Jean Laherrere 17 March 2023

NG ultimate reserves: creaming curve, parabolic fractal, HL or decline

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-Introduction

Before drilling a new field wildcat, the geologist presents a prospect to his boss where the reserves are estimated from the volume of the structure (from seismic data: net pay multiplied by surface) multiplied by the supposed porosity, the supposed saturation, and the supposed recovery factor = volumetric method.
After discovery to decide the development of the field, the reserves are estimated running a simulation of Monte Carlo of the Net Profit Value of the cumulative production during all its life of the field which is the mean value (about 2P defined as 50% probability) using all the data from the seismic data, the wells data (logs, production, tests): it is the probabilistic method, which gives the full range of reserves proven, probable and possible.

The original reserves of the field are reduced by the field production to give the remaining reserves at one year end and many report remaining reserves forgetting to report the year.

To estimate the country reserves the aggregation of the field reserves could be wrong with an arithmetic sum for the minimum (1P) or the maximum (3P). Only the mean values (about 2P) arithmetic aggregation is correct. A probabilistic aggregation should be right, but on one knows how to do it.

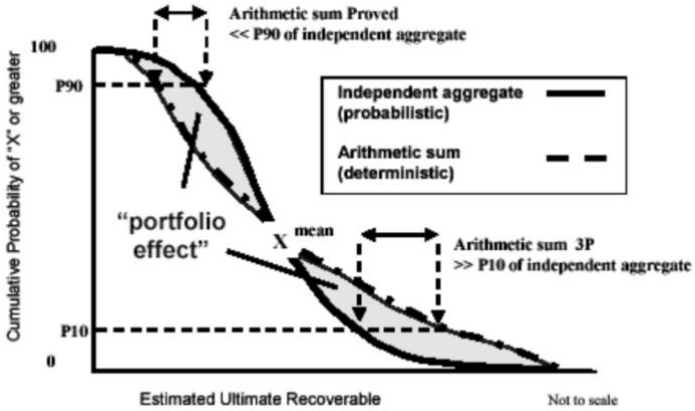


Figure 3-2: Deterministic versus Probabilistic Aggregation

https://www.researchgate.net/publication/336579041_UKERC_Review_of_Evidence_on_Global_Oil_Depletion_Technical_Report_2_Definition_and_interpretation_of_reserve_estimates

6.5 Aggregate reserve estimates can be highly misleading

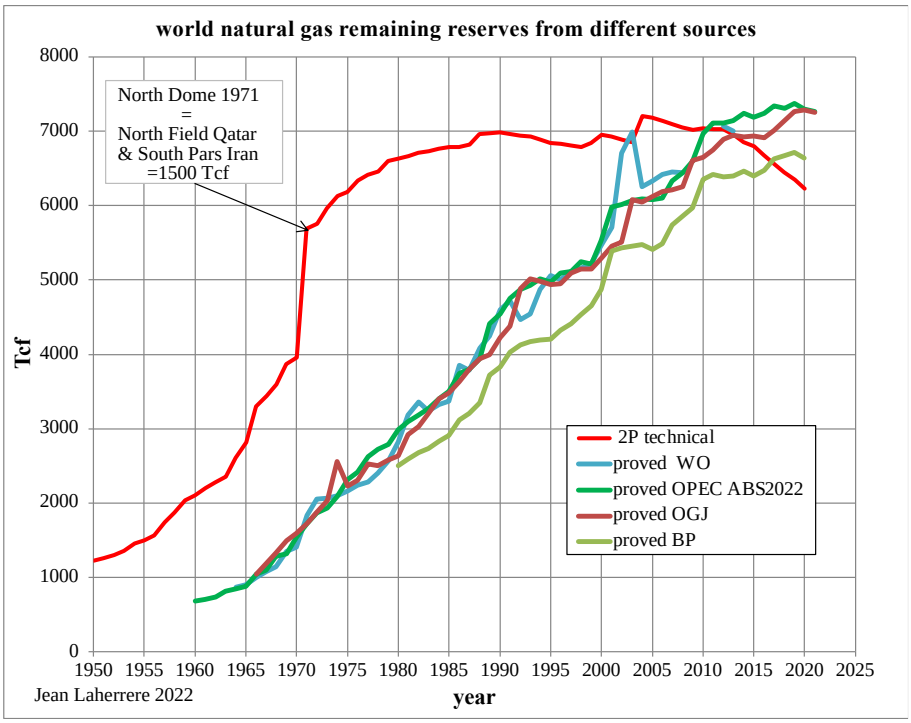
Deterministic estimates cannot be aggregated by simple addition, because the terminology used to describe them represents an underlying distribution of probability which is not removed by choosing to describe it qualitatively rather than quantitatively. Due to this probability distribution, aggregation of 1P estimates causes an underestimation of total proved reserves and aggregation of 3P estimates causes an overestimation of total proved, probable and possible reserves. Aggregation of 2P estimates correctly interpreted as the median introduces quantitatively less error, which may be positive or negative depending on the underlying probability distributions. If the 2P estimates are (incorrectly) interpreted as the mean estimate, then there will be no bias upon aggregation.

The addition of minimum field reserves is not the minimum of the country reserves because it is unlikely that all field values will be at minimum. It is as giving the same probability of getting 1 with one die (1 out of 6) and 6 with six dice (1 out of 36). Only the addition of mean (expected value) field gives the mean value of the country. Only the product of mode values (most likely) is the mean of the product.
All world proven reserves are the arithmetic sum of the country proven reserves and are then wrong. But no one objects, because no one knows how to do a probabilistic aggregation.

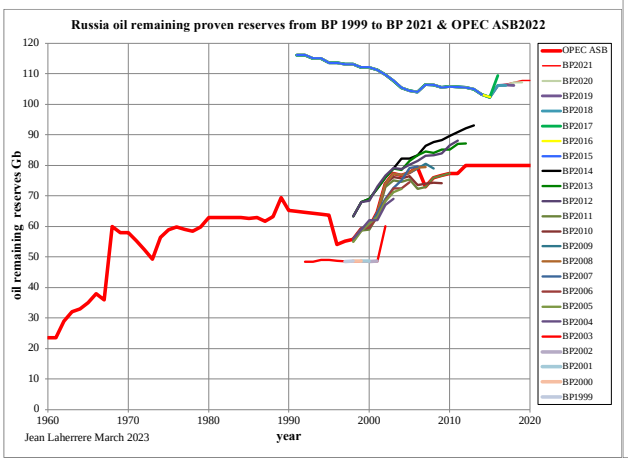
USGS reports since 2000 their undiscovered resources assessments of geologic provinces and displays the aggregation; some assessments report rightly only mean aggregation (like for the world or W Siberian), but some (like for Mac Kenzie Delta) report wrongly all aggregations for F95 (minimum) and F5 (maximum): see annex page.

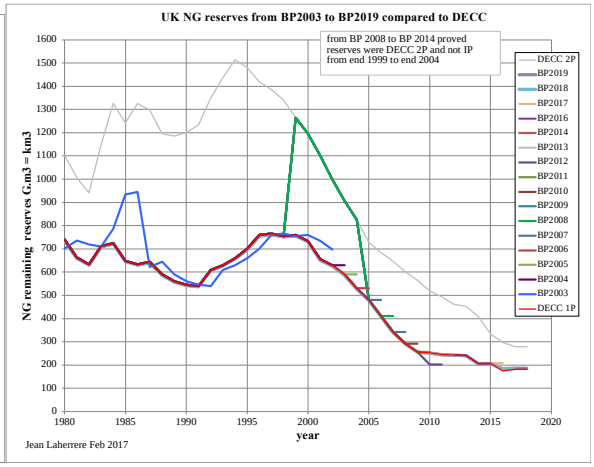
Most of proven reserves are financial (SEC rules) or political (OPEC, Russia, China) and display current growth in contrary with the backdated 2P.

The evolution of the world NG remaining current proven reserves from different sources shows a great uncertainty and a big difference with the backdated 2P reserves.



BP has decided to stop reporting their BP Statistical Reviews but some of their proven reserves data were not too reliable: Russia oil proven reserves varying sharply with time (after been thrown out of TNK) and UK gas proven reserves from 2008 to 2014 where they reported DECC 2P data instead of 1P: more than 6 years to find that BP was confusing 2P and 1P for the only country where the data is public and every one can find it on the web immediately: BP is guilty but also all the readers!





Only the producers know well the volumes of reserves that they will produce, and they want to keep the data confidential, but the rules are not the same everywhere on publishing reserves.

In the US oil and gas reserves are owned by the owner of the land, when in the rest of the world oil and gas reserves are owned by the State: two different worlds!

US landowners, as States without a national oil and gas company, sign agreement with oil and gas companies to explore and produce. But, as exploration is risky, very often agreement is signed not with one oil company but several oil companies. It is why many sources have the right data, but it is kept confidential.

