

## World oil production: past & forecasts

### -Definition

Oil reserves are reported following different classifications in use (JHL 2007)

**US:** all energy companies listed on the US stock market are obliged by the SEC to report only **proved** reserves (**1P**), assumed to be the **minimum** (reasonable **certainty if deterministic or 90% probability if probabilistic**); these reserves are audited.

**OPEC:** because quotas depend upon reserves, OPEC members report **proved** reserves (**1P**), which is their national wish (of course non-audited).

**Former Soviet Union: ABC1** (Khalimov 1979) reports **maximum** theoretical recovery, being equal to proven plus probable plus possible (**3P**).

**Rest of the world:** SPE/WPC (1997) regulations report reserves as proven plus probable (**2P**), close to the **mean value or a probability of 50%**. Oil companies use SPE 2P reserves to decide the development of their fields, but they are obliged to report only SEC 1P reserves!

Scout companies, who report 2P reserves by field, (from oil companies data obtained by some unknown means) use the present estimate of the ultimate of the field to report this estimate at discovery year (method called backdating).

Every year some probable reserves, which were not reported following SEC rules, become proven and are considered as new discovery. As new discoveries become harder, companies love this proven reporting, showing a better picture than reality.

The problem is that the aggregation of a country proven (90 % probability) field reserves does not represent the proven (90 % probability) reserves of the country, but less, as shown by the next graph:

Figure 1: deterministic versus probabilistic aggregation

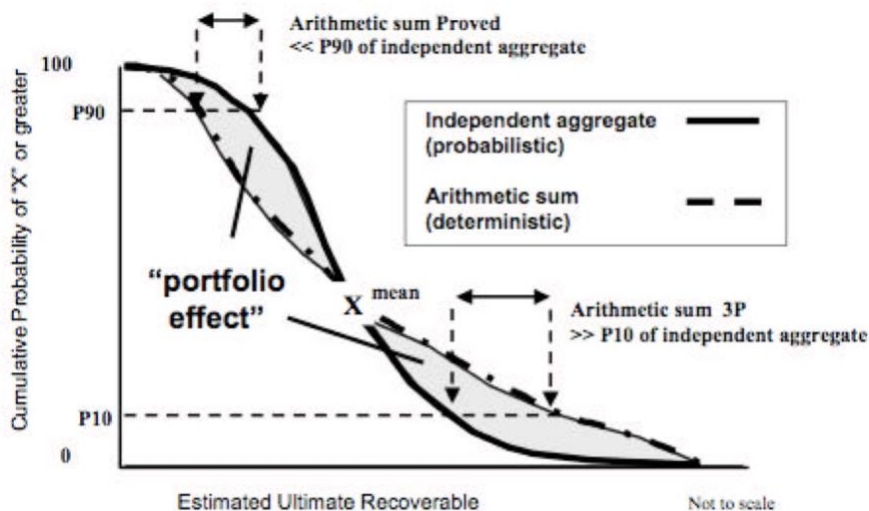


Figure 3-2: Deterministic versus Probabilistic Aggregation

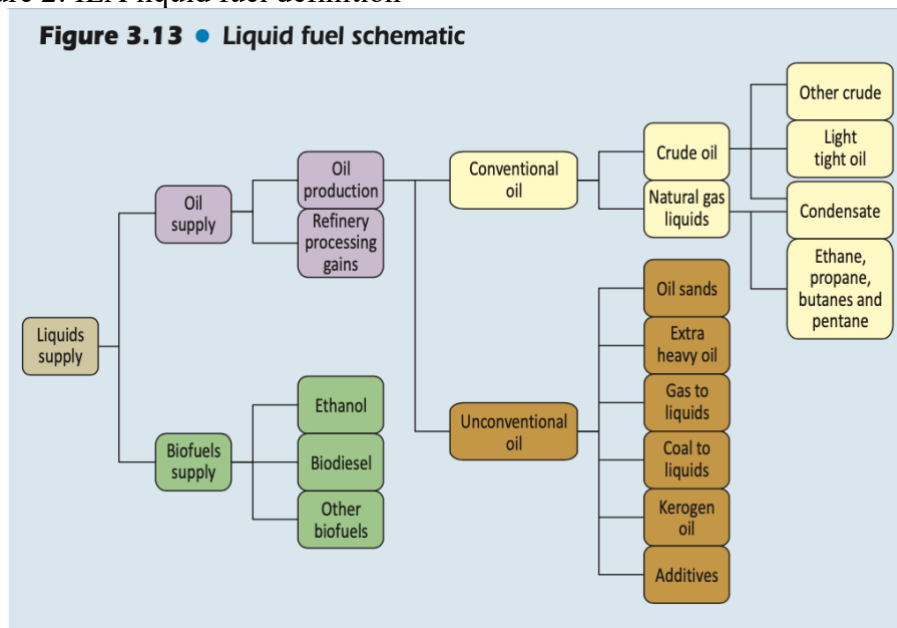
Only the aggregation of 2P field reserves represents the 2P (probability 50%) of the country. It means that the aggregation of world proven reserves as reported by all agencies is incorrect, but, as it is political (OPEC) or financial (SEC), nobody worries!

