The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Comments on BP Statistical Review 2012

Posted by Luis de Sousa on August 13, 2012 - 6:48pm

This is a guest post by Jean Laherrère a long time contributor to TheOilDrum.

Digest

- The BP Statistical Review has the merit to release every year free and convenient updated historical data on energy.
- This data is recopied from what is reported by national agencies, avoiding diplomatic conflicts.
- Despite the heterogeneity of the data, the report displays a ridiculously high number of digits, in contradiction with the real accuracy of the sources.
- The report wrongly adds unconventional to conventional reserves.
- BP ignores backdating, using obsolete reporting rules that lead to artificial reserve growth.
- Most economists believe this reserve growth to be the real, when in fact known Oil and Gas reserves peaked in 1980.

---

1. Oil

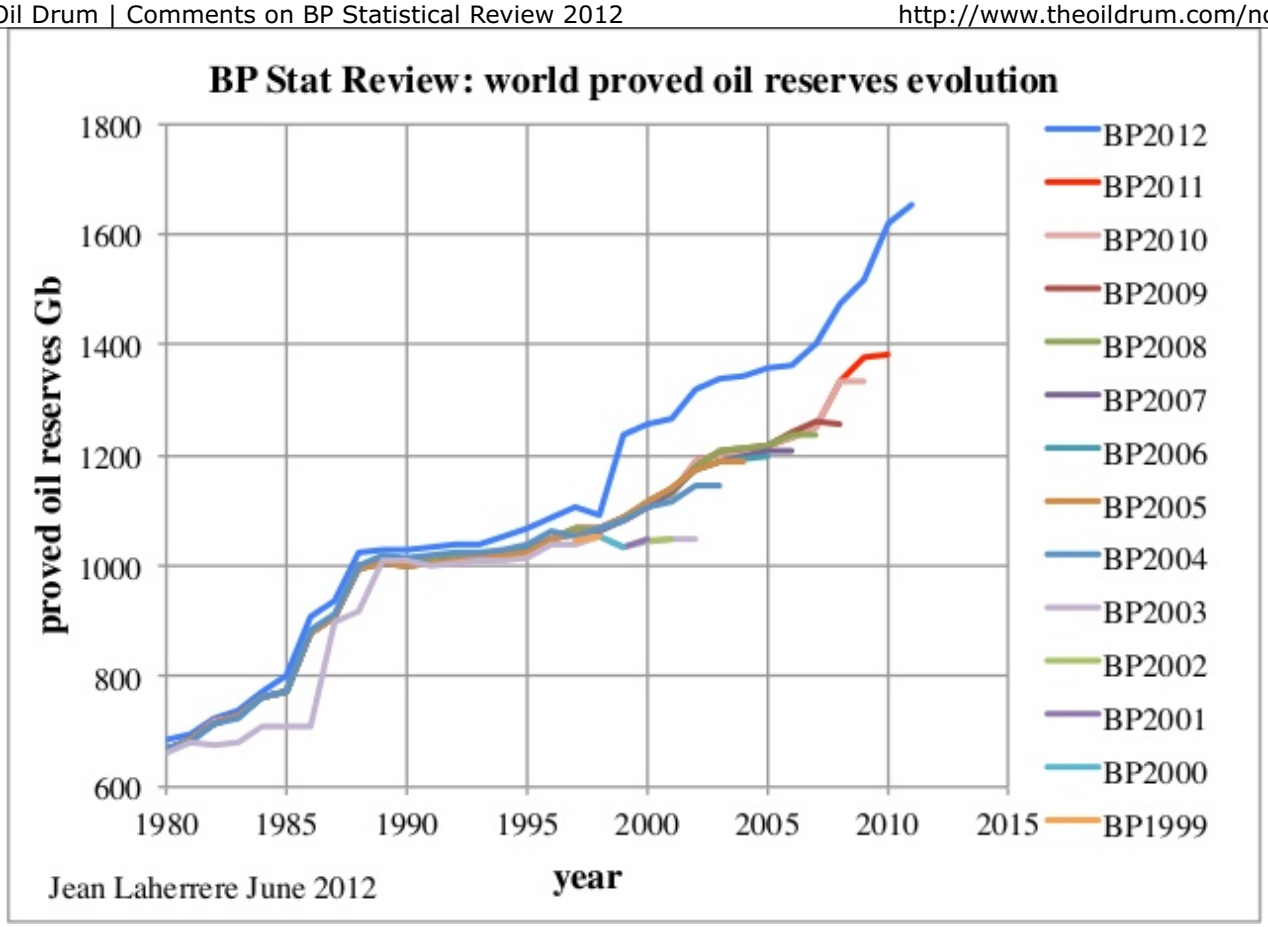
1.1. Reserves

The new 2012 BP report (BP2012 for short) shows a drastic change in the world proved reserves, increasing to 1653 Gb at the end of 2011 from 1383 Gb at end the 2010 in the 2011 report (for a quick overview of the oil reserves nomenclature please visit the Wikipaedia).
BP is wrong by:

- adding proven reserves, when an arithmetic aggregation is wrong (it is only correct for mean 2P);
- adding conventional and non conventional reserves (where the size of the tap matters more than the size of the tank). These should be reported separately, as it is done in Canada and as it was in BP's 2011 report and before;
- using different definitions for oil supply and oil consumption;
- using a different definition for oil reserves by including oilsands in the “total world” item, when it was not in previous years editions.

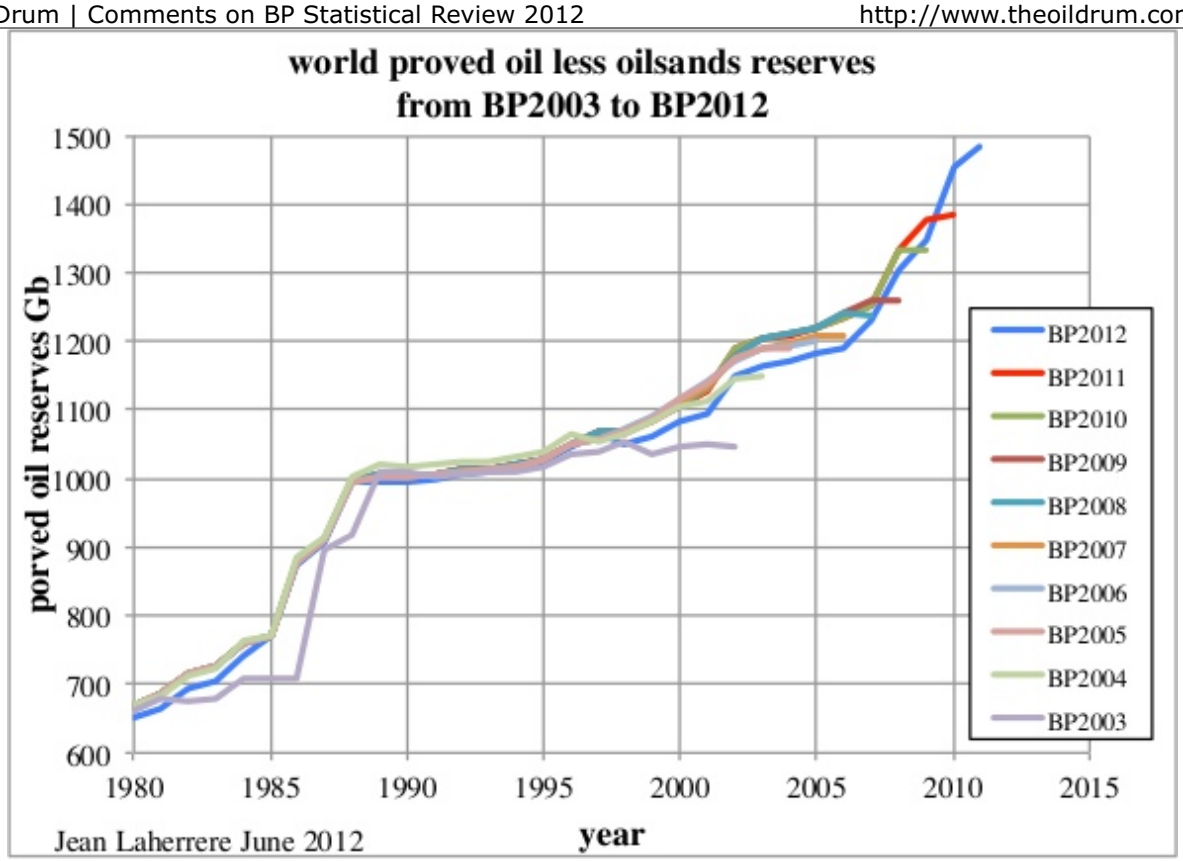
The evolution of BP reserves estimates from 1999 to 2012 editions is shown below.

Figure 1: World proved oil reserves from BP 1999 to BP 2012



The new BP 2012 edition corrects the previous 2011 estimates drastically since 1999. It is not due to a new estimate of reserves but only a new presentation and a new definition. This drastic change is due to the addition to the "world total" item of the Canadian oilsands reserves from 1999, and since 2006 the extra-heavy oil from the Orinoco belt. Before oilsands where presented outside the world total, as "proved reserves and oilsands", but Orinoco was included in the "world total". In fact by removing oil sands, the total reported by BP at the end of 2009 shows a decrease to 1348 Gb in the 2012 report from the 1376 Gb reported in 2011. There is negative reserves growth!

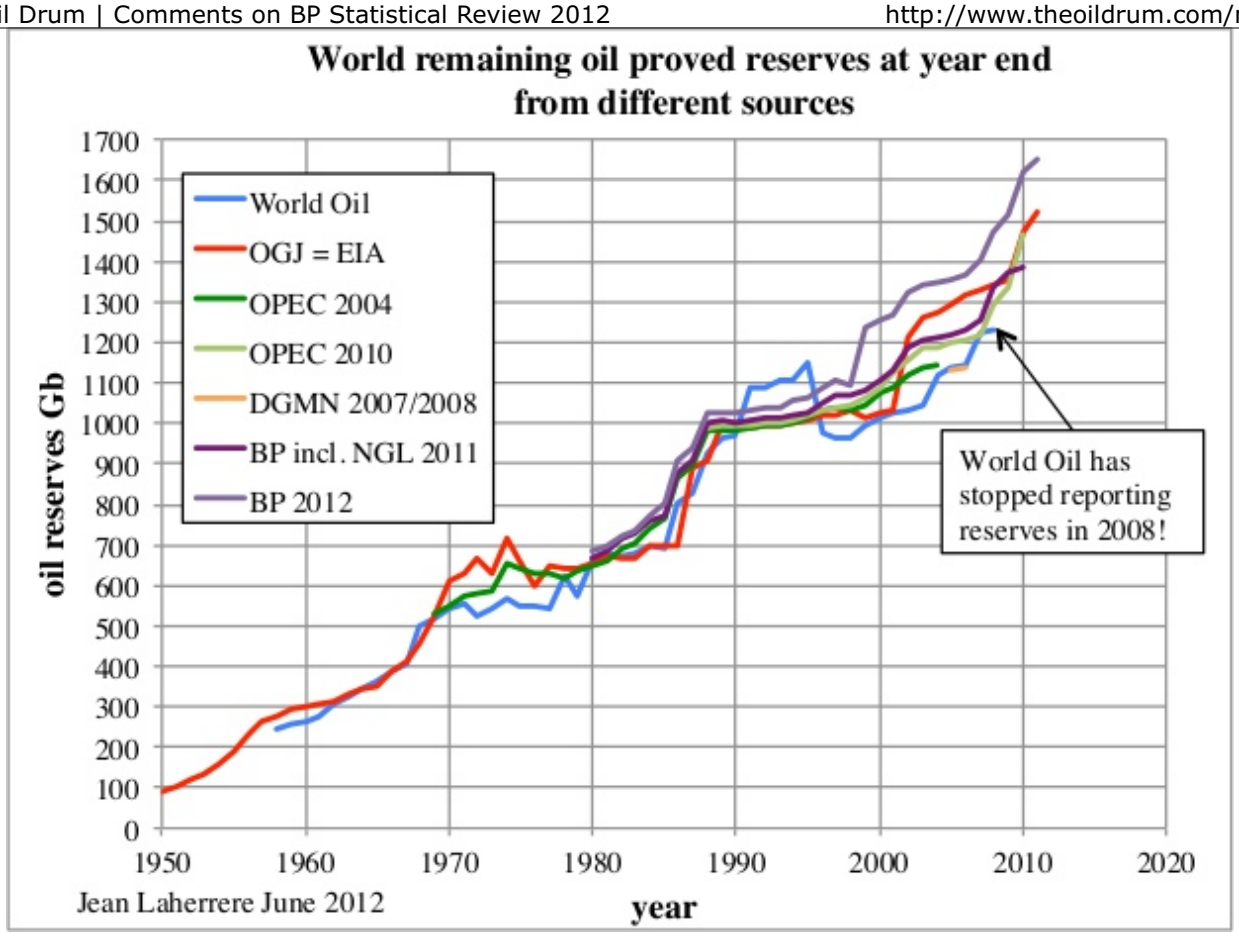
Figure 2: World proved oil less oilsands reserves from BP 1999 to BP 2012



BP in 2012 now considers Canadian oilsands like Venezuela's Orinoco - in fact they are both extra-heavy, but with a completely different viscosity because of the sharp difference in temperature in the reservoirs (55°C in Orinoco, where the fuel is fluid, compared to 5°C in Athabasca, the fuel being bitumen). They are both continuous-type accumulations and they should be treated separately!

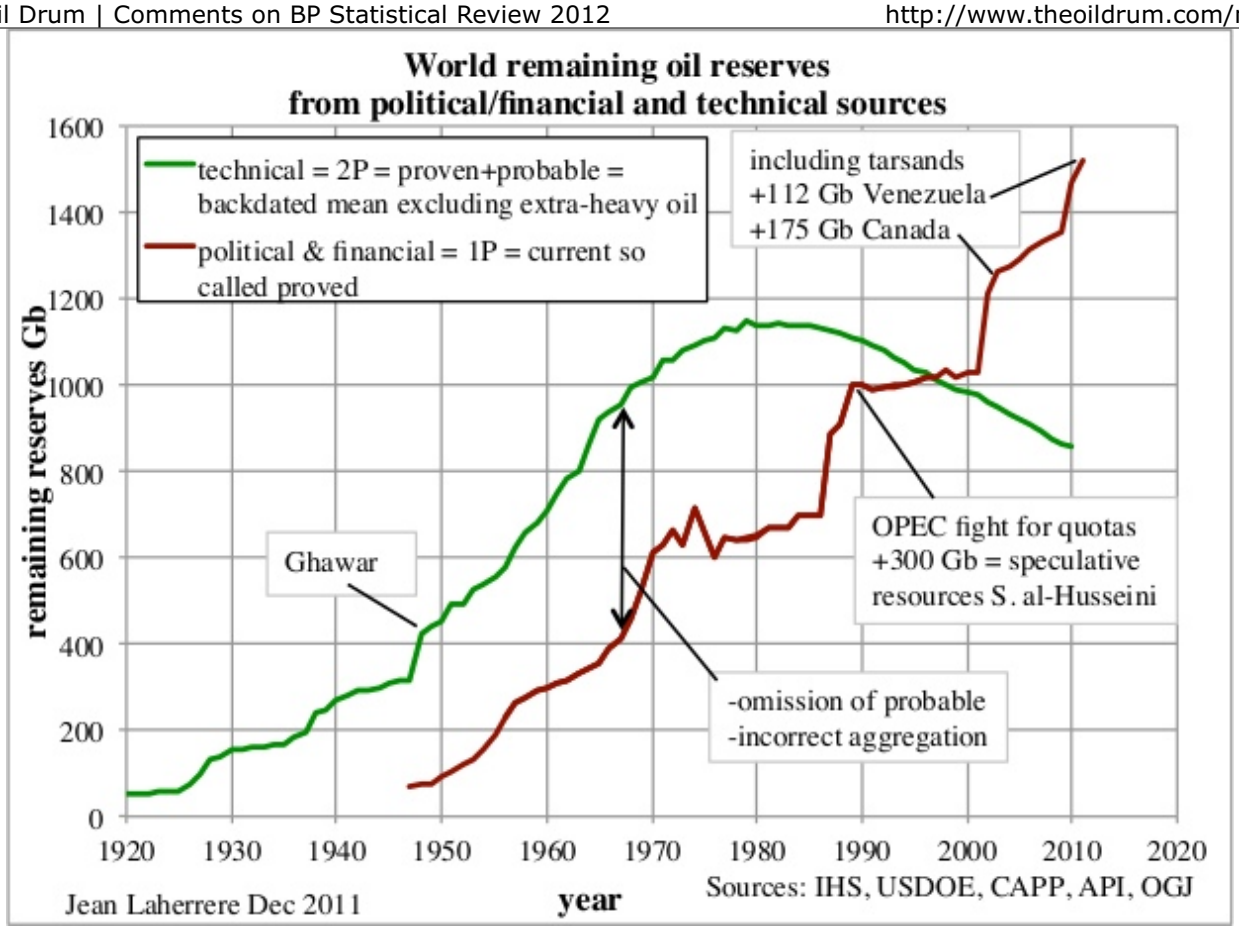
Comparing BP's world “total oil reserves” with other sources shows that the “new” (different) BP 2012 is ahead of the crowd.

Figure 3: World proved oil reserves from different sources.



The comparison of the current proved reserves (EIA) with the remaining backdated 2P technical data is drastic. Current proved reserves follows the financial SEC rules for audited data or the political non-audited OPEC sources. Arithmetic aggregation of proved data is incorrect, leading to an underestimate of the reserves and to future reserve growth. Backdating is also a very important factor (see Laherrère J.H. 2011 "Backdating is the key" ASPO 9 Brussels 27 April)

Figure 4: World remaining oil reserves from political/financial and technical sources



Let's look in the detail at BP2012.

In the proved oil reserves file at end 2011, the values are given in Gb and in Gt with many ridiculous decimals for several countries (14 for Azerbaijan in Gt, meaning down to 10 grammes!) and none for few (Azerbaijan in Gb). Some countries report reserves in weight others in volume and the average density is often badly known, in the end being simply guessed. A round value in barrels is converted in weight with many useless decimals: it is wrong not to restrict the amount of decimals to the accuracy of the measure (which is in fact an estimate and not a real measure).

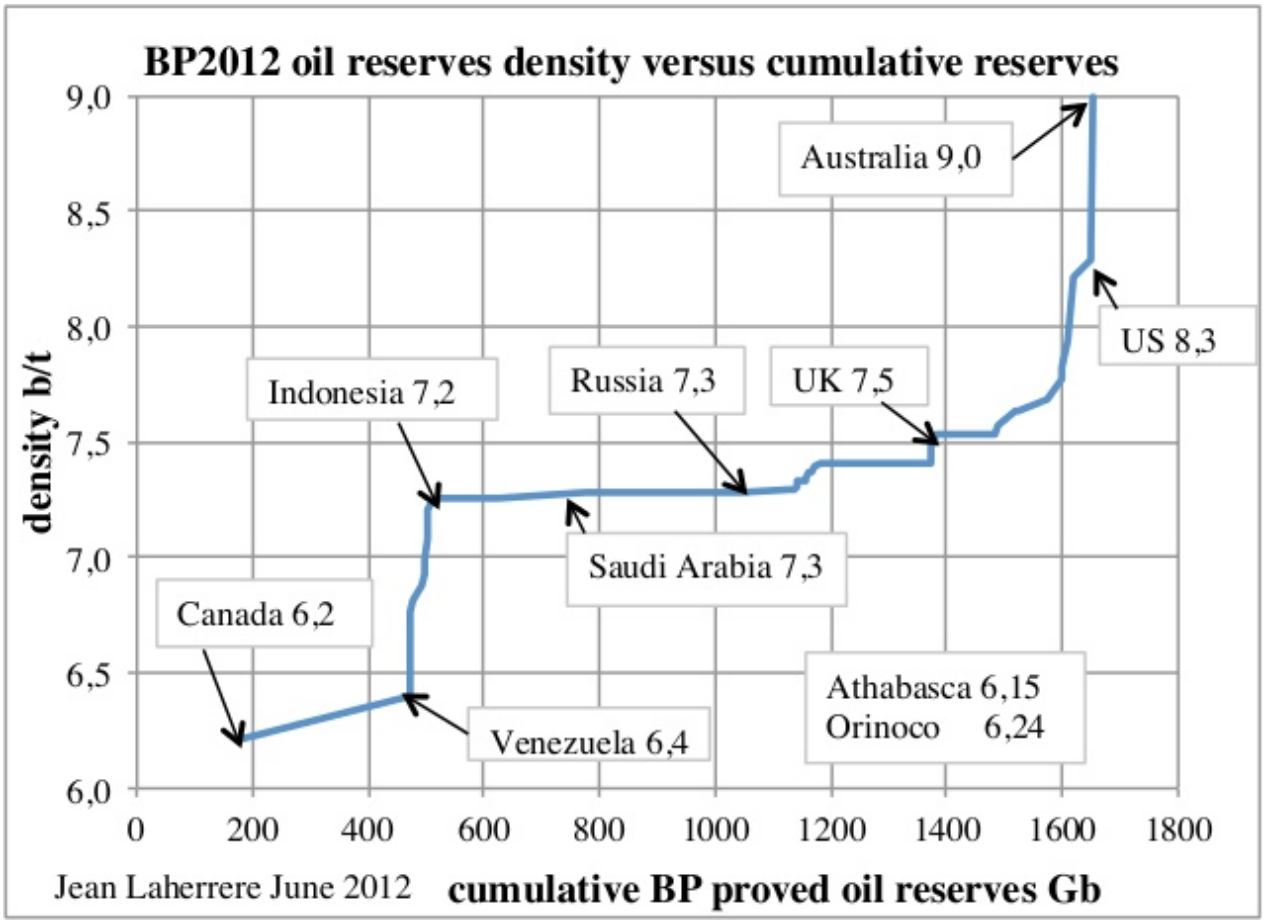
country	**Gb**	**Gt**	**b/t**
US	30.8719987869262	3.72332507371902	8.29
Azerbaijan	7	0.95890408754349	7.30
Iraq	143.100006103515	19.3117408752441	7.41
Kuwait	101.5	13.980716705322	7.26
Total World	1652.61132445929	234.25108317424	7.05

A ridiculous number of decimals down to the hundredth of a barrel, when country estimates are usually given in thousands barrels at the most, shows that BP does not know the accuracy of its data, being badly checked and managed!

Besides this, the b/t density values reported by BP vary from 6.2 b/t (Canada) to 9.0 b/t (Australia).