Oil and gas producers listed on the US stock market (almost all major) are obliged by the SEC to report proven reserves (close to a minimum estimate). But the real data is the 2P = proven + probable (mean value) reserves

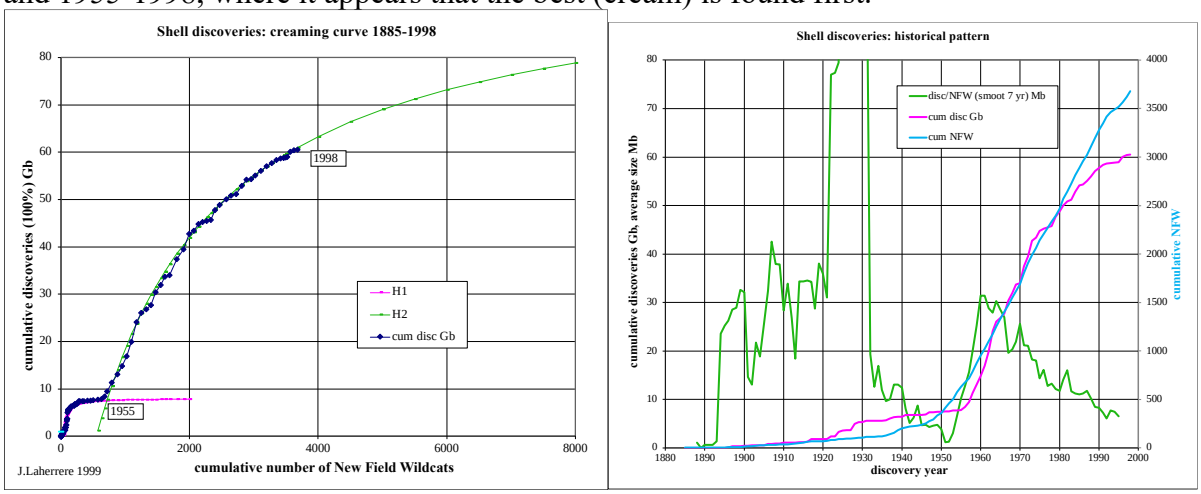
The only way to obtain the confidential (by their producers) 2P reserves data is to buy expensive reports from scout companies as IHS or Rystad, but their data need correction for OPEC and former URSS countries. (ABC1 = 3P are reported as 2P).

To forecast future production, it is necessary to know the present discoveries, but also the ultimate, being known discoveries + "yet to find".

The "yet to find" could obtained by the extrapolation of past discoveries using creaming curves.

-Creaming curves

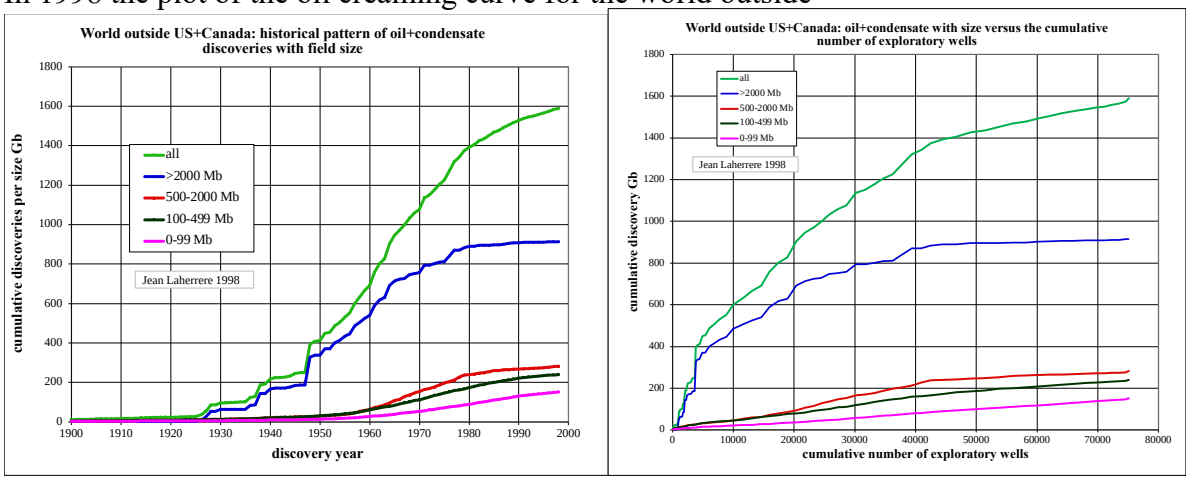
The term "creaming curve" was introduced by Shell which models Shell cumulative oil discoveries (1885-1998) versus new field wildcats modeled with two parabolas 1885-1955 and 1955-1998, where it appears that the best (cream) is found first.



Creaming curve could be extrapolated to the double of present NFW to estimate the ultimate reserves.

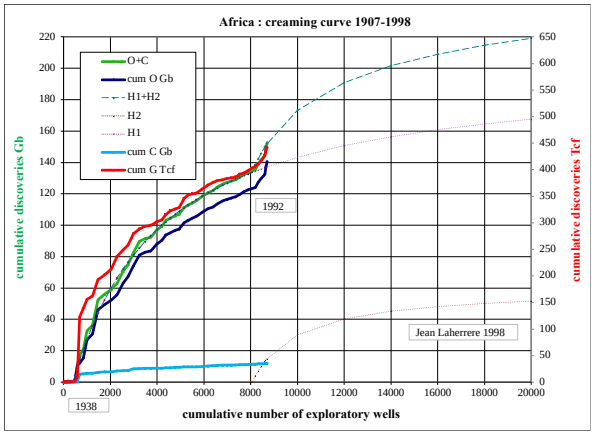
-Creaming curve in 1998

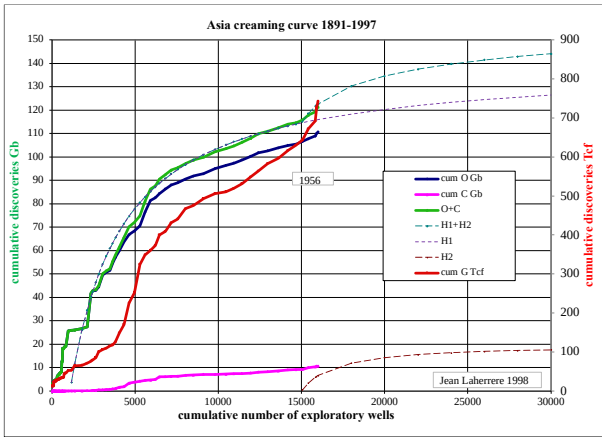
In 1998 the plot of the oil creaming curve for the world outside



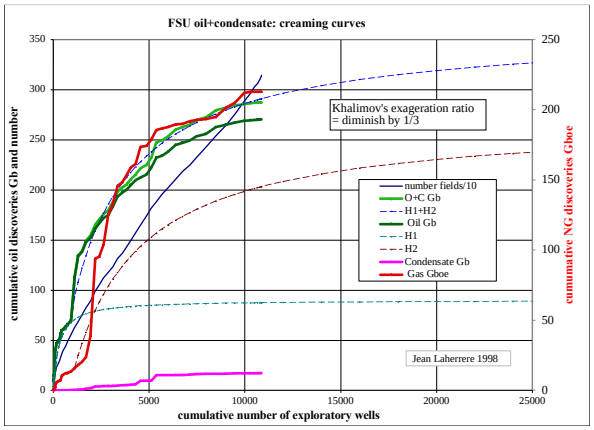
The curve of the largest fields (>2Gb) is flattening, contrary with the smaller fields.

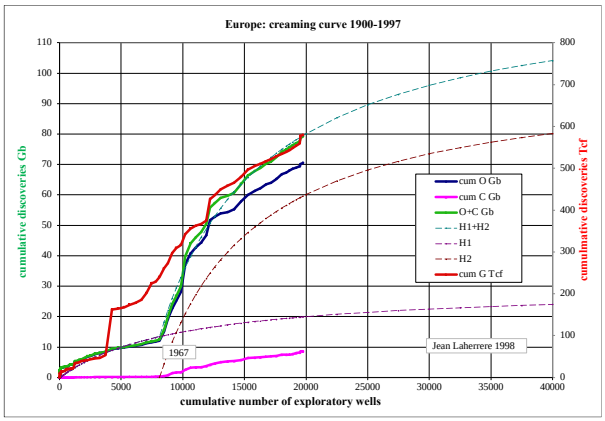
For oil, NG and condensate new discoveries for the continents: Africa and Asia display new potential of growth.