Oil could be either

-crude oil for OPEC because condensate is not submitted to quotas

-crude oil +condensate for IEA conventional oil when condensate is sold with crude oil (but condensate is NGL = natural gas liquids if sold with liquids)

Figure 2: IEA liquid fuel definition



But EIA reports “lease condensate” with crude oil and distinguishes “plant condensate” from natural gas plant liquids = NGPL: see EIA glossary

There is a large discrepancy between IEA NGL and EIA NGPL (Laherrere 2019)

As extra heavy (XH) oil (oilsands Athabasca very viscous and extra heavy Orinoco less viscous) is trapped and produced differently (unconventional for IEA), it is excluded in my 2P reserves.

### -Past known reserves and production

World 2P crude oil less extra-heavy oil reserves are estimating using Petroconsultants backdated after several corrections

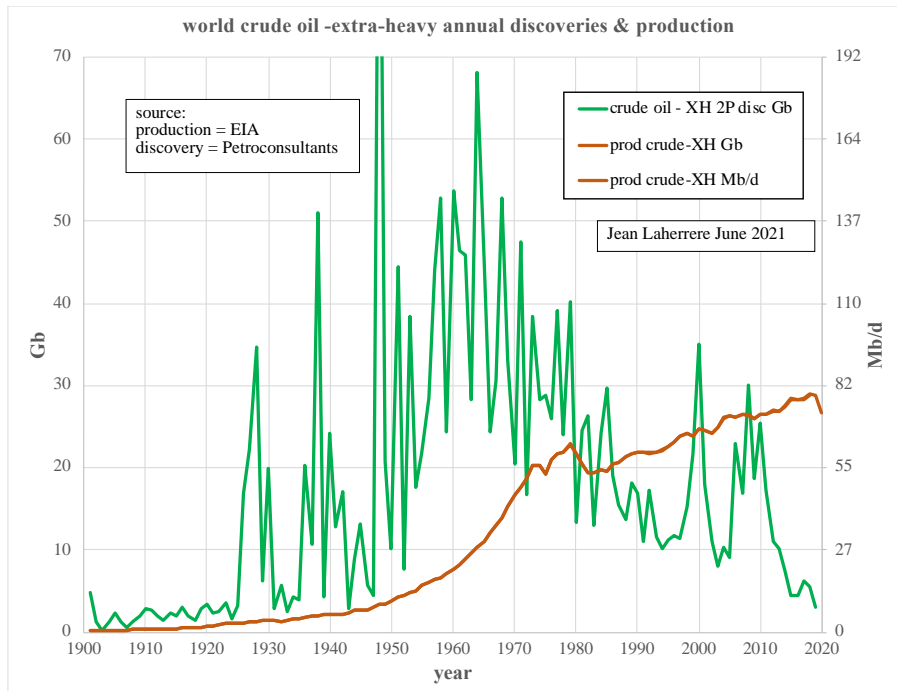
-removing Orinoco discoveries 215 Gb from 1936 to 1939

-correcting ABC1 of former USSR (called wrongly 2P) into 2P

-correcting OPEC overestimations (coming from the OPEC quotas battle 1985-1989) after 2005

