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**Oil and gas: what future?**

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This presentation is issued to a long text which is available on [www.aspofrance.org](http://www.aspofrance.org) (go to documents)

**-Problems of wording**

Petroleum = *an oily flammable bituminous liquid in upper strata of the earth*

Oil = *any of numerous unctuous combustible substances that are liquid*

Oil is an ambiguous term and includes biofuels and alcohols.

Oil should not be confused with petroleum or hydrocarbons

**-Reporting data**

**-publishing data is a political act** and depends upon the image the author wants to give.

-OPEC productions are ruled by quotas, but because OPEC members were cheating on quotas, OPEC oil productions are flawed and unreliable.

-oil field reserves are confidential except in UK, Norway and US federal lands.

-words such as **energy, oil, reserves, resources, conventional, proved, probable, light, heavy, reasonable, sustainable, dangerous** are badly or not defined on purpose

**-reporting any data with more than 2 significant digits shows that the author is incompetent**

USDOE/EIA proved reserves as end of 2005 posted 5 Oct. 2006

Oil Gb	OGJ	BP	WO
World	1 292,935 5	1 201,331 538 509 4	1 119,615 3
Russia	60,000	74,436 476 05	74,4
Norway	7,705	9,691 349	8,033
Canada	178,7924	16,500	12,025
China	18,25	16,038 12	16,188 5

Gas Tcf	OGJ	BP	WO	Cedigaz
World	6 124,016	6 359,172	6 226,554 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	82,99025

## **-Reserves**

There is no consensus on how to assess reserves and there is no world organisation to impose one.

Field reserves are confidential, except Norway, UK and US federal lands.

Reserves represent what will be recovered in future,

**Resource is what is in the ground; reserves are only a small part of resource.**

There are several reserve definitions in use:

-**US** = all companies listed on the US Stock Market are obliged to report only proved = **1P**  $\approx$  assumed to be the **minimum** for SPE

-**FSU** classification = **maximum theoretical recovery**  $\approx$  proven + probable + possible = **3P**  $\approx$  maximum

-**Rest of the world** = SPE/WPC 1997 rules (I was a member of the task force) = proven + probable = **2P**  $\approx$  expected value

Reserve growth occurs when reserves are reported as the minimum (proved), but does not occur statistically when reported as proven+probable  $\approx$  mean (expected) value.

**-Political and technical data**

Figure 1: World remaining conventional oil & gas reserves from **political and technical sources**

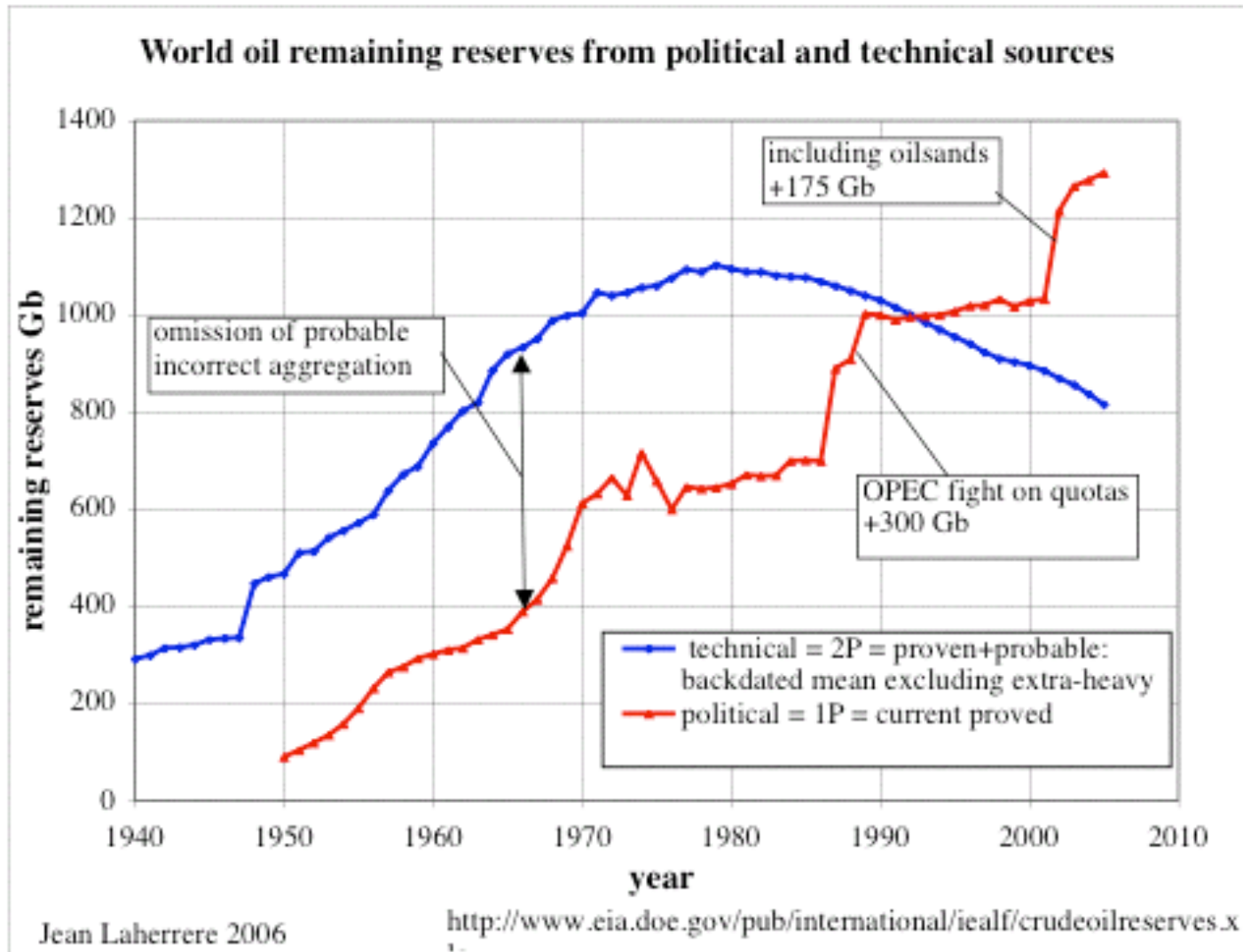
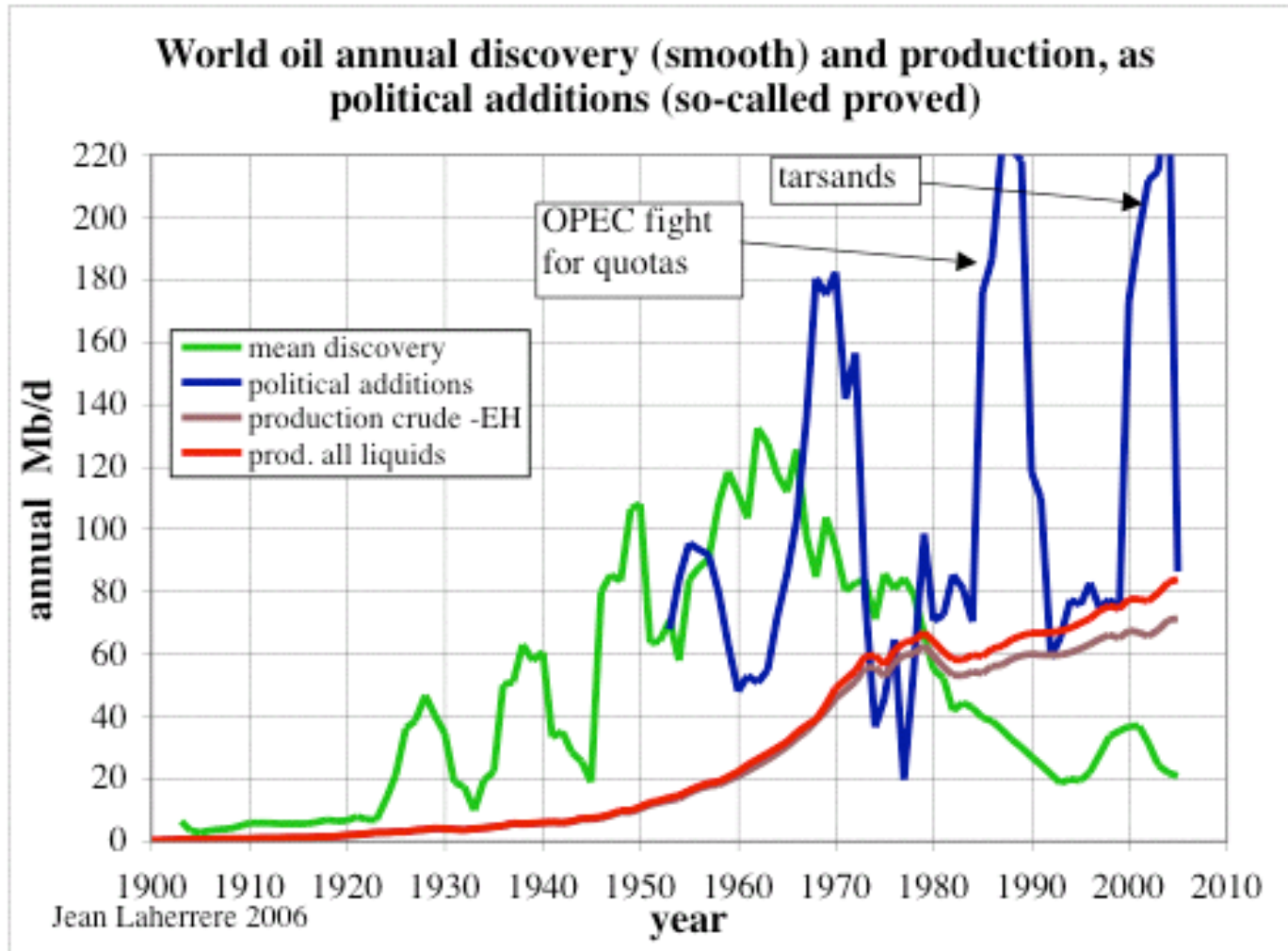


Figure 2: World annual crude oil (less extra-heavy) mean discovery & production and political additions (so-called proved)