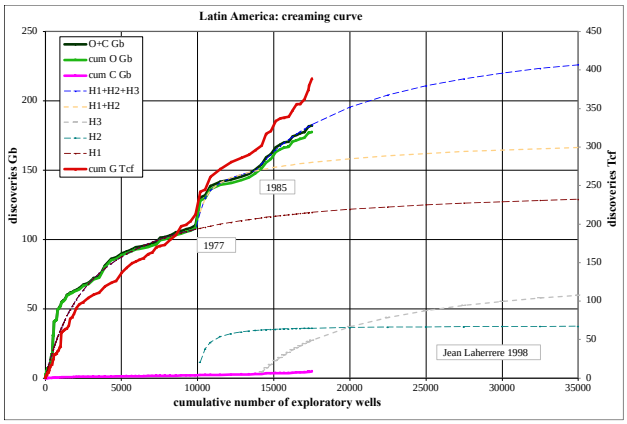


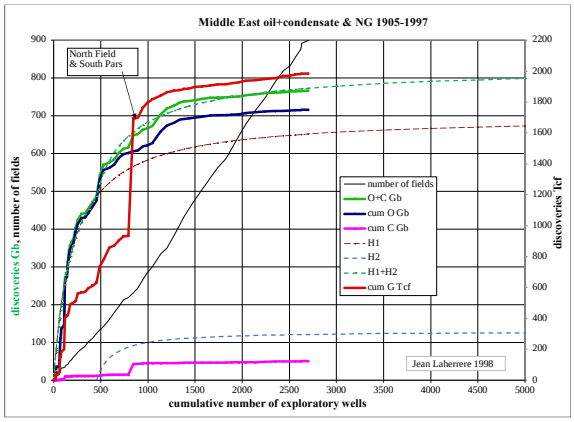


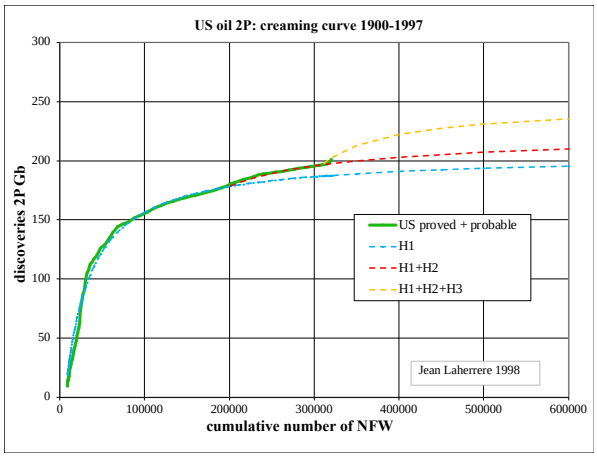
but not FSU

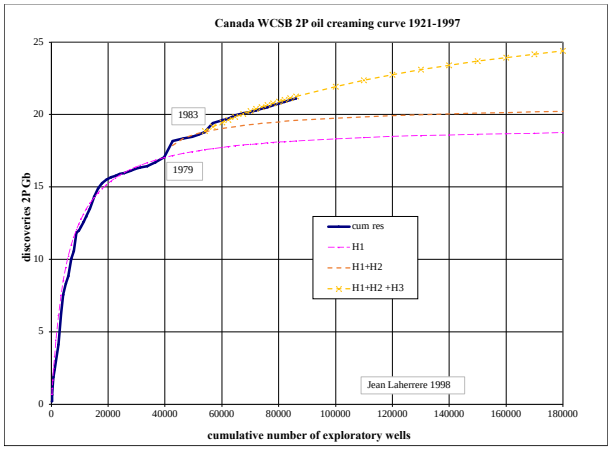








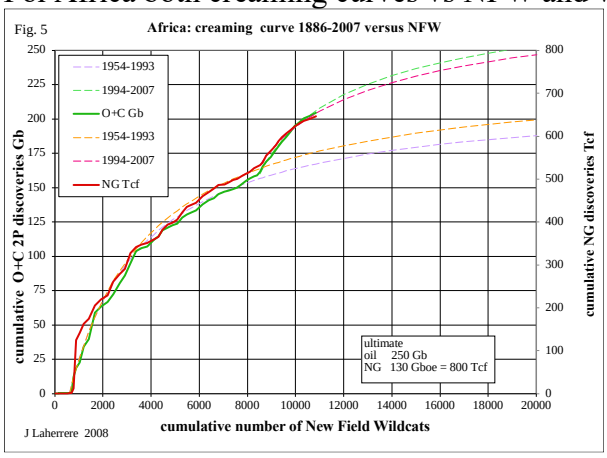


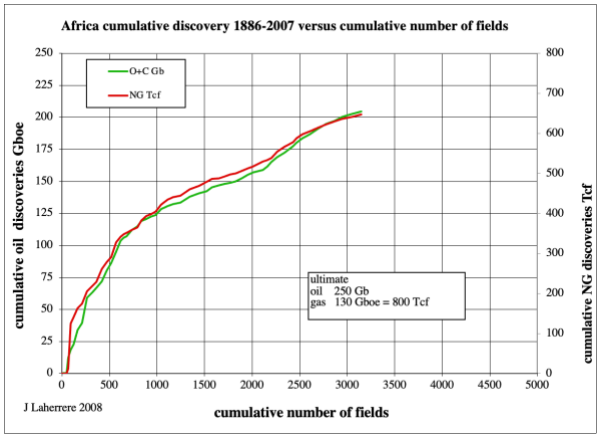


-creaming curves in 2008

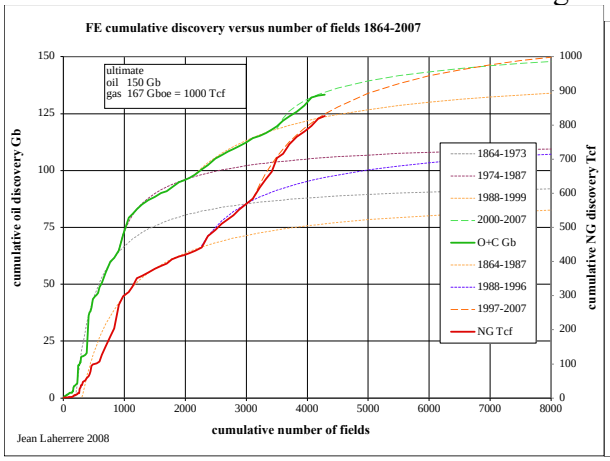
For the country production forecast, my first papers were based on a creaming curve of backdated 2P, first cumulative real 2P discoveries versus cumulative number of NFW (New Field Wildcat), later, as NFW data was wrong in China, versus cumulative number of fields, as in 2008 where ultimate is taken as the extrapolation of the creaming curve for the double of present fields.

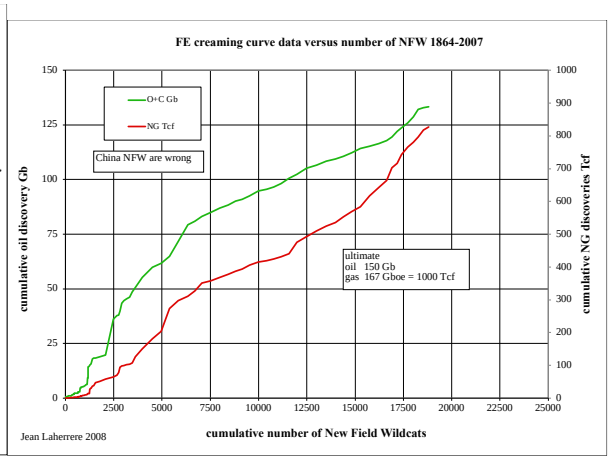
For Africa both creaming curves vs NFW and vs fields are very similar.





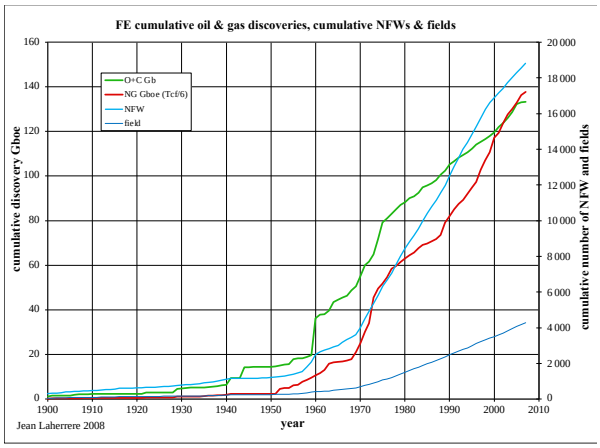
It is not the case for Far East because wrong NFW in China after 2000

