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Energy Dragons Rising Global Energy Governance and the Rise of China and India

Uncertainty of oil & gas supply and demand?

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Few facts on reporting

Publishing data is a political act and depends upon the image the author wants to give (rich in front of a banker or for quotas, poor in front of a tax collector).
Because of uncertainty in assessment, reserve estimates should be reported as a range and not a single value as usually done in order to not afraid bankers who hate uncertainty.
OPEC productions are ruled by quotas based on reserves, but because OPEC members were cheating on quotas, OPEC oil productions and reserves are flawed and unreliable. Real data on oil transported by tankers have to be bought from spy companies (Petrologistics in Geneva).
Words such as **energy, oil, reserves, resources, conventional, proved, probable, light, heavy, reasonable, sustainable, dangerous are badly or not defined on purpose.**

Reserves

Reserves represent the expected cumulative production to be recovered at the end when the field is abandoned.
Resource is what is guessed to be in the ground; reserves are only a small part of resources.

US Department of Energy reports world reserves with different sources: Oil & Gas Journal, World Oil, BP Statistical Review, Cedigaz
USDOE/EIA **proved reserves** as **end of 2005** posted 5 Oct. 2006

Oil Gb	OGJ	BP	WO	(WO Sept, 2006)
World	1 292.935 5	1 201.331 538 509 4	1 119.**615 3**	1 119.**058 3**
Russia	60.000	74.436 476 05	74.4	
Norway	7.705	9.691 349	8.033	
Canada	**178.792 4**	**16.500**	**12.025**	
China	18.25	16.038 12	16.188 5	
India	**5.847 84**	**5.918 58**	**3.979 8**	

Gas Tcf	OGJ	BP	WO	WO Sept. 2006	Cedigaz
World	6 124.016	6 359.172	6 2**26.554 6**	6 2**15.219 6**	6 380.625
Russia	1 680.000	1 688.046	1 688.748 9		1 688.763 3
Norway	84.26	84.896 5	83.272 1		109.759 02
Canada	56.577	55.950 5	53.700		55.974 275
China	**53.325**	**82.955**	**55.606 1**		82.990 25
India	38.88	38.865 3	27.258 9		38.881 815

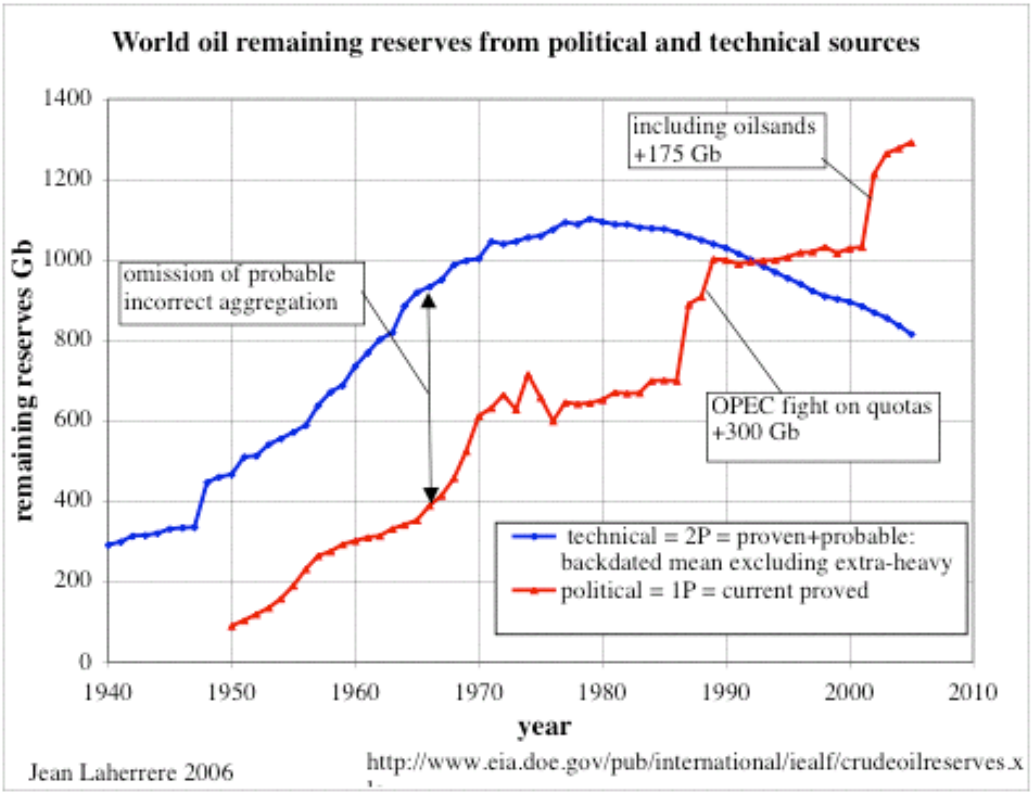
Reporting any data with more than 2 significant digits shows that the author is incompetent because the accuracy of the different estimates varies over 10%.

There is no consensus on how to assess reserves and there is no world organisation to impose one.
Oil & gas field reserves are confidential except in UK, Norway and US federal lands. In Russia who reports oil reserves could be put in jail for 7 years!

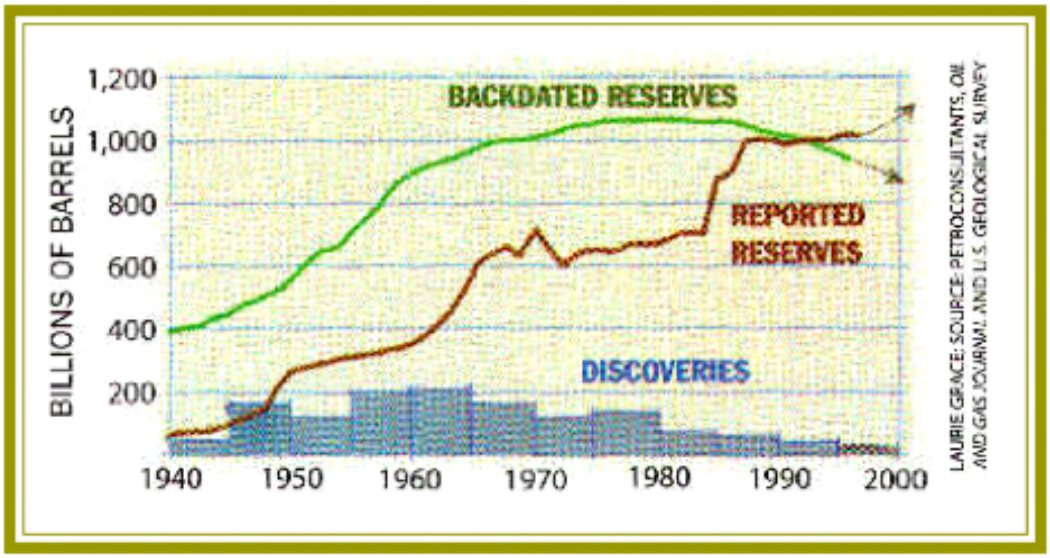
There are several reserve definitions in use:

-US = all companies listed on the US Stock Market are obliged to report only proved =1P ≈ assumed to be the minimum?, but SEC rules = reasonable certainty: what is reasonable?: probability of 51 or 99 %?
-FSU classification (1979) = maximum theoretical recovery ≈ proven + probable +possible = 3P ≈ maximum
-Rest of the world = SPE/WPC 1997 rules (I was a member of the task force) = proven + probable = 2P ≈ expected value (should be the mean ≈ P40, when given as the median P50, but often confused with the mode (most likely) ≈ P65); range 1P=90%, 3P=10%
Proved reserves (1P) tell bankers that the company could not be bankrupted, but development decisions are taken on mean reserves (2P). Aggregation of proved reserves is wrong, underestimating the total. The national proved reserves is more than the addition of field proved reserves. World proved reserves are more than the addition than all national proved estimates. Only mean (proven + probable) data could be added.
Reserve growth occurs when reserves are reported as the minimum (proved), but does not occur statistically when reported as proven+probable ≈ mean (expected) value.

The following graph display my technical data, which is the compilation of several heterogeneous databases, corrected to best represent the world mean reserves from field, backdated to the year discovery. The best way should be to backdate to the year where investment are made but it is impossible to obtain it worldwide by lack of data, and undeveloped reserves will be omitted.
Figure 1: **World remaining conventional oil reserves from political and technical sources**



It is interesting to compare this graph with a 1998 graph that I drew in an article in Scientific American: My forecast of future trends war right: decrease in technical reserves and increase in political reserves, but without anticipating the change with the addition of unconventional Canadian reserves!
Figure 2: World conventional oil remaining reserves from political and technical sources in **Scientific American March 1998 Campbell & Laherrere "The end of cheap oil"**



Proven reserves are only financial data and should never been used for forecasting future production.

Forecast of future oil production

The oil demand, as it is published by USDOE/EIA and IEA includes all liquids even synthetic oil as GTL (gas-to-liquid), CTL (coal-to-liquid) and BTL (biomass-to-liquid).

All liquids ultimate is estimated at 3 Tb being the sum of

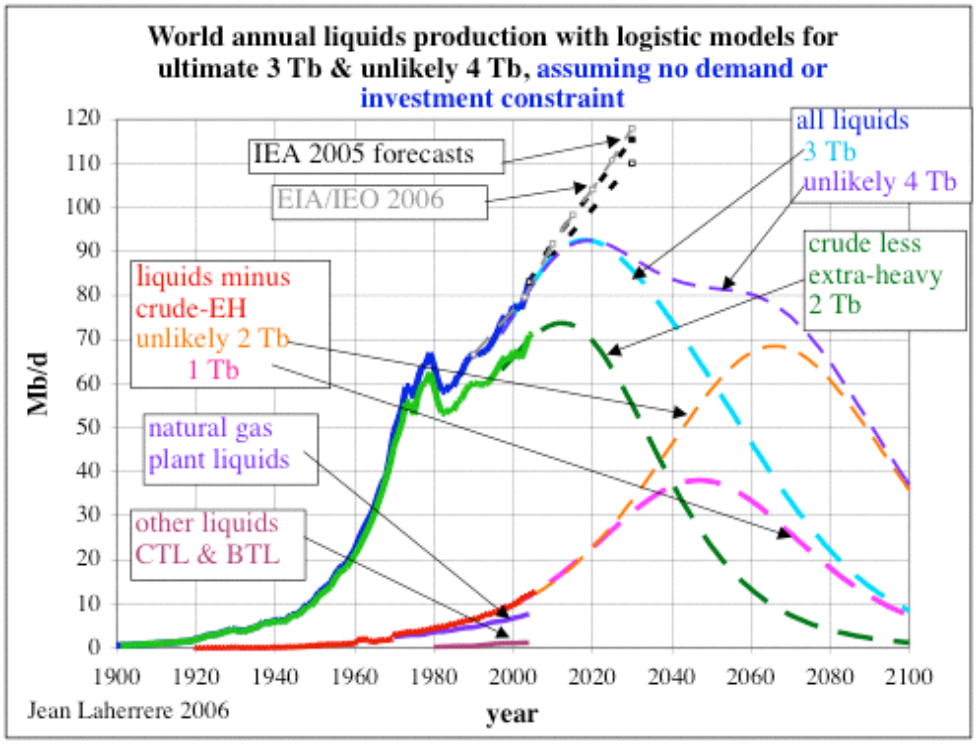
-crude less extra-heavy	2000 Gb
-extra-heavy	500 Gb
-natural gas liquids and GTL	250 Gb
-synthetic oil (BTL, CTL) & refinery gains	250 Gb

Crude oil less extra-heavy (**cheap oil**) is modelled with an ultimate of 2 Tb.. The rest being **expensive oil** is modelled (red curve) with an ultimate of 1 Tb, making an all liquids ultimate of 3 Tb, with a peak around 2050. The all liquids peak is around 2015 and over 90 Mb/d, but this is theoretical **assuming no constraint from the demand or from investments**, which is unlikely in front of Paul Volcker 2004 forecast (75% chance) of an economic crisis in the next 5 years.