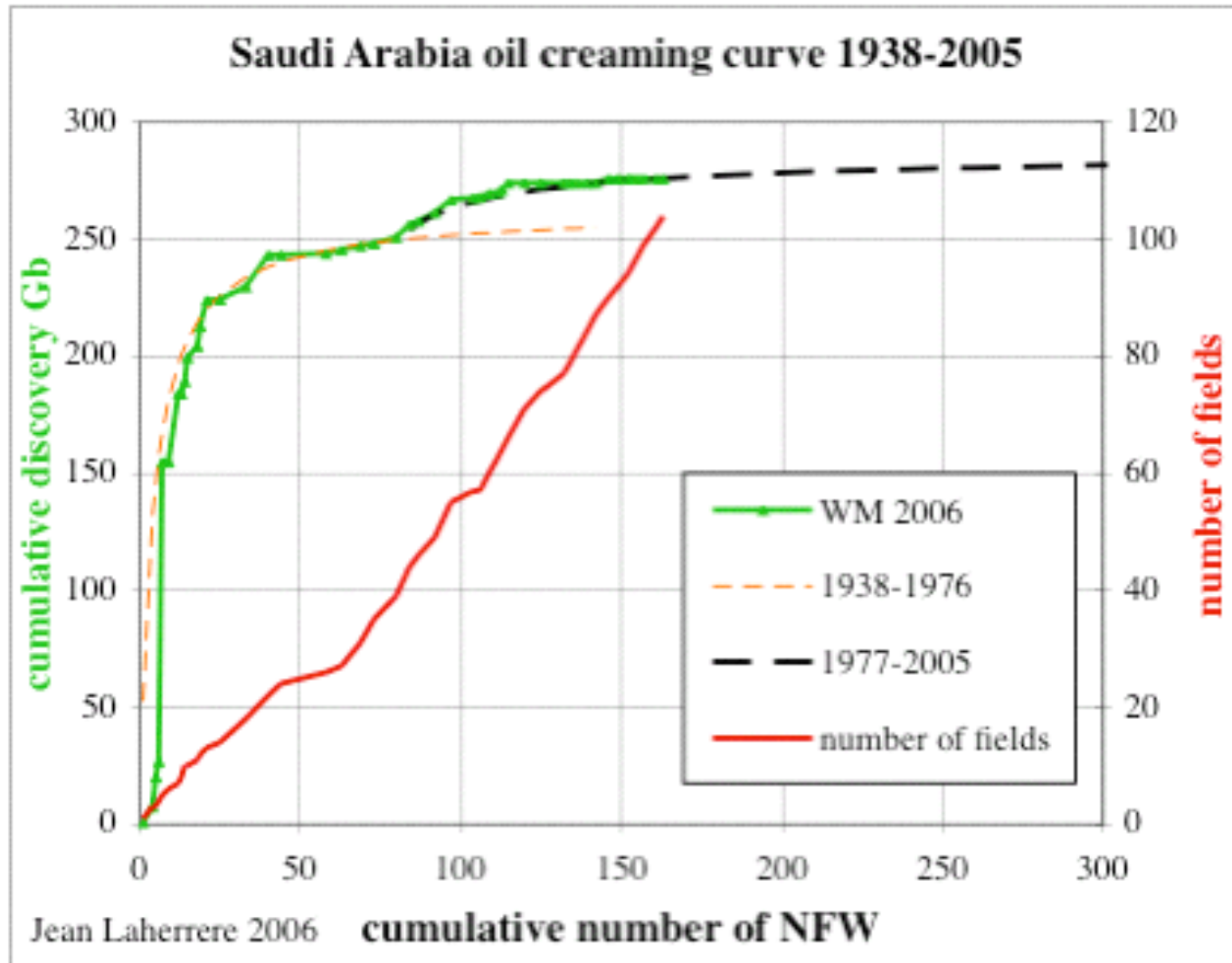


Every study based only on the so-called proved reserves should be discarded as useless following the principle GIGO: **Garbage In, Garbage Out**.

**-Myths to be rejected** To prevent showing decline, all means are used, in particular myths.

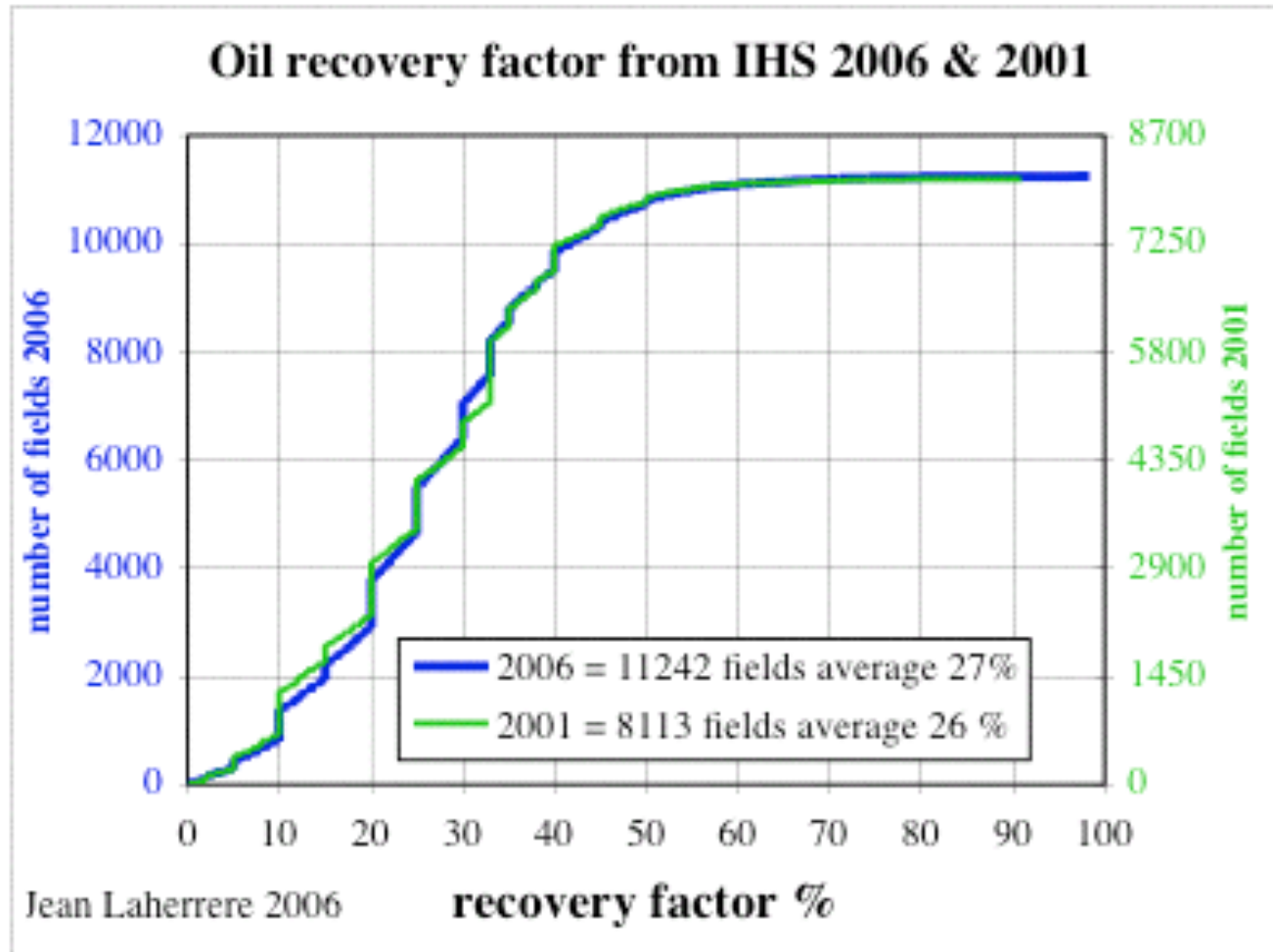
**-Myth 1: Middle East is under explored**

Figure 3: Saudi Arabia oil creaming curve from WM



**-Myth 2: oil recovery factor (RF) is about 35% in the world and 50% in North Sea, so world reserves can be increased widely**

**Figure 4: Oil recovery factor from IHS (world outside US onshore) 2006 & 2001**

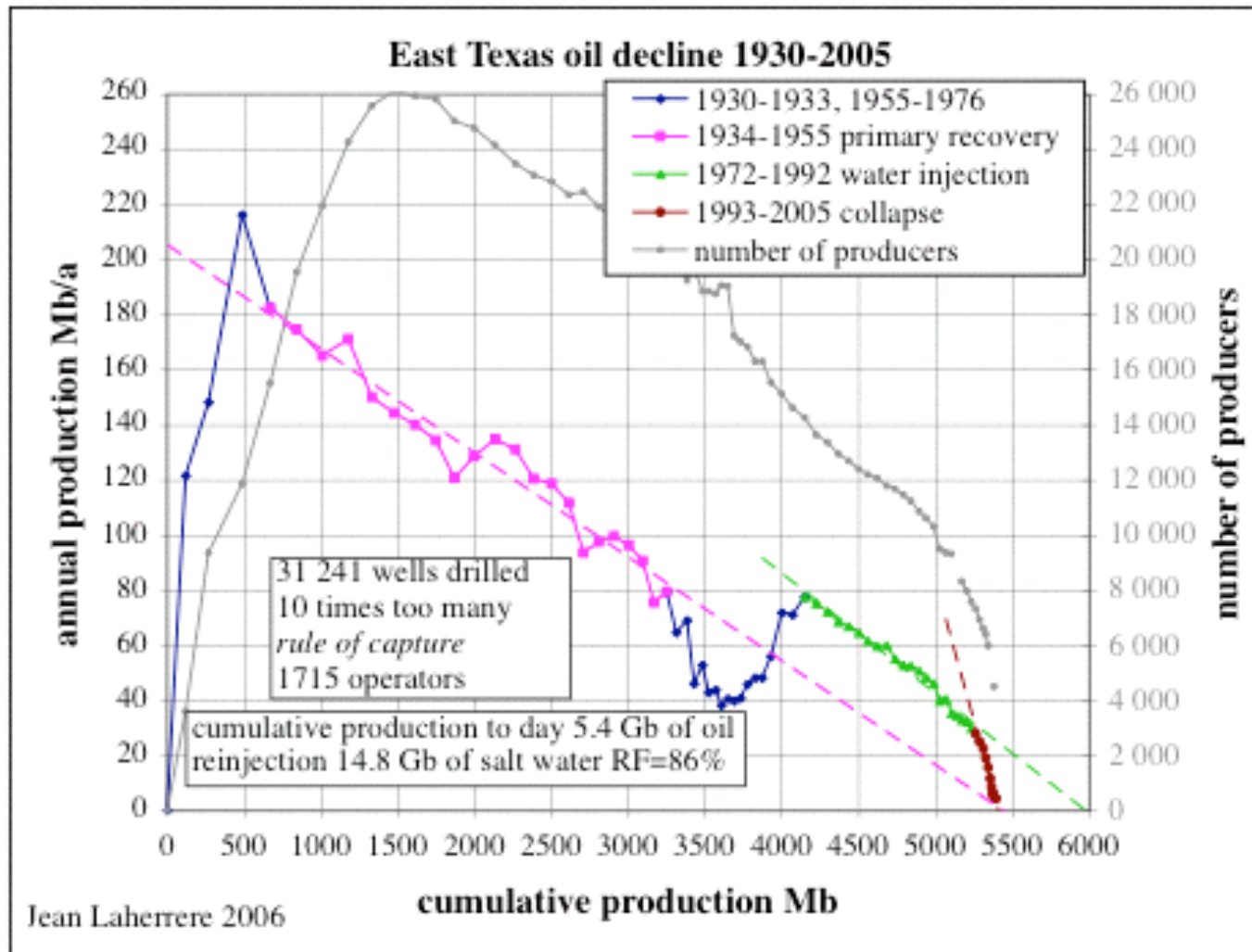


Recovery factor depends mainly upon the geology of the reservoir : from 1% for tight reservoir to 85% for very porous and permeable reservoir. **Technology cannot change the geology of the reservoir**

**-Myth 3: technology increases reserves**

Reserve growth due to technology should be shown on the decline of annual production versus cumulative production