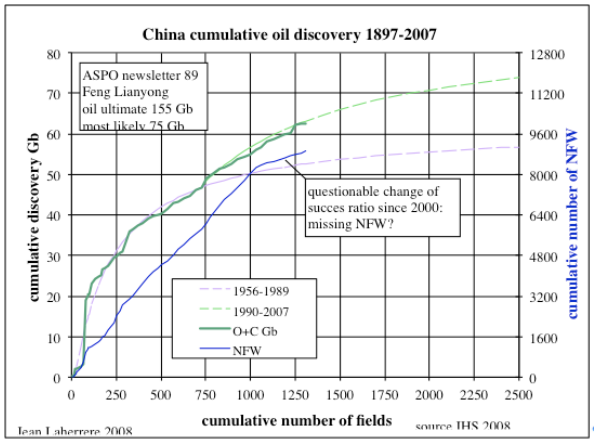




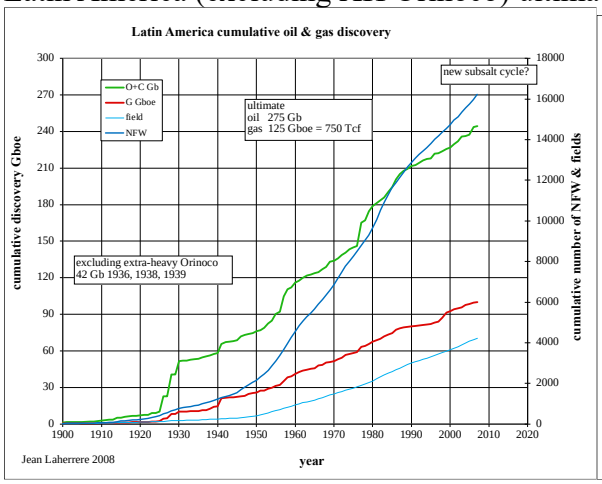
China NFW are wrong after 2000. Chinese born American IHS geologist Xue Feng, trying to get the Chinese right data (state secrets!) was jailed in 2008 for 8 years for espionage https://en.wikipedia.org/wiki/Xue_Feng)

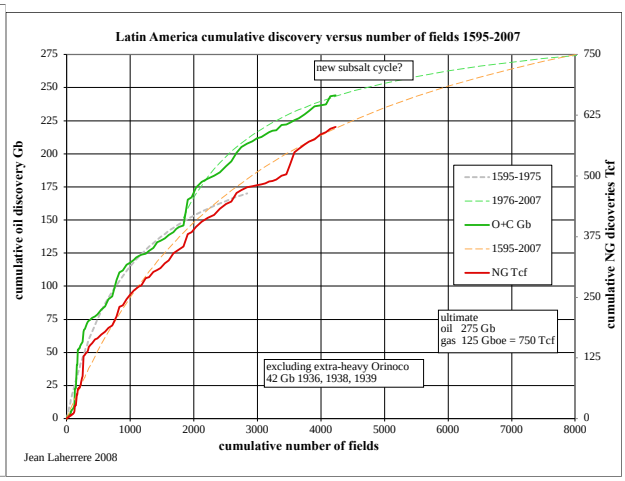
Oil and gas reserves in Russia were considered "state secrets" until 2013.



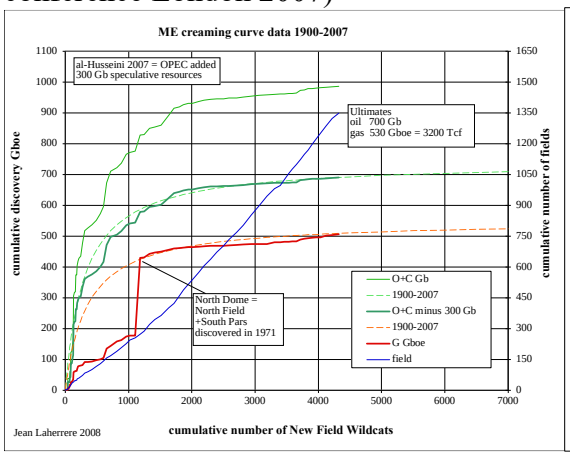


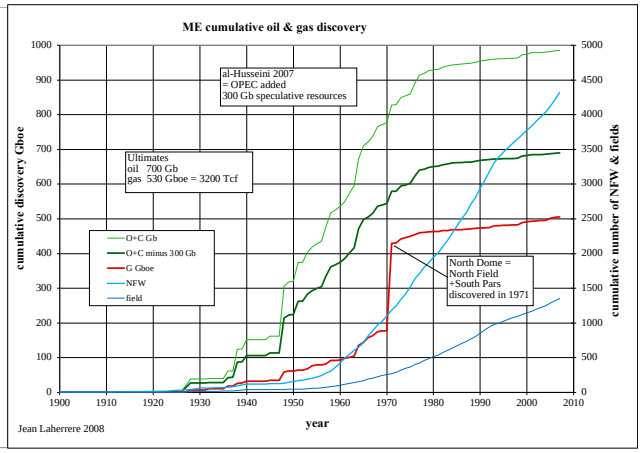
Latin America (excluding XH Orinoco) ultimates are estimated 275 Gb and 750 Tcf



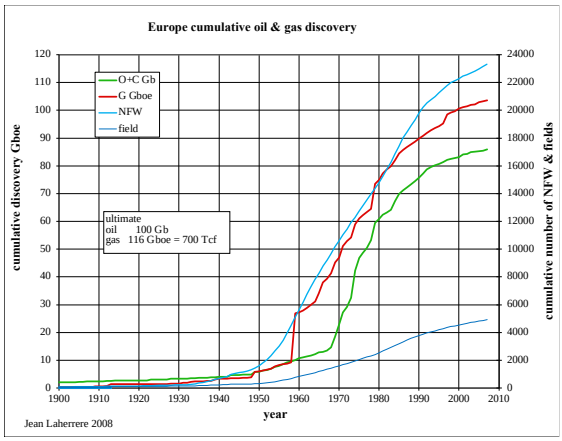


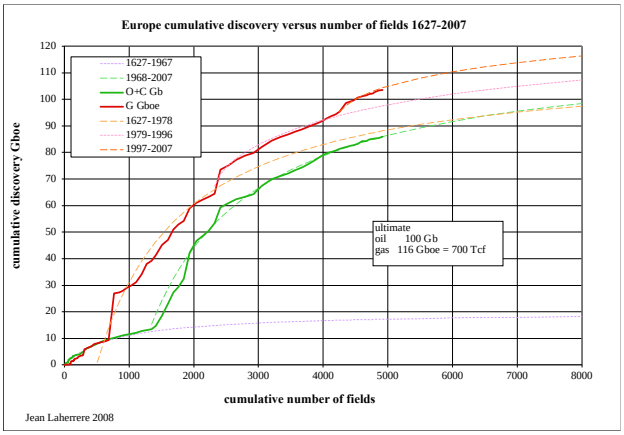
Middle East (excluding 300 Gb of speculative resources (Sadad al-Husseini Oil & money conference London 2007)



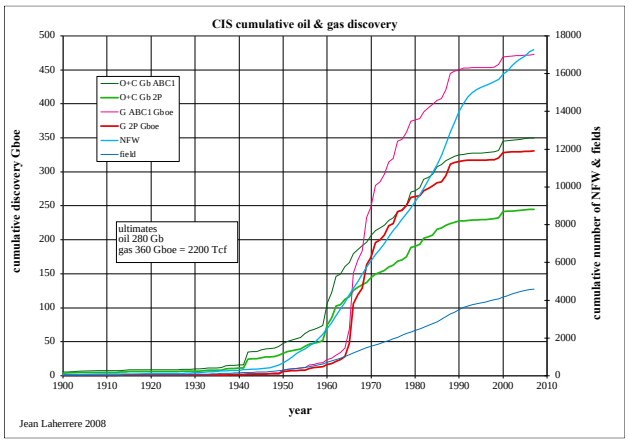


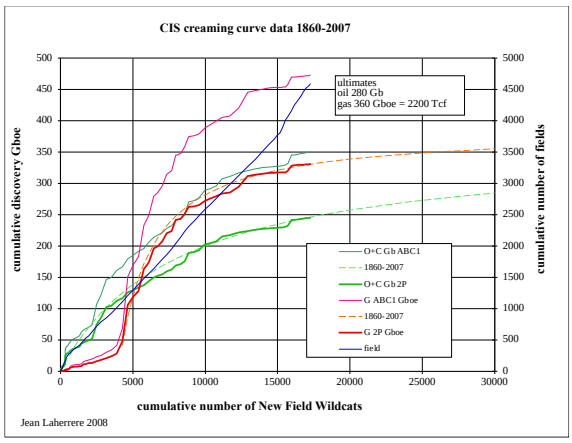
Europe ultimates are estimated 100 Gb and 700 Tcf