Figure 5: BP2012 oil reserves density (barrel per tonne) by country versus cumulative

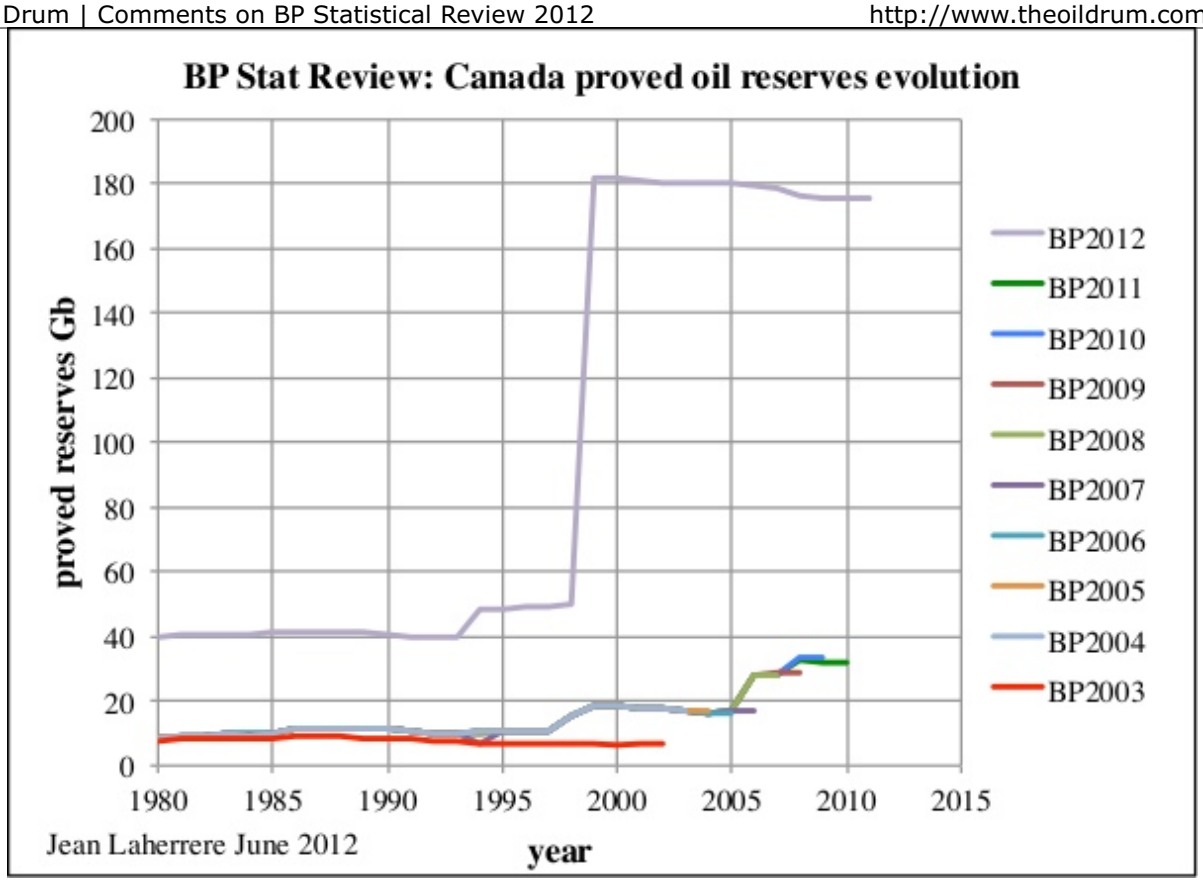
reserves.



1.2. Canada

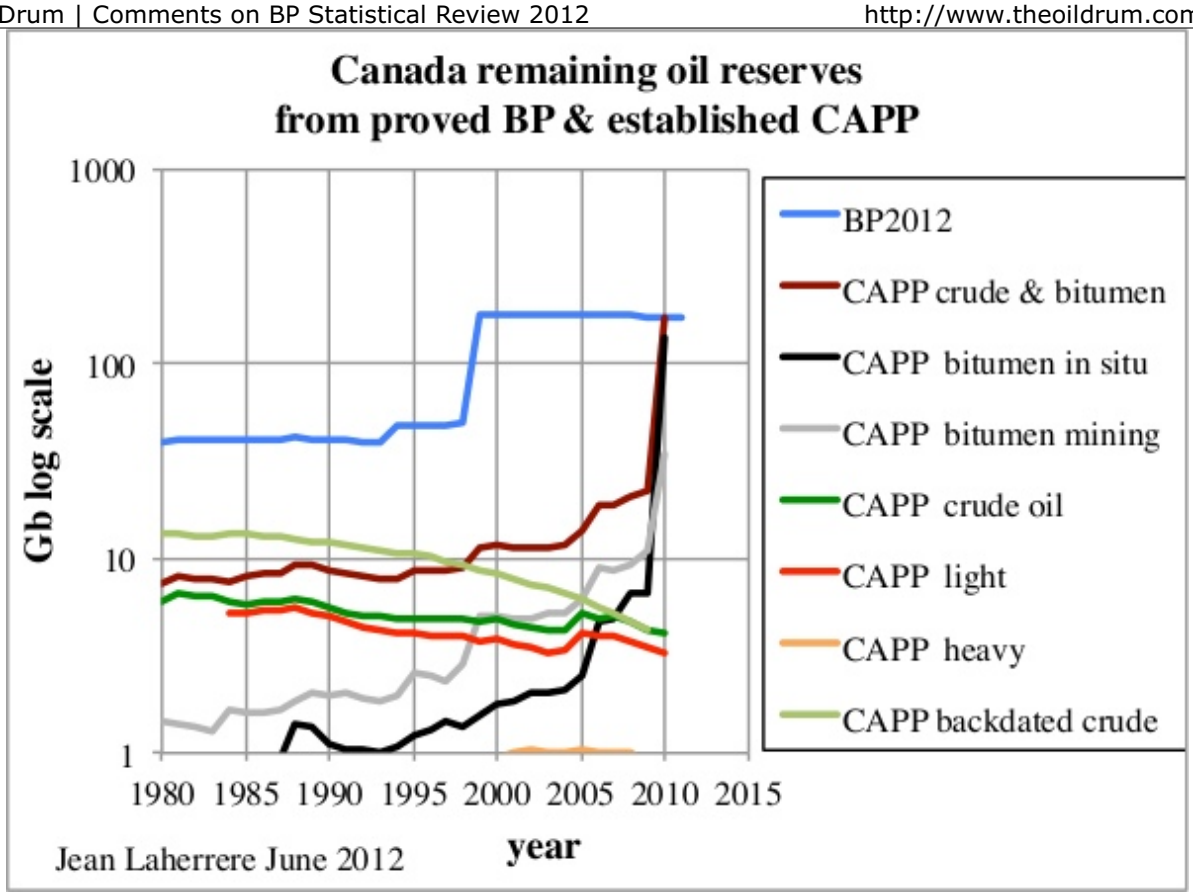
Canadian oilsands production started in 1967 but it was only in 1996 that BP reported large reserves from oilsands. The Canadian Association of Petroleum Producers (CAPP) only did so in 2010.

Figure 6: Canada proved oil reserves from BP 2003 to BP 2012



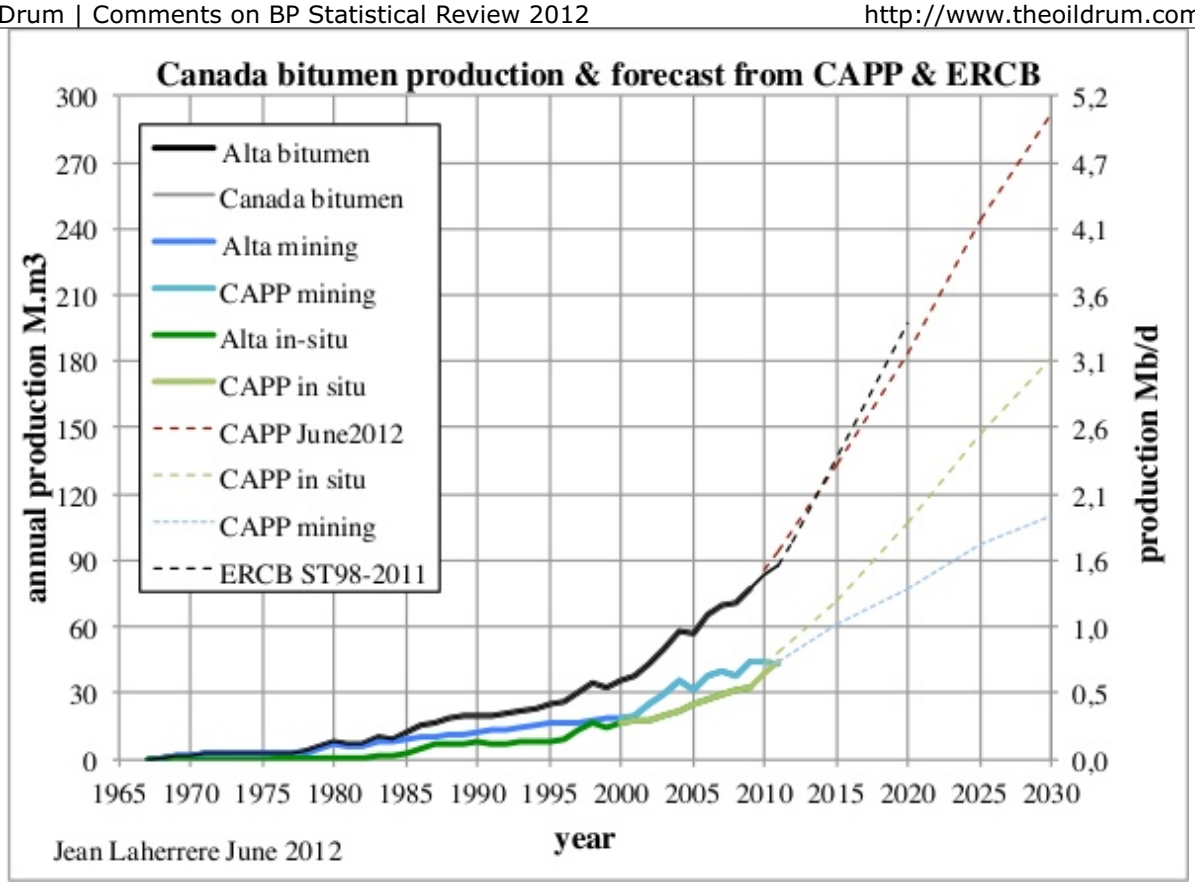
The CAPP reports established reserves, which represents proved plus half probable reserves (less than 2P). This association reports separately crude oil (broken down into light and heavy), bitumen mining and bitumen in situ, plus the backdated crude oil reserves. Unfortunately, bitumen backdated estimates are not reported and they stopped reporting backdated crude oil in 2009.

Figure 7: Canada remaining oil reserves from proved BP and established CAPP in log scale



Bitumen production occurs in Alberta and the provincial organism Energy Resources Conservation Board (ERCB) provides data on production, reserves and forecast on its website up to 2020. CAPP has published in June 2012 its crude oil forecast, markets & pipelines.

Figure 8: Canada bitumen production & forecast from CAPP & ERCB



These institutions forecast bitumen production at about 5 Mb/d in 2030 and 3.2 Mb/d in 2020. Mining, which was higher than in-situ before 2010, will definitely lose in 2030, because mining reserves in 2010 were 34 Gb, whereas in situ were 135 Gb.

1.3. Venezuela

Another big increase is the extra-heavy oil from Venezuela, with BP adding about 200 Gb from 2006 to 2011. This Orinoco oil has been produced since 1979 and had a sharp increase since 1999 with production in 4 fields from international companies associated with PDVSA in the areas called Hamaca, Zuata , Cerro Negro and Machete. Hugo Chávez nationalized these operations in 2005, with these same areas getting the names Ayacucho, Junin, Carabobo and Boyaca. Production data are now unreliable, presently reporting around 0.7 Mb/d in 2010. Forecasts vary from PDVSA around 3 Mb/d in 2020 (David Voght "Venezuela, the Faja and Elections" IPD Latin America Institute of the Americas XXI Annual La Jolla Energy Conference May 21-23, 2012 - La Jolla, California), but the IEA forecasts only 2.2 Mb in 2035 (WEO 2011) and 1.5 Mb/d for IEO 2011.

Figure 9: Venezuela Orinoco extra-heavy oil production & forecasts from EIA, IEA & PDVSA

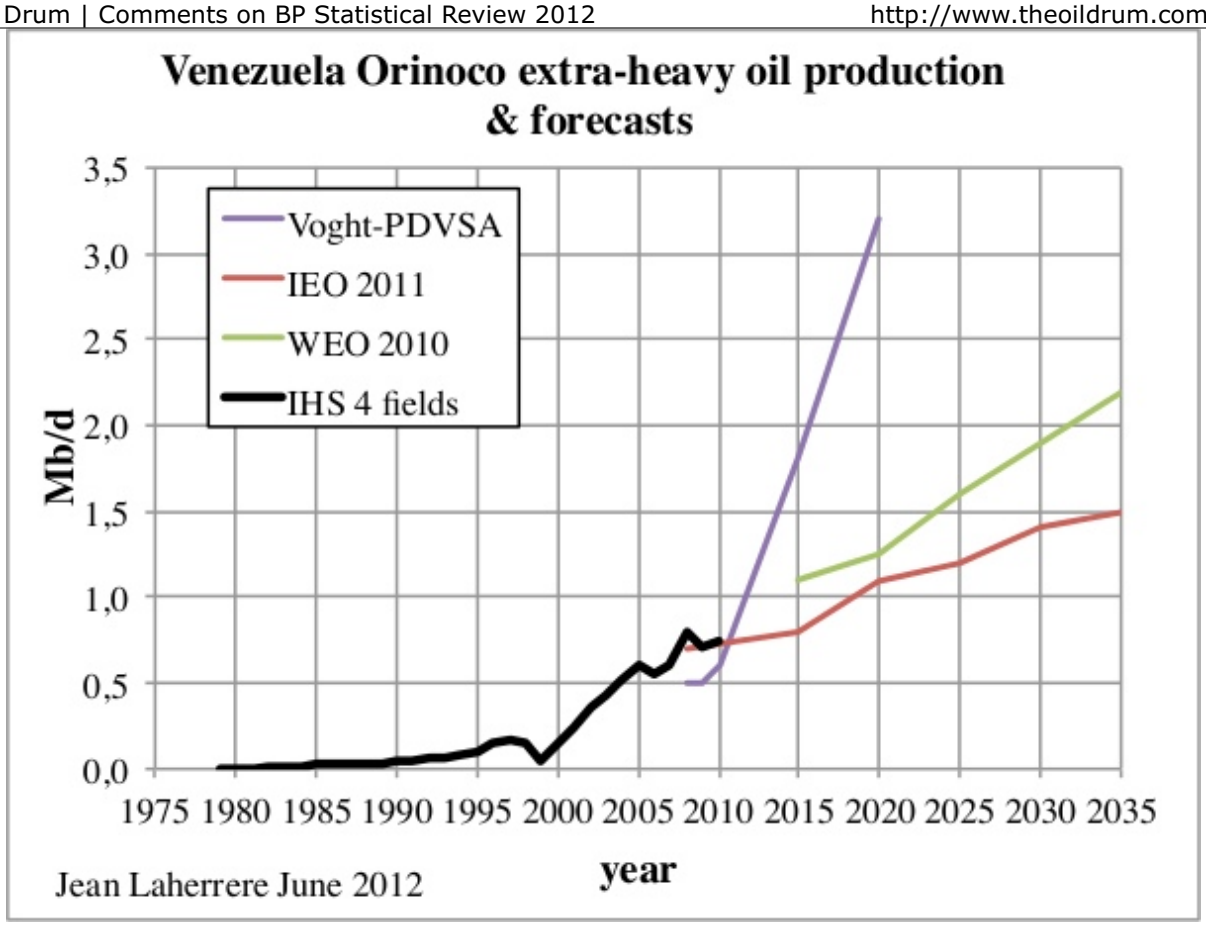
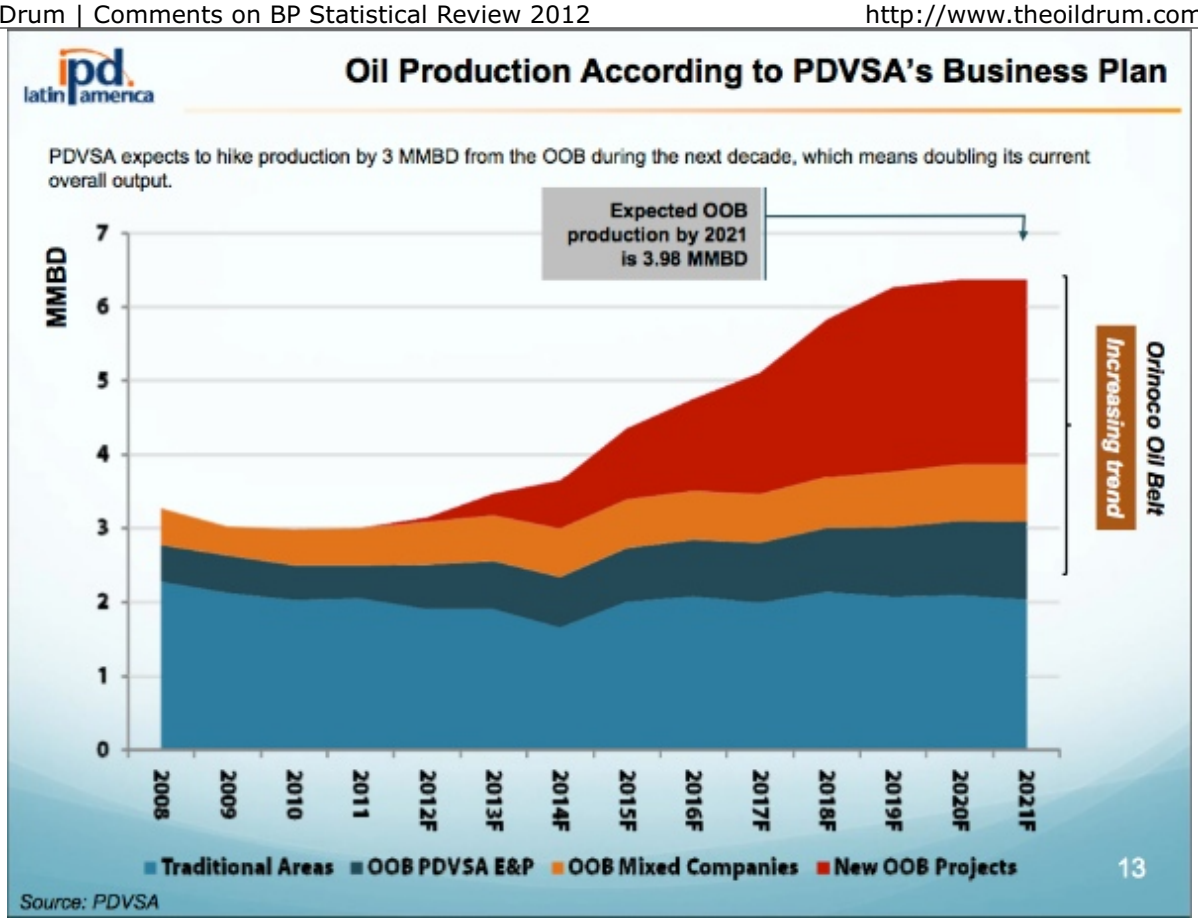
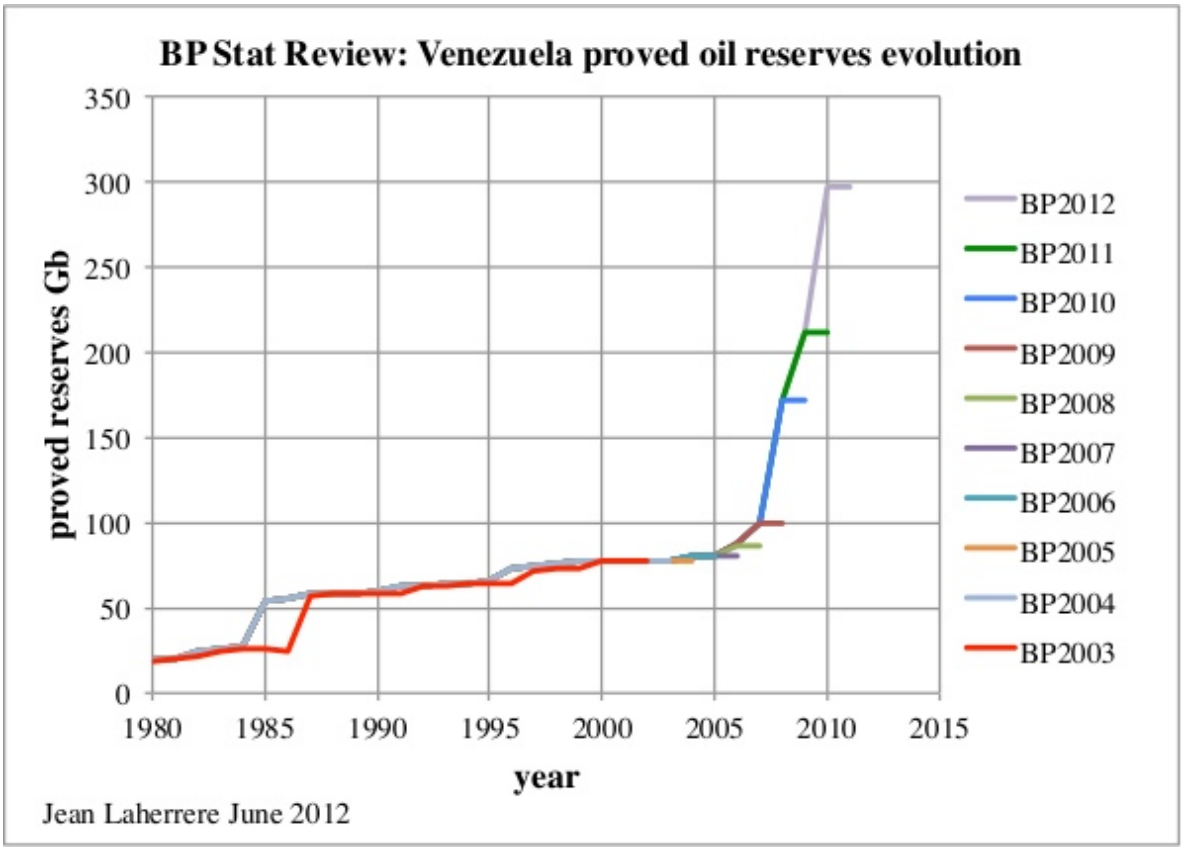


Figure 10: Venezuela Orinoco extra-heavy oil production & forecasts from PDVSA: D.Voght



BP reports Venezuela oil reserves by recopying OPEC values, but being always one year late!