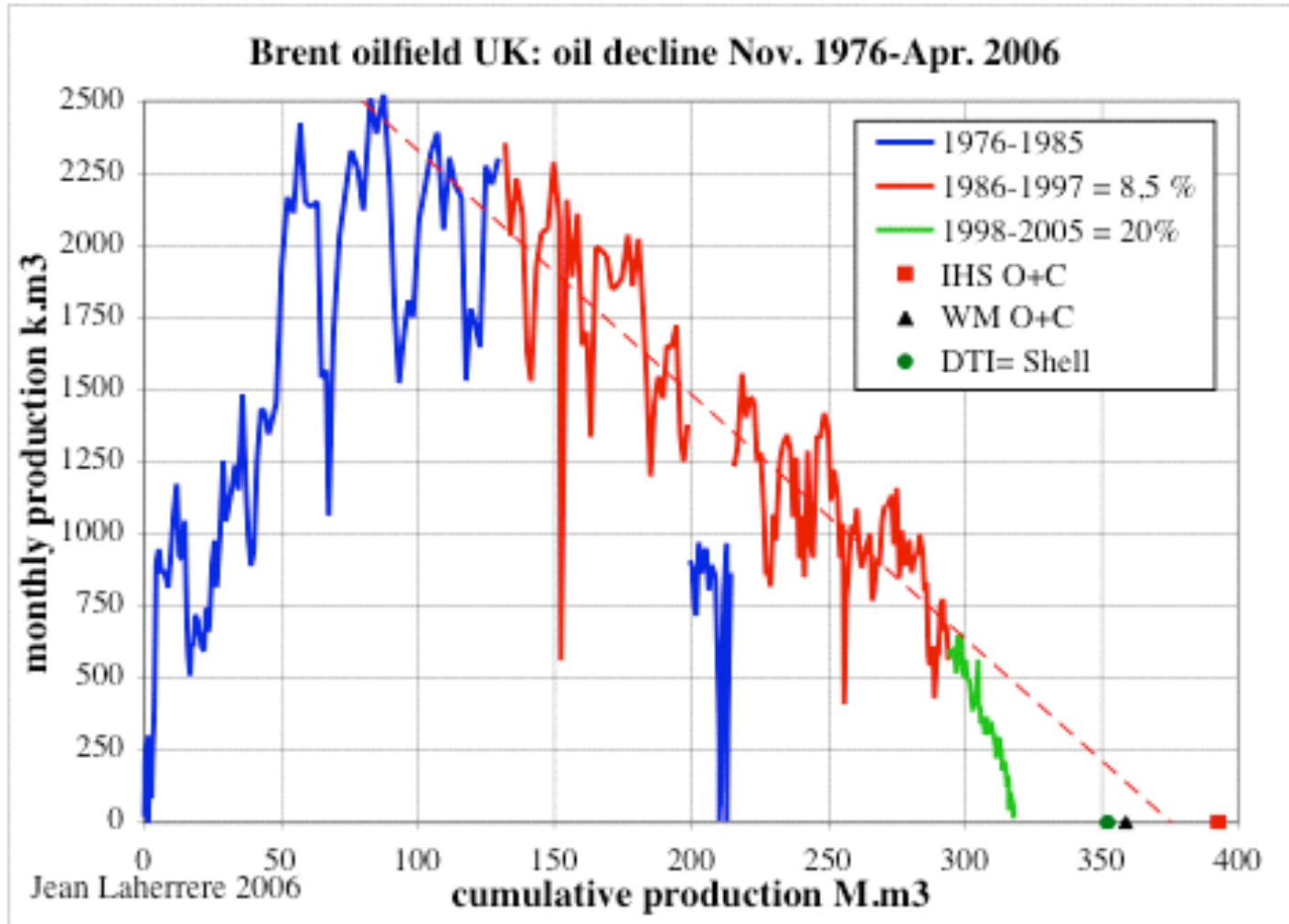
**Figure 6: Oil decline of East Texas, largest US L48 oilfield 1930-2005**





Maximum production practice leads to a collapse at the end (20%/a)

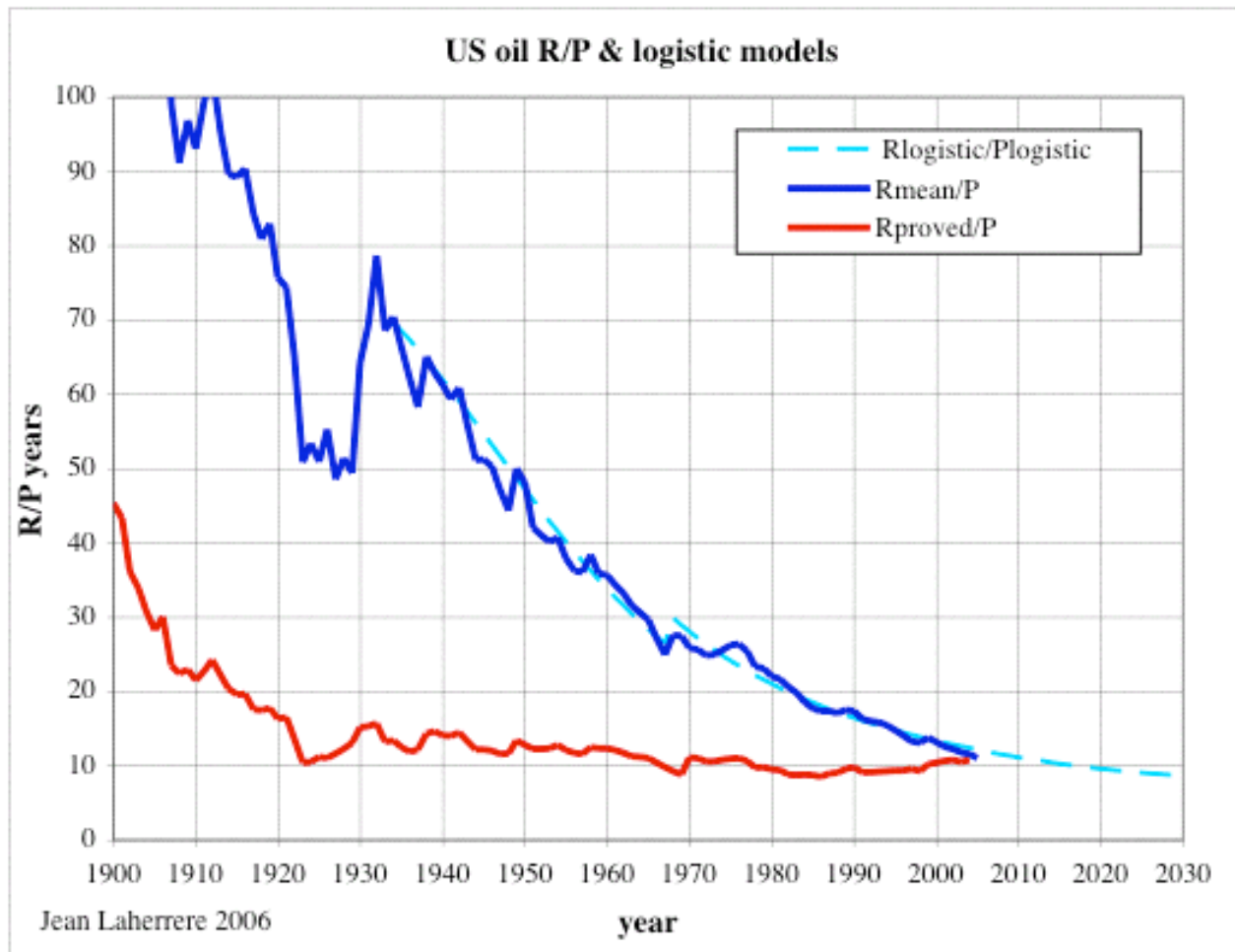
Figure 7: **Brent oil decline showing a late collapse Nov.1976-Apr.2006:**



**-Myth 4: reserves represents 40 years for oil, 60 years for gas and 250 years for coal!**

**R/P from US proved reserves is about 10 years since the last 80 years**, showing that this ratio is useless for forecasting

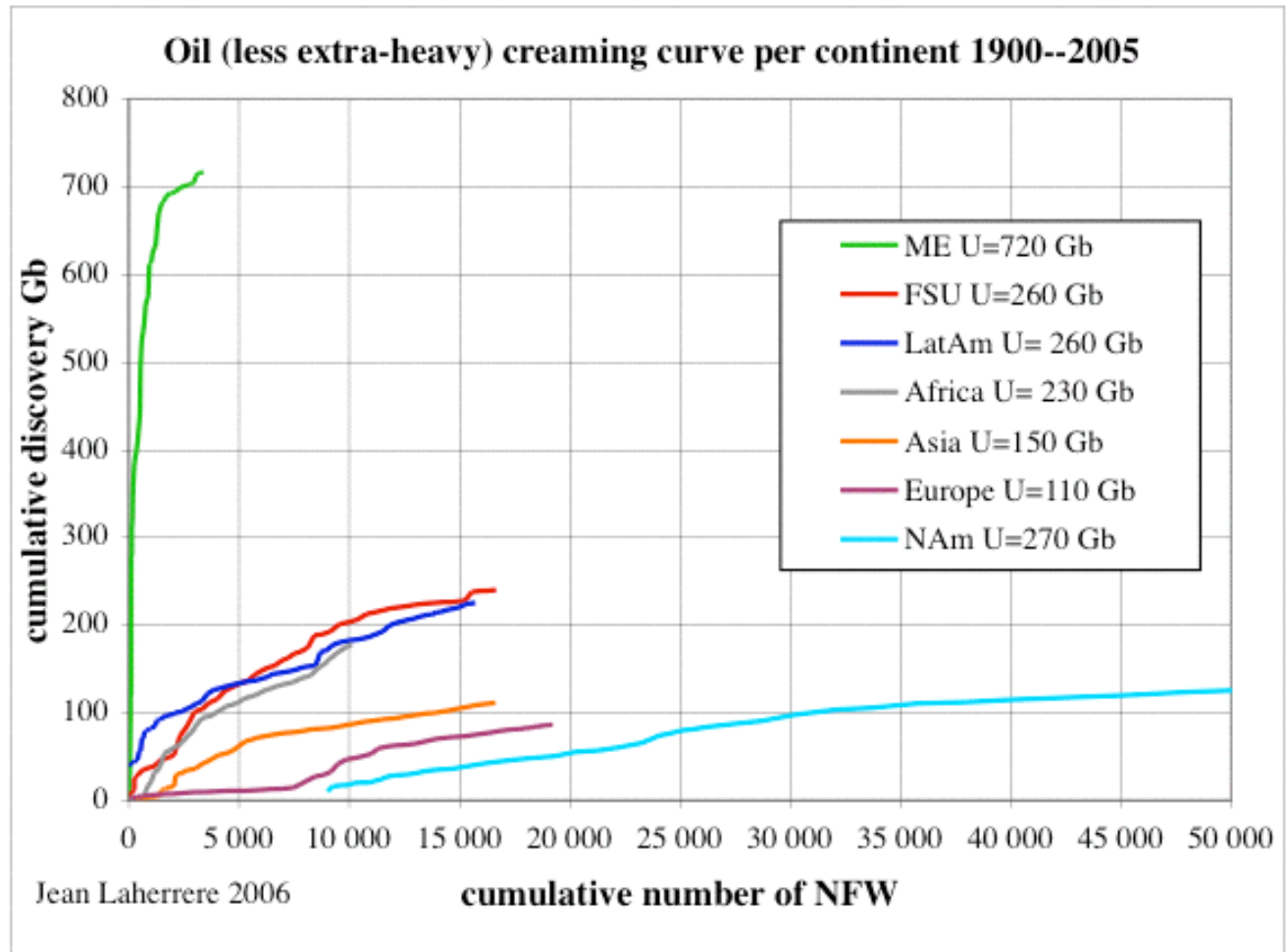
**Figure 12: US R/P from mean backdated reserves and from proved current**



