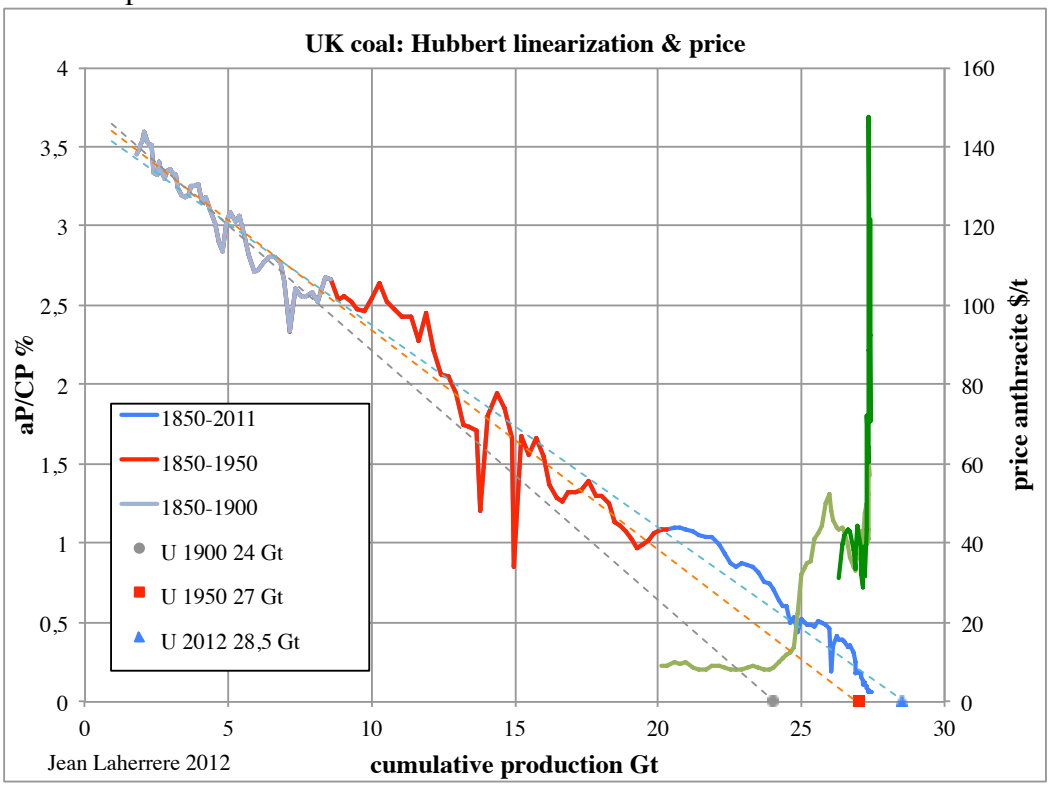
Jean Laherrere 16 July 2014

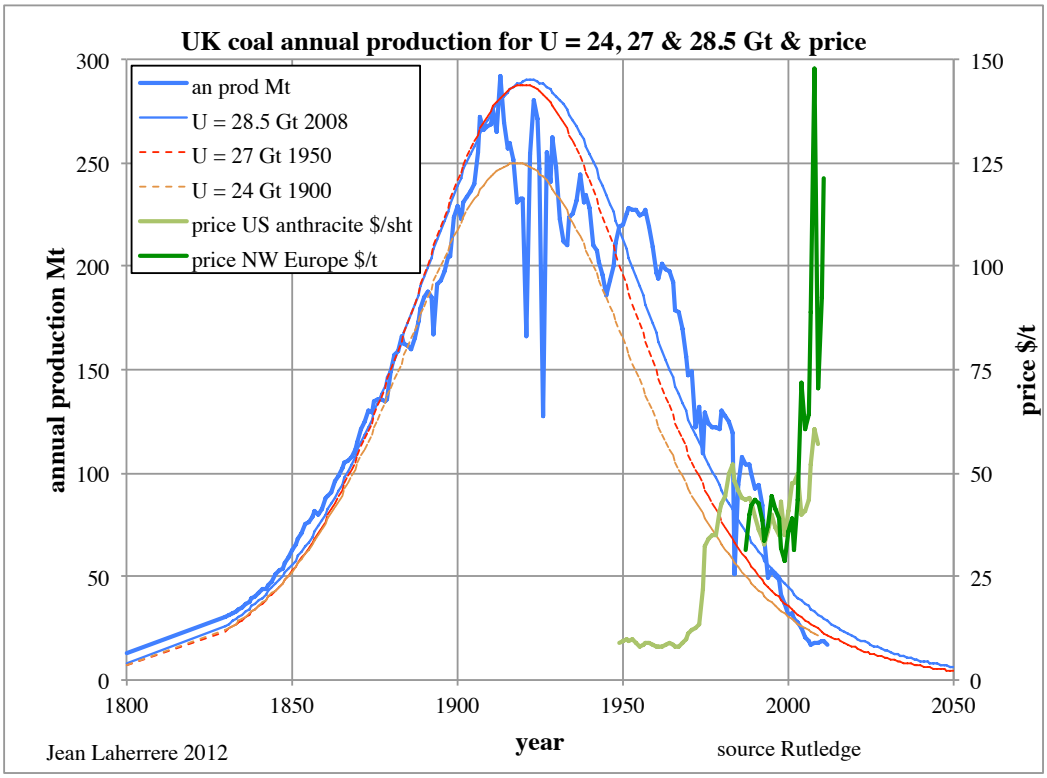
Steel production, Hubbert linearization and forecasts

It is hard to find complete historical production data
I did my best to gather steel data from Internet
Forecasting future steel production needs to estimate the ultimate (being the cumulative production from start to end)
For oil accumulations it is done estimating the volume in place and the recovery factor
Another way is to extrapolate the growth versus cumulative production, the ultimate corresponds to the future zero growth. The only problem is how to extrapolate!
If the cumulative production follows a logistic curve, the so-called Hubbert linearization (percentage annual from cumulative versus cumulative production) trends towards the ultimate.
Most of the times the growth plot does not follow a complete linear trend but only by periods
The steel production depends upon the coal production and it is worth to study coal production first

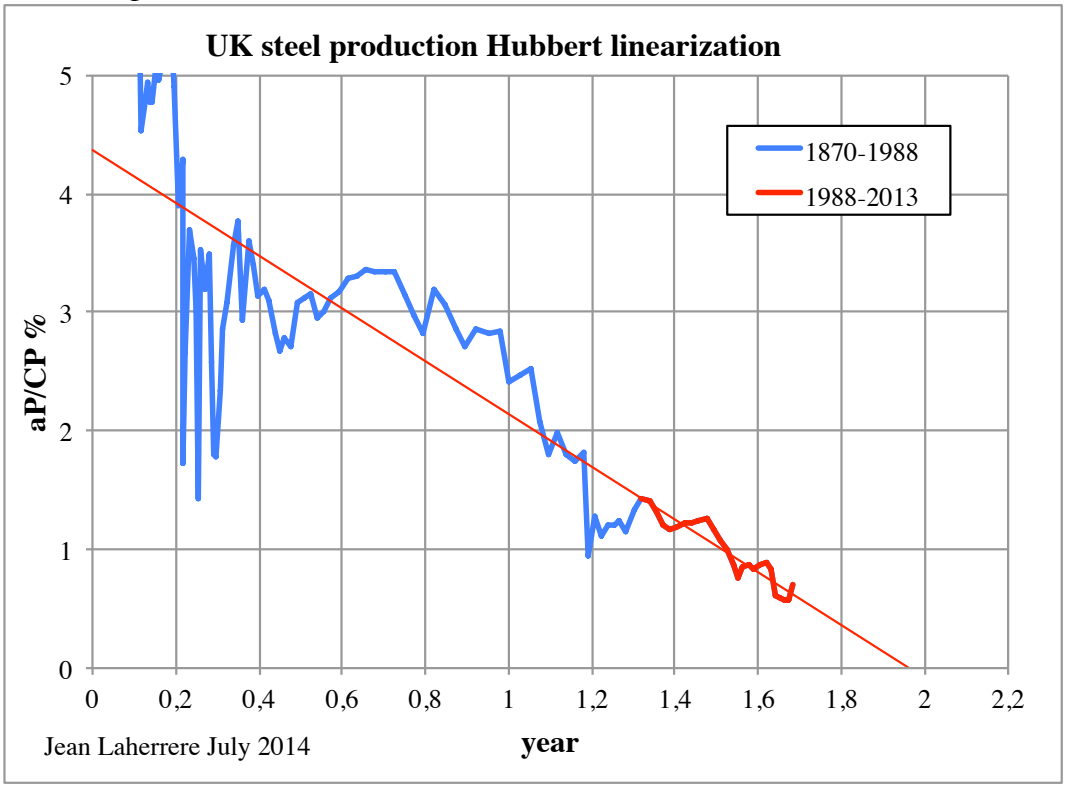
-**UK**
UK coal production displays good linear plots even before 1900 (24 Gt) when the last trend is about 28.5 Gt
Fig 1: UK coal production Hubbert linearization