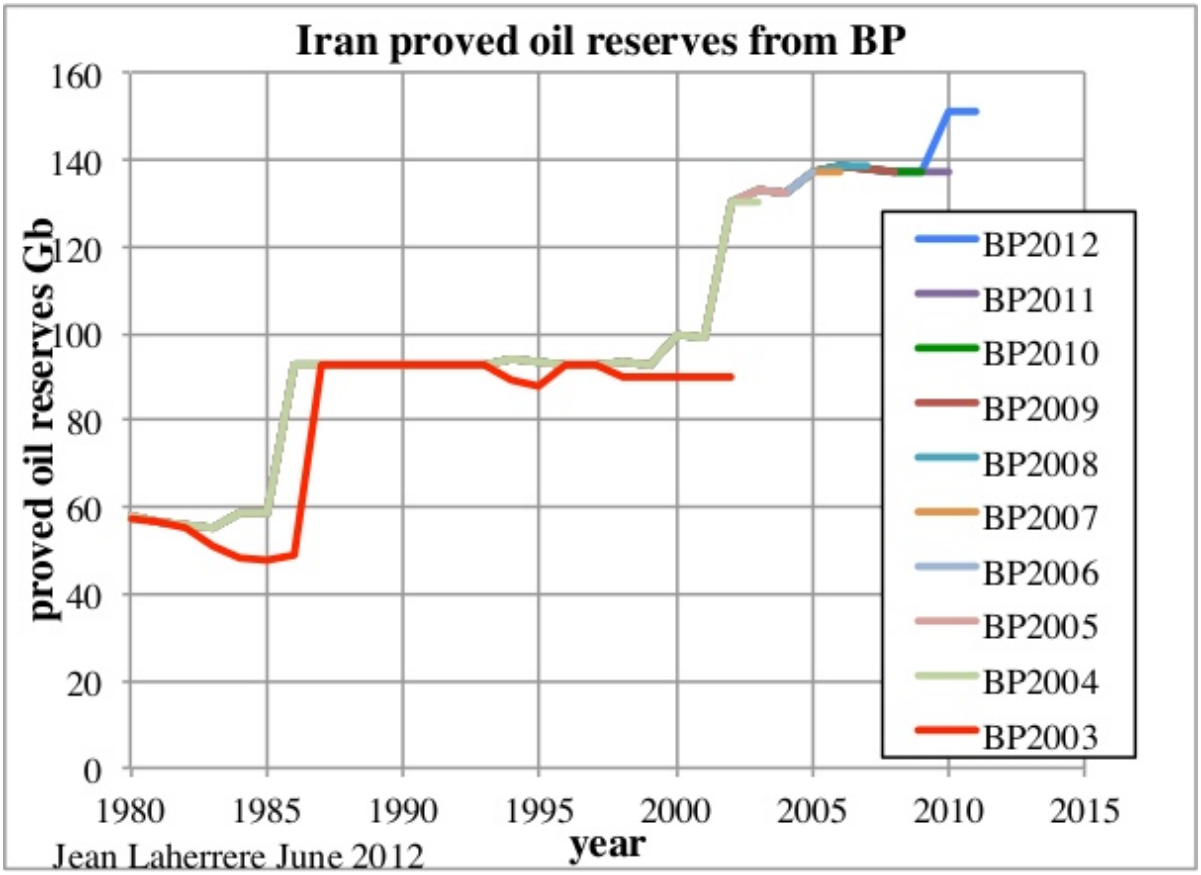
Figure 11: Venezuela proved reserves evolution from BP 2003 to BP2012



1.4. Iran

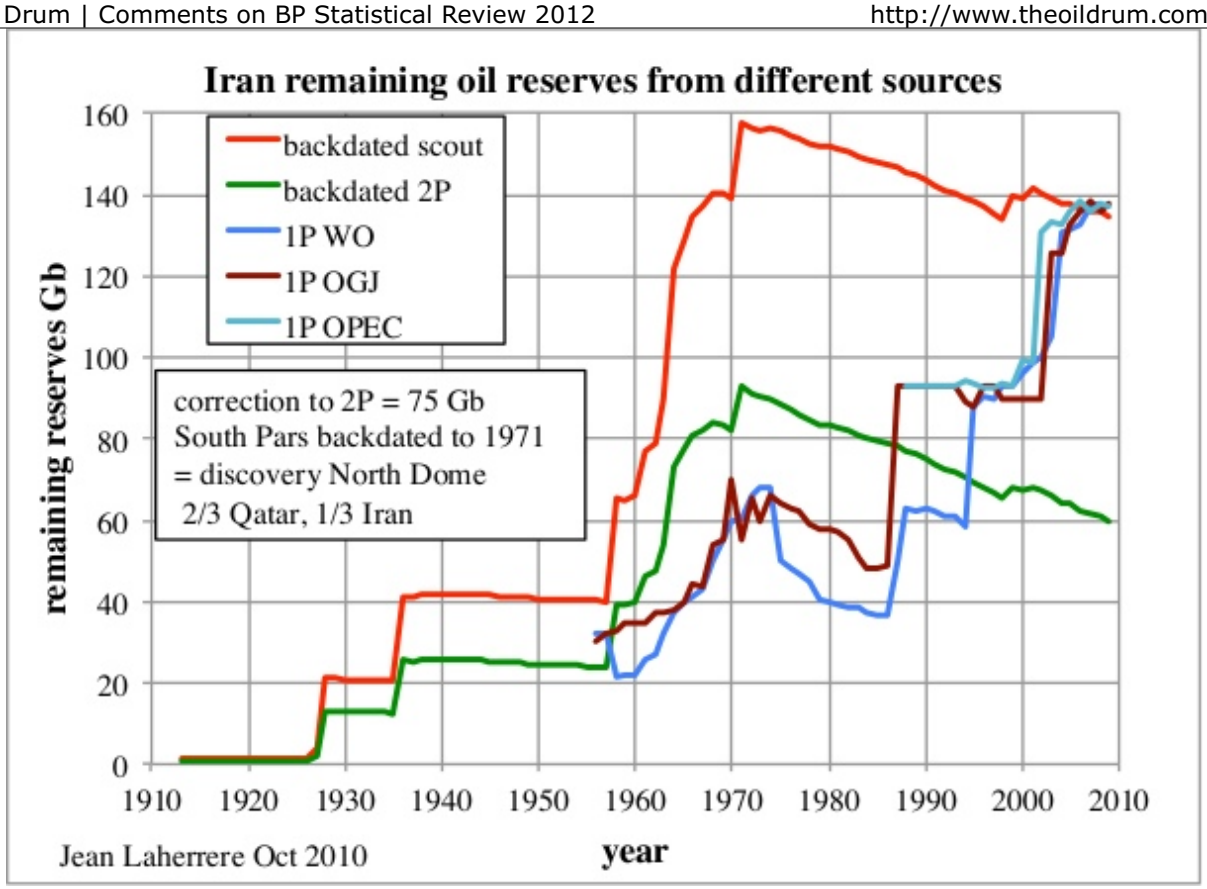
BP follows Iran's own reserves estimates, which are mainly political in their fight with Iraq!

Figure 12: Iran proved reserves evolution from BP 2003 to BP2012



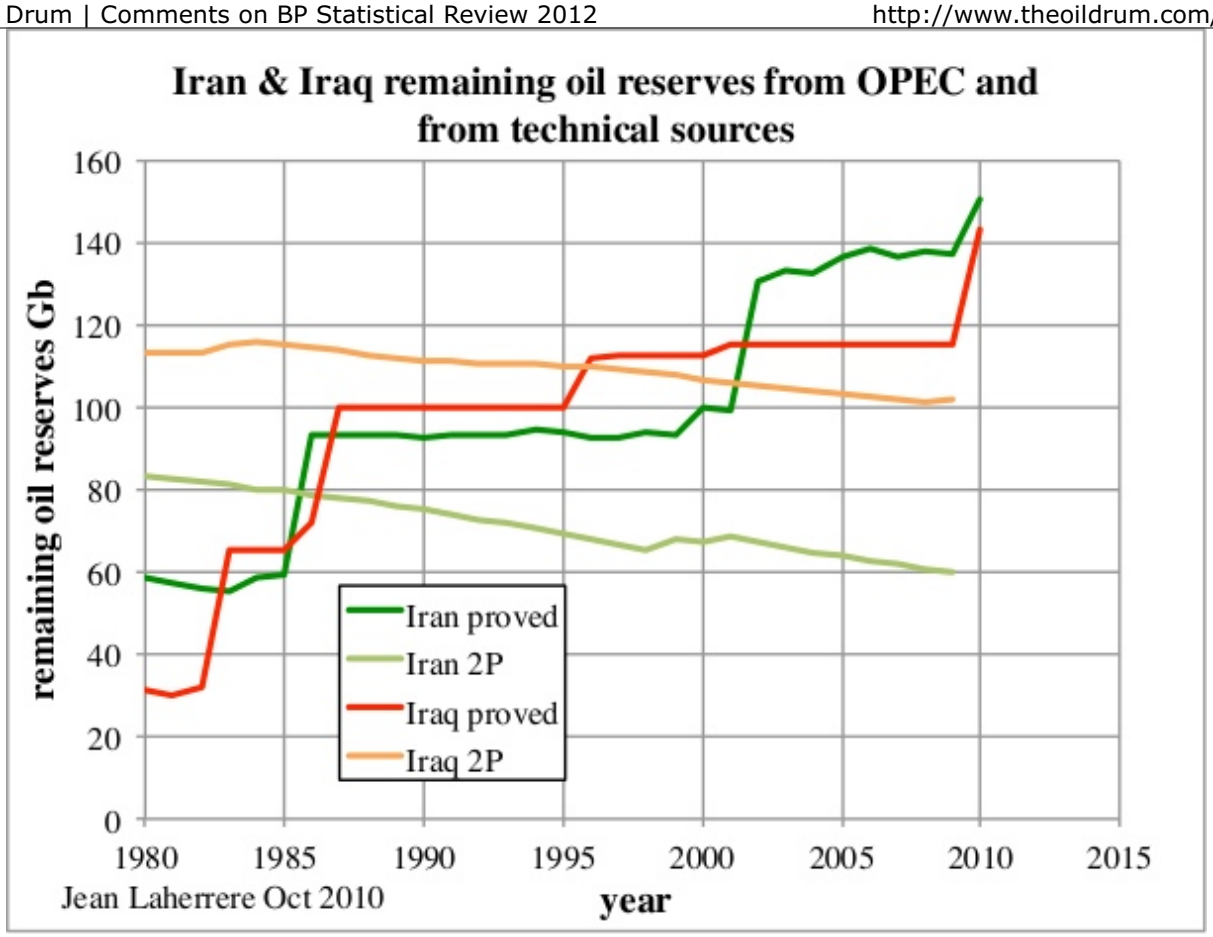
The remaining reserves from backdated 2P data are quite different from the 1P estimates reported by OPEC/BP, OGJ/EIA and WO.

Figure 13: Iran proved reserves evolution from different sources: OPEC, OGJ & WO



It is interesting to compare the evolution of official oil reserves in Iran and Iraq, and with the reserves from technical sources. Iran was below Iraq when Saddam Hussein was in power! In October 2010 Iraq increased their reserves to be a little over Iran; a few days later Iran did increase its reserves too, to be back on top. Both proved reserves are quite higher than the technical 2P.

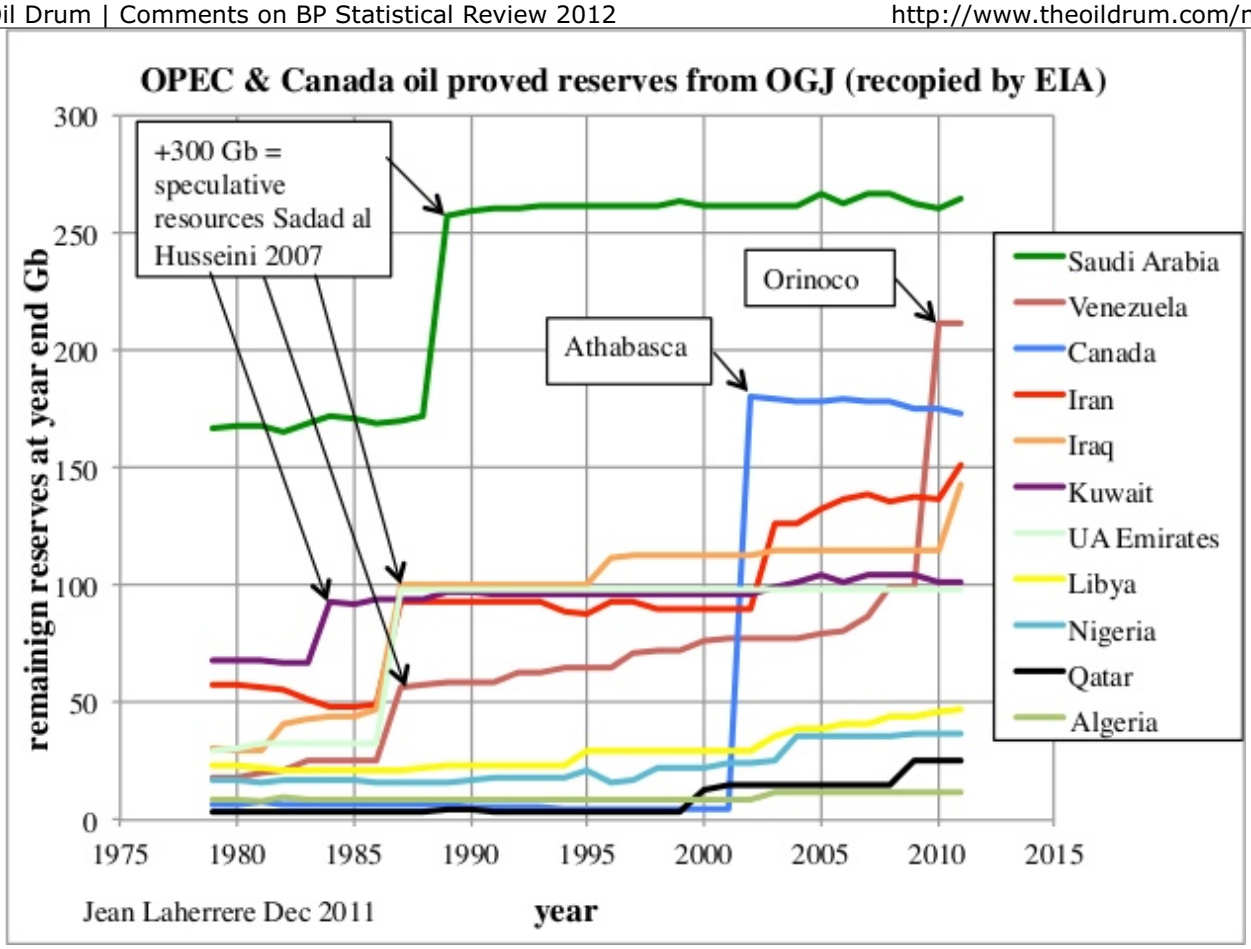
Figure 14: Iran & Iraq remaining oil reserves from OPEC and from technical sources



1.5. OPEC and Canada

The OPEC and Canada proved oil reserves from OGJ (recopied by EIA) displays marked steps of political origin, and long periods without changes, when in reality, remaining reserves are constantly varying.

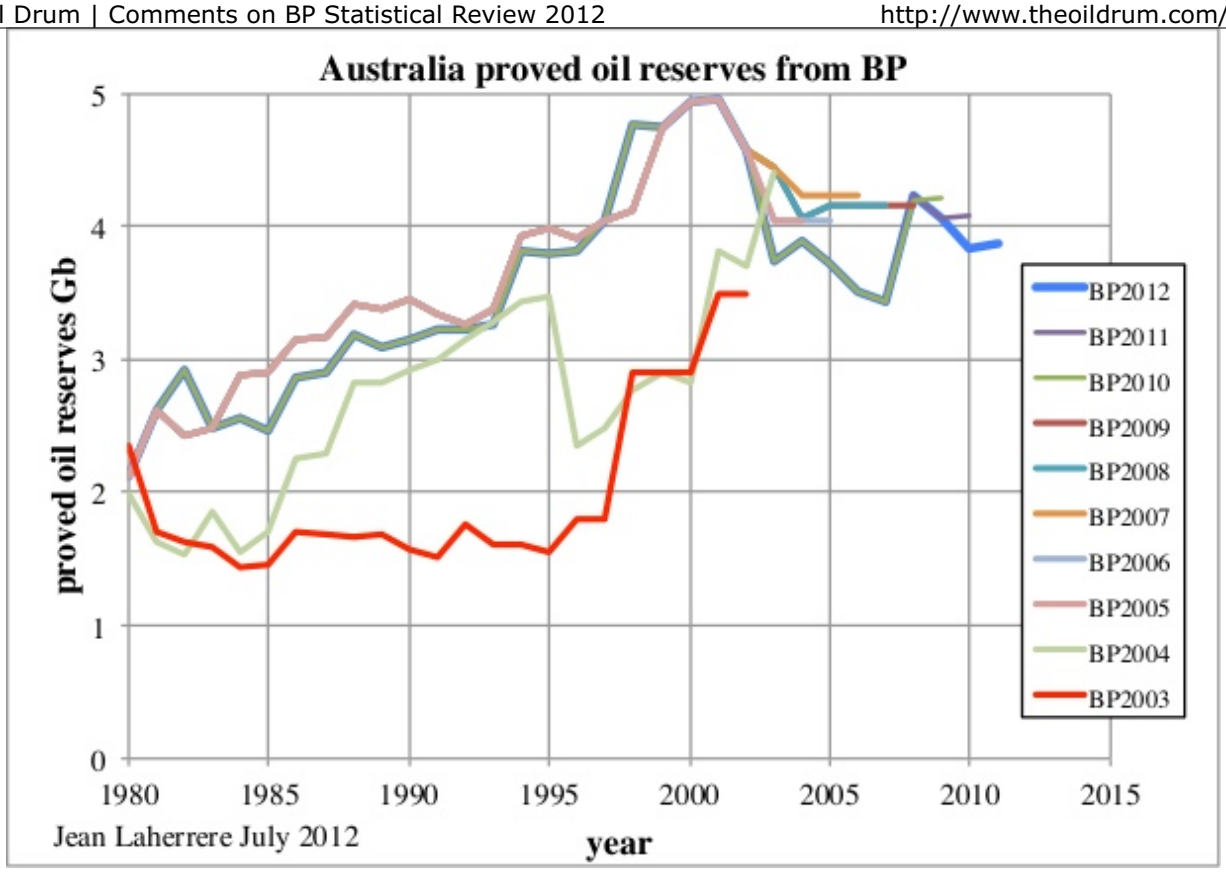
Figure 15: OPEC and Canada oil proved reserves from OGJ



1.6. Australia

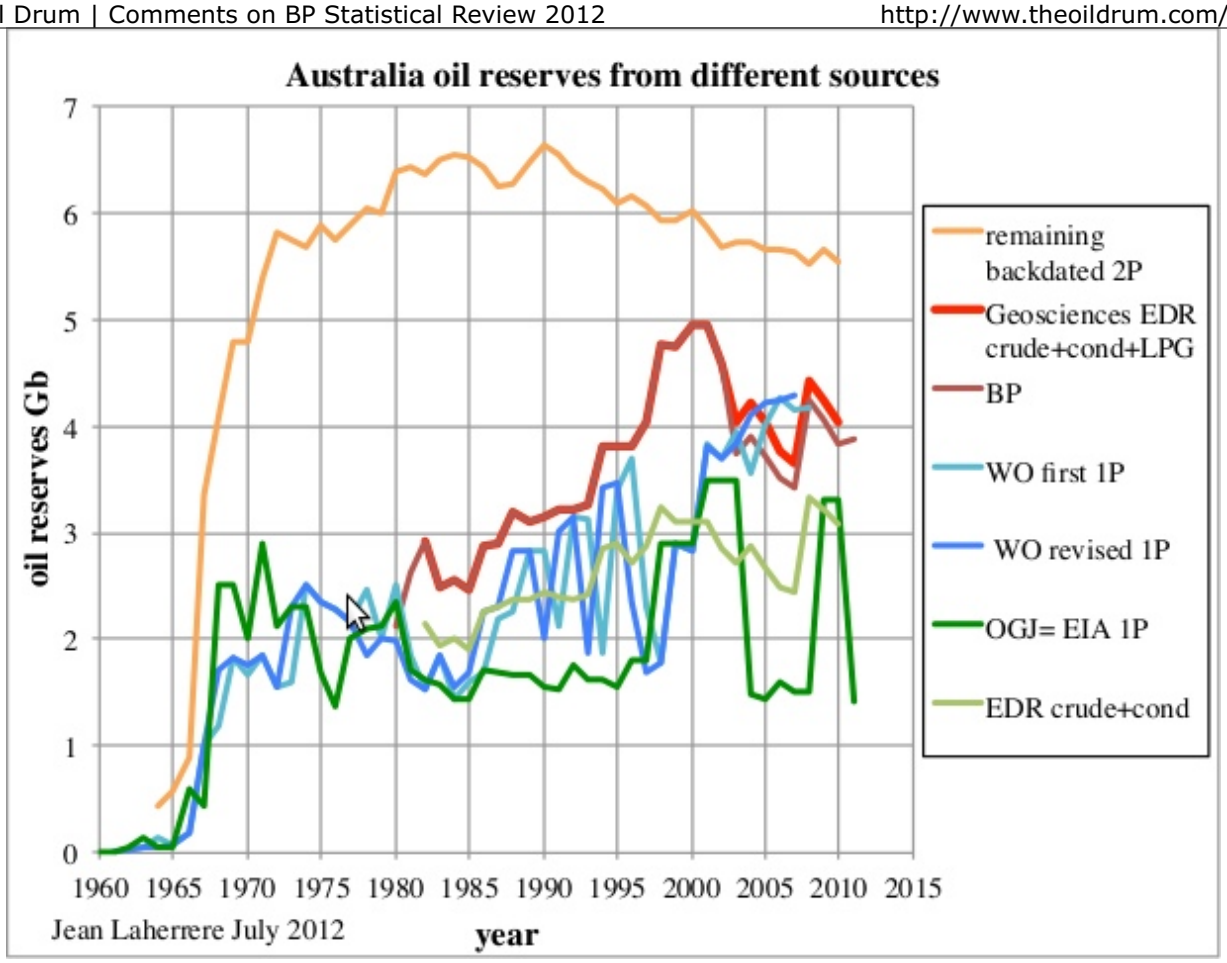
BP proved oil reserves for Australia have changed significantly with time from 2003 to 2012 for the period 1980-2000

Figure 16: Australia proved oil reserves from BP 2003 to BP 2012



Australia oil reserves plotted from different sources show drastic differences. In 2012, BP states to report crude oil plus condensate and NGL proved reserves.

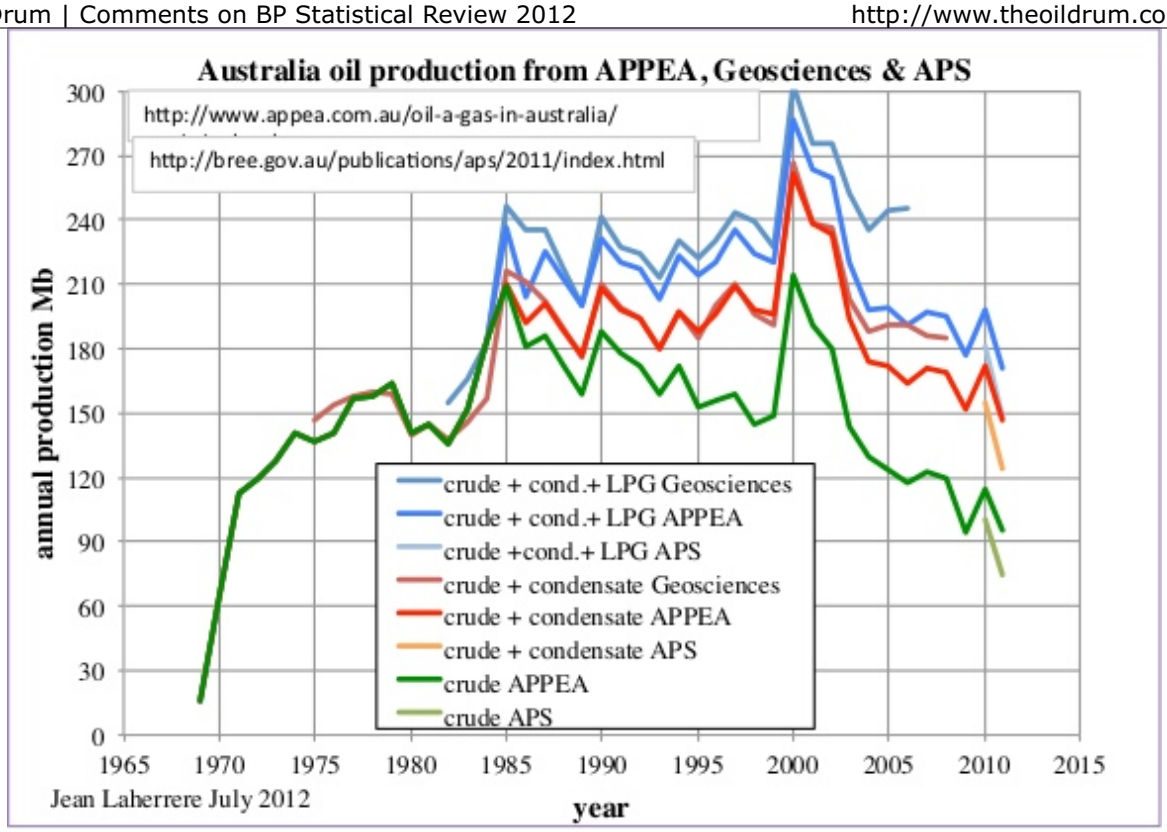
Figure 17: Australia proved oil reserves from different sources



The figures presented in 2012 BP report agree exactly with the Geosciences Economical Demonstrated Resources (EDR) for crude oil plus condensate plus LPG from 1982 to 2002; but EDR figures are 2P, not 1P. From 2003 onwards the BP reserves values are higher than EDR by about 0.3 Gb, meaning that some other liquids are reported, but it is difficult to find what it is. BP should report the LNG separately like the EIA does.

