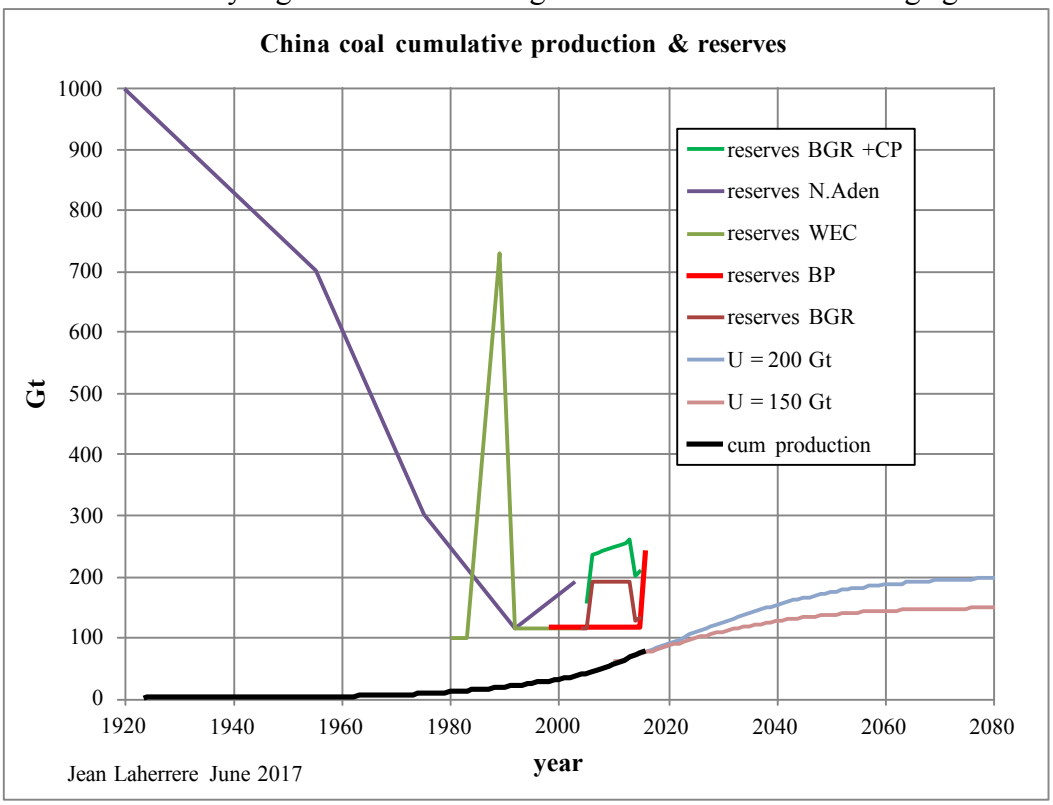
Jean Laherrere 18 June 2017

Updating fossil fuels production and CO2 emissions graphs

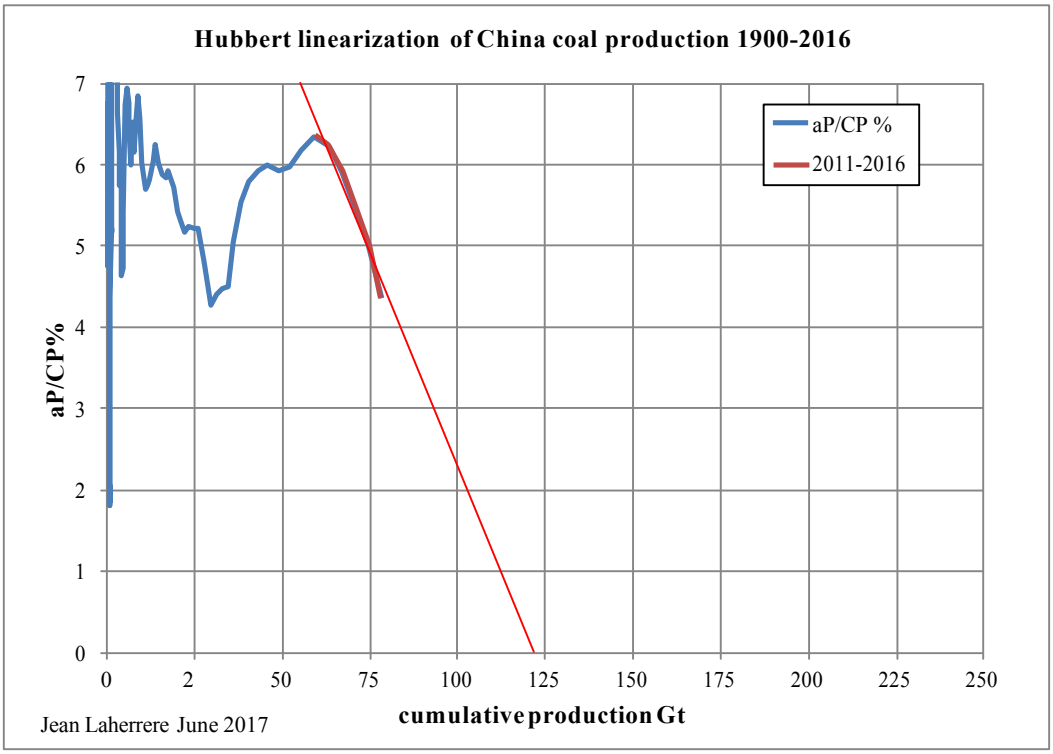
Using the 2017 BP statistical review data fitted to past data, the new graphs are quite different from previous ones because the peaking of world coal production, in particular in China

-China coal production

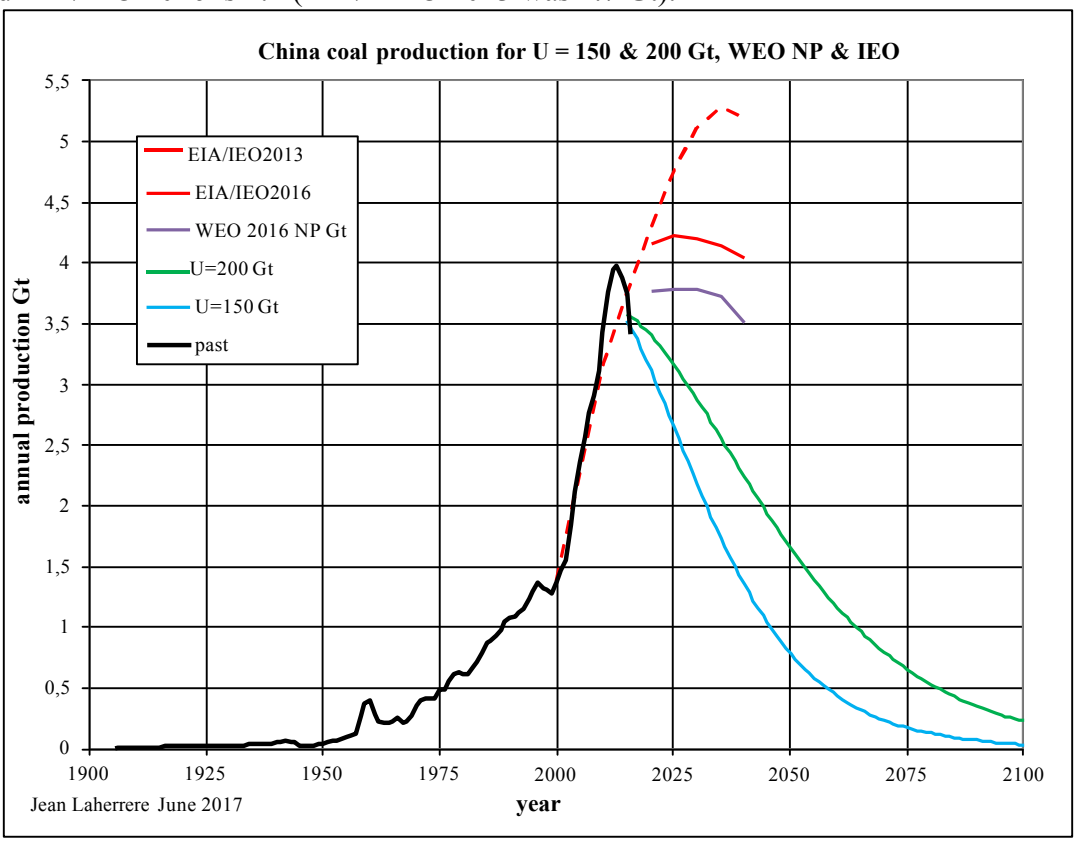
Because the pollution due to particles (and not to CO2) the Chinese coal production has peaked in 2014 at 4 Gt per year
Last year my ultimate was 200 Gt, now I prefer 150 Gt
BGR reserves (in green) decline in 2016 when BP reserves (in red) increase sharply!
WEC reserves were very high in 1920 declining down to 1990 and increasing again in 2004



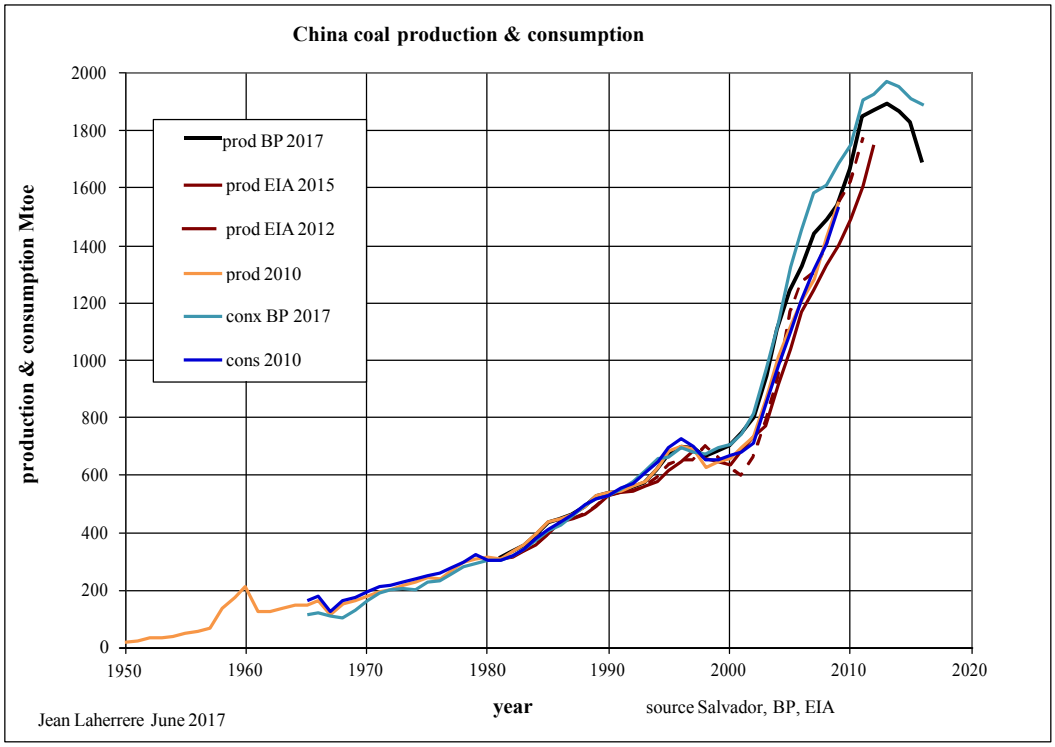
All these reserves estimates vary but added to the cumulative production an ultimate of 200 Gt looks better than 150 Gt.
The linear extrapolation of the coal production for the period 2011-2016 trends towards 120 Gt



My coal production forecast is modeled with both ultimates of 150 Gt and 200 Gt.
My production forecast for 2025 is between 2.6 and 3.2 Gt when IEA/WEO 2016 NP is 3.8 Gt and EIA/IEO 2016 is 4.2 (EIA/IEAO 2013 was 4.7 Gt).



The large differences in data show clearly that China coal production is hard to forecast but China needs coal for electricity despite their efforts on sun and wind and nuclear.