**R/P is a very poor indicator, but used by many.**

**-Ultimate estimation**

**Figure 14: Crude oil less extra-heavy creaming curve by continent**

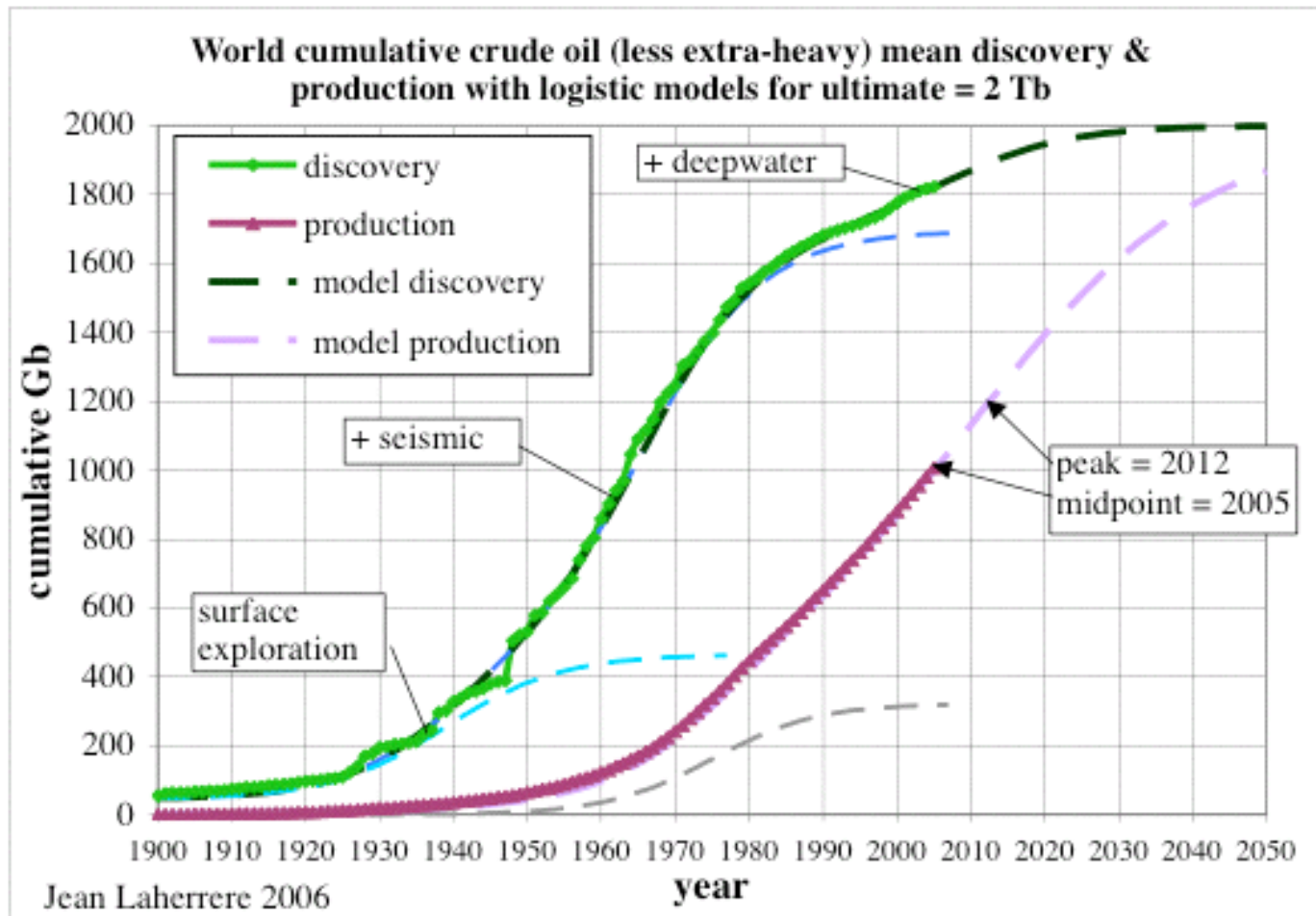


Creaming curves are rarely used because few have the detailed and complete data of NFW.

**-Modelling of future » oil » production**

**-Cumulative discovery & production**

**Figure 15: World cumulative crude oil (less extra-heavy) mean discovery & production with forecast for an ultimate of 2 Tb 1900-2050**



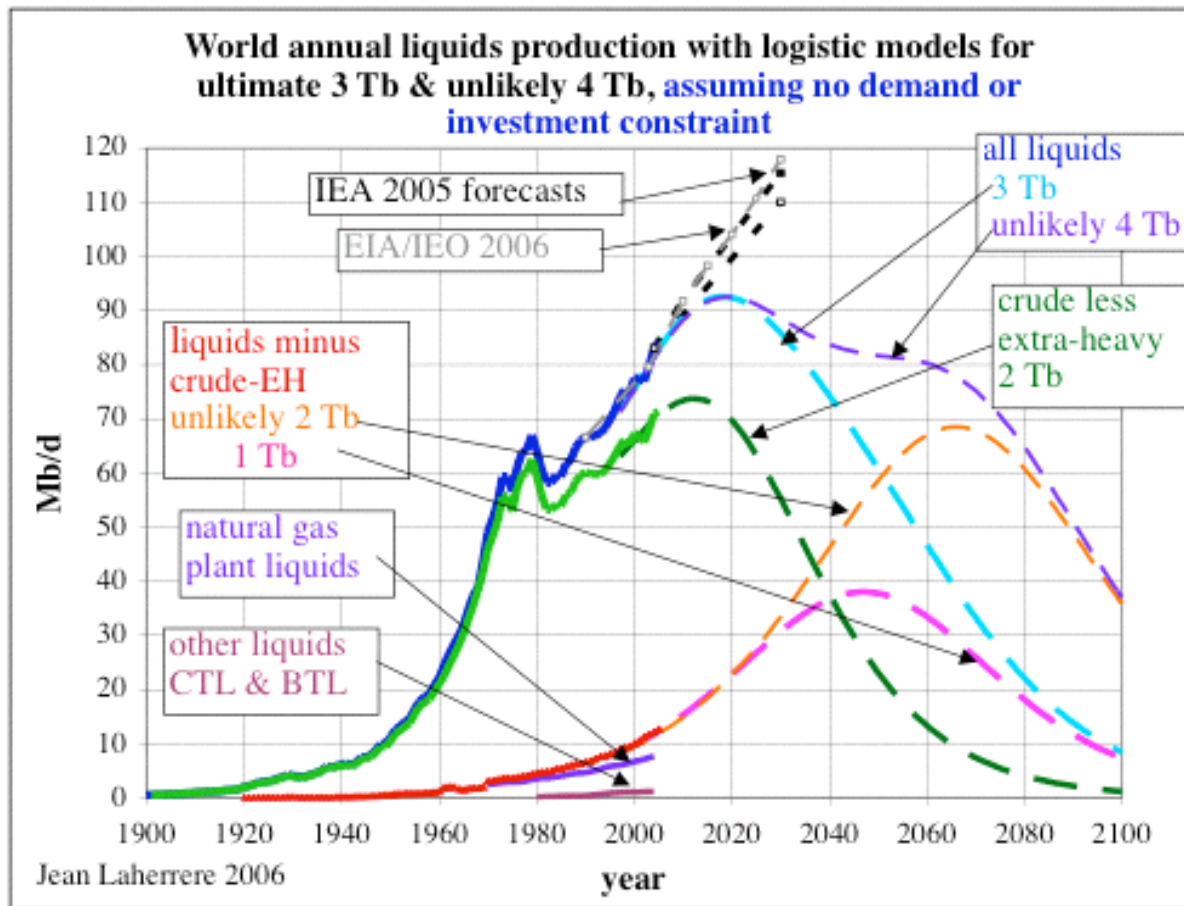
**Present cumulative discovery is over 1800 Gb, leaving less than 200 Gb for yet to find,**



### -liquids production

All liquids ultimate is 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

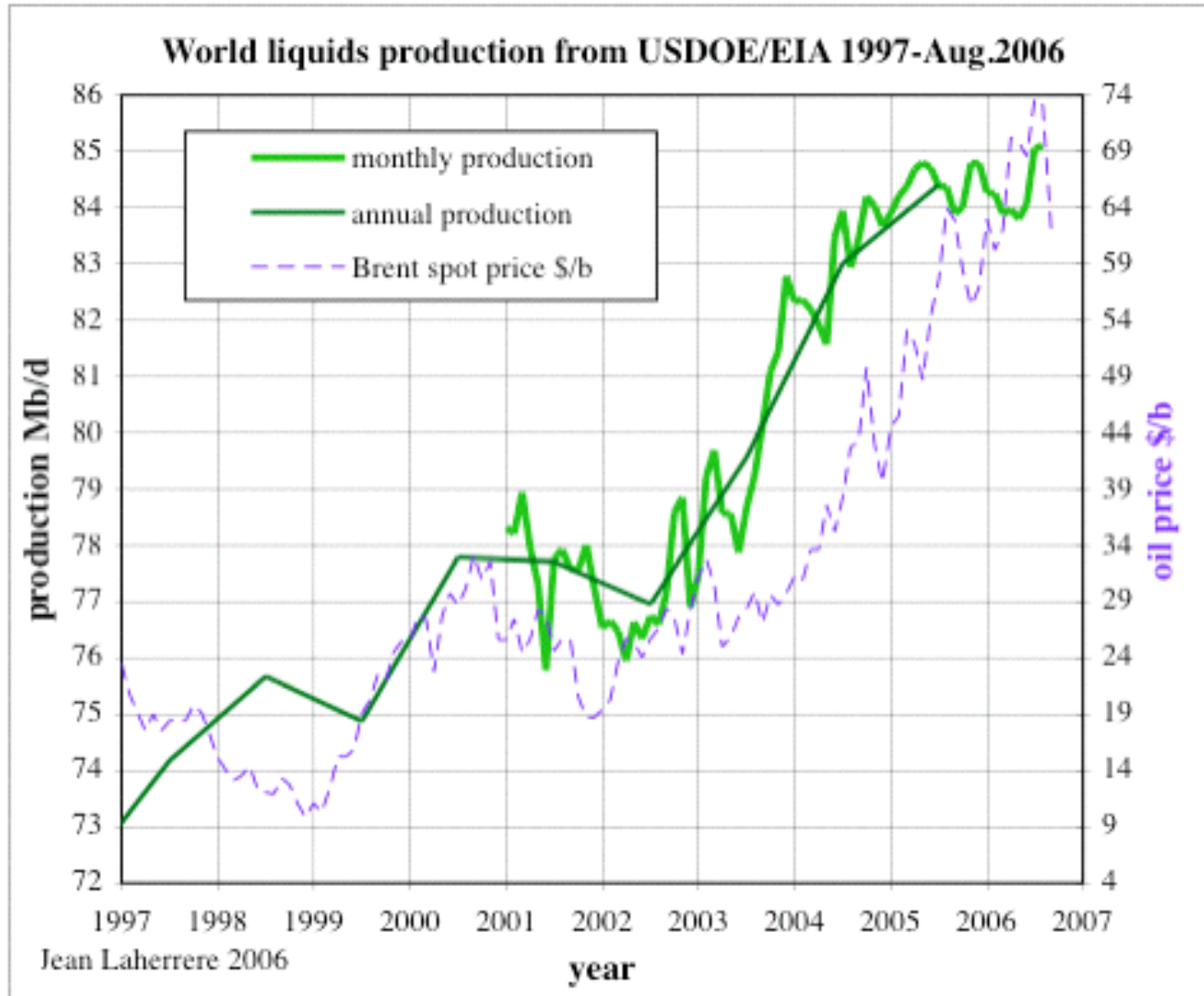
Figure 17: **World liquids production** (no demand or investment constraint)