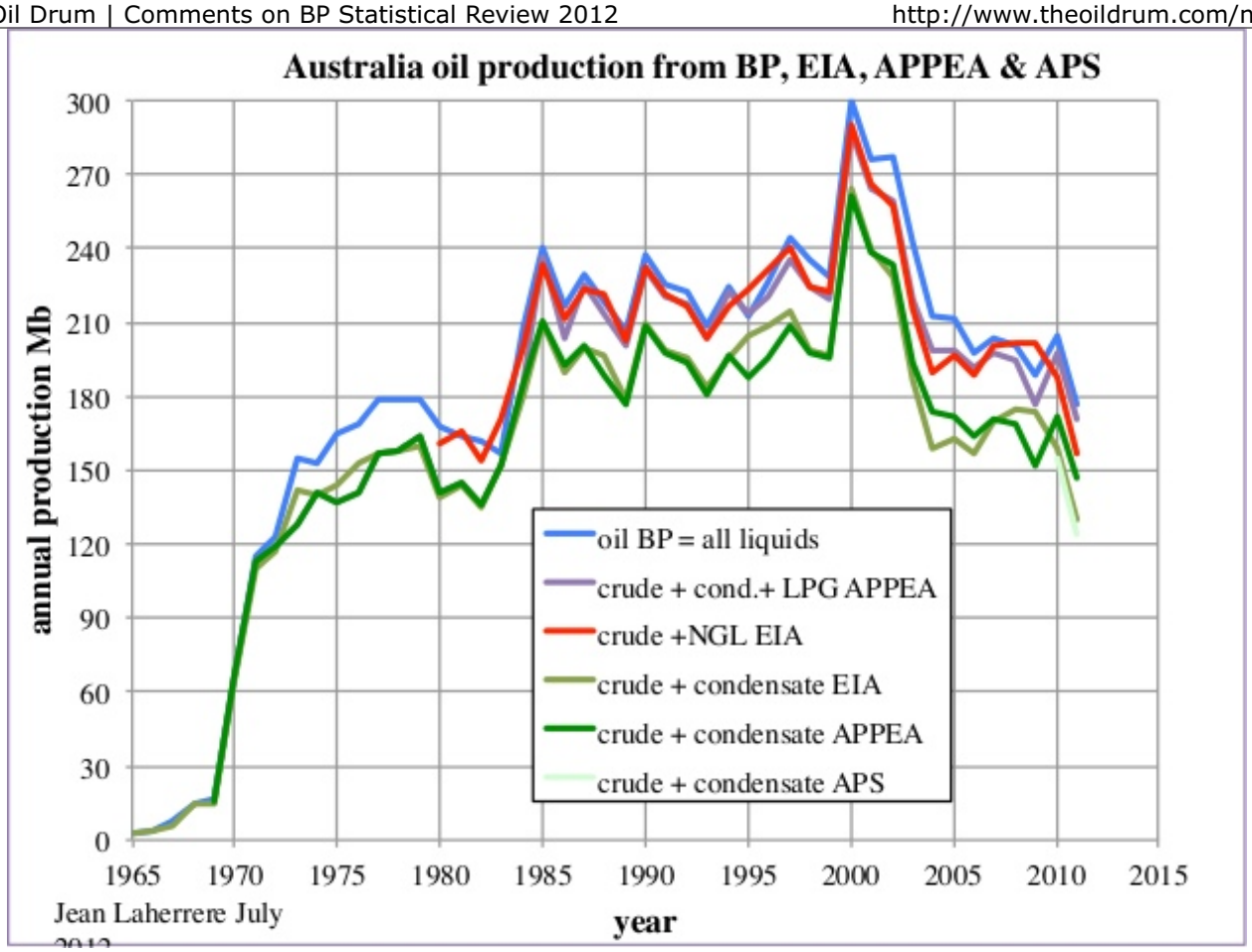
Australia reports oil production data through several organizations like Geosciences Australia, now taken over by Australian Petroleum Statistics and the Australian Petroleum Production & Exploration Association. One of the problems of Australia is that the fiscal year covers two years in the Gregorian calendar. Geosciences production data differs in last years and APPEA data should be preferred. However the new APS production data (starting in 2010) is lower than the APPEA data, also disagreeing with EIA figures.

Figure 18: Australia oil production from APPEA, Geosciences & APS



The BP oil production values (in blue) are higher than crude oil + condensate + LPG from the APPEA (in purple) and crude + LNG from the EIA (in red). Either BP is adding to oil production data (like in oil reserves data) something else than crude oil and NGL, or it just represents the inaccuracy of the data, despite that Australian data is in volume and not in weight! The difference peaked in 1975 at 28 Mb and again in 2003 at 23 Mb.

Figure 19: Australia oil production from BP, EIA, APPEA & APS

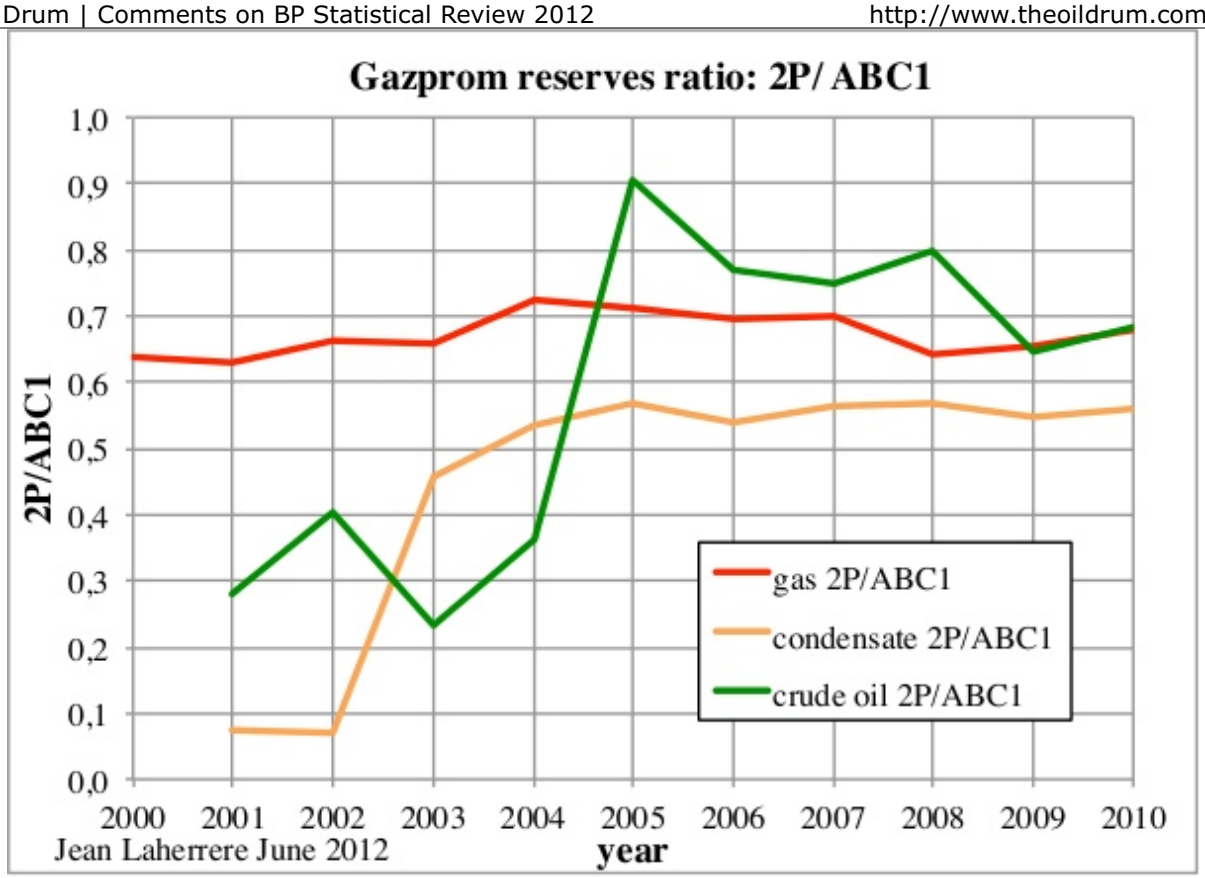


1.7. Russia

It is hard to find data for Russia from the start, because up to 1996 most data covers the Former Soviet Union, and during the cold war, oil data was a State secret. This State secret was abolished at the break up of the USSR but the Duma reintroduced it and publishing oil reserves can be punished with 7 years of jail (but not for gas!).

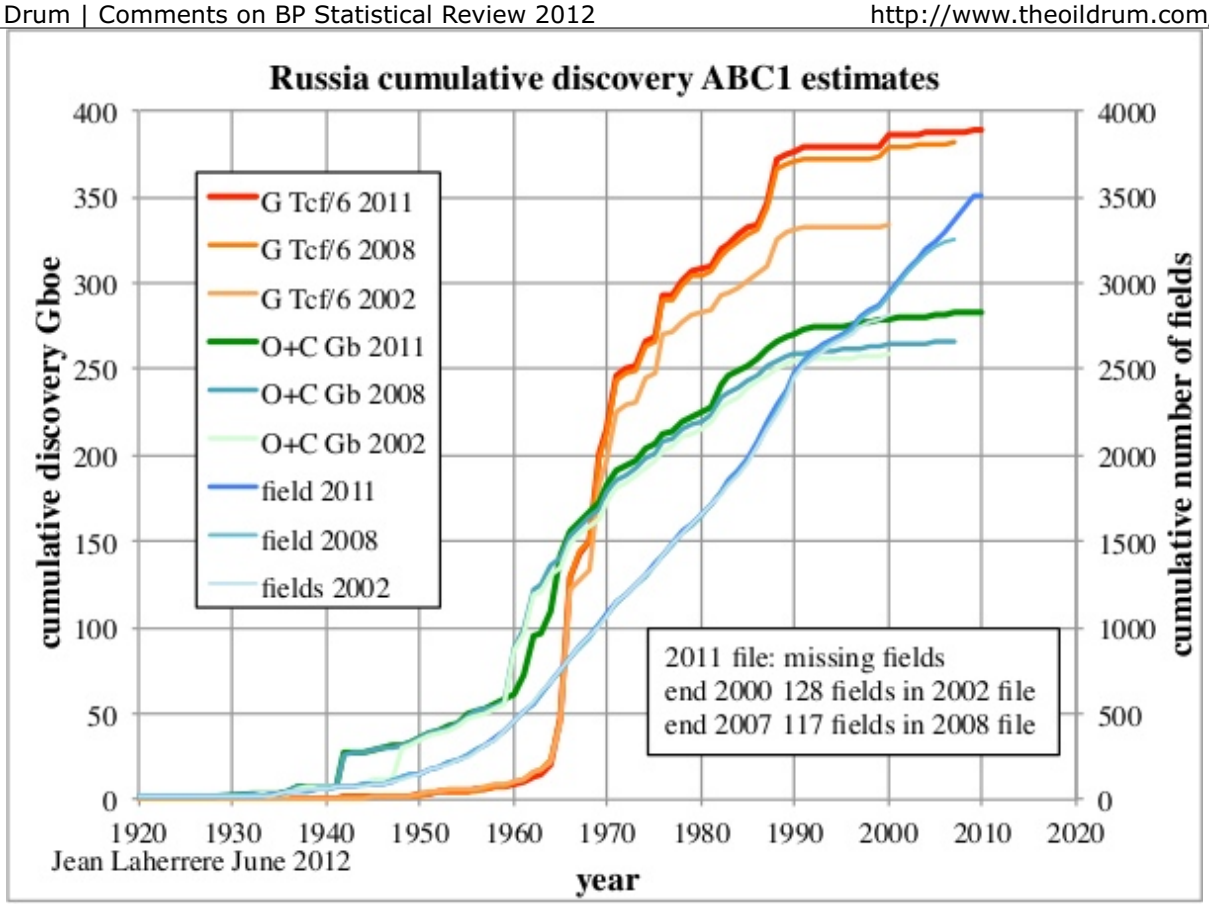
The other problem is that FSU reserves estimates are Russian estimates called ABC1, following a classification presented by Khalimov at WPC 1997 (Khalimov E.M., M.V.Feign 1979 "The principles of classification and oil resources estimation" WPC Bucharest, Heyden London 1980 p263-268). The same Khalimov stated in 1993 these ABC1 estimates as “grossly exaggerated” (Khalimov E.M., 1993, "Classification of oil reserves and resources in the Former Soviet Union" AAPG 77/9 Sept, p.1636) It is necessary to correct ABC1 oil data to 2P (mean values) estimates and for a long time I had used a 30% reduction, based on the ultimate estimated from the oil decline in mean giants fields (Romashkino, Samotlor, Urengoy). Fortunately, Gazprom's annual reports since 2000 provides reserves estimates using ABC1 and 2P. The ratio 2P/ABC1 from Gazprom is for oil between 0.9 and 0.7 during the last few years.

Figure 20: Gazprom reserves ratio 2P/ABC1



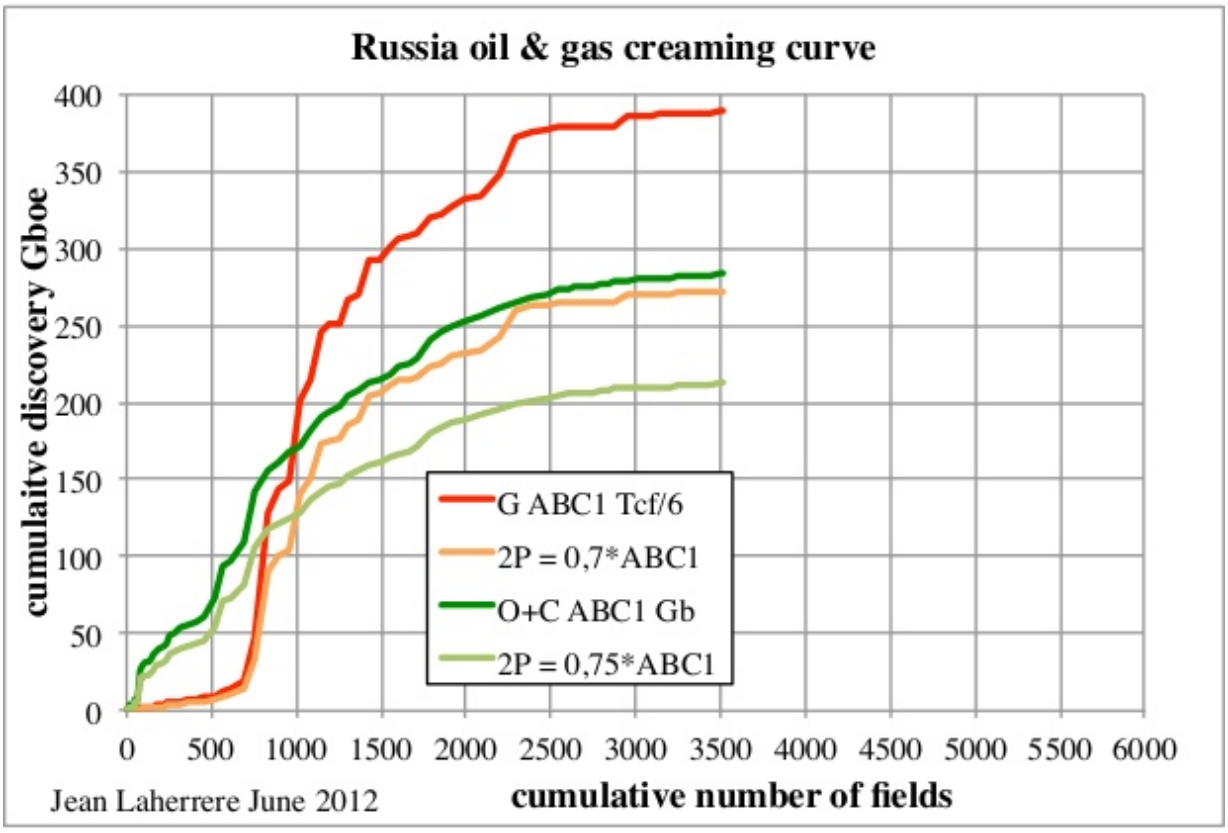
The evolution of ABC1 estimates has increased with time but it is due mainly to the fact that the data was incomplete. At end of 2007 the 2008 file is short of 117 fields, comparing to the 2011 file, meaning that the cumulative discovery at this date was small.

Figure 21: Russian cumulative oil & gas discovery from 2002 to 2011



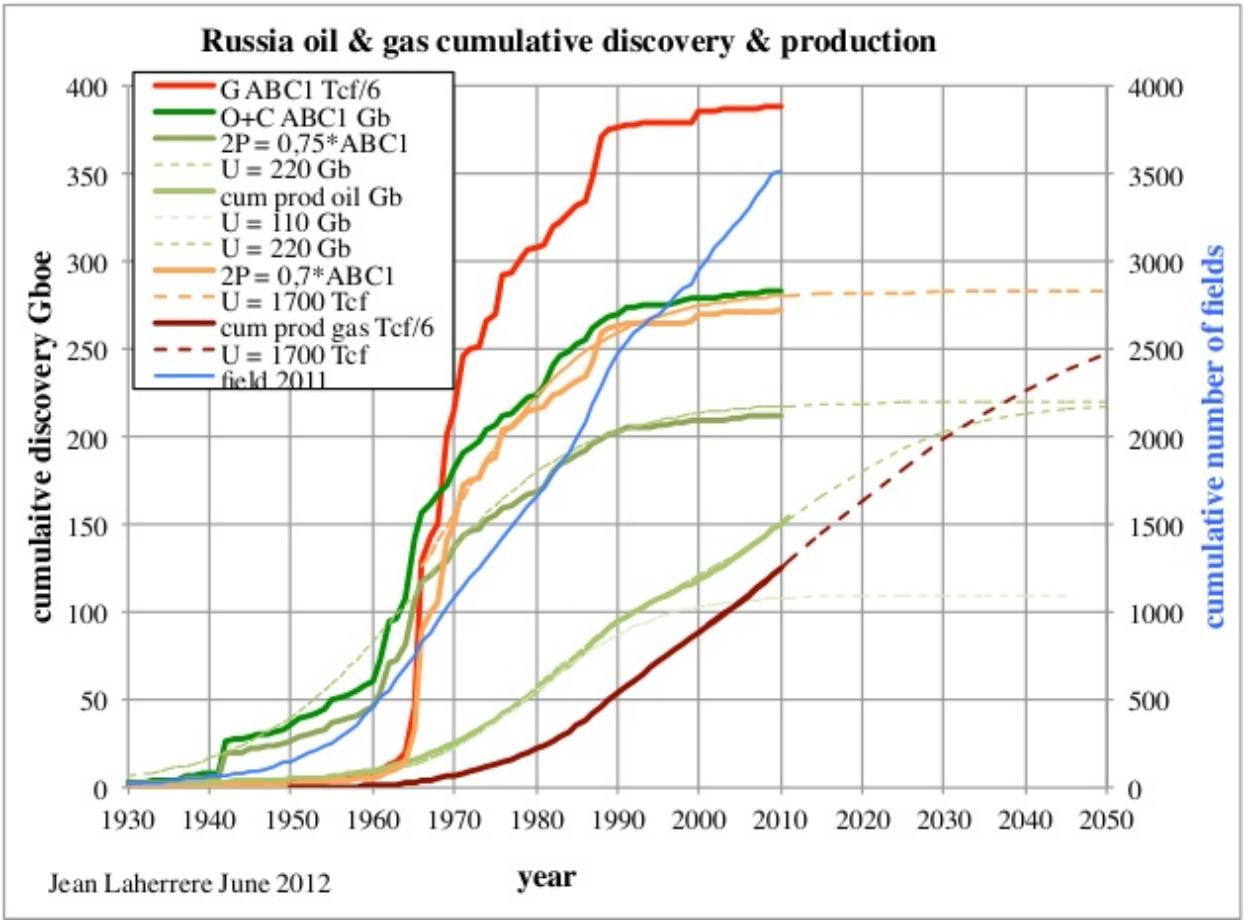
The creaming curve for ABC1 oil (2011 file) trends towards 300 Gb and for 2P with a ratio of 0.75 towards 220 Gb.

Figure 22: Russian oil & gas creaming curve



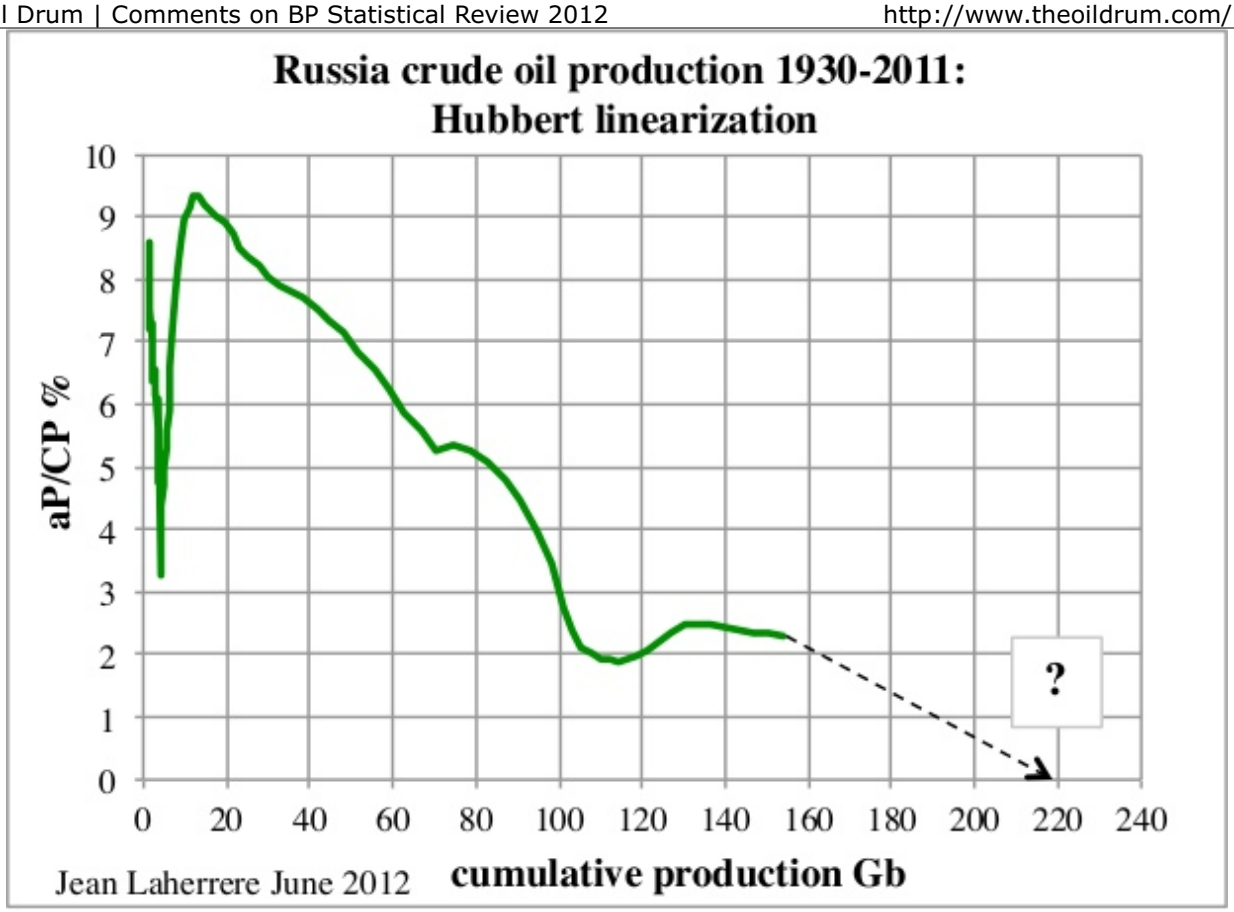
In time, the cumulative 2P discovery can be modeled with an S curve with an ultimate of 220 Gb for oil and 283 Gboe (1700 Tcf) for natural gas. The cumulative production is modeled with two cycles (one with FSU and one after the break up).