From all planned *megaprojects* up to 2010, Skrebowski (Petroleum Review 2006) has forecasted an oil peak in 2010 at 94 Mb/d. This independent forecast is in line with mine.

Doubling the ultimate of expensive oil (red curve), making the all liquids ultimate at 4 Tb, will not change the oil peak date, changing only the slope after the peak.

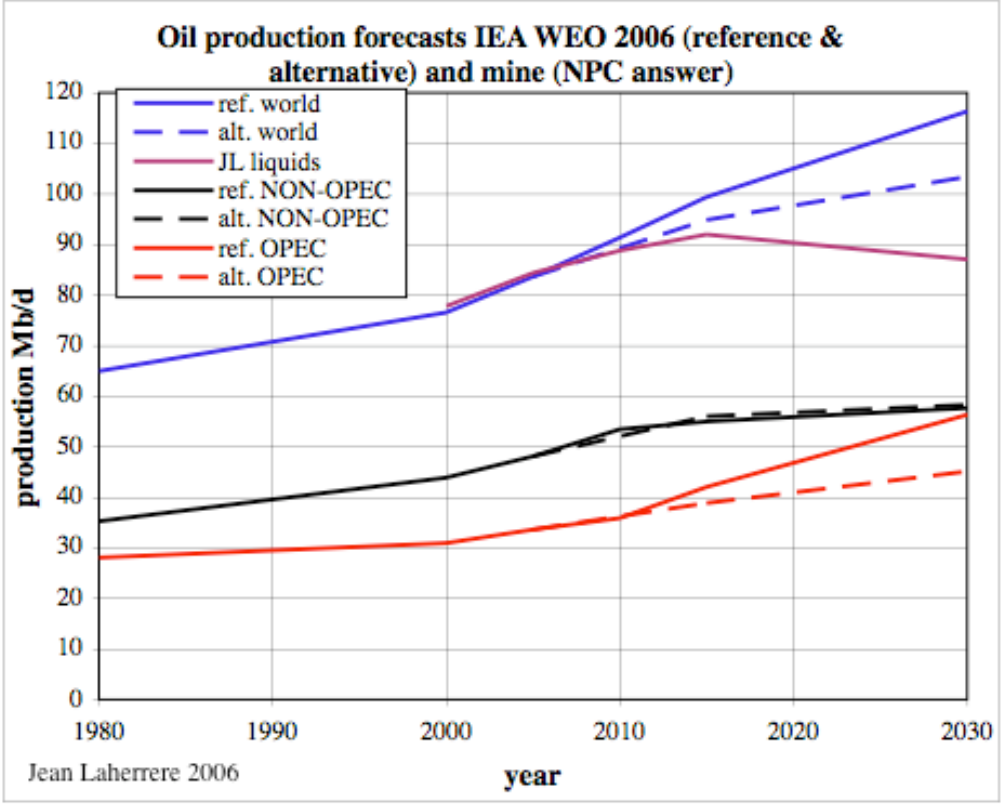
Figure 3: **World liquids production** (no demand or investment constraint)



The International Energy Agency (IEA) in Paris has published in November 2006 their World Energy Outlook WEO 2006. Last year, the main WEO 2005 forecast, called the reference, was a scenario of **business as usual** which was wished to provide a continuous economic growth; and an alternative scenario was issued in case of unwanted lack of investments leading to less growth.
This year, the reference case of business as usual is described by IEA van Hulst (Energy Convention Groningen Nov. 2006) as unstable, dirty and expensive and the alternative scenario with more energy savings, renewables and nuclear is wanted.
Figure 4. statement by van Hulst IEA on WEO 2006

The comparison between WEO and my forecast for oil production, as given in my answer (Dec. 2006) to an enquiry on global oil and gas study by the National Petroleum Council requested by the US Secretary Bodman, shows a large difference in 2030 where the oil (all liquids including biofuels) is 87 Mb/d for me and 103 Mb/d for the WEO alternative and 116 Mb/d for the WEO reference being not the wished case. OPEC production is forecasted in the reference case to be over 56 Mb/d in 2030, forecast stated as unrealistic by Al-Husseini former Aramco VP. But OPEC is changing in 2007 by adding Angola and Ecuador, so forecasts should be changed!

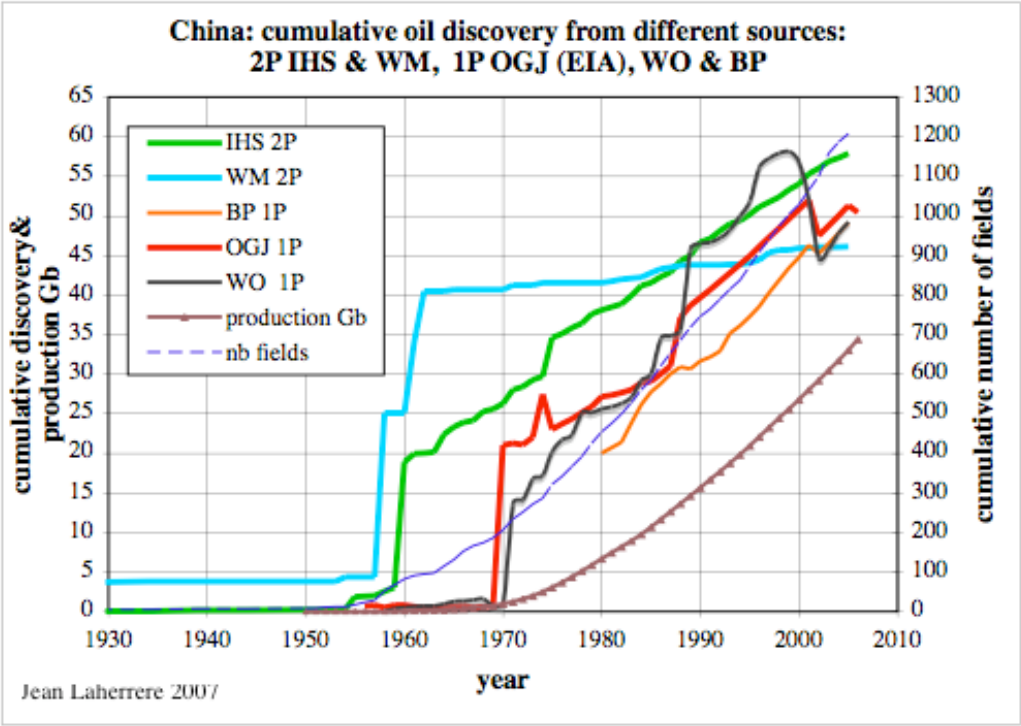
Figure 5: Oil production forecasts WEO 2006 and from technical data



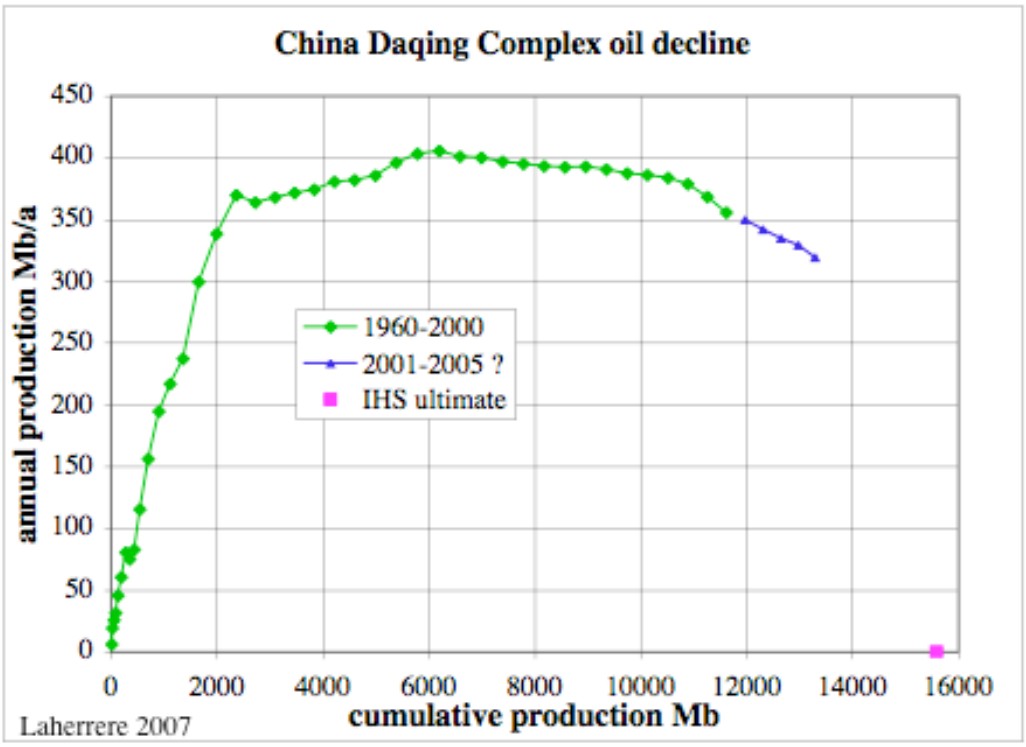
Most of officials forecasts are wrong not because of wrong thinking, but because based on wrong data coming from national reports, aiming to overstate their potential.
The main problem is then to obtain true and complete data from the start.
Too many databases are incomplete.
All the attempts to improve the data have failed, despite all the claims of good will by governments and agencies, in particular the JODI (Joint Oil Data Initiative) gathering seven international agencies under the UN since 2000, providing only some incomplete production data.

If oil is global because transport is very cheap, transport for gas is about 10 times more expensive and gas is not global with several gas market: North America, Europe, Asia Pacific and lately South America. Gas production has to be studied locally within each gas market, despite that the new development in LNG will change a little this situation. Larger amount of stranded gas will be developed, but problems could be expected on LNG market in the balance of plants, carriers and terminals, because, as shown below, demand forecasts are different from sources.