An all liquids ultimate at 4 Tb, will not change the oil peak date, changing only the slope.  
This graph assumes **no constraint from demand or investments** = unlikely, instead **bumpy plateau!**

### Bumpy plateau and chaotic prices: already there?

Figure 17 b: world liquids production from USDOE/EIA 1997-august 2006

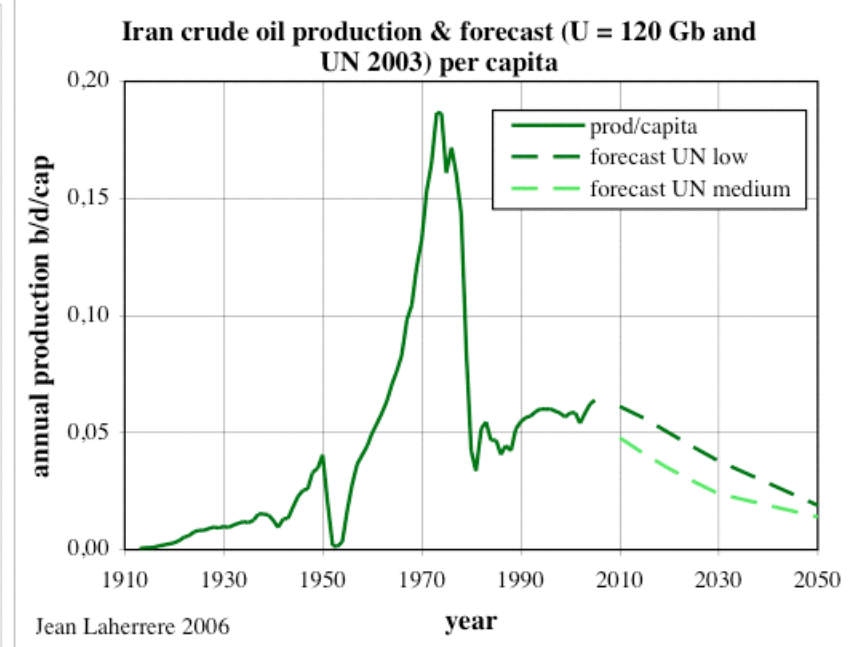
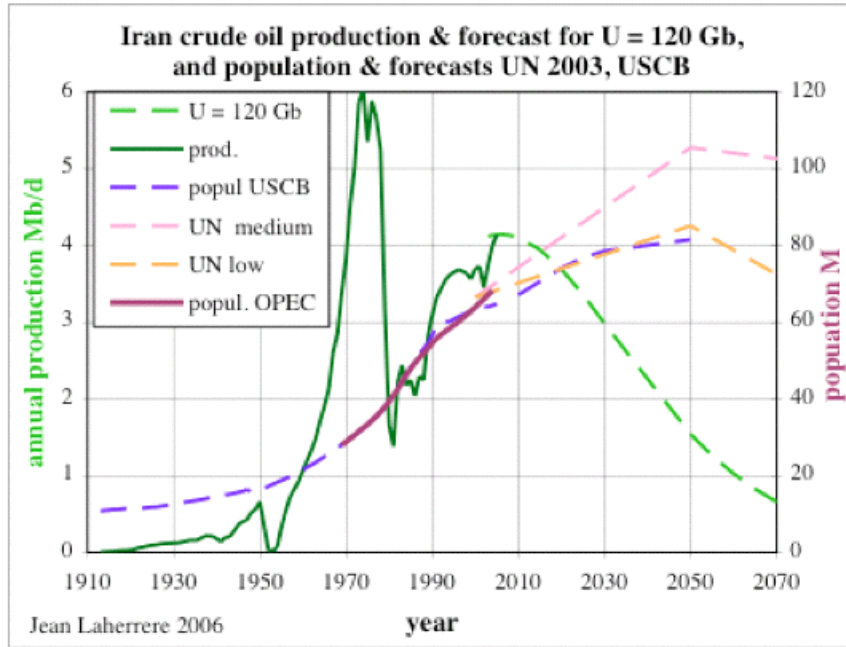




**-Iran**

Figure 22: **Iran: forecast of oil production and of population 1910-2070**

Figure 23: **Iran: forecast of oil production per capita 1910-2050**



**-Denial of signed contracts**

A recent trend of denial of signed contracts in Bolivia, Russia and Venezuela is a bad sign for investors.

All these constraints will make the oil peak a bumpy plateau and will lead to chaotic prices.



**-Natural gas**

**Figure 25: 2006 forecast: World conventional cumulative gas conventional discoveries and production with logistic models**

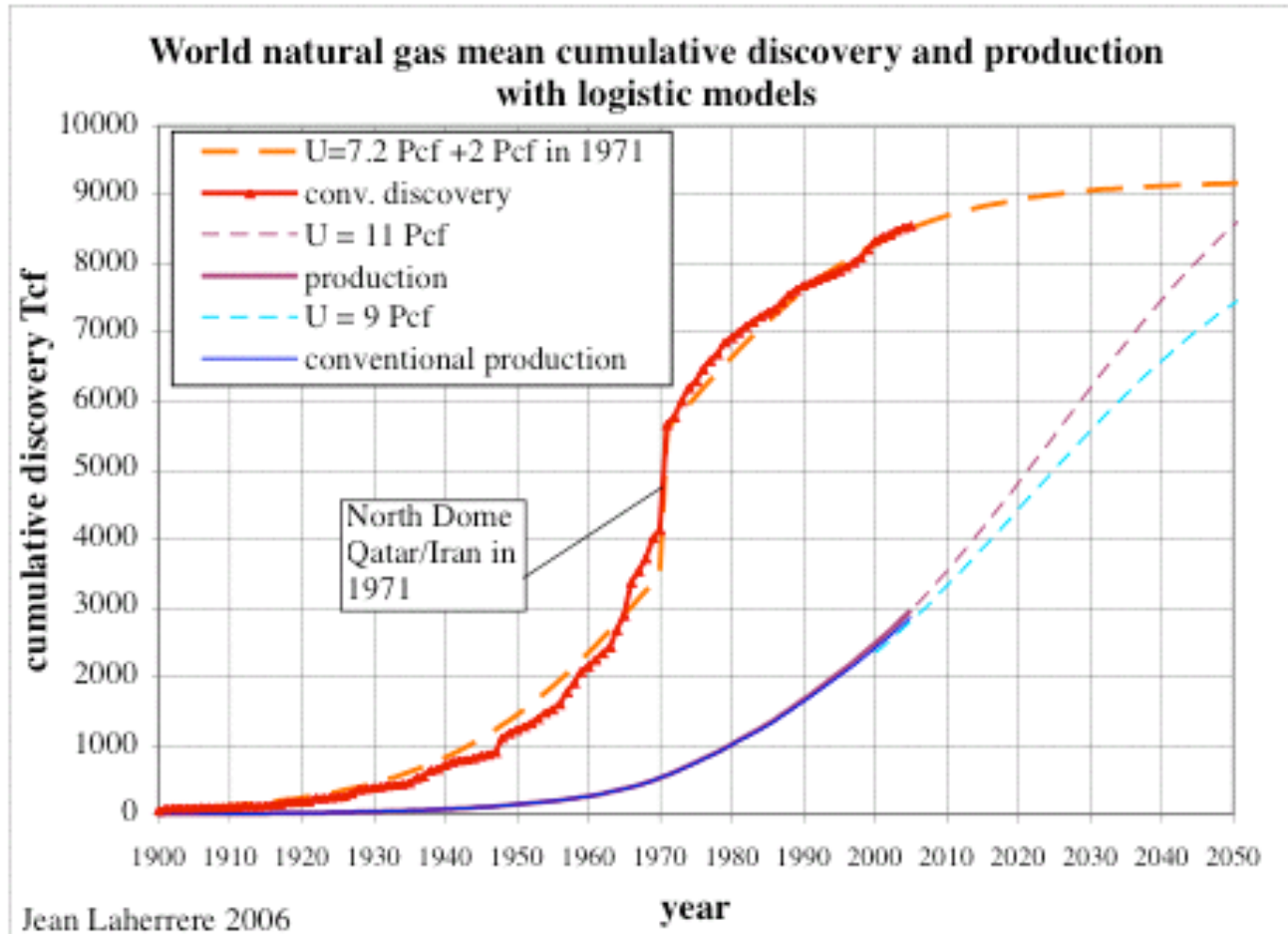
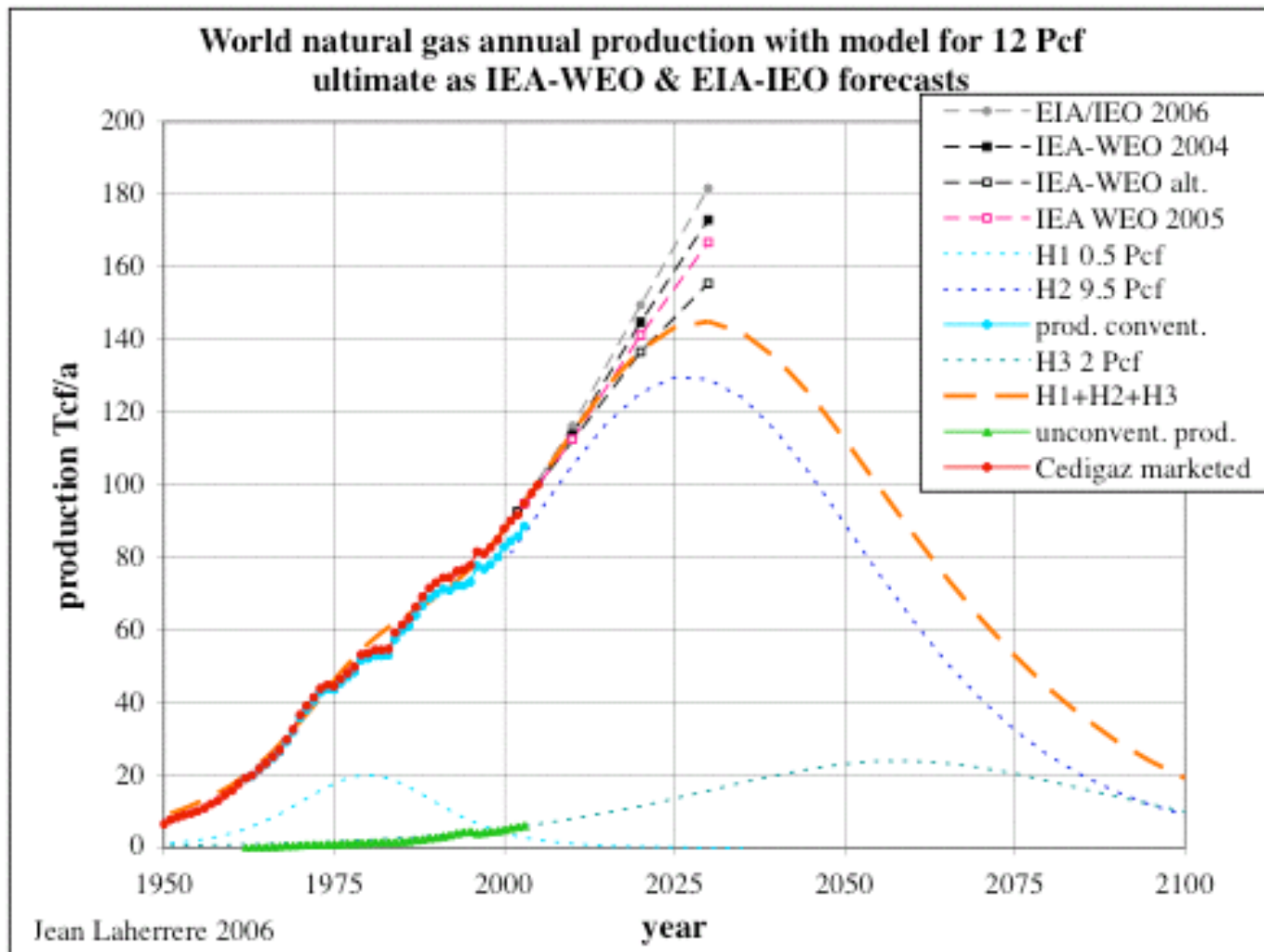
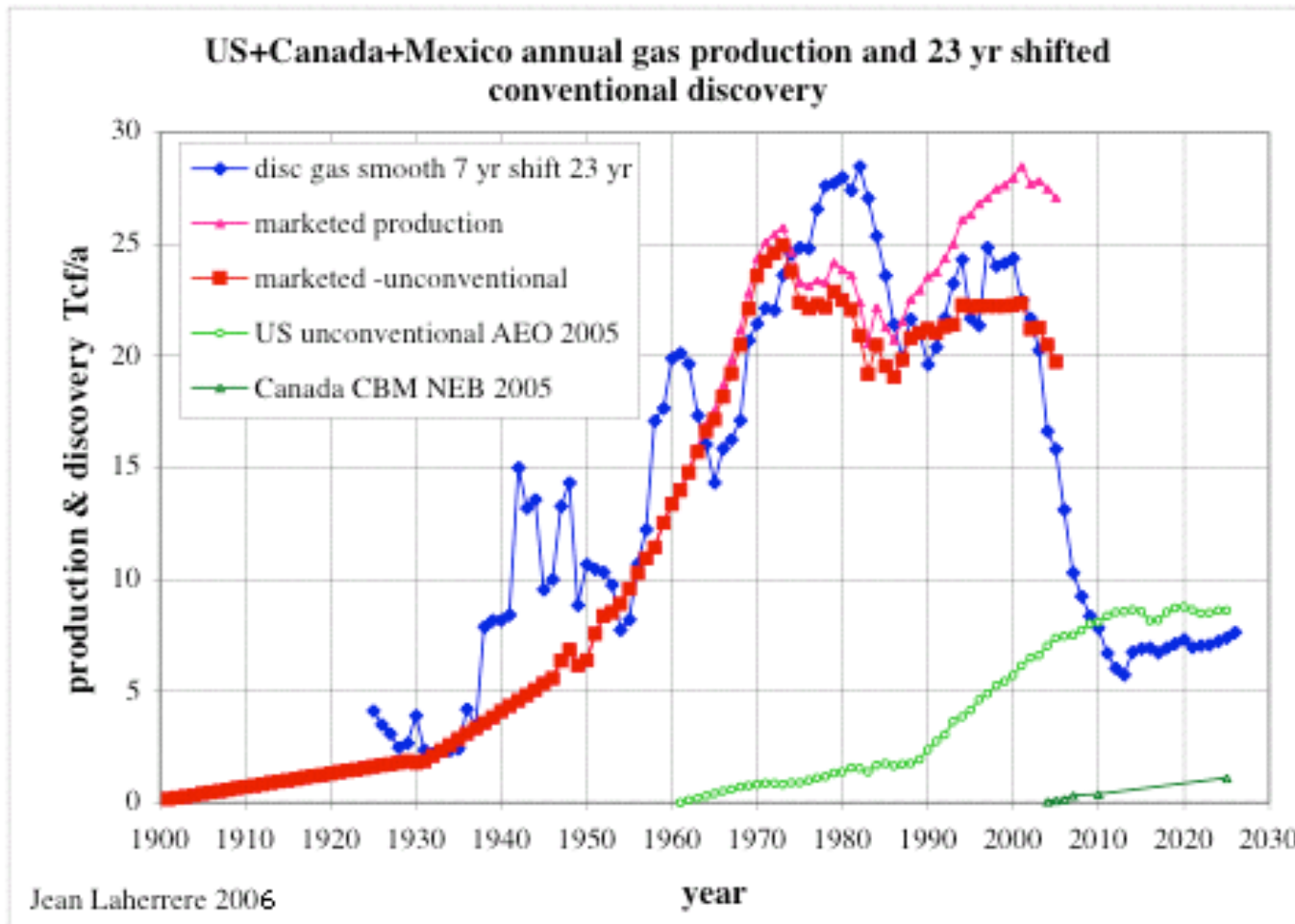