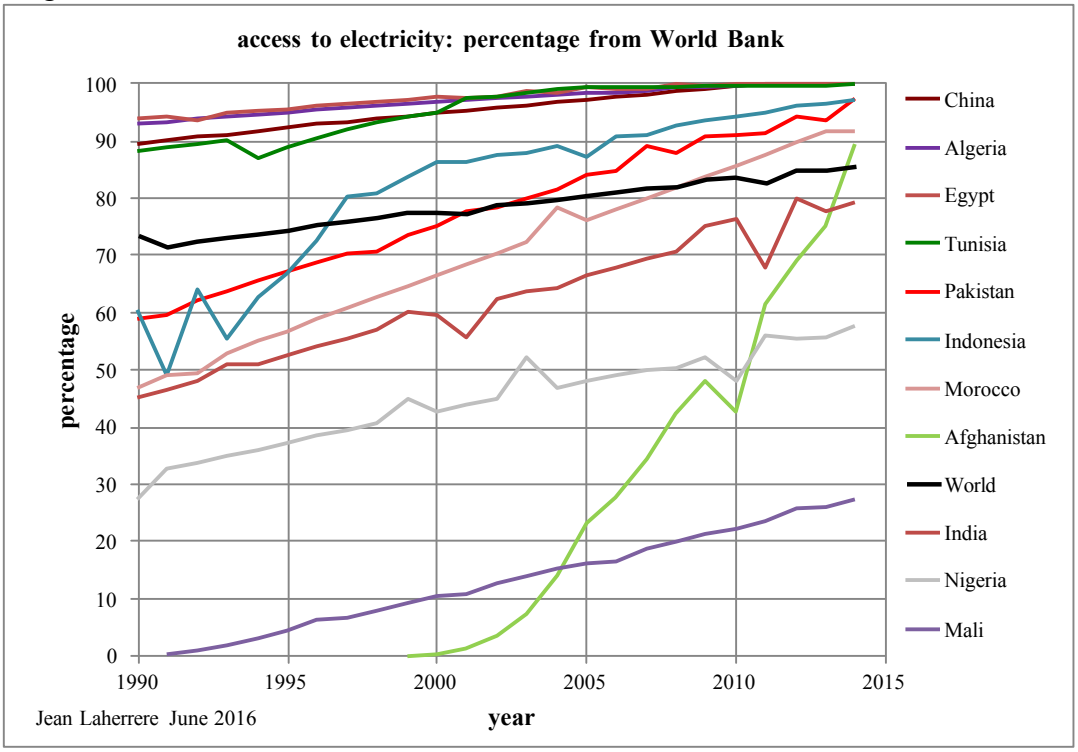


-India coal production

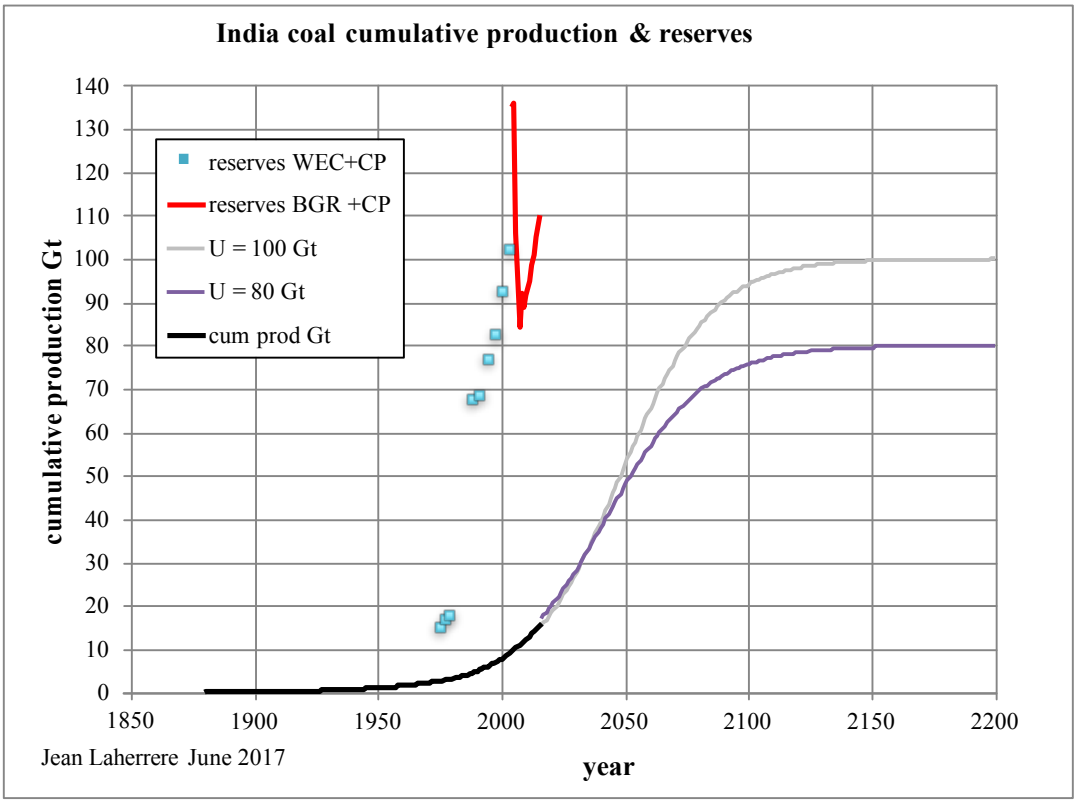
India needs more than China electricity from coal because in 2015 about 250 M Indians have no access to electricity when none in China.

World Bank provides the percentage of access to electricity from 1990 to 2014: only 85 % has access in 2014 for the world (81% in India) with 1186 M with no access

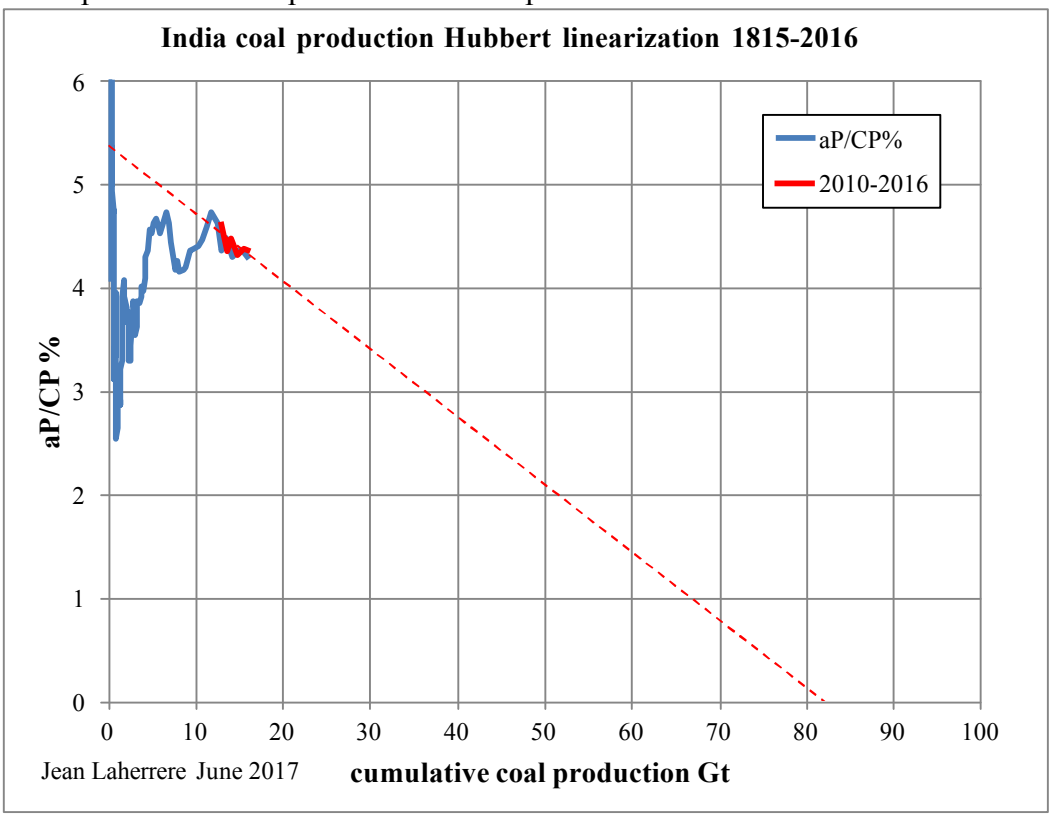
Some country as Mali (27%) have a low access, but it is surprising to see Afghanistan increasing from 0% in 2000 to 90% in 2014!



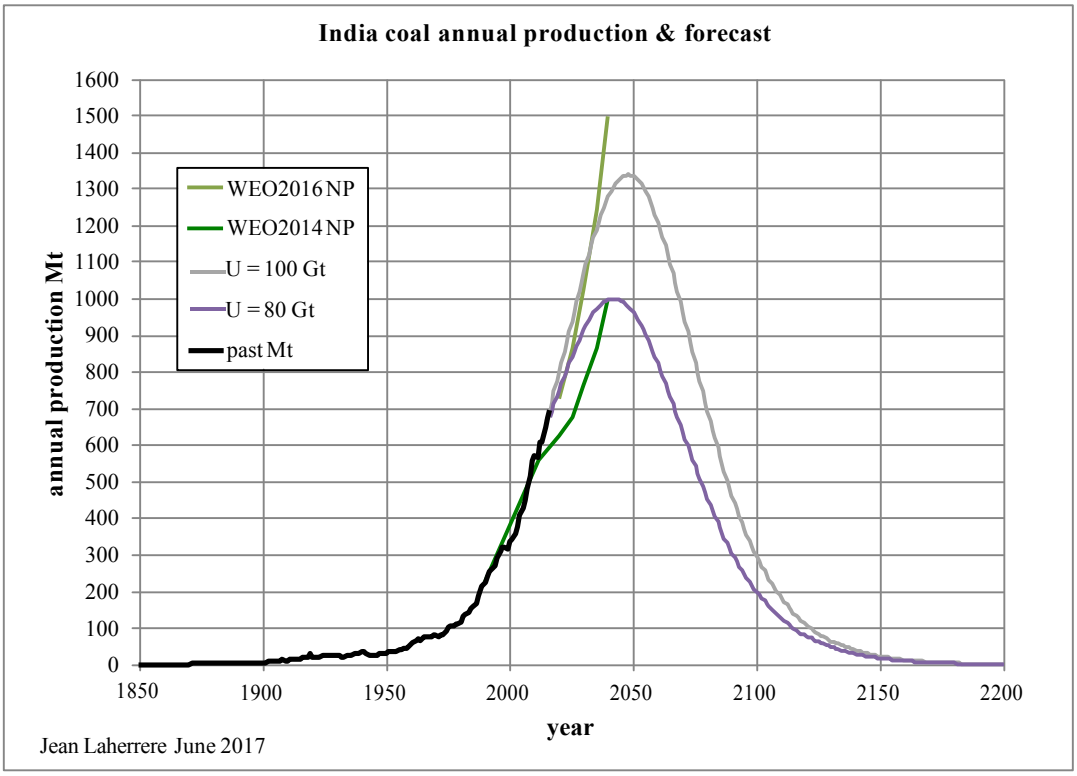
India coal reserves have varied sharply from BRG or WEC sources and the ultimate is estimated between 80 and 100 Gt



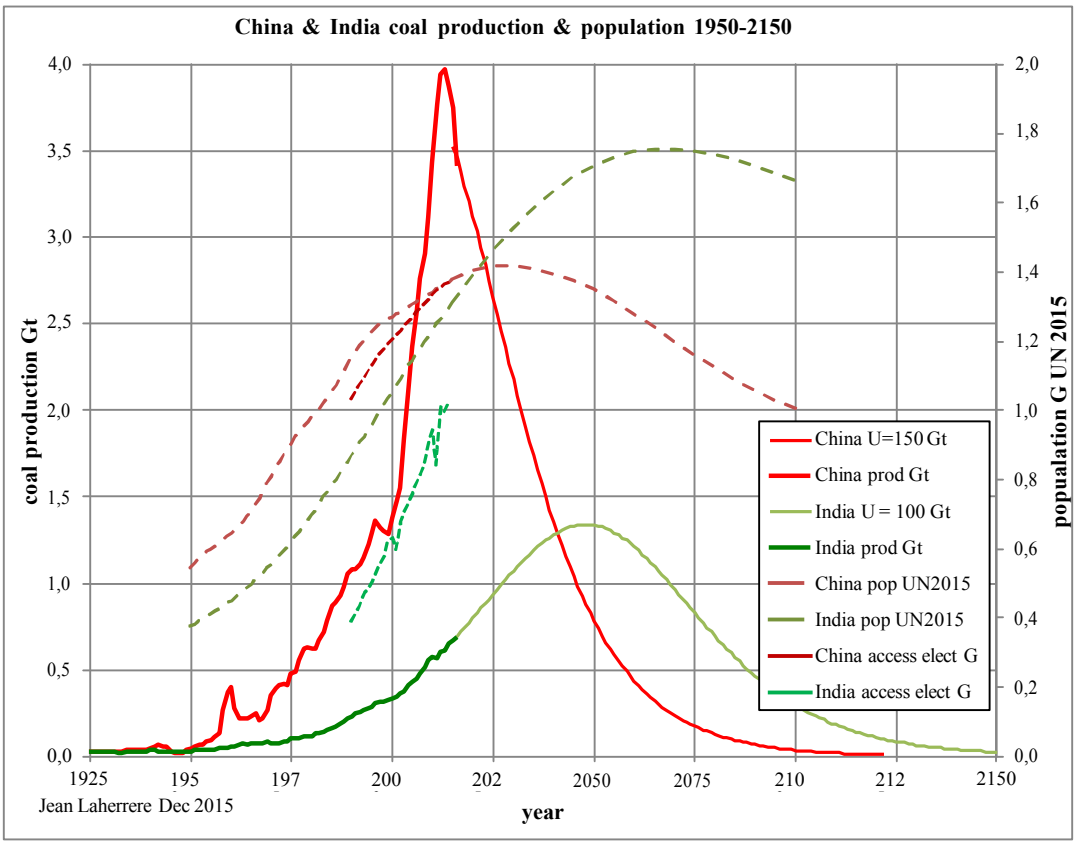
Linear extrapolation of coal production for the period 2010-2016 is about 80 Gt



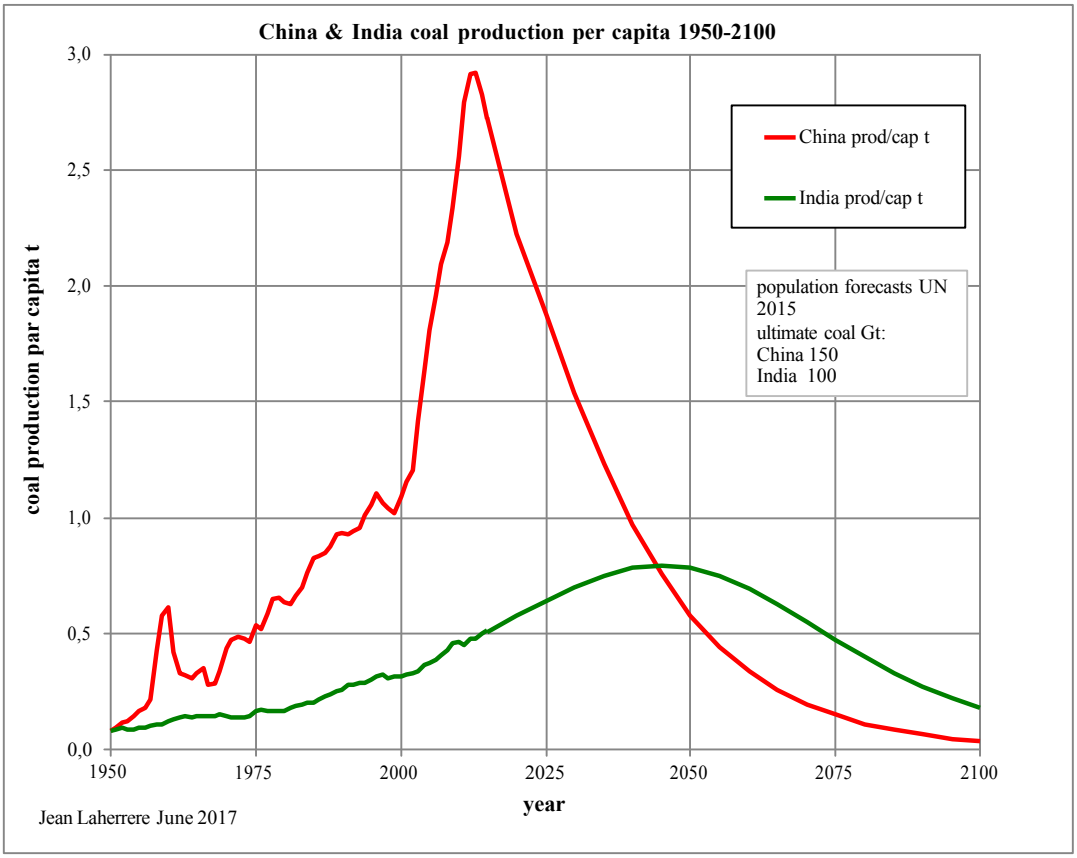
IEA/WEO NP forecasts for 2040 were 1 Gt for WEO 2014 and 1.5 Gt for WEO 2016: quite a change8