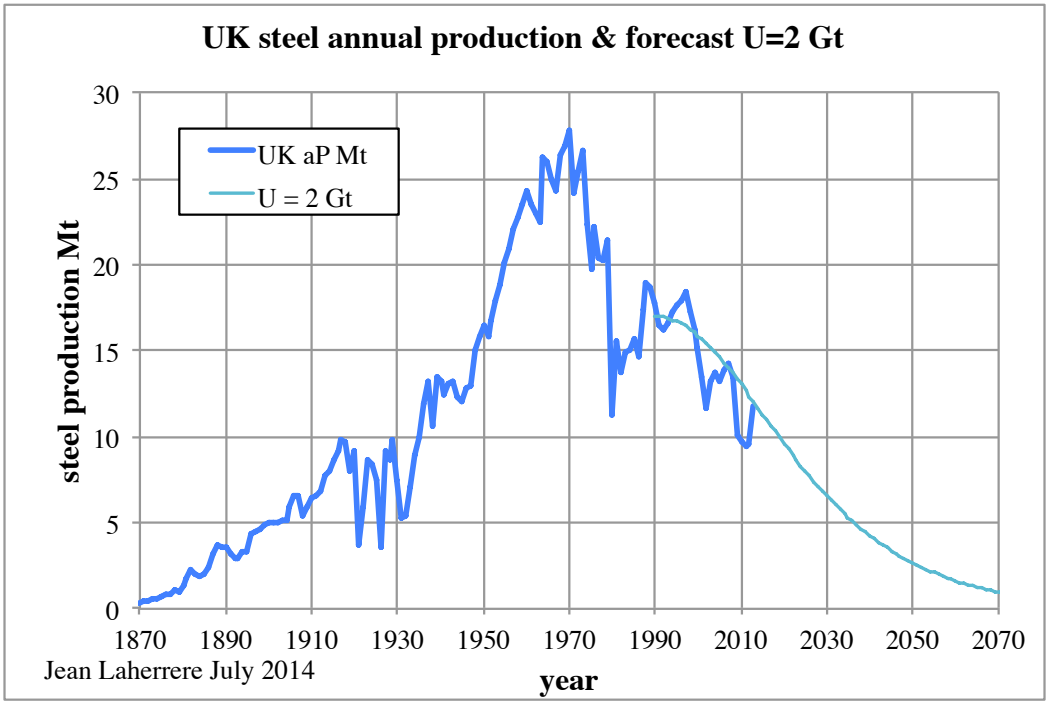
The forecast in 1900 with 24 Gt is not bad compared to present data
Fig 2: UK coal production forecasts with different ultimates in the past



The UK steel production displays for 1988-2013 a linear trend towards 2 Gt
Fig 3: UK steel production Hubbert linearization 1870-2013



The UK steel production has peaked in 1970 and its decline for an ultimate of 2 Gt will continue, with only 1 Mt in 2070.
Fig 4: UK steel production & forecast for U=2 Gt



-France

As for UK coal, France coal production Hubbert linearization should have estimated an ultimate of 6 Gt in 1913, 8.3 Gt in 1960 when the real value is 7.2 because coal production has ceased since 2004.

Fig 5: France & Belgium coal production Hubbert linearization

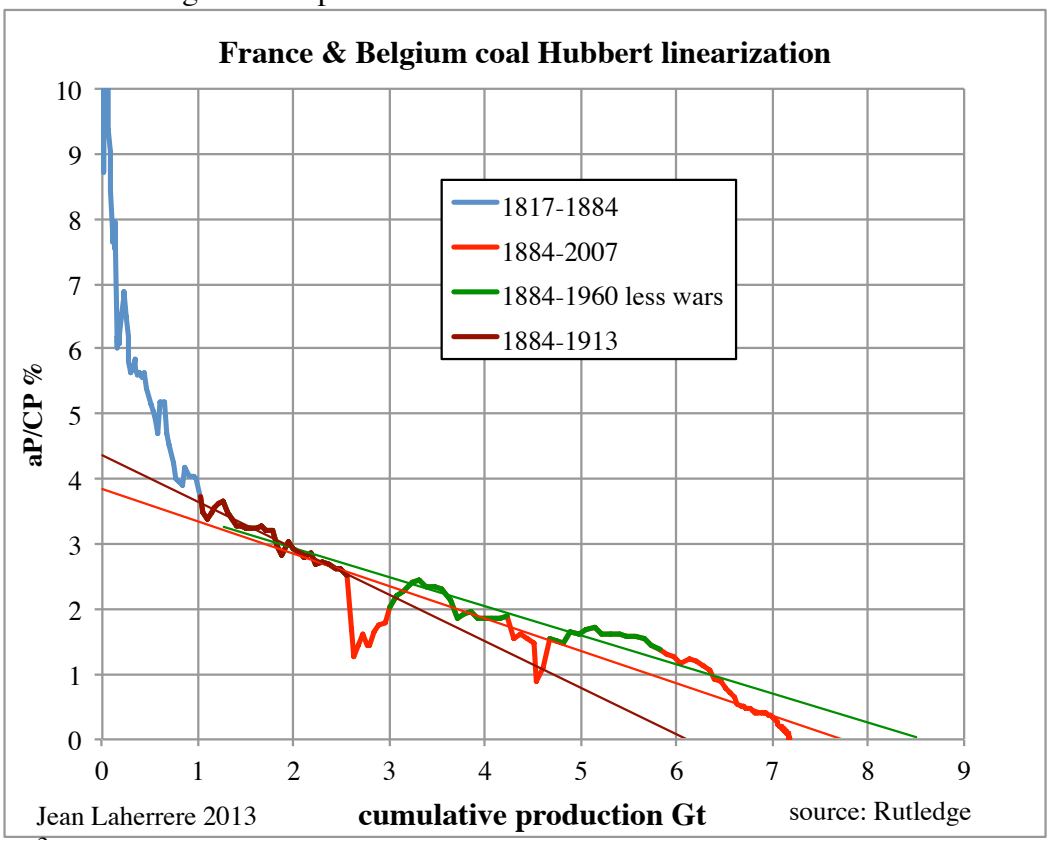
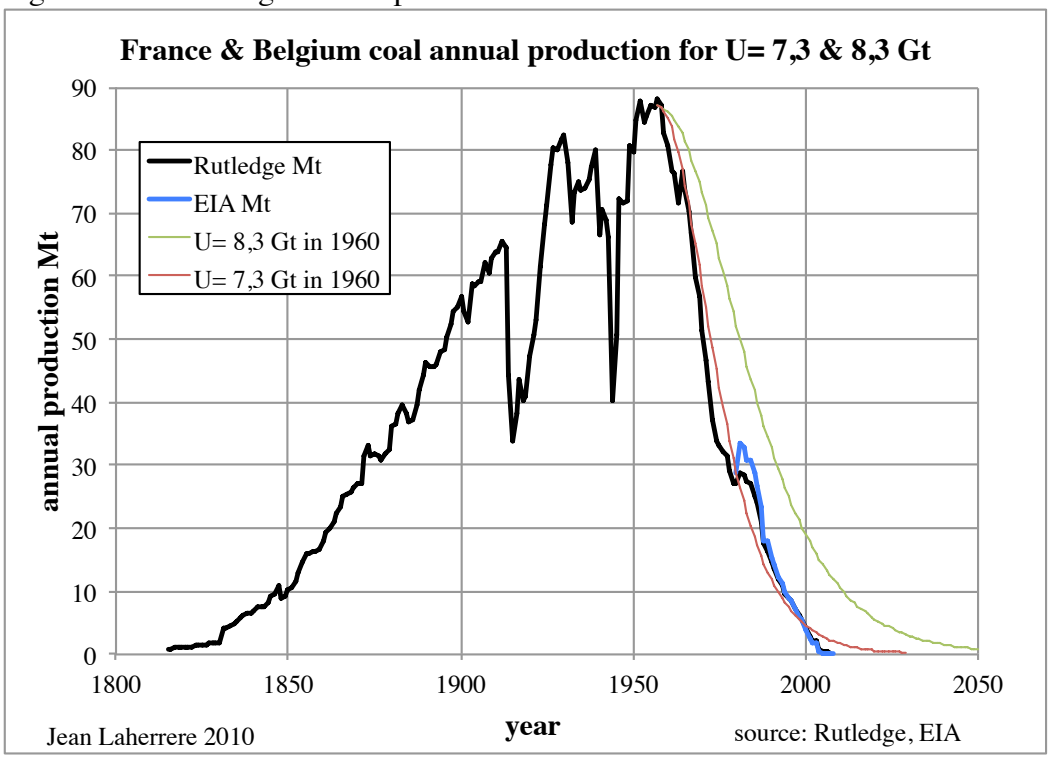
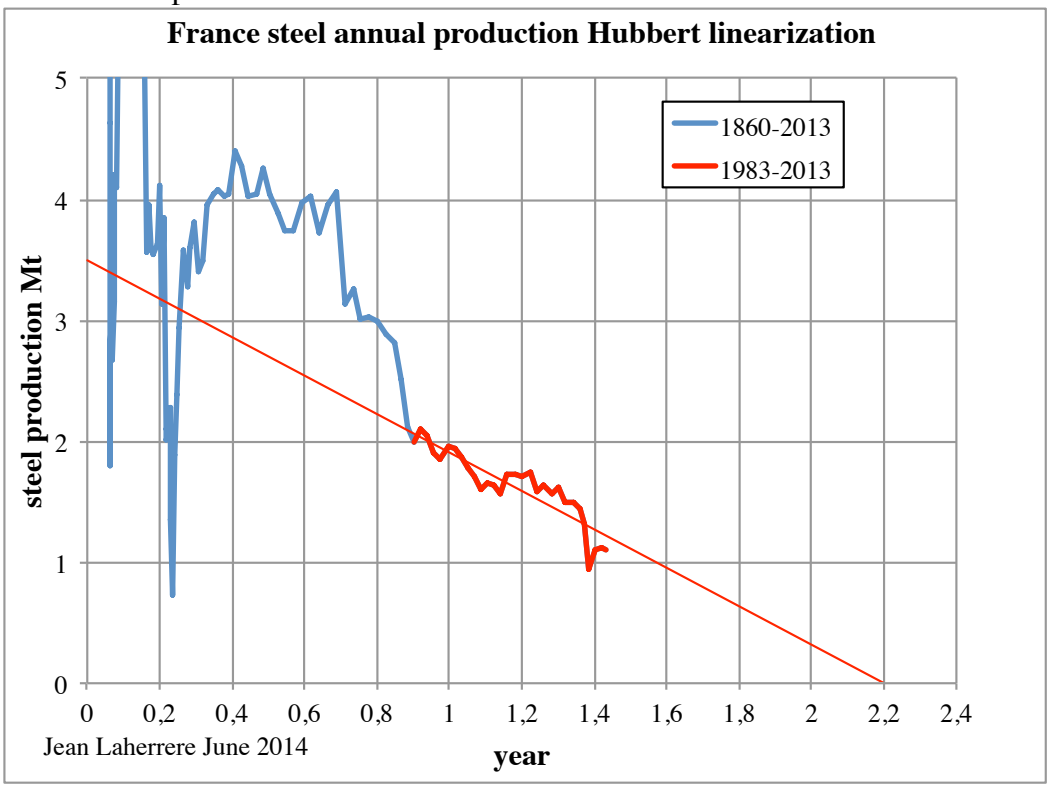


