and the percentage that would be produced in conventional fields, finding a very low range: 1.4% for the Persian Gulf province (covering 600 000 km2), 1% for the North Sea, 0.8% for the Triassic of the Sahara, 0.5% for the Niger delta and 0.4% for Gippsland.

Two years ago, Toreador (bought by Hess) wrote that the oil generated in the shales (*schistes cartons*) of the Paris Basin amount to 95 Gb, of which 20 Gb have migrated, with the balance of 75 Gb being retained in the source-rocks. This is the result of a serious French study by Beicep-Franlab. But the problem is that to produce it, as it would be necessary to search in the fissures and fracture the rock.

The recovery rate, namely the amount of the 2P Reserves in relation to the Oil-in-Place, of a classic oilfield ranges from 1% in a compact reservoir to 90%. The East Texas oil field is 86% and the average of the North Sea is 50%, but that says nothing about the recovery of non-conventional oil which must be in the order of 1%-3% in relation to the resource in the source rock. The deception is to assume that all the basin is productive when only the sweet spots are economic for a time – the decline is as much as 50% over the first year and the rest is not economic. The shale oil promoters seek to make money on the Stock Market and not through their production.

The methane gas resources are huge. In the US, there is more methane dissolved in the geopressured aquifers than in shale gas! Cattle annually emit 100 kg or 140 cubic meters of methane. In France with 19 million cows that represents 2 billion cubic meters ($G.m^3$) a year (peak of Lacq production = 8 $G.m^3/a$, production 2012 France = 1 $G.m^3/a$). For the world with one billion cattle, it represents 100 Mt or 140 $G.m^3/a$, which in other words is equivalent to 4 per cent of world gas production in 2012(3300 $G.m^3$).

Rice paddies emit methane as much as ruminant animals. Termites emit 30 Mt or 4 $G.m^3/a$. Humans emit 0.12 kg of methane a year, namely 0.17 m^3, meaning that the world population releases 1.2 $G.m^3/a$. The methane resource is huge but who will produce methane from cattle? The answer is no one because it is not economic.

Production Data

Public production data are unreliable and subject to obscure definitions. Many suppliers cheat or lie on production data: the OPEC monthly report publishes two different OPEC member productions from secondary sources and from direct communications with huge discrepancies and they seem to rely on the secondary data

The game of football has its rules, and anyone offending them is given a red card by the referee, but in the world of oil there is no agreement on definitions, rules, referees or red cards.

The United Nations should insist that countries publish reliable data on reserves and production by field, following the example of Norway.

The world reported data on oil supply show a range of 3 Mb/d between the different sources (IEA, USDOE/EIA, and OPEC). It must however be admitted that compiling the data without knowing the exact definition, by weight or volume, is difficult.

The EIA reports 76 Mb/d (including condensate), with gas liquids at 84 Mb/d and including refinery gains 89 Mb/d. Campbell reports the production of Regular Conventional under his definition (excluding heavy, tight, deepwater, polar and gas liquids) at 66 Mb/d

Fig 26: World oil supply: discrepancy between IEA, EIA & OPEC

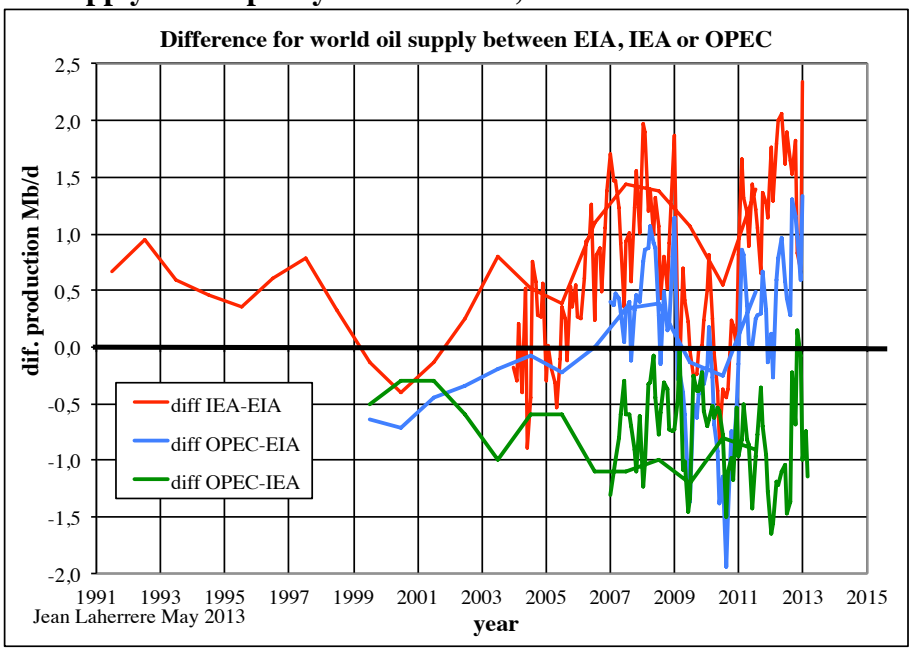
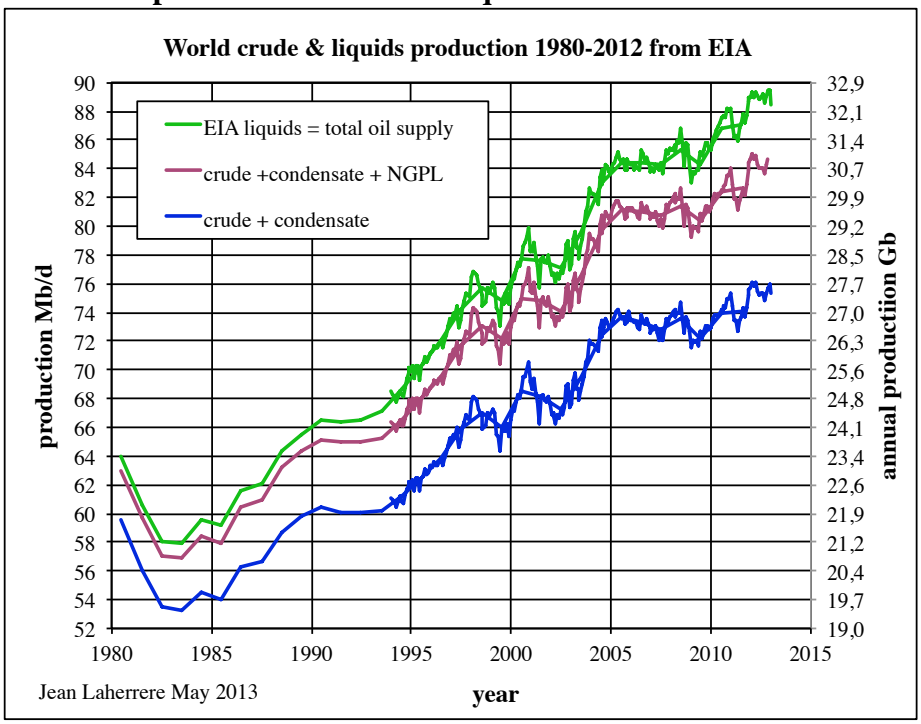


Fig 27: World: crude oil production brut & all liquids from EIA



The OPEC countries cheat on their production data, the best example being the OPEC bulletin of July 2013 reporting production for May 2013 as follows in Mb/d

	Secondary source	OPEC direct communication	Difference
Iran	2.669	3.710	+39%
Venezuela	2.758	2.343	-15%
OPEC	32.221	30.688	-5%

Giving the numbers to five digits is a second mistake, and BP goes so far as to give them to fifteen digits, which is ridiculous.

World production of conventional oil (excluding Extra Heavy) is on a bumpy plateau.

Fig 28: World conventional oil production (OPEC et Non-OPEC) & forecast for an ultimate of 2.1 Tb*, assuming no demand constraint.*

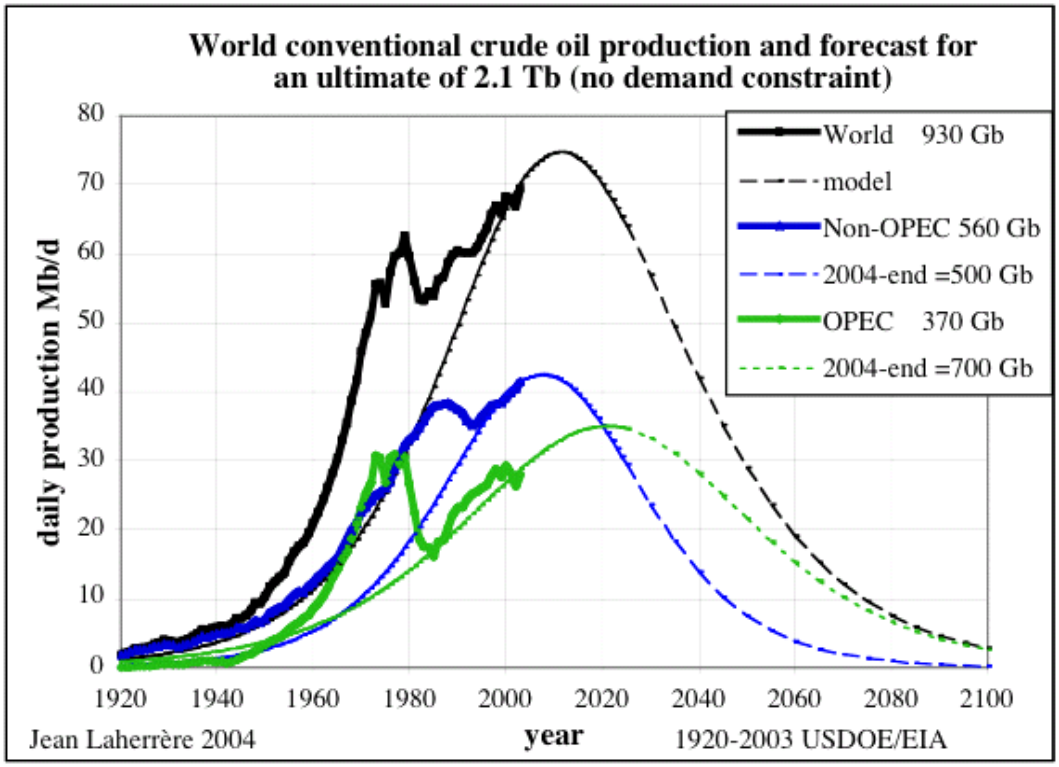
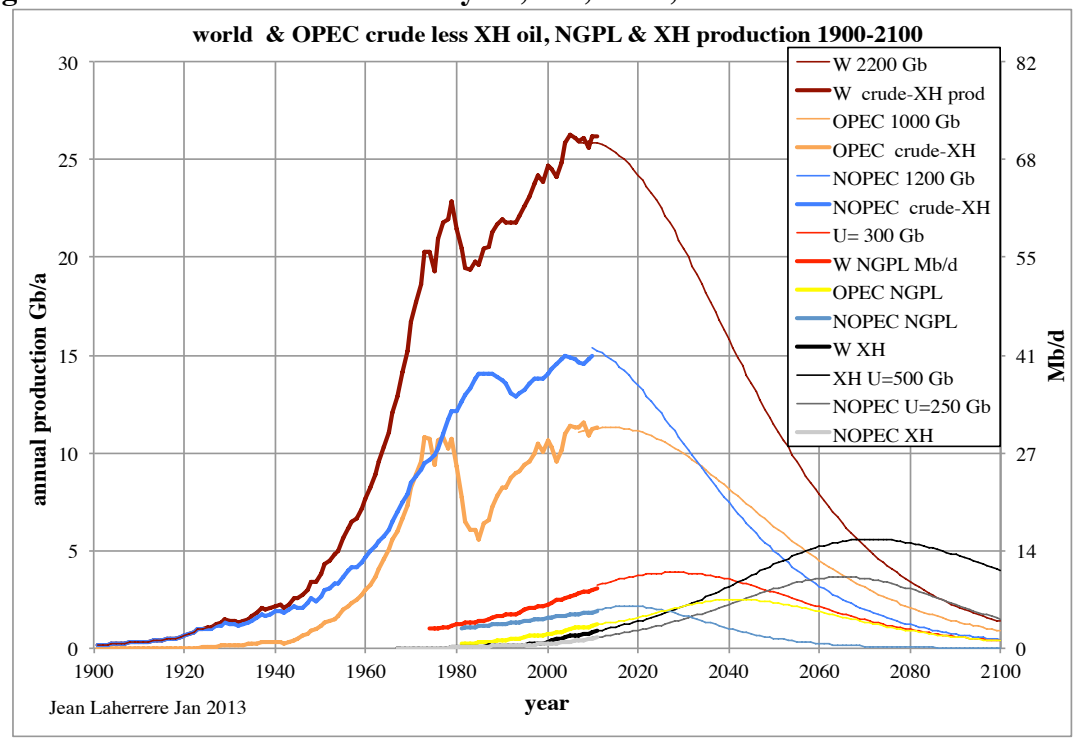


Fig 29: World crude less extra-heavy oil, XH, NGL, OPEC et NOPEC



In conclusion, we may note that there is little difference between 2004 forecast and 2013 forecast with the discrepancy being less than the accuracy of the present data.

Fig 30: World liquids production with Hubbert

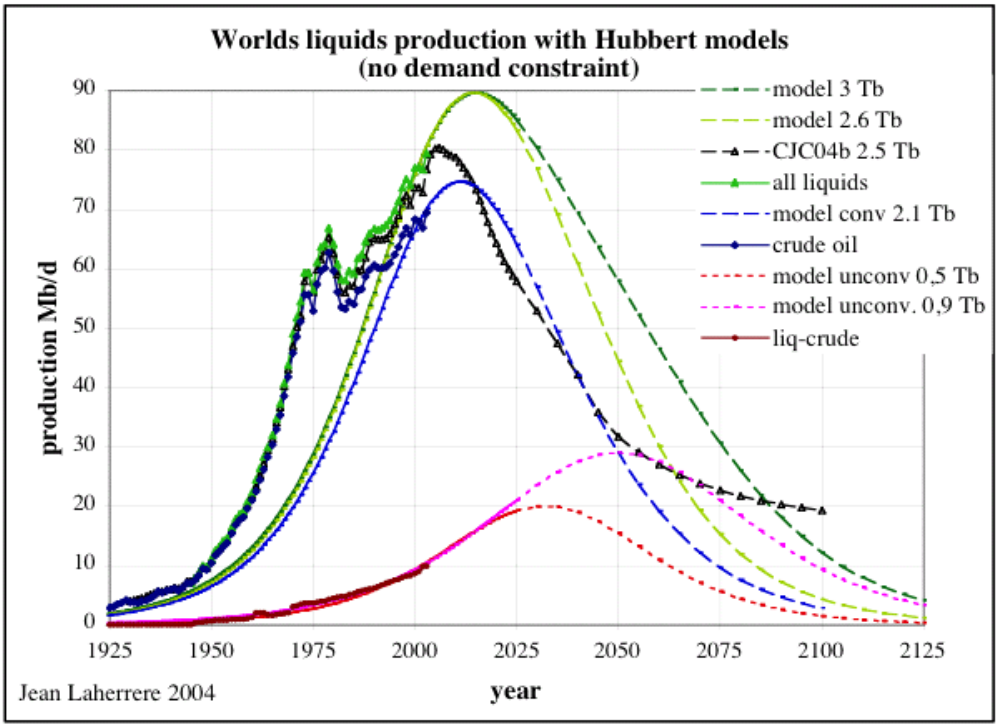
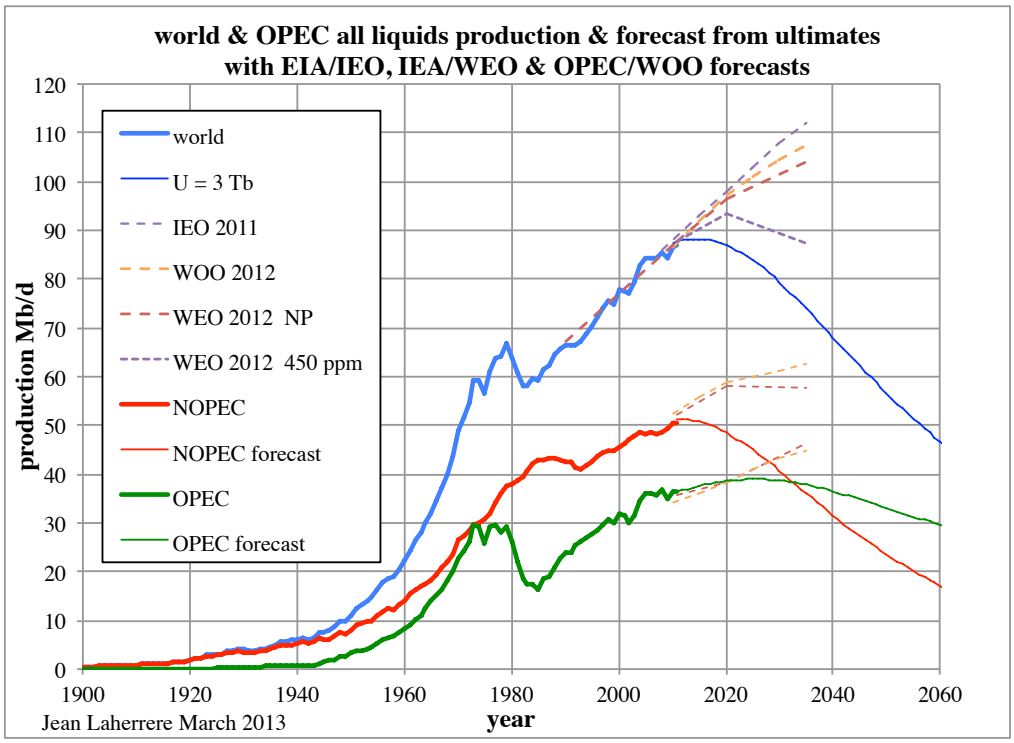


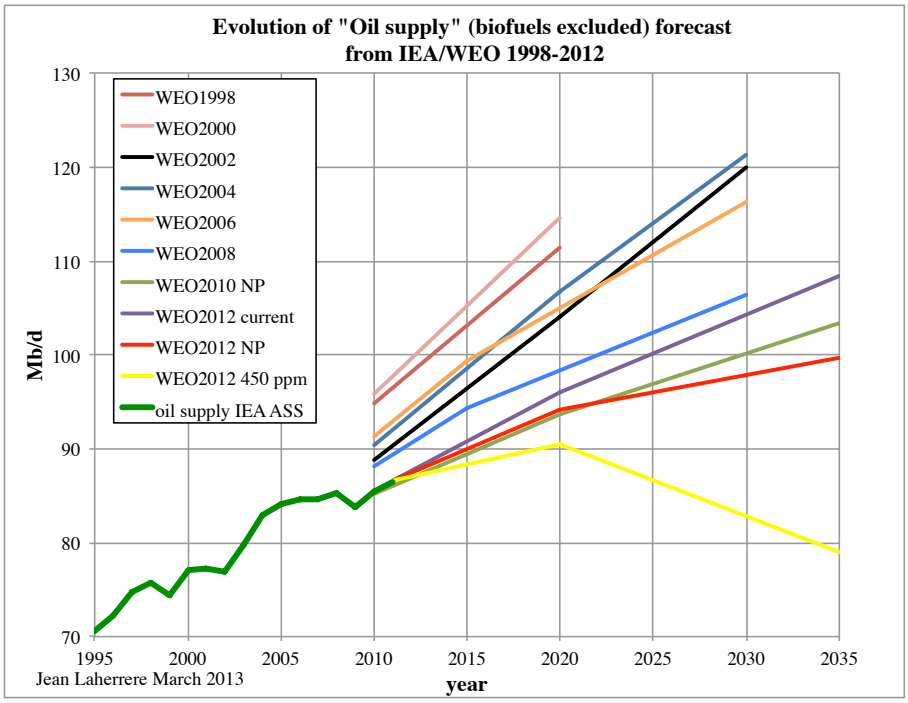
Fig 31: Laherrere forecast and official forecasts



The IEA in its report World Energy Outlook 2010 wrote that production (crude less Non-conventional) had peaked in 2006 at 70 Mb/d. It was 67.9 Mb/d in 2009, 69.3 Mb/d in 2010 and 68.8 in 2011. Naturally, there are motives to forecast the production of all liquids to reach 109 Mb/d (reference) by 2035 to support business as usual, unrealistic as it is. The forecast WEO 2012 450 ppm is not far from my forecast.

But the forecasts made by the IEA from 1998 to 2012 show that they are far from reality and it is probable that that will continue.

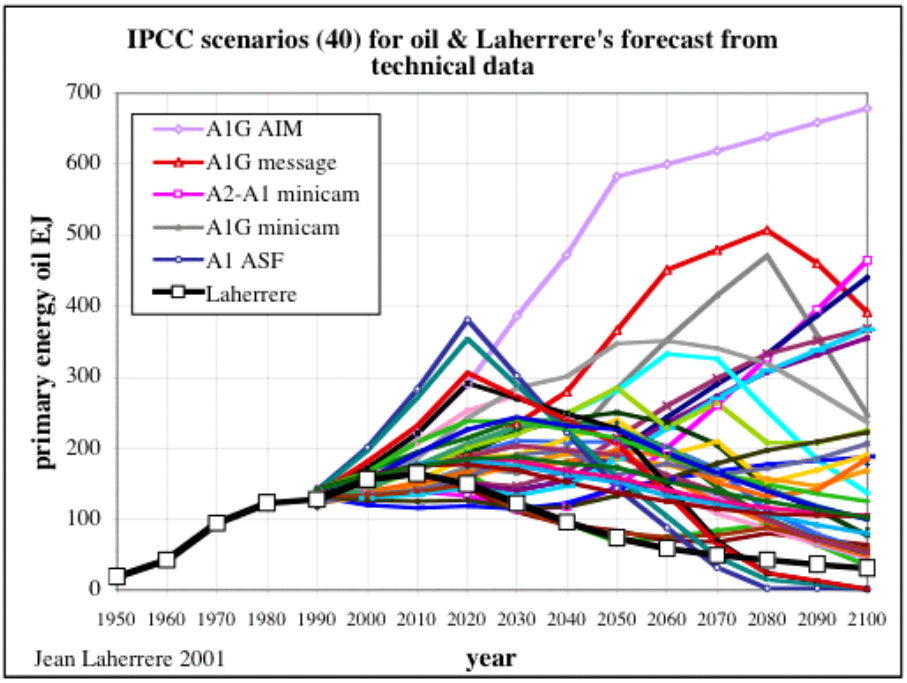
Fig 32: Evolution of IEA/WEO forecasts from 1998 to 2012



The former scenarios of the IEA since 1998 have all proved wrong.

The IPCC scenarios are all wrong

Fig 33: IPCC (1998) oil scenarios as shown in a IIASA 2001 presentation



The IPCC President, Dr Pachauri, is an Indian economist who confused his institute (TERI) with the IPCC and was involved (apart from the accounting of personal expenses) in the so-called Himalayagate, where his employee wrote a report foreseeing the total thawing of glaciers in the Himalayas by 2035 (bringing studies for his institute). His 2035 forecast was challenged by an Indian scientist and he replied by talking about “vaudou science”, but later he admitted a typing mistake (instead of 2350)

The IPCC is primarly a political organisation. As its name indicates, it is inter-governmental, and the Summary for Policy Makers is distributed before the technical study.

The Nobel Peace Prize is given by Norwegian politicians, contrasting with the other Nobel Prizes given by Swedish scientists. They are also given to politicans such as Mandela, Arafat or Obama, who have nothing to do with science.