China
Cumulative oil discovery (in volume) from different sources and definitions (1P and 2P) versus time shows chaotic discrepancies, despite the fact that cumulative number of fields is smooth and rising.
IHS backdates every field to the discovery year when WM groups fields close to the main discovery.
Figure 6: China cumulative oil discovery from different sources 1930-2005

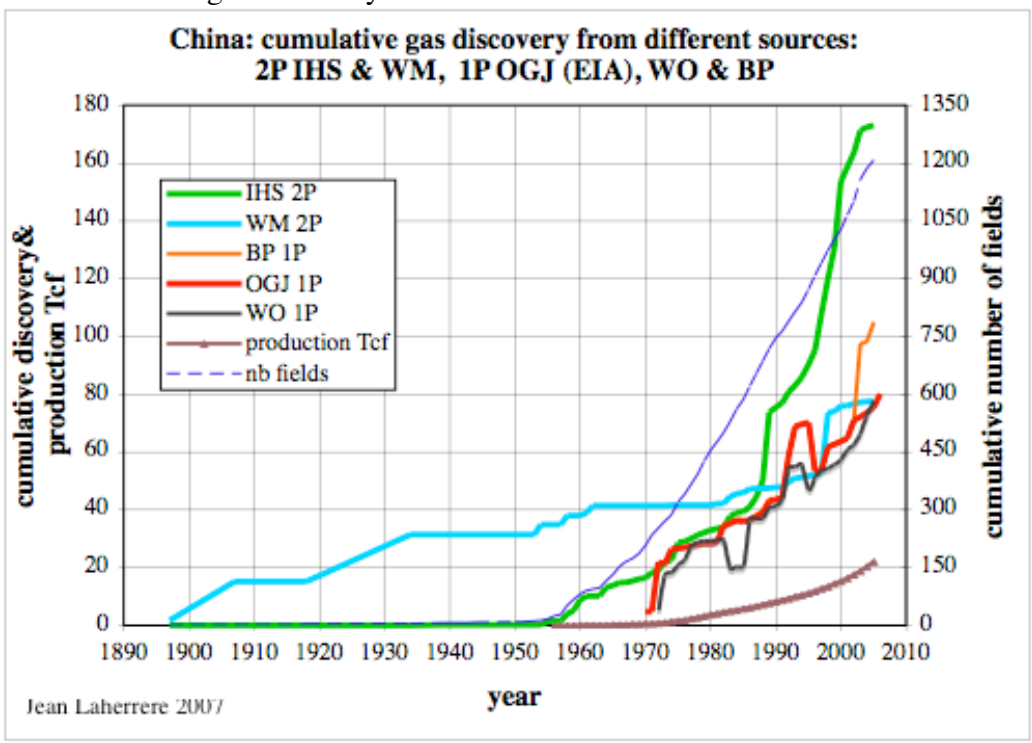


In our ASPO Lisbon 2005 meeting, Pang Xiongqi, Meng Qingyang Zhang Jun, Natori Mariko presented "The Challenges Brought By The Shortage of Oil And Gas In China And Their Countermeasures" with cumulative discovery at end 2003 of 6,5 Gt for oil and 2,5 T.m3 for gas or 50 Gb and 87 Tcf (cumulative production 30 Gb and 13 Tcf) closer to WM than to IHS.
Estimating the ultimate recovery of the mature major fields with the extrapolation of their production declines could solve the discrepancy between the two databases. Unfortunately field annual production are not recently reported and the largest oilfield Daqing complex (in fact several fields: Saertu, Xingshugang, Lamadian and 4 smaller fields) has not yet definitively declined, compensating normal decline by drilling many wells and using tertiary recovery in particular polymer. It means that production will collapse later on.
Figure 7: China Daqing Complex oil decline



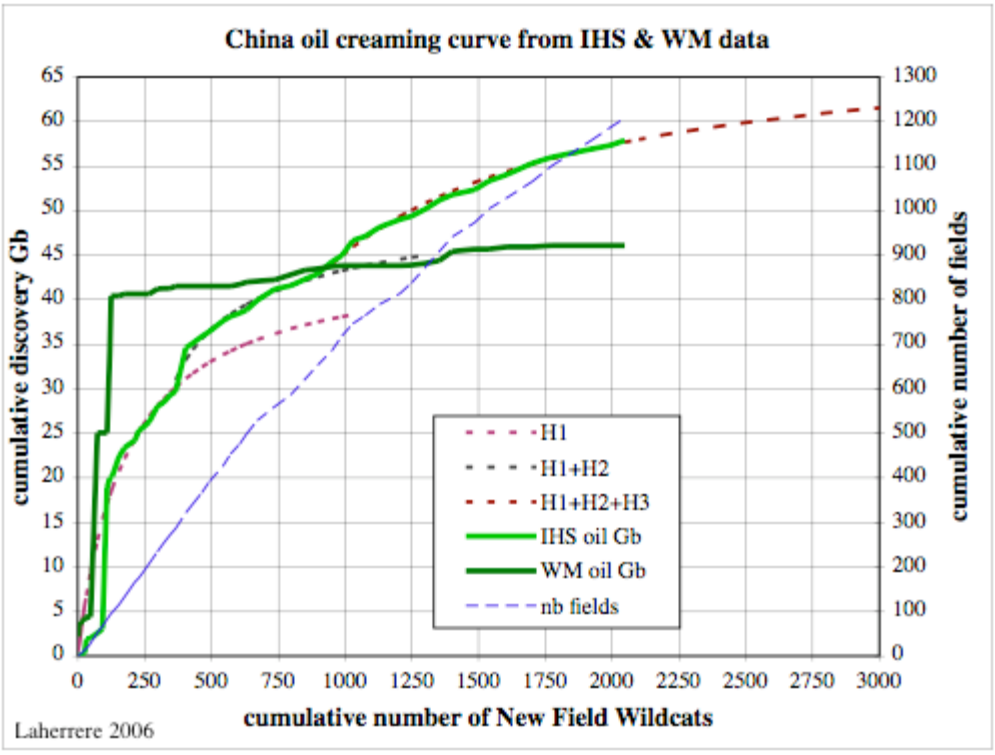
The gas cumulative 2P discovery is reported by WM as half of IHS value, but being in line with 1P from OGJ and WO. Furthermore Pang Xiongqi with 87 Tcf at end 2003 is closer to WM (77) than to IHS (172).

Figure 8: China cumulative gas discovery from different sources 1897-2005

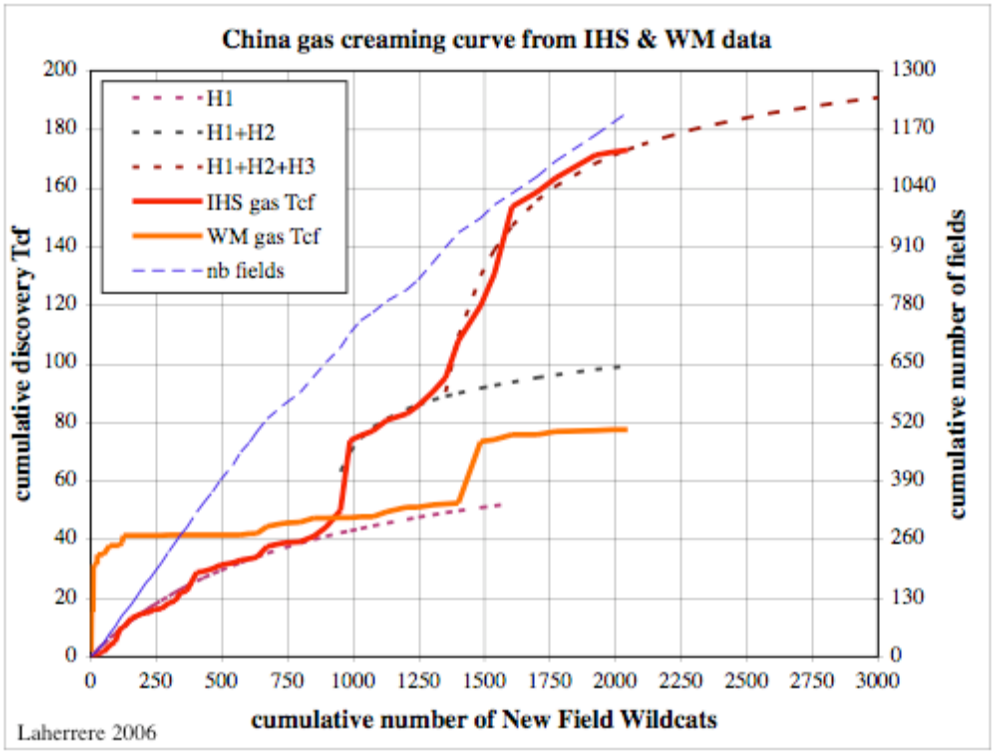


Cumulative discovery versus cumulative number of pure exploratory wells (New Field Wildcats NFW) is better to extrapolate for estimating the ultimate using a hyperbola model with several cycles. The main problem is to guess if a new cycle will occur. A deepwater potential can occur, but the discrepancy between IHS and WM is very large and likely higher than this possible new cycle.

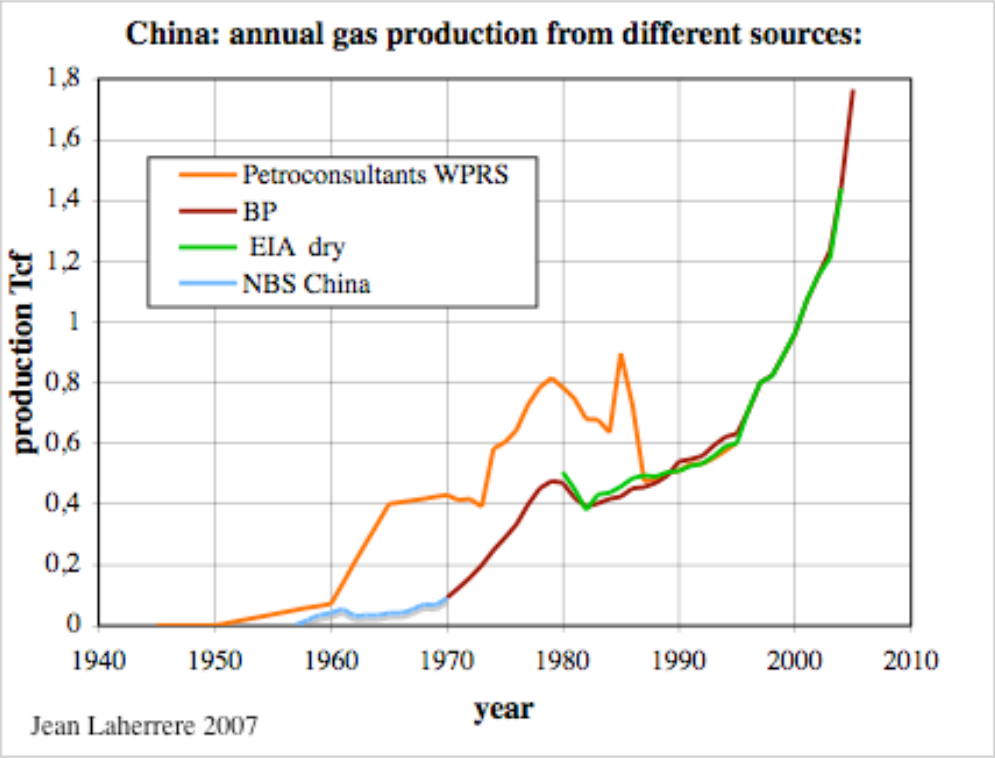
The oil ultimate is about 60 Gb, trusting more WM than IHS. But WM grouping fields prevents getting a good creaming curve.
Figure 9: China oil creaming curve