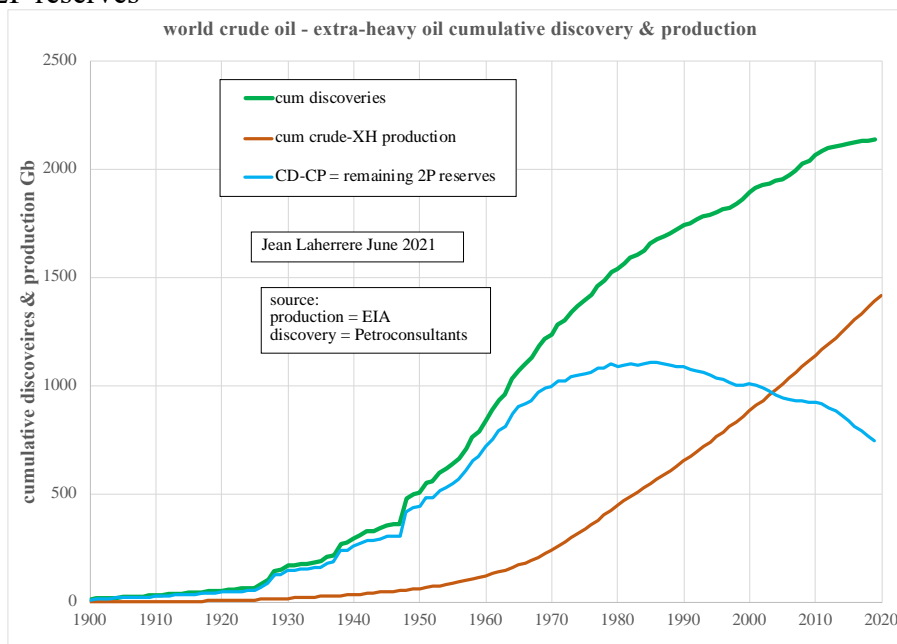
The plot of world annual discoveries and production for the period 1900-2020

Figure 3: world annual crude oil less XH discoveries and production



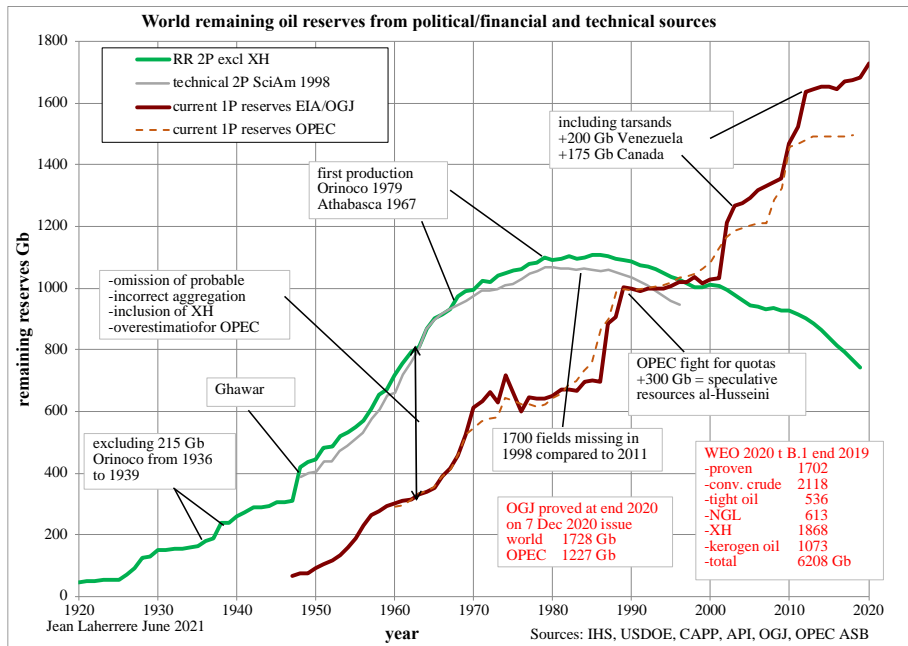
The same data for cumulative discoveries and production and the difference discoveries less production represents the remaining 2P backdated reserves