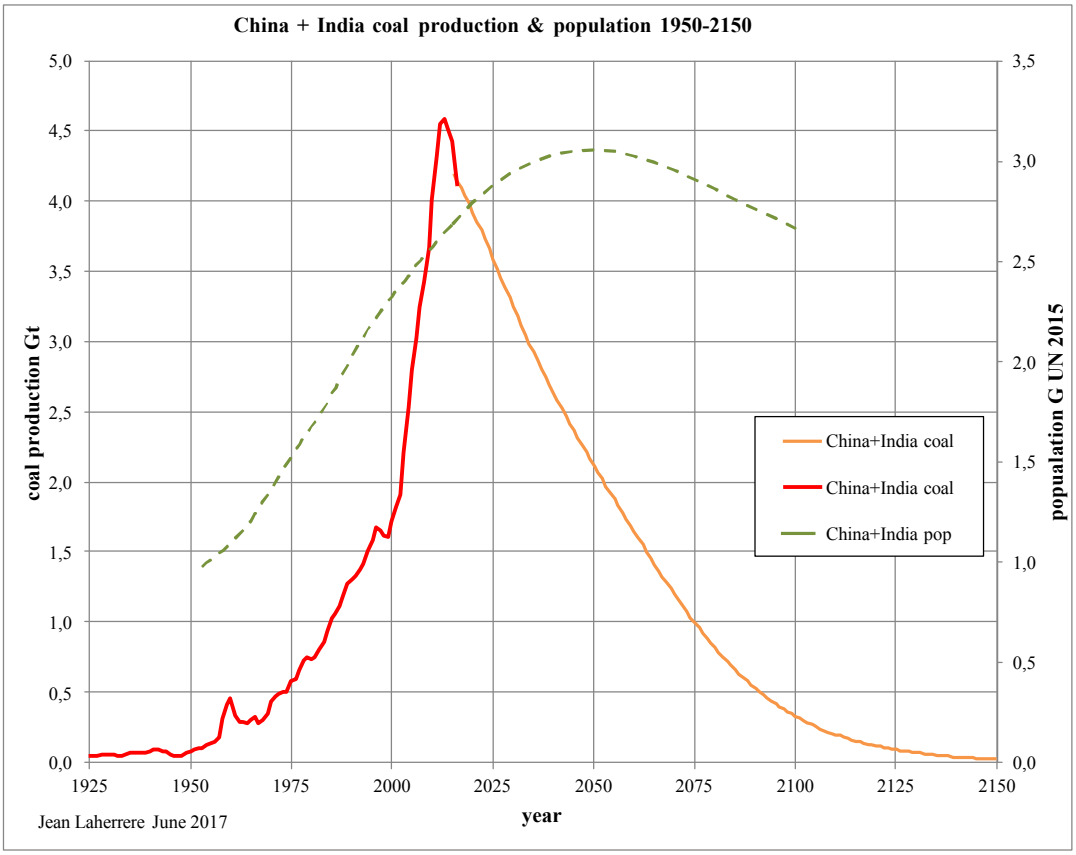
-comparison China and India
Coal production are compared as population and access to electricity
China coal production has peaked in 2014 at 4 Gt/a, when India will peak around 2050 at 1.4 Gt/a



The production per capita was about 3 t for China (ultimate in 2014 and will be only 0.8 t around 2050

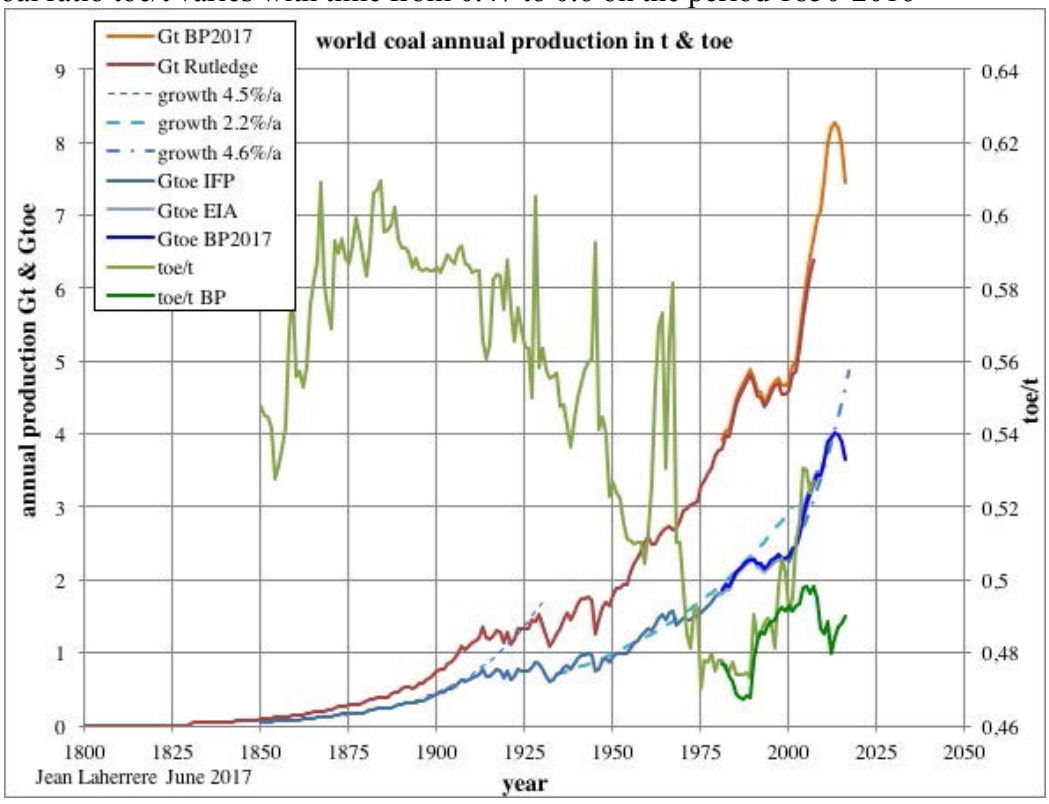


Adding China and India for coal production and population shows that coal peak is far from population peak

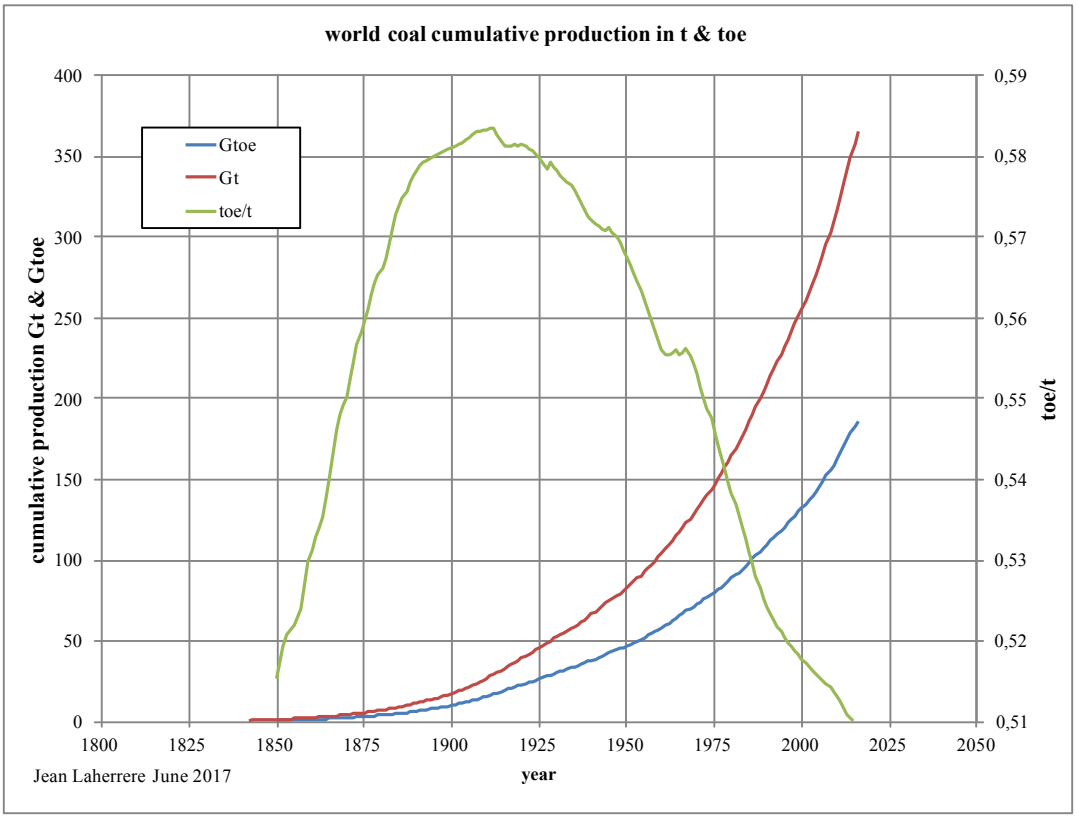


-World coal production

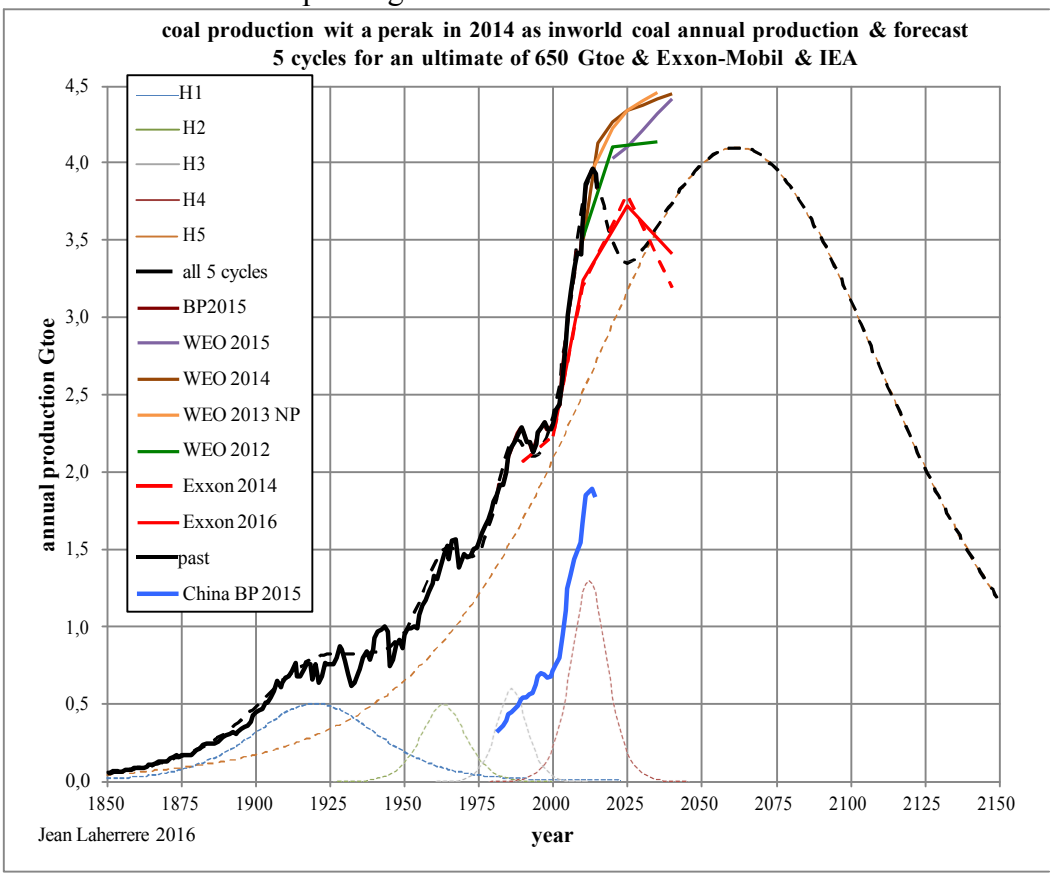
The coal ratio toe/t varies with time from 0.47 to 0.6 on the period 1850-2016



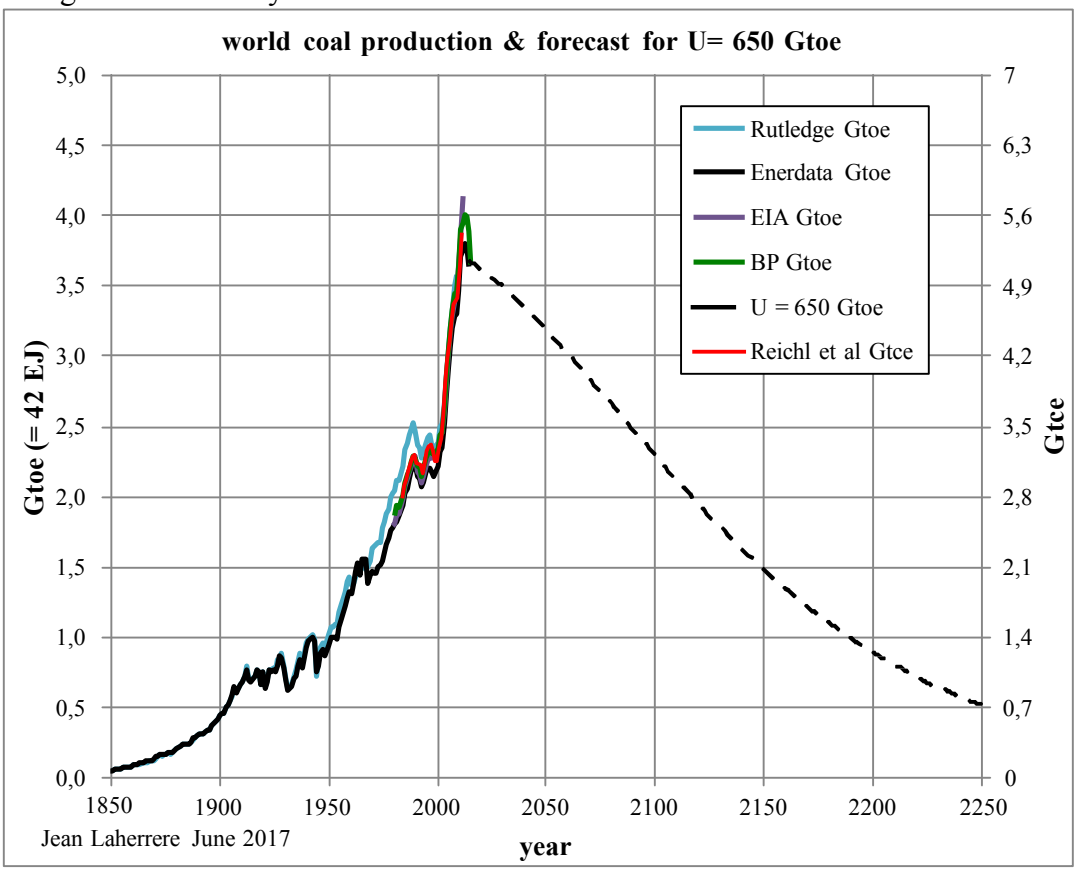
On the coal, cumulative production toe/t varies from 0.51 (2016) to 0.59 (1910)