The IPCC has tried to deny the Little Ice Age with a curve, resembling a hockey stick (from Mann). The current warming is in fact a reaction to the Little Ice Age of the Middle Ages. We return towards that which is called optimum: Holocene, Roman, Mediaeval. There is nothing new under the sun.

As shown on Figure 31, the oil peak or plateau is not evident on IEA and EIA forecasts, which go up to the sky (except WEO 2012 450 ppm). But the oil peak is obvious on the graph of oil production per capita: it occurred in 1979 (in fact an undulating plateau 1973-1979) at 5.5 b per year. It is now at 4.5 b/a and will likely be 3.5 in 2030. All the optimistic official forecasts up to 2040 are designed to show that sufficient oil is available to sustain a stable level per capita, and yet they are all below the production level of 1979.

Fig 34: World oil production forecast per capita

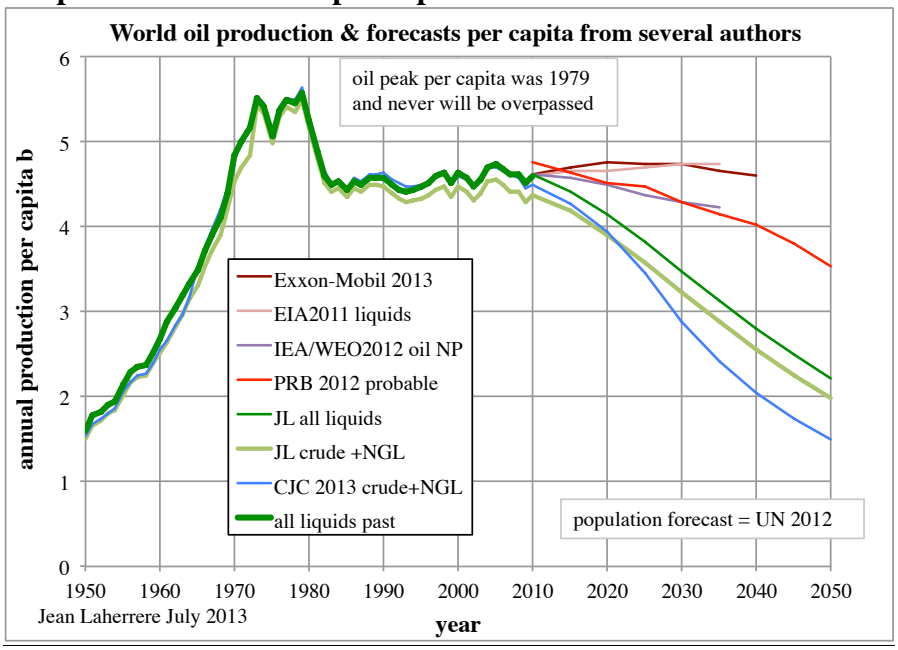
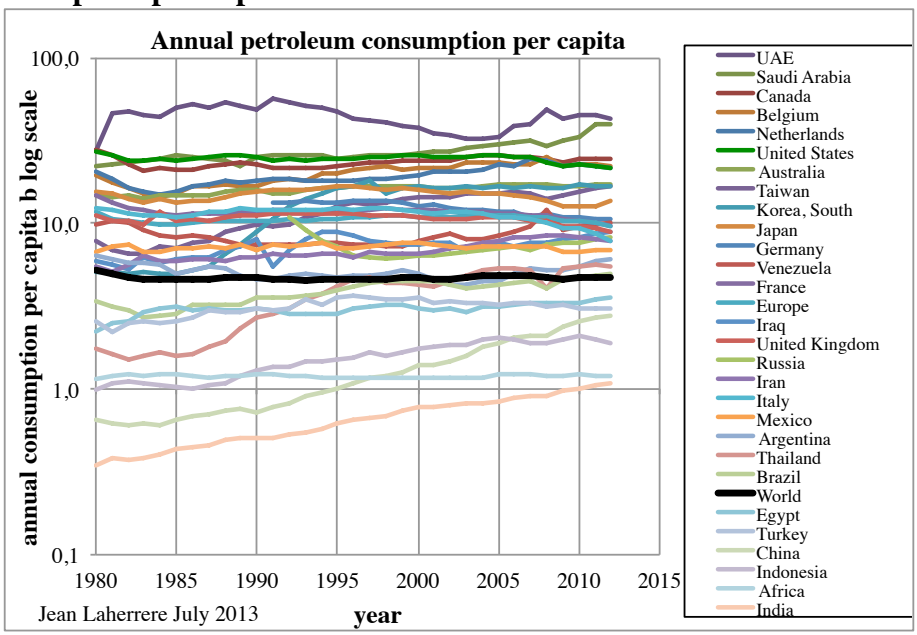


Fig 35: Oil consumption per capita



The actual consumption of oil per capita shows a gigantic range: 80 b in Singapore, 40 b in Saudi Arabia, 24 b in Canada, 22 b in the USA and Belgium, 17 b in Australia, 14 b in Japan, 10 b in France and Spain, 8 b in Russia, 6 b in Argentina, 4.7 b for the world as a whole, 3.5 b in Egypt, 3.2 b in Algeria, 2.8 b in China, 1.9 b in Indonesia and 1 b in India.

The tax charged on the retail pump sales pump ranges largely, and is unrealistic in certain countries such as Venezuela. For example, for gasoline they are 0.02 € per litre in Venezuela compared with 2.07 €/L in Turkey – a hundred fold range, while for diesel the range is from 0.014 €/L in Venezuela to 1,89 €/L in Norway. Figure 36 shows the ten least expensive and the ten most expensive countries.

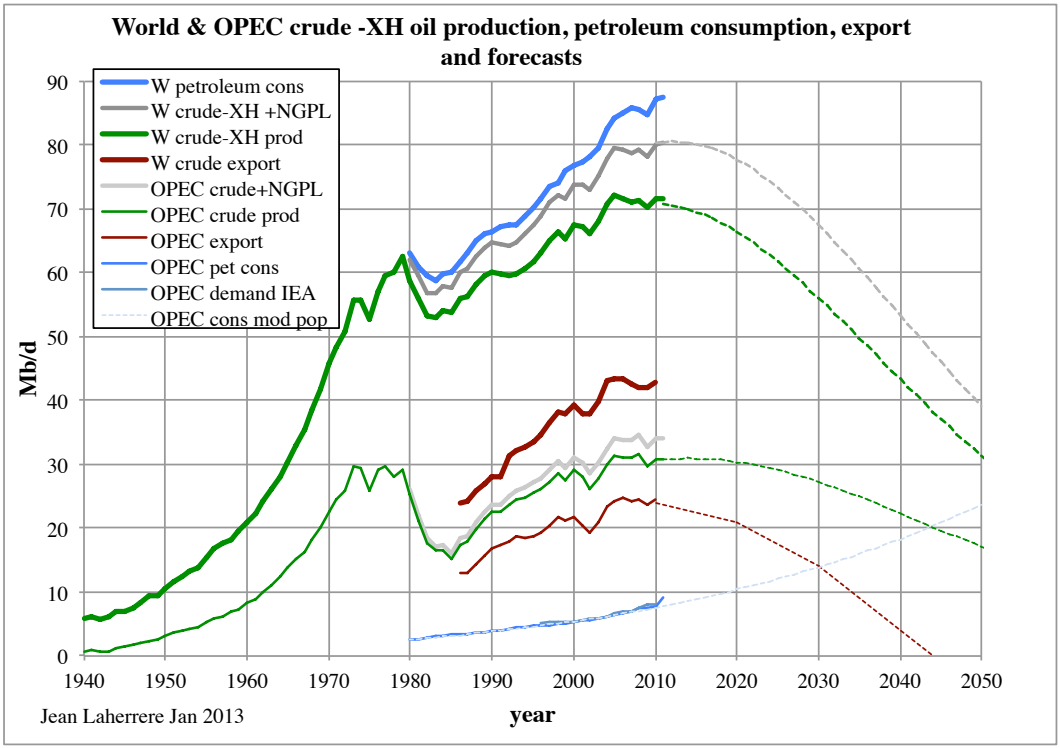
Fig 36: gasoline & diesel price in €/L in July 2013

	Diesel		Gasoline
Venezuela	0,01	Venezuela	0,02
Iran	0,02	Iran	0,09
Saudi Arabia	0,06	Saudi Arabia	0,15
Bahrain	0,12	Qatar	0,18
Qatar	0,18	Bahrain	0,2
Kuwait	0,2	Kuwait	0,22
Yemen	0,22	Oman	0,29
Brunei	0,23	Yemen	0,33
Ecuador	0,26	Brunei	0,37
Egypt	0,35	Bolivia	0,42
France	**1,34**		
Ireland	1,48	**France**	**1,64**
Rwanda	1,52	Cape Verde	1,64
Cent. Afr. Rep.	1,59	Israel	1,65
Iceland	1,61	Greece	1,67
Sweden	1,62	Portugal	1,67
UK	1,62	Hong Kong	1,68
Italy	1,62	Italy	1,74
Israel	1,76	Netherlands	1,79
Turkey	1,81	Norway	2,06
Norway	1,89	Turkey	2,07

The oil producing countries of the Middle East strongly subsidize their consumption linked to their growing population (1.8% in Saudi Arabia) but the increase is supported by few discoveries.

The OPEC consumption curve will cross the production curve in 2045, implying the end of exports and of OPEC itself.

Fig 37: World oil (excluding extra heavy) production & oil consumption and forecasts with OPEP



Natural Gas – The Example of the USA and Shale Gas (rock source gas)

Drilling operations in the USA are cyclical; the first rig peak was in the 1950s, followed by another in 1982 prompted by the 1979 Oil Shock. This shock increased the income of the oil companies, which were then pushed to drill less economic projects. It was followed by a collapse in 1986 when drilling stagnated until 2005. It then built again with the search for gas starting in 2000 and following a rise in oil prices to above 50 $/b and the financial crisis of 2009.

The number of rigs drilling for gas collapsed with the fall in the price of gas in 2009, since when it has increased from 200 in 2009 to 1400 in 2012. The number of drilling rigs is published every day by Baker Hughes, but the number of wells is more difficult to obtain with the number varying from different sources. The EIA stopped reporting drilling data in 2010.

Fig 38: US: number of rigs 1950-2012 wells.

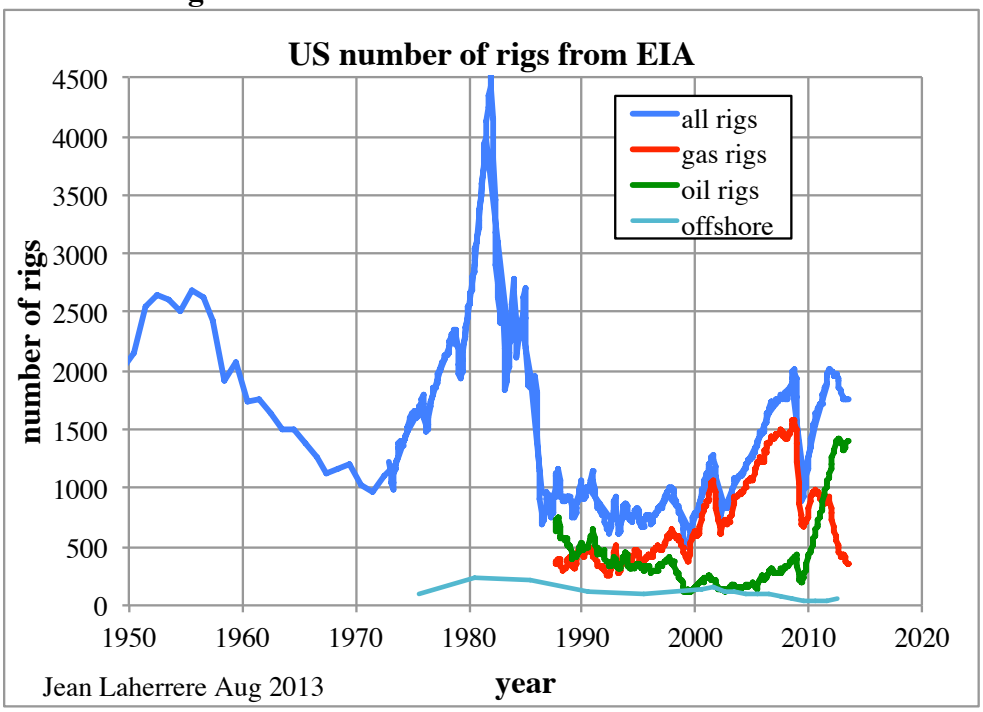
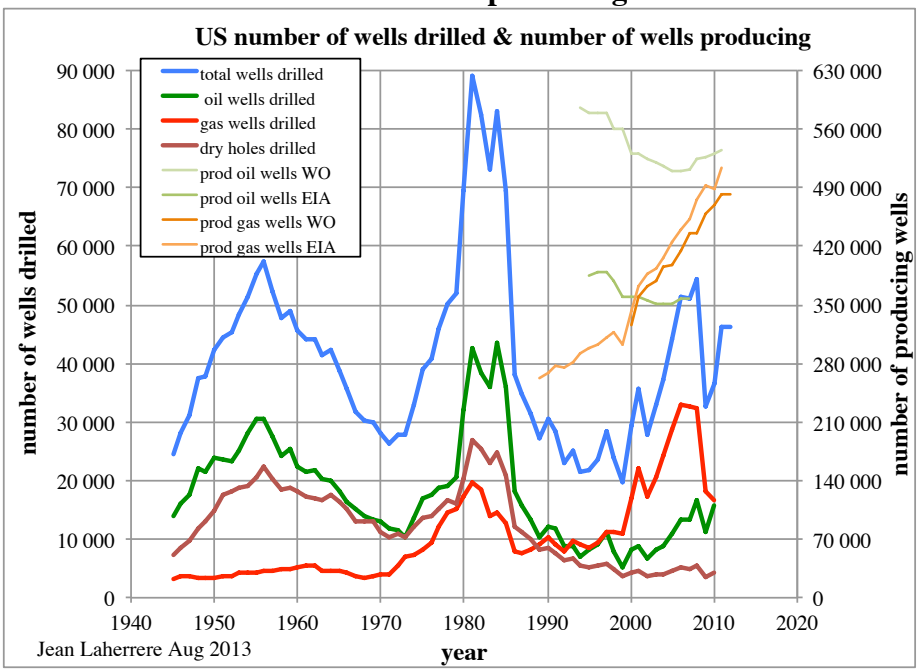


Fig 39: US: number of drilled wells & number of producing wells.

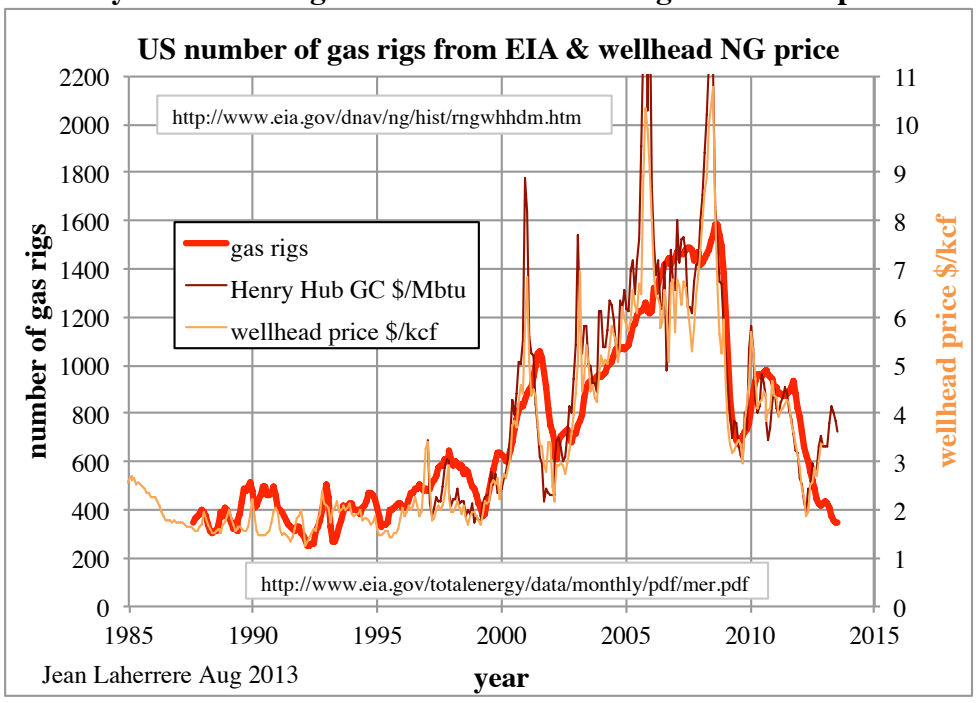


The number of rigs drilling for gas tracks the price of gas after a lapse of several months. The number started to rise in 1995 and reached a peak in 2008 which was followed by a collapse and the production of Shale Gas. This pattern was experienced in 1931 in East Texas oil field, where there are more than 31 000 wells, ten times what were required because the fight between land owners. The government then declared martial law and closed the wells to raise the price of oil that had fallen from 1 dollar to 10 cents.

All the promoters drilled their wells without concern about demand. Pipeline constructors have hesitated to invest in the new Shale Gas game confirming its precarious nature.

Today, operators do not drill for gas if the cost (5-7 $/kcf) is higher than the price (4 $/kcf), which explains why the number of rigs has not increased and will not do so until price exceeds 5 $/kcf.

Fig 40: US: monthly number of rigs from EIA and natural gas wellhead price.



The production of gas from the Barnett Formation reached its peak in 2011, following the peak in the number of wells in 2008. Its reserves are here estimated at 23 Tcf based on an extrapolation of the decline. This is in the same order of magnitude as the reserves of gas in the Prudhoe Bay Field whose production has been awaiting a gas pipeline for forty years.

The development of the Haynesville Formation in East Texas and Louisiana followed the Barnett but is also in decline. The next project to-date is the Marcellus in Pennsylvania. It has a much wider extent, but the sweet spots are less defined

Fig 41: Shale gas production per formation 2002-2012

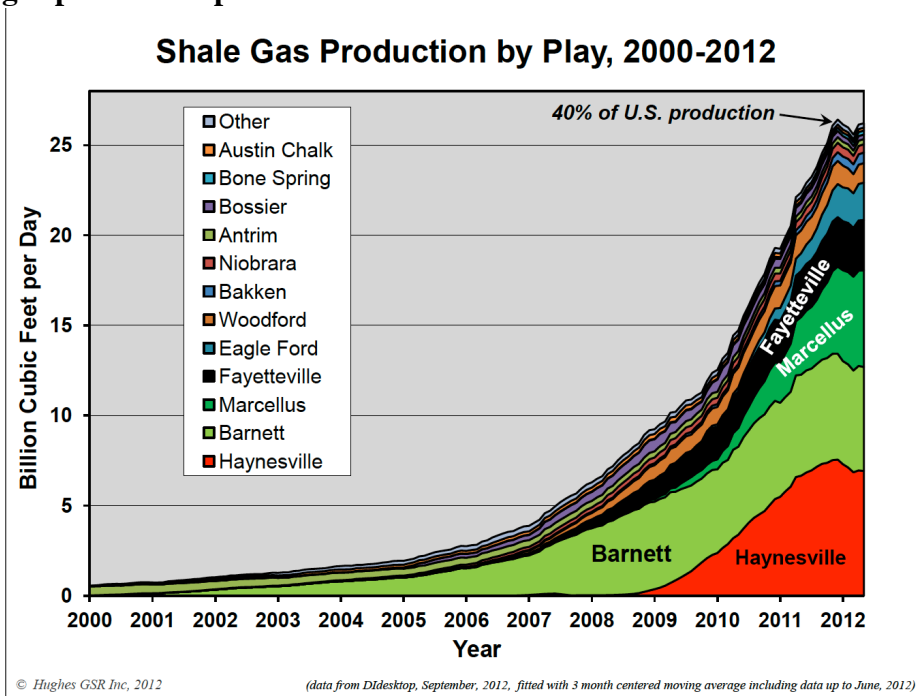
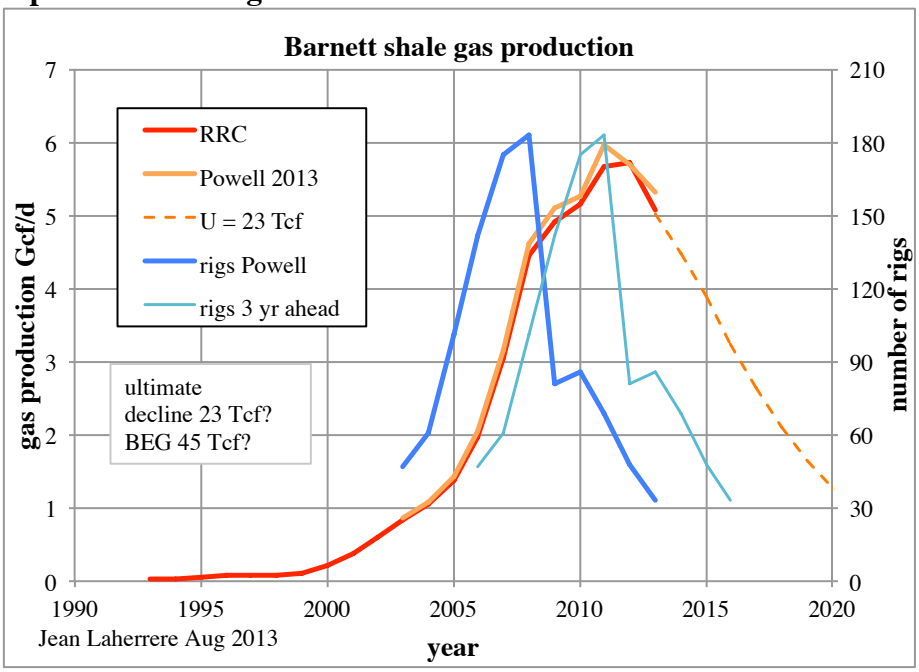


Fig 42: Barnett production & rigs number



An article by David Hughes in May 2013, following his book of 2012 *Drill, Baby, Drill*, gives some excellent graphs of Shale Gas production in the USA, notably the number of wells by geological formation.

The high quality maps of Hughes 2013 on Shale Gas are very instructive.

For the Barnet, the good wells (red) are concentrated near Dallas - Fort Worth, with the rest of the Barnet area being devoid of wells: as many as 18 900 wells had been drilled by 2013. The production from the Barnet is in decline with 32 rigs operating in August 2013 compared with 70 in August 2012.