Figure 4; world cumulative crude oil less XH discoveries and production and remaining 2P reserves



The world remaining oil reserves are plotted as backdated 2P and current 1P from different sources (EIA/OGJ and OPEC): OPEC 1P reserves are political when non-OPEC 1P reserves are financial. 1P reserves from IEA (WEO2020) are also reported, giving the breakdown into conventional, tight oil, NGL and XH

Figure 5: world remaining oil reserves from political/financial and technical sources



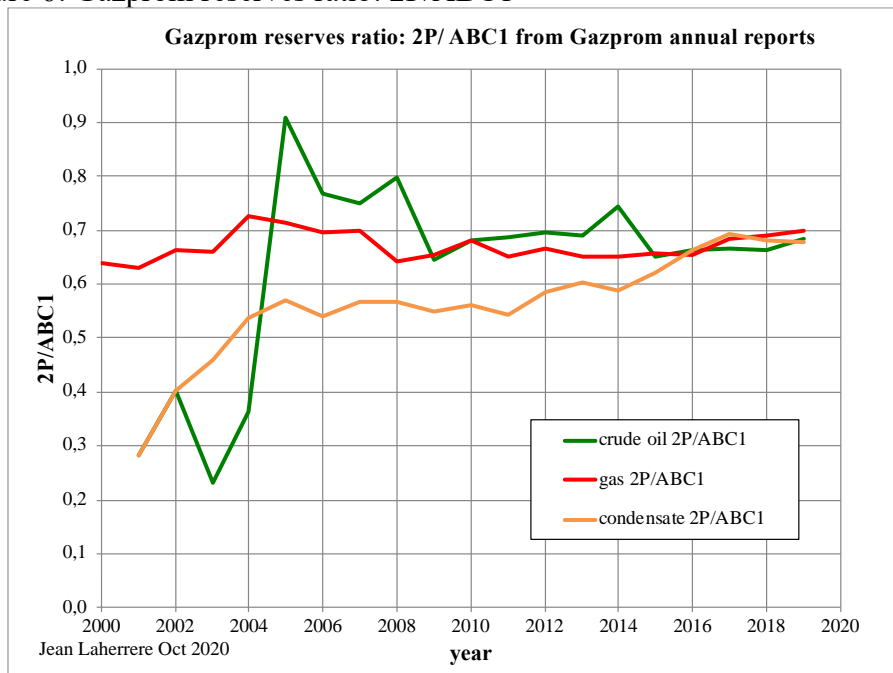
These 1P data are too high for three reasons:

- EIA/OGJ includes the 375 Gb "extra-heavy" Canadian and Venezuelan "reserves" , but OPEC (ASB T31) includes only Orinoco

- The inclusion of overestimates of oil by OPEC in their quotas fight, estimated as speculative resources by Sadad al Hussein (former VP E&P Aramco) at 300 Gb (“Oil and Money” London 2007).

- The inclusion of ABC1 Russian reserves (former USSR = CIS = Commonwealth of Independent States)) which have to be corrected: Gazprom annual reports show that 2P = 0.7 ABC1. This correction is about 100 Gb.