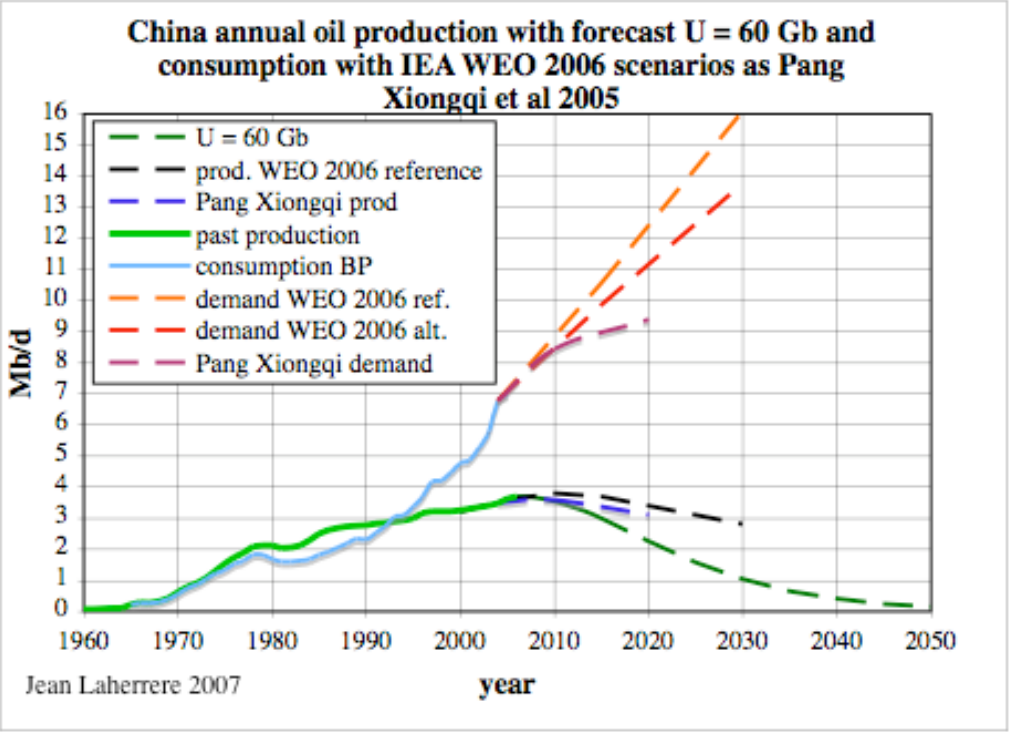
Same curve for gas, again even larger difference between the two databases but Pang Xiongqi is closer to WM.
The gas ultimate is guessed as 100-120 Tcf
Figure 10: China gas creaming curve



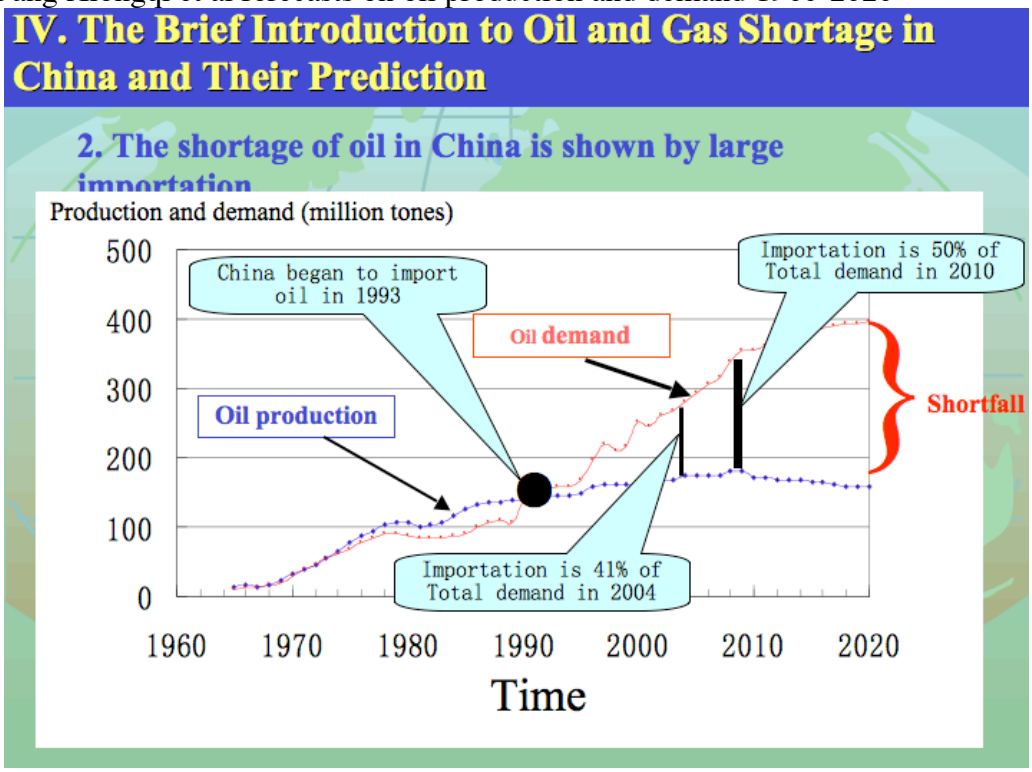
Most of published official database (USDOE/EIS, BP Review) report historical series since at the most 1965 without giving cumulative production. It is difficult to get reliable values before. Previous production values from World Production & Reserves Statistics by Petroconsultants displays for gas production erroneous values from 1948 to 1986, presumably confusing units (NASA blew up Mars Climate Orbiter because sending instructions in metric when the probe was built in non-metric!)
Figure 11: China annual gas production from different sources



Annual production is modelled using a derivative of the logistic function for the last cycle to fit the past production (and slope) and to deliver an ultimate of 60 Gb. This forecast assumes that there will be no constraint from the demand or from investments, which is unlikely.
Figure 12: China annual oil production forecasts for U= 60 Gb & IEA WEO 2006, and consumption

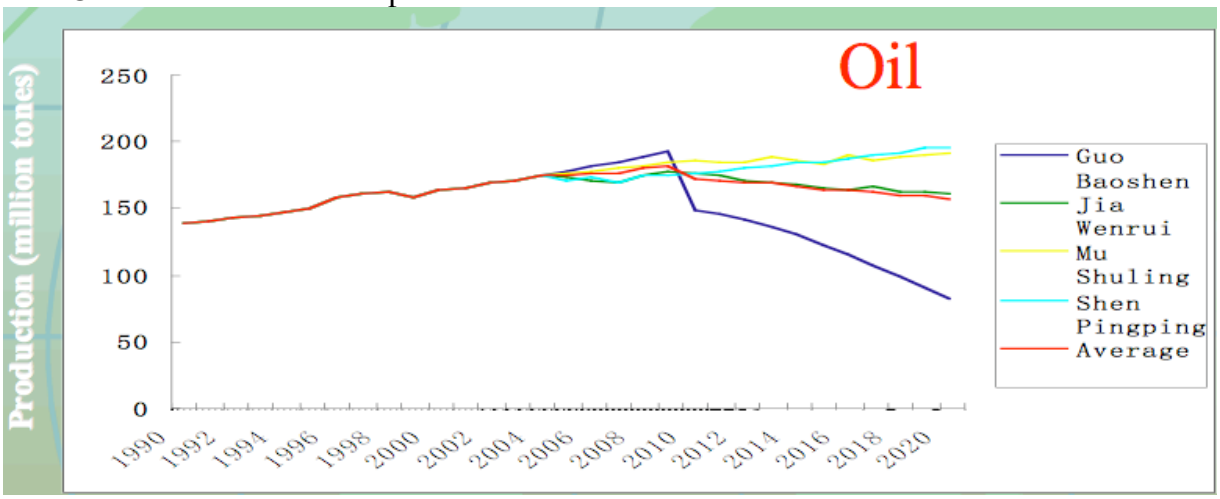


The gap between supply and IEA demand in 2030 is huge: 1 Mb/d (3 Mb/d for IEA) for supply against 14 or 16 Mb/d for demand!
Pang Xiongqi et al foresees a supply (average of several authors) close to mine, but a demand much smaller than IEA WEO
Figure 13: Pang Xiongqi et al forecasts on oil production and demand 1960-2020



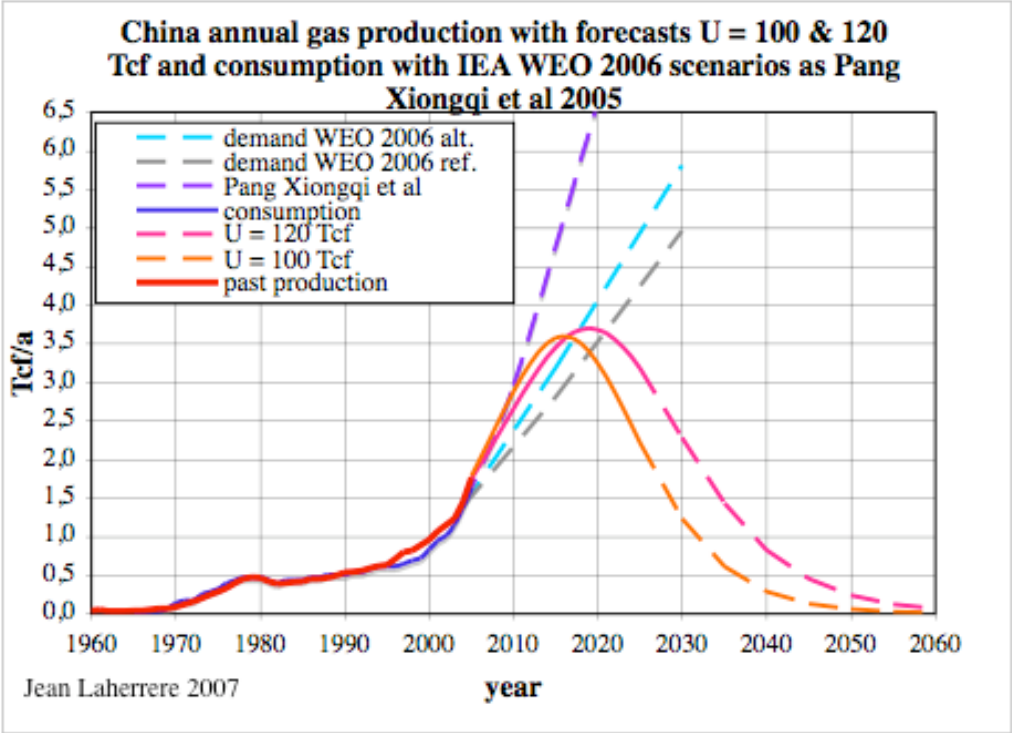
Pang Xiongqi et al shows the oil production forecasts from different Chinese authors, showing a large rage with the average peaking around 2010, with a decline between WEO and mine.