For the Marcellus, good wells are concentrated in two areas, and it remains to be seen if a third will be found. It will have to be found soon because the number of rigs has fallen from 140 in February 2012 to 86 in August 2013

Fig 43: Barnett quality map Hughes 2013

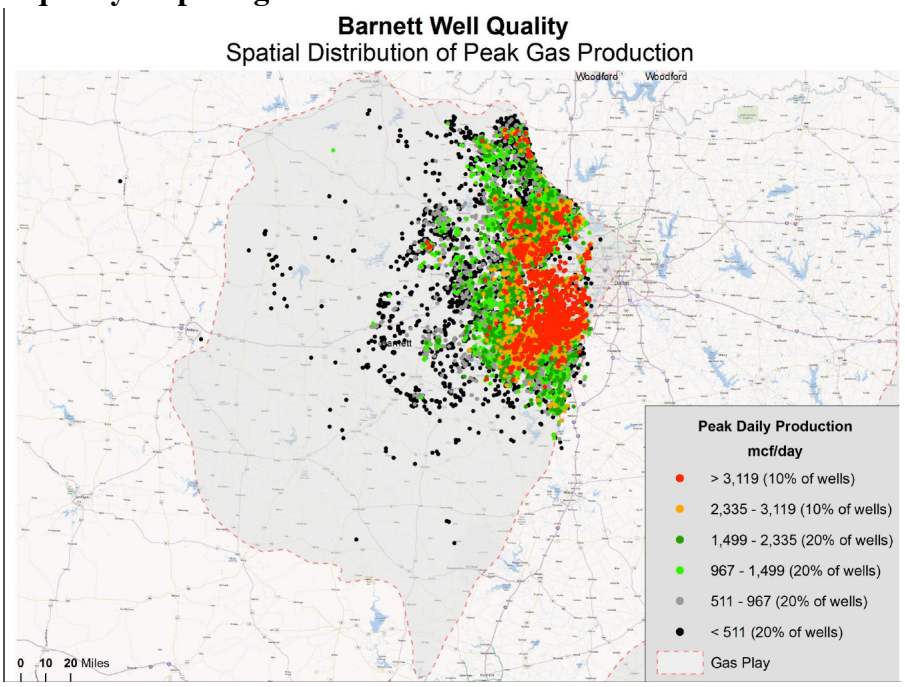
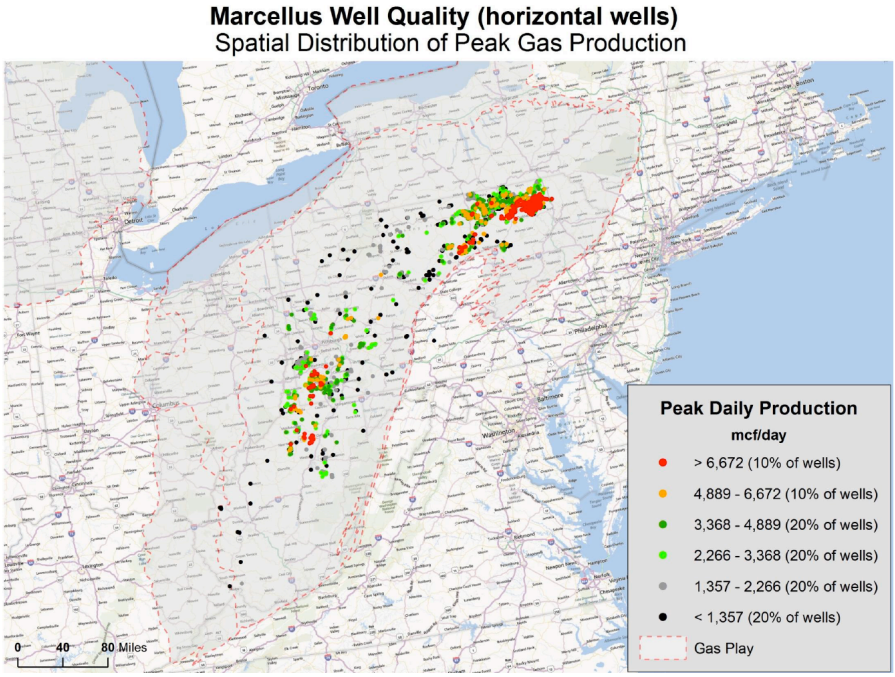


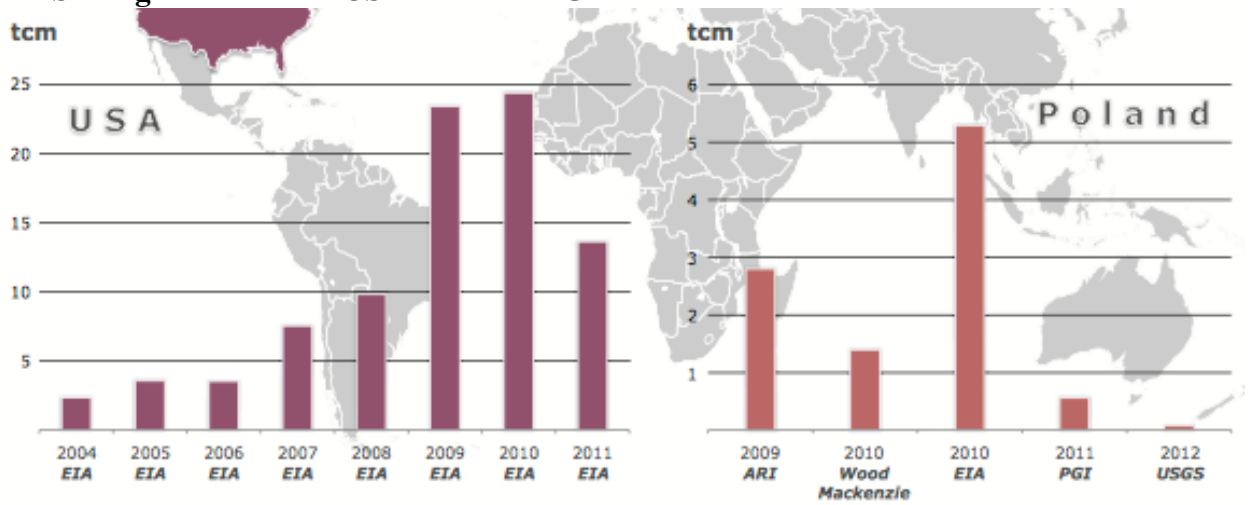
Fig 44: Marcellus quality map Hughes 2013



R. Weijerrmars (OGJ 5, Aug, 2013) has studied the expenses of the Chesapeake Company in the production of Barnett at the Dallas Fort Worth Airport. During the period 2007-2012, it had a negative balance of $316 million although the airport had a positive return of $305 million. Chesapeake had to drill 110 wells following the fall in the price of gas. Its rights will expire if it fails to continue to drill, but it has asked for an extension, hoping that the price will rise.

The shale gas reserves vary according to the BGR 2012 report.

Fig 45: Shale gas reserves in US & Poland: BGR 2012



In the US, the calorific value of gas is 1 boe for 5.6 kcf, whereas for the world it is 1 boe for 6 kcf.

The ratio of the price of crude oil energy (MBtu) versus natural gas was 7 in 1950 but had fallen to 1 in 2011, rising to 9 in April 2012.

It follows the flaring of gas in the United States (red) from 1950 to 2000 and in N. Dakota (orange) from 2005 to 2013.

Fig 46: US: ratio crude price/gas price & % flaring/production

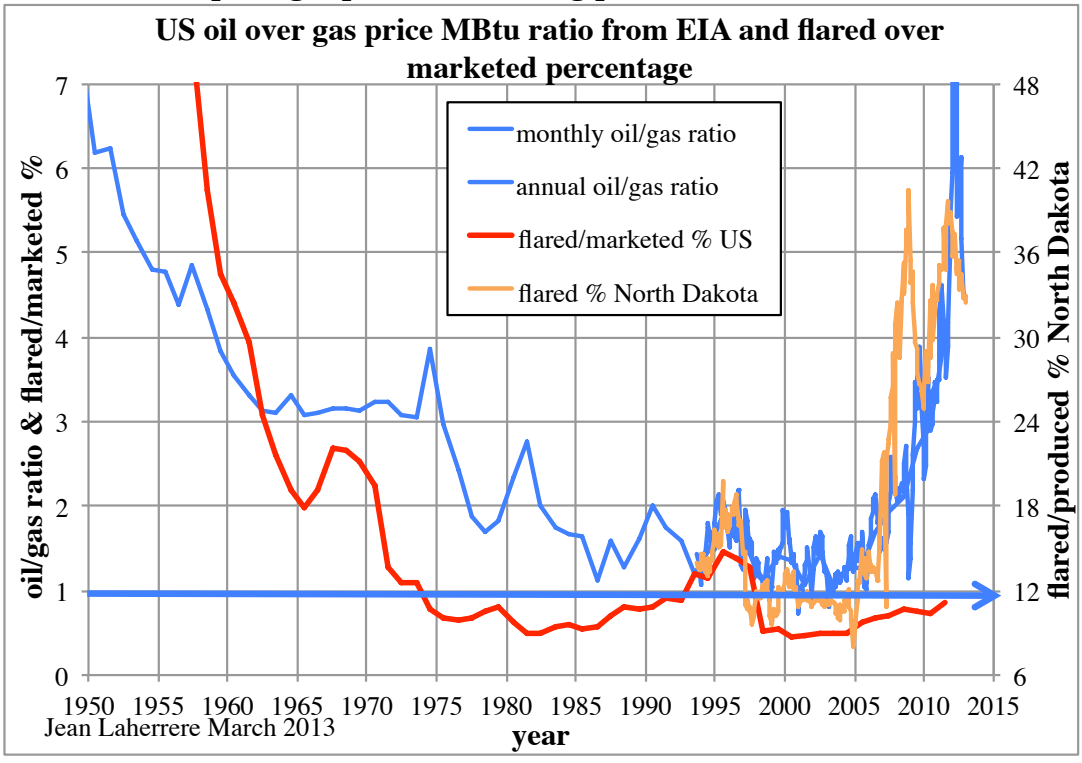
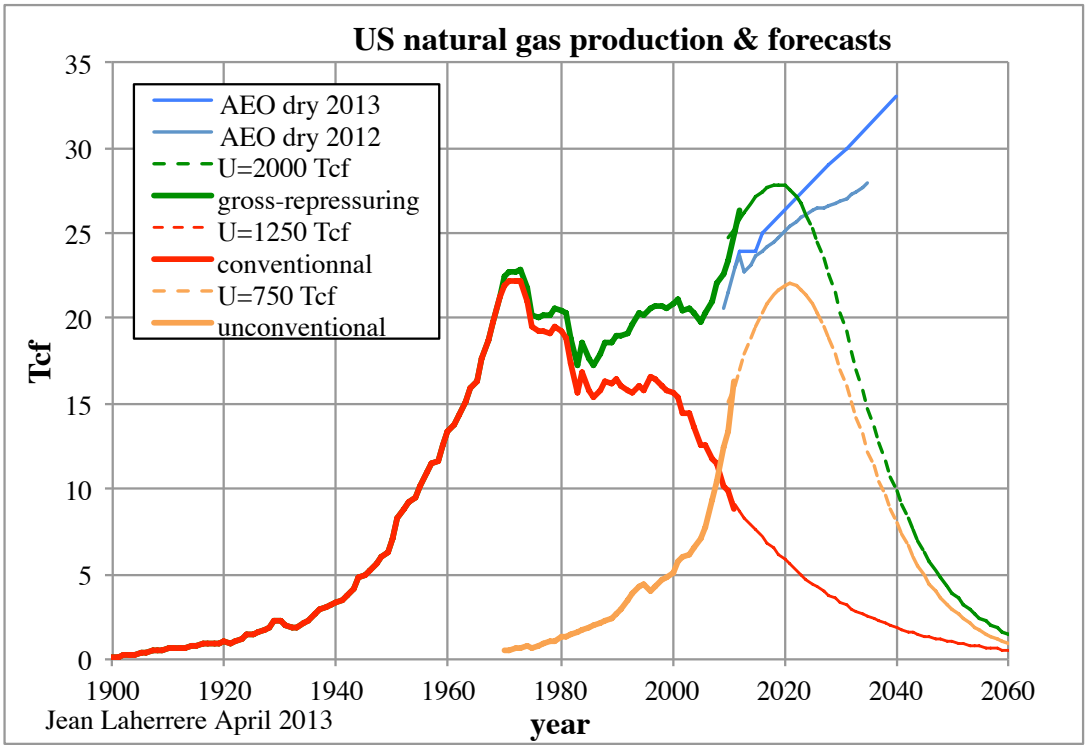


Fig 47: US natural gas production & unconventional forecast



The absence of gas pipelines, and the lack of dialogue between the many promoters looking for immediate profit (to the detriment of future generations) has led to a stupid waste through gas flaring and to a gas price collapse which is unsustainable. The situation echoes the subprime financial praised by many before its collapse. There is talk of the export of liquefied shale gas with 22 projects under consideration, in which Sempra or GDF Suez must invest 1.7 G€ for an interest of 17%, according to a report of July 2012, of which Cheniere is the only one to give approval. These projects would represent 180 Mt (60% of the US gas consumption) with the world current LGN total being 250 Mt. There were 47 applications to gasify imported gas liquids of which that by Cheniere will soon be doing the contrary in 2016!

The miracle of shale gas is attributed to promoters such as Mitchell, XTO (bought for $41 billion by Exxon) and above all Chesapeake, which has sold some of its interests to major companies (Exxon-Mobil, Statoil, Total, CNOOC) wishing above all to include the certified reserves in their balance sheets, because they produce more than they find. In fact the first US natural gas production was in 1821 at Fredonia in New York State coming from shale gas and used for illumination. In 1850, lighting was based primarily on whale oil sold at 2000 $ a barrel (in 2013$). The discovery of crude oil in 1859 led to the closing of Fredonia, but the Big Sandy shale gas field in Kentucky discovered in 1880 had in 1960 thousands of wells fractured by nitro glycerine (7 tonnes per well).

The Shale Gas has been rediscovered thanks to subsidies by the US Department of Energy and above all when the price of gas rose above 5 $/kcf, which is about its cost. But the promoters did not manage well this boom (like the East Texas field in 1931), and the lack of pipelines has depressed the price. This boom does not rely on new technology because hydraulic fracturing and horizontal drilling have been practiced for 50 years, but depends on the economics and above all new 2010 Stock Exchange Commission rules, which are even more lax than SPE rules. The major companies (Shell, BP, BHP and Encana) a have been obliged to write off more than 10 G$. It resembles the scandals of Bernie Madoff in relation to the sub-prime loans, which were sold on the basis of unrealistic dreams. The resource is perhaps there, but not the reported reserves based on a price of oil that is too low to be viable.

For guessing the future of Shale Gas, look at the record of Chesapeake, the premier US producer in 2010. Its president has been dismissed; it is in debt to the tune of 12 G$, and its stock price has collapsed since 2008 (as in 1997 before).

Fig 48: Chesapeake debt & income 1993-2012

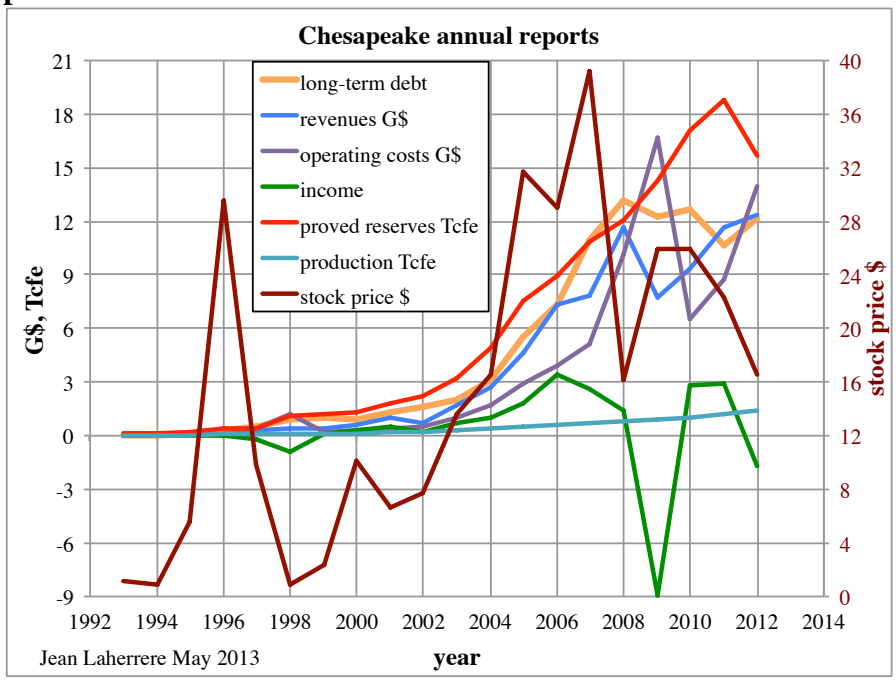
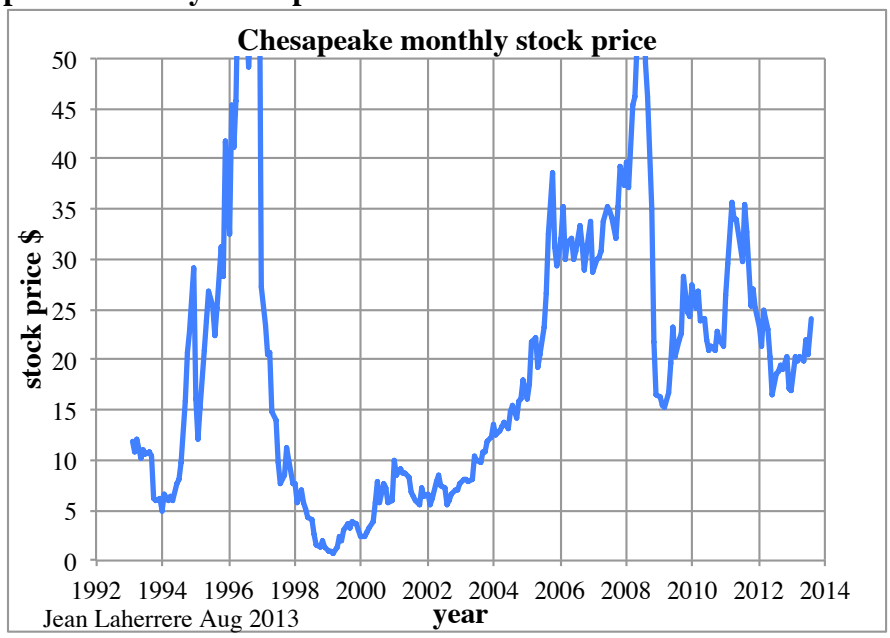


Fig 49: Chesapeake monthly stock price 1993-2013



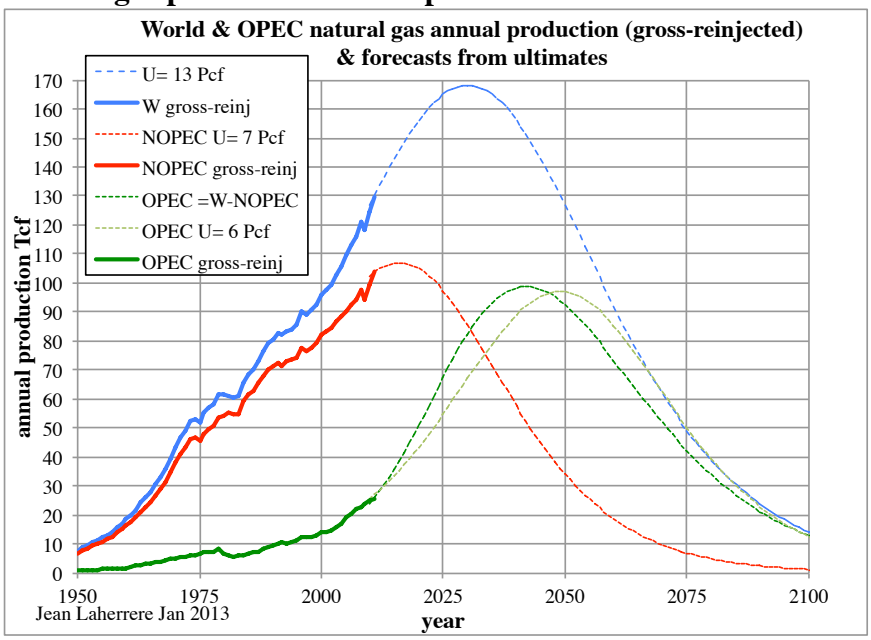
Considering the rest of the world, Shale Oil is attracting attention in Poland (but Exxon and two other companies left after few wells), Great Britain and Argentina, where it is hampered by the nationalisation of Repsol-YPF, and Australia.

The big unknown is China, but I have my doubts if it will take off.

The world ultimate reserves of gas are estimated at 13 000 Tcf or 340 T.m^3, with 7000 Tcf in Non-OPEC countries. By contrast to oil where there is a single market, gas is traded on several different markets (Europe, North America, Asia Pacific and Latin America), but the transport of gas costs ten times that of oil. The gas reserves in the Arctic of North America (25 Tcf in Prudhoe Bay) has been blocked for 40 years for lack of a pipeline.

The political and economic constraints are considerable, and it is very difficult to forecast future production, especially by the OPEC countries.

Fig 50: world natural gas production should peak in 2030



The production of Non-OPEC gas (red) must peak before 2020 and that of OPEC (green) around 2040, assuming that Shale Gas does not contribute much outside the US.

For the present, we conclude that the reserves of Shale Gas are less than the uncertainties related to conventional gas, but there is much confusion between reserves and resources.

The remaining reserves are above all in the Middle East, especially in the super giant field forming the North Field of Qatar whose extension, holding one-third, runs into Iran where it is known as South Pars. It is estimated to hold 1200 to 1500 Tcf. This is equivalent to 200-250 Gb of oil equivalent and is therefore larger than Ghawar with 100-140 Gb.

The future production of OPEC assumes that there are no constraints other than geological ones, but the political constraints are considerable. Qatar with a small population has decided to limit its gas production to 25 Gcf/d.

Combustible Fossils: Coal

The coal forecasts of 2004 were based on an Ultimate of 450 to 600 Gtoe. The present estimate is 750 Gtoe, but there is much uncertainty especially in relation to the opaque reporting by China.

The peak of coal production was forecast at 3-3.5 Gtoe, but it is presently forecast at 5 Gtoe in 2060.

Fig 51: World coal, oil & gas production & forecasts in 2004

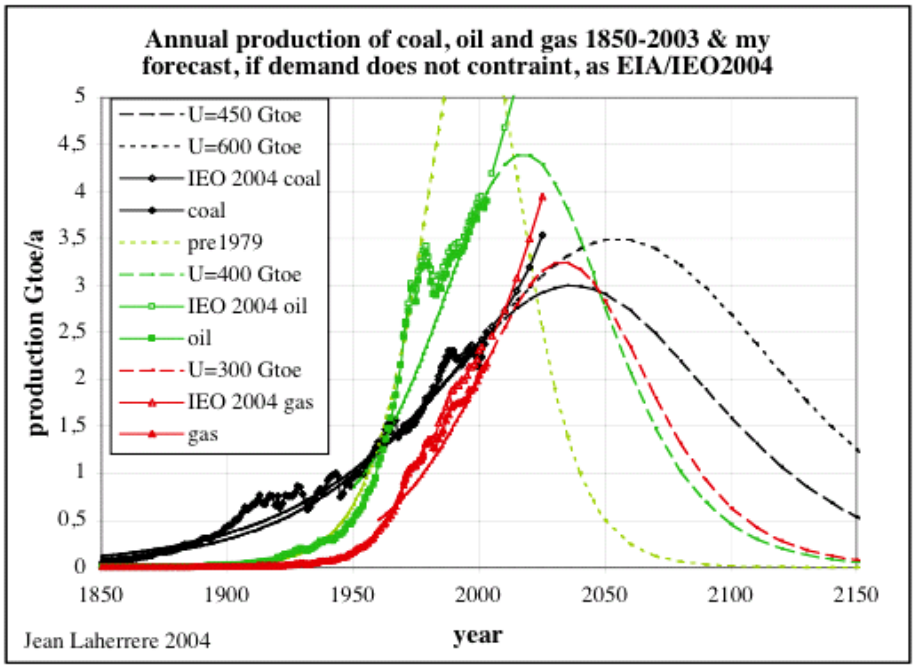
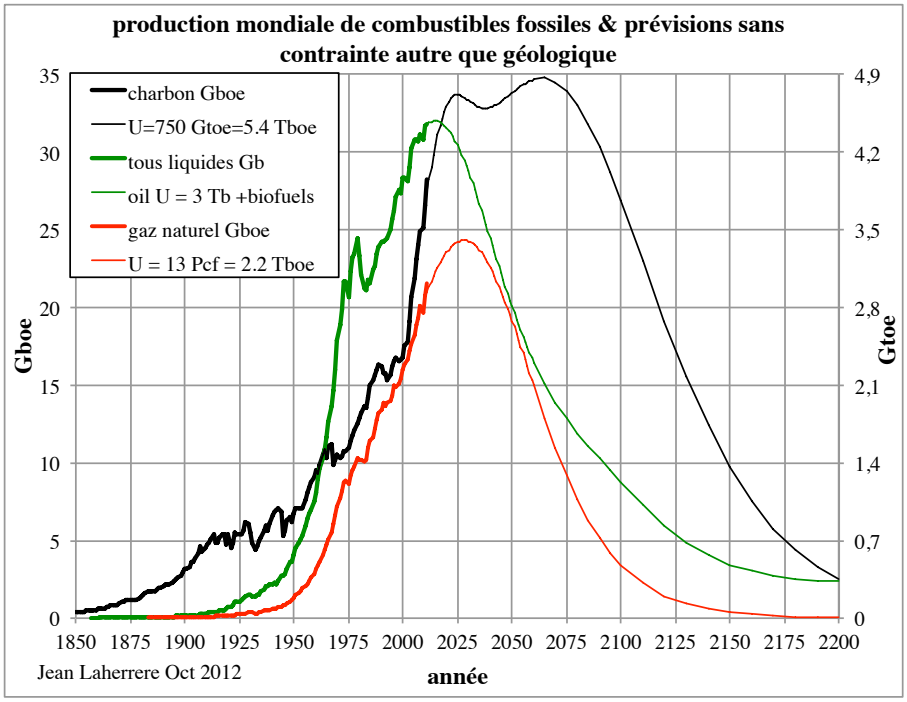


Fig 52: updated in 2012



The large change since 2004 is due to the rapid and unforeseen growth in China since 2001 that radically affected the estimates. But we are far from expert on the subject, and China's data are poorly known. The Chinese economic miracle and our weak inflation (the French shopping basket is full of cheaper Chinese goods) are based on Chinese coal, whose reserves are badly known. There are large reserves in Mongolia, but in China the great problem is water and pollution.