Figure 6: Gazprom reserves ratio: 2P/ABC1

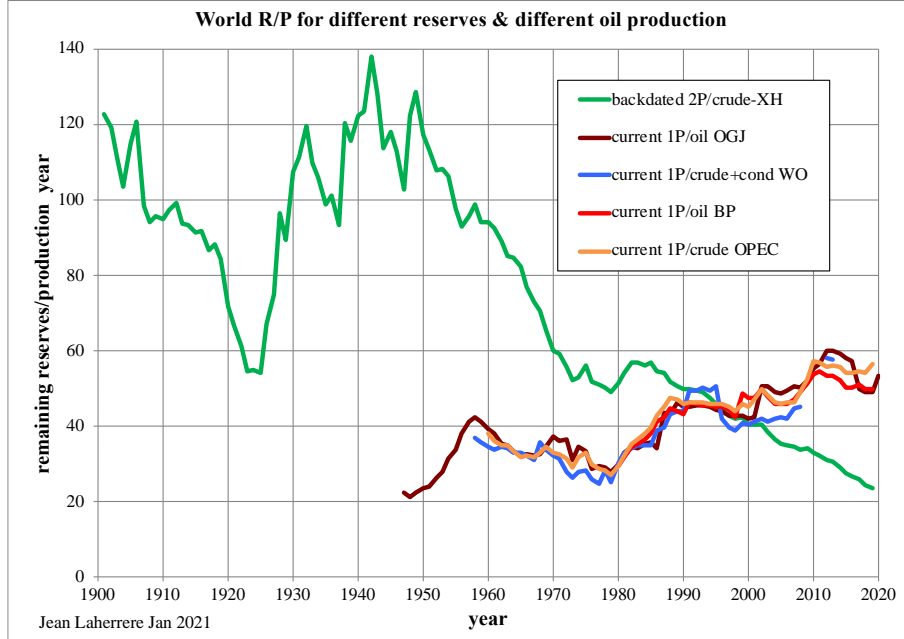


These three corrections total 375 + 300 + 100 Gb, so the world remaining proven reserves (1684 Gb end 2019) should be 775 Gb less (= 909 Gb) to be compared with the 2P reserves

end 2019 = 744 Gb: in fact with the same definition, 1P are 165 Gb higher than 2P when they should be lower. It shows also that oil remaining reserves uncertainty is about 200 Gb!

Dividing reserves by annual production gives the number of years remaining if the production stays constant (unlikely!).

Figure 7: world R /P for different remaining reserves and different oil production



R/P declines for 2P since 1950; when R/P increases for 1P since 1980.

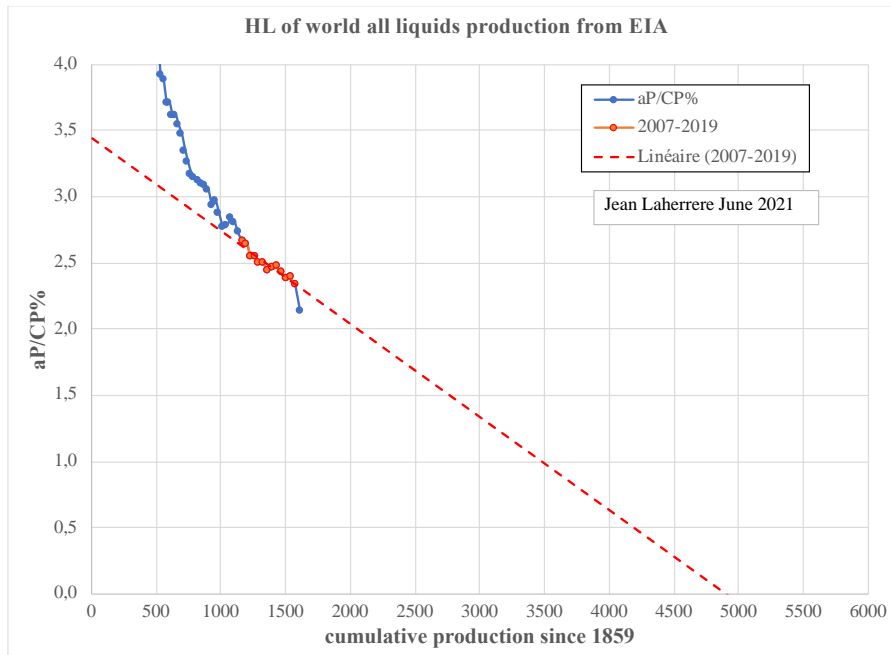
For 2019, R/P for 2P = 24 years, when for 1P = 50 years: about the double!

### -Future production

To forecast future oil production, known discoveries are not enough, “yet to find“ has to be estimated to obtain the “ultimate” (cumulative production +remaining reserves +yet to find) The ultimate can be estimated with the Hubbert Linearization of past production = HL technique (Laherrere 2015).