Fig 6: France & Belgium coal production and forecasts for U= 7.3 & 8.3 Gt



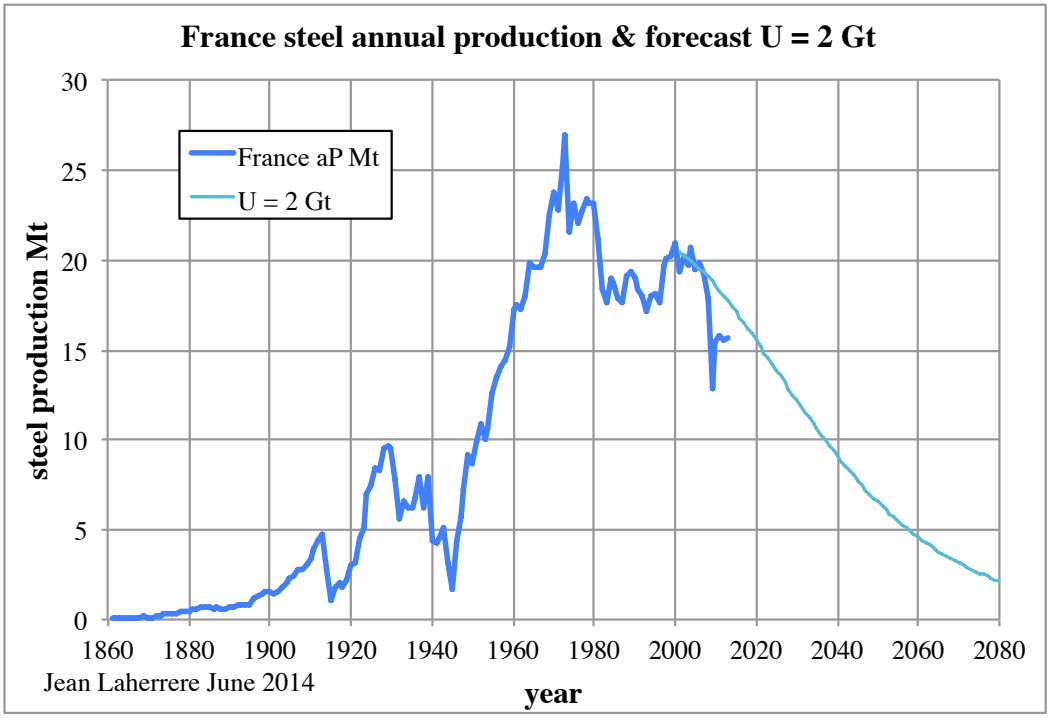
France steel production Hubbert linearization is chaotic but the last period 1983-2013 trends towards 2.2 Gt.

Fig 7: France steel production Hubbert linearization



France steel production peaked in 1973 (oil shock) and the decline for an ultimate of 2 Gt is less than the present decline with the 2009 crisis.

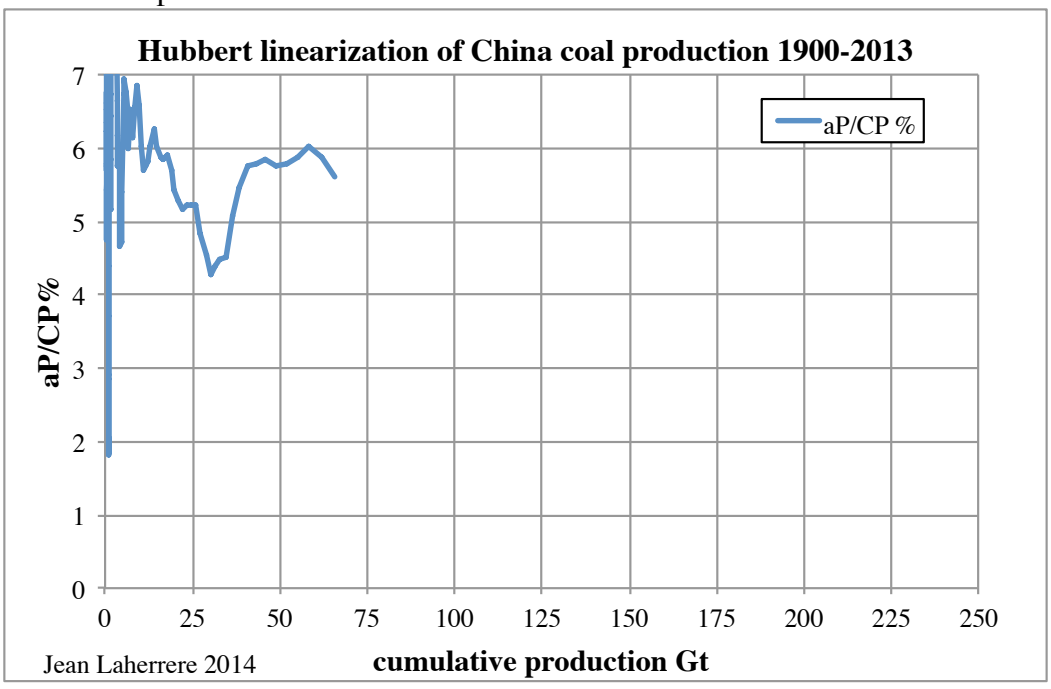
Fig 8: France steel production & forecast for U=2 Gt



-China

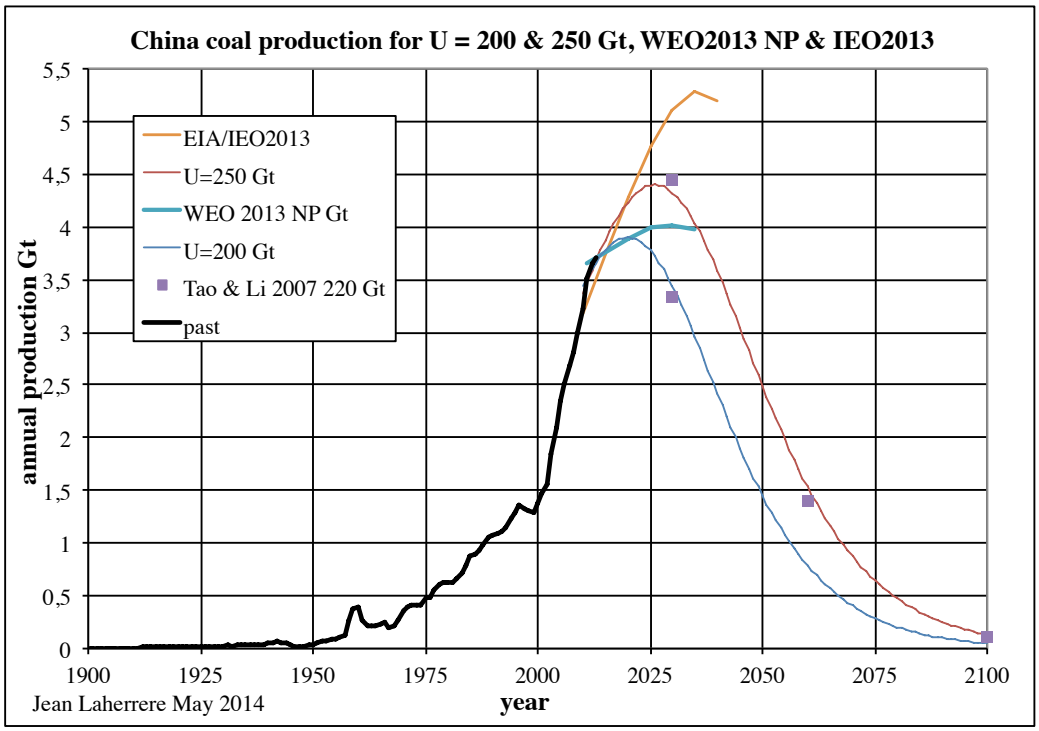
China coal production Hubbert linearization coal is hard to extrapolate