The so-called Asiatic Brown Cloud (ABC) extends from China to India and is similar to the smog that struck London in 1952 costing 12 000 lives. The number of tourists to China has fallen as a result of the pollution. There are 60 million unoccupied apartments (compared with 3 million in Spain). The so-called Chinese miracle has accordingly lost its validity.

Our coal forecasts are most uncertain, largely because of confusion between Reserves and Resources, as illustrated in the 2012 report (remaining volume at end 2011) by the BGR in Germany.

	Reserves EJ	Reserves Gtoe	Resources EJ	Resources Gtoe	Resource/Reserves
Convent. oil & gas	14 254	341	18 308	438	1.3
Non-Convent. oil & gas	2 193	52	31 029	742	14
Coal	21 952	523	473 893	11 283	22

The production of coal will remain the principal source of primary energy for a long time to come.

Fig 53: World fossil fuels production

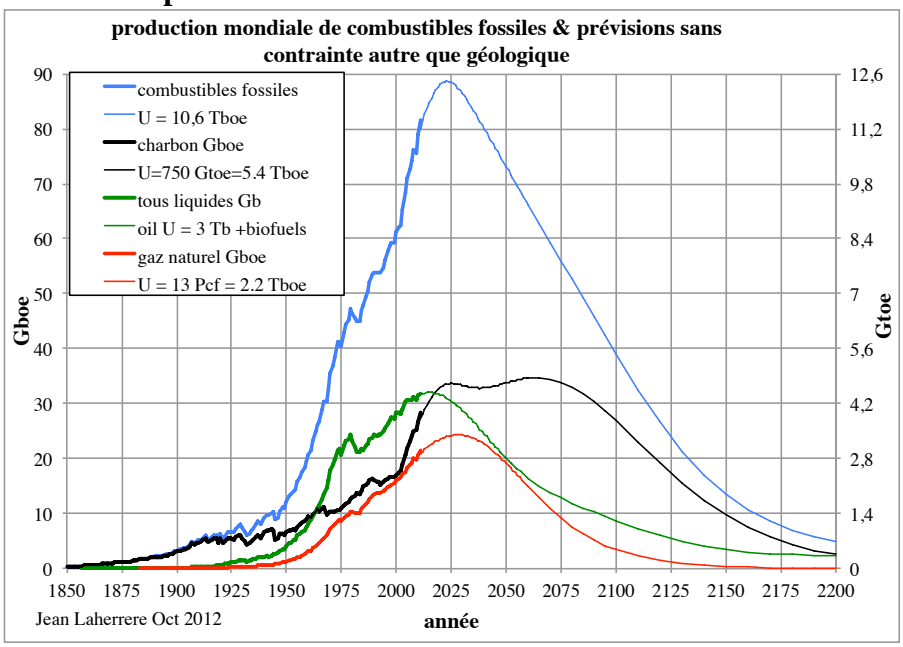
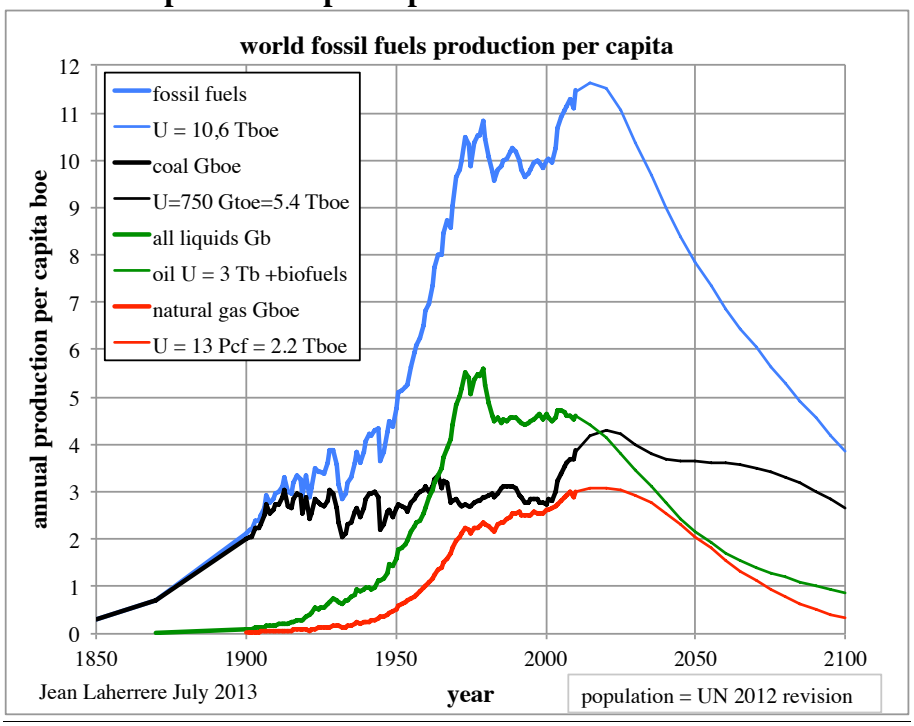


Fig 54: World fossil fuels production per capita



Based on this assessment, the production of fossil fuels must peak in 2025 at 12 Gtoe/a, and then decline at one per cent a year, with coal overtaking oil in 2025.

The world's annual production of coal per capita has been stable at 3 boe since 1905, but has recently increased to 4 boe due to China. The annual production of all fossil fuels per inhabitant will increase to around 12 boe, followed by a decline at 1.3 per cent a year. It relies heavily on coal production, yet the world seeks to cut pollution due to coal. Where are clean coal plants?

World Production of Primary Energy

Our forecast of 2004 was too pessimistic, due to coal.

Fig 55: World primary energy production & forecasts in 2004

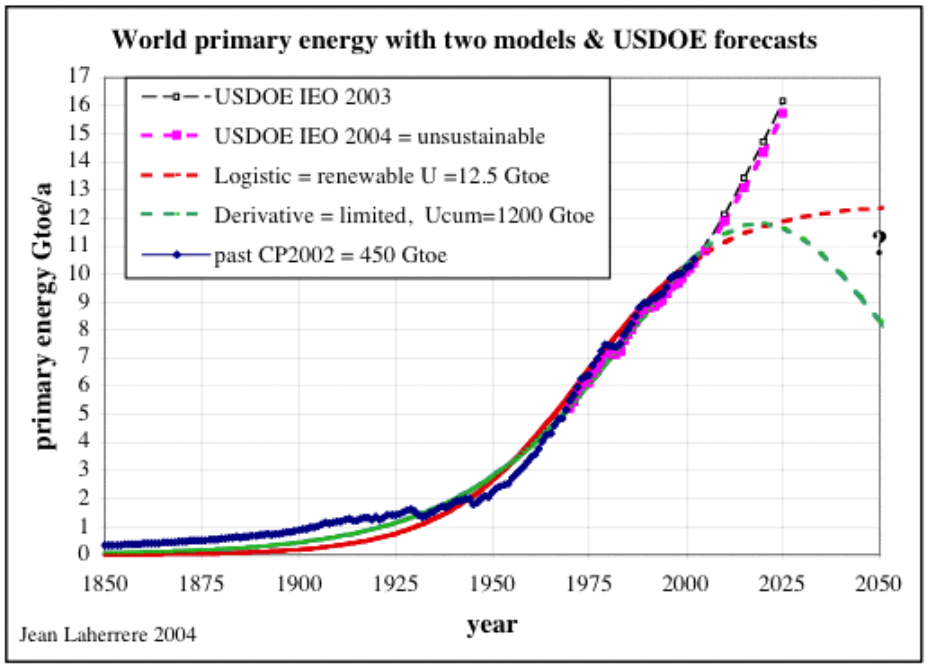
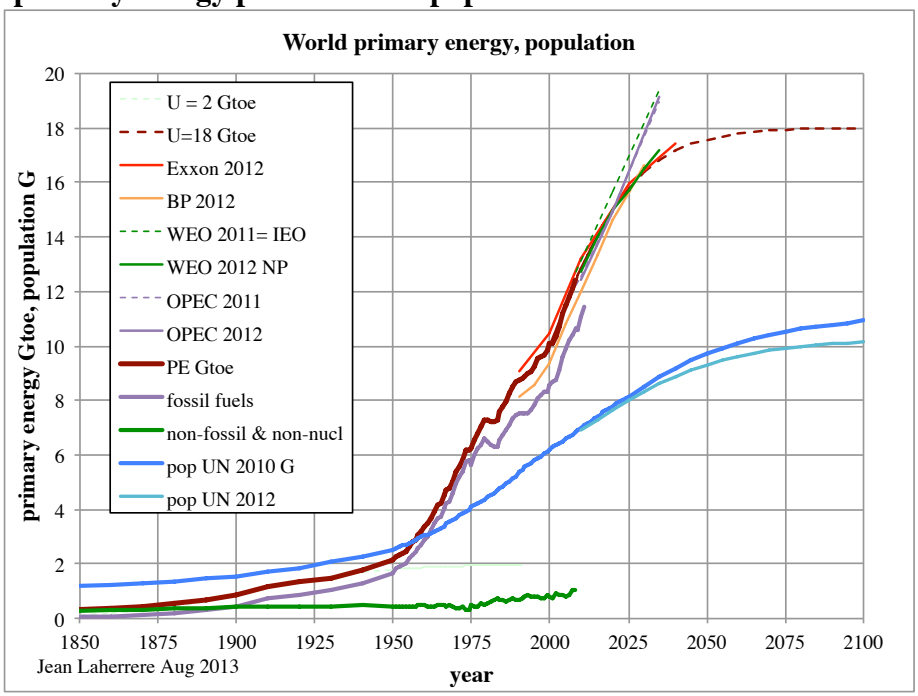


Fig 56: World primary energy production & population in 2013



The supply of primary energy derived fossil fuels has shown a strong growth since 2000 due to the development of coal in China. Our forecast shows an asymptote at 18 Gtoe in line with the forecasts of Exxon Mobil (red) but differs from those of OPEC and the IEA, which are based on

limitless growth. Fossil fuels (violet) represent 86% of primary energy, and it is difficult to imagine how they could be replaced by renewable energy (9%) over the next decades, especially if nuclear energy is suppressed.

Solar energy faces problems in Spain and Germany where subsidies are needed to reduce the cost of electricity.

The sole solution is to change our way of life in order to save energy.

The DGEMP forecasts in 2000 and 2004 displayed an increase in primary energy until 2030

Fig 57: France: DGEMP 2000 & 2004 forecasts: primary energy consumption

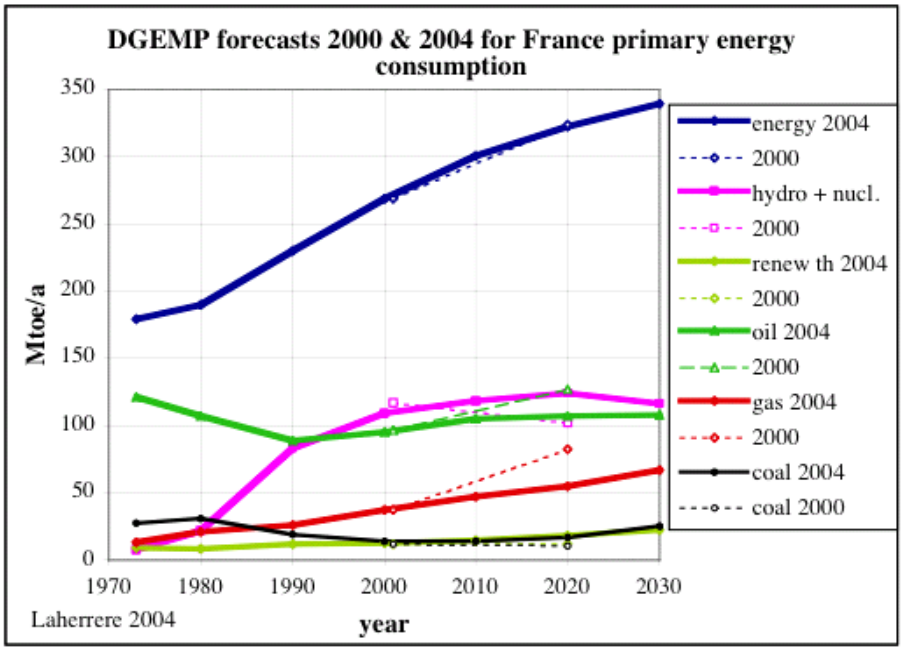
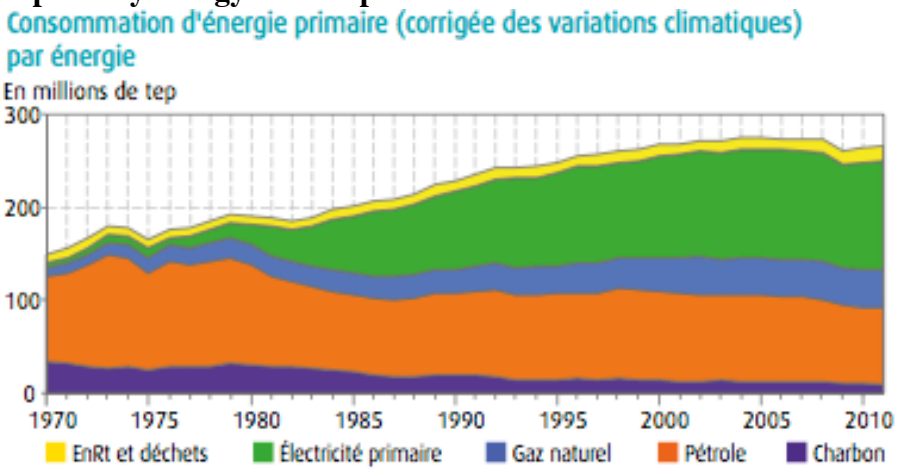


Fig 58: France: primary energy consumption 1970-2011



The growth foreseen by the DGEMP is not taking place due to the increase in the price of oil and because the contribution of renewable energy (including waste in yellow) is always weak. There was a peak in 2005 followed by a decline at 2.3% in 2012.

The national debate of the current energy transition did not issue any forecasts. The request by ASPO FRANCE to participate in the national debate has not elicited a response. The Quai d`Orsay (CAPS) has published a very debatable note "*The Climate, Innovation and the Oil Peak - the Good, the Bad and the Ugly"* signed by Justin Vaisse, claiming that the prophecy of the peak oil is a non-scientific thesis (energetic chiliasm). P.R. Bauquis has not succeeded in having a meeting at the Quay d`Orsay, and I sent a registered letter in the name of ASPO France on 24th June, but there was no response.

The peak of petroleum production in the North Sea (as in France and in many other countries) is a fact, not a theory.

Energy prices

Fig 59: Oil price 1860-2003: BP review 2004

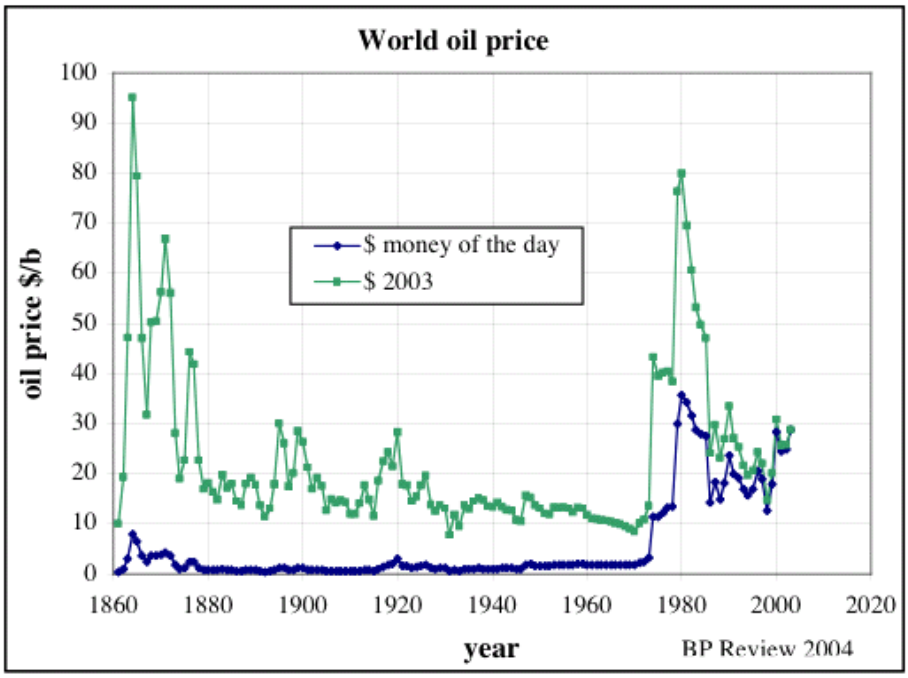
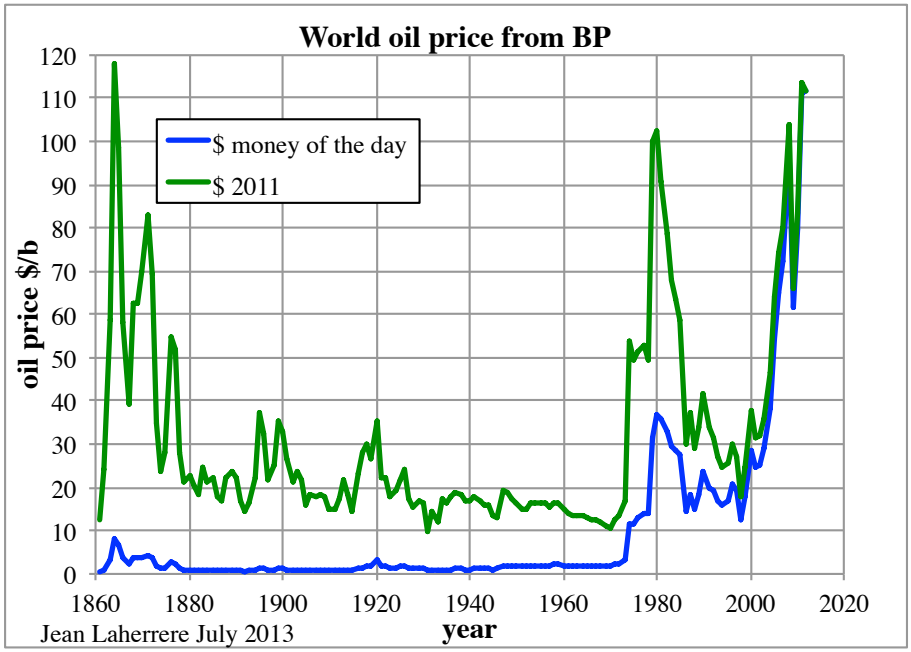


Fig 60: Oil price 1860-2012: BP Review 2013



In 2004, the official organisations had not foreseen the surge in oil prices. The contents of the article - *The End of Cheap Oil* (Campbell and Laherrere) - in the Scientific American of 1998 - was ignored. In 2005, the price exploded. According to BP 2013, past prices were as follows: $118 in 1864. $103 in 1980 and $112 in 2011, quoted in 2011 dollars. But the adjustment based on inflation is not the best indicator. It is necessary to relate the cost of oil to the cost of, say, a haircut or the SMIC (French minimum wage). It took 25 minutes of work at the SMIC in 1960 to buy a litre of gasoil (diesel fuel) TTC, 12 minutes in 1970, 10 minutes in 1980, 6 minutes in 1991 and 9 minutes in 2012. By contrast to buy a barrel of oil, it was necessary to work 11 hours in 1981, and 9 hours in 2012. In constant 2011 Euros, adjusted for inflation, the price of gasoil was 0.7 in 1971, 1.1 in 1985, 0.7 in 1991, and 1.3 in 2011. The share of energy in a household budget in France was 9% in 1970 and was still less than 7% in 2011.