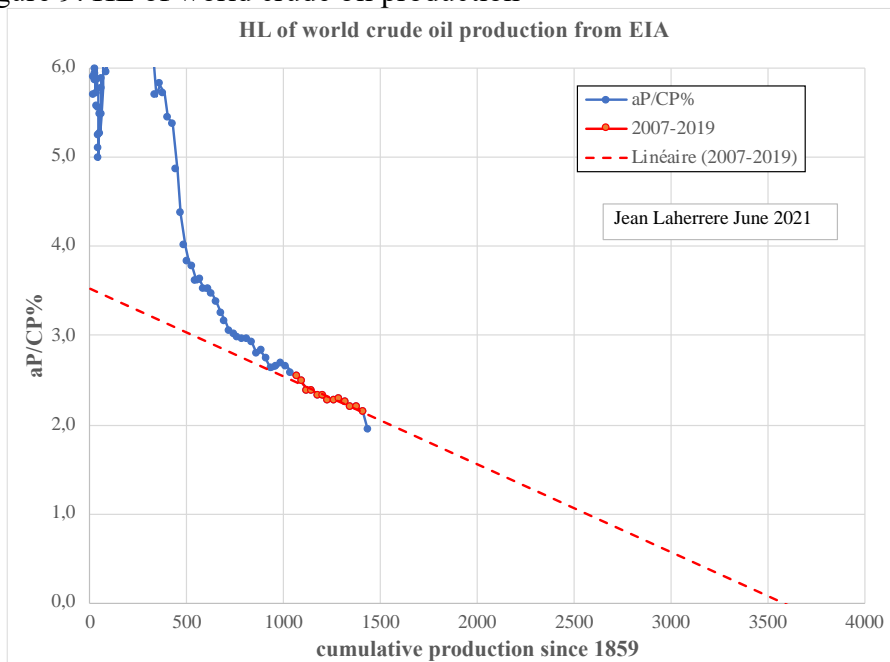
HL of all liquids production trends towards 5000 Gb for the period 2007-2019

Figure 8: HL of world all liquids production



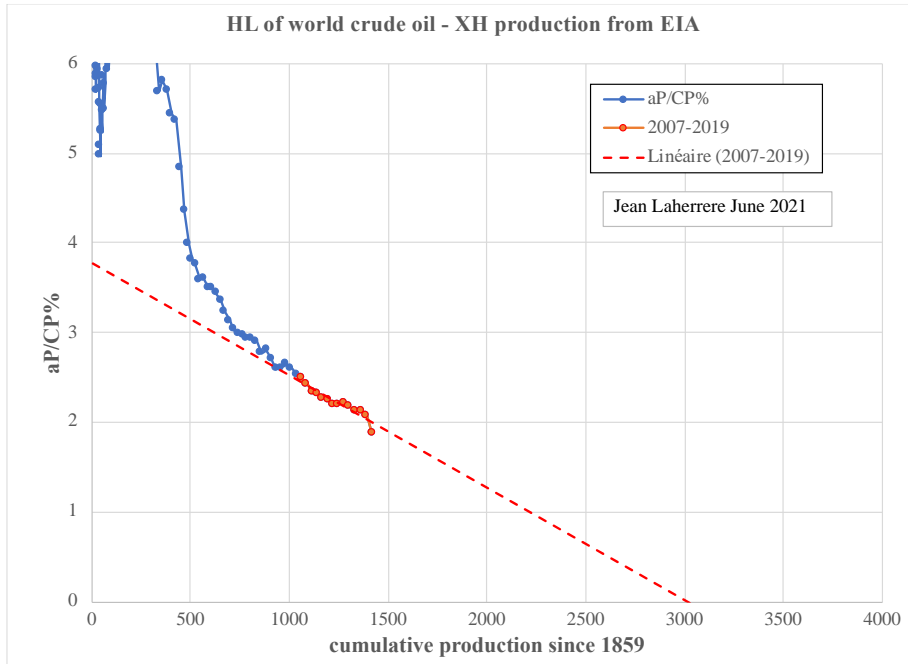
HL of past crude oil (including lease condensate for EIA) production for the period 2007-2019 trends towards 3500 Gb

Figure 9: HL of world crude oil production



HL of past crude oil less XH (2007-2019) trends towards 3000 Gb.