Figure 14. Chinese forecasts for oil production 1990-2020



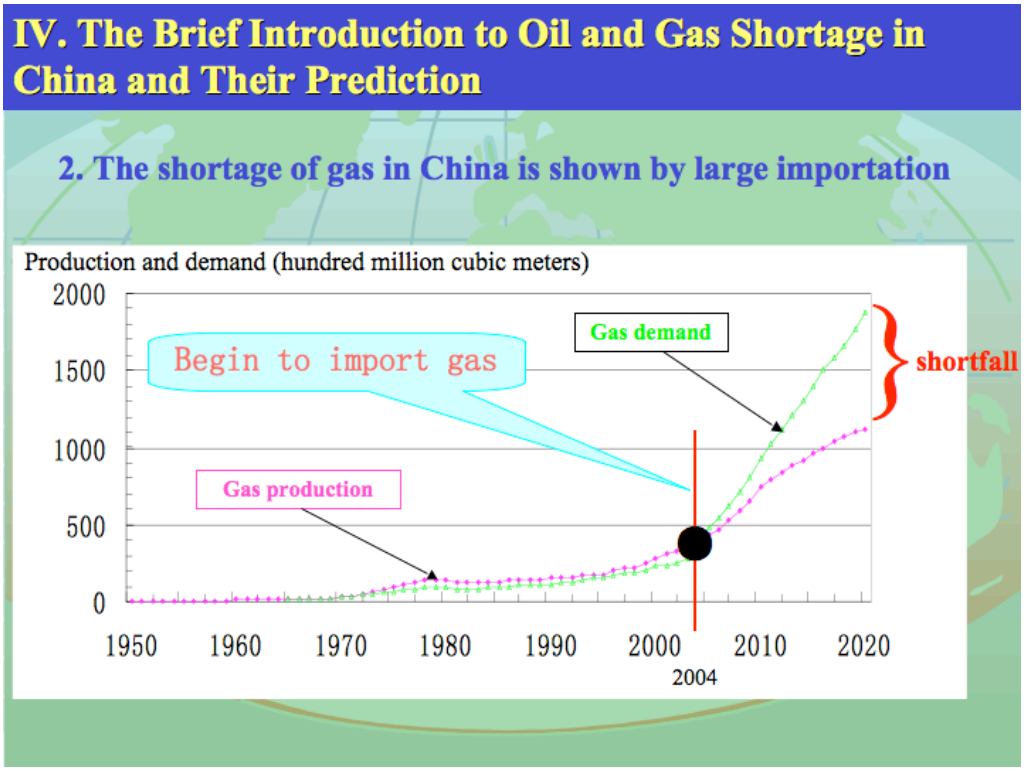
For gas up to now consumption is filled by production and may continue for a while, but in 2030 production will be half of the demand!

Figure 15: China annual oil production forecasts for U= 60 Gb & IEA WEO 2006, and consumption



Pang Xiongqi et al foresees a gas peak in 2025 at 100 T.m3 (3,5 Tcf), but his forecast for consumption is much higher with 190 G.m3 (6,7 Tcf) in 2020 than IEA WEO 4 Tcf, leading to large import.

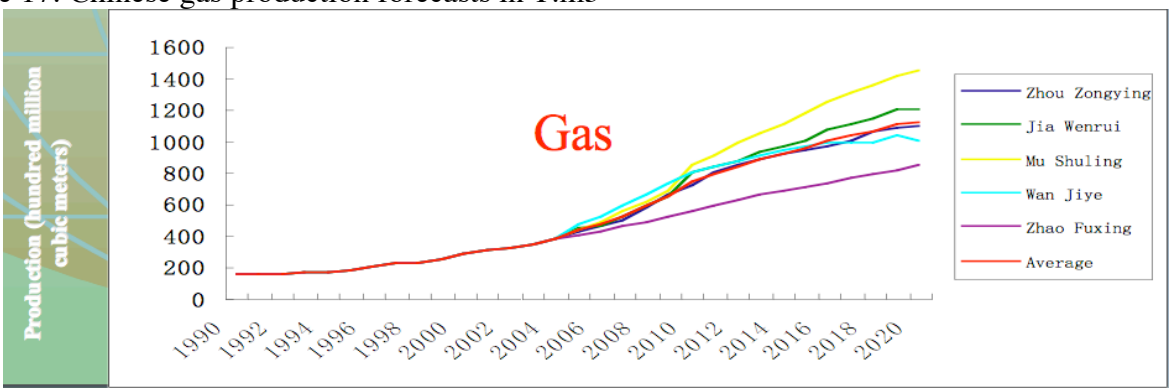
Figure 16: Pang Xiongqi et al forecasts on gas production and demand



This explains why China is trying to deal with Russia on gas import, when with IEA forecasts this need is much less because a much smaller forecast on demand. It seems that the ambitious Chinese plan may find constraints, because their growth looks unsustainable!

For gas production Chinese forecasts is similar to mine, with a range of about 25%

Figure 17: Chinese gas production forecasts in T.m3

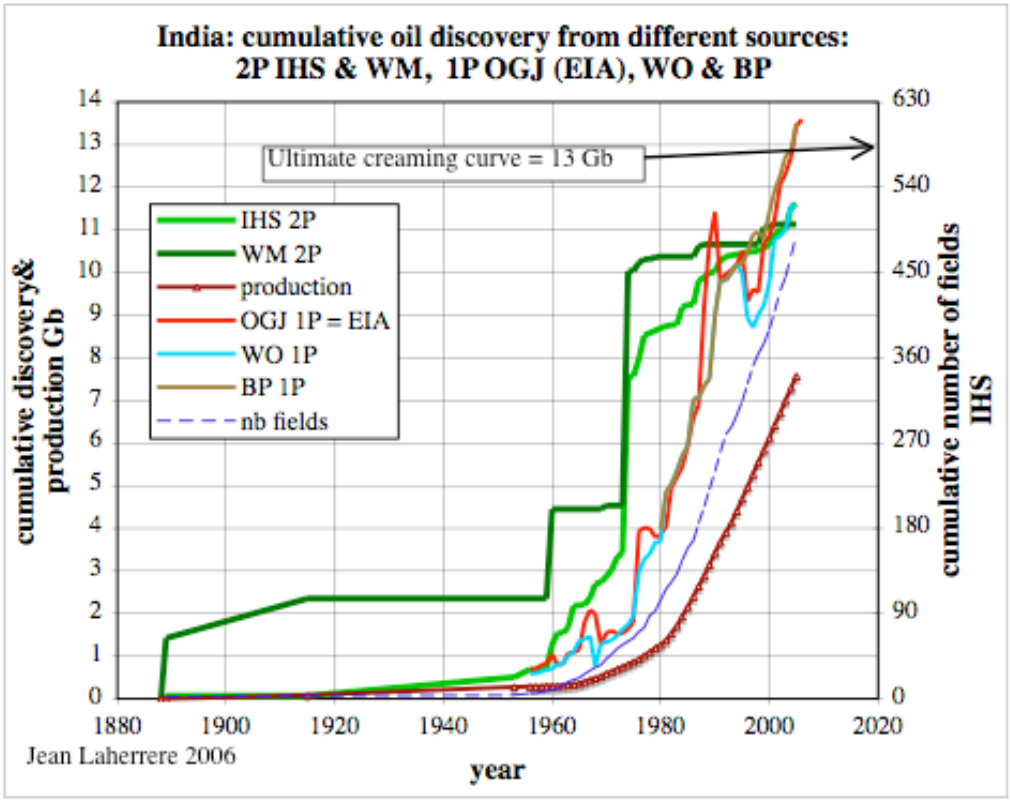


To conclude on China, despite questionable oil and gas discovery data, the forecast for future production is in good agreement between our forecasts and Chinese forecasts. The problem is that China has a present consumption growth which seems unsustainable: The dream for each Chinese to copy the American way of life with big cars is impossible due to the size of the population and that also that present American way of life, based on borrowing 80% of world savings, needs to be changed in front of the limit of world resource and the US high level of debt.

India

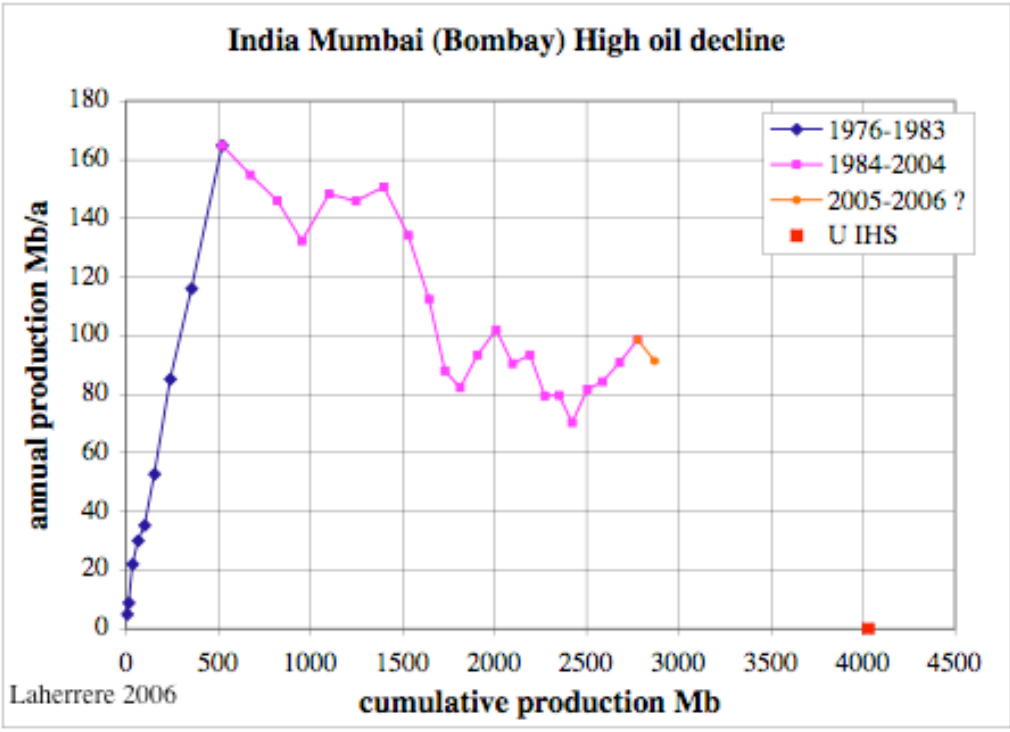
India seems to be very reluctant to publish reserves and their estimates were in the past influenced by their training with Russian methodology. IHS and WM are lower in their 2P oil cumulative discovery than the political 1P from EIA.

Figure 18: India cumulative oil discovery from different sources



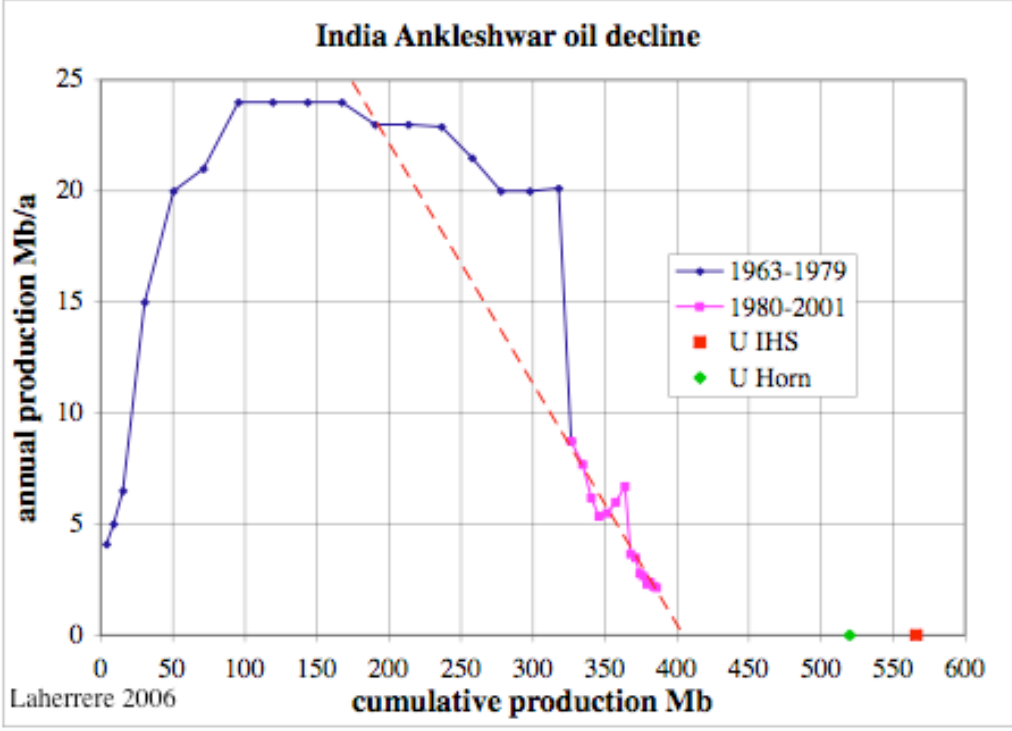
Checking reported field reserve values with the estimate from decline is not obvious for the largest oilfield in India. AAPG 2005 M.K. Horn book "Giants fields 1868-2004" reports Bombay High (now called Mumbai High) with an ultimate of 1,3 Gb and 0,8 Tcf when IHS reports 4 Gb and 7.4 Tcf, with a cumulative production of 2,8 Gb end 2005, as if Horn is not talking of the same field! The field has peaked in 1984 and has declined with up and down following new works, the last one being in 2001. 2006 is in decline despite in big fire in 2005 destroying completely a platform (11 deaths).