Fig 61: Number of minutes at SMIC to buy one litre of diesel 1960-2012

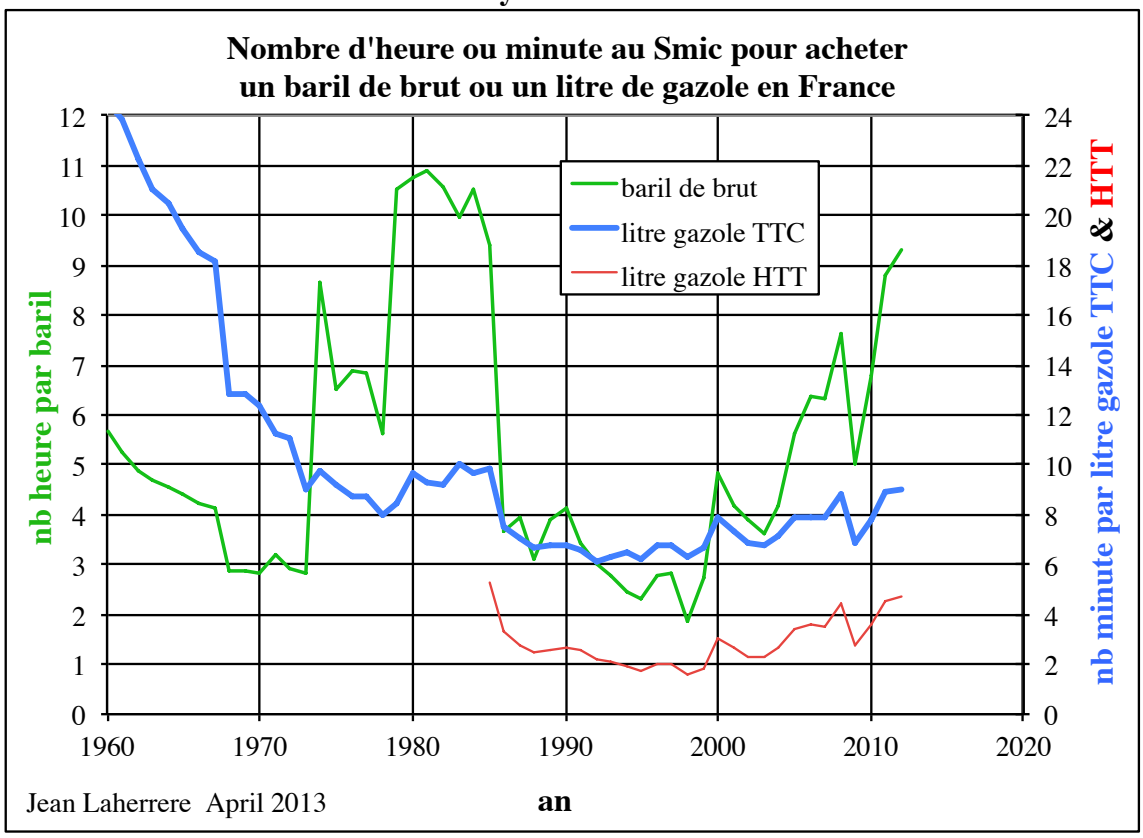


Fig 62: Fuels price at service stations 1970-2011

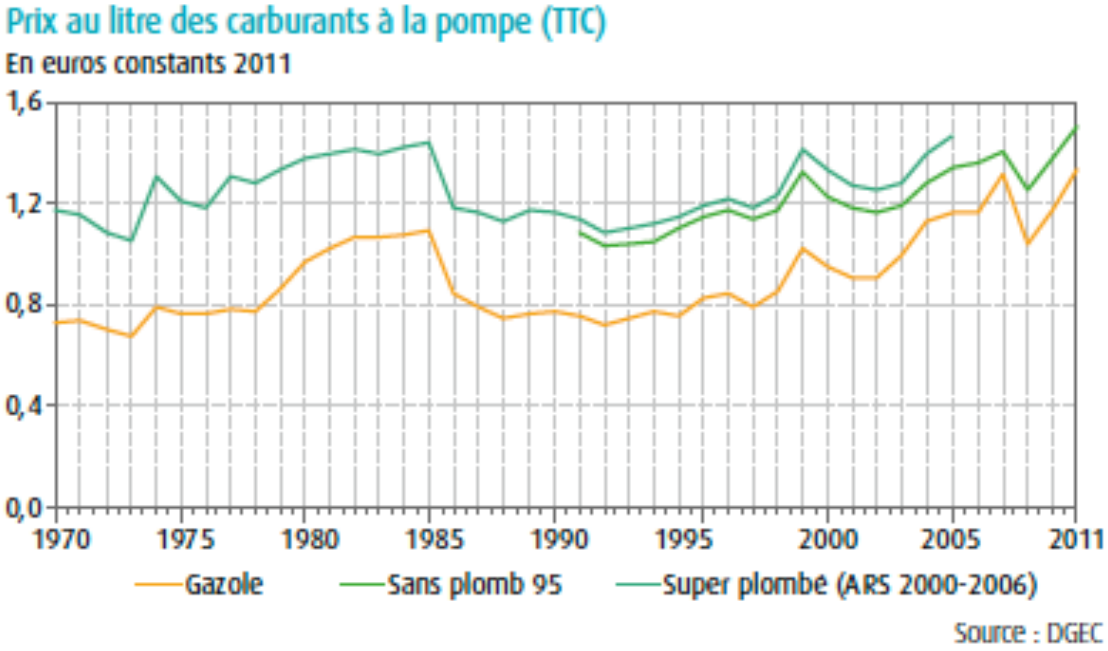


Fig 63:France energy percentage household budget = 10% 1973, <7% 2011

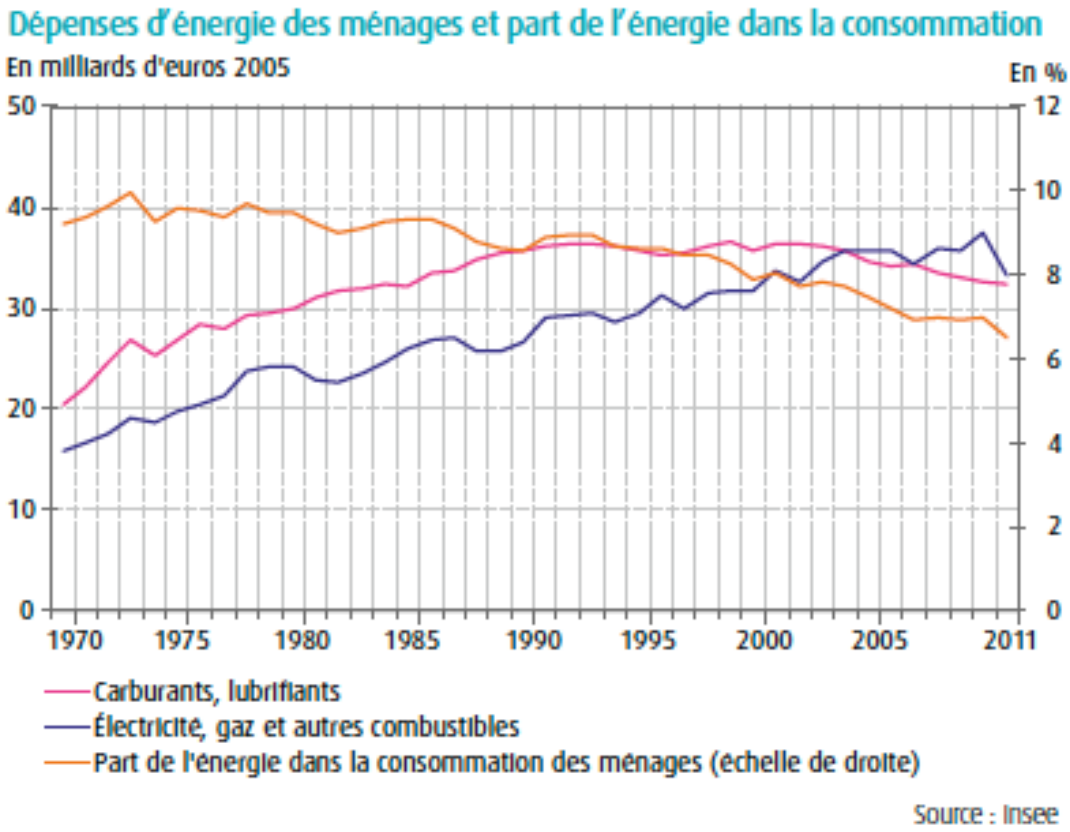


Fig 64: Always wrong forecasts on oil price by USDOE/EIA 1983-2001

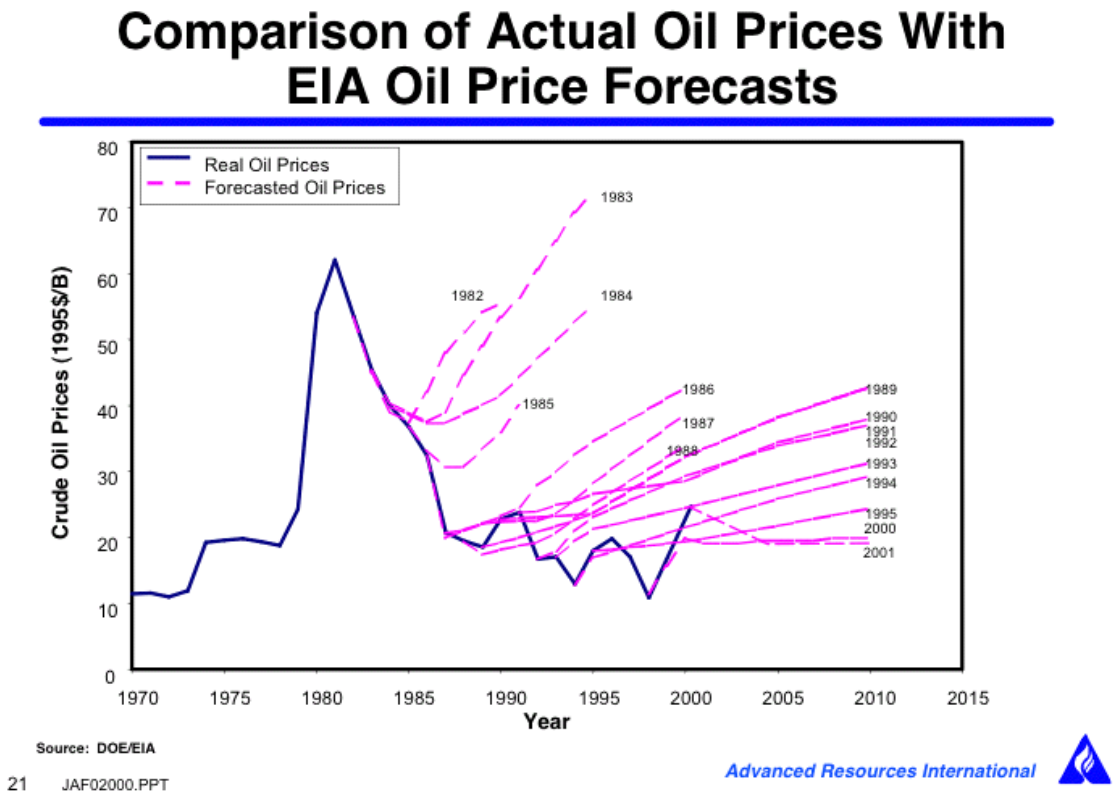


Fig 65: evolution of oil price forecasts USDOE 1986-2013

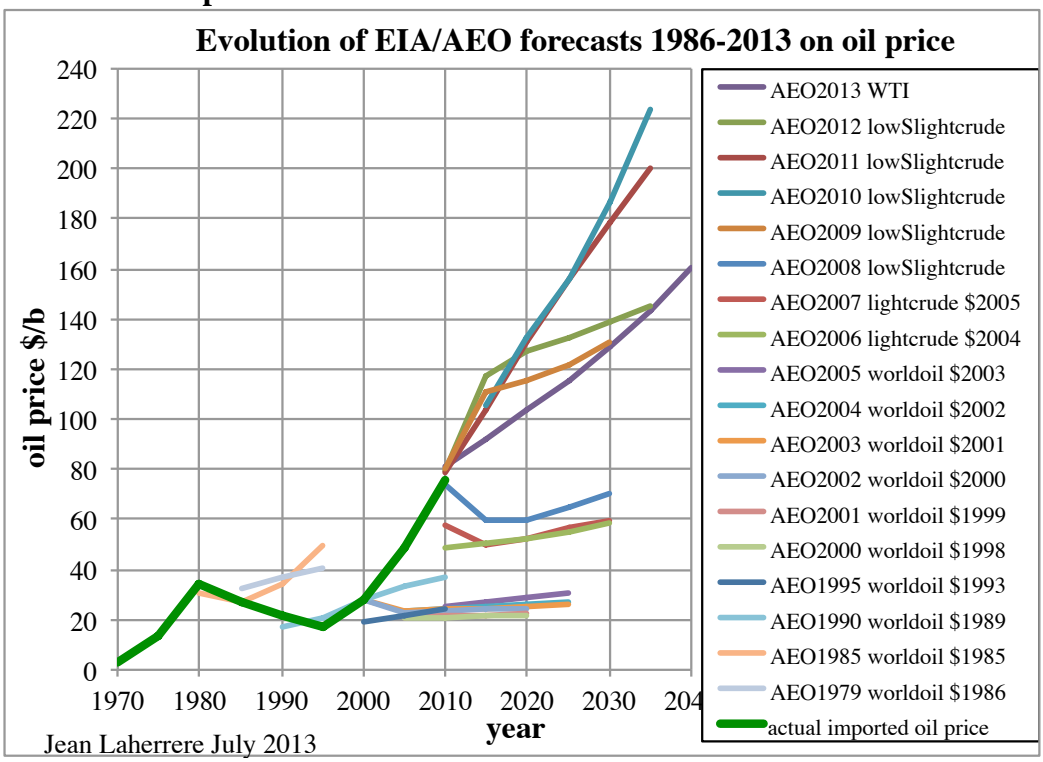
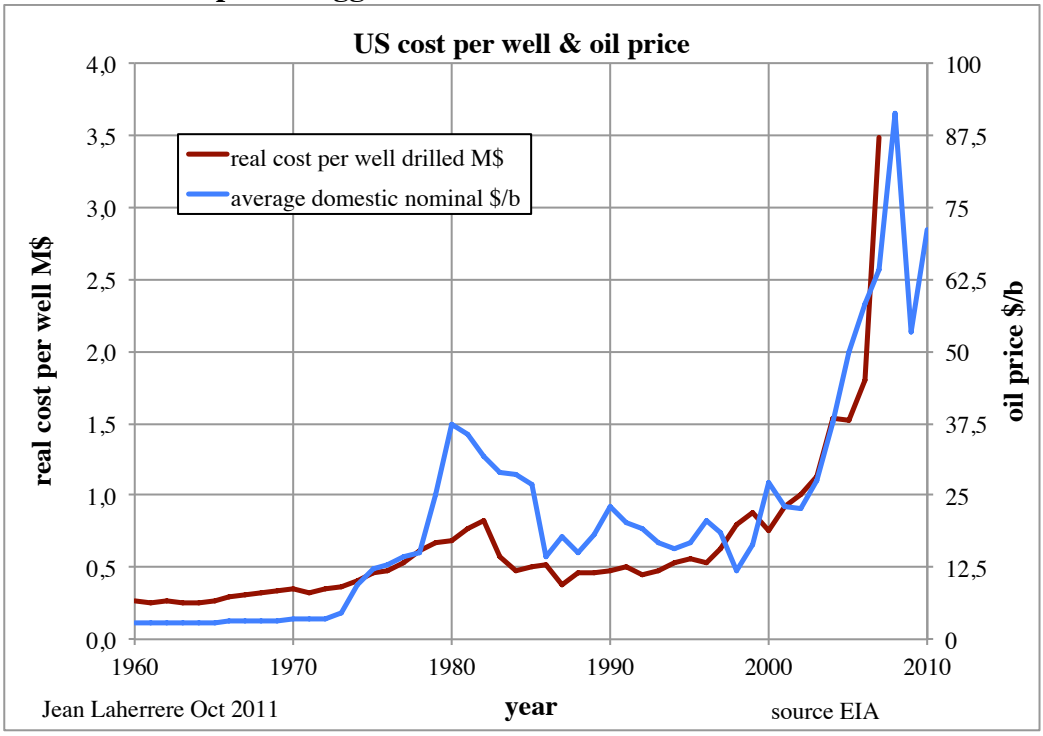


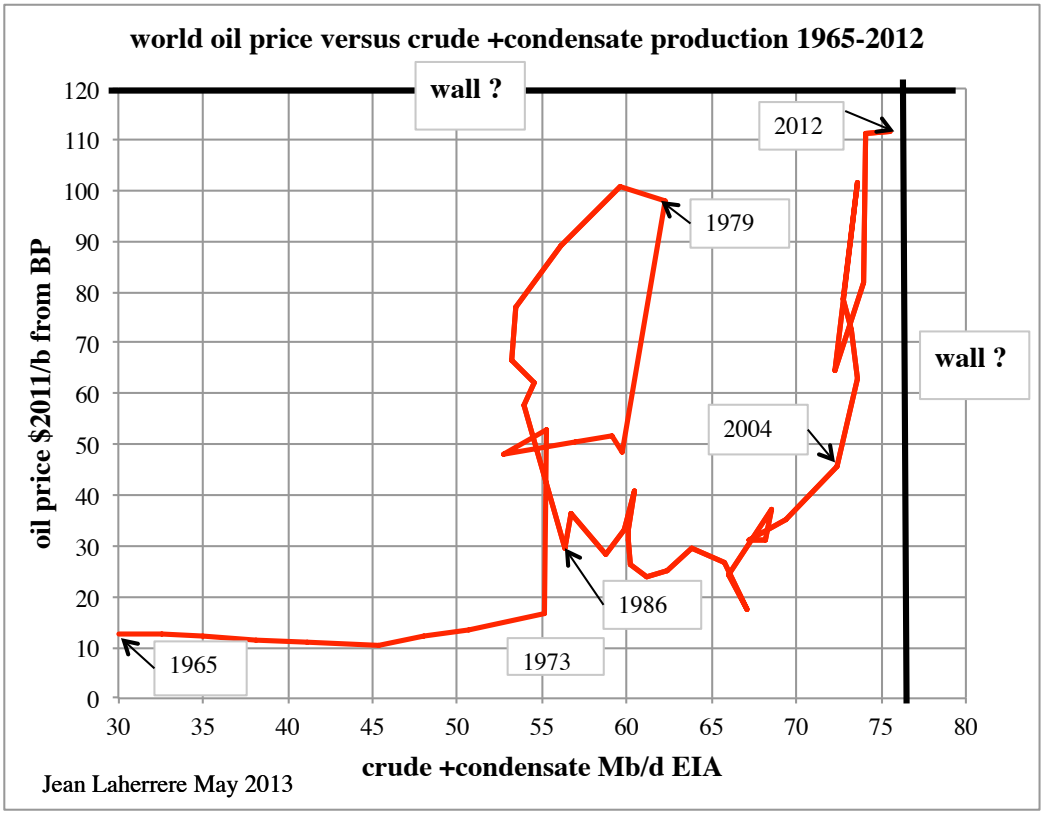
Fig 66: The cost and oil price = egg & chicken



The graph showing the price of crude (based on BP in $2011) against world production indicates that the curve appears to reach a wall or ceiling at 120 $/b or 77 Mb/d.

Of course, in the future the actual price might pass the platform due to inflation, recognising the difference between official manipulated numbers and real data.

Fig 67: Is there a ceiling for price (120 $/b) or a wall for crude oil (& condensate) production (77 Mb/d)?



The Scandal of Diesel fuel

Refineries produce a both gasoline and diesel in proportions depending on their facilities and the nature of the crude used.

Diesel is heavier than gasoline and contains 7% more energy by volume. Diesel vehicles consume less than gasoline-powered vehicles due partly to their better performance and because their fuel has a higher energy content (car sellers forget to say so!).

Fig 68: Refinery cut of the barrel (API) US, Europe & Japan

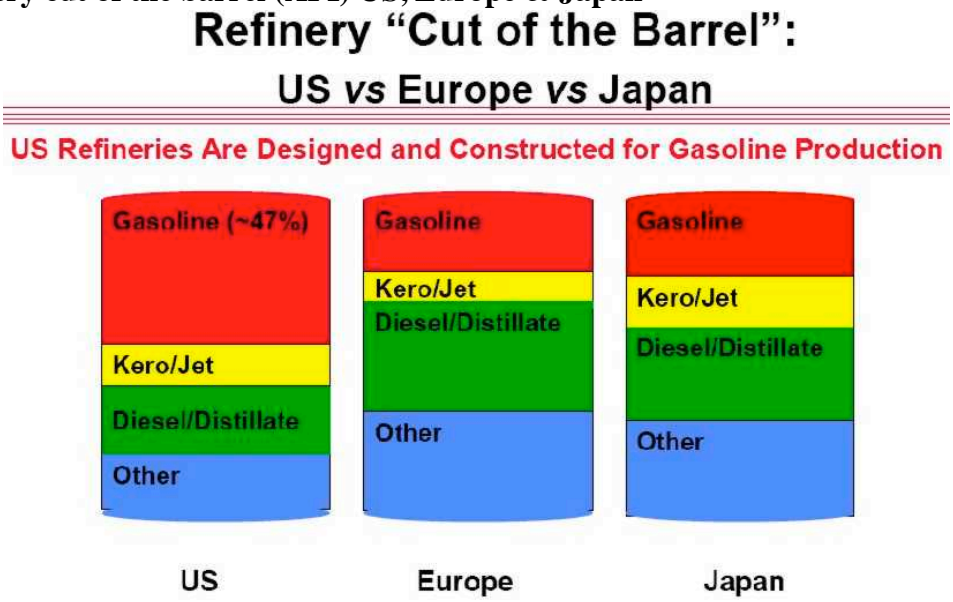
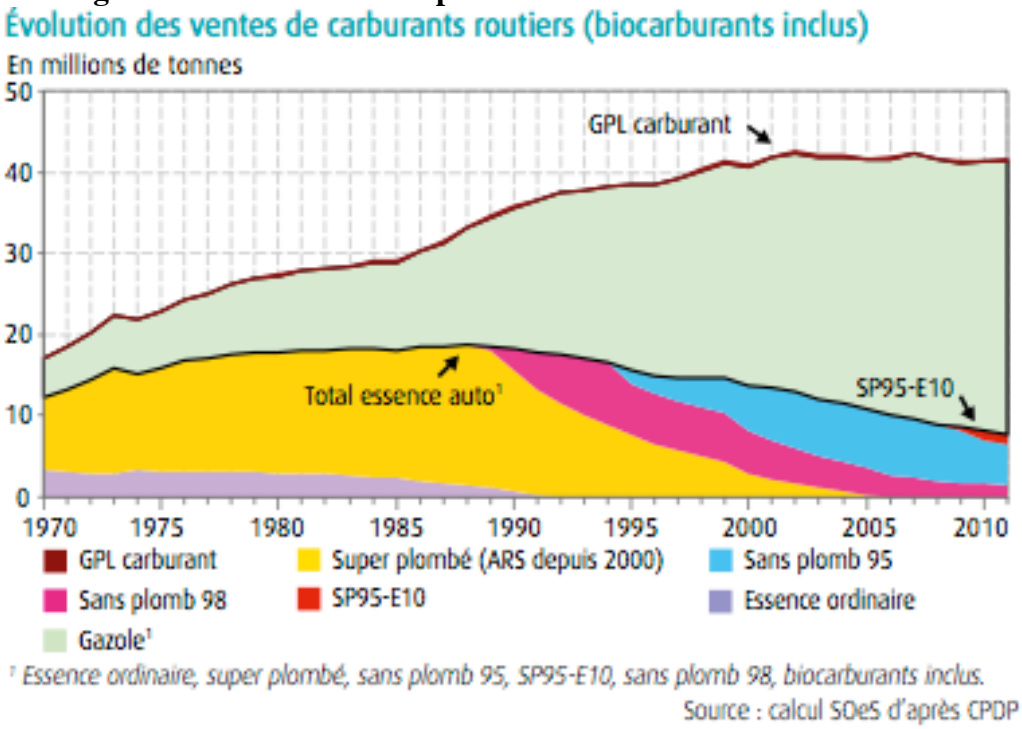


Fig 69: France:gasoline & diesel consumption Mt



The consumption of fuel by car and trucks has been on a plateau since 2003, but the consumption of diesel has increased. This is principally due to the fact that taxes are lower on diesel, being 0.52 €/L quoted in 2011$ (57%) whereas they are 0.73 €/L on gasoline (49%), but the price from refineries in Rotterdam is less on gasoline at 0.53 €/L than on diesel at 0,58 €/L.

In the United States, the taxes are at 12% on gasoline and 13% on diesel, and logically diesel is sold at a higher price than gasoline.

The comparison of the price percentage is as follows

	France (UFIP 2011)			United States (2013 EIA)	
	gasoline	diesel		gasoline	diesel
Crude	34%	38%		66%	62%
Refinery	2%	6%		12%	9%
Marketing	7%	7%		11%	16%
Taxes	57%	49%		12%	13%
Price €/L	1.5	1.335	$/gallon	3.63	3.85

In France, the peak of gasoline consumption was in 1987 and the peak of diesel consumption may follow in 2015.

The price ratio between diesel and gasoline was 0.76 in 1986 and fell to 0.66 in 1989 when it increased to 0.7 in 1995 as the Senate demanded fiscal equality within ten years.

In fact the calorific value in volume is 1.07. The best was in 2008 at 0.97 since when it has fallen to 0.89.