Figure 23: Russian oil & gas cumulative oil & gas discovery & production



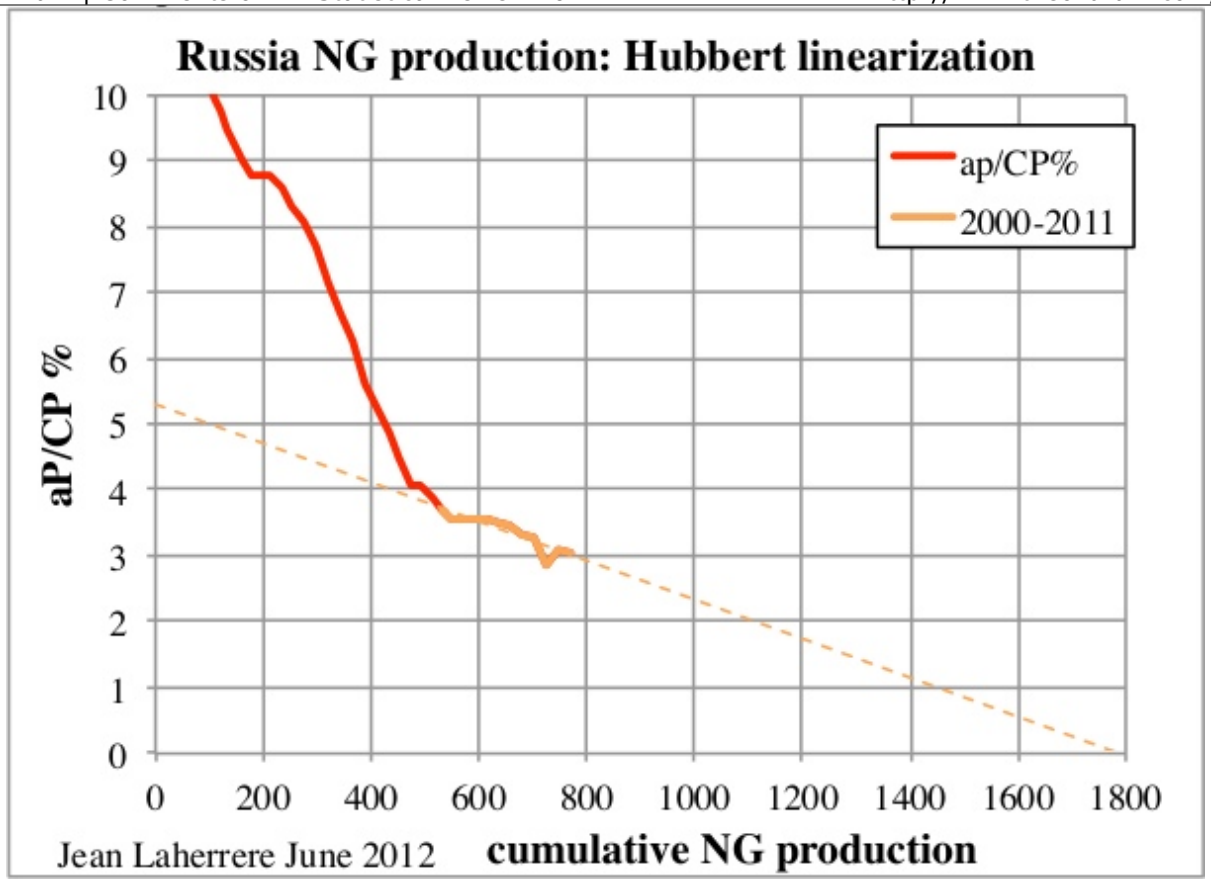
In studies where only production data is available, an extrapolation of ultimate reserves can be made using the method called Hubbert linearization, but when the trend is not linear, any estimate is unreliable. For Russian oil, the extrapolation with the Hubbert linearization is poor and the ultimate of 220 Gb from the creaming curve is not obvious.

Figure 24: Russian crude oil production : Hubbert linearization



For NG, the extrapolation of the last period 2000-2011 trends towards 1800 Tcf, in line with the questionable ultimate of 1700 Tcf from the creaming curve.

Figure 25: Russian NG production: Hubbert linearization

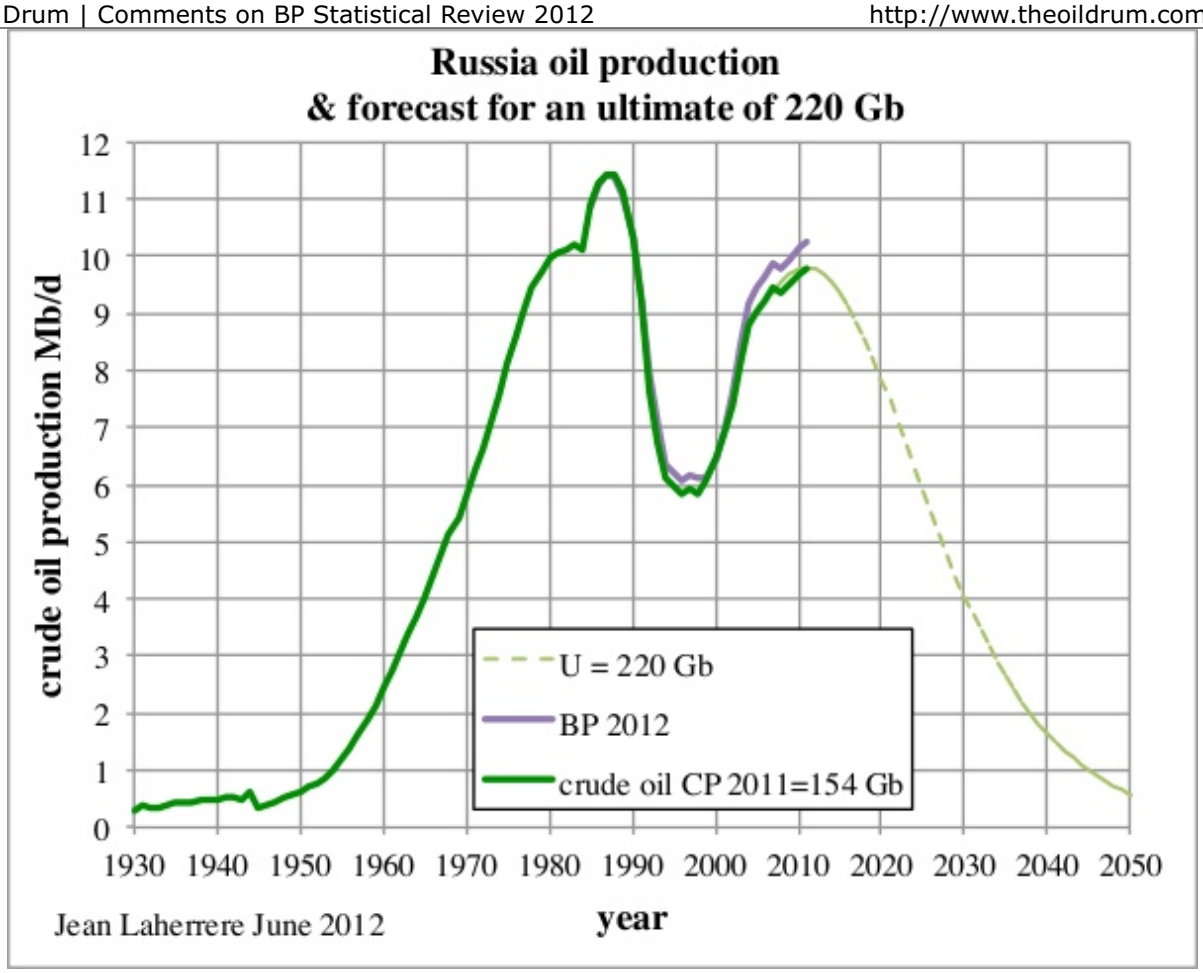


The remaining 2P oil reserves have peaked during the 1970s and are sharply in decline since 1983, whereas the published proved reserves from OGJ/EIA/BP are still rising. The 2011 estimate is a flat 60 Gb since 2001, which is obviously impossible, Russia is not finding exactly what it produces! World Oil magazine is showing erratic values and, because of that, they stopped reporting world reserves since 2009.

Figure 26: Russian remaining reserves from different sources

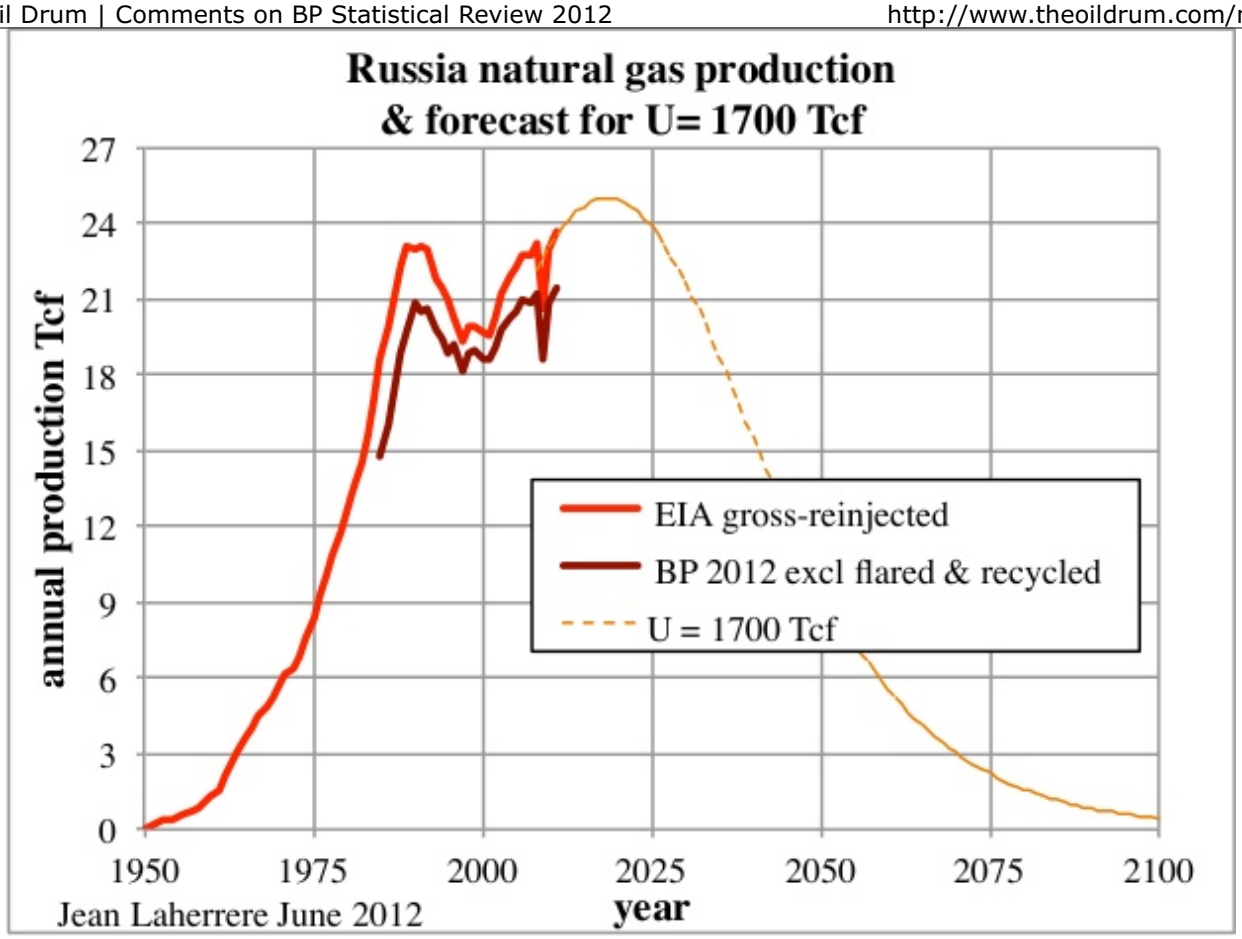
In the past my Russia oil ultimate was a round figure of 200 Gb; now with better data (but still questionable) I assume an ultimate about 220 Gb and that the annual oil production will decline from a second peak in 2011. The Russian energy minister has stated in the 20th of June that oil production will decline from 500 Mt to 370 Mt in 10-20 years (about 7 Mb/d in 2025), which is in line with my forecast.

Figure 27: Russian crude oil production & forecast for an ultimate of 220 Gb



BP reports natural gas production excluding flared and recycled gas. But what is flared is lost and should be removed from reserves. The gross less re-injected is about 2 Tcf higher than BP, because of the flaring. My model for the future with an ultimate of 1700 Tcf is a simple one, assuming only geological constraints (below ground), while above ground constraints exist in Russia. Uncertainties remains in particular around the investment on the giants fields in the Yamal Peninsula (Bovanenko) and in the Arctic (Shtokman) but also regarding environmental problems. Bovanenko (discovered in 1971) is just developing and the development of Shtokman (discovered in 1988) is yet to be decided. The model with an ultimate of 1700 Tcf displays a second peak around 2020 at 25 Tcf/a.

Figure 28: Russian NG production & forecast for an ultimate of 1700 Tcf



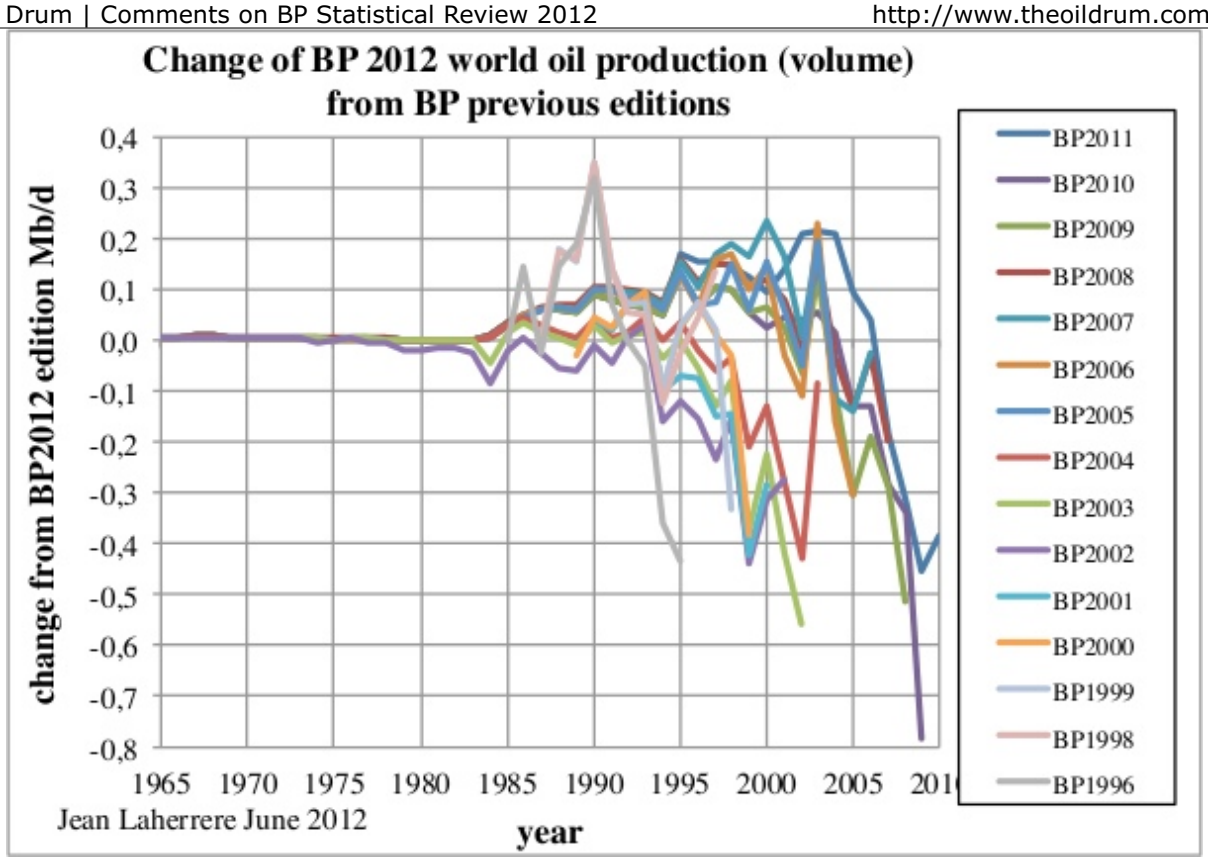
It is likely that the gas peak around 2020 will be more complex, depending the development of giant fields like Shtokman.

1.8. World oil production & oil consumption

BP uses different definitions for oil production and for consumption, biomass, as coal derivatives are also excluded in oil production, but not in oil consumption. Oil production "includes crude oil, shale oil, oil sands and NGLs (the liquid content of natural gas where this is recovered separately)". Oil consumption is "inland demand plus international aviation and marine bunkers and refinery fuel and loss". Consumption of fuel ethanol and biodiesel is also included.

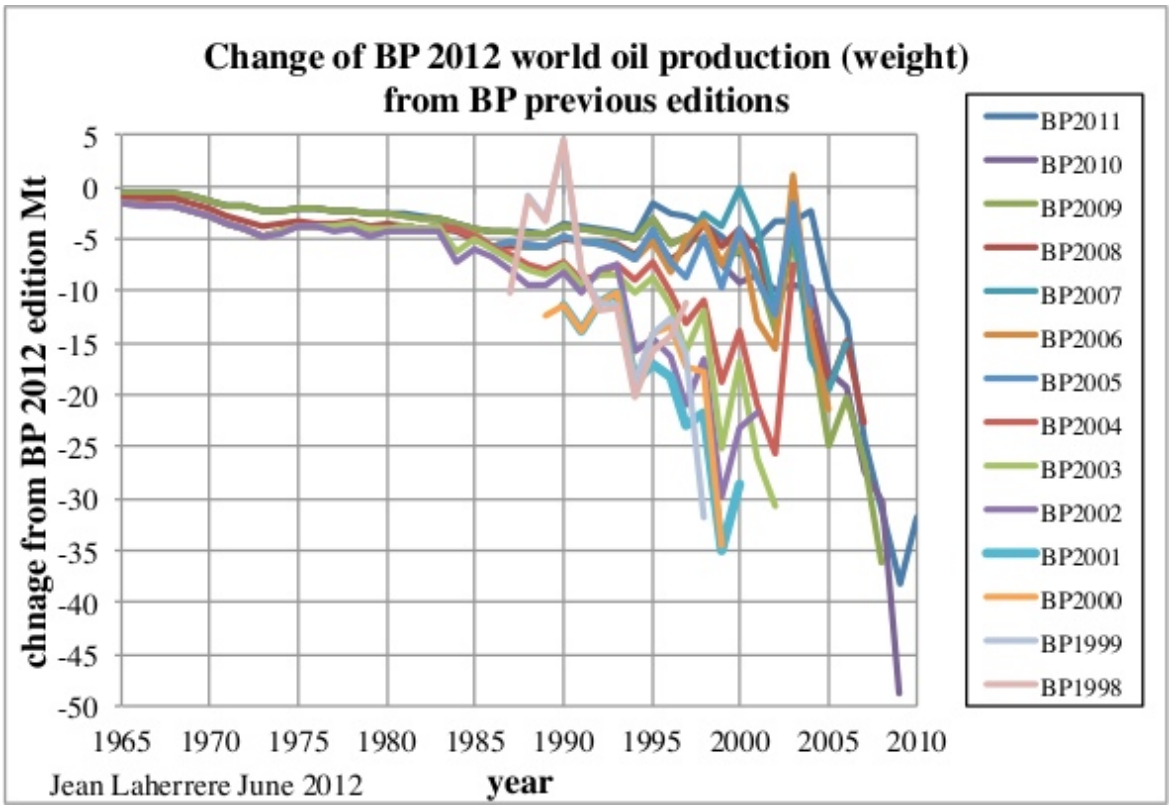
The change between previous editions and BP 2012 for world oil production in volume shows a range of about 1 Mb/d (from - 0.8 to 0.2 Mb/d).

Figure 29: change of BP 2012 world oil production (volume) from previous BP editions



The same plot for the world oil production in weight shows a different trend, meaning that the average density of oil is varying.