Figure 19: Mumbai (Bombay) High oil decline



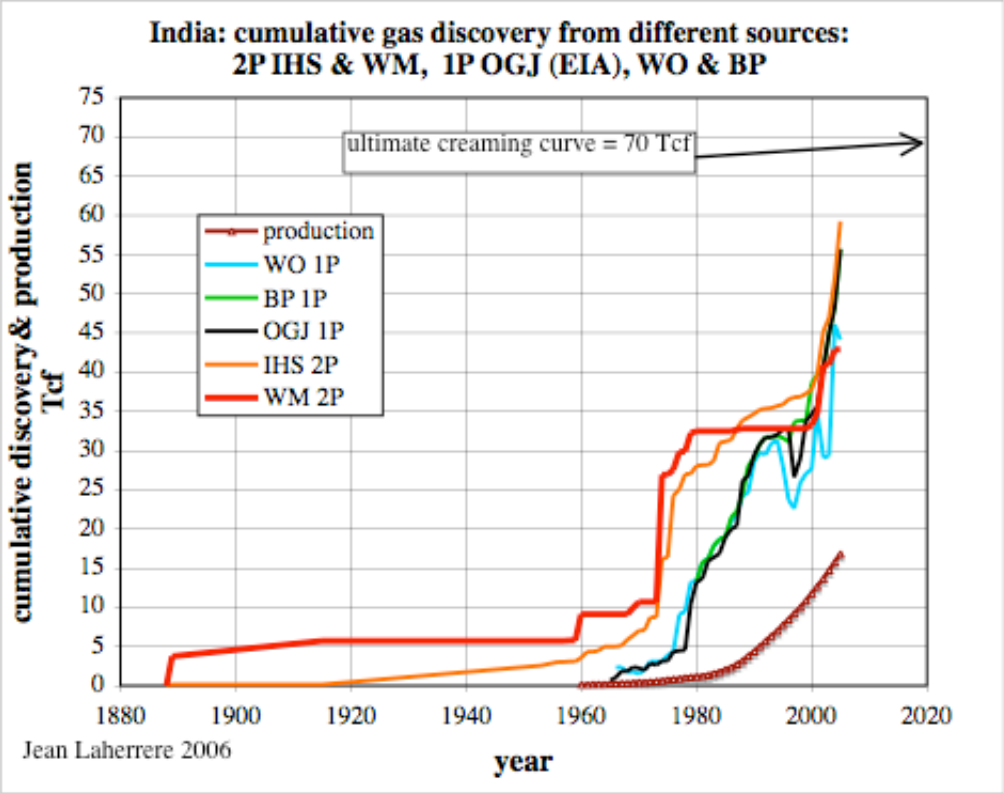
The ultimate of another giant field Ankleshwar can be better estimated because a steeper, but queer, decline, giving an ultimate about 400 Mb when IHS reports 566 Mb, confirming that ONGC estimates are optimistic, using Russian methodology of maximum theoretical recovery close to 3P, as already stated for FSU reserves estimates in many of my papers.

Figure 20: Ankleshwar oil decline 1963-2001



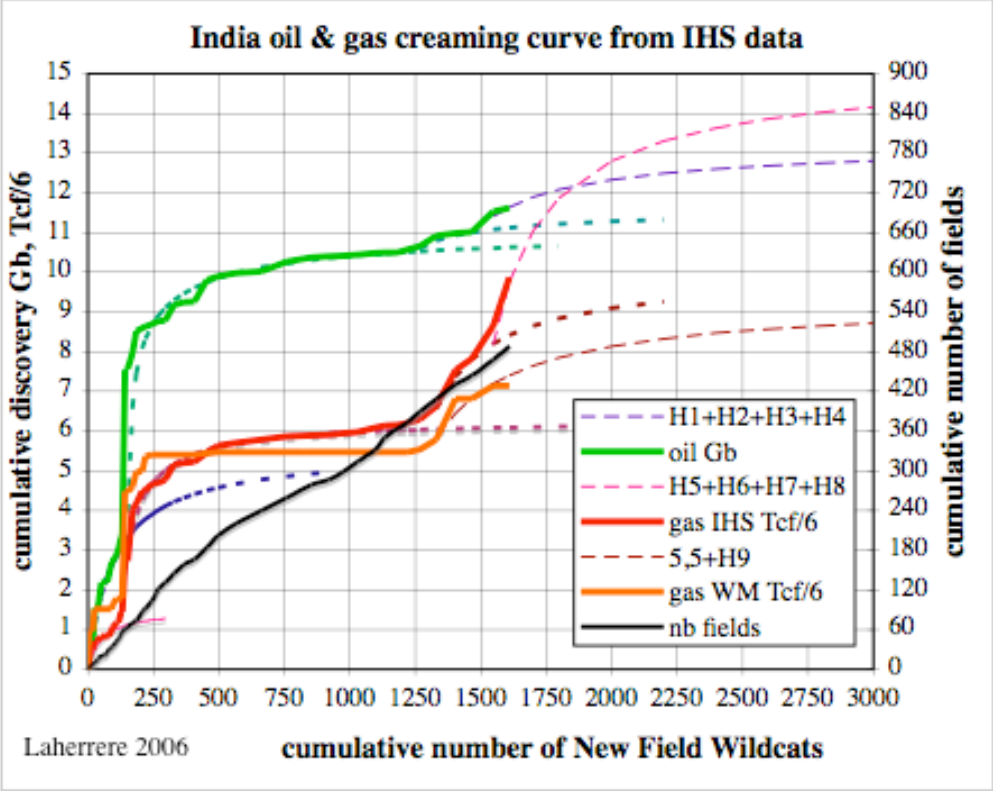
Cumulative gas discovery is more difficult to assess with the present large discoveries in deepwater of Krishna-Godavari (about 20 Tcf), which are not fully appraised. WM reports technical and commercial estimates, when IHS reported more geological estimates, but now more political data, explaining the large discrepancy between them.

Figure 21: India cumulative gas discovery.

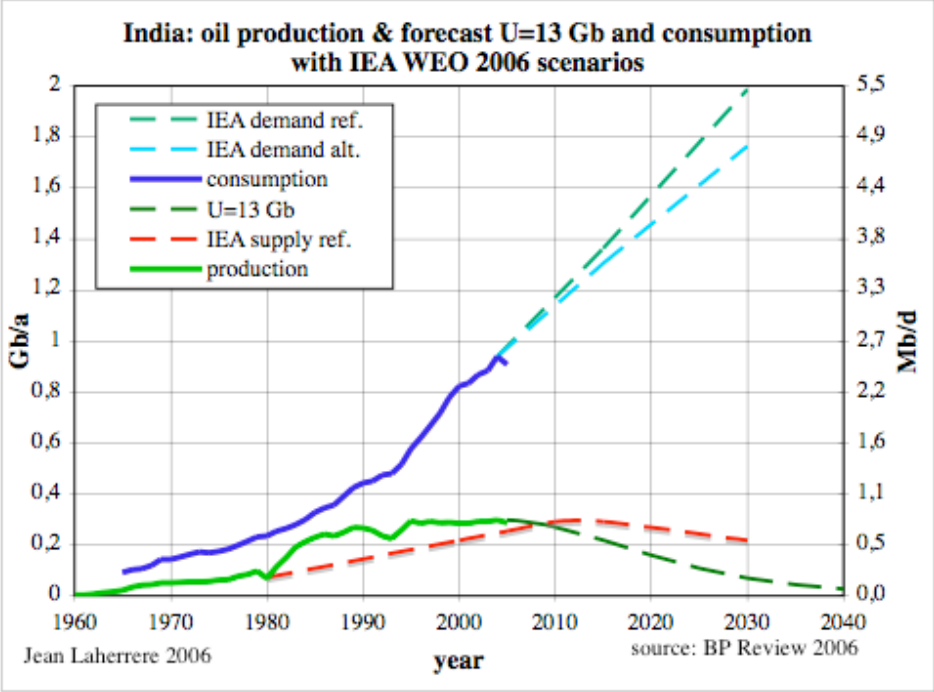


Creaming curves lead to estimate oil ultimate at 13 Gb because the numerous dry holes in deepwater in western India (the attractive reef prospects seem to have failed because lack of source-rock) and deepwater in the eastern India mainly gas-prone. Gas ultimate is estimated about 70 Tcf, but uncertainty on the potential of deepwater could bring more.

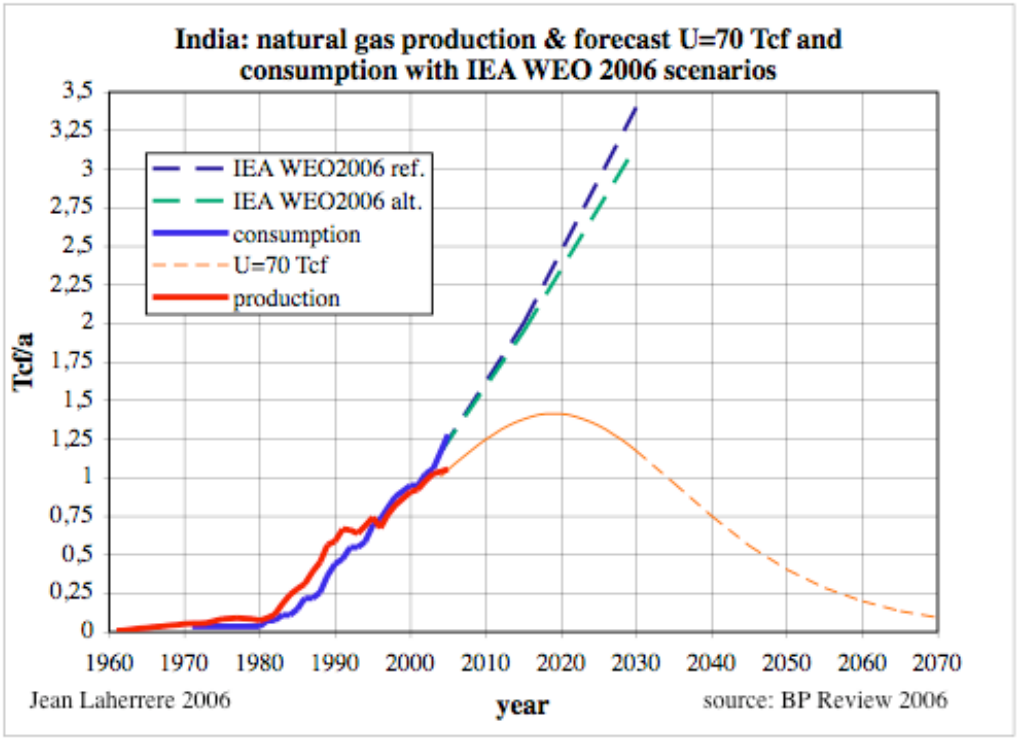
Figure 22: India oil & gas creaming curve