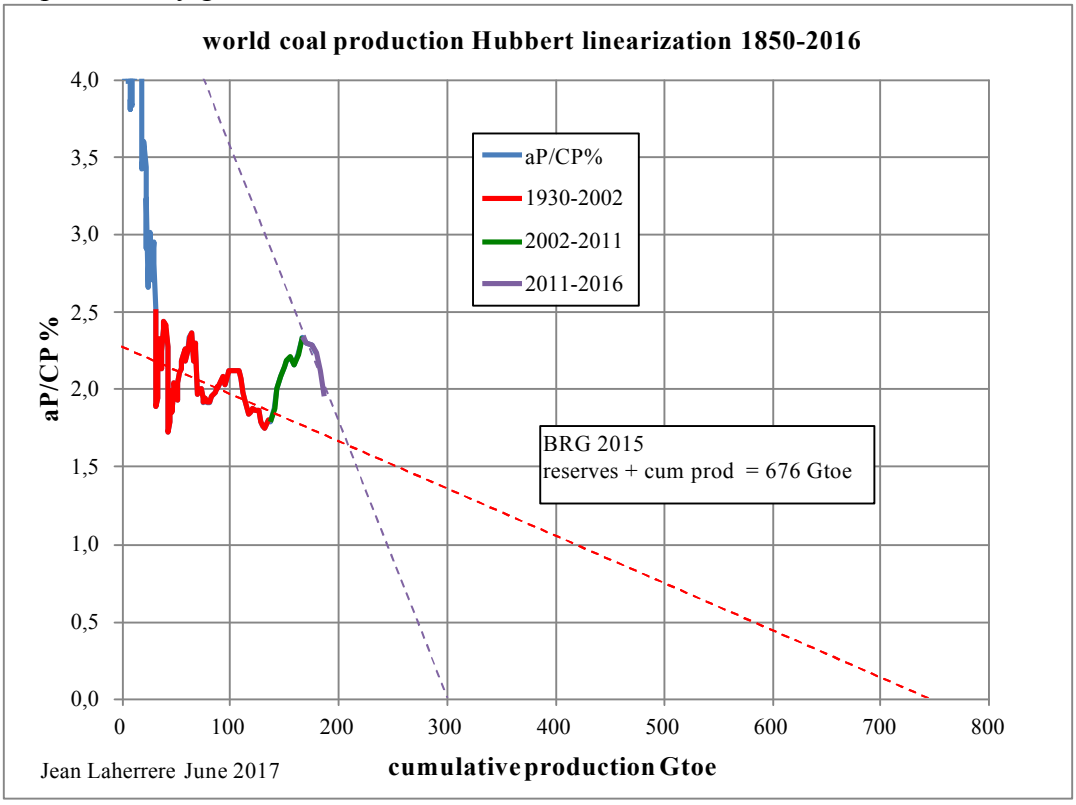
In 2016, I did model coal production with an ultimate of 650 Gtoe with a peak in 2014 as around 2060. It is interesting to see that Exxon 2016 forecasts a coal peak around 2025 when IEA/WEO 2015 does not see peaking before



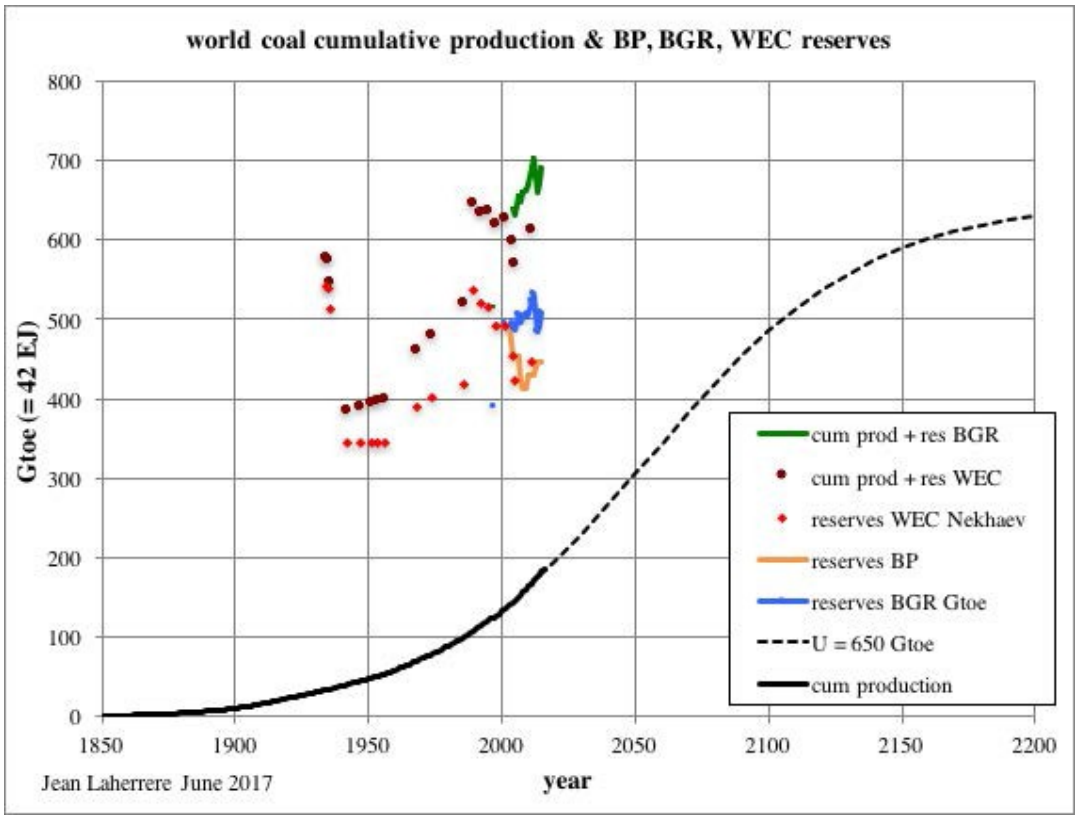
Today I assume that coal production will soon soften their decline and will not peak again to please the green community and the World Bank!



The linear extrapolation of past production (% annual/cumulative = Hubbert linearization) does not provide any good estimate

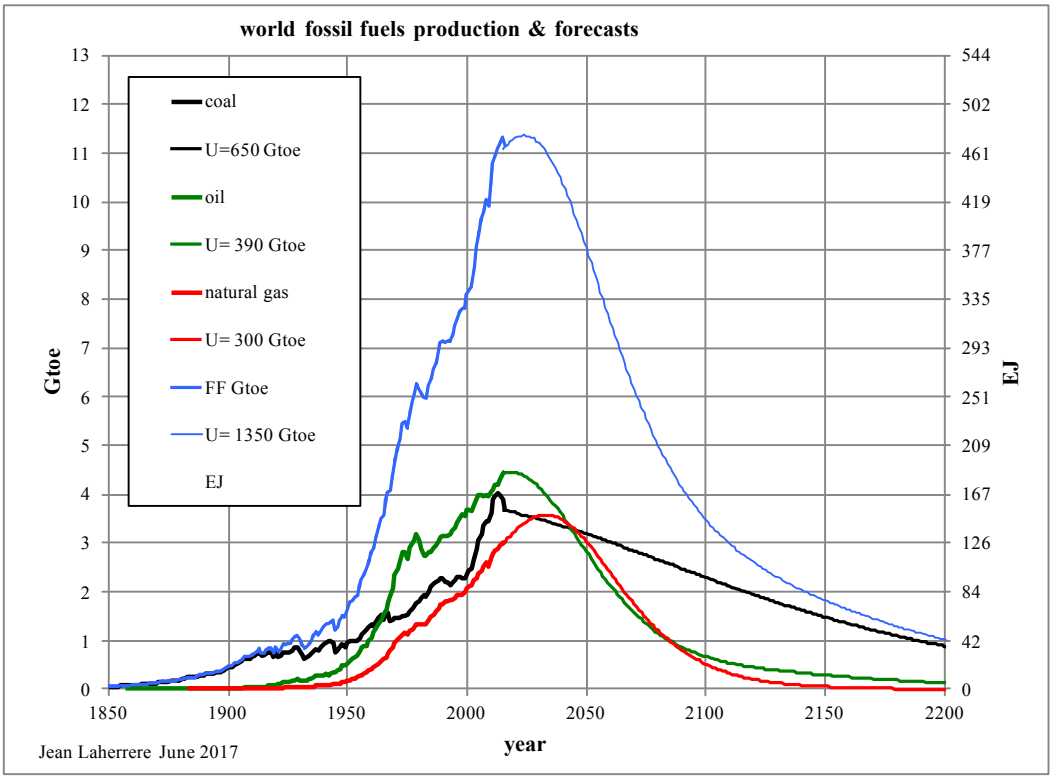


The cumulative coal production plus remaining reserves from BP, BGR and WEC shows a wild range between 550 Gtoe and 700 Gtoe. An ultimate of 650 Gtoe looks in line with those estimates.

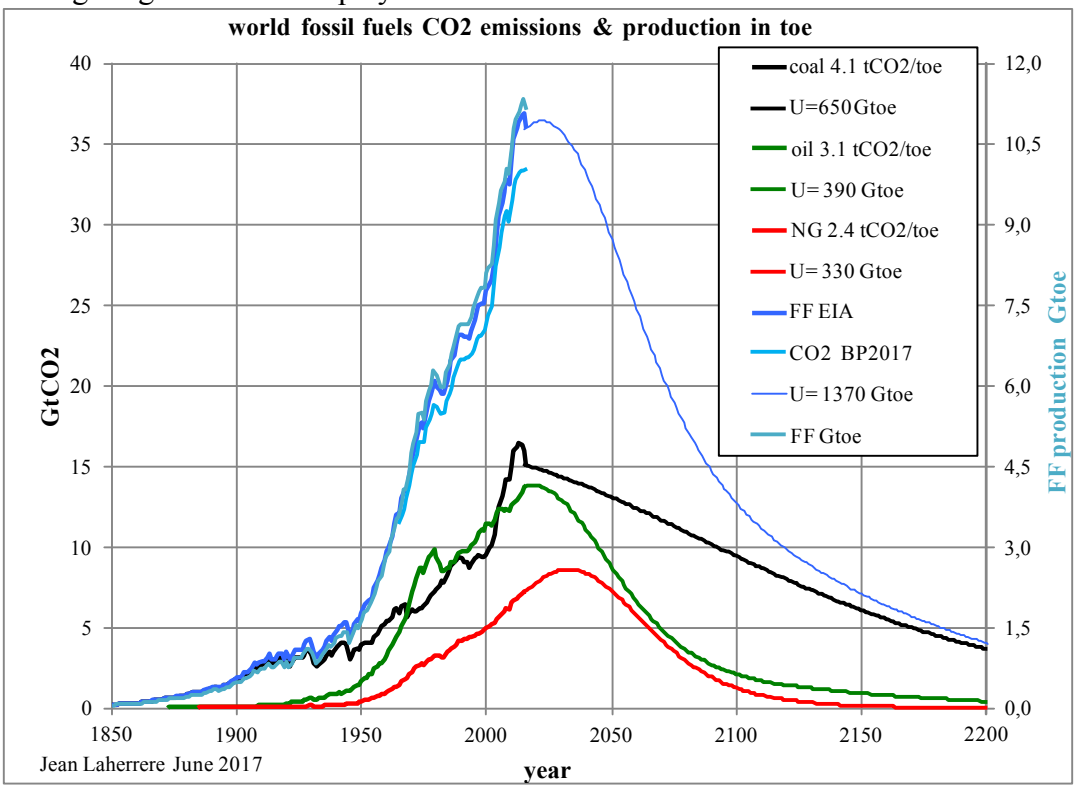


-Fossil Fuels production and CO2 emissions

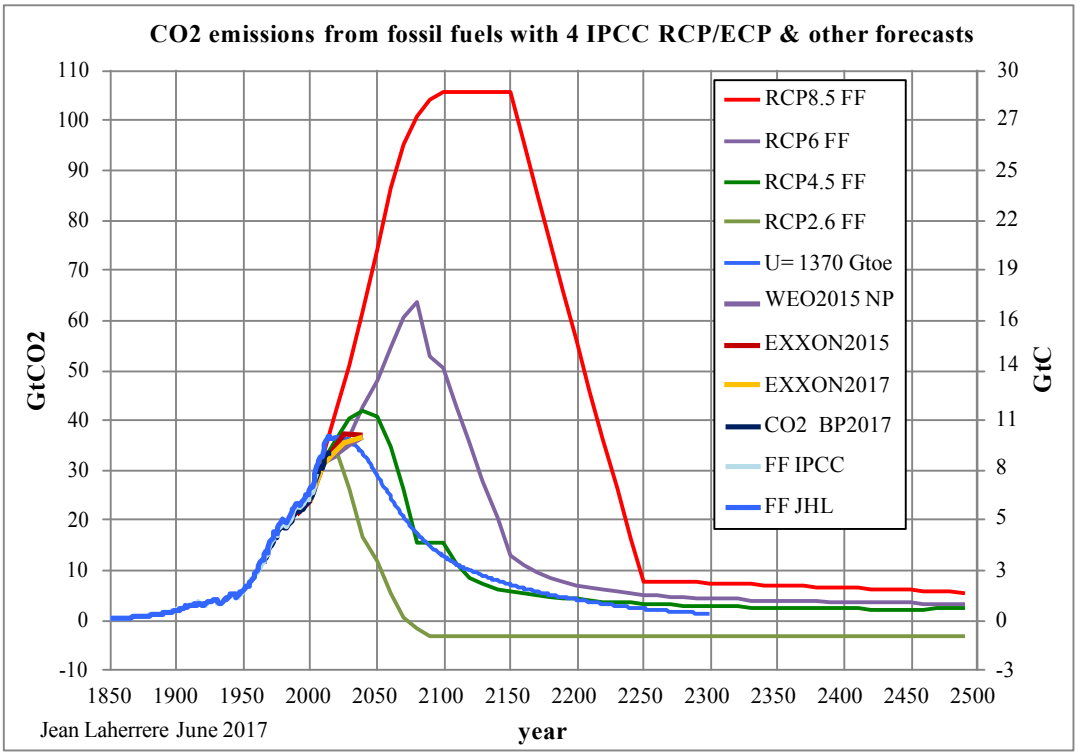
The new coal forecast is shown in this updated graph for fossil fuels in Gtoe and EJ