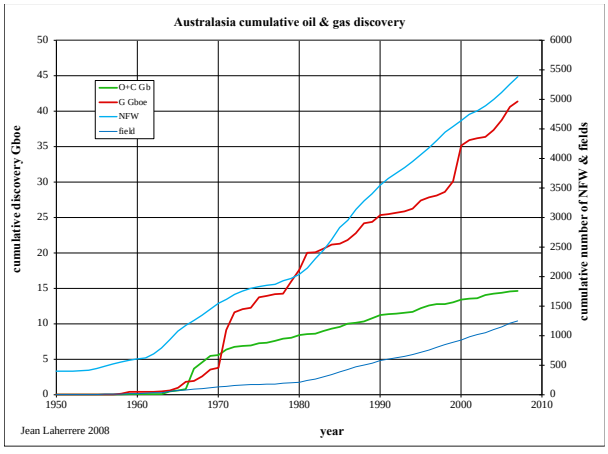


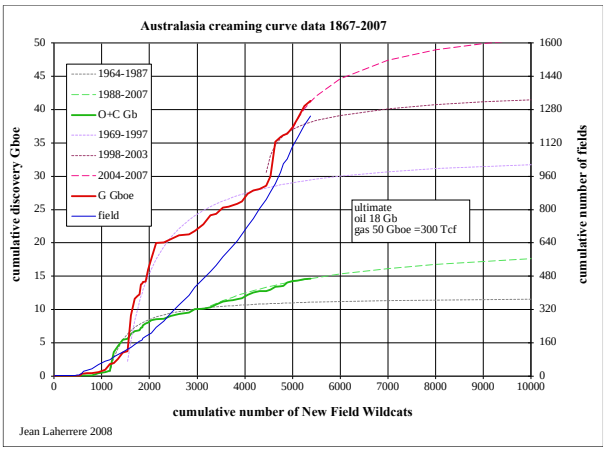
The Commonwealth of Independent States (CIS) was created in December 1991 by eleven countries from the ex-USSR: Armenia, Azerbaijan, Belarus, Kazakhstan, Kirghizstan, Moldavia, Uzbekistan, Russia, Tajikistan, Turkmenistan, Ukraine. Georgia joined it in December 1993.
CIS reserves data are corrected as being under Russia classification ABC1 (and not 2P) and should be corrected.



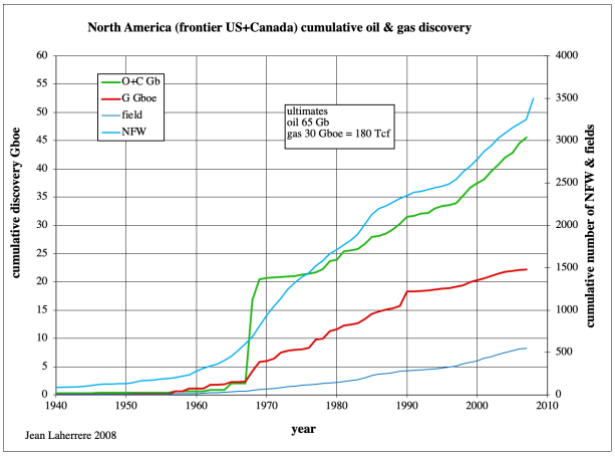


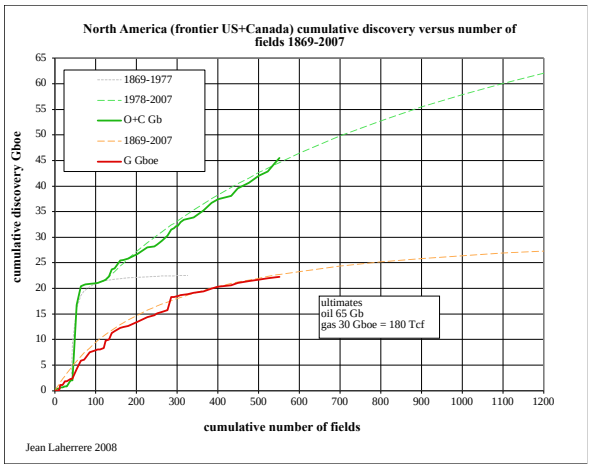
Australasia ultimates were estimated at18 Gb and 300 Tcf