India oil production is peaking but oil consumption has increased sharply for the last 10 years and is expected to continue for the next 25 years in both IEA scenarios, leading to a huge need of oil imports.
Figure 23: India oil production for an ultimate of 13 Gb and consumption with IEA WEO forecasts

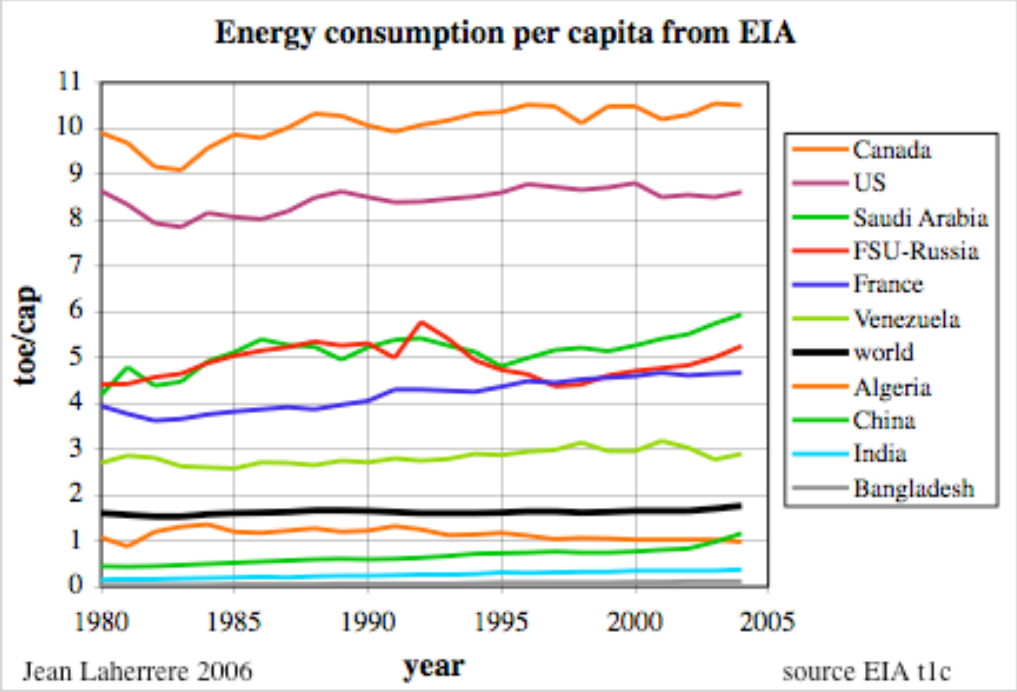


India gas production will peak around 2020 for an ultimate of 70 Tcf. Up to now India gas consumption came from India gas production but not anymore in the last two years and the shortfall will be huge in 2030
Figure 24: India natural gas production for an ultimate = 70 Tcf and consumption with IEA forecasts



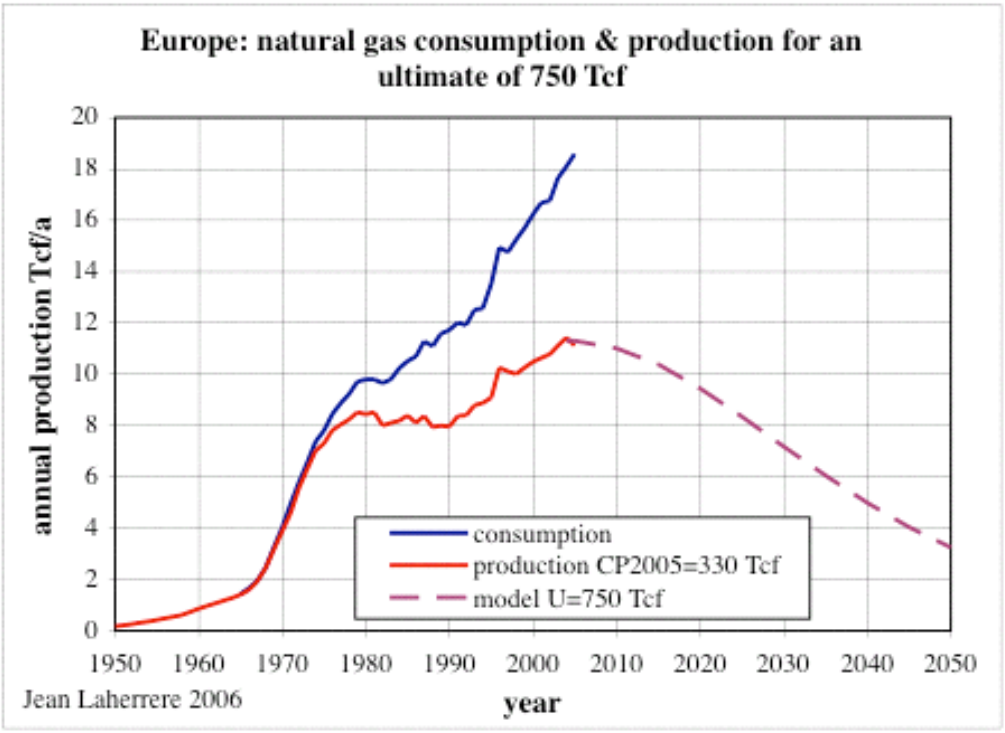
India has a big problem in securing enough imports to fill the oil and gas demand.

India energy consumption per capita is about 0.4 toe compared to 1.8 toe for the world, 1.2 toe for China
Figure 25: Energy consumption per capita from EIA 1980-2004

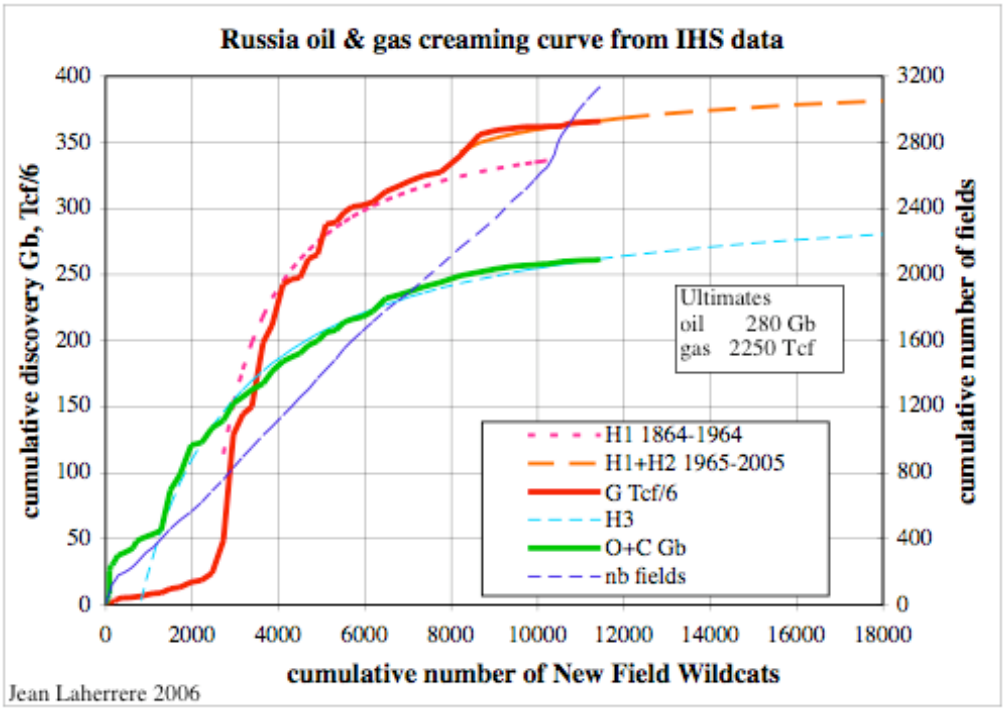


India with a growing population will have problems to rise the energy per capita, which is already very low.

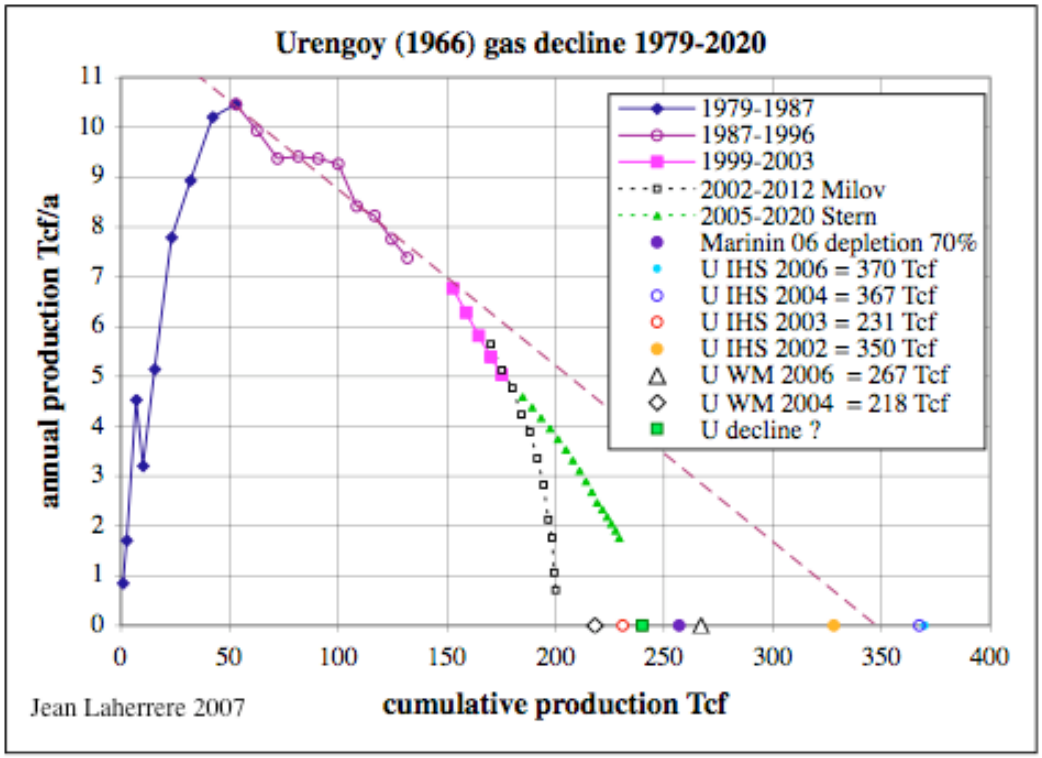
Other energy shortfall in natural gas: Europe
Europe gas production is peaking now and will decline steeply.
Figure 26: Europe natural gas production for an ultimate of 750 Tcf and consumption