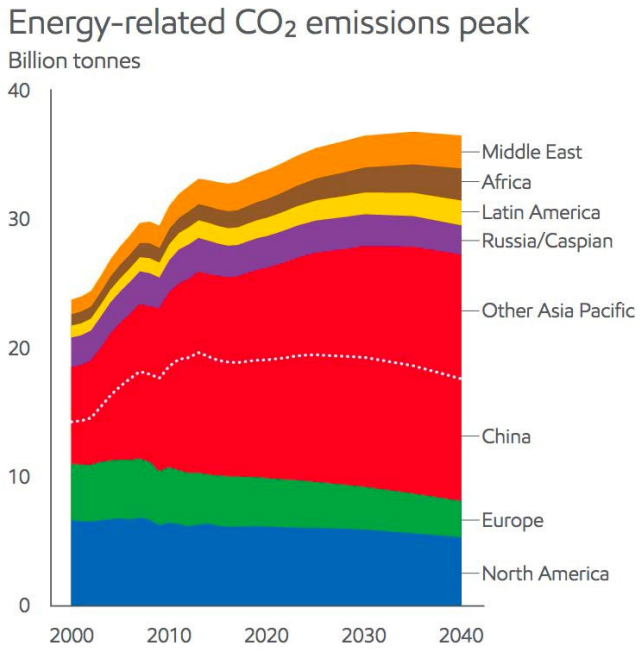
This FF production is converted into CO2 emissions in tCO2/toe with for coal 4.1, oil 3.1 and for NG 2.4 giving a different display



This FF CO2 emissions is compared to the 4 IPCC RCP scenarios (ECP = extended beyond 2100 to 2500) as the last forecasts from IEA, WEC and ExxonMobil



ExxonMobil 2017 outlook for energy sees peak in CO2 emissions around 2035

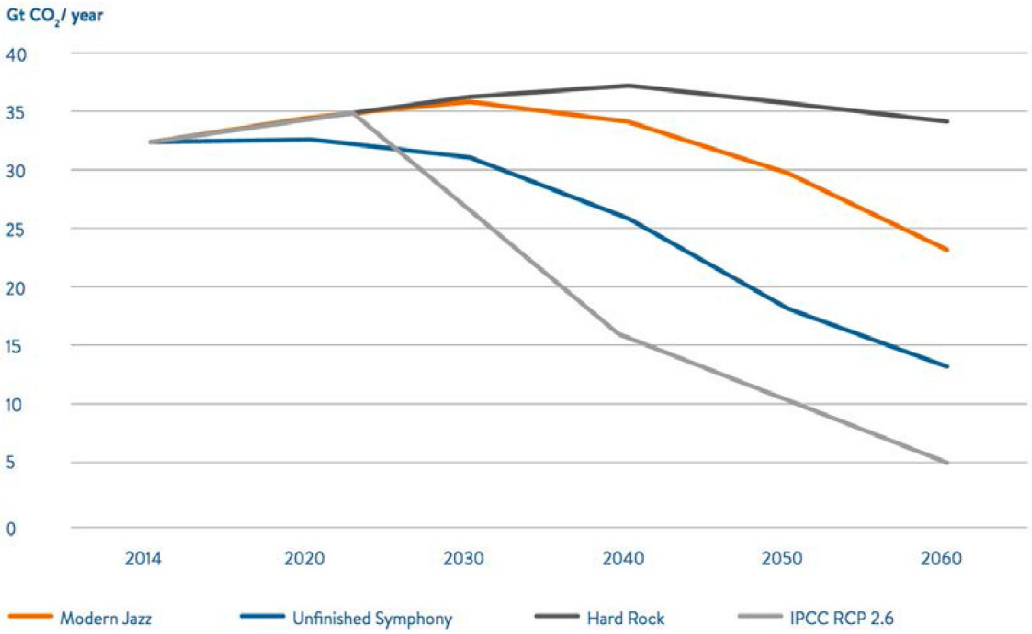


WEC (World Energy Council) energy resources were carried out since 1933 and WEC 2016 was the 24th

WEC 2016 forecast is based on three scenarios = Modern Jazz, Unfinished Symphony and HardRock https://www.worldenergy.org/wp-content/uploads/2016/10/World-Energy-Scenarios-2016_Full-Report.pdf

The peak of CO2 emissions is at the most 37 GtC02 in 2040

FIGURE 49: GLOBAL CARBON EMISSIONS (GTCO$_2$/YR)

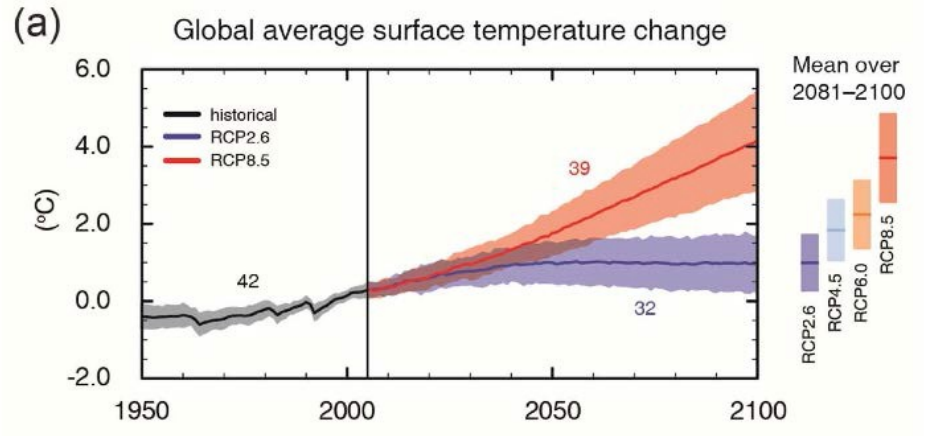


Source: The World Energy Council, Paul Scherrer Institute, Accenture Strategy

It is obvious from all these forecasts by energy agencies that the two IPCC scenarios RCP8.5 and RCP2.6 are unrealistic: there were designed by economists as storylines without any check with energy experts. There are also political views being approved by the 195 countries members of the IPCC

Many claims that the temperature in 2100 could reach over 4°C based on RCP8.5, but RCP8.5 will never be reached and corresponds to a storyline from the mind of an incompetent thinker.

Figure SPM.7 [FIGURE SUBJECT TO FINAL COPYEDIT]



It is ever worse with the claim of over 9°C in 2300 with RCP8.5

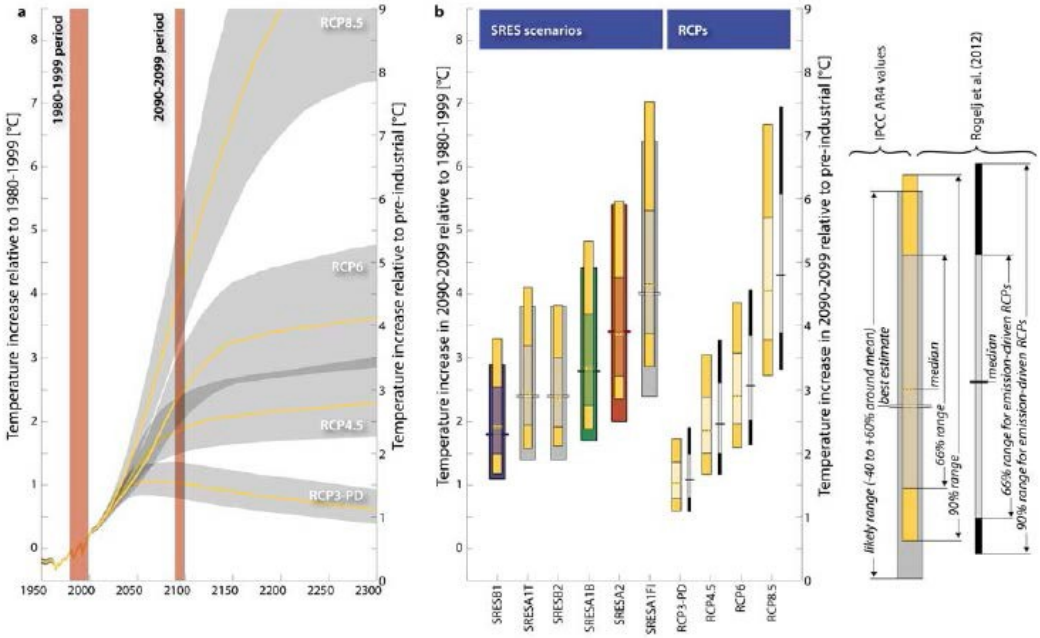
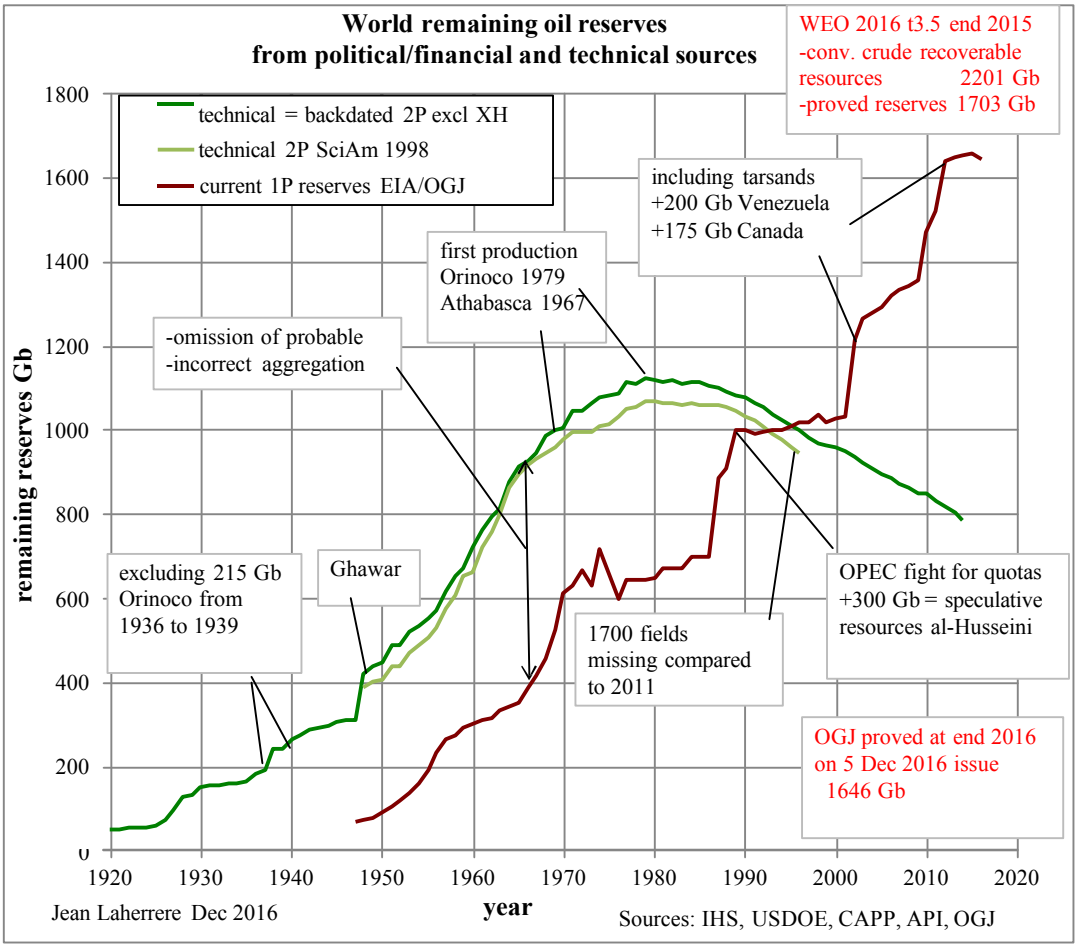
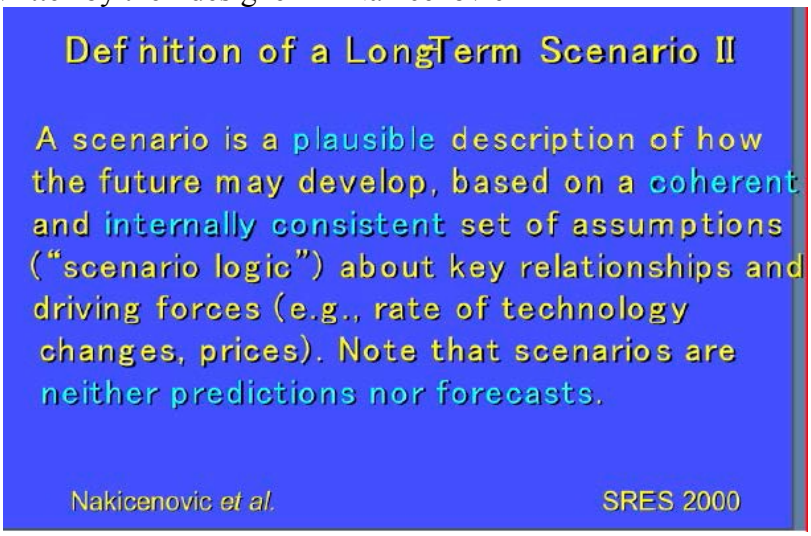


Figure 12.40: Temperature projections for SRES scenarios and the RCPs. (a) Time-evolving temperature distributions (66% range) for the four RCP scenarios computed with the ECS distribution from Rogelj et al. (2012) and a model setup representing closely the carbon-cycle and climate system uncertainty estimates of the AR4 (grey areas). Median paths are drawn in yellow. Red shaded areas indicate time periods referred to in panel b. (b) Ranges of estimated average temperature increase between 2090 and 2099 for SRES scenarios and the RCPs respectively. Note that results are given both relative to 1980–1999 (left scale) and relative to pre-industrial (right scale). Yellow ranges indicate results obtained by Rogelj et al. (2012). Colour-coding of AR4 ranges is chosen to be consistent with AR4 (Meehl et al., 2007). RCP2.6 is labelled as RCP3-PD here.