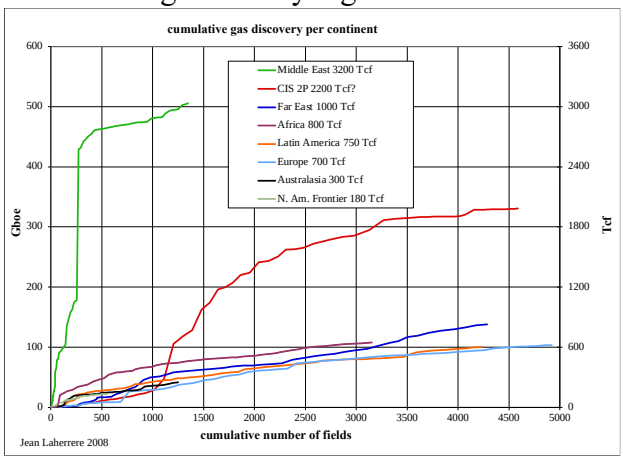


North America frontier US + Canada ultimates were estimated at 65 Gb and 180 Tcf

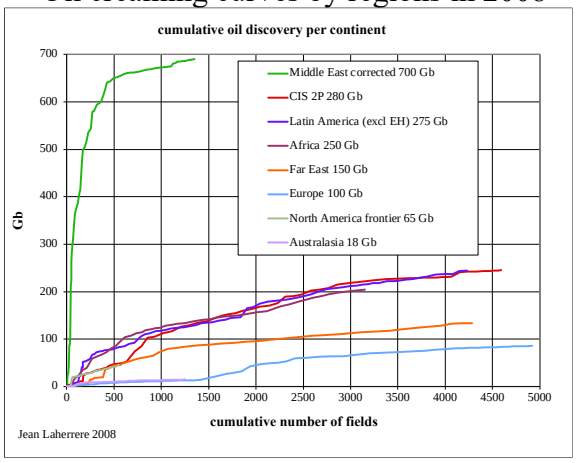




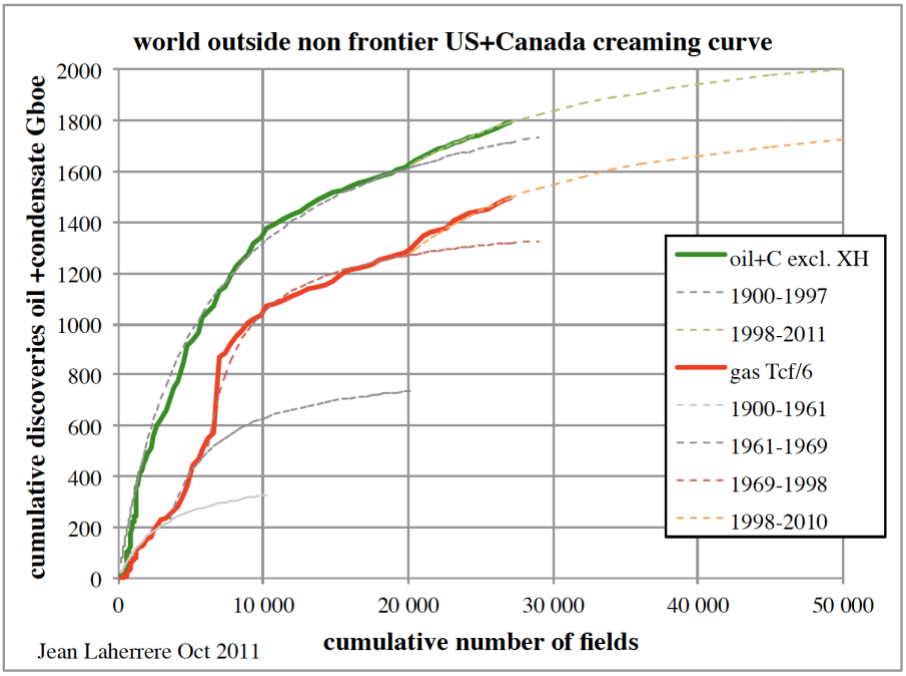
NG creaming curves by regions in 2008



Oil creaming curves by regions in 2008

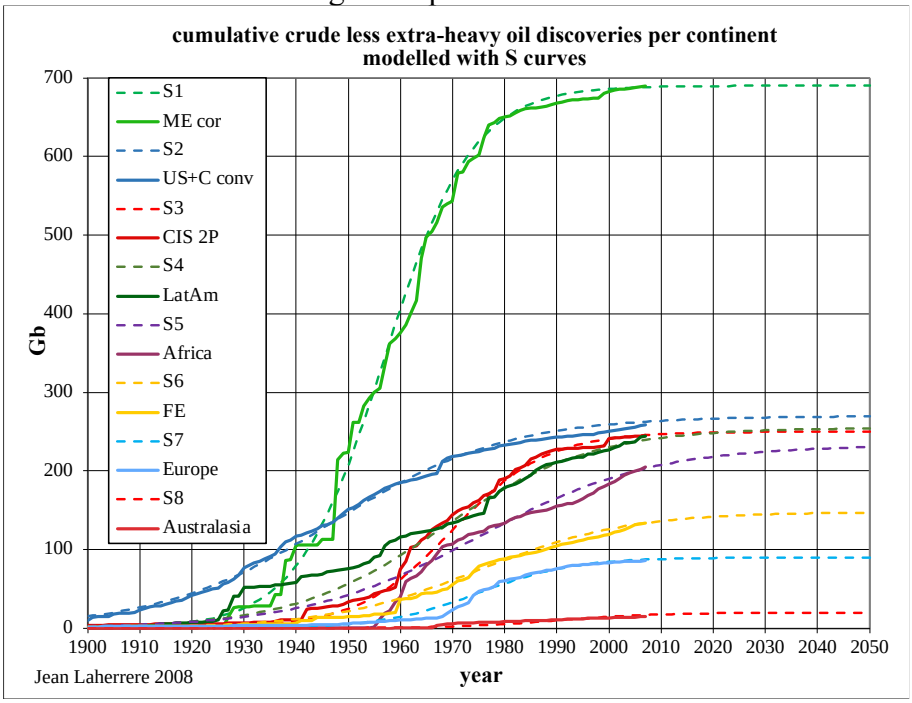


World outside non frontier US + Canada in 2011

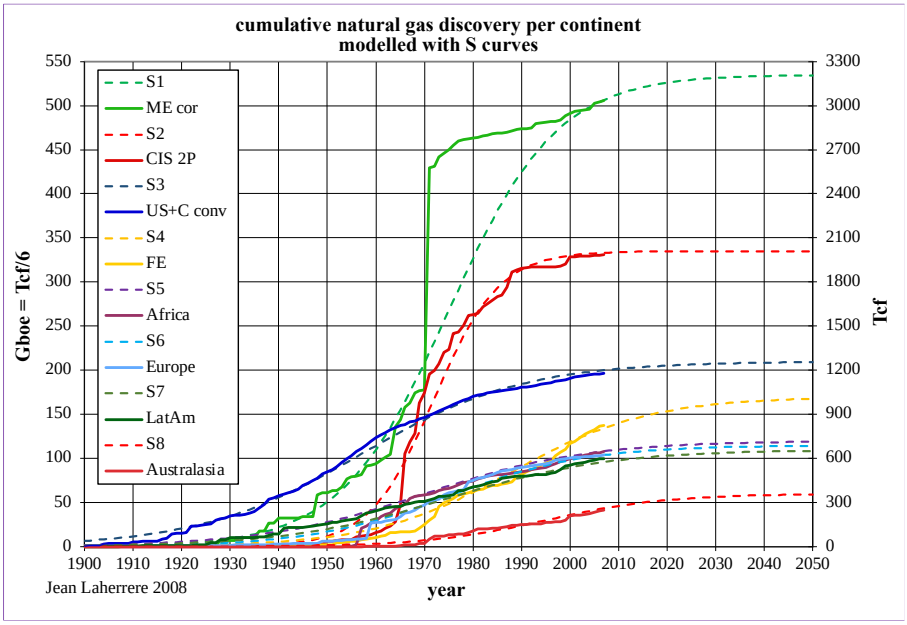


-S curve in 2008

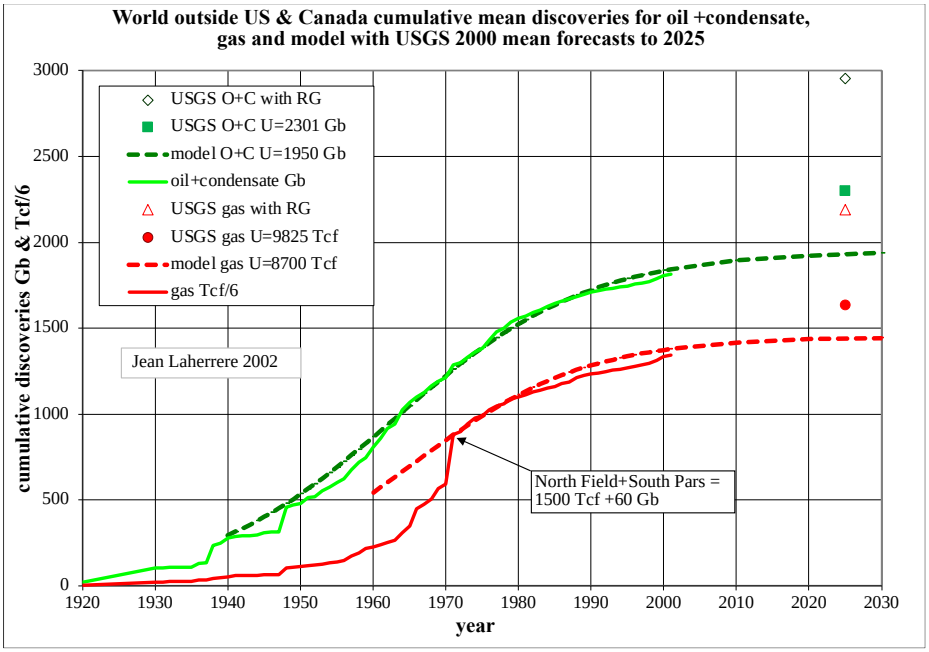
If creaming curves can be modelled with hyperbolas as above, cumulative discoveries versus time can be modelled with S curve logistic equation.



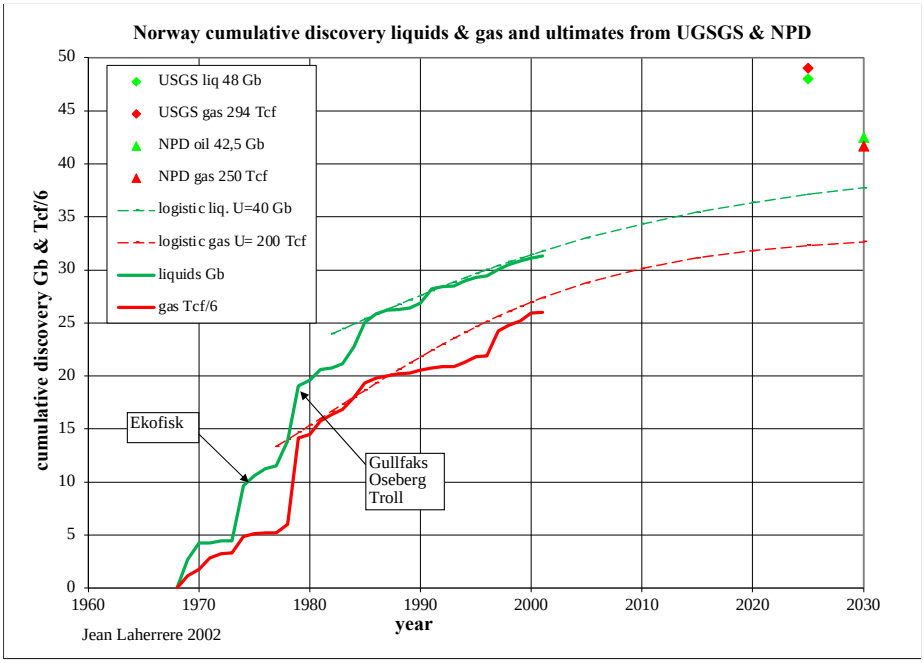
It appears that most of the crude oil discoveries in 2008 were close to the ultimates.
Same for the NG discoveries.



In 2002 I was comparing the world cumulative mean discoveries displayed with S curves with USGS 2000 assessment (see page 3) with reserve growth (RG) and without
USGS estimate without reserve growth was more optimistic than my estimate for oil, the USGS estimate with reserve growth is for me unrealistic.
For NG I find today that I was too pessimistic and USGS was right!



In 2002 I did the same comparison for Norway with USGS forecast for 2025 and NPD forecast for 2030: NPD was closer with me than with USGS!



-Present creaming curves

Every oil and gas company listed on the US stock market is obliged to respect SEC financial rules on reserves (almost everyone outside OPEC) and to report only proven current reserves (on deterministic approach = reasonable certainty to exist (without any definition of reasonable, on probabilistic = 90 % probability) with the price of the year and not on future price for future production)

As reported page 2, within a probabilistic approach it is well known that the sum of proven field reserves of a country is not the proven reserves of the country but less because the aggregation assumes that all fields are at minimum. Only the aggregation of mean reserves (about 2P reserves) is right.

The open file USDOE/EIA-0534 1990 "US oil and gas reserves by year of field discovery" reported backdated US data and was supposed to be the first one of future open files, but the 0534 report was censured and was the last open file on reserves!
https://digital.library.unt.edu/ark:/67531/metadc1182481/m2/1/high_res_d/6596157.pdf

EIA Introduces New Oil and Gas Reserves Report

The Energy Information Administration (EIA) has released the first of a series of periodic statistical reports presenting comprehensive information about the Nation's reserves of crude oil and natural gas. This report, *U.S. Oil and Gas Reserves by Year of Field Discovery*, illustrates the development and depletion of U.S. crude oil and natural gas resources over the history of the industry.