Fig 9: China coal production Hubbert linearization 1900-2013



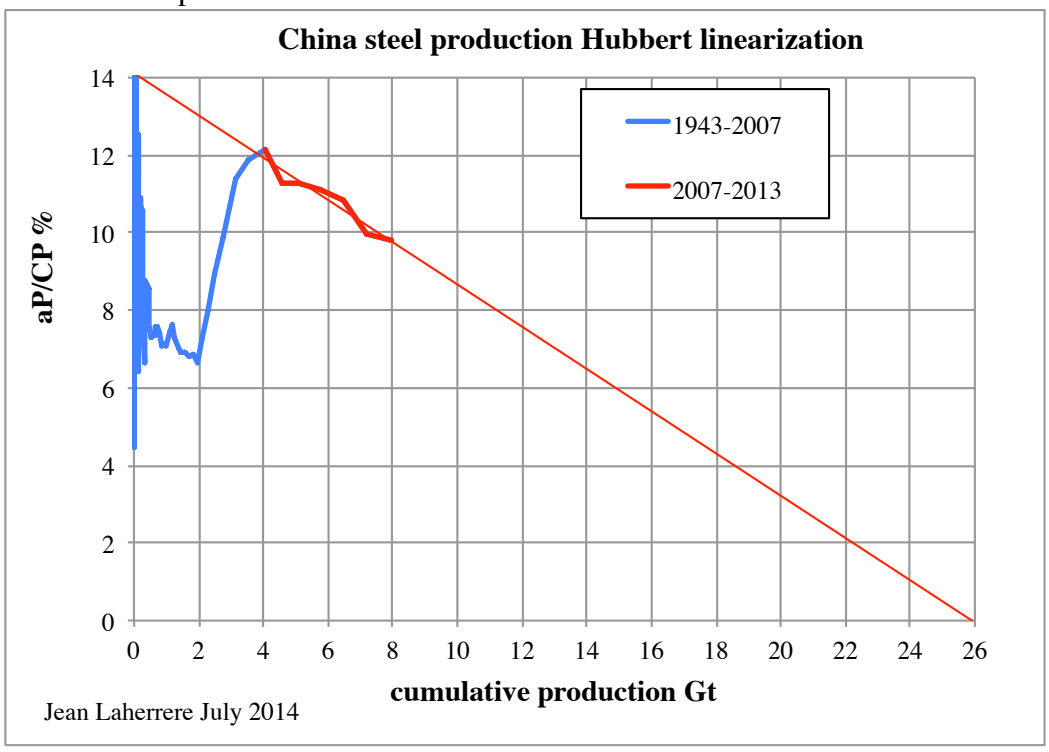
China coal production is modeled with two ultimates of 200 and 250 Gt to fit Tao & Li forecasts.

Fig 10: China coal production for U=200 & 250 Gt, IEA & EIA & Tao & Li



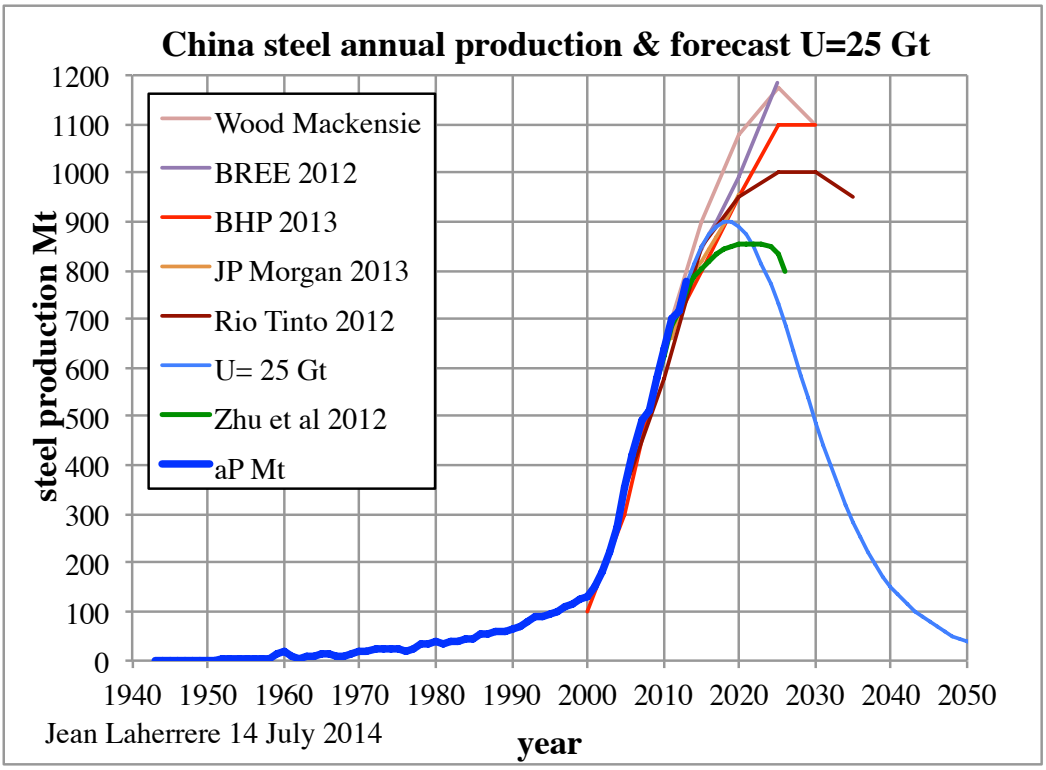
China steel production Hubbert linearization trends towards 25 Gt for the last period 2007-2013

Fig 11: China steel production Hubbert linearization 1943-2013



The annual steel production should peak around 2017 around 900 Mt for an ultimate of 25 Gt and being very low around 2050: it means that new means and ways have to be found. However the forecast by Zhu et al 2012 (Standard Chartered Banks Shanghai) peaks also around 2020 around 850 Mt (lower than my forecast), when Australian BREE forecasts a steep increase with 1200 Mt in 2025, BHP foresees a peak in 2025 at 1100 Mt. However Rio Tinto foresees a peak at 1000 Mt in 2025.

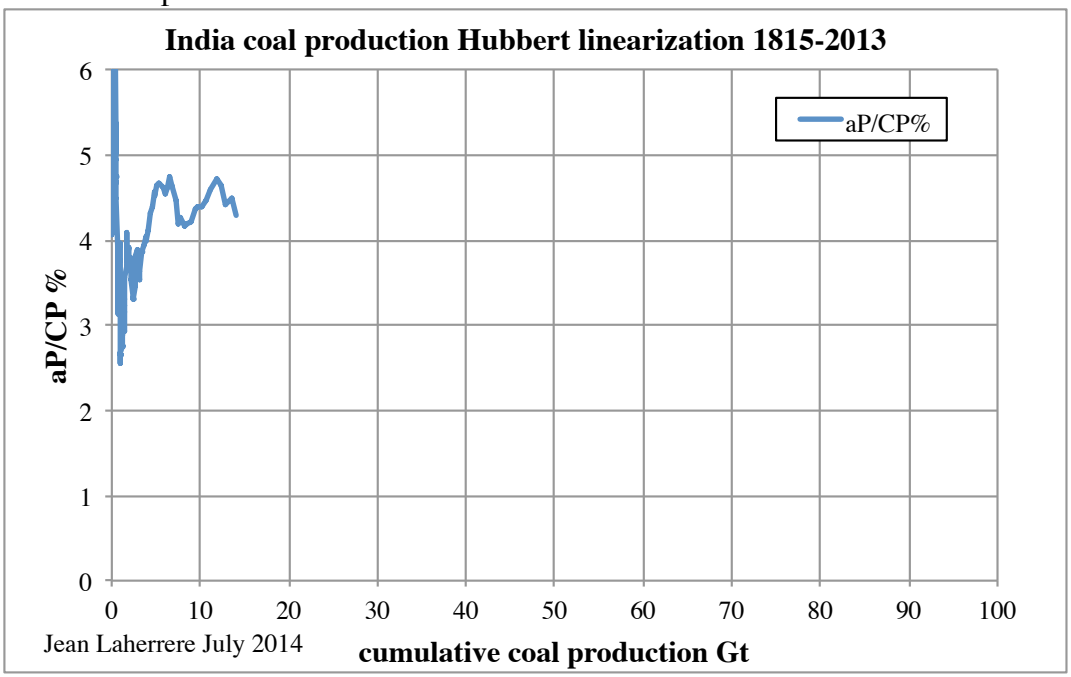
Fig 12: China steel production & forecast U=25 Gt, Wood Mackenzie, BREE, Rio Tinto & Zhu



-India

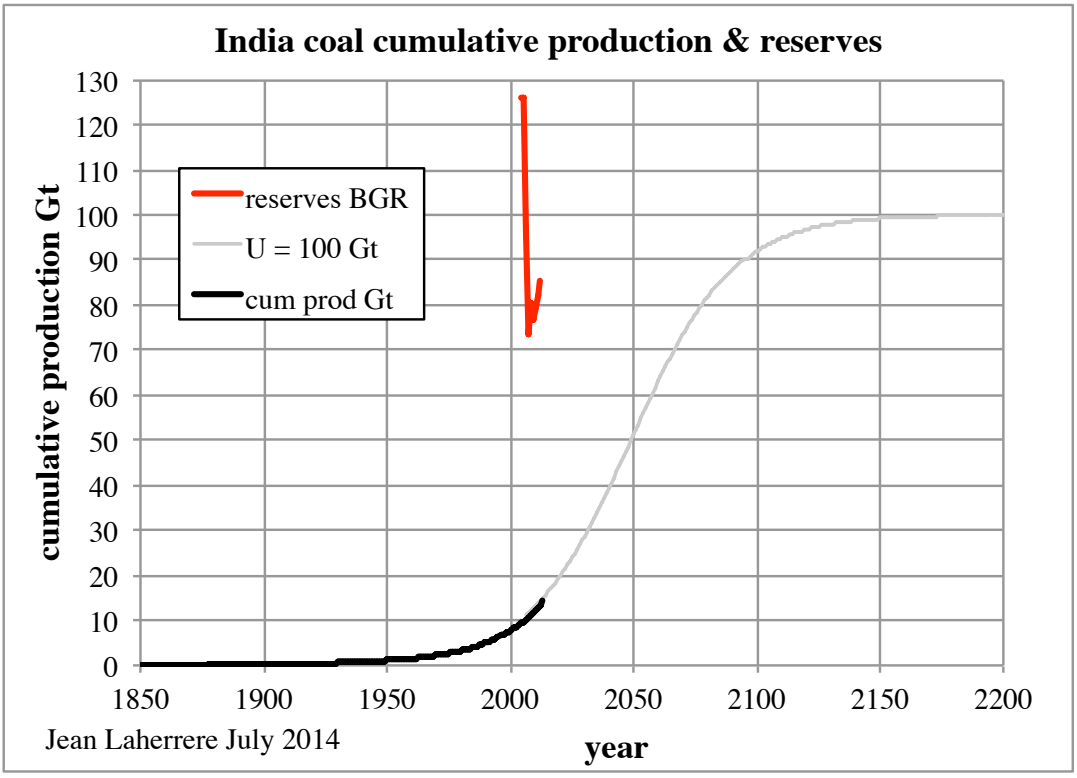
India coal production Hubbert linearization is useless