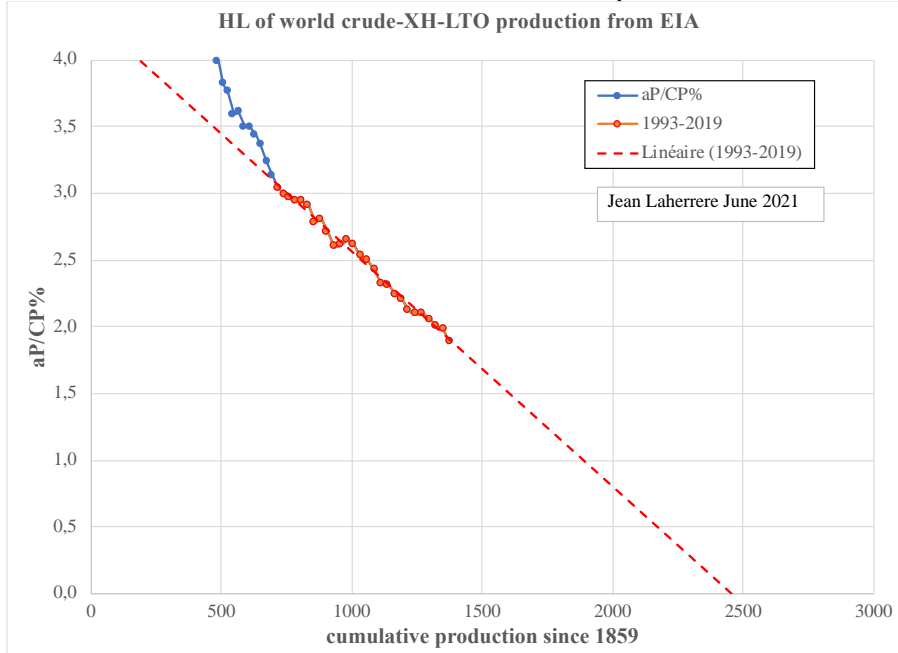
Figure 10: HL of world crude less XH oil production



It means that the ultimate of extra-heavy is 500 Gb which is in line with the above XH reserves = 375 Gb

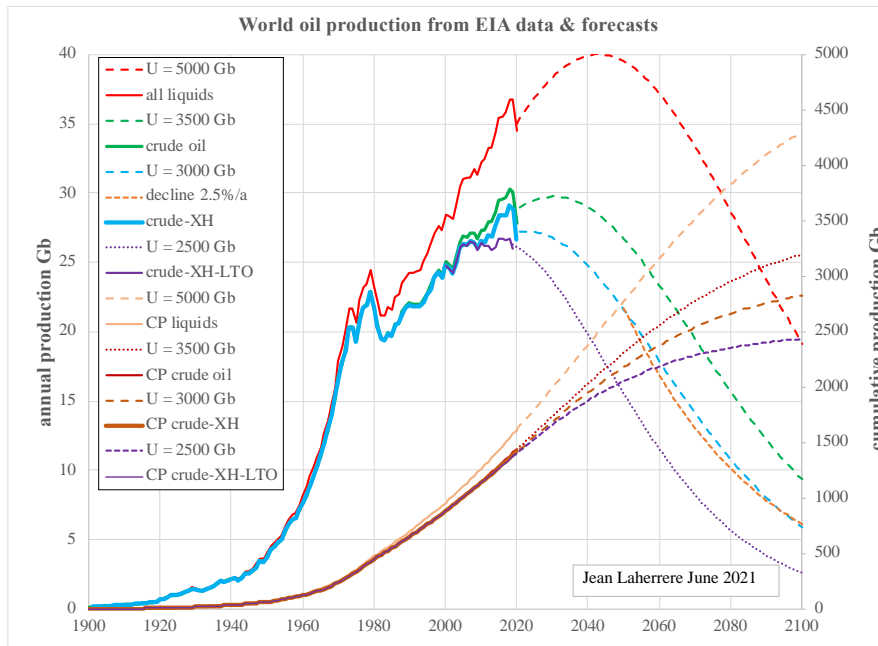
HL of past crude oil-X-LTO for the period 1993-2019 trends towards 2500 Gb