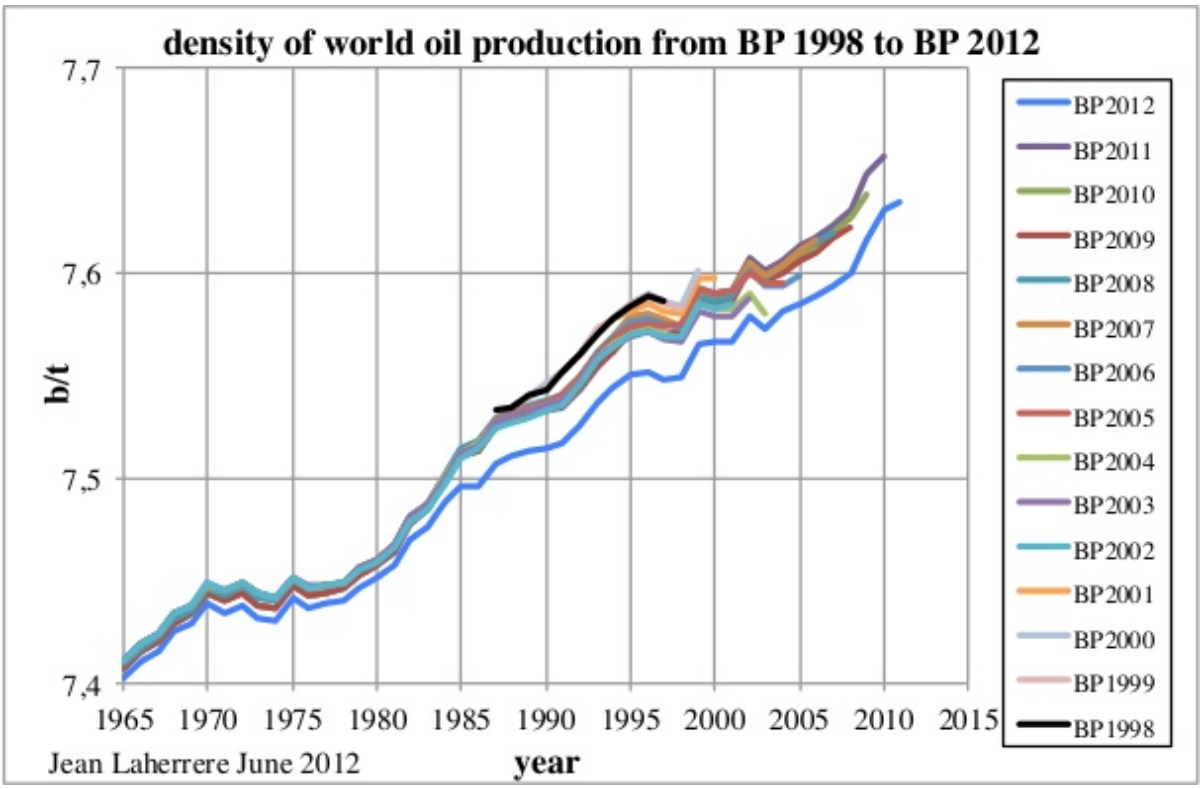
Figure 30: change of BP 2012 world oil production (weight) from previous BP editions



The plot of the density (in barrel per tonne) of world oil production from BP 1998 to BP 2012

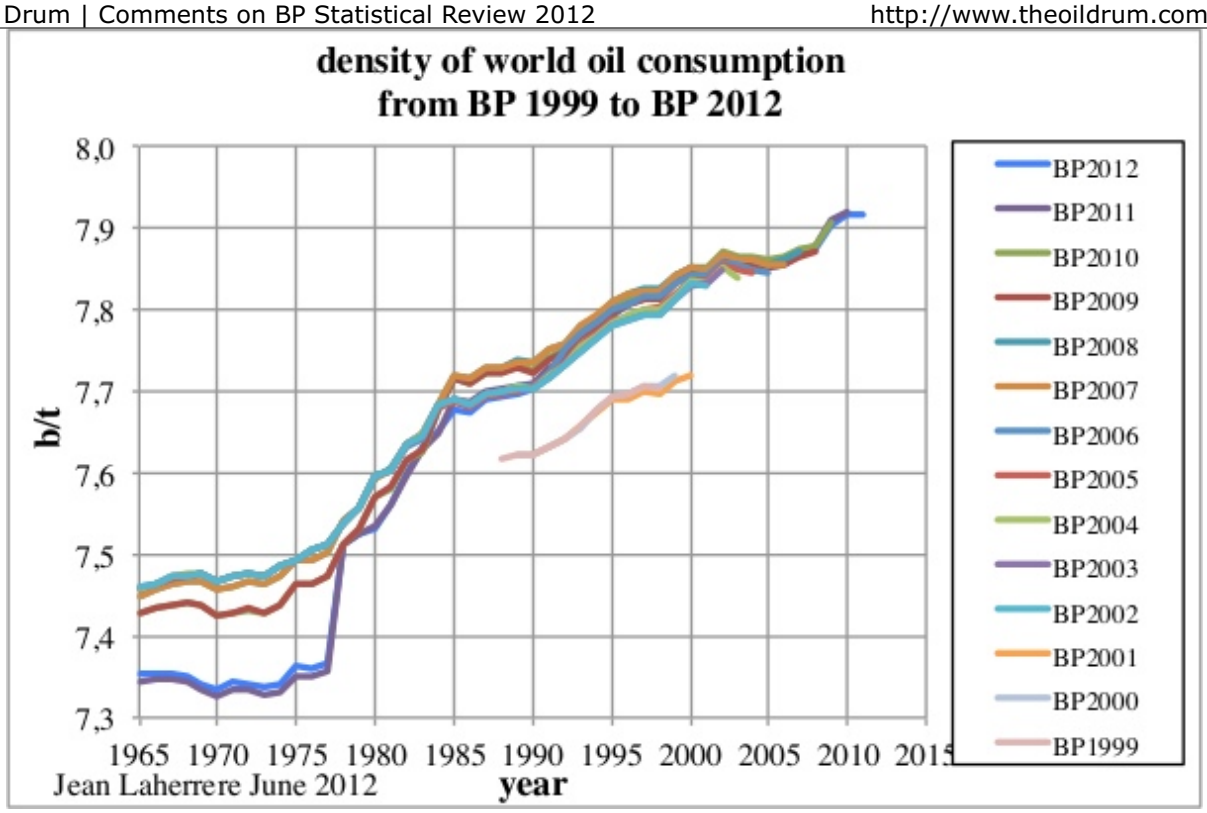
shows that oil is getting lighter from 7.4 to 7.65 b/t, but BP is continuously correcting this trend, meaning that they do not have the right data. These are mainly guesses and guesses change with authors!

Figure 31: density of world oil production from BP 1998 to BP 2012



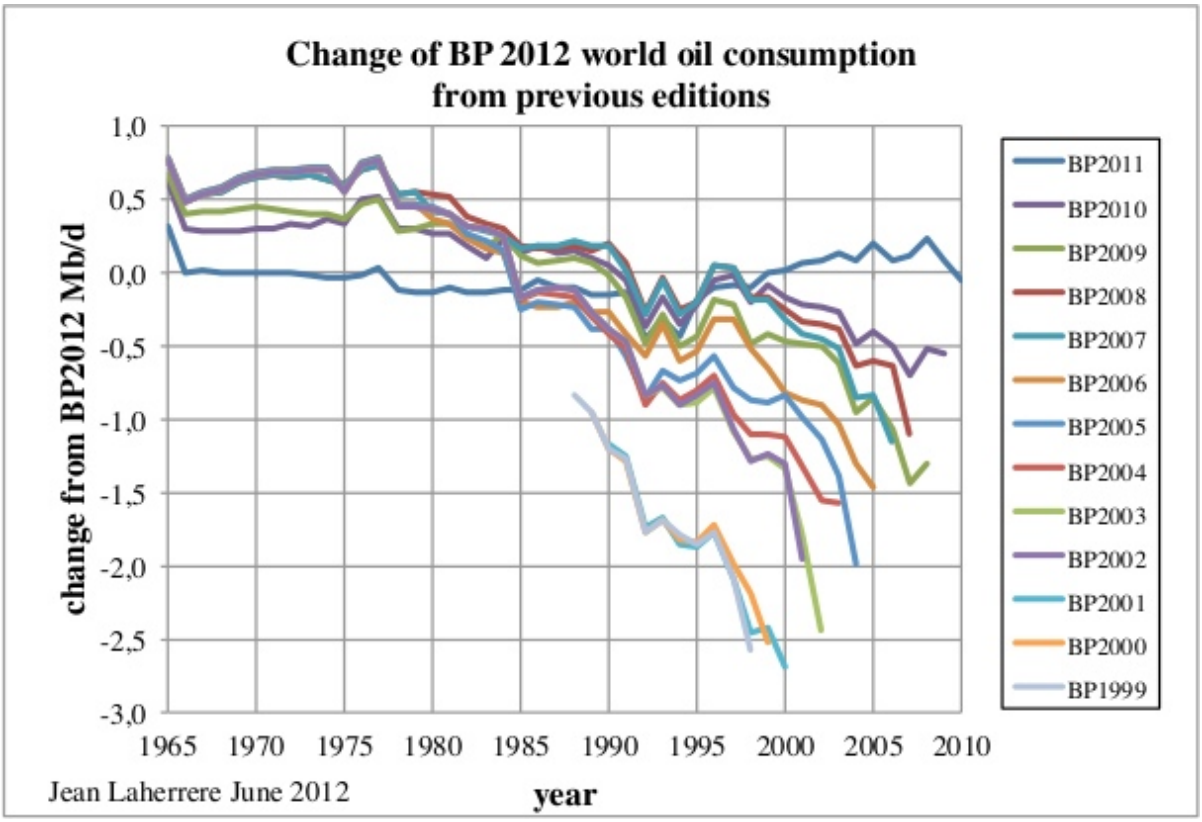
The plot of the density of world oil consumption from BP 1998 to BP 2012 shows a different behavior (because of the different definition that includes biofuels), but BP corrected in recent years by diminishing the density for the data from 1965 to 1977. The plots from editions before 2010 look more harmonious!

Figure 32: density of world oil consumption from BP 1998 to BP 2012



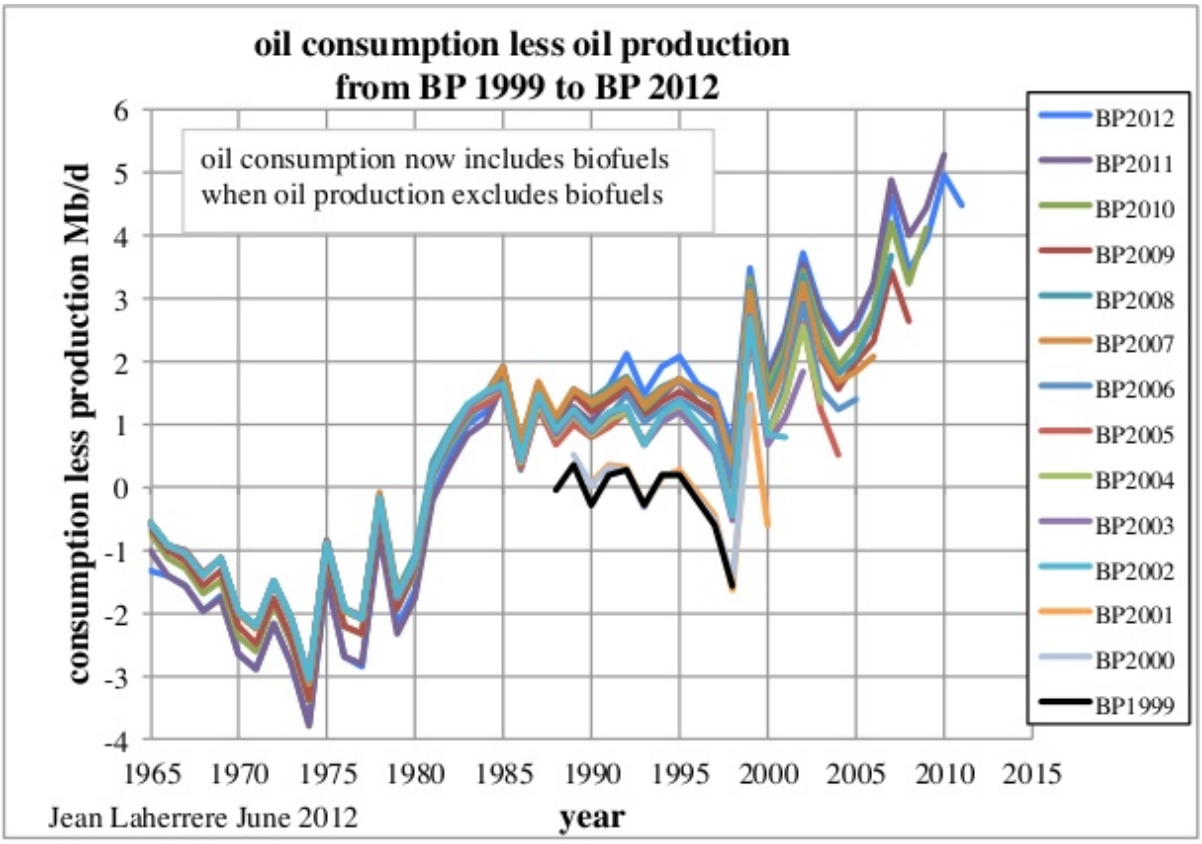
The world oil consumption change from previous BP editions shows erratic behavior, meaning that the data is not reliable! It will certainly change next year again.

Figure 33: change of BP 2012 world oil consumption from previous editions



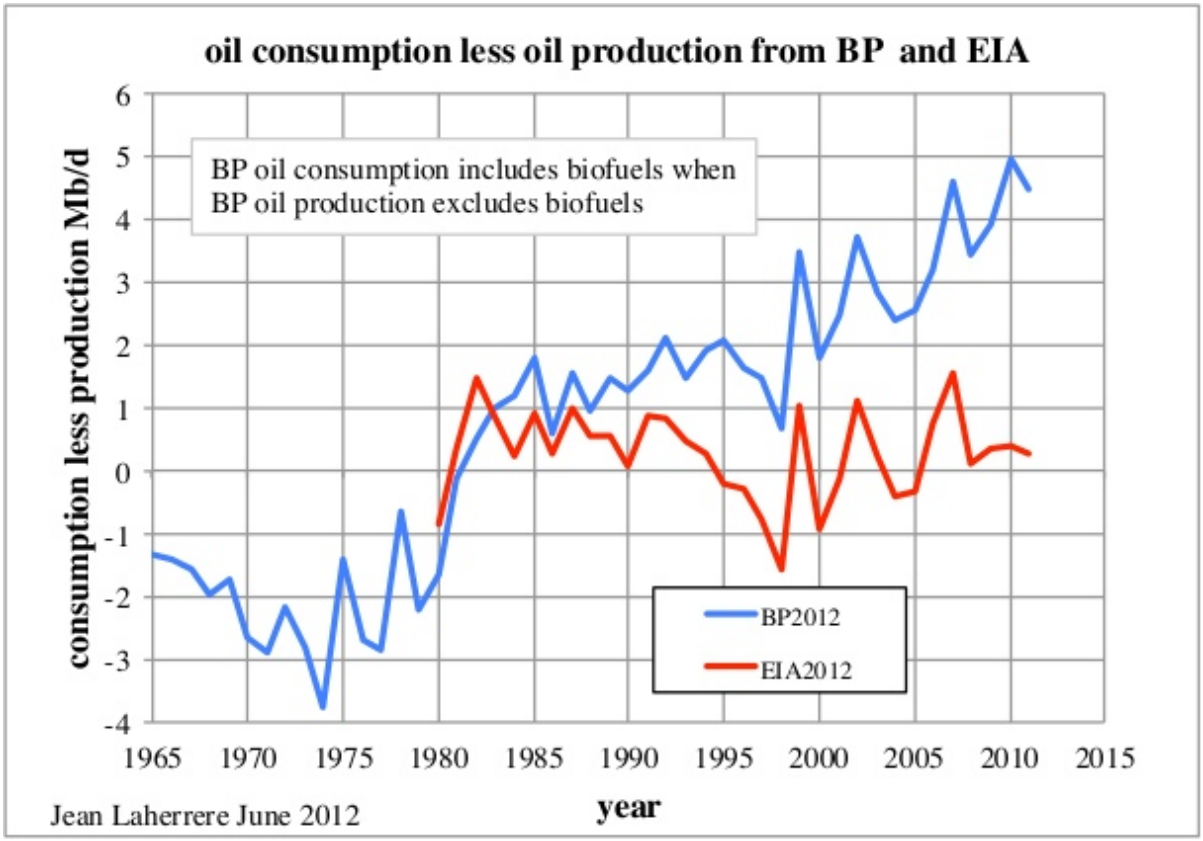
The difference between oil consumption and oil production (mainly due to biofuels and refinery gain) shows an increase from 1974 but with a range of uncertainty of about 2 Mb/d.

Figure 34: world oil consumption less oil production from BP 1999 to BP 2012



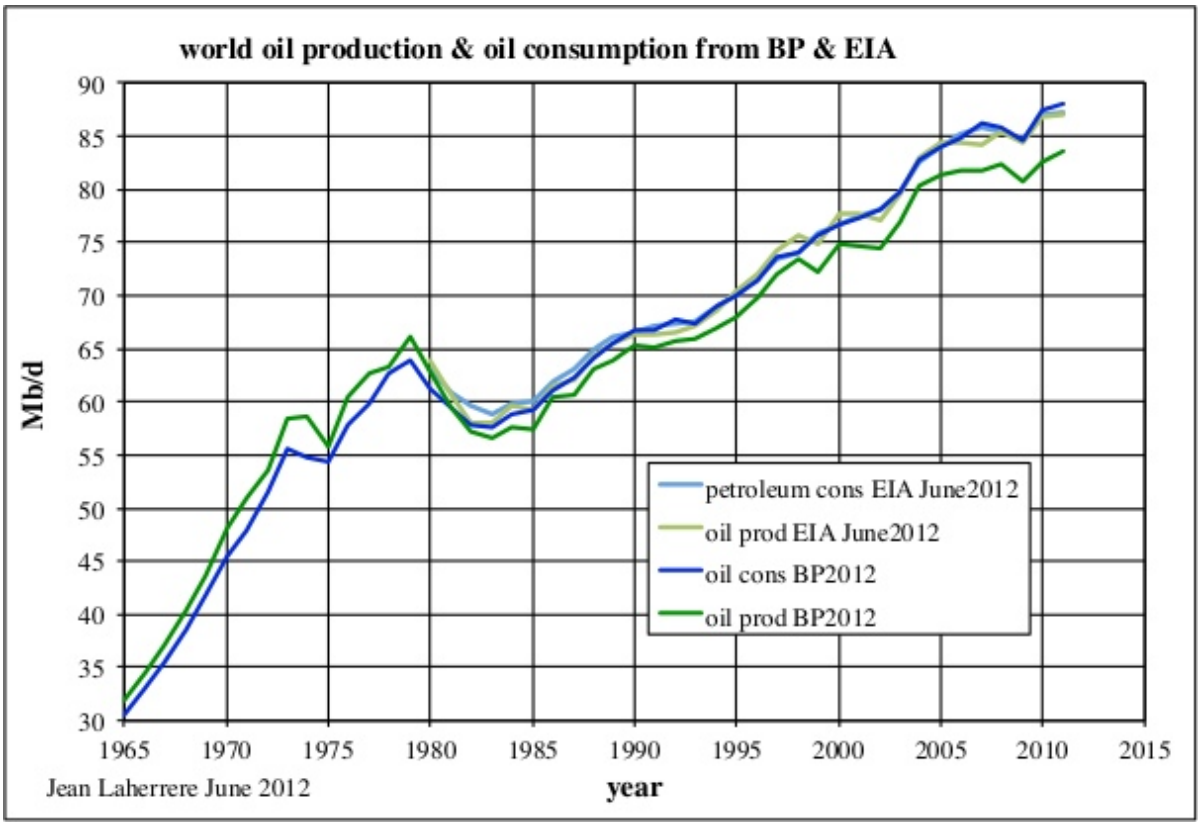
EIA reports oil production & consumption since 1980 and the world difference varies around zero (depending on stocks). The plot of EIA 2012 is close to the plot of BP 1999.

Figure 35: world oil consumption less oil production from BP and EIA



The difference is mainly due to the biofuels. Oil consumption data is about the same for BP and EIA, while oil production data are different because of biofuels and refinery gains!

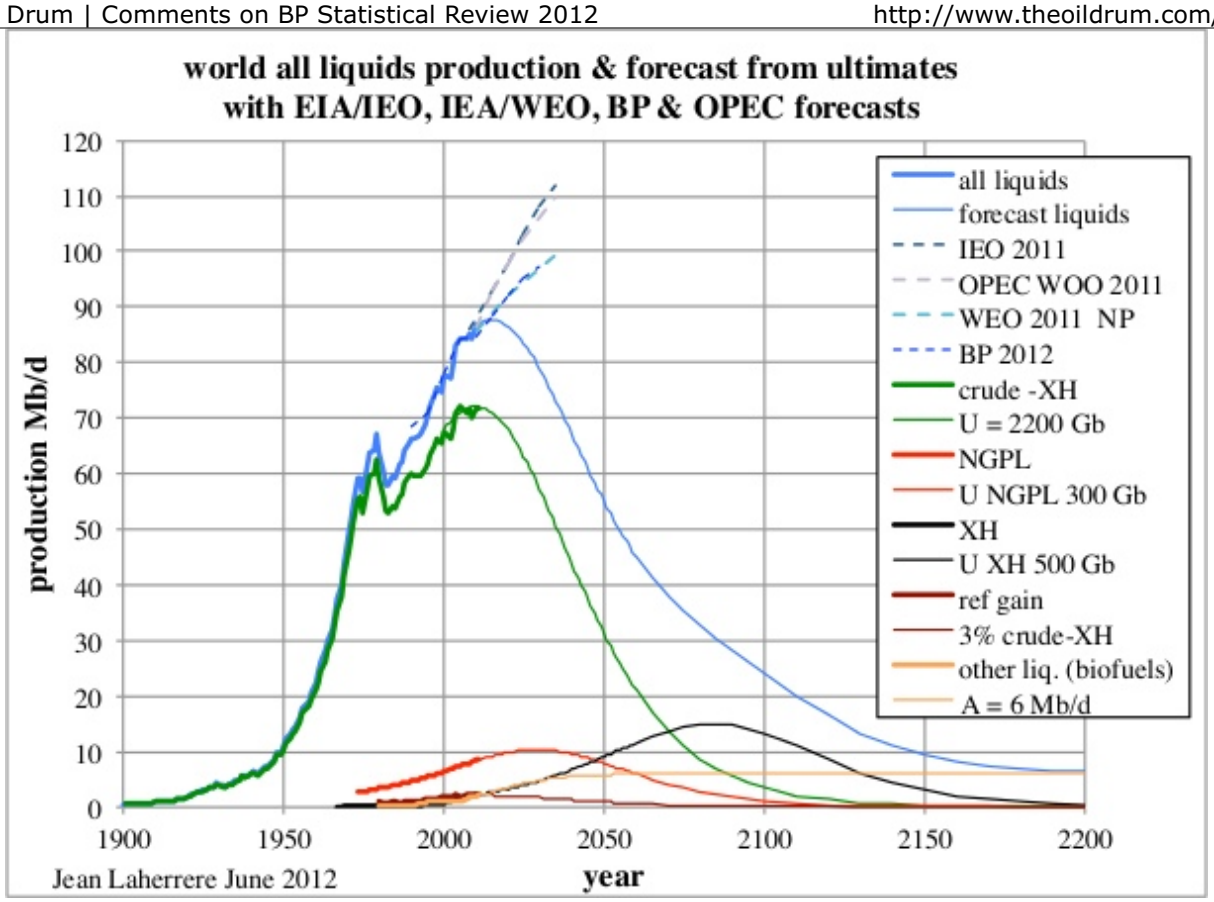
Figure 36: world oil consumption and production from BP and EIA



1.9. Oil production forecast

The forecast presented in BP 2012 are similar to those found in the IEA/WEO 2011 NP, but are lower than USDOE/EIA/IEO2011 (which is similar to OPEC/WOO2011). BP recopies other sources, but prefers IEA to USDOE/EIA! Its main merit is to provide historical series in spreadsheets. But BP does not like to report the discrepancy with others sources, or the discrepancy with its previous editions. The comparison of official oil production forecasts with the forecast using the technical data shows an obvious difference, like in Figure 4 on remaining reserves. The breakdown of the all liquids production is modeled with ultimates estimated from creaming curves: 2200 Gb for crude oil less extra-heavy (XH), 500 Gb for extra-heavy, 300 Gb for NGL, with refinery gains being 3% of the crude less extra-heavy, and other liquids (renewable biofuels) trending towards an asymptote of 6 Mb/d.