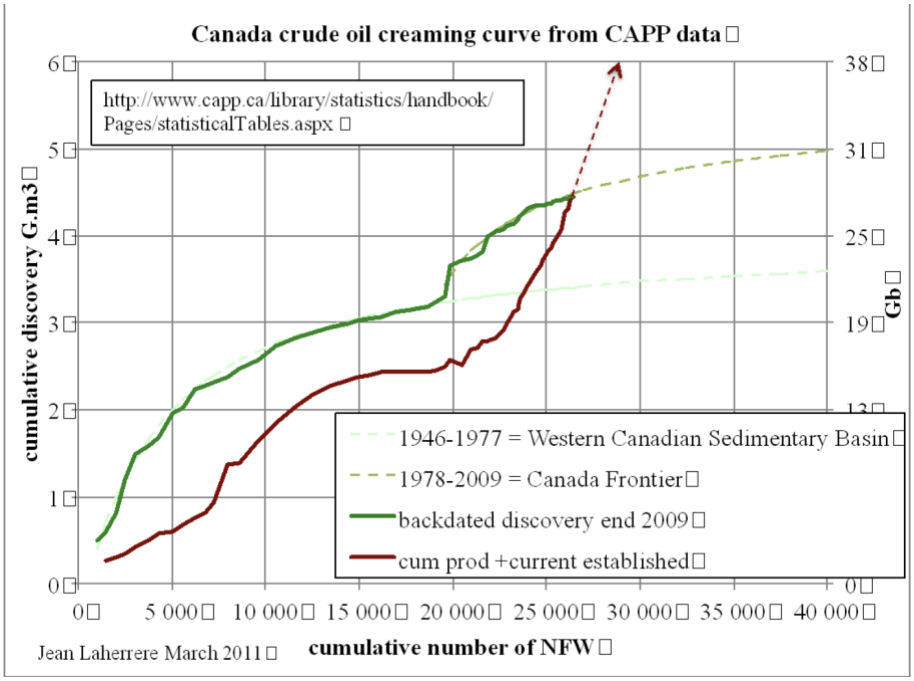
Included in the publication are statistically produced estimates of total discovered domestic crude oil and natural gas reserves, termed "ultimate recovery," for groups of fields discovered each year between 1900 and 1988. Reserves credited to the period between the first U.S. oil field discovery (in 1859) through the year 1899 are shown in the aggregate. Also presented for each year-of-discovery vintage are the components of ultimate recovery, cumulative production (reserves previously produced), and proved reserves (reserves yet to be produced). Annual production and counts of identified oil and gas fields are indicated for each vintage as well.

The publication presents the full set of year-of-discovery oil and gas reserves estimates for the most current year (1988) available, but only a sample of data for prior years; therefore, a set of two computer diskettes is offered, presenting the full set of estimates for both the current year and for the 11 prior years. The 5 1/4 inch, MS-DOS/PC-DOS compatible diskettes (file type: ASCII) may be requested by calling the National Energy Information Center on (202) 586-8800.

Subsequent reports in this EIA series will provide distributions of U.S. oil and gas fields by size and depth. Also to be included will be technical factors descriptive of the geologic occurrence of hydrocarbons, such as the structural trap type, geologic age, rock porosity of the reservoir, and the quality of the hydrocarbon deposits.

This censure of true oil and gas reserves data is contrary to the US Freedom of Information Act FOIA!

CAPP in Canada was reporting backdated reserves and in 2011 I published «Backdating is the key » ASPO 9 Brussels http://aspofrance.viabloga.com/files/JL_ASPO2011.pdf, showing the extrapolation of current reserves was too optimistic compared with the extrapolation of backdated reserves.



The result was that CAPP stopped reporting established reserves by year of discovery 1947-2009; it is a pity!

Reserves

-GoM (Gulf of Mexico federal waters) data

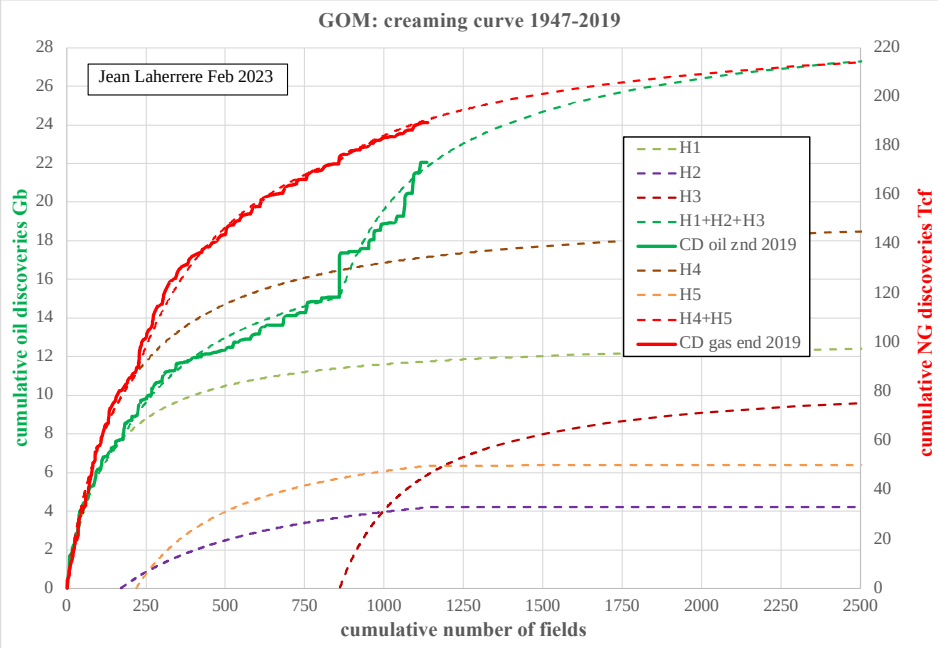
In contrary BOEM in charge of reporting data on federal waters decided in 2014 to report GoM 2P backdated reserves following the SPE rules instead of proven current reserves following the financial obsolete SEC rules (see The Tragedy of 21 Darts" Altendorf http://www.cwsx.org/21darts.pdf).

BOEM is today (with UK) the only place in the world reporting freely reliable 2P data on reserves by field.

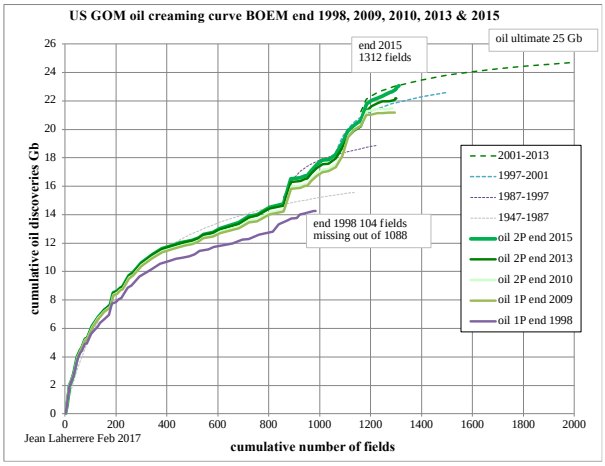
The GoM 1947-2019 creaming curve can be very well modelled with 2 or 3 hyperbolic curves.

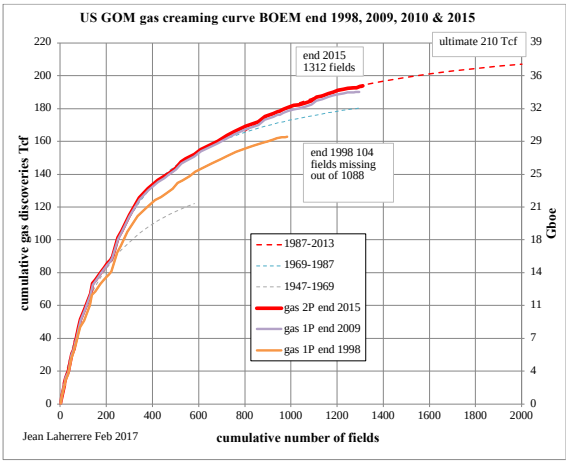
The GoM is the best place to study evolution of reserves, because the reliability of the reserves, despite the complexity of trapping with the salt tectonic.

The ultimate reserves are estimated with the extrapolated model for a number of fields double of the present number: 27 Gb for crude oil + condensate and 210 Tcf for NG.