Europe counts too much on Russian gas reserves, which are overestimated (due to Russian old classification) and lack of investment. P.Mandil, former head of IEA, stated that "the problem is not the Russian gas, but Gazprom". The large gas reserves of Yamal as Bovanenko found in 1971 with 150 Tcf are still undeveloped and should be developed before Shtokman found in 1988 with 87 Tcf. But politics prevail.
The creaming curve of Russian from IHS data indicate no recent important new cycles (no deepwater nor new Arctic new basin) and the potential of yet-to-find looks small, except maybe for the offshore Arctic basins but if any the impact will be many decades away
Figure 27: Russia oil & gas creaming curve



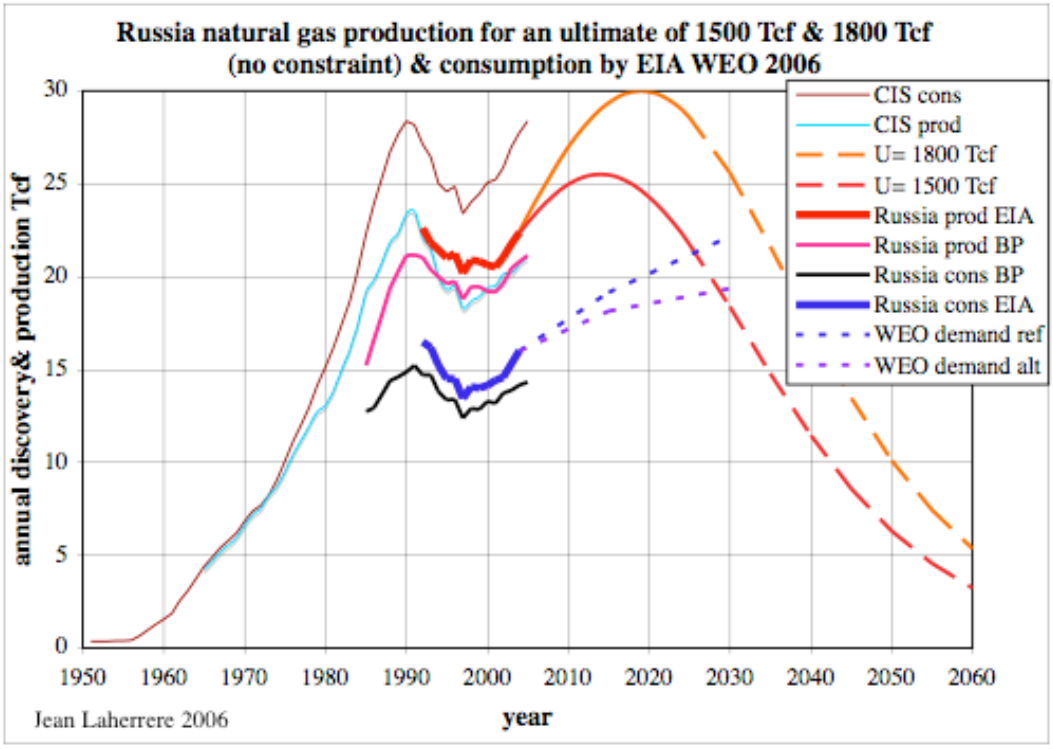
Ultimate from IHS data is about 280 Gb and 2250 Tcf, but it is 3P and should be reduced by about 30% down to 200 Gb and 1500 Tcf. Natural gas cumulative discovery is reported by WM for end 2005 at1850 Tcf, but these estimates are coming from the inventory under Russian classification giving in fact 3P = proven + probable + possible, which need to be reduced to 2P.
This is confirmed by the overestimate of the Russian largest gasfield Urengoy (Western Siberia), stated by many to be the world largest gasfield (in fact a quarter of North Dome gasfield of Qatar/Iran)
Figure 28. Urengoy gas decline



Russian gas production is modeled for ultimate of 1500 Tcf (likely) and 1800 Tcf as consumption with IEA WEO 2006 forecasts. But this production forecast assumes no constraint (demand or investment), which is unlikely because Gazprom lacks sharply investment, because politics! Yamal is still undeveloped despite planning for several decades!

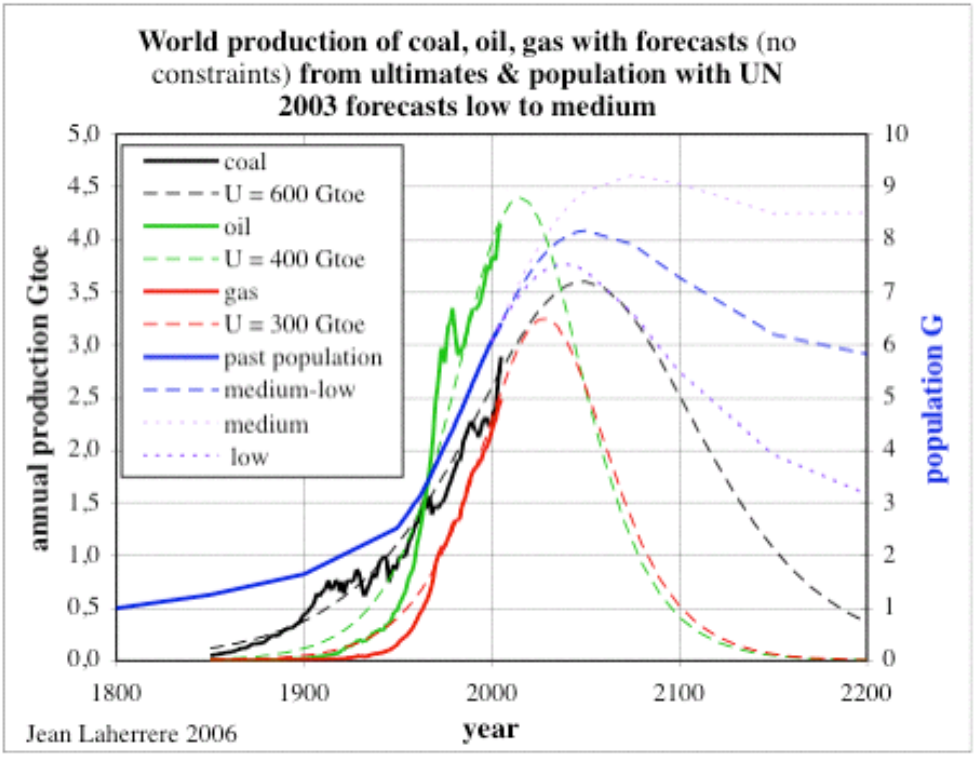
Our 1500 Tcf model is too optimistic for the next two decades because of the constraints from investments by Gazprom and Russian consumption will catch up production before 2030. Gas was largely wasted in the past: Moscow is gas heated without any metering because rents include gas heating.

Figure 29: Russia gas production for ultimates 1500 & 1800 Tcf (no constraint) and consumption by EIA

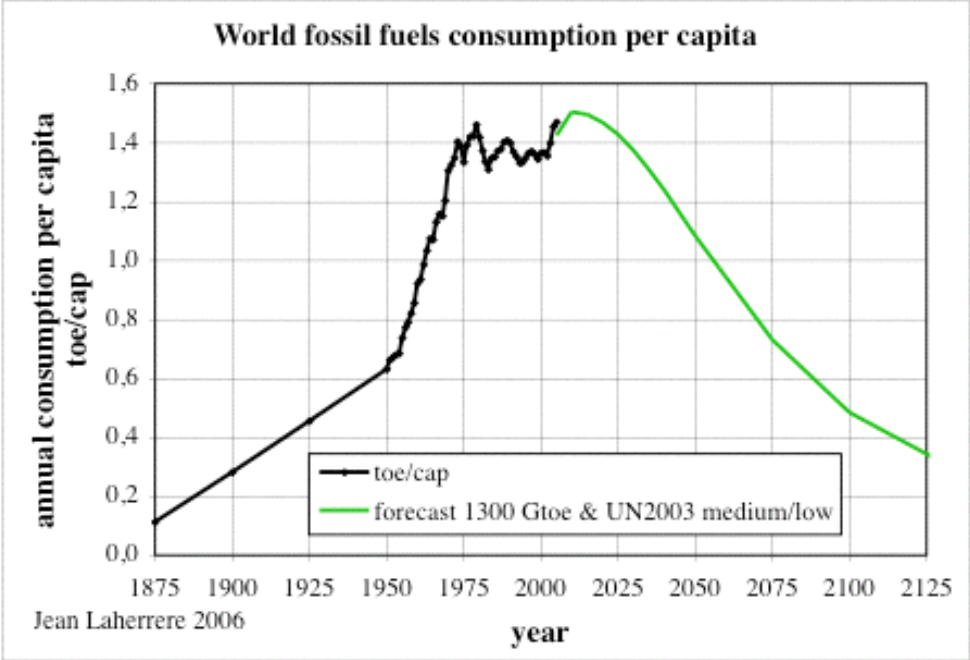


The cutting of gas delivery to Ukraine in January 2006 is presented as political when it is due (Vladimir Milov www.energypolicy.ru) to shortage of supply because very low temperature and poor Gazprom practices, gas was cut to everyone, even Russians.
Gazprom is approaching Sonatrach another gas supplier and Europe should worry about planning a strong gas demand. Is an OGEC coming?

Fossil fuels production forecast
Ultimate of fossil fuels is estimated to be about 1300 Gtoe (oil 400 Gtoe, gas 300 Gtoe, coal 600 Gtoe)
If there is no constraint from demand, investment or politics (unlikely), oil will peak around 2015, gas 2025 and coal 2050. Fortunately world population will also peak around 2050 following the low-medium likely forecast by UN 2003.
Figure 30: World fossil fuels production for an ultimate of 1300 Gtoe and world population



The world fossil fuels consumption per capita rose sharply after the second war until the first oil □shock and stayed flat for the last 25 years. It will stay the same for the next 25 years, showing that if the rich countries waiting energy can save some it will help the poor countries to get a little more per capita. But the way of live of the society of consumption has to be changed.
Figure 31. World fossil fuels consumption per capita



Conclusions

Most of official forecasts are not based on real studies but on wishes, mainly to continue the past economic growth, being the scenario of BAU business as usual. The BAU scenario is for the first time described by the IEA (WEO 2006) as unsustainable.

IEA is a consumers club founded to oppose the OPEC producers club. But as OPEC includes now Angola, IEA should include China and India

Only the BGR in Germany is making a complete inventory of the world energy resources, when other as the WEC (World Energy Council) is compiling heterogeneous statements. There is a need for worldwide-agreed definitions on products and assessments.

Forecasts based on published data are flawed, not because wrong methodology but because wrong definitions and wrong data. Published proven oil & gas reserves are not at all proved but what the nations wants to show, mainly for the OPEC countries. The SEC rules in the US stock market obliges oil company to omit probable reserves and aggregation of proved reserves is incorrect. Only UK and Norway publish real true (2P) field reserves.

More complete inventories (not compilation) of the world resources are needed, only the BGR is making one.

Most of misunderstandings and disagreements come from the lack of good definitions and reliable data.

A true dialogue between producers and consumers will improve security of oil and gas supply and demand.

China and India will see a large shortfall in oil and IEA future demand seems difficult to occur.

Unfortunately the solution seems to be, either energy saving with a behaviour change in the consuming society (unlikely), or an economic crisis as forecasted by Paul Volcker in 2004 in the next 5 years.