But the claim that 60 to 80% of the fossils fuels should be kept in the ground in order to keep the temperature below 2°C is based on wrong reserves data. The present real fossil fuels reserves correspond about RCP6 and IPCC forecast for RCP is about 2°C in 2100.
It is then wrong to claim that a part of the fossils fuels should not be produced.
I want to remind that the proven oil reserves are overestimated being political or financial and that the real technical reserves are well below, about 50 % of the so-called proved reserves



Most people believe that the IPCC scenarios are about the same probability: they are not they are storylines as written by their designer Dr Nakicenovic

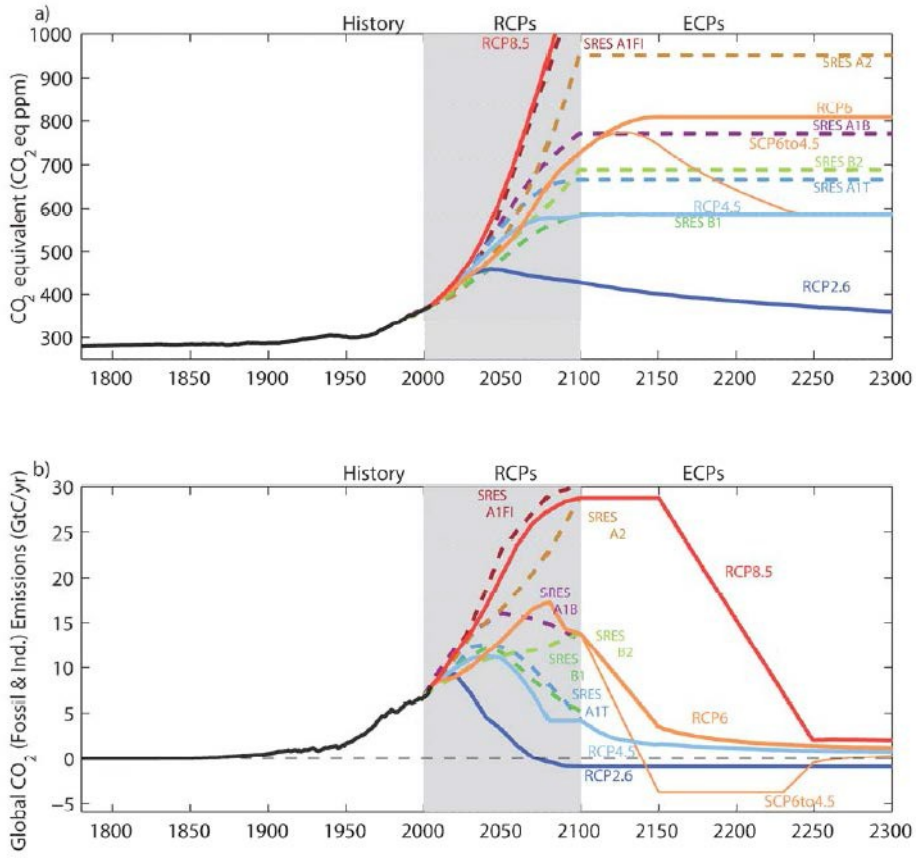


and as stated by the last IPCC report AR5

11-11: *No probabilities or likelihoods have been attached to the alternative RCP scenarios (as it was the case for SRES scenarios). Each of them should be considered plausible, as no study has questioned their technical feasibility*

The famous 2006 Stern report on the economics of climate change (loosing 5% of GDP per year and reaching 560 ppm in 2035 is nothing is done) is completely wrong, being based on equal probability of every scenario and on unrealistic amount of oceanic methane hydrates (more than oil, NG and coal together! impossible because less surface and sedimentary thickness).

The AR5 report sees RCO scenarios followed by ECP scenarios



Box 1.1, Figure 3: (a) Equivalent CO_2 concentration and (b) CO_2 emissions (except land use emissions) for the four RCPs and their ECPs as well as some SRES scenarios.

IPCC SRREN 2011 report displays the 164 different scenarios for CO2 emissions with different colors. Comparing to the forecasts by energy experts it is obvious that most scenarios (in particular the dark ones called baselines) are completely unrealistic, pure wishful thinking, nothing scientific!
IPCC omits to add official energy agencies forecasts!
Their comparison should hurt these views
https://www.ipcc.ch/pdf/special-reports/srren/SRREN_Full_Report.pdf
page 802

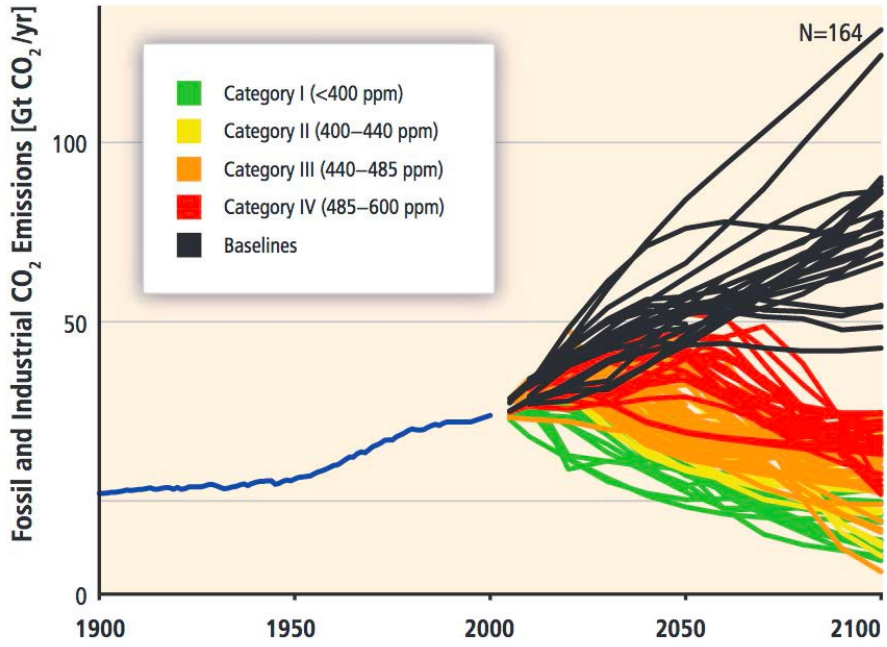
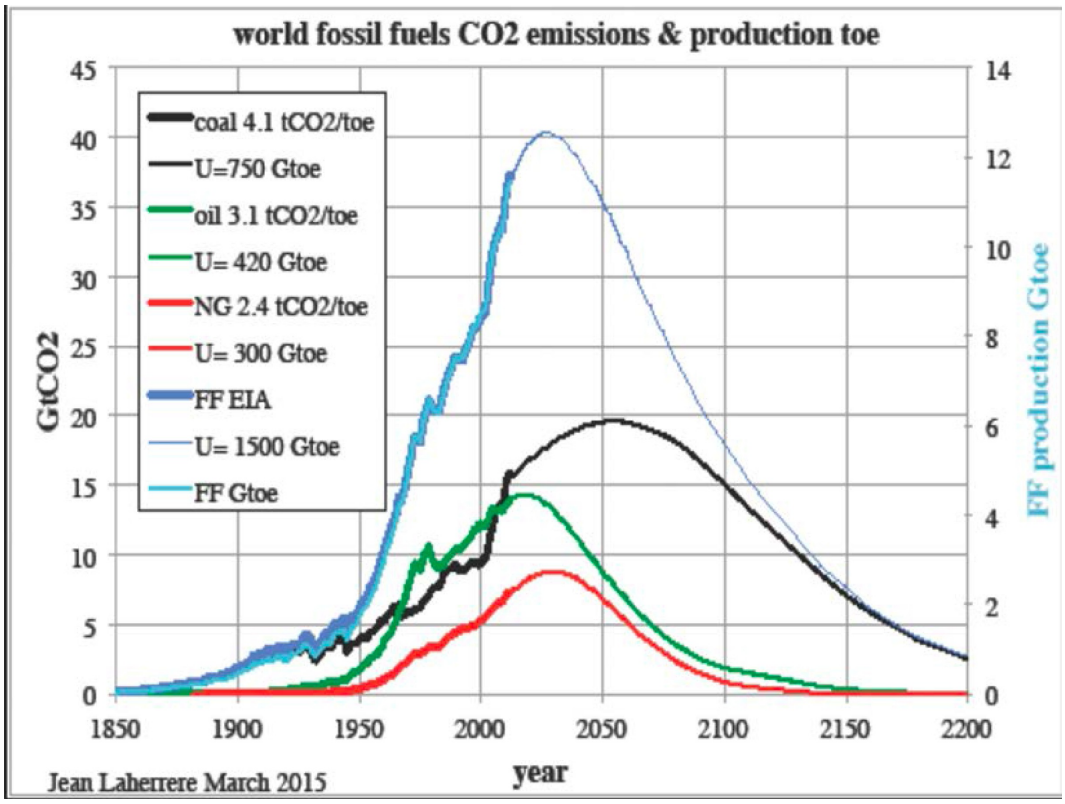
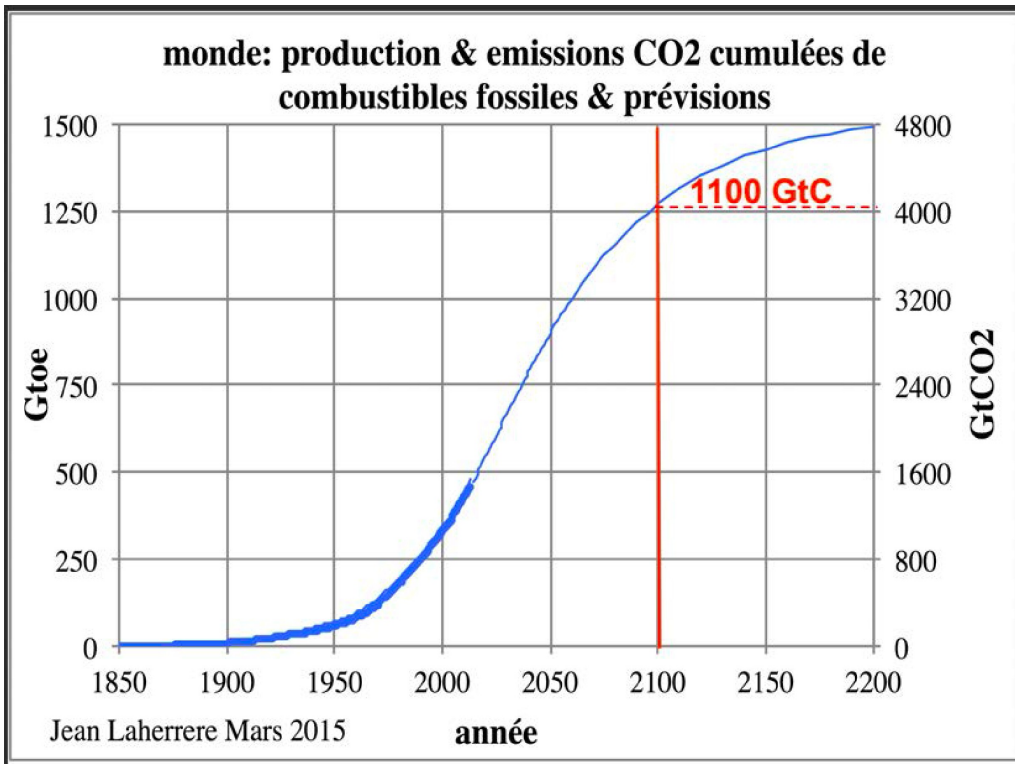


Figure 10.1 | Historic global fossil and industrial CO_2 emissions and projections from 164 long-term scenarios. Colour coding is based on categories of atmospheric CO_2 concentration in 2100 as defined in the IPCC AR4, WGIII (Fisher et al., 2007), with historic emission data from Nakicenovic et al. (2006). Figure and data adapted from Krey and Clarke (2011), modified to include two additional scenarios.

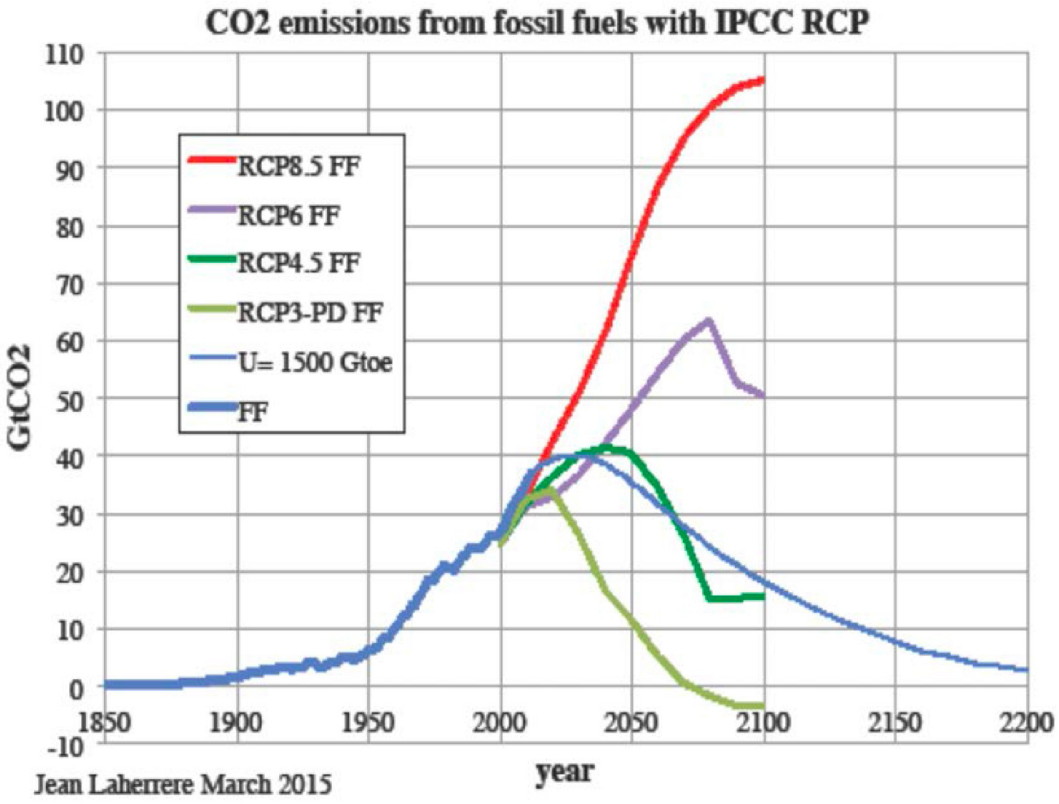
In 2015 Bernard Durand presented in Paris scientific conference for the preparation of COP21 this paper showing that the IPCC RCP scenarios are wrong, except RCP6. But the COP21 is not scientific it is political.