Figure 37: world all liquids production & forecast

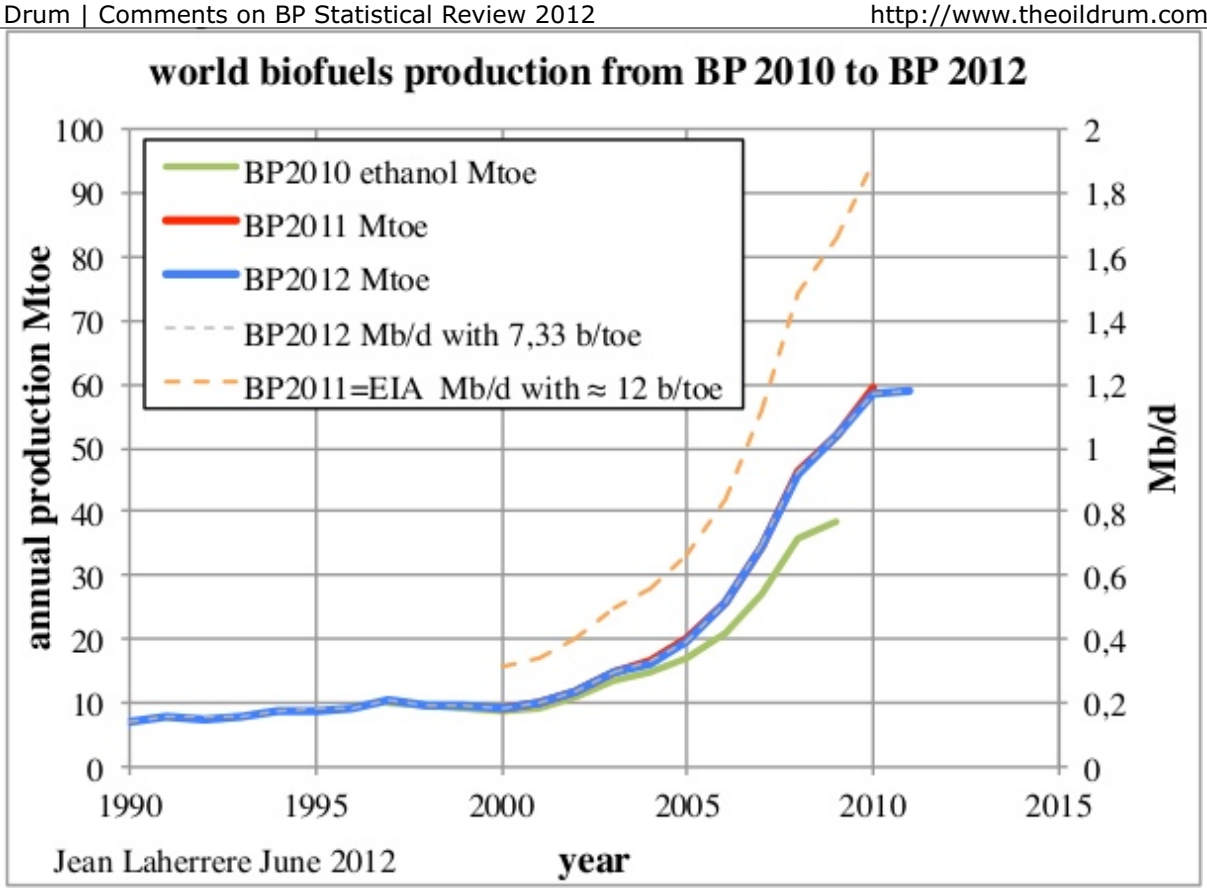


Official forecasts are simply "no worry": business as usual will prevail, peak oil is a myth, while technical data shows the contrary!

2. Biofuels

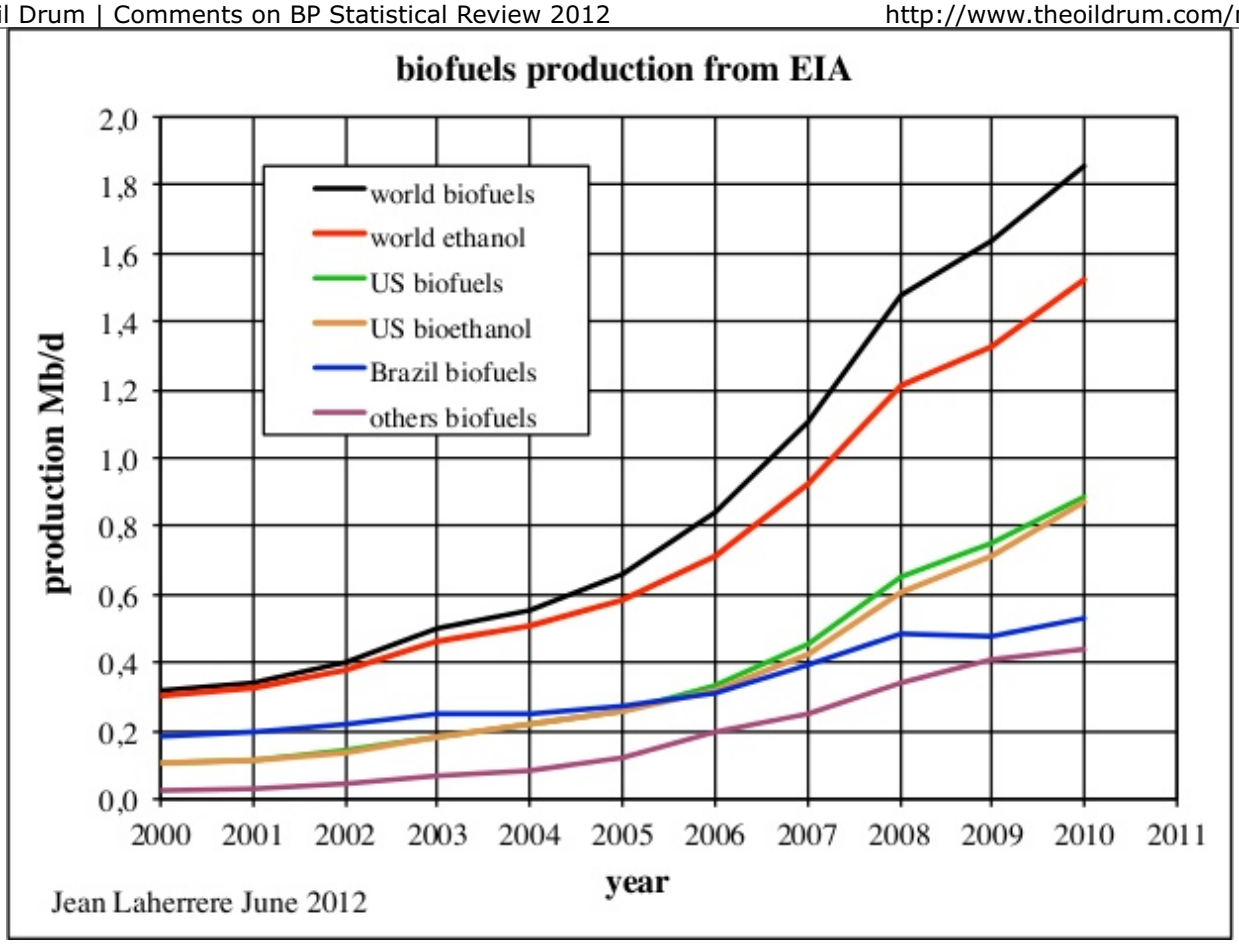
BP reports biofuels since 2010 in ktoe and kb/d, but the conversion between barrel and toe looks queer!

Figure 38: world biofuels production from BP 2010 to BP 2012



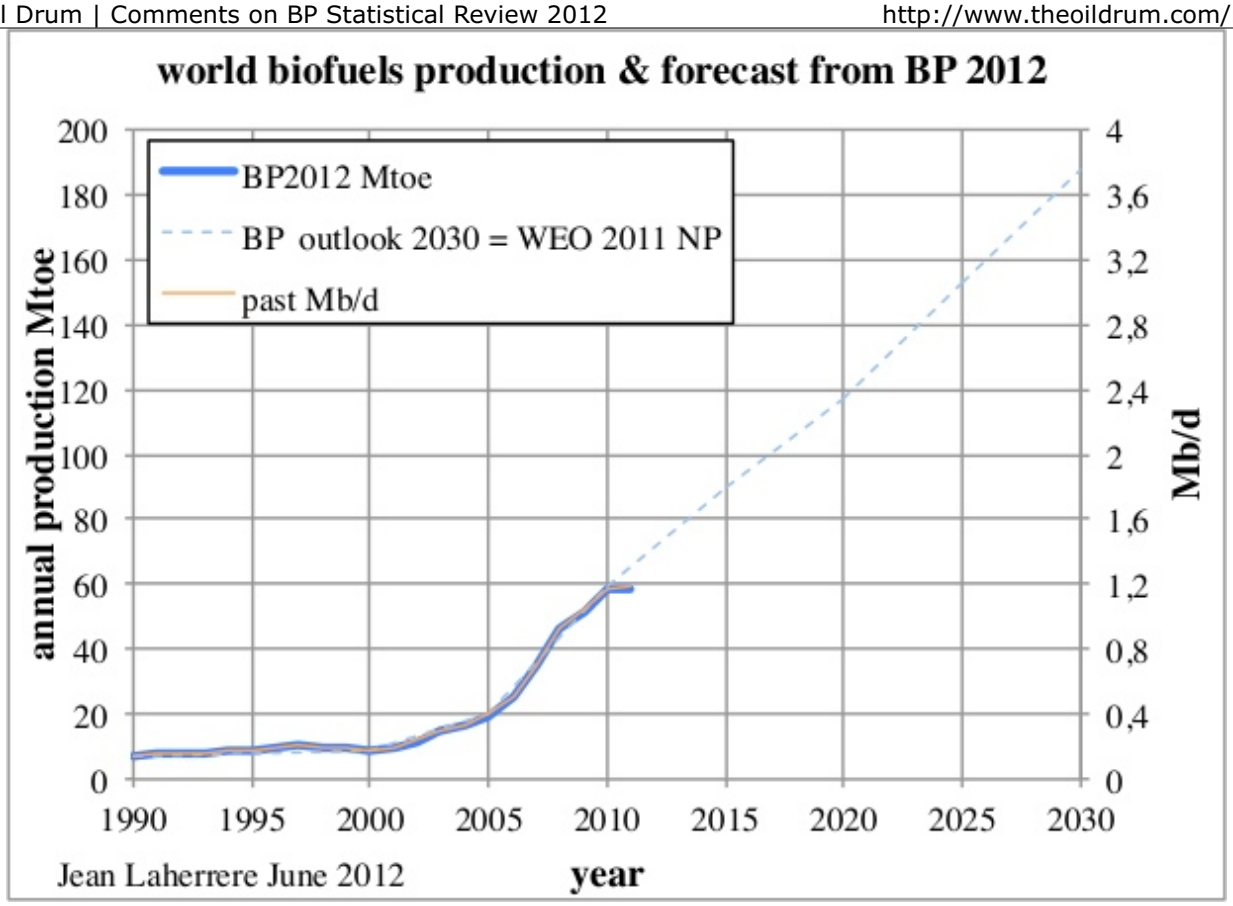
The data in b/d is computed for BP 2012 with a constant density of 7.33 b/t (toe) with constant 365 days per year and for BP 2011 with the real biofuel density varying from 12.6 to 11.6 b/t. EIA reports world biofuels only in Mb/d from 2000 to 2010 and the data is the same as BP 2011, which is over 1.8 Mb/d for 2010, against less than 1.2 Mb/d reported in BP 2012.

Figure 39: world biofuels production from EIA



BP should report biofuels data in volume in real barrels and not in barrels of oil equivalent to be in line with what is made by the EIA; it is only for data in toe that the density correction is done. The BP outlook to 2030 forecasts biofuels by simply copying what's published by the IEA in WEO 2011 New Policies.

Figure 40: world biofuels production

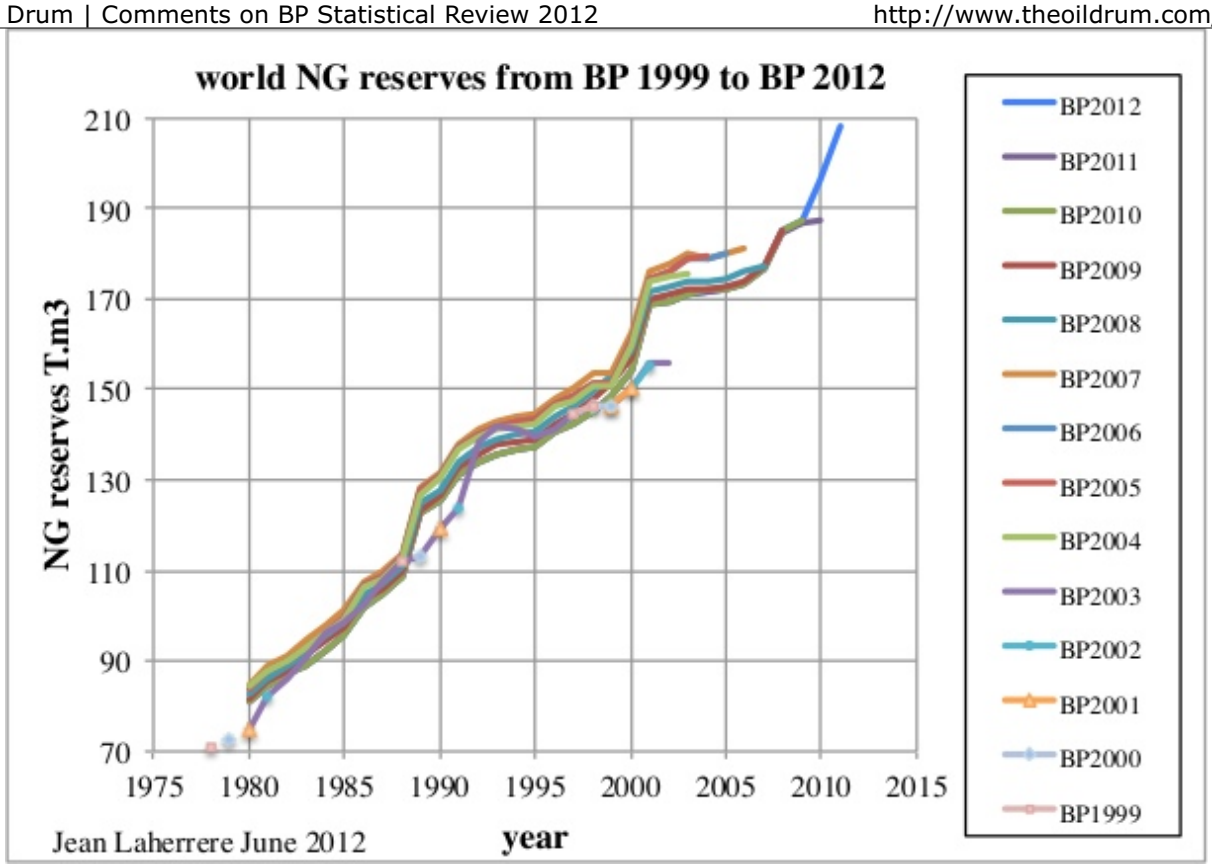


3. Natural gas

3.1. Reserves

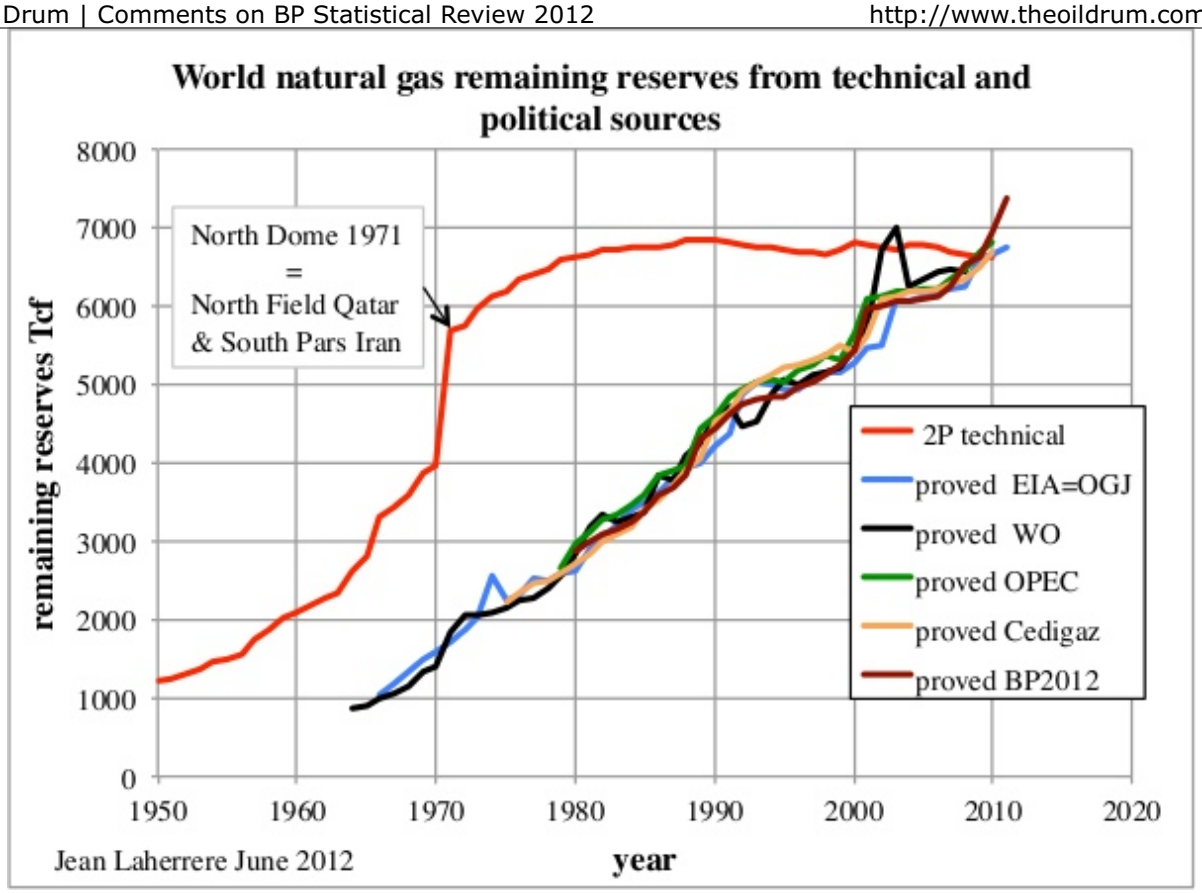
The Natural Gas (NG) proven reserves reported by BP have changed significantly with time, not always on the increase, for 2005 BP2007 was higher than BP2012.

Figure 41: world NG reserves from BP1999 to BP2012



The comparison of remaining reserves between current 1P (political/financial) and backdated technical 2P is as striking as it is for oil. The 2P technical data has flattened since 1980 when the current 1P is on then increase since 1965!

Figure 42: world NG remaining reserves from technical and political/financial sources



3.2. Production

BP presently reports NG production since 1970 in cubic meters, cubic feet per day and toe. The change of NG production from BP 1999 to BP 2012 are small when compared to the changes for oil. Practically there is no change in production for the period 1970-2011 for the data in volume (Gm^3) or in energy (Mtoe).