Fig 13: India coal production Hubbert linearization 1815-2013



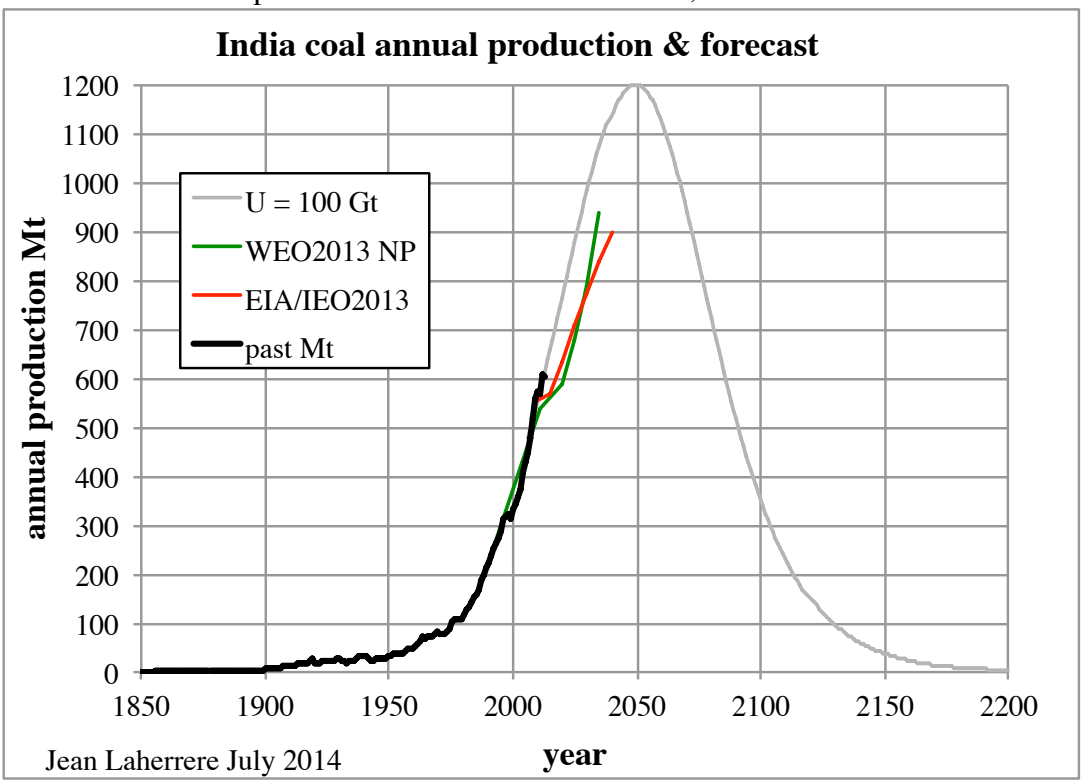
It is necessary to rely on BGR reserves to estimate an coal ultimate of 100 Gt

Fig 14: India coal cumulative production & BGR reserves



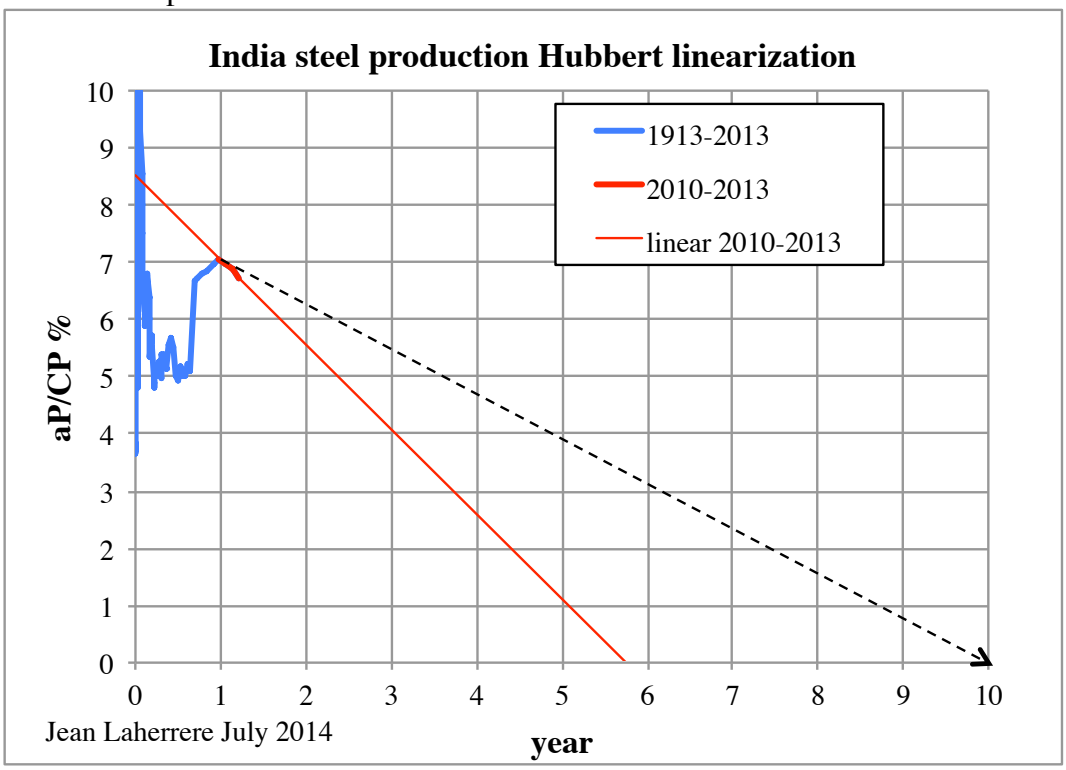
India coal production will peak around 2050 at 1200 Mt (double 2013) if BGR reserves are right, but IEA and EIA forecast 900 Mt for 2035

Fig 15: India coal annual production & forecast U = 100 Gt, UEA & EIA



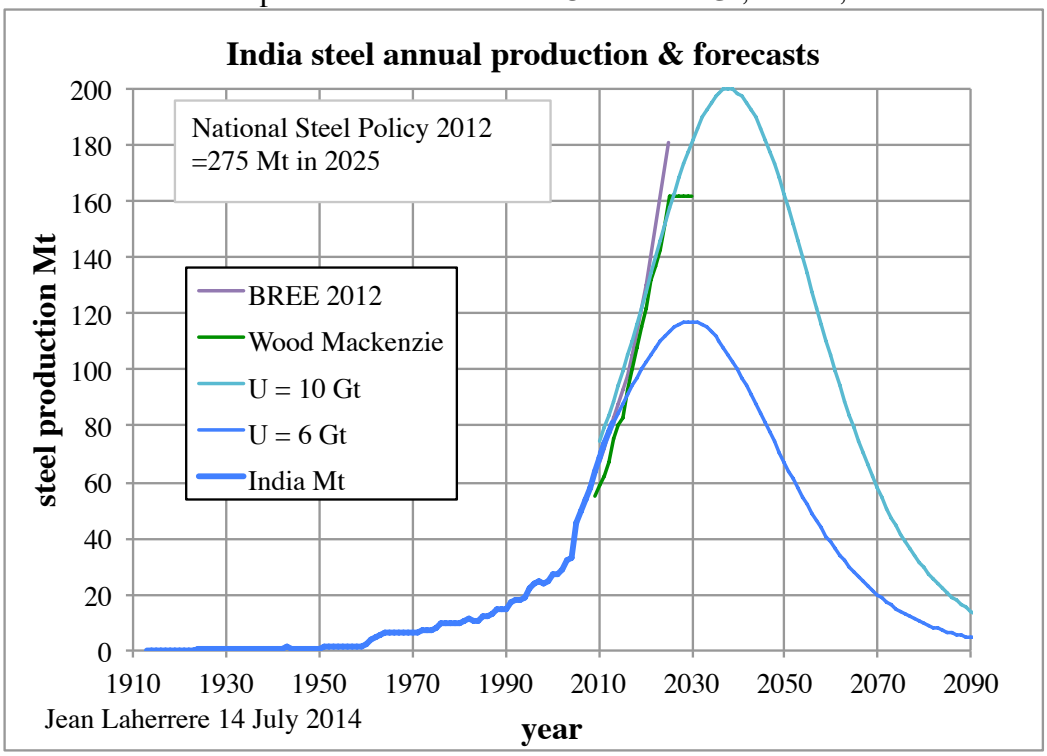
India steel production Hubbert linearization cannot be extrapolated, except for the last 4 years towards a doubtful 6 Gt and its cumulative production is about 1.2 Gt up to 2013, small compared to China 8 Gt.

Fig 16: India steel production Hubbert linearization



The annual steel production has sharply increased since 2007 to 81 Mt in 2013 and we assume an ultimate of 5 Gt or 10 Gt. India National Steel Policy hopes 275 Mt in 2025, against only 180 Mt for BREE. For an ultimate of 5 Gt the peak will be in 2025 at 100 Mt, but for an ultimate of 10 Gt a peak in 2040 at 200 Mt.