-Durand B. & Laherrere J.H. 2015 « Fossil Fuels Ultimate Recovery Appraisal, Clue to Climate Change Modelling » International Scientific Conference 7-10 juin Paris http://aspofrance.viabloga.com/files/BD_Fossils_Fuels_Ultimate_2015.pdf
https://aspofrance.org/2015/12/11/fossil-fuel-ultimate-recovery-appraisal-clue-to-climate-change-modeling-december-2015-bernard-durand/


world fossil fuels CO2 emissions & production toe
coal 4.1 tCO2/toe
U=750 Gtoe
oil 3.1 tCO2/toe
U= 420 Gtoe
NG 2.4 tCO2/toe
U= 300 Gtoe
FF EIA
U= 1500 Gtoe
FF Gtoe
GtCO2
FF production Gtoe
year
Jean Laherrere March 2015

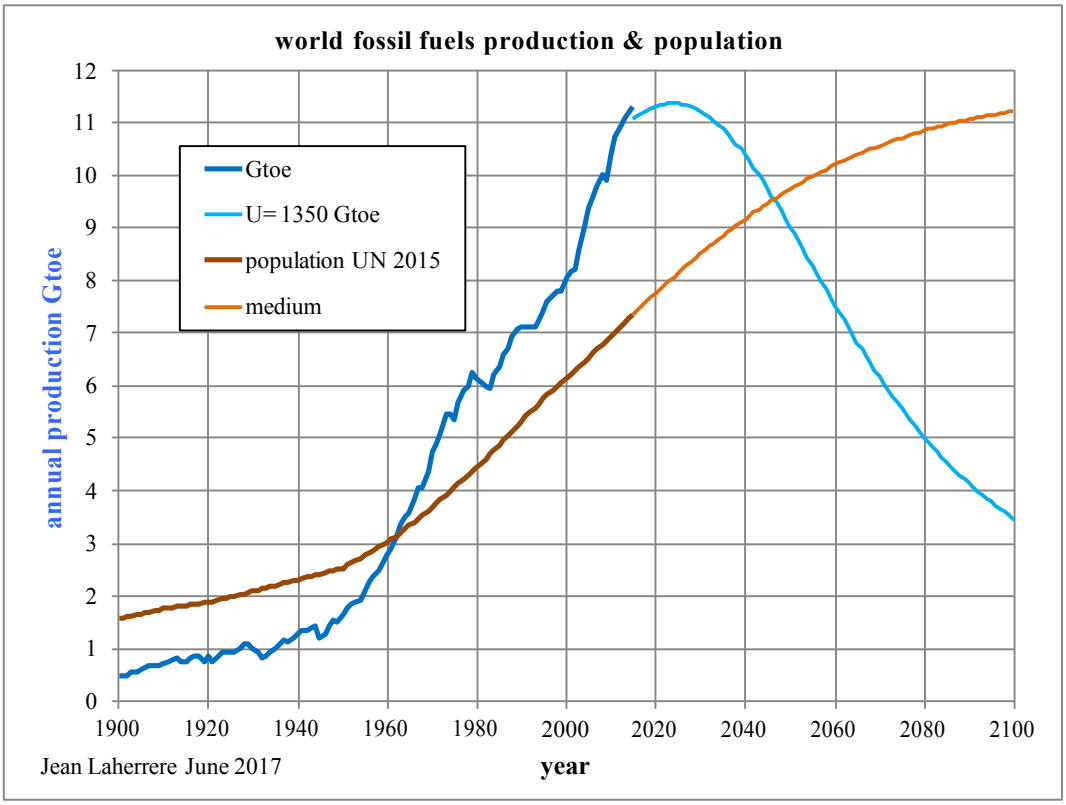

monde: production & emissions CO2 cumulées de combustibles fossiles & prévisions
1100 GtC
Gtoe
GtCO2
année
Jean Laherrere Mars 2015

- **Best guess for ultimate recovery of fossil fuels is 1500 Gtoe, corresponding to 1300 GtC (4800 GtCO2), whose 1100 GtC would be emitted from 1870 to 2100.**
- **This is less than fossil fuel emissions of RCP 4,5 (1250 GtC).**

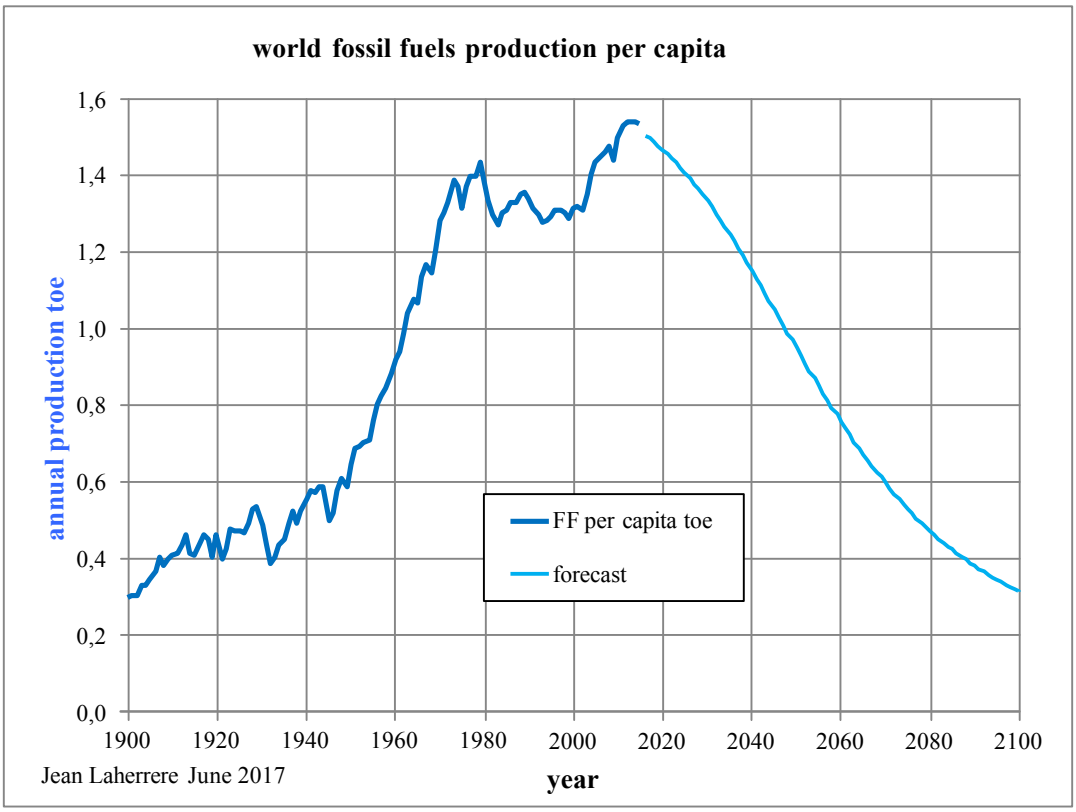


-Fossil fuels production per capita

FF production will peak around 2025, but before FF growth is less than population growth



FF production per capita has already peaked in 2014 at 1.5 toe and the decline will be fair, but less than the rise since 2002

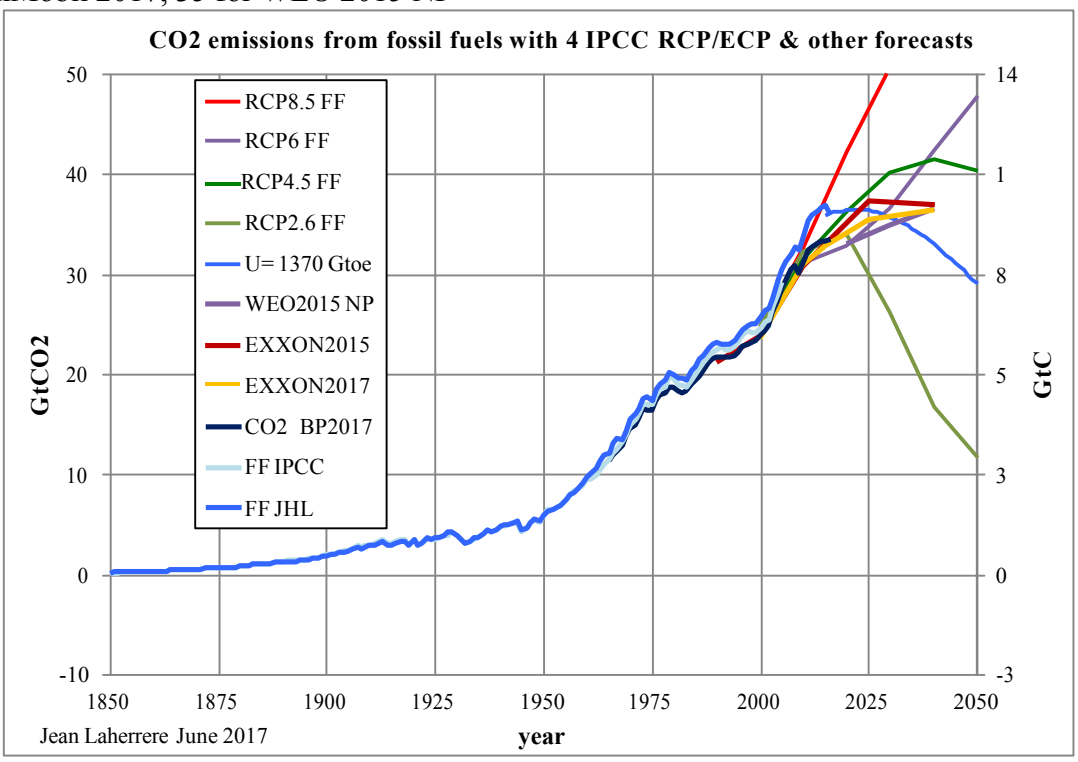


In 2060 the FF production will be half the peak production of 2014!
The nuclear and the renewable have to fill the decline. I doubt that renewable alone will be enough and energy storage has to improve greatly to fill the intermittence of sun and wind.

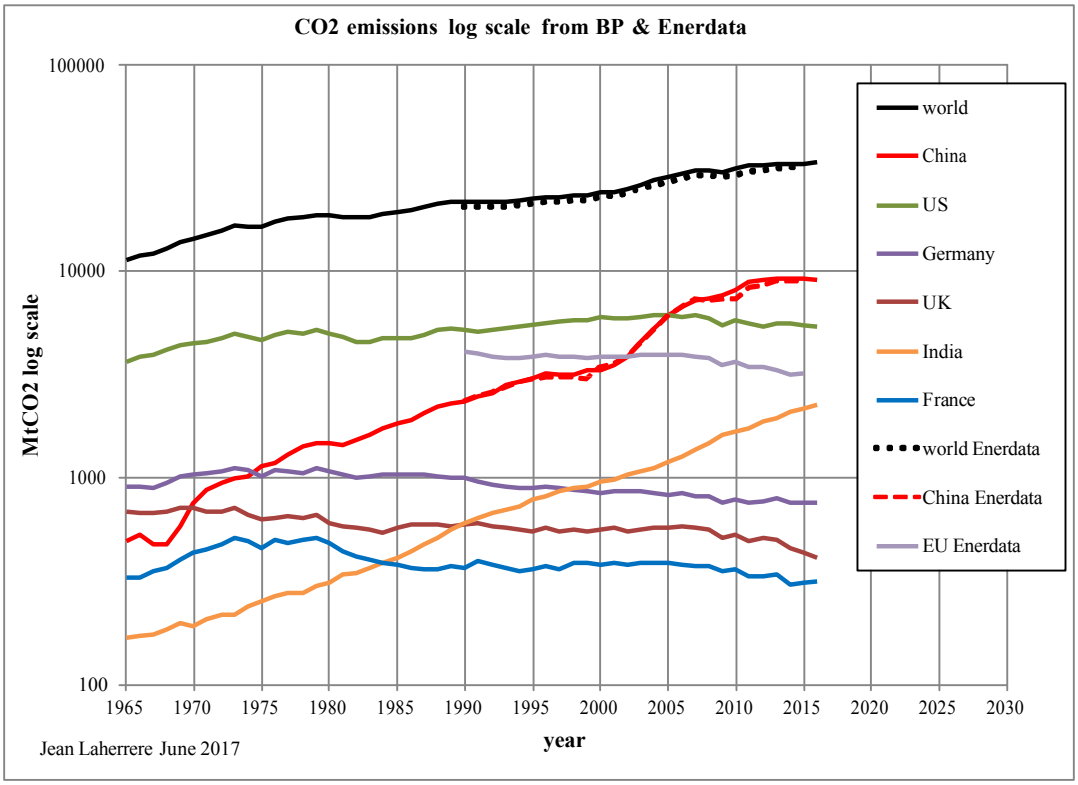
-Energy transition

In October 2014, the European Union has agreed to the Energy Transition with a reduction of CO2 emissions from the 1990 level by 40% in 2030) and by 80-95 % in 2050
France has agreed (law of 17 August 2015) to reduce from 1990 their CO2 emissions by 40% in 2030 (and to grow up renewables at 32% of energy consumption) and 75% in 2050 (reduction by 50% of energy consumption)