Figure 43: world NG production (Gm^3) from BP 1999 to BP 2012

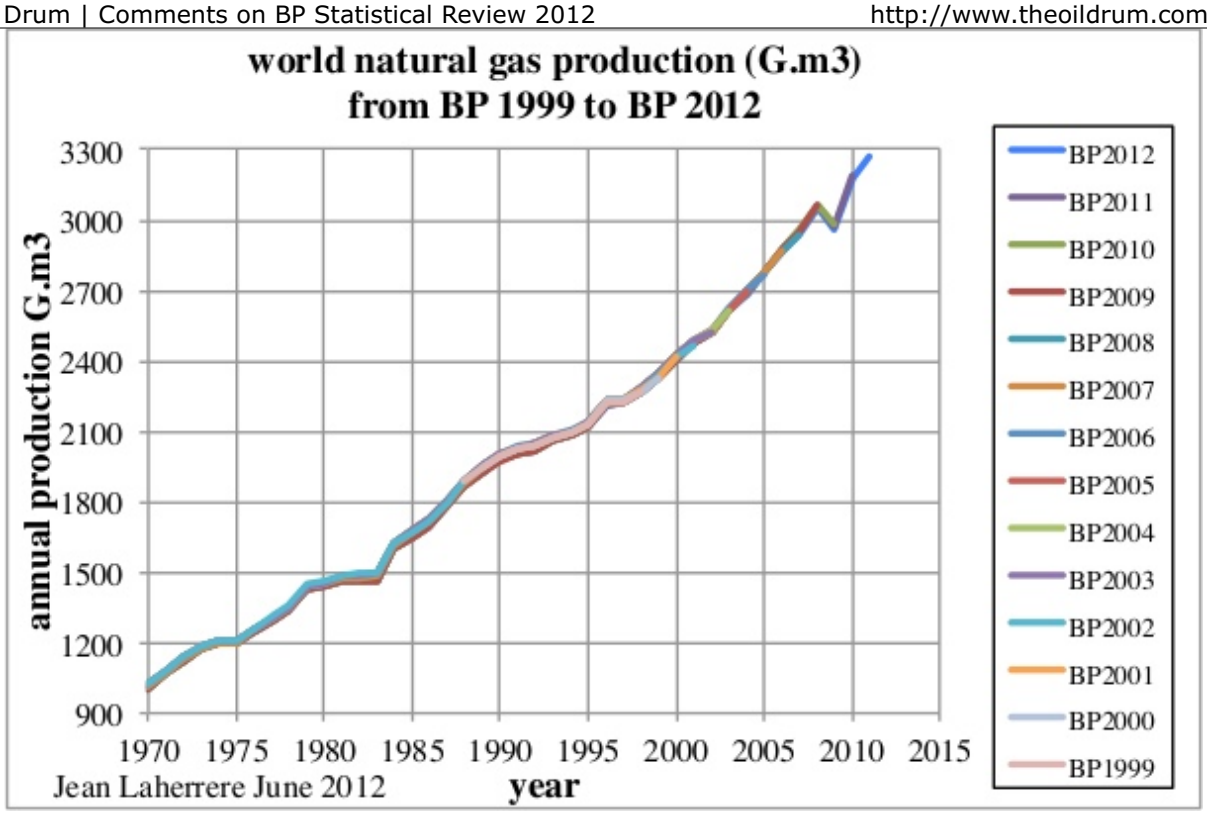
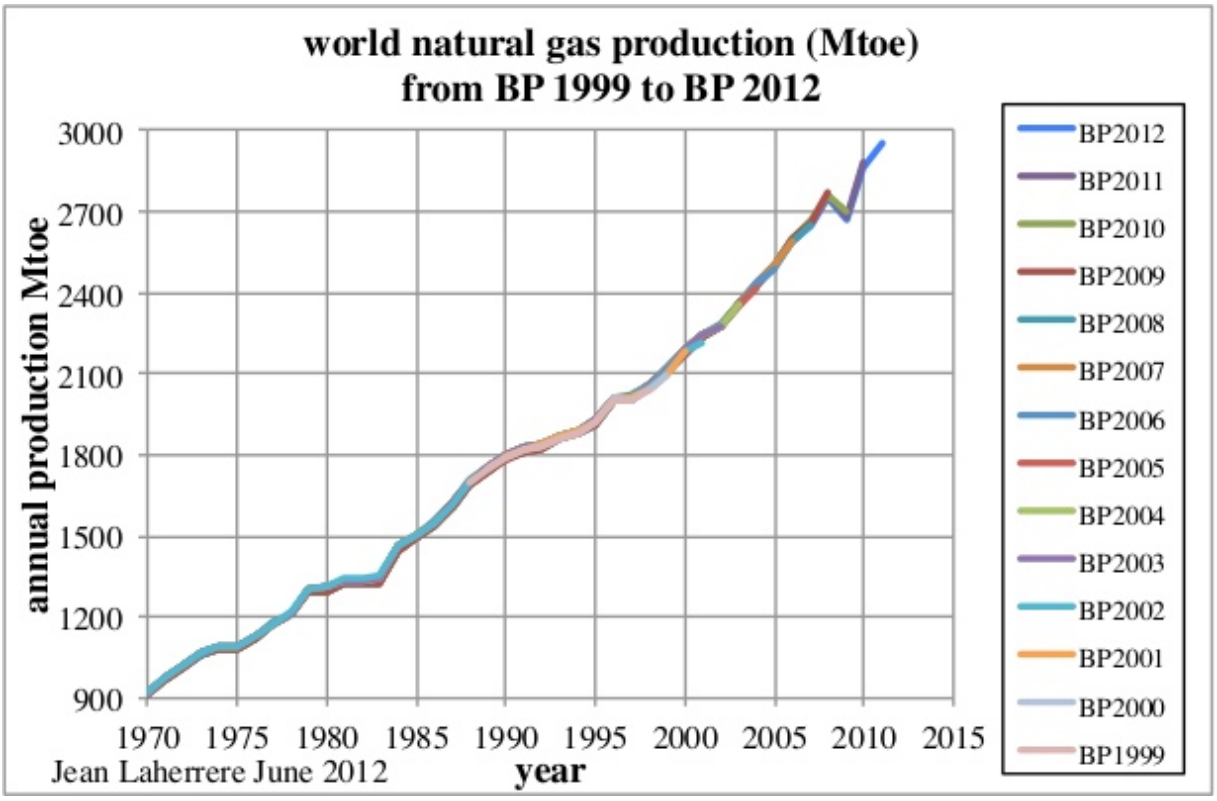
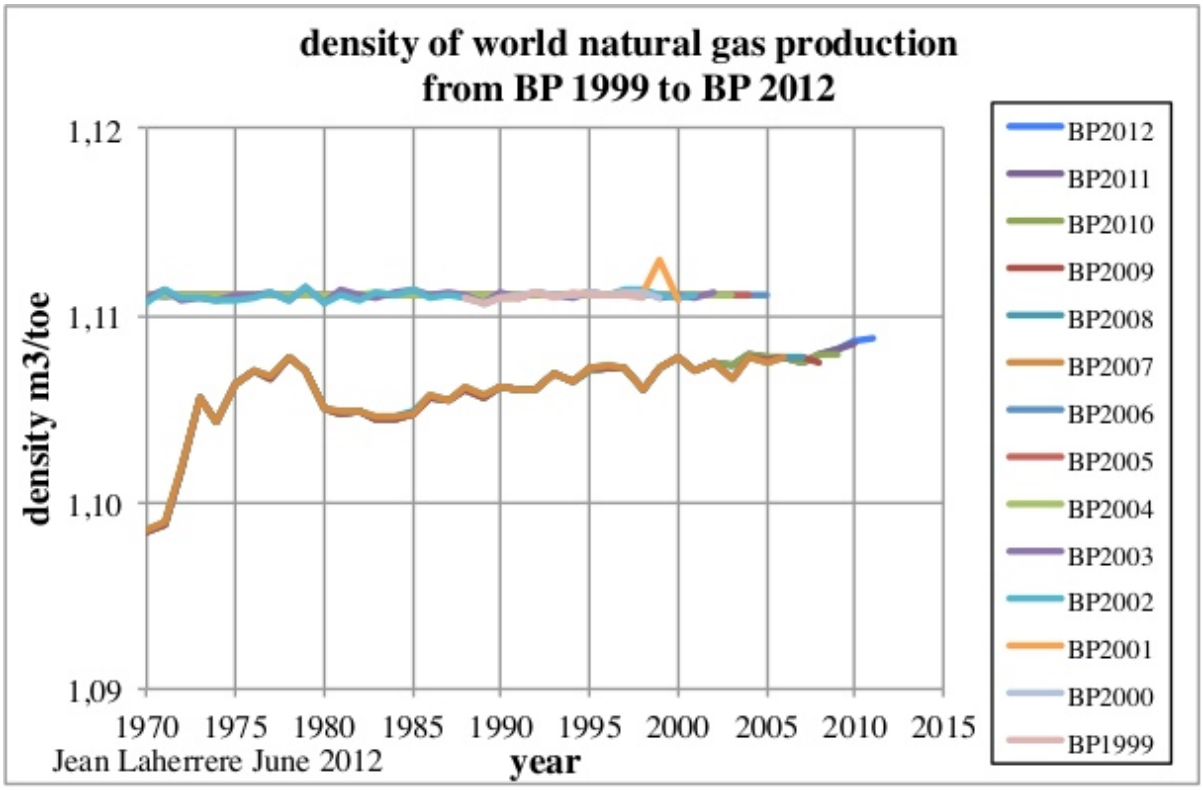


Figure 44: world NG production (Mtoe) from BP 1999 to BP 2012



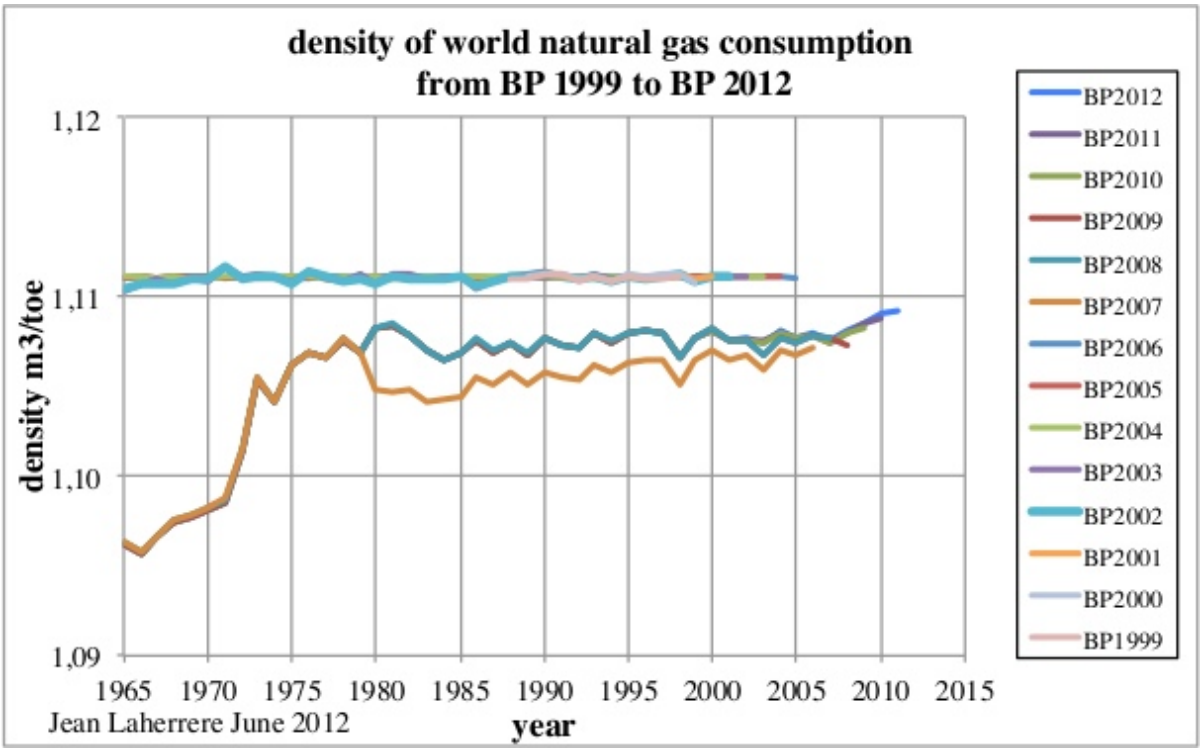
For the report in Gcf/d it seems that BP converted wrongly the data for the editions 2000, 2002 and 2003. The conversion ratio from cubic meters to toe was almost constant (poor practice?) from 1999 to 2006 at 1.111 m^3/toe, but increasing from 1.099 to 1.109 m^3/toe from 2007 to 2012.

Figure 45: density (m^3/toe) of world NG production from BP 1999 to BP 2012



The same plot for NG consumption density, which starts at 1965, is slightly different for the editions since 2007, meaning that BP does not use the same conversion ratio since for production and for consumption as it was different gas!

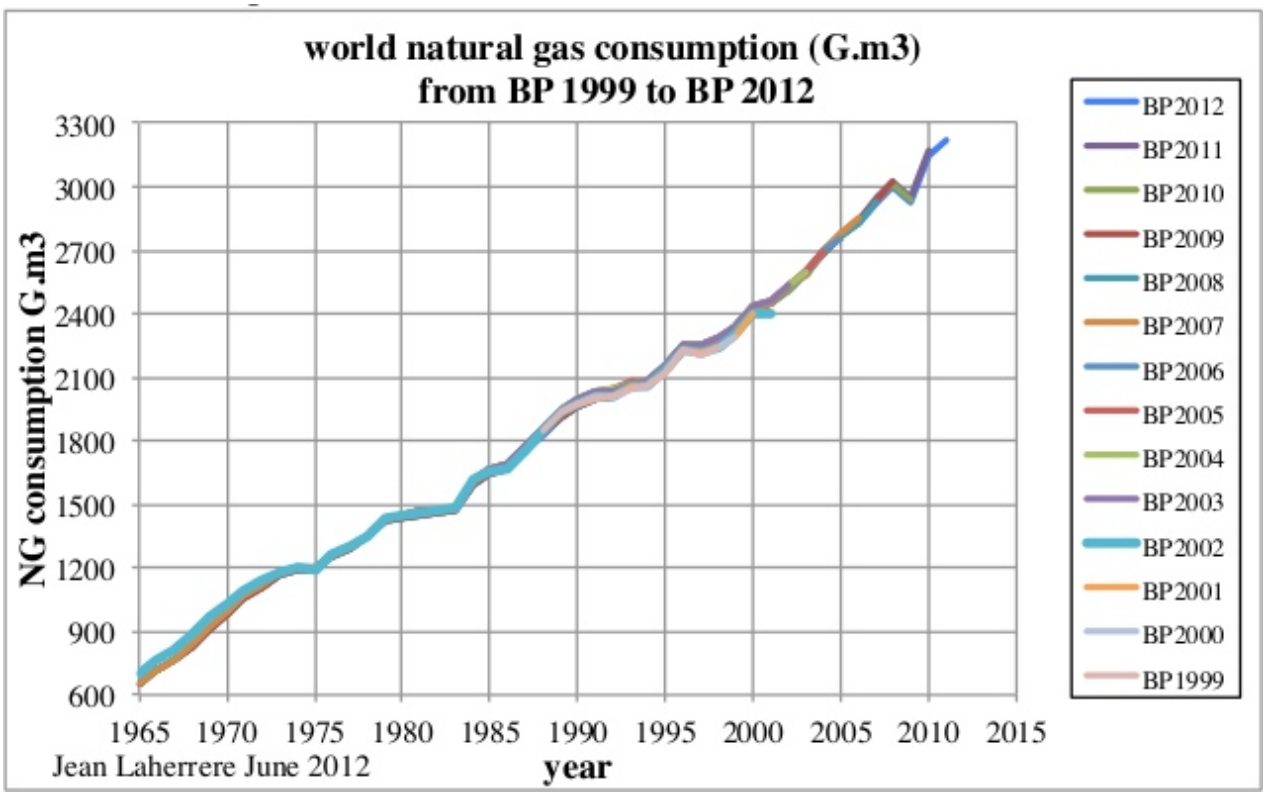
Figure 46: density of world NG consumption from BP 1999 to BP 2012



The plot of the world NG consumption shows roughly not much change, but being slightly

different from NG production.

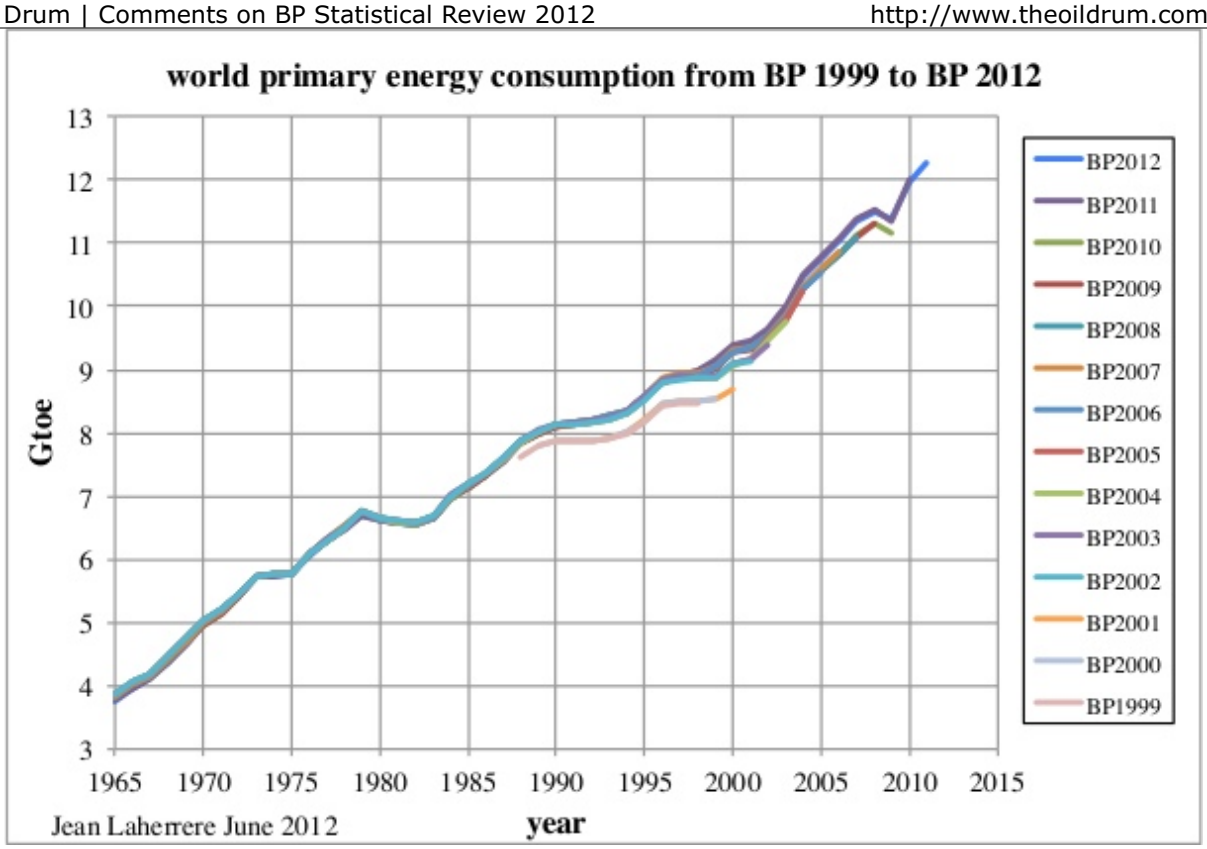
Figure 47: world NG consumption (G.m3) from BP 1999 to BP 2012



4. Primary energy

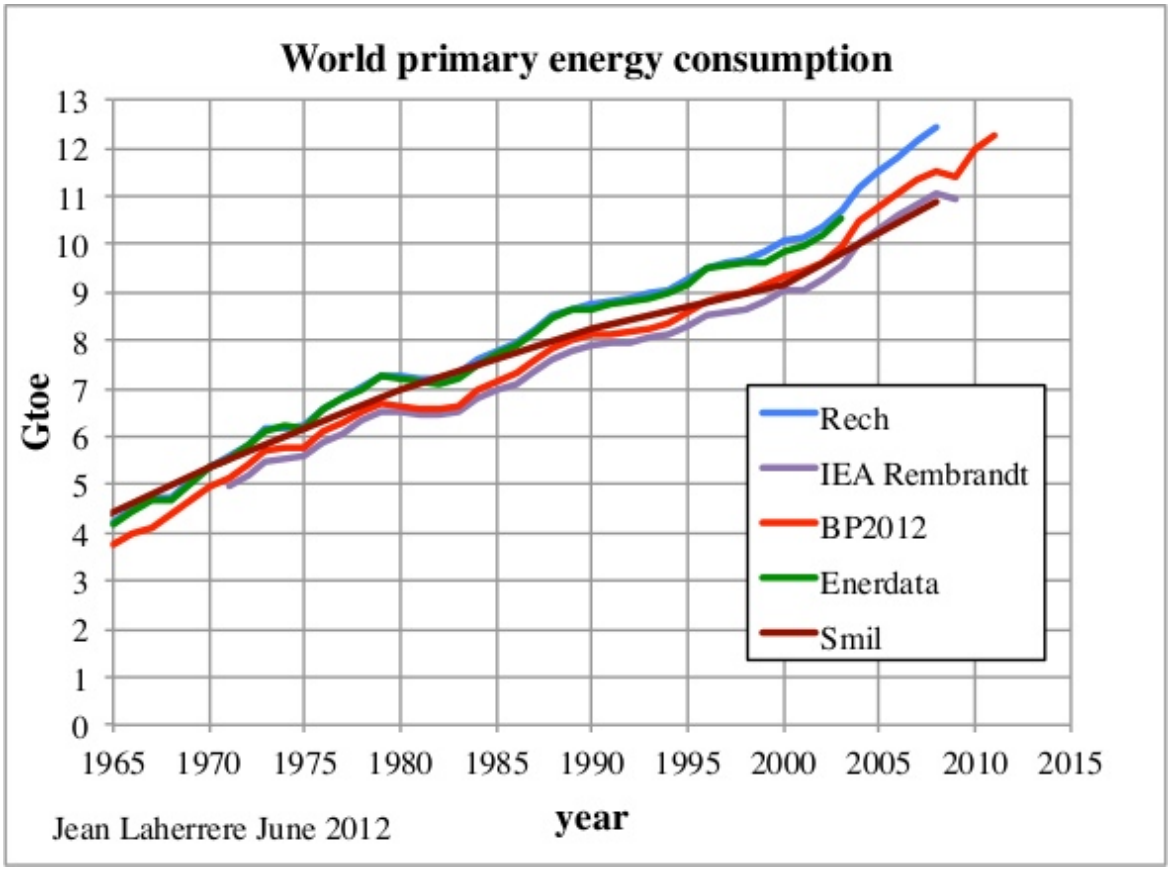
BP primary energy data varies little with time, showing a break in 1979 with the oil shock and an increase since 2002.

Figure 48: world primary energy consumption from BP 1999 to BP 2012



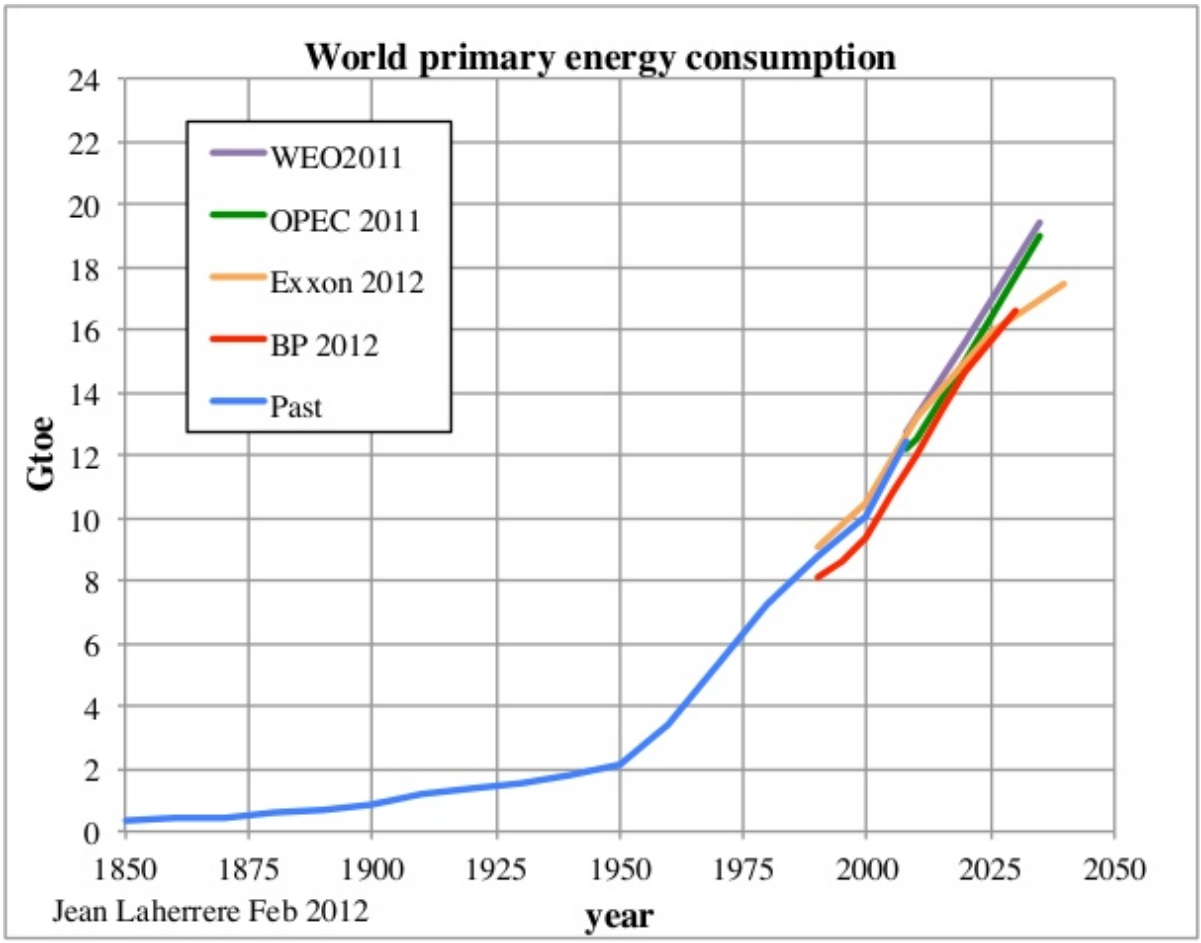
The same plot from different sources displays some uncertainty because of different conversion factors and definitions. The main problem is the biomass.

Figure 49: world primary energy consumption from BP 1999 to BP 2012



The forecasts vary, BP 2012 is in line with Exxon 2012, and lower than WEO2011 and OPEC 2011.

Figure 50: world primary energy consumption and forecasts



5. Conclusions

The BP Statistical Review has the merit to release every year free and convenient updated historical spreadsheets of energy data. But BP recopies what is officially reported by national agencies, avoiding diplomatic conflicts. Once in the '80s, in the annual statistical review. BP changed the official UEA reserves estimates by their own data (being the operator of almost every fields), but the next day they were obliged to destroy all their reports and to replace their values with the official data. Since then, BP avoids repeating this mistake! It is the same problem with most official agencies, so official data from other nations is difficult to deny. But BP reports heterogeneous and wrong data, displaying ridiculous numerous digits in contradiction with real accuracy. BP wrongly adds unconventional reserves to conventional reserves, despite these sources having completely different flows; they should be kept apart. BP, like many official agencies, ignores backdating, when the use of current reserves with obsolete (SEC) rules leads to artificial reserve growth. The problem is that most economists believe this wrong data, in particular the remaining reserves, which are reported on the increase, when in reality oil and gas conventional reserves peaked in 1980.