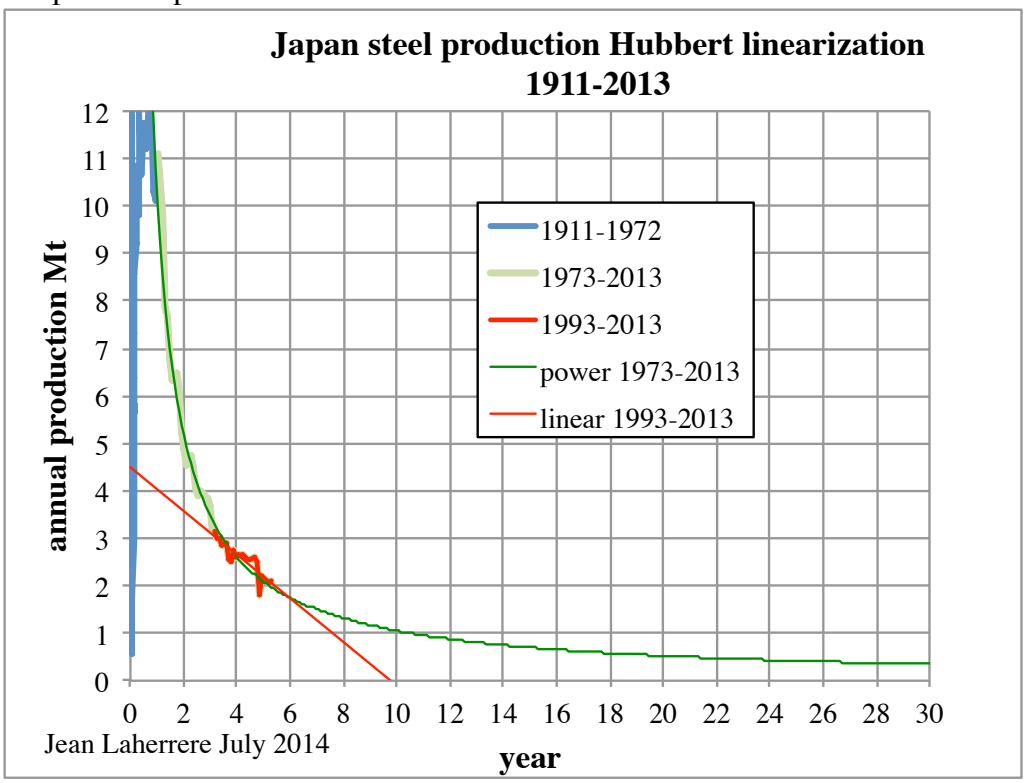
Fig 17: India steel annual production & forecasts U= 5 & 10 Gt, BREE, Mac Kenzie



-Japan

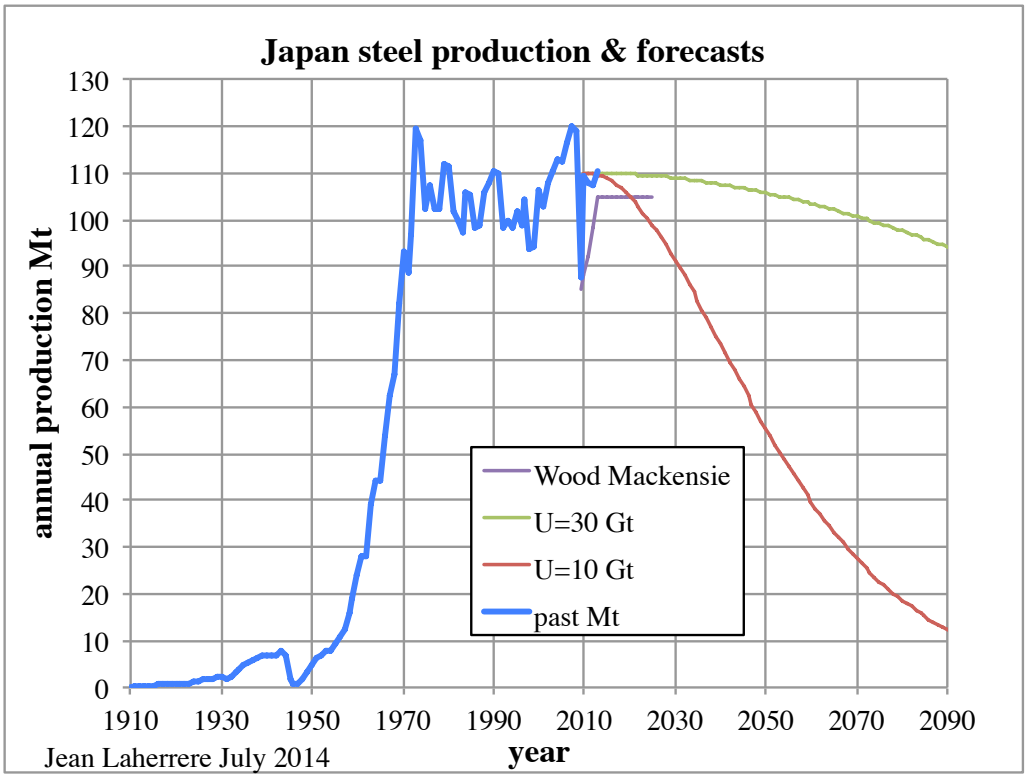
Steel production started in 1911 and the Hubbert plot is curved and well fitted with a power law for the period 1973-2013 which is close to zero for an ultimate of 30 Gt. The linear part is for the period 1993-2013, trending towards 10 Gt

Fig 18: Japan steel production Hubbert linearization



The annual steel production is plateauing since 1973 (peak and first oil shock) around 110 Mt. The future production corresponding to the two ultimates 10 & 30 Gt is compared to Wood Mackenzie forecast (plateau at 105 Mt)

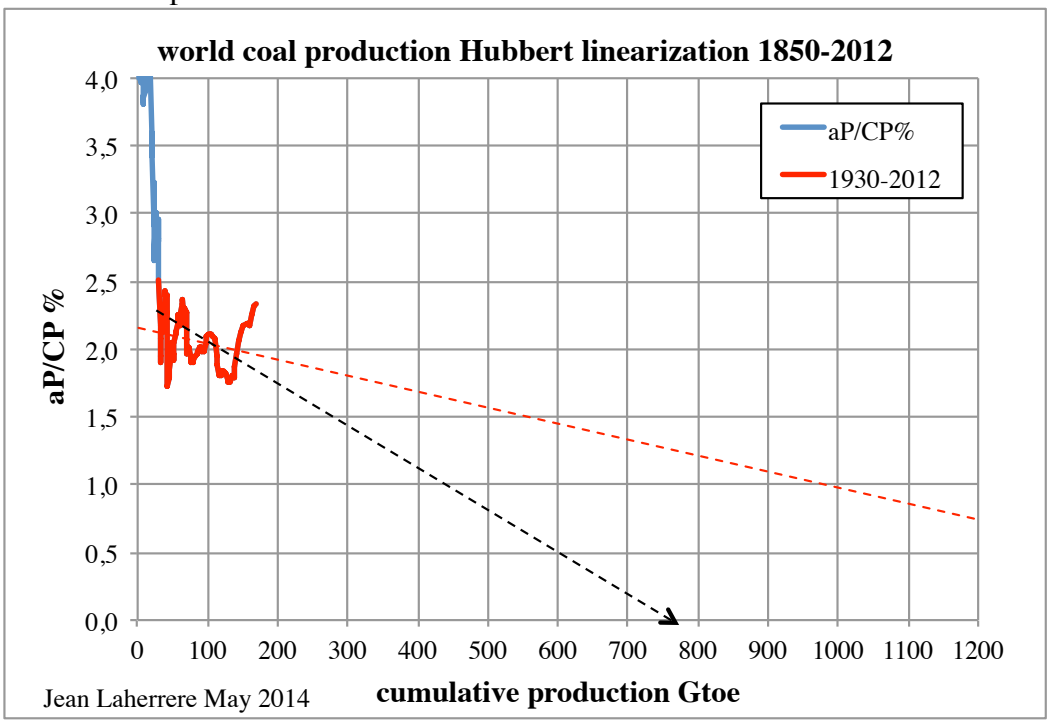
Fig 19: Japan steel annual production and forecasts



-world

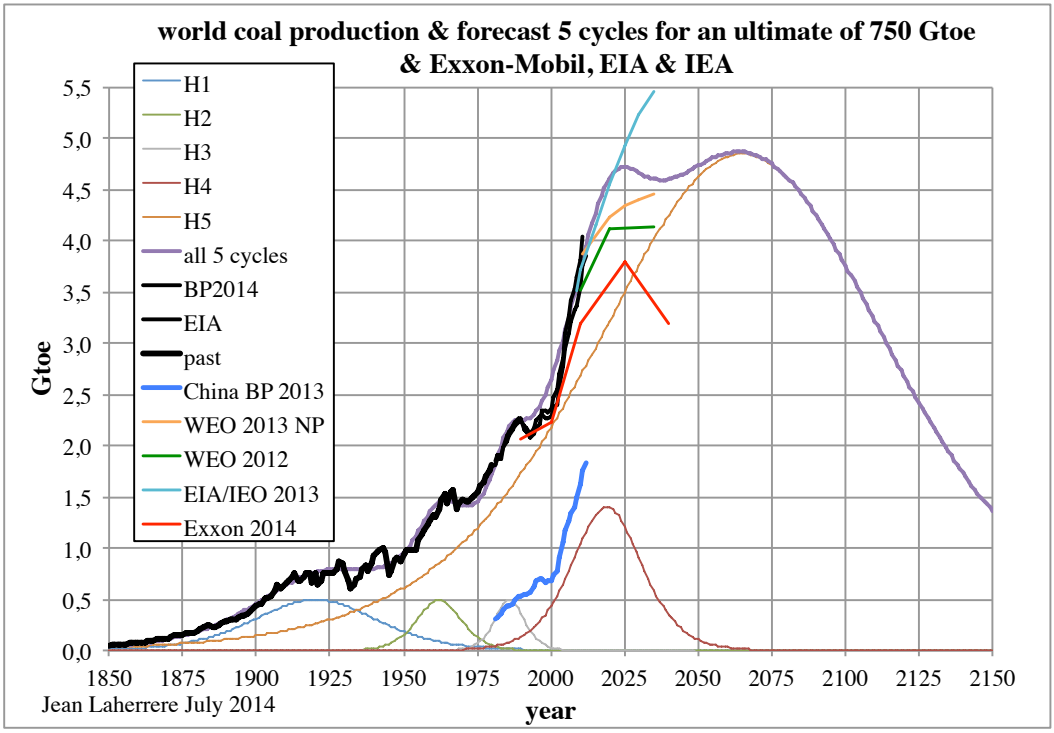
The world coal production Hubbert linearization is impossible to extrapolate and we must relies on reserves estimates, which have varied very much in the past