Fig 70: France: fuels consumption 1947-2012

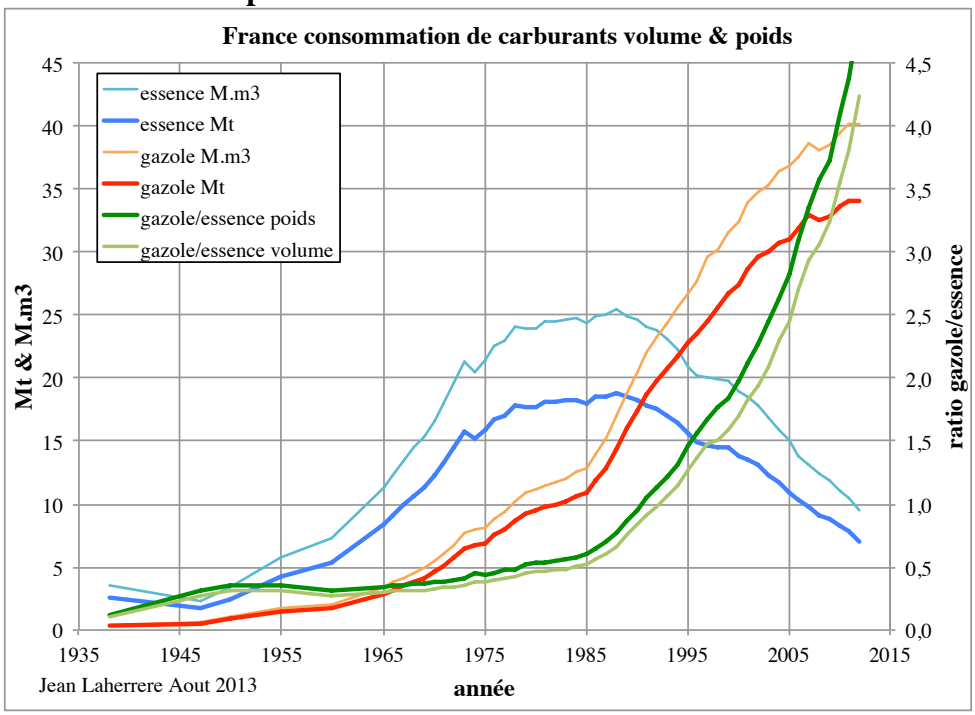
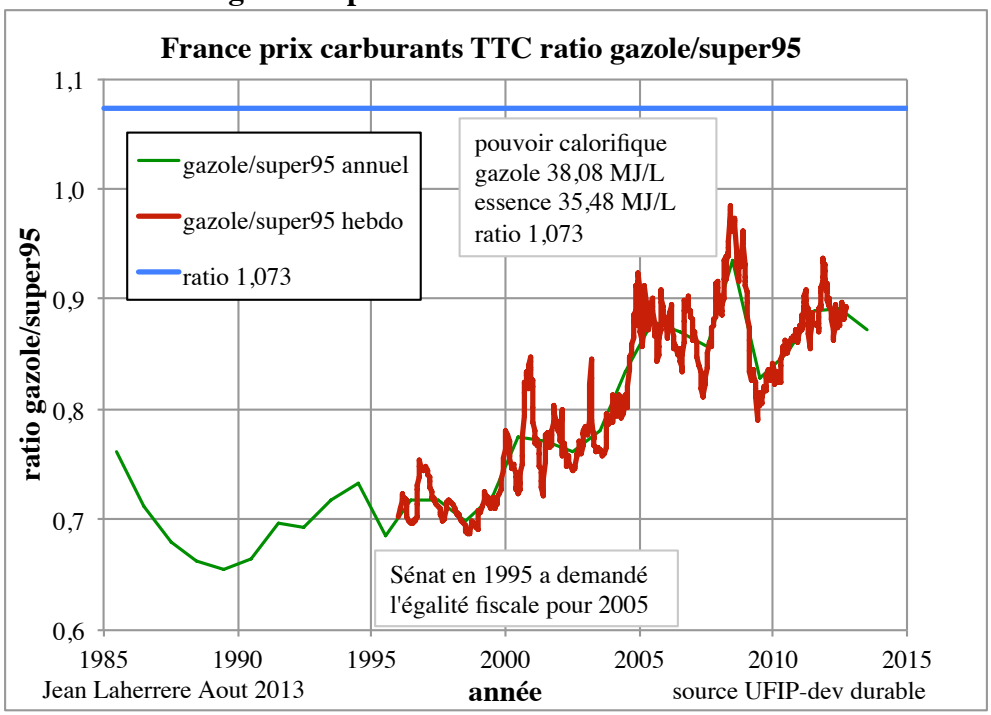


Fig 71: France: ratio diesel/gasoline price all taxes



In 2012, the fiscal subsidy for diesel was 11 G€. The Press speaks of 7 G€, but ignores the relative calorific values

The ratio in the price of diesel to gasoline varies over time and place, being 1.2 to 0.7 for seven countries according to the IEA, with France having the lowest.

In France, the all taxed fuels price is compared to Rotterdam refinery price, as the Brent price

Fig 72: Ratio prix diesel/gasoline price for some countries

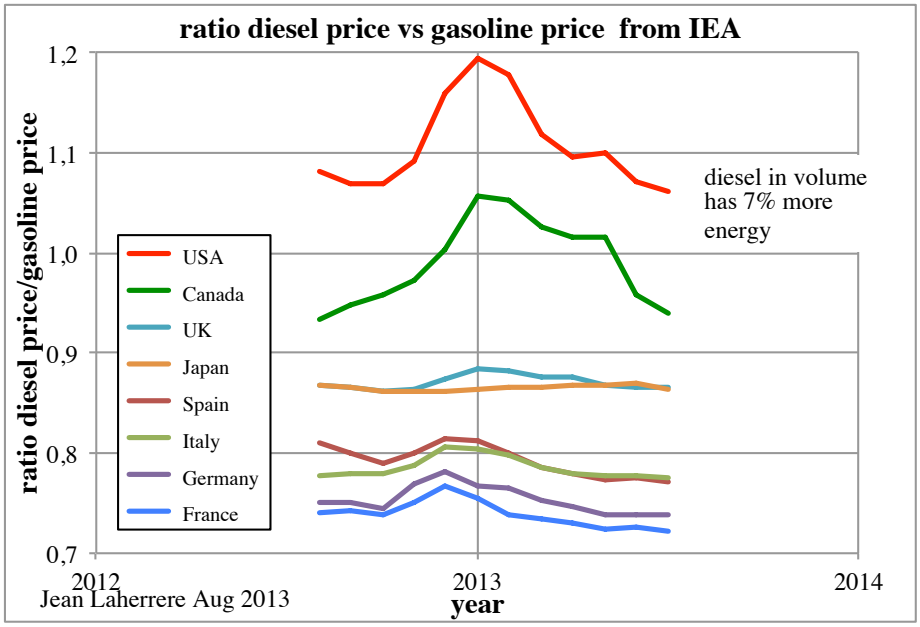
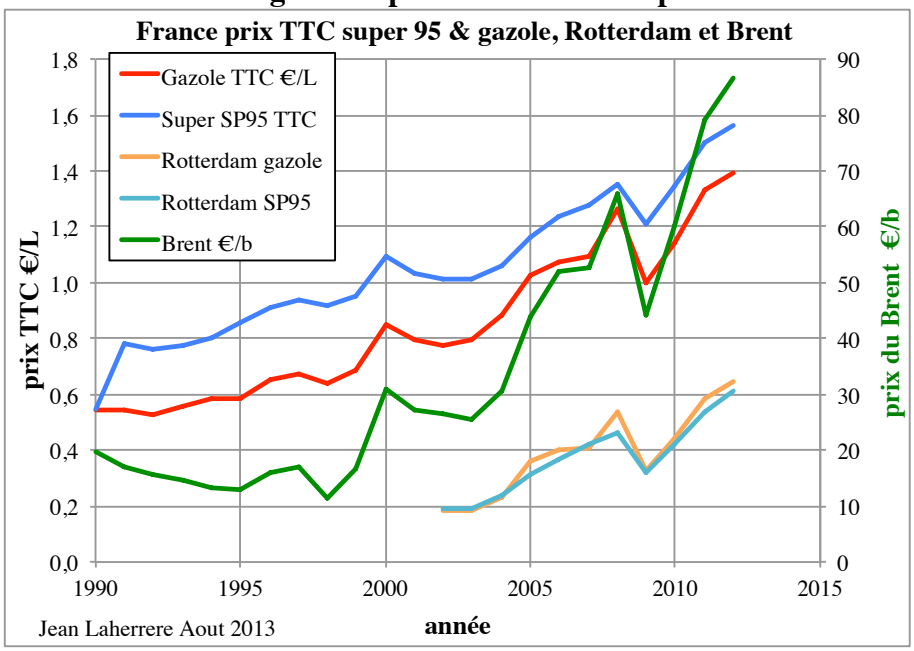


Fig 73: France: all taxes diesel & gasoline price & Rotterdam price



The ratio of taxed price of France gasoline, diesel and fuel oil against the Rotterdam price has reduced since 2009 to 5 at 2.8 in 2012 for gasoline and 3.3 at 2.8 for diesel but has been practically flat for a year and a half. The consumption of diesel has increased since 1990 from 18 Mt to 34 Mt but the consumption of gasoline has declined from 18 Mt to 7 Mt.

The fiscal loss, which was 1 G€ in 1990, has increased to more than 10 G€ in 1998 and the cumulative fiscal loss is 200 G€.

But all our governments, trades unions and political parties have carefully failed to mention this gigantic fiscal trick. The government desperately searches for money but diesel is sacred (truck drivers and diesel car makers Renault & Peugeot/Citroen) and yet one continues to affirm that equality is a priority for our country.

Fig 74: France: ratio price: gasoline, diesel & fuel oil versus Rotterdam

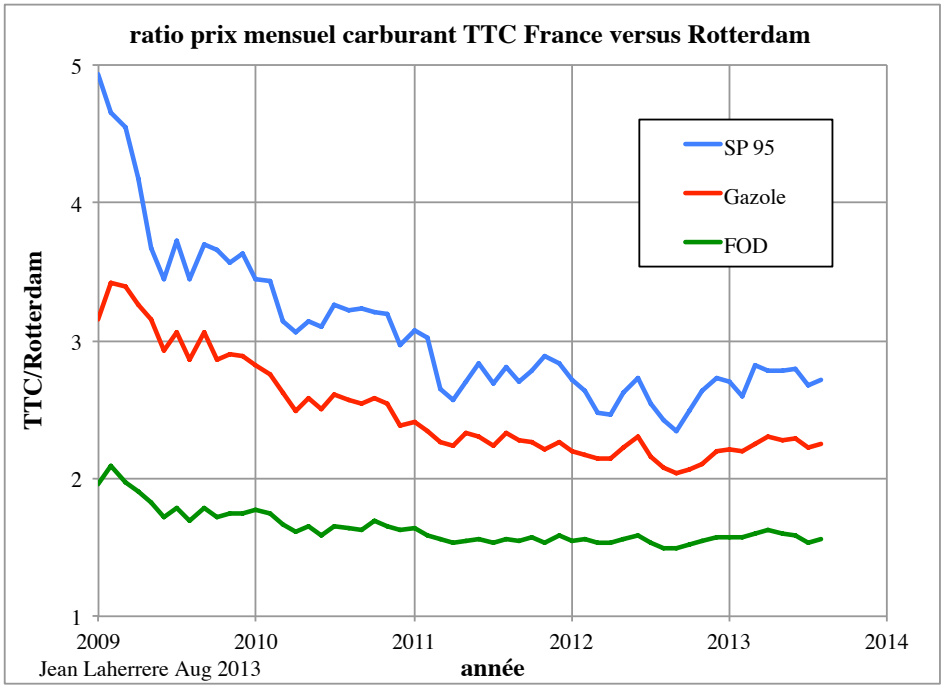
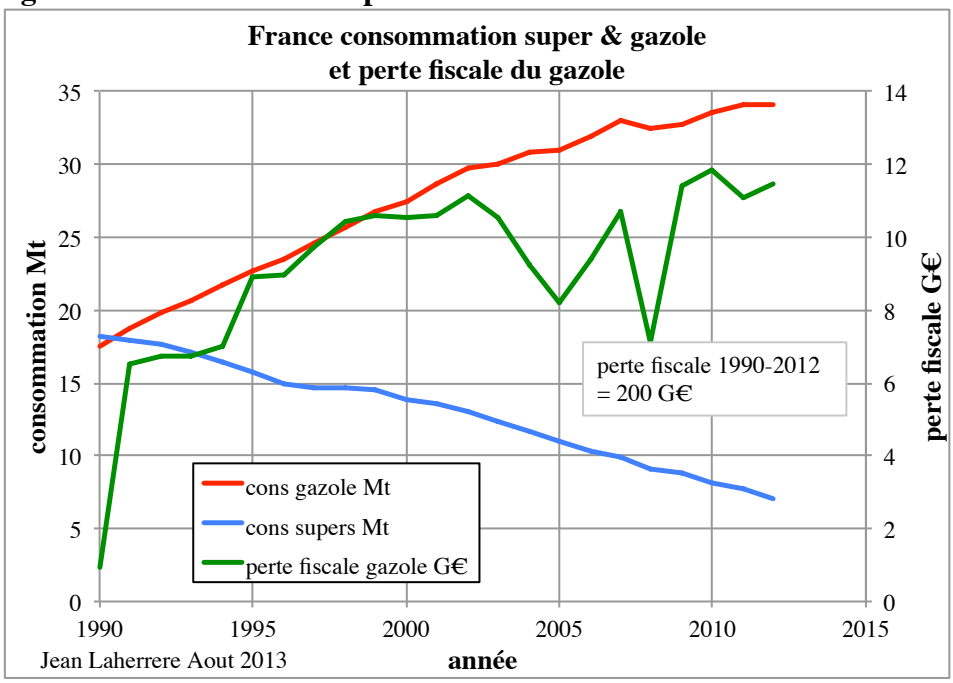


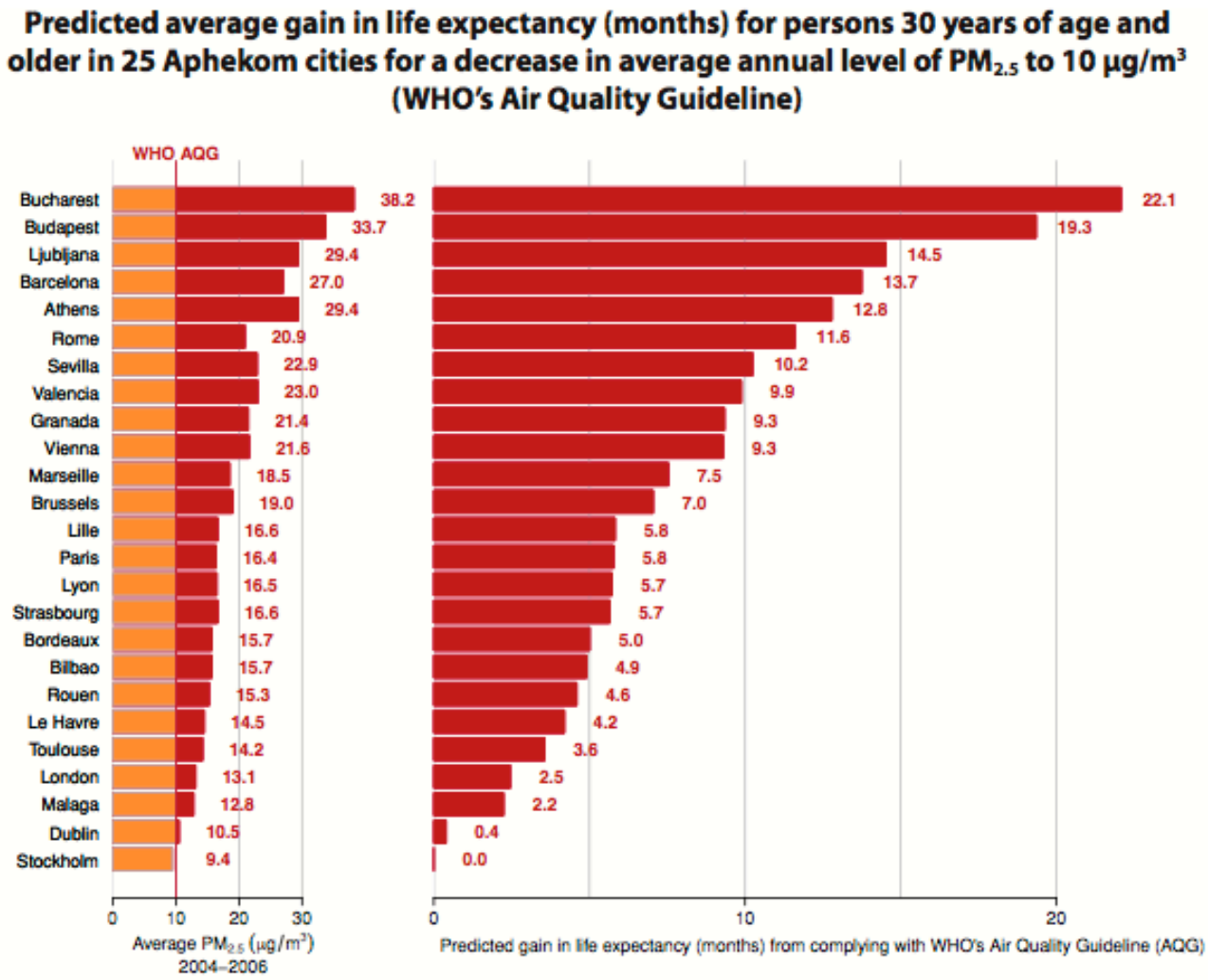
Fig 75: France gasoline & diesel consumption and fiscal loss



In 1996, the Deputy, Laurent Dominati, spoke of the annual death rate in Paris from 260 to 350 due to diesel fuel pollution. Today, the WHO speaks of 42 000 deaths in France. It is surprising to find that the Green Party is very active on the issue of GMO and carbon dioxide, which has never killed anyone being minor in relation to diesel pollution that shortens the life of the French.

Aphekom in 2008 to 2011 indicates that the Parisians would gain six months of life expectation if the PM 2.5 were reduced to10 μg/m3 whereas those in Marseilles would add eight months. Brussels has criticised France in relation to 16 towns but the government has long failed to react to the impact of gasoil in the belief that Brussels is always wrong.

Fig 76: Aphekom study: predicted life expectancy in 25 towns



Population

The production of energy per capita calls for the study of population forecasts.

All population forecasts are based on fertility rate forecasts

Fig 77: World: fertility rate & woman education in 2004

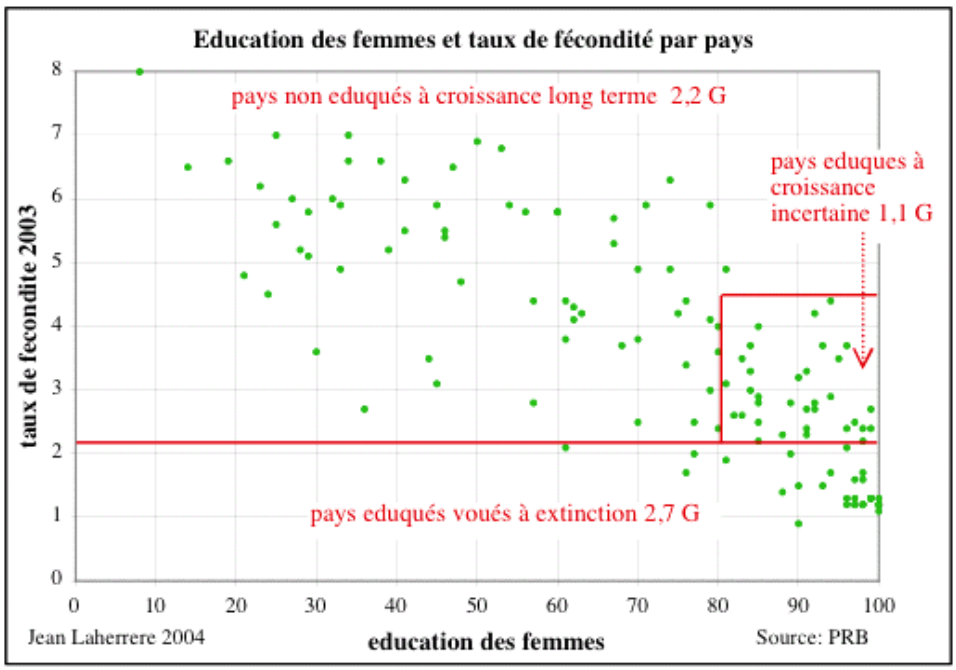
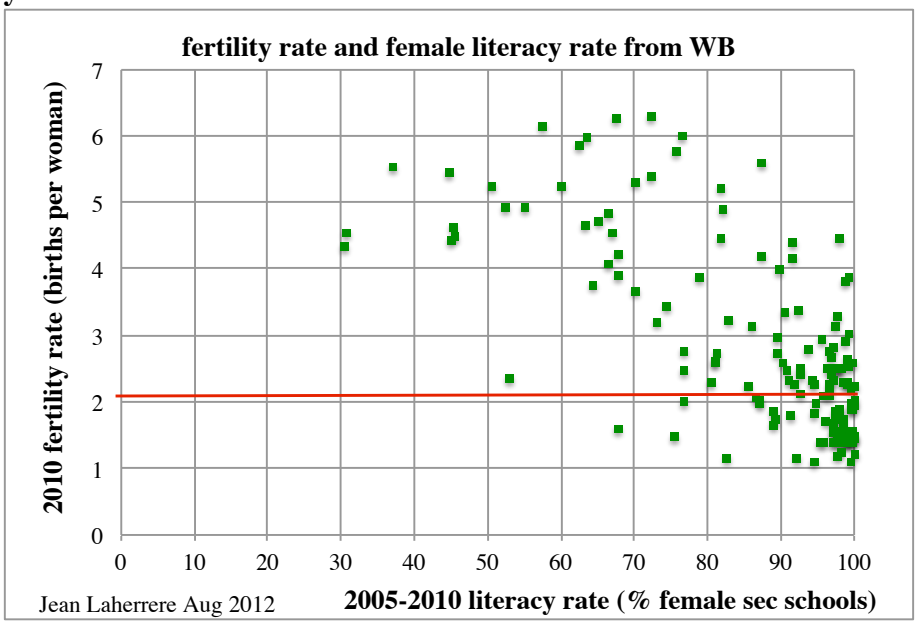


Fig 78: fertility & woman education in 2012



The world is divided into two with the fertility below 2 or higher than 5. The two worlds are always there: the educated move towards the extinction and the non-educated will survive.

The United Nations forecasts of population are based on the pious view that the long-term fecundity of all nations will be the same and equal to the replacement rate of 2.1 children per woman. The Taliban countries are far from this when they kill and mutilate girls going to school.

In 2004, the peak of population was forecast to arrive during this century but the rate of growth has fallen since 1990, although being flat since 2000.

From 1998 to 2012 the forecast of the world's population by 2100 has increased by 1.5 billion, with 2 billion living in Africa.