Figure 26: World annual gas discovery & production as forecasts



Global gas will peak around 2030, but as gas is ten times more expensive to transport than oil, there are several natural gas local markets: North America, Europe, Asia Pacific and now South America.  
**Figure 27: US + Canada + Mexico: conventional gas production & shifted discovery by 23 years: 1900-2030**



Europe is counting too much on Russia gas. Europe will suffer soon of gas shortage and high prices  
Figure 28: **Europe: natural gas consumption & production for an ultimate of 750 Tcf: 1930-2050**

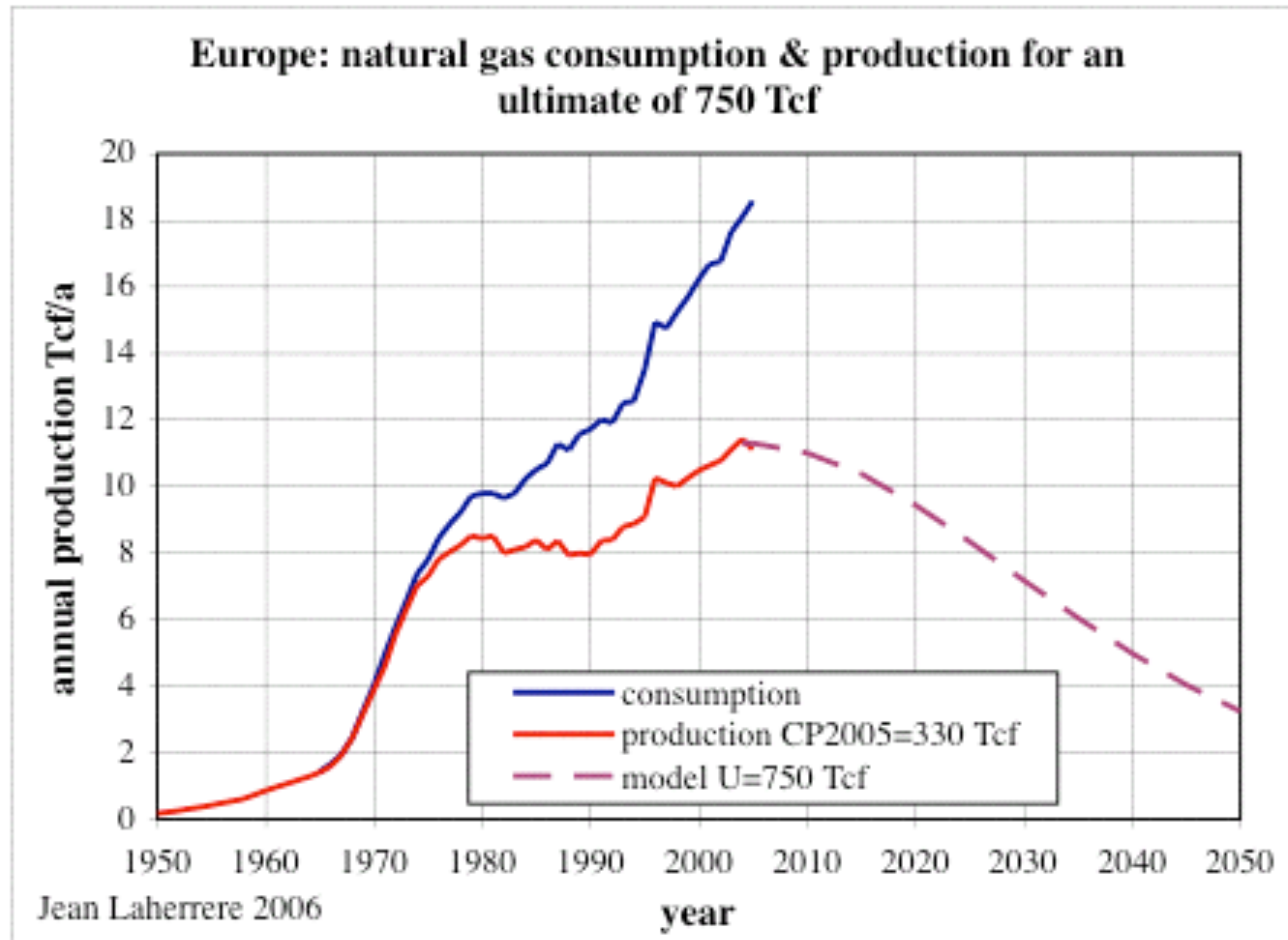
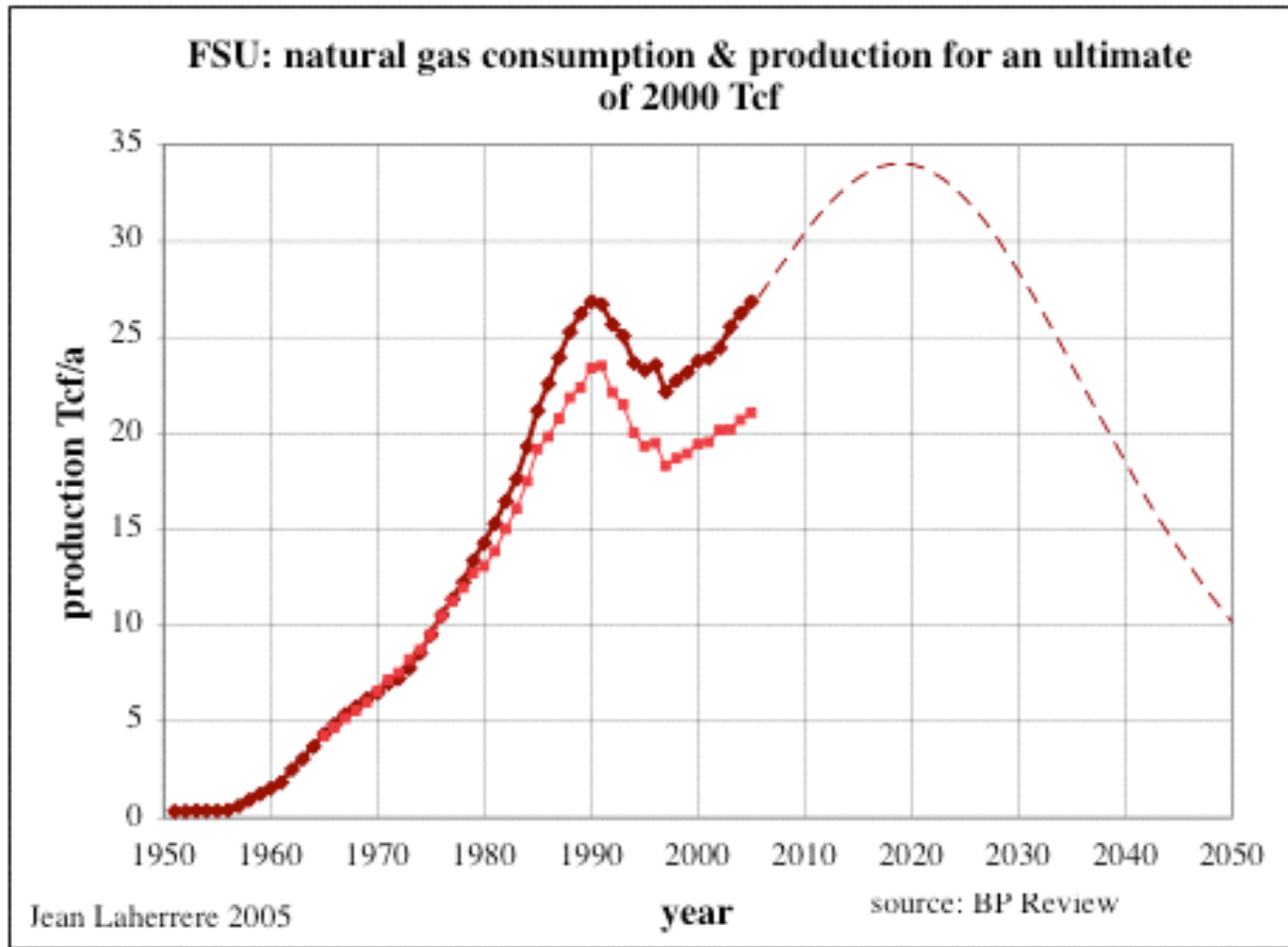