Fig 20: world coal production Hubbert linearization 1850-2012



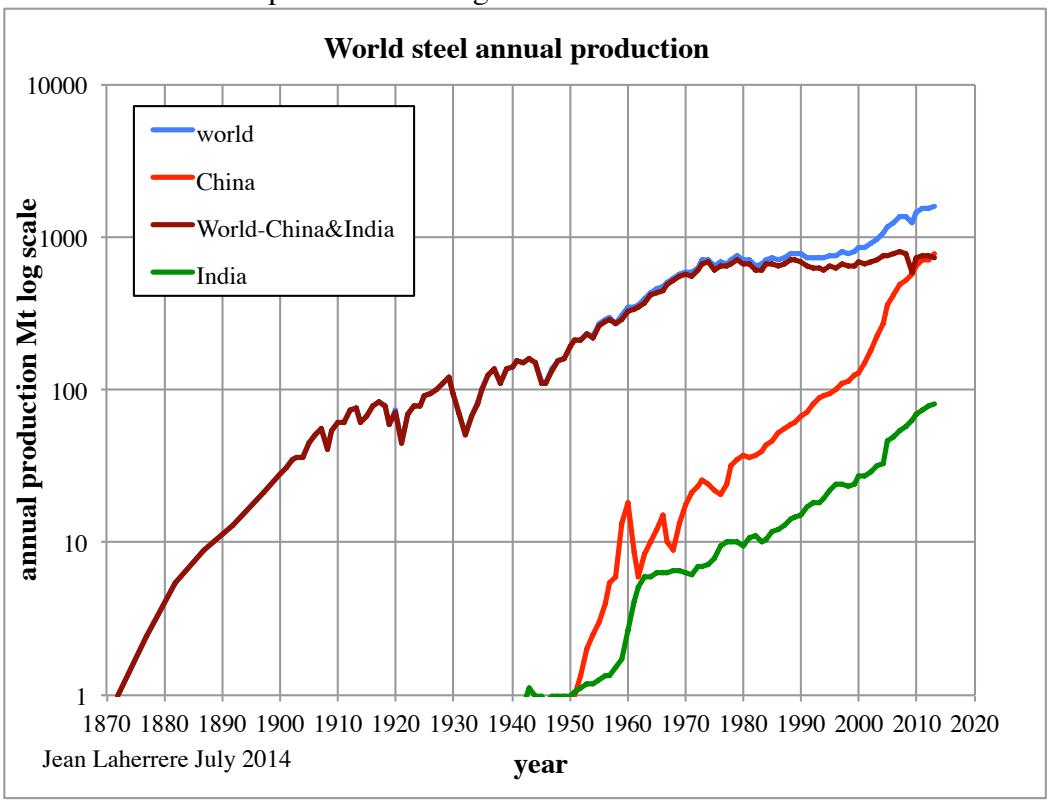
World coal production is modeled with 5 cycles for an ultimate of 750 Gtoe and compared to Exxon, EIA & EIA forecasts

Fig 21: world coal production & forecasts



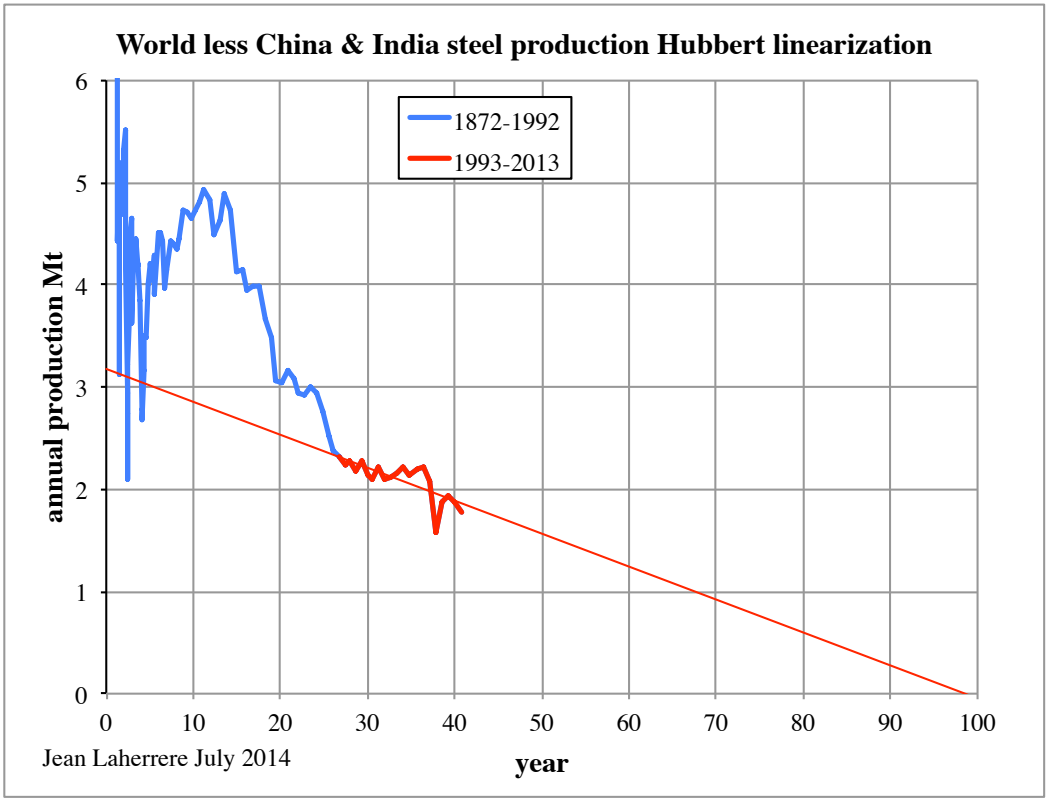
The world less China and India (Chindia) steel production has increased exponentially until the first oil shock, then plateaued as shown in the graph in log scale where the growth for China is higher than for India.

Fig 22: world steel annual production in log scale



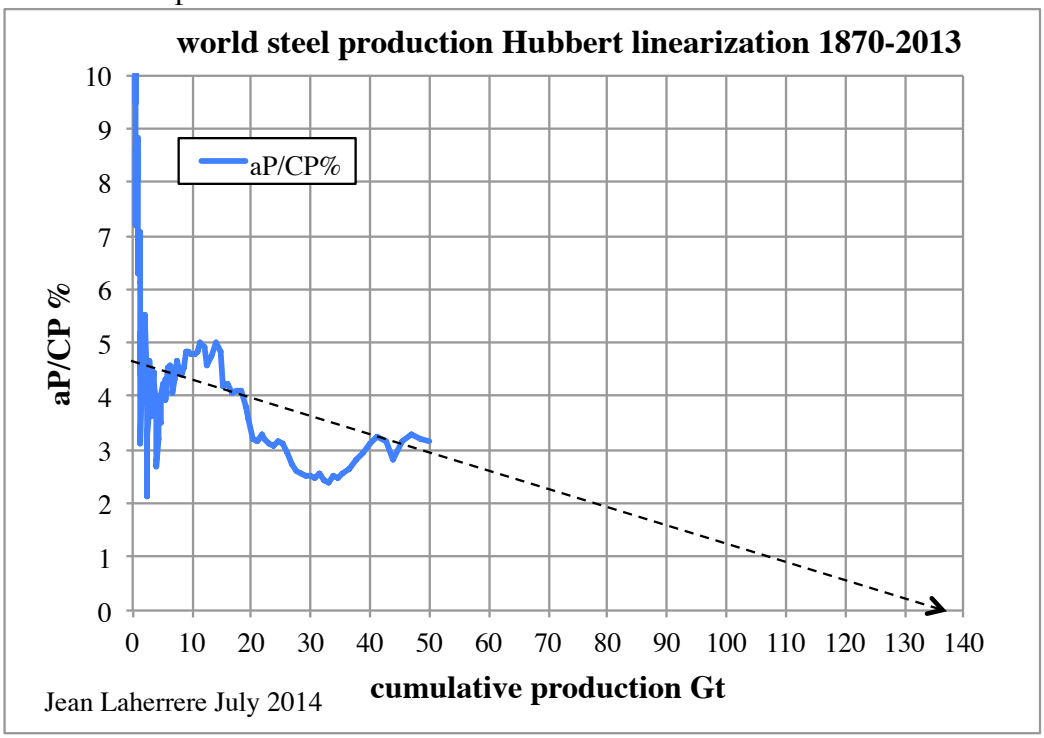
The world less Chindia Hubbert linearization for the period 1993-2013 trends 100 Gt. Adding China (25 Gt) and India (10 Gt) the world steel ultimate should be 135 Gt