Figure 11: HL of world crude oil less XH less LTO production



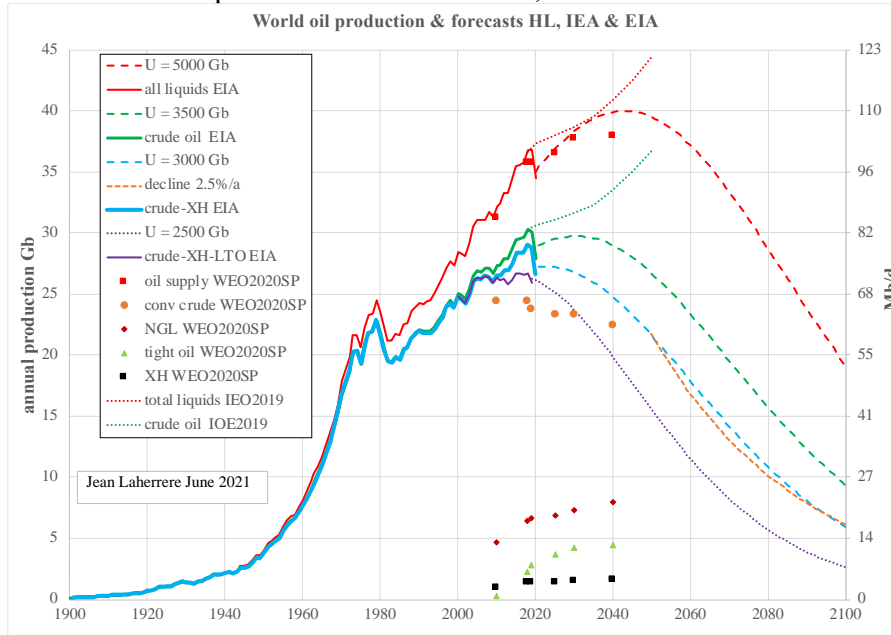
The future production of crude less XH for an ultimate of 3000 Gb means a peak in 2019 and a decline of 2%/a after 2050.

Figure 12: world oil annual & cumulative production and forecasts



The future production of oil displays a range from crude oil-XH-LTO to all liquids with peak from 2019 to 2040, from 26,7 to 40 Gb (73 to 110 Mb/d)  
 The large difference between crude oil peak and all liquids peak is due mainly to the NGL, because the gas peak will occur much later than the crude oil peak.

The comparison between forecasts by HL, IEA & EIA is interesting  
 Figure 13: world oil production forecasts: HL, IEA & EIA



IEA WEO2020SP forecasts increasing NGL, LTO up to 2040  
 EIA WEO2019 forecasts for 2050 100 Mb/d for crude oil against 73 Mb/d from HL

## Conclusions

Fake news are everywhere, starting at young age with Santa Claus, and published oil reserves to please the SEC and the OPEC members are out of reality, like Santa Claus, being political or financial, far from the technical reserves.



Since 1980 annual crude oil discoveries are lower than annual crude oil production, leading to a decline in oil real reserves, when so called proven reserves are increasing!  
The peak of conventional (excluding extra-heavy oil) crude oil is past = 2019

#### References:

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- Laherrère J.H. 2011 «Backdating is the key » ASPO 9 Brussels 27 April [http://www.aspo9.be/assets/ASPO9\\_Wed\\_27\\_April\\_Laherrere.pdf](http://www.aspo9.be/assets/ASPO9_Wed_27_April_Laherrere.pdf)  
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- Laherrere J.H. 2019 "World NGL production" June <https://aspofrance.org/2019/06/17/world-ngl-production/>

#### EIA glossary:

- Lease condensate: Light liquid hydrocarbons recovered from lease separators or field facilities at associated and non-associated natural gas wells. Mostly pentanes and heavier hydrocarbons. Normally enters the crude oil stream after production.
- Plant condensate: Liquid hydrocarbons recovered at inlet separators or scrubbers in natural gas processing plants at atmospheric pressure and ambient temperatures. Mostly pentanes and heavier hydrocarbons.
- Natural gas plant liquids (NGPL): Those hydrocarbons in natural gas that are separated as liquids at natural gas processing, fractionating, and cycling plants. Products obtained include ethane, liquefied petroleum gases (propane, normal butane, and isobutane), and natural gasoline. Component products may be fractionated or mixed. **Lease condensate and plant condensate are excluded.**