Figure 31: FSU: annual consumption & production of natural gas with an ultimate of 200 Tcf (no investment constraint) 1950-2030



## -Fossil fuels forecasts

Figure 32: World annual production of coal, oil and gas & population 1800-2200

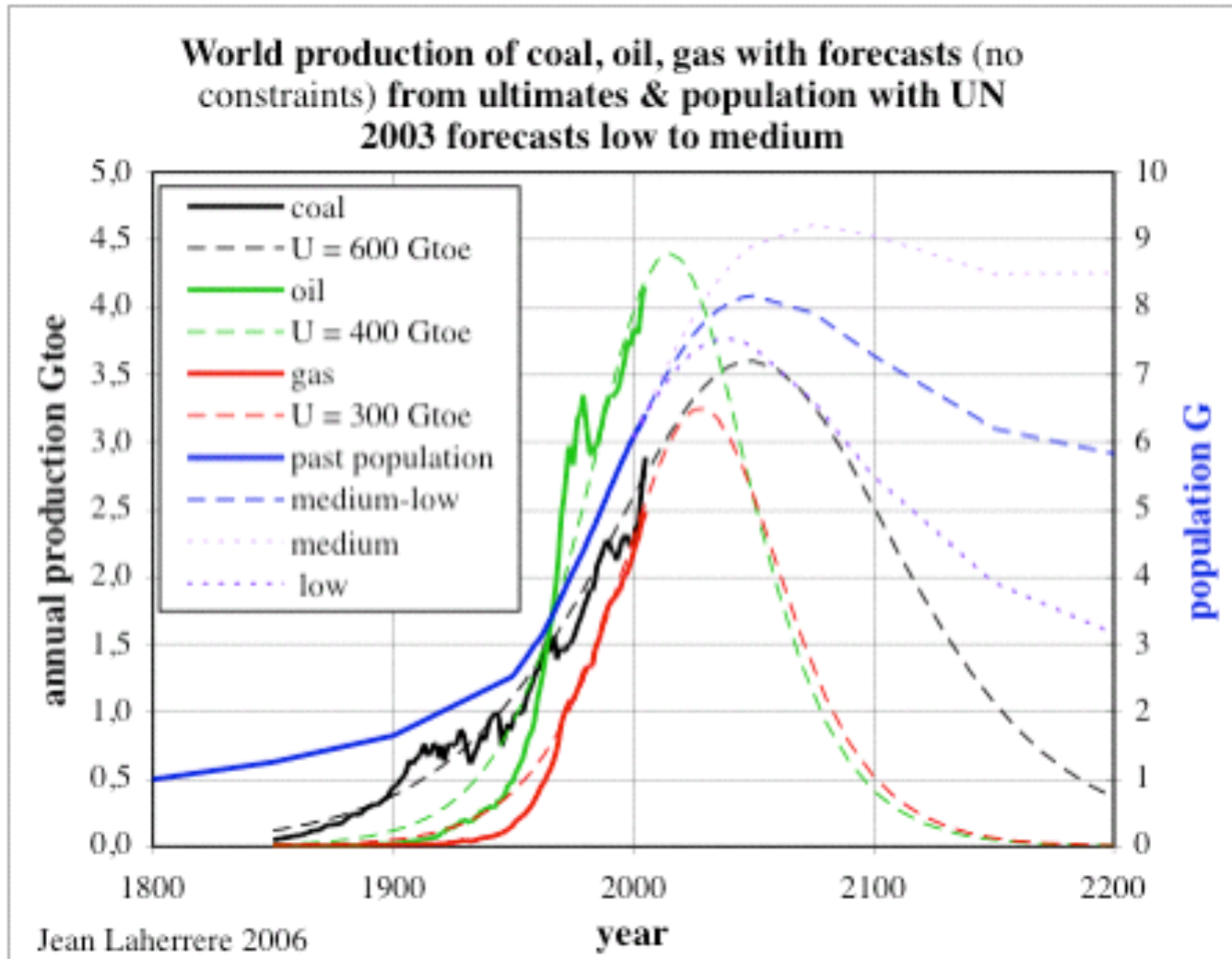
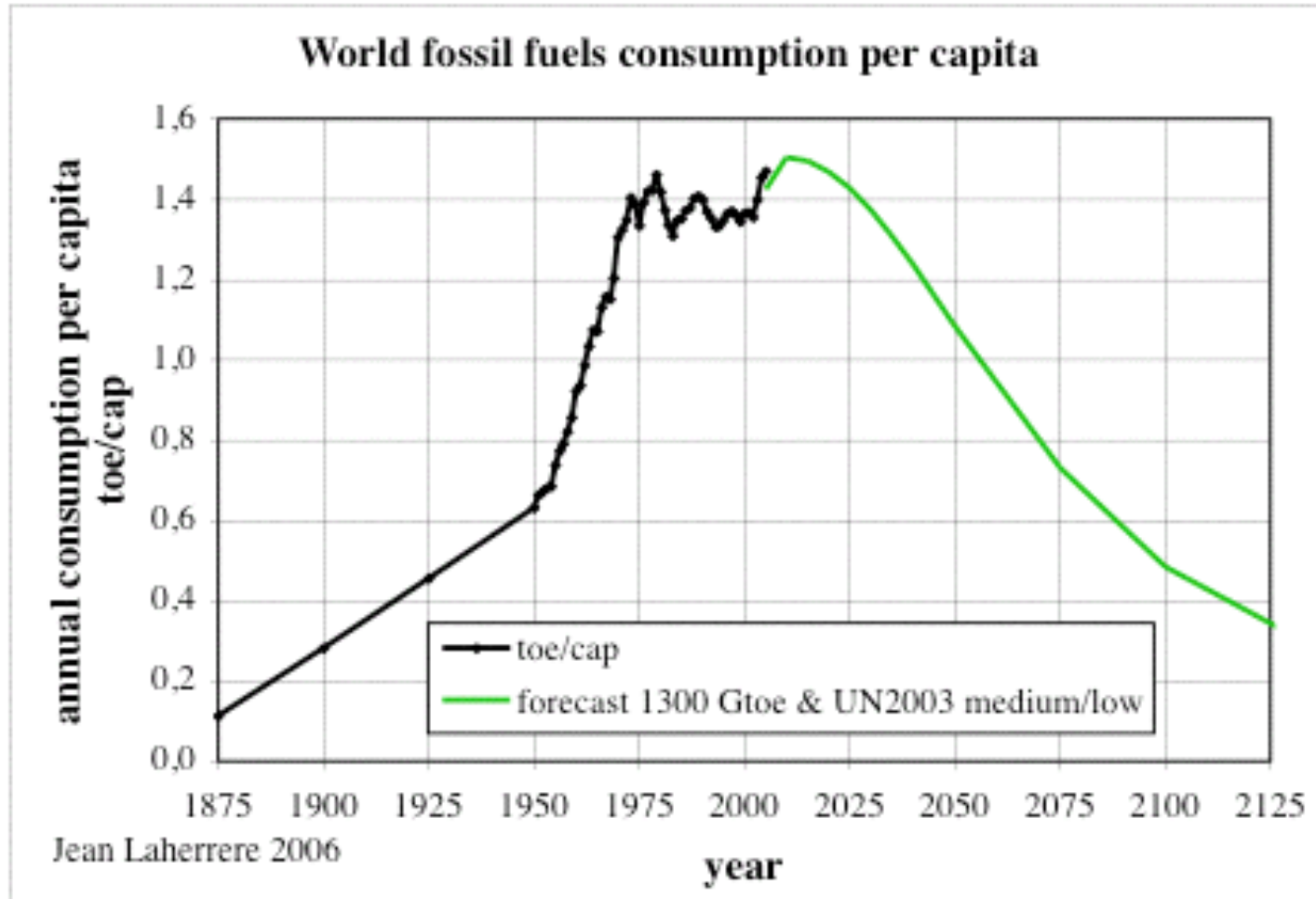


Figure 34: World annual fossil fuel production per capita 1875-2125



More nuclear reactors will be needed, because renewable cannot replace the fossil fuels in volume.