Fig 23: world less Chindia steel production Hubbert linearization



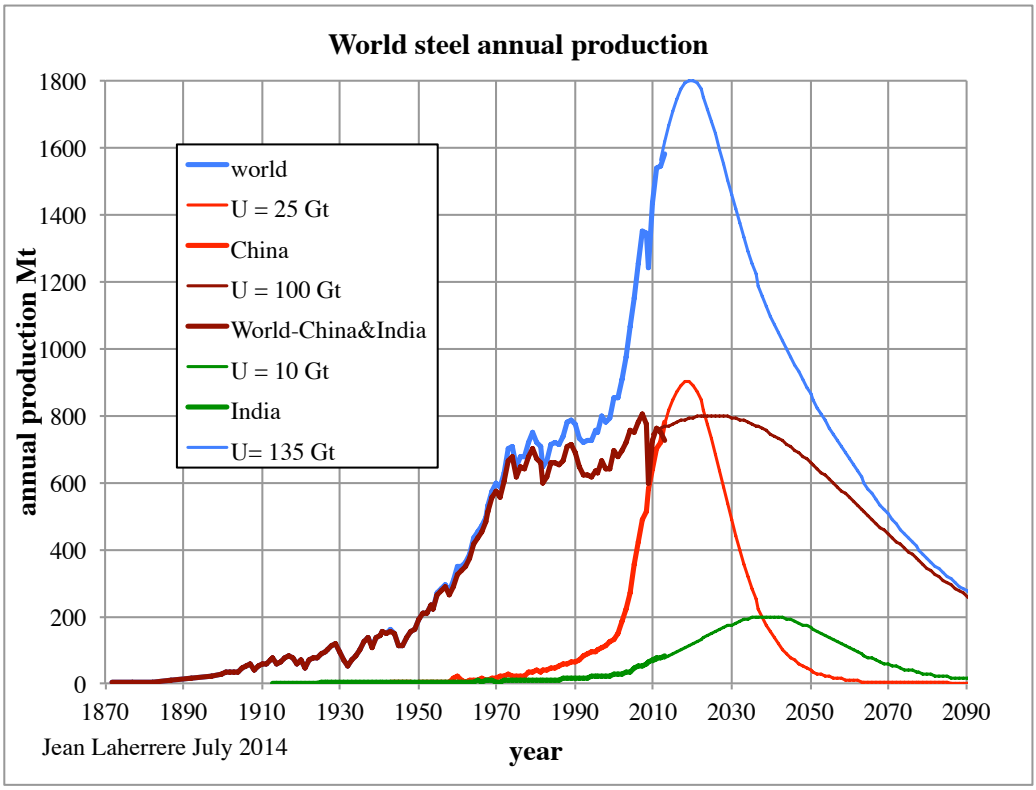
The world steel production Hubbert plot is hard to extrapolate but the above estimated ultimate of 135 Gt is plotted

Fig 24: world steel production Hubbert linearization

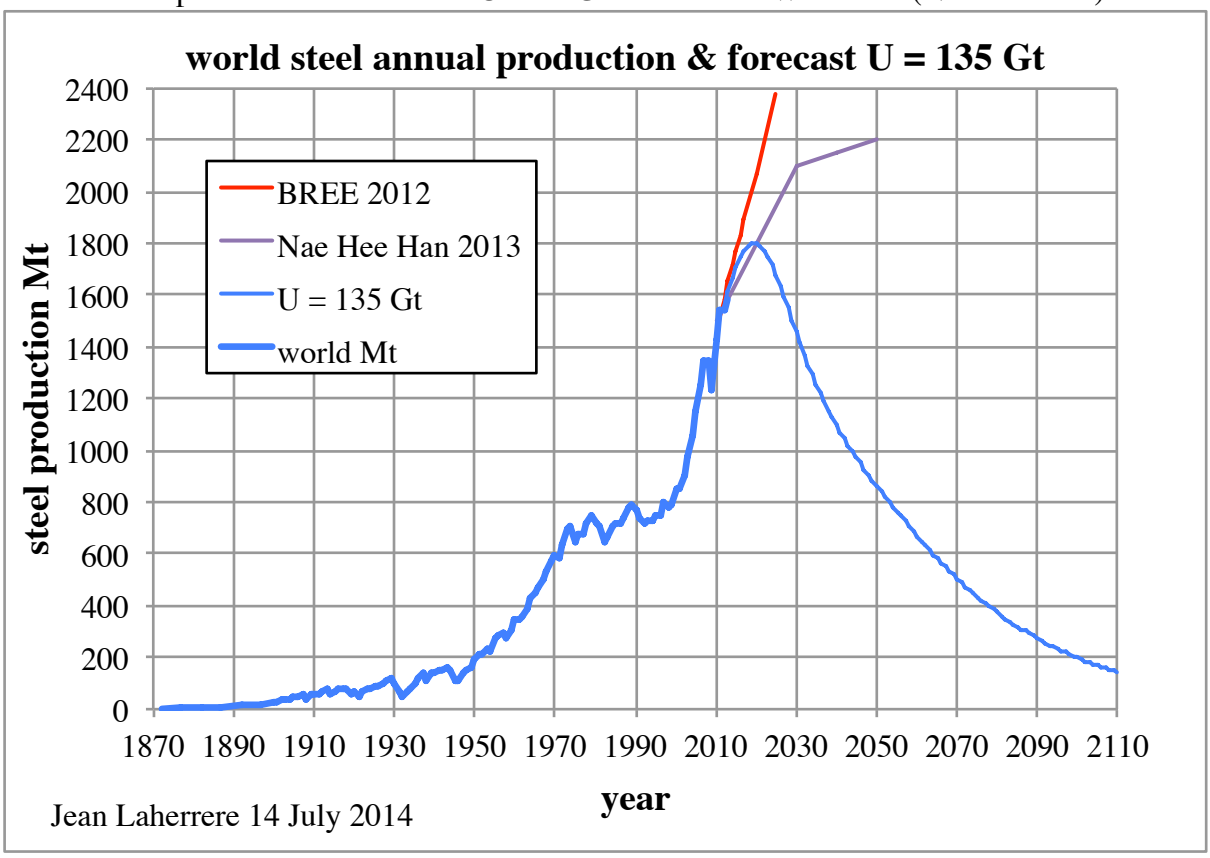


The world steel production is modeled with an ultimate of 135 Gt being the aggregation of the world less Chindia plus China and plus India and the peak is likely to be around 1800 Gt around 2035 and the decline would be severe.

Fig 25: world, China & India steel annual production and forecasts



The world steel production and forecast for an ultimate of 135 Gt (peak at 1800 Mt) is compared with the BREE forecast of 2377 Mt (ridiculous accuracy!) for 2025
Fig 26: world steel production & forecasts U=135 Gt & BREE & Worldsteel(Nae Hee Han)



Conclusion

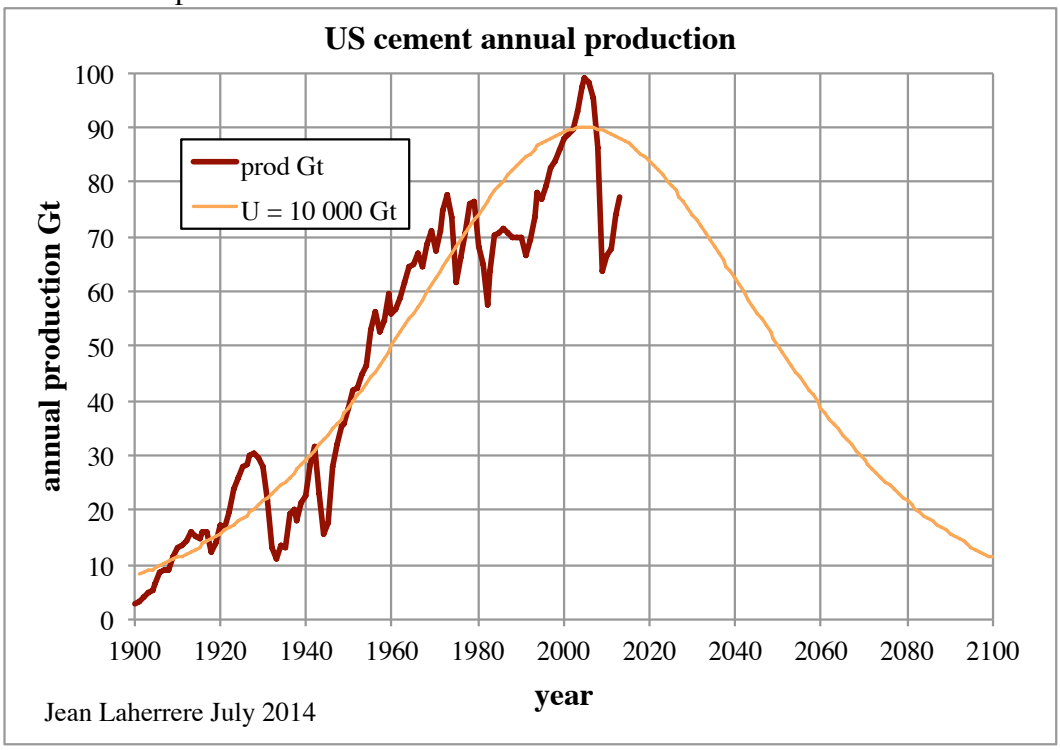
What goes up must goes down and the steel production could peak before 2030 when estimating steep ultimate from Hubbert linearization.

The method is not too reliable but it shows that more studies have to be done because a possible world steel peak could be around 2030. Such steel peak is not forecasted by any western organization.

Only Judy H Zhu et al (Standard Chartered Bank Shanghai) forecasted in 2012 China steel peak for 2020.

Steel and oil are important indicators on our consumption society and their peaks should be carefully studied, like also cement (US cement peak seems to be in 2005).

Fig 27: US cement production & forecast U = 10 000 Gt



It is a pity of not finding more studies reporting free historical production data per country and forecast up to 2040 on the main indicators such as steel or other commodities.