Fig 79: World population & forecasts in 2004

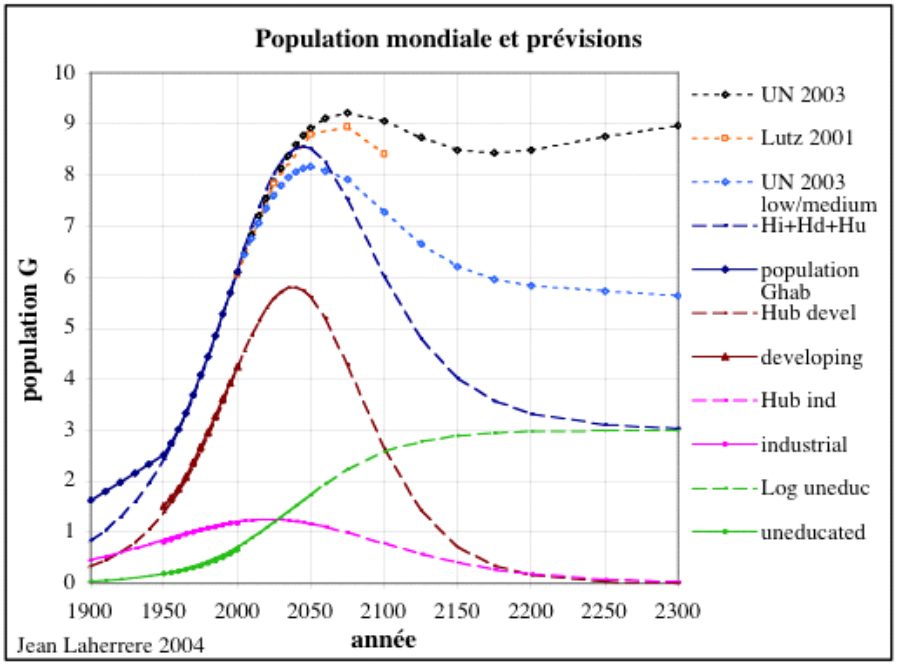


Fig 80: World population annual growth in 2012

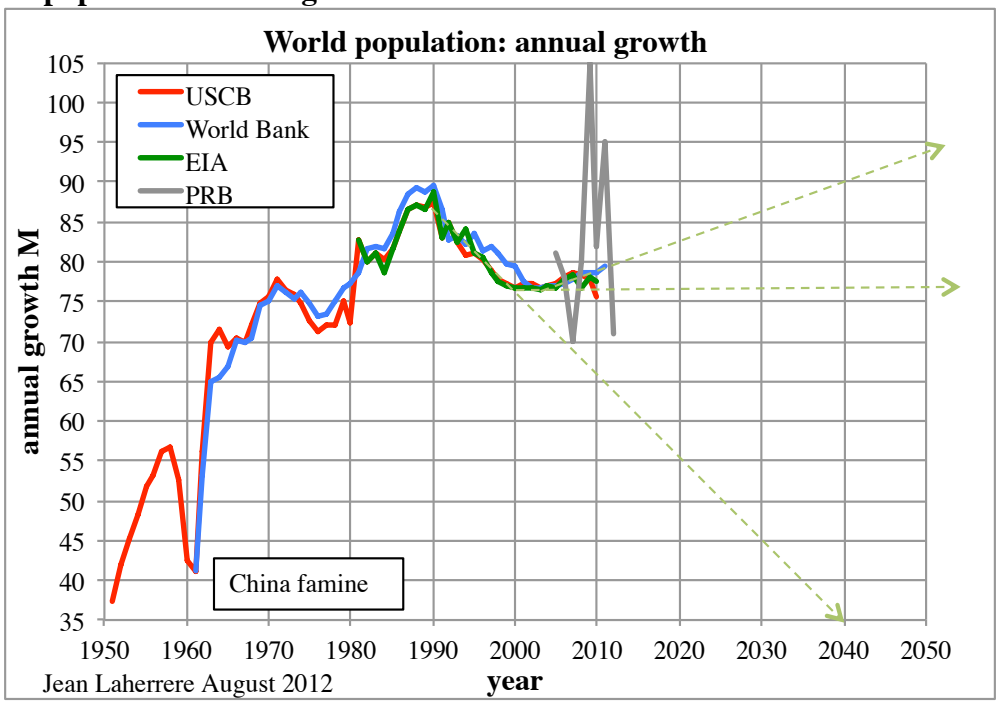
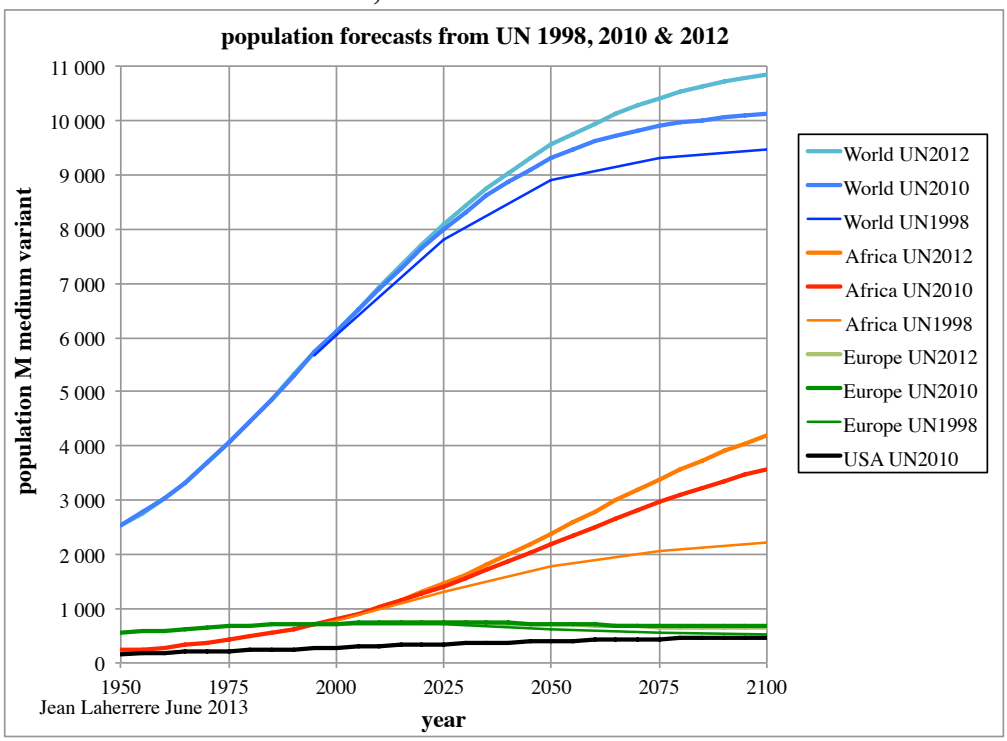


Fig 81: United Nations forecasts: 1998, 2010 & 2012



The forecasts for France have varied.

In 2001, the forecast peak was 2025, but in 2006 it moved to 2050 on the assumption that immigration would increase from 50 000 to 100 000, that fertility would increase from 1.8 to 1.9 children per woman, and life expectancy fall from 87.7 to 86.4 years.

Fig 82: France: population & forecasts in 2004

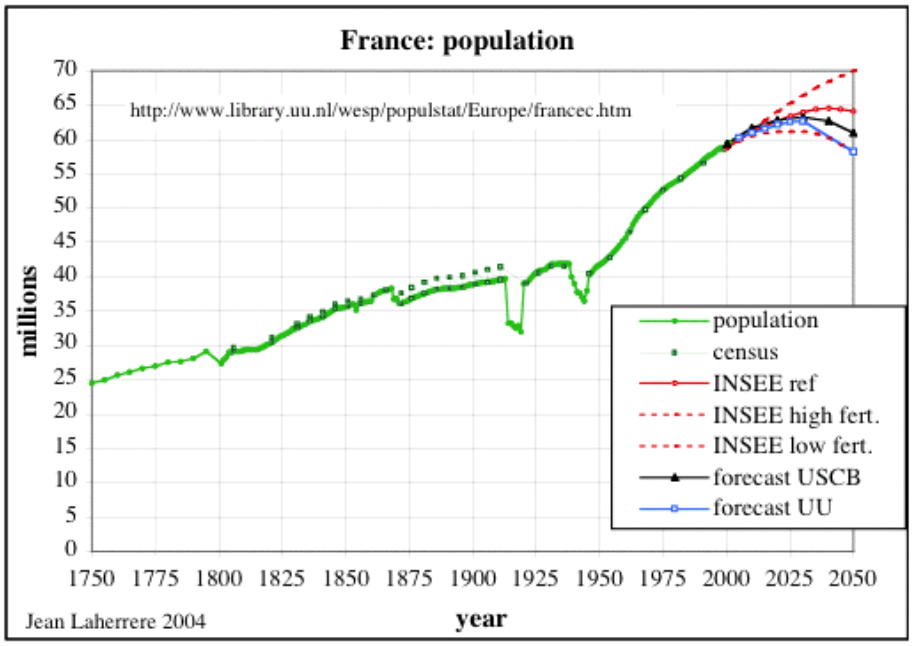


Fig 83: France population forecasts 2001 & 2006

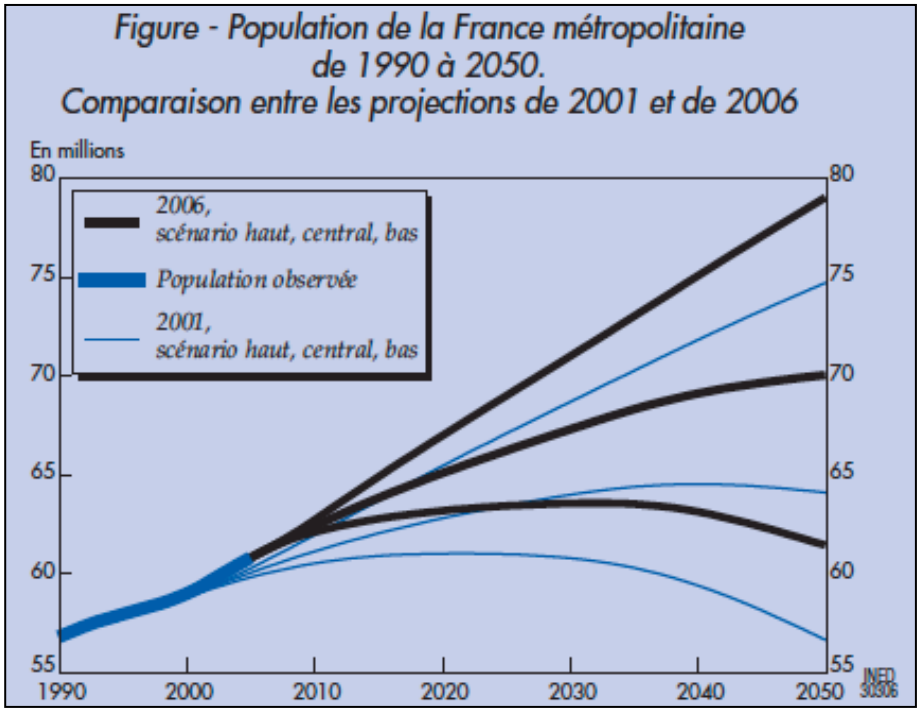


Fig 84: Difference in immigration, fertility, life expectancy

Révisions des hypothèses du scénario central entre les projections de 2001 et de 2006 et conséquences sur l'effectif de la population projetée en 2050

	Hypothèse centrale		Différence		Effet total
	2001	2006	annuelle	cumulée	
Solde migratoire annuel	50 000	100 000	50 000	2 500 000	3 000 000
Fécondité (enfants par femme)	1,8	1,9	40 000	1 800 000	2 000 000
Espérance de vie (en année)	87,7	86,4			−800 000
Population en 2005	59 983 000	60 702 000		700 000	1 100 000
Effets combinés					600 000
Population en 2050	64 032 000	69 961 000			5 900 000

The population of France may reach 70 to 73 M by 2050. It had increased from 7 M by year 0 to 20 M by 1700, fluctuating with climate changes, but has tripled since 1700.

Fig 85: France: population 1750-2100

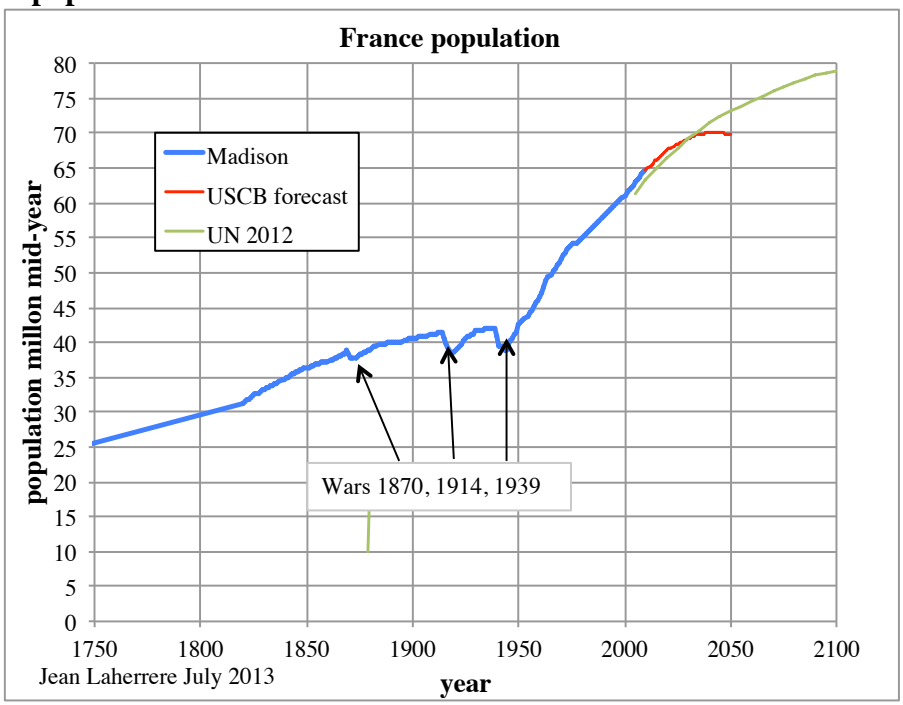
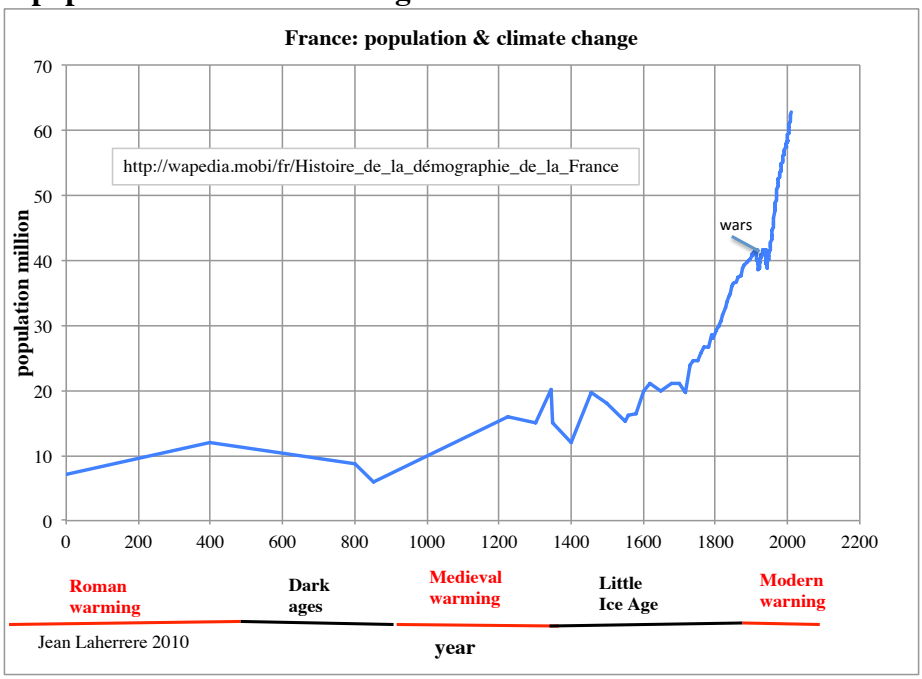


Fig 86: France: population & climate change 0—2000



The data on unemployment are weak in most countries. An article INSEE (Laroque & Samanie) in 2000 said after the 1997 inquiry that the voluntarily unemployed in France represented 57% of the unemployed, because the small difference between RMI (unemployment) and SMIC (minimum wage). There was an outcry, and the subject has since been censored in France. So, it is not possible to make accurate estimations but everyone knows of unemployment in his region and how many workers are illegal. Cahuzac had cheated, but how many people do not report working (under the table) and how many people employ them?

The inquiries are non-existent or weak. The same is true for offers of employment. We lie by omission.

In 2004, the population of Russia was in decline following a peak of 149 M in 1993, and is forecast to fall to 120 M by 2050. The population of Germany had a peak in 2004 at 84 M and will pass below those of France and the United Kingdom by 2050 to match Italy by 2100.

The population of Italy will peak in 2020 at 61 M and will slowly decrease to 57 M in 2100.

Fig 87: Russia: population 1900-2050 in 2004

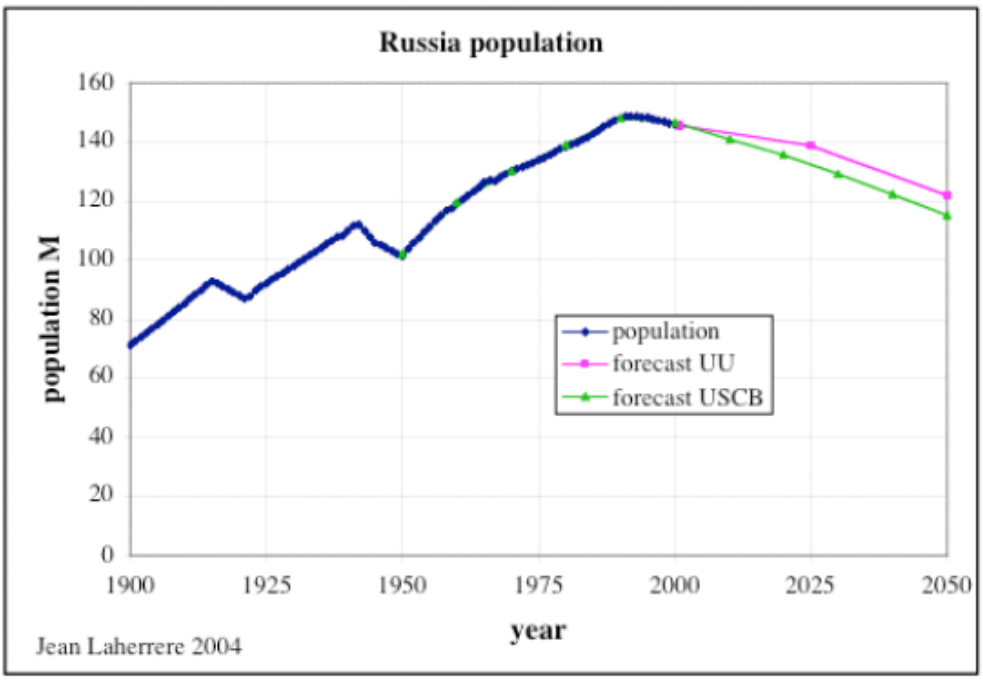
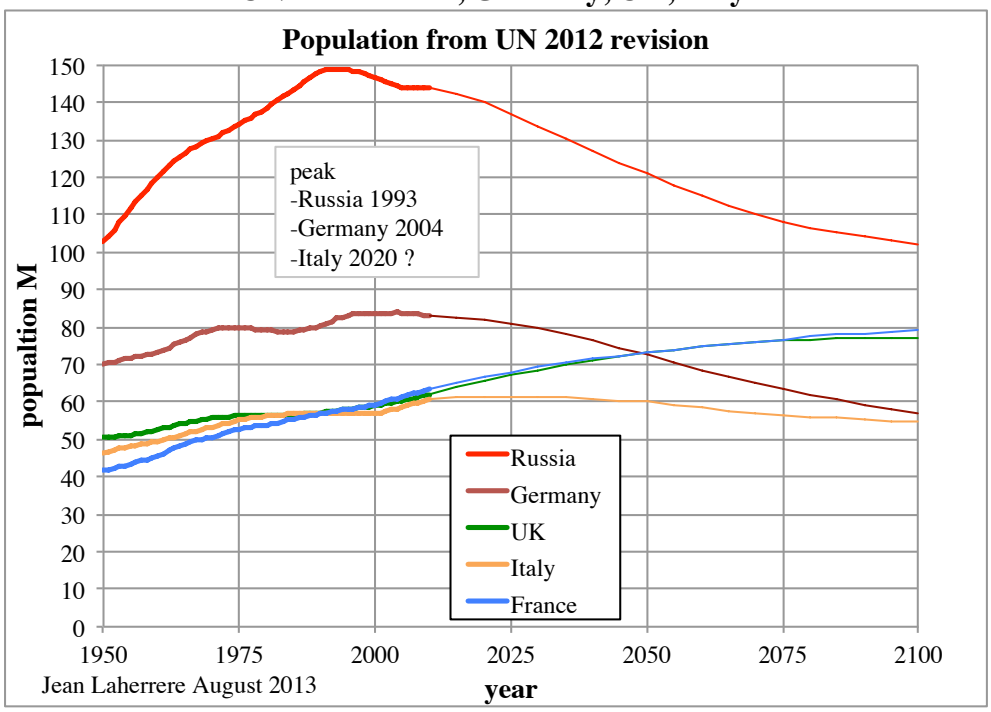


Fig 88: population forecasts UN 2012 Russia, Germany, UK, Italy & France



In 2004, the peak population of Europe, which had been forecast for 2000, is expected by 2025.

In 2004, the populated of the United States was forecast to reach 450 M by 2100, but is now thought to exceed 500 M.

Fig 89: Europe et North America: population & forecasts in 2004

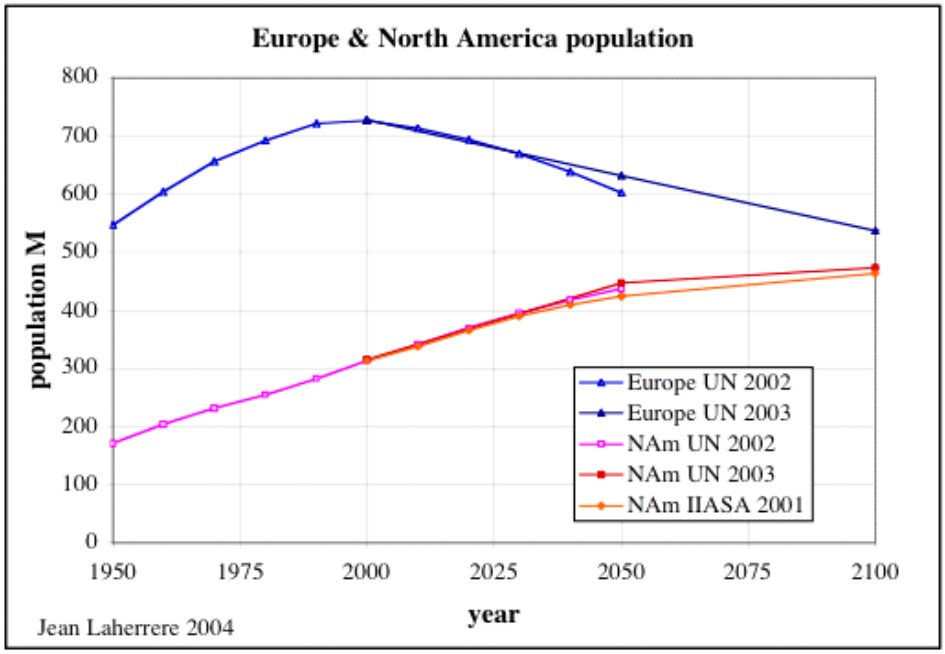
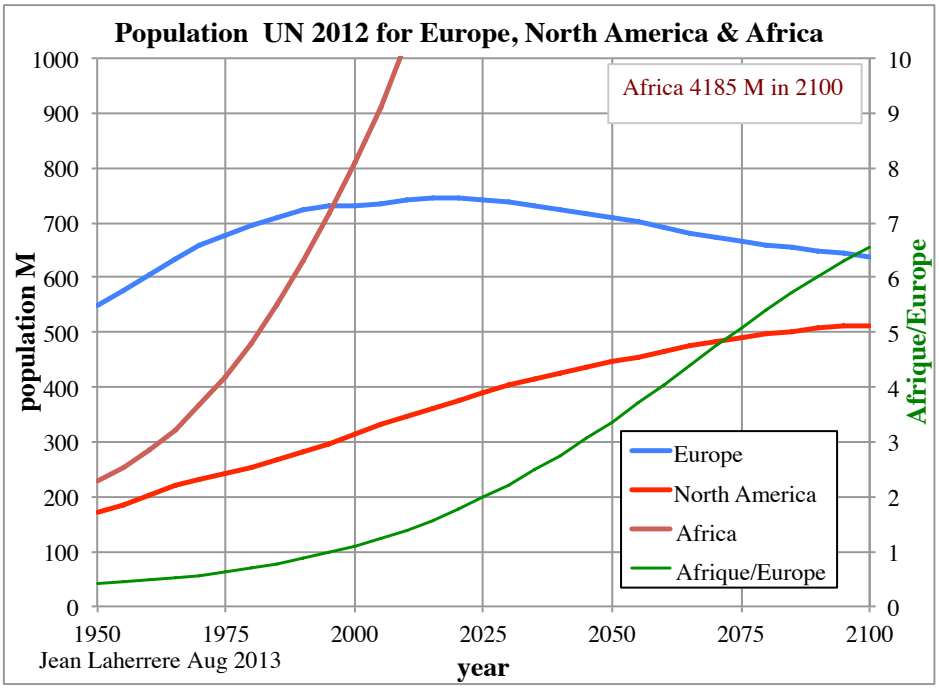


Fig 90: Europe, North America & Africa UN 2012



How can we speak of durable development in Europe when the population is in decline? But Africa, which passed Europe in 1997, will be seven times larger by 2100. Africa will have to invade depopulated Europe. The United Nations forecasts will have to be changed when one continent invades another – It is a new *Out of Africa*.