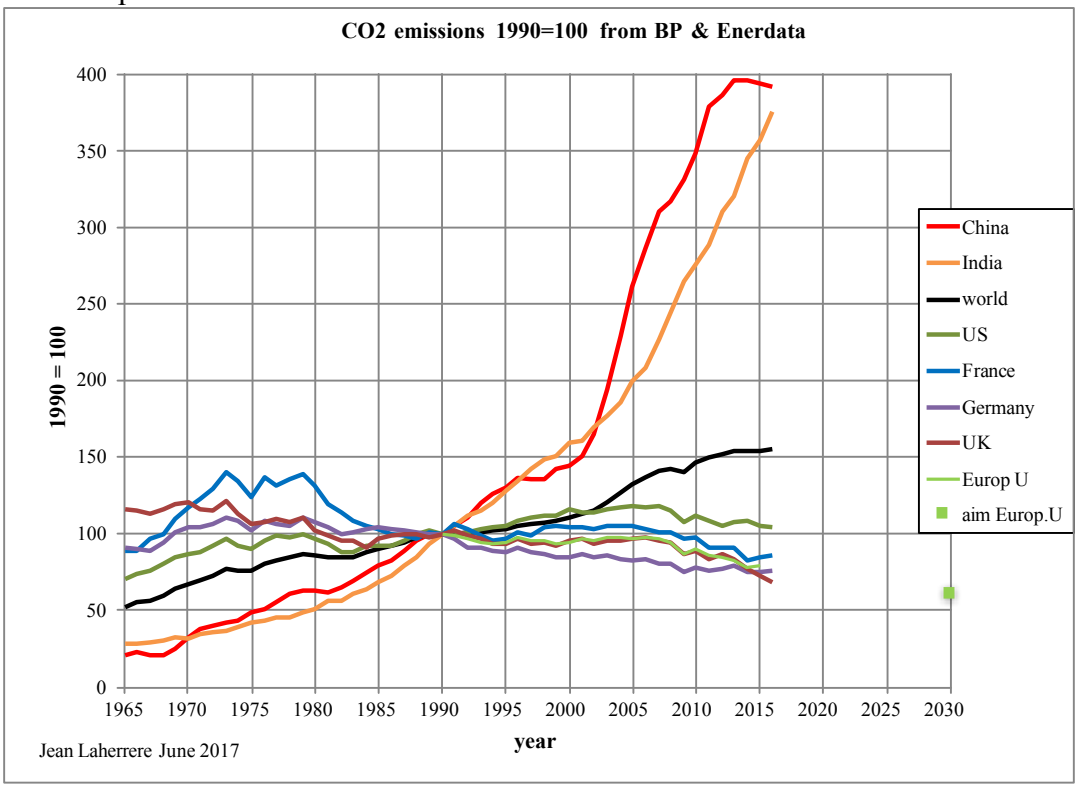
The world CO2 emissions were 22.5 GtCO2 in 1990 and the forecasts in 2030 are 36 for ExxonMobil 2017, 35 for WEO 2015 NP



BP 2017 and Enerdata 2016 provides CO2 emissions per country
The plot of CO2 emissions in log scale shows a continuous rise since 1965 for the world, but a sharp rise for India. European countries CO2 emissions decrease since the first oil shock.

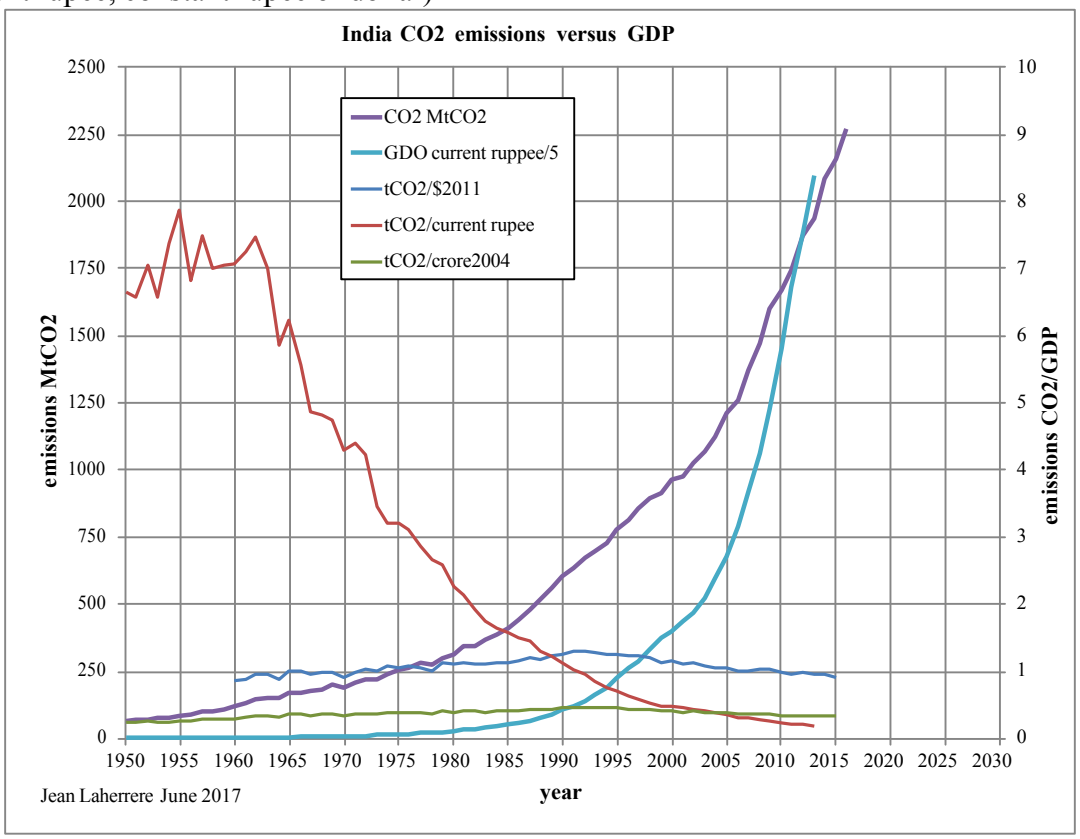


The same data plotted with 1990 = 100

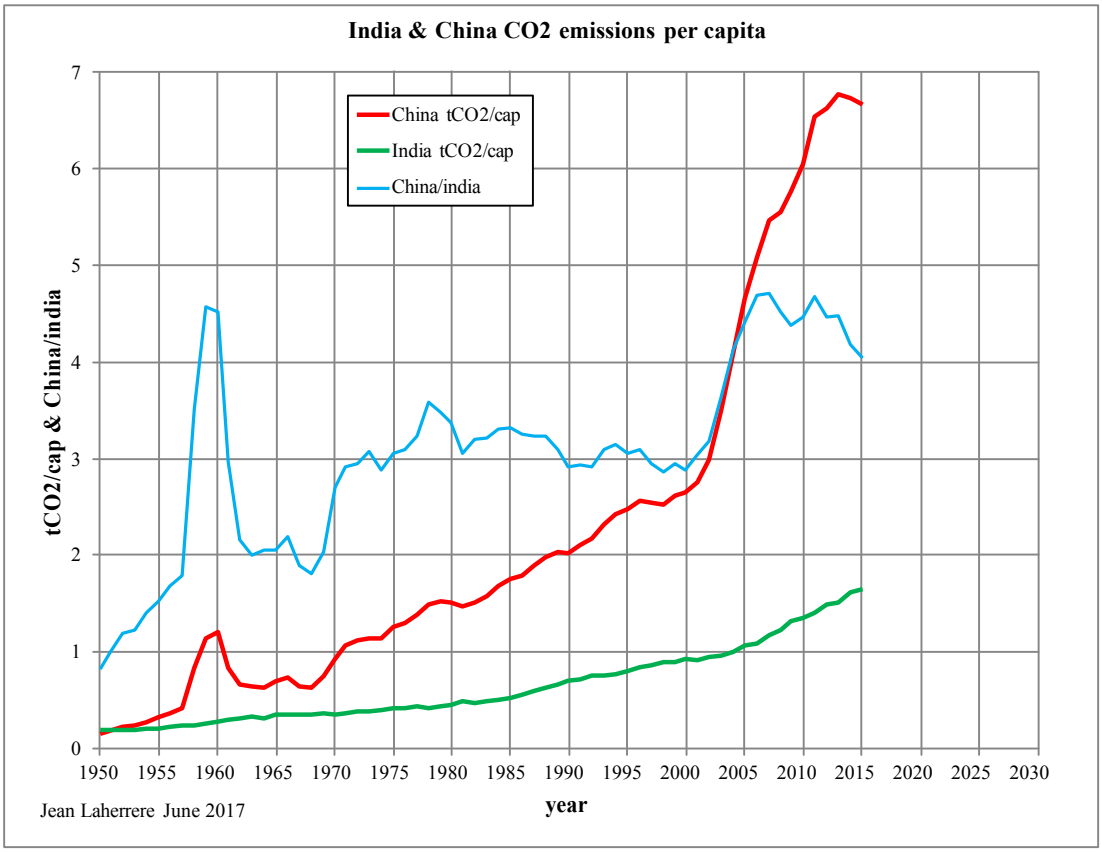


The European Union CO2 emissions are today 80% compared to 1990 and the aim to reach 60% of 1990 in 2030 should easily achieved.
But China after a sharp rise peaked in 2014 and India rise is unlikely to stop soon.
For COP 21 the INDC (Intended Nationally Determined Contributions) China indicates that their CO2 emissions will peak before 2030: it is already done. India indicates reducing the emissions intensity of its GDP by 33% from 2005 level, but without mentioning which GDP

(current rupee, constant rupee or dollar)



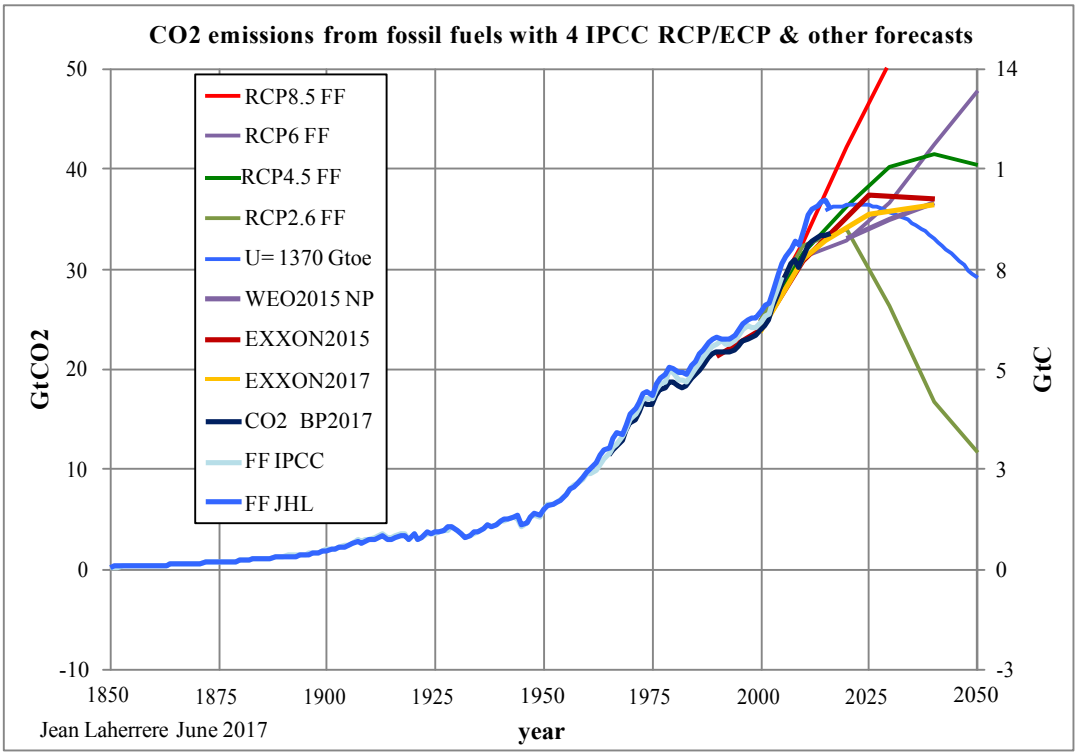
The decline of CO2/GDP varies with the unit of GDP.
But it is obvious that the growth of GDP is much larger than the growth of emissions: so, the CO2 emissions could continue to growth and the CO2 emissions per GDP will decline. India INDC does not oblige them to decrease the CO2 emissions!
India needs more electricity to give like China access to all and coal is the best answer.
India CO2 emissions per capita in 2015 is 1.6 tCO2 compared to 6.7 in China = 4 times more



It is hard to accuse India to pollute with CO2 when comparing to China!

-Conclusions

The majority of the world is convinced that the IPCC energy scenarios are forecasts from energy data. No, they are storylines dreamed by economists before 2000. As these SRES scenarios were approved by the 195 IPCC members they cannot be modified, these 40 SRES were only converted from energy (Joule or toe) into 4 radiative forcing's expressed in W/m2.
The majority of the world believes that temperature can be forecasted using model, but it appears that past modeling as the three scenarios) made by J. Hansen in 1988 for 2015 were wrong.
No one can prove that IPCC modeling is right because these models cannot model the main GHG which is the water vapor (60% when CO2 contributes only as 26% (Trenberth 1997-Dufresne 2011) and only by blue sky: as far as I know, there is no estimate of CO2 contribution when clouds.)
No one can show past modeling fitting present data.
It is obvious that the two extremes RCP8.5 and RCP2.6 are impossible, contrary to every reliable energy sources.
Everyone quoting forecasts from these impossible scenarios shows that he confuses scientific data and religious claims.



IPCC means Intergovernmental Panel on Climate Change gathering 195 countries where most have no climate expert. The report "Summary for policy makers" is approved by politicians and does not reflect the bulk of scientific papers of the full report.
IPCC was translated wrongly in French as "Groupe d'experts intergouvernementals sur l'évolution du climat" adding the presence of experts which was not in the English title.
It is the same with the translation of "Sustainable development" (1987 Brundtland report) into French "développement durable"
Confusing "durable" and "sustainable" hides something!

IPCC in their new report should rely on scenarios based on data from reliable agencies (IEA, WEC) and should estimate their probability (but without forgetting that only mean values can be arithmetically added = the arithmetic addition of proved reserves is wrong!)
Bankers and financial people uses proved reserves (SEC rules), forgetting that they cannot be added (it is hard to find any notice of such wrong practice: as it is done by everyone it is ok!).

Oil companies relies on SPE proved plus probable (2P) reserves, which can be added(close to mean), but these 2P data are forbidden by the SEC rules. Every oil company listed on the US stock market follows the SEC rules in their annual report, but not when deciding to develop an expensive oil project (the Net Present Value is based on mean (2P) data and not on proved (1P) data).