**-Primary energy**

**Figure 35: World annual primary energy mix 1800-2005**

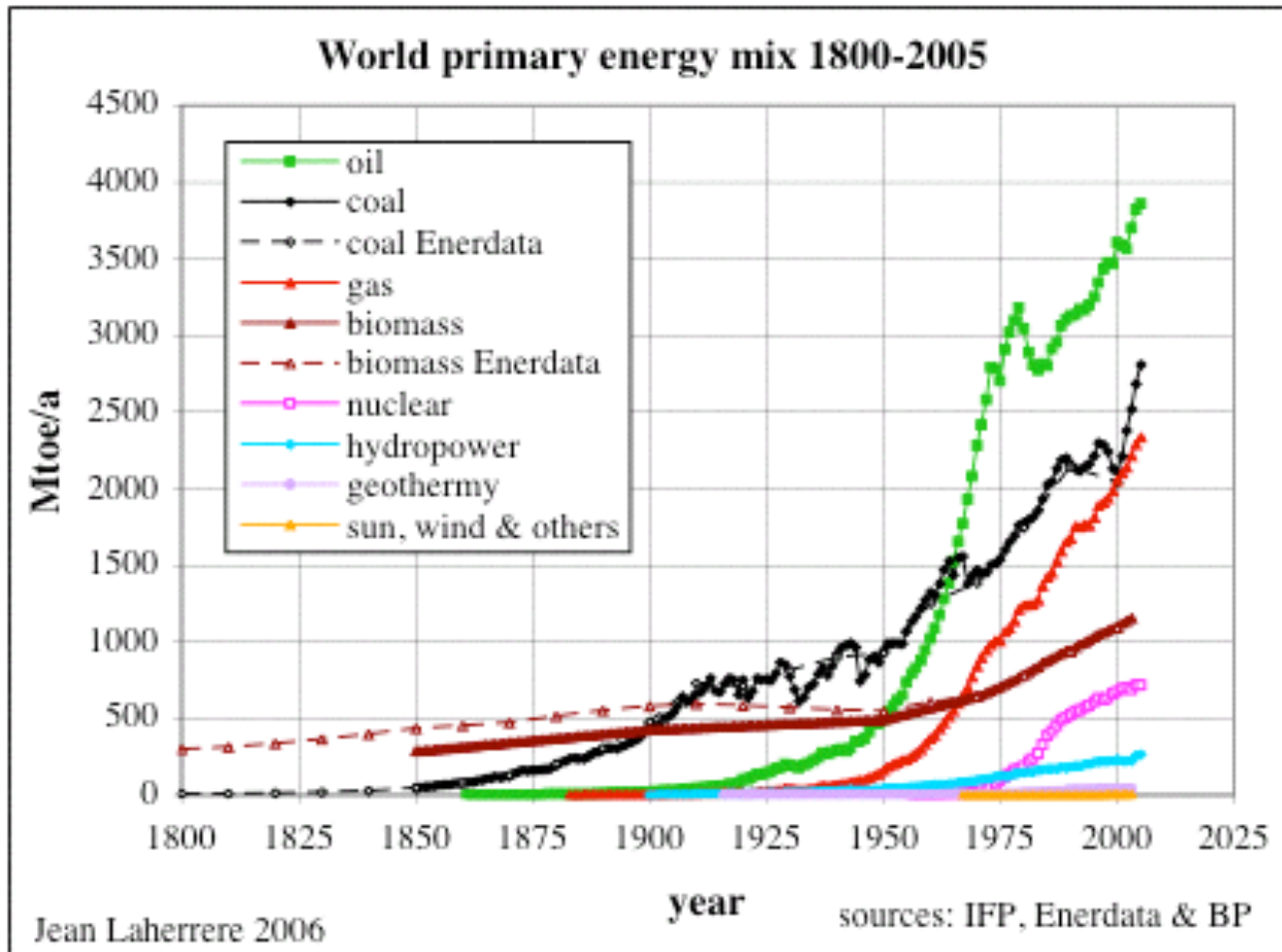
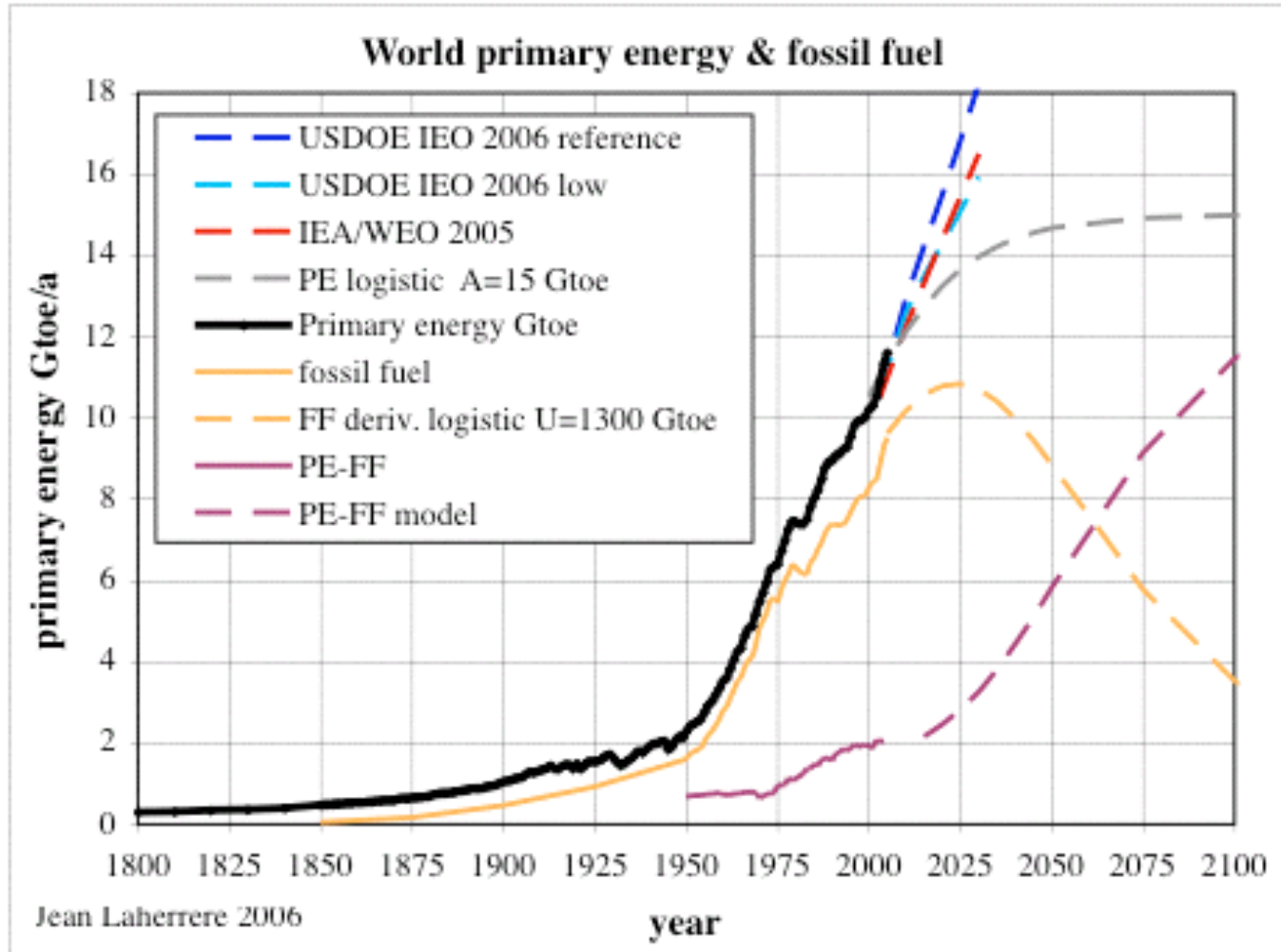


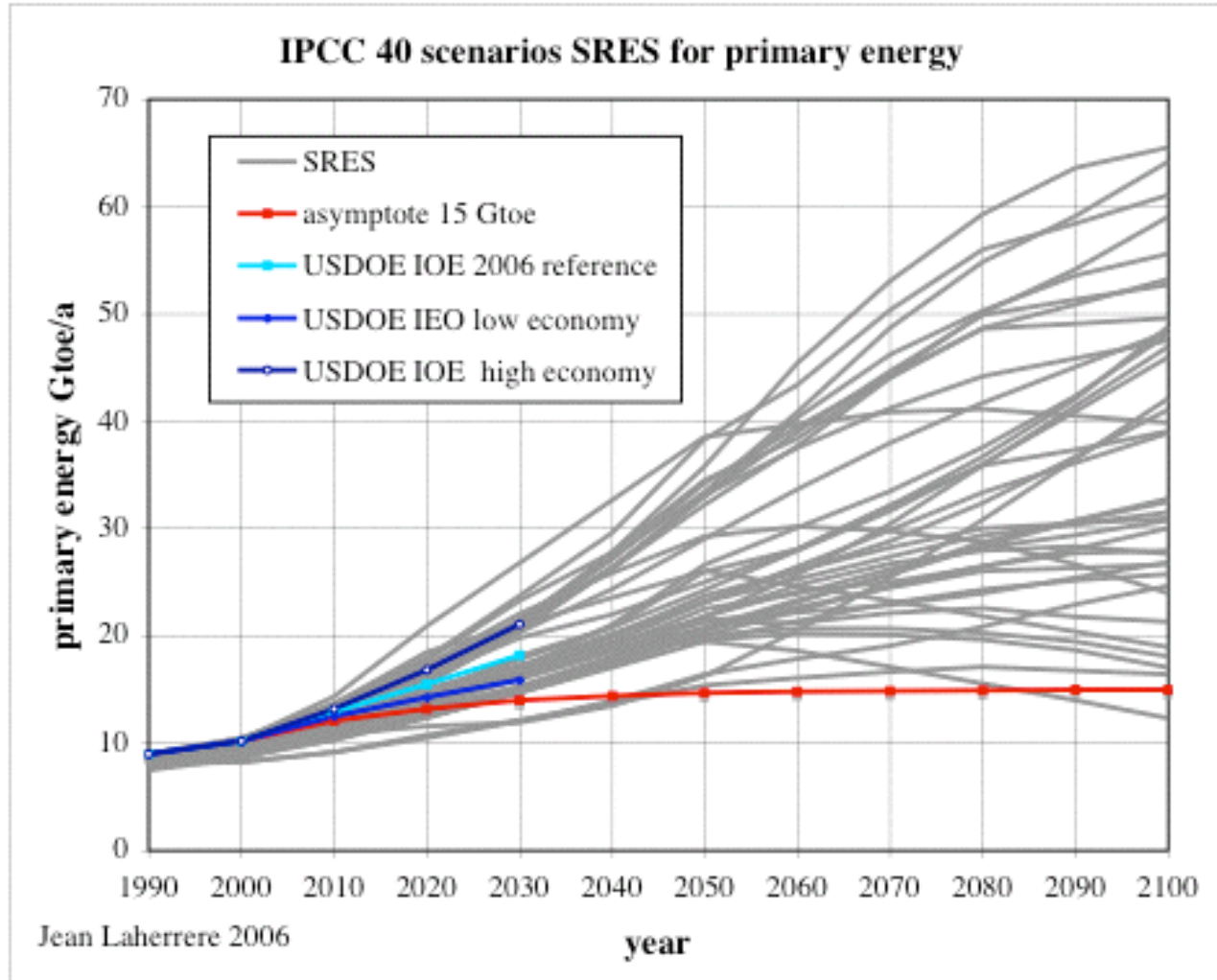


Figure 36: World annual primary energy 1800-2100



How to fill the gap between primary energy and fossil fuels beyond 2050?

Figure 37: World IPCC 40 scenarios for primary energy 1990-2100



IPCC 40 scenarios used for the 2001 and 2007 reports seem mostly unrealistic.

## **Conclusions**

Fossil fuels public data are unreliable, in particular on reserves, confused with resources. Official production forecasts are based on continuous growth wishes, denying any peak. There are many myths based on general statements without any proof, but dismissed by individual fields data.

R/P is a very poor parameter for forecasting the future, but used by many.

Oil (liquids including synthetic oils) will peak in less than 10 years, if there is no constraint from the demand or investments, or will follow [a bumpy plateau with chaotic prices](#).

Gas is not global because the high cost of transport and shortage could occur before oil shortage in North America or Europe. World gas will peak around 2025.

Coal will peak around 2050, because reserves are often confused with resources (case of France).

Fossil fuel per capita is flat at 1.4 toe/cap since 1975 and will stay until 2025.

Primary energy will flatten and may trend towards 15 Gtoe.

## **Two statements:**

- Europe could see shortage of natural gas soon
- Iran oil production is peaking and should need nuclear plants soon.