The demographic problems seem to me more important than those of resources, but the data are weak, and the subject is politically incorrect

Climate Change

We live in an interglacial period. The change is regulated by Nature, and it is an illusion to try to stabilise climate change, see Fig 33.

There are numerous astronomical cycles: for example the Milankovitch cycles (elliptical trajectory of earth, obliquity of earth axis and precession of equinoxes) as well as solar activity (sun spots giving a Little Ice Age = Mander minimum). There are numerous solar cycles, giving the day, the year, eleven-year cycles, and many others, up to the 200 million year cycle (our sun in our galaxy), but the most visible is that of 60 years, shown in particular on the energy of cyclones in the

Atlantic (ACE) which have been measured simply on the basis of wind velocity and duration since 1850 and the 1500 year cycle found in temperatures, giving maxima (called optimum) in Roman and Mediaeval times.

Fig 91: Cycle 60 years: Accumulated Cyclone Energy

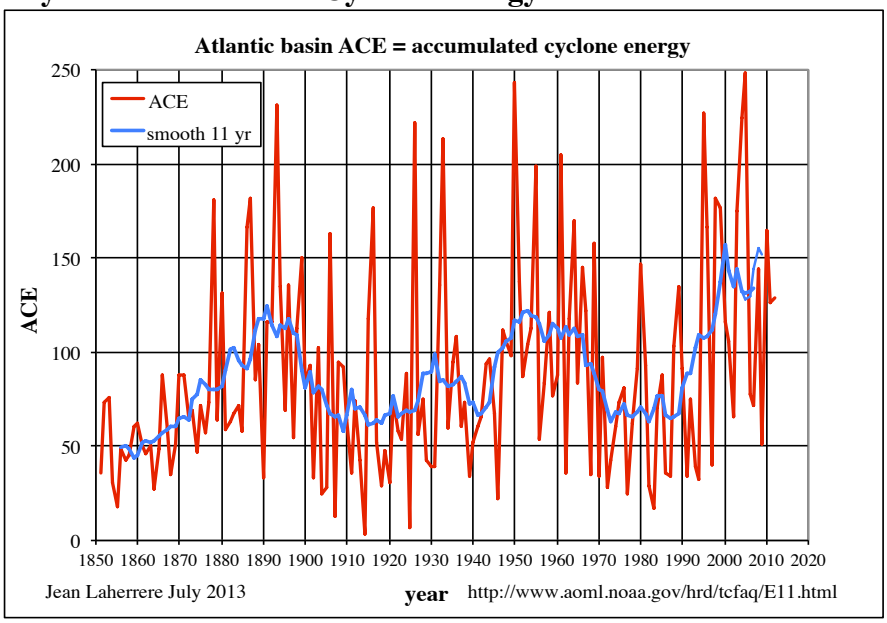
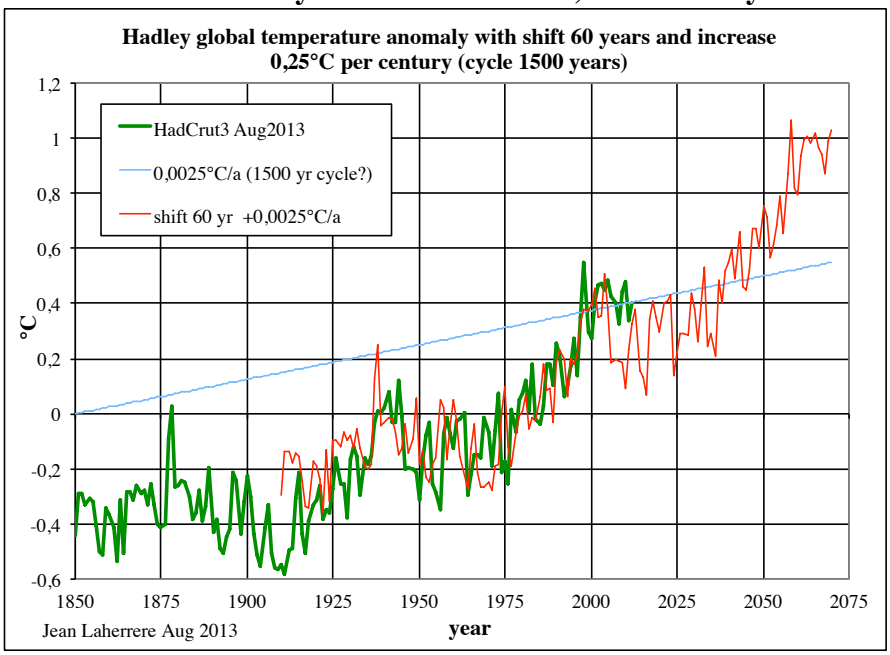


Fig 92: temperature model with 60 yr shift & increase 0,25°C/century



I defy anyone to find a simpler method to forecast world temperature over the next decades. It combines the shift by 60 years of the average of temperatures measured since 1850 (Hadley) and in addition 0.25 °C by century to represent the 1500 year cycle since the Little Ice Age. The model (Figure 92 in red) shows a good correlation for the 1910- 2010 period comparing the actual (green). It is on the basis of this model that I bet that the temperature will not increase over the next ten years (this bet was proposed to Jancovici, Cochet, Arthus-Bertrand and I won by default).

The plateau of temperature since 1998 seems to confirm my model. It will last until 2030 and then rise again.

The GIEC is convinced that by 2100 the temperature will have increased by 4 °C due to the increase in carbon dioxide, and that life will be difficult. No one can guarantee that a reduction in carbon dioxide will reduce the temperature. The only demonstration is the climatic models but there are more than 70 models and the range is large. The IPCC models foresee a continuous increase but the temperature has been constant for the last 15 years as illustrated in the green curve in the

following figure. The models are unreliable, having to take into account cloud cover other than by feedback, when water is by far the main actor of the greenhouse gases. CO2 contributes only by 20% when clear sky, much less when cloudy.

The oldest forecasts based on modelling are those of Hansen (1988) which have three scenarios: A = same growth of CO2 emissions as the last twenty years; B = same CO2 emissions as in 1987; C = very reduced CO2 emissions for the period 1990-2000. For 2012, when the temperature was 0.4 °C, Scenario A forecasted 1.1 °C, Scenario B 1 °C and Scenario C 0.6 °C. All scenarios were therefore over-estimated for temperature when the reality of the carbon dioxide emissions is Scenario A.

Hansen 1988 forecasts are wrong for 2012 and likely to also be so for the future!

Fig 93: 1988 Hansen temperature forecasts for2012 wrong by 0,6°C

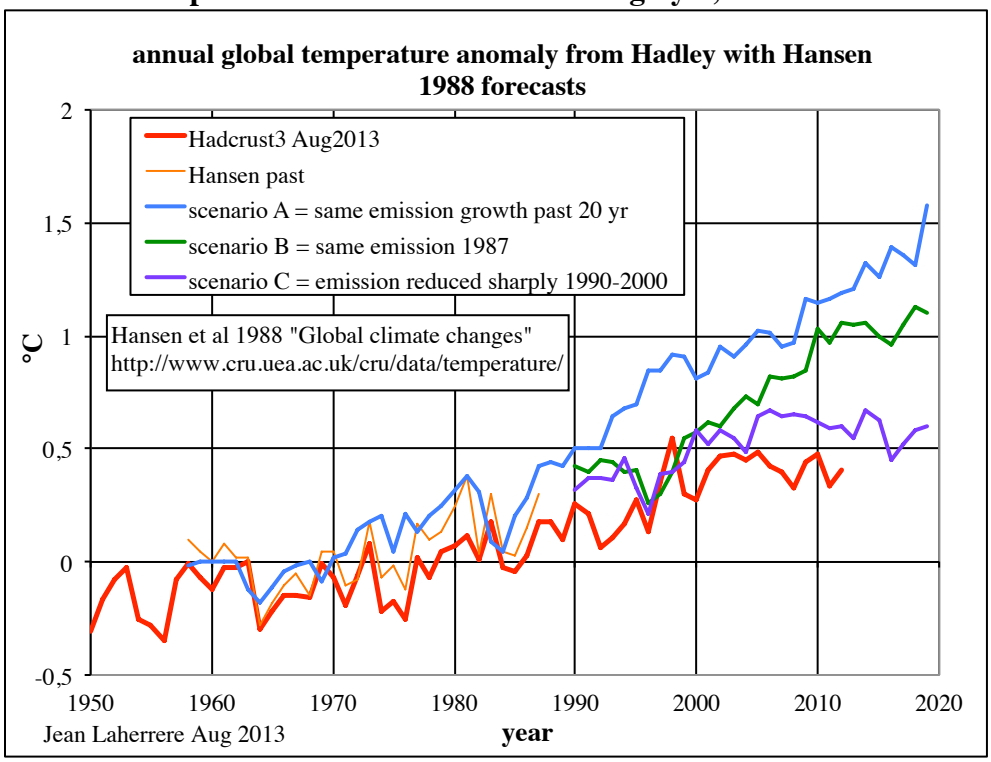
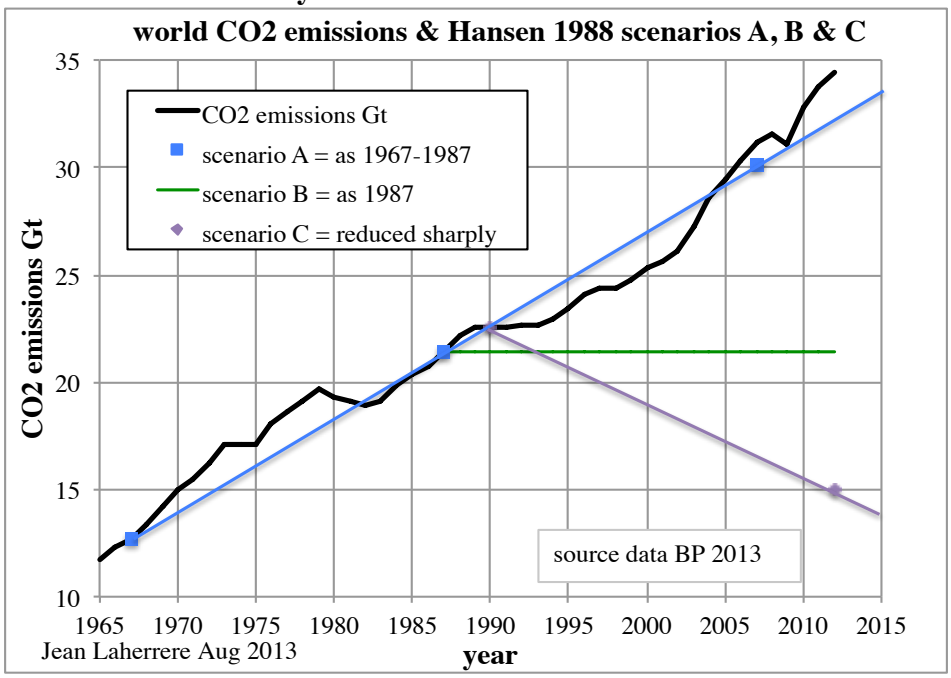
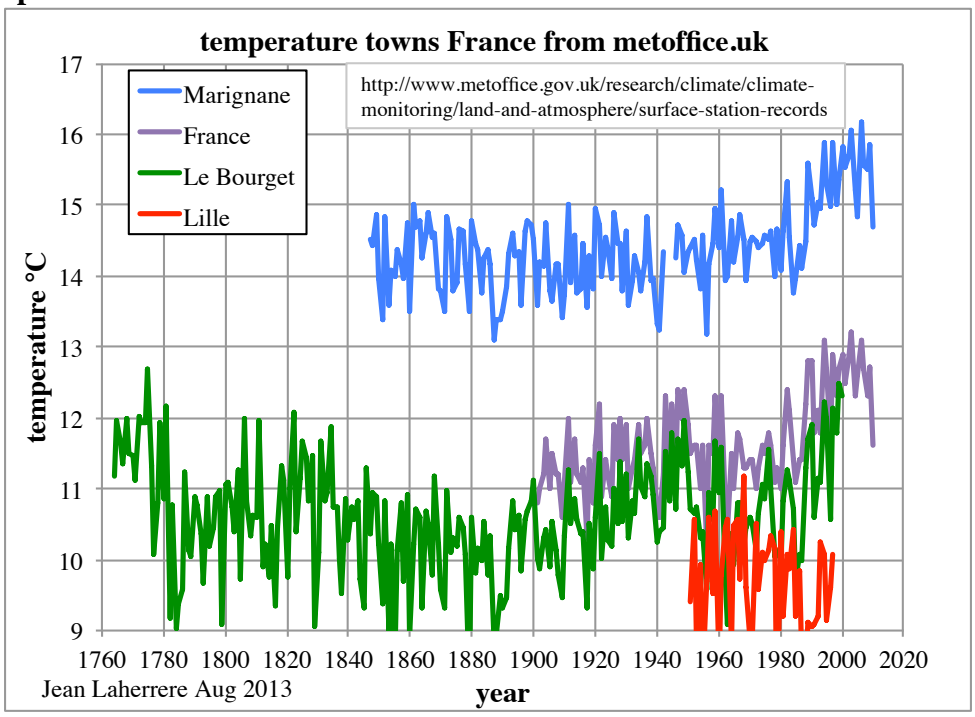


Fig 94: CO2 Hansen model & reality



Forecast of 4°C in 2100 equals to move from Lille to Marseille

Fig 95: Temperatures in some towns France source UK ?



The Hadley data are the compilation of thousands of stations but the number varies and also they reflect urban heating. The values differ from sea to land as well as from satellites.

Fig 96: Global temperature from Hadley (stations) & UAH (satellite)

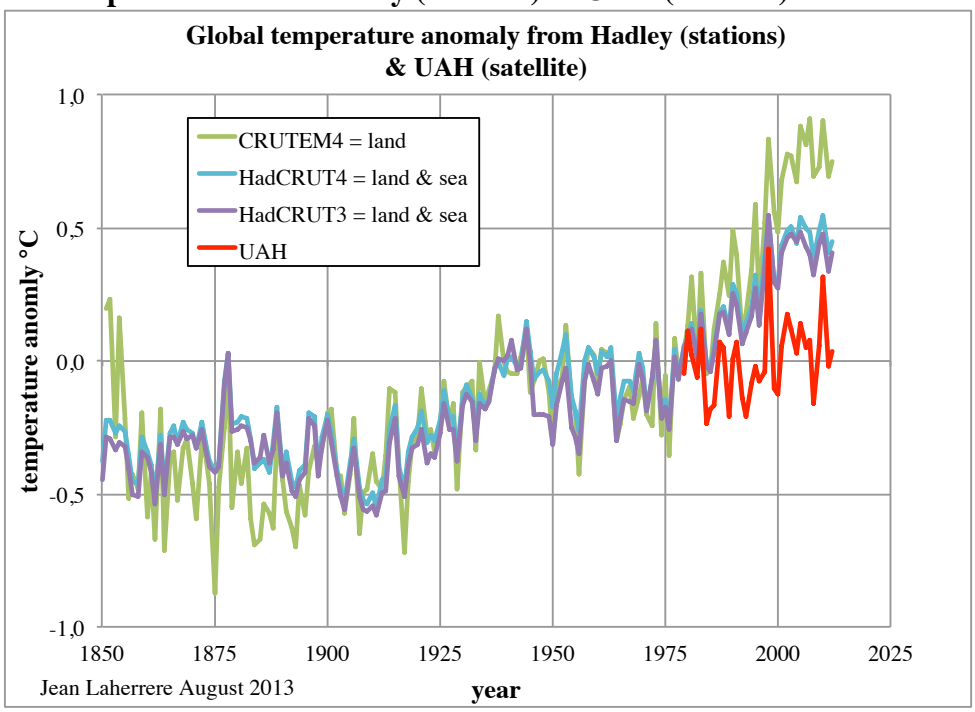
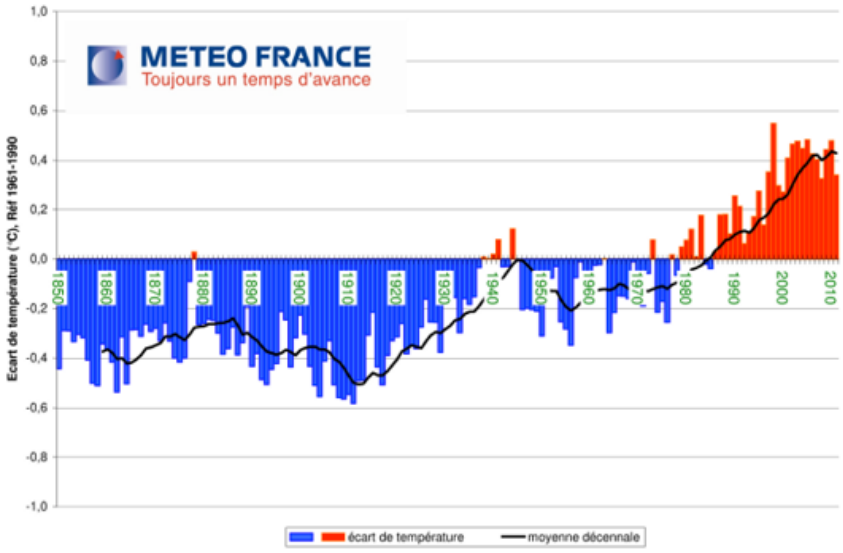
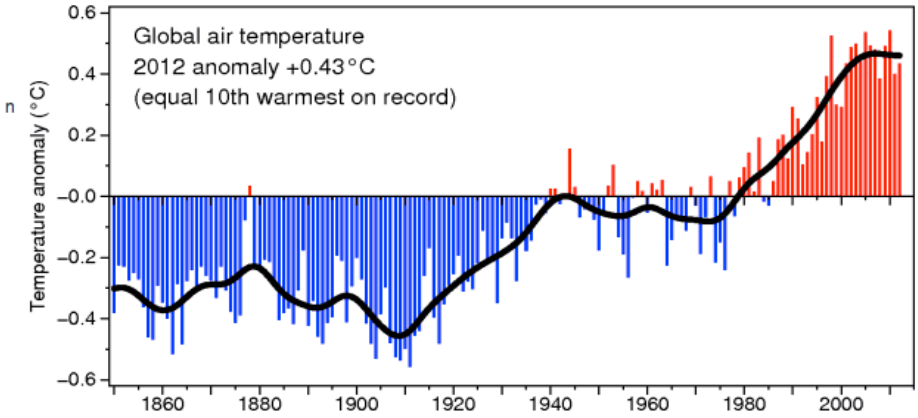


Fig 97: Météo France: temperature with decennial average



Météo France evidently does not know how to locate the decennial average, its decennial average peaks differently from annual data!



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, but the probe was constructed in pound units. The mistake cost 150 M$

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.

2010 – The Xynthia Storm at Faute-sur-Mer: the building of 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 sea pollution instead of an 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 economise 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: 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 Santagio 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

What goes up must come down!.

The Consumer Societies, above all those based on the cheap energy acquired with debts, such as the US, are condemned to change their way of life.

The word decline is politically incorrect for government because salvation is assumed to come from growth,

Continual growth has no future in a finite world where the population will decline.

Drastic policy revisions should be introduced.

The peak of oil production depends on the supply (ultimate reserves) and on the demand (economy, population, behaviour) and can occur between tomorrow and 2020 : it will be a bumpy plateau

The peak is less important than the subsequent declin,e and the date of peak will not be evident until decline has set in.

The only almost-certainty is that the official forecast (IEA, USDOE/EIA) of production reaching 130 Mb/d by 2030 will not be attained.

Gas shortages will arrive locally as in North America, before the global shortage of oil.

A comparison of my forecasts of 2004 and the reality of 2013 is rather good, and much better than the official forecasts. My conclusions of 2004 are still valid, save for the following : population will likely decline; the shortage of gas in North America, which is distorted by source-rock gas (which could maybe a bubble). It seems that the present success of American source-rock gas is difficult to extrapolate to the rest of the world because of property rights, save in China. It

will be necessary to change the mining laws in order to associate landowners and local communities.

When one speaks of growth, it is based on GDP (an indicator of expenditures not wealth) because it is manipulated and should be suppressed. The US GDP increased by 3% on the 1st of July 2013 (the objective being to reduce debt in relation to GDP) by changing artistic expenditures into investments.

The only objective for every country must be employment growth and not GDP, but again the statistics are weak.

The prime objective for a political party must be to improve transparency and to publish reliable data especially on energy. That is far from being the case in France. The energy patrimony of France is not revealed in the official documents.

All data collected by a public organisation in France should be made public on the web being free of censorship, as is the case in the United States or United Kingdom (Freedom of Information Act). But, even in the United Kingdom, Phil Jones of the University of East Anglia (HadCRUT data figure 96) refused to provide original temperature data, and after an inquiry, the government did no more than criticise him to be not open: nothing more. It is not enough to have rules: they must be applied.

Glossary of Abbreviations

ABC: Asiatic Brown Cloud
ACE: Acccumulated Cyclone Energy
AEO: Annual Energy Outlook (USDOE/EIA)
BGR: Bundesamstad fur Geowischenshaft und Rohrstof
boe: barrels of oil equivalent
CNOOC: Chinese National Offshore Oil Company
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 = 109 b = billion (US) barrels (billion SI = square million = 10^{12} = trillion US
GMO: genetically modified organism
GDP: Gross Domestic Product
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
OPEC: Organisation of Petroleum Exporting Countries
RMI: minimum guaranteed income
SEC: Securities and Exchange Commission
SMIC: guaranteed minimum wage
TAC: Total Allowable Catch
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
XTO : an American (Texas) energy producing company
WHO: World Health Organisation