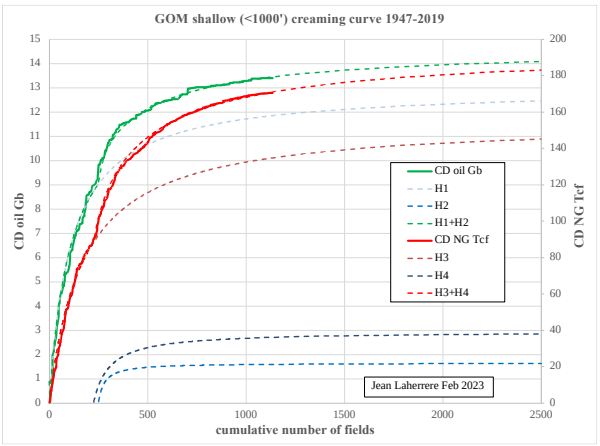


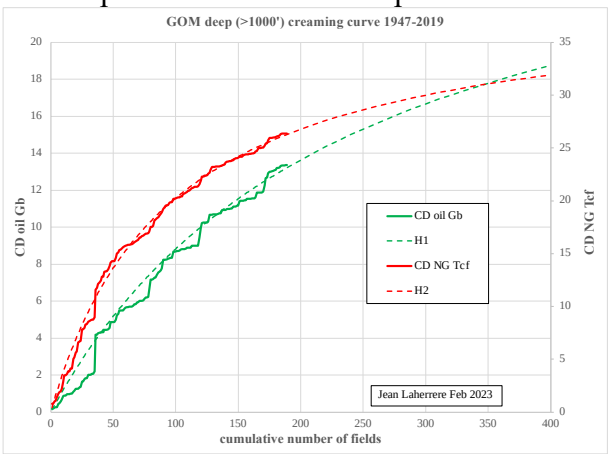
These ultimates are similar to those estimated from end 2015 data.





The GoM shallow water (<1000') creaming curve is very well modelled with 2 hyperbolas (1947-1970, 1971-2019) both for oil and for NG leading to ultimates of 14 Gb for oil and 180 Tcf for NG. There are more NG in shallow waters compared to oil than in deep waters.

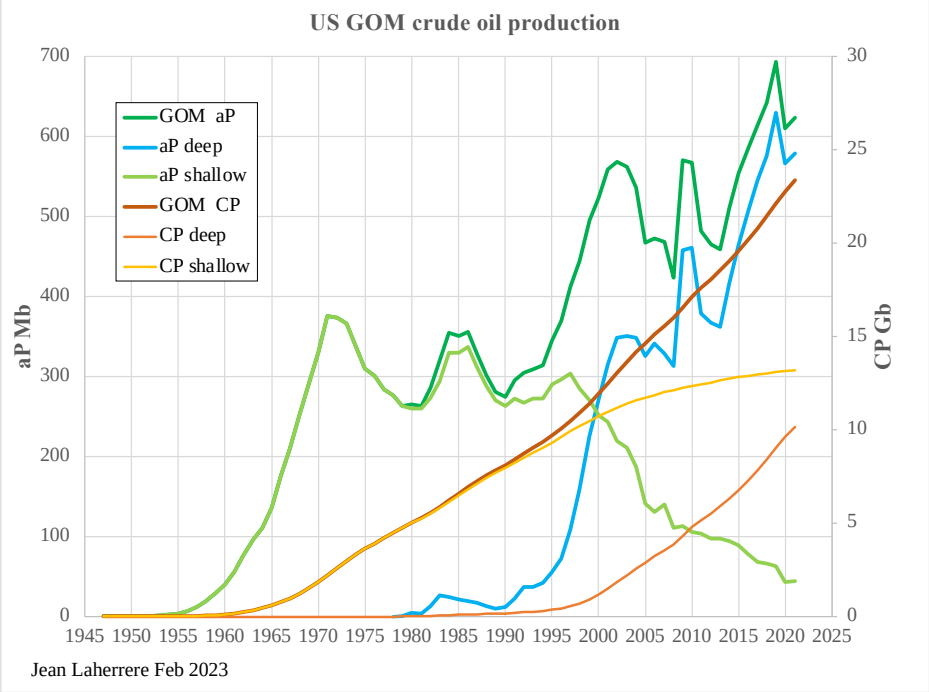




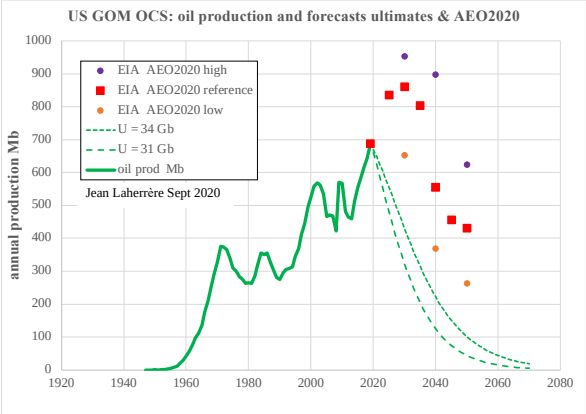
The GoM deep water (>1000') creaming curve is modelled only with one hyperbola leading to ultimates of 18 Gb and 30 Tcf.

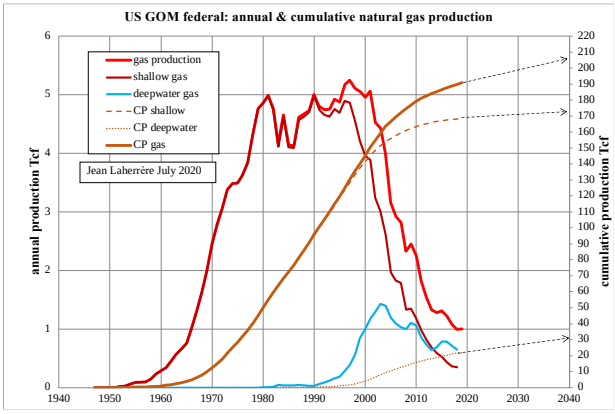
Adding shallow and deep gives a total of 32 Gb and 210 Tcf compared to the global 27 Gb and 210 Tcf. Deepwater is more complex for oil than for NG.

GOM deep oil production displays a very sharp rise from 1990 to 2019 when shallow oil production is decreasing since 1997.



In 2020 GOM crude oil and NG production





-parabolic fractal distribution for the GOM

In my old papers I have displayed many examples of parabolic fractal distribution for oil and gas reserves, earthquakes, galaxies, urban agglomerations and incomes.

“Distributions de type fractal parabolique dans la Nature”- Comptes Rendus de l’Académie des Sciences- T.322 -Série IIa n°7-4 Avril 1996 p535-541

http://www.oilcrisis.com/laherrere/fractal.htm

"Assessing the oil and gas future production and the end of cheap oil ?" CSEG Calgary April 6 1999 http://dieoff.com/page179.htm

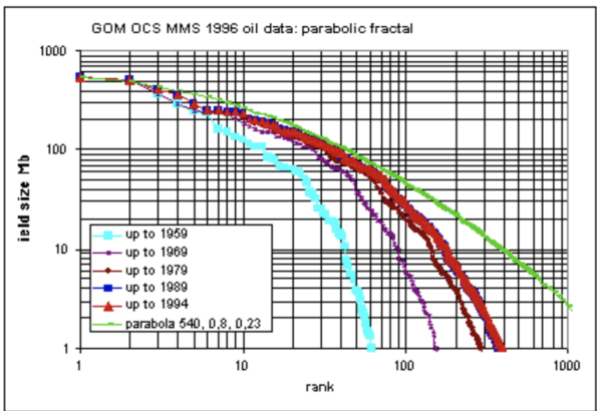
"Parabolic fractal, creaming curve improve estimate of US Gulf reserves" Offshore Magazine May 1999 p113, 114, 177

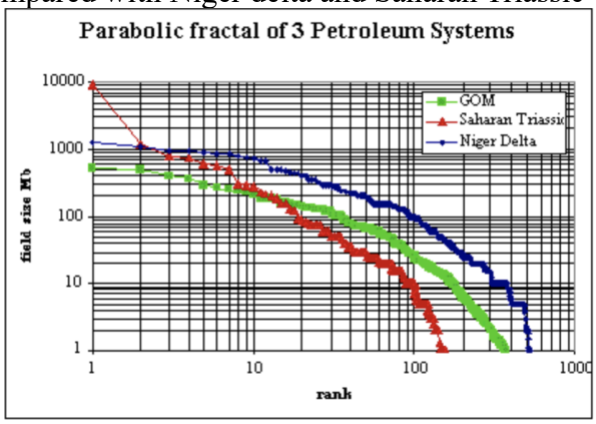
" Distribution of field sizes in a Petroleum System: lognormal, parabolic fractal or stretched exponential?" Marine and Petroleum Geology 17/4, April 2000, p539-546

http://www.elsevier.nl/cgi-bin/cas/tree/store/jmpg/cas_free/browse/browse.cgi?year=2000&volume=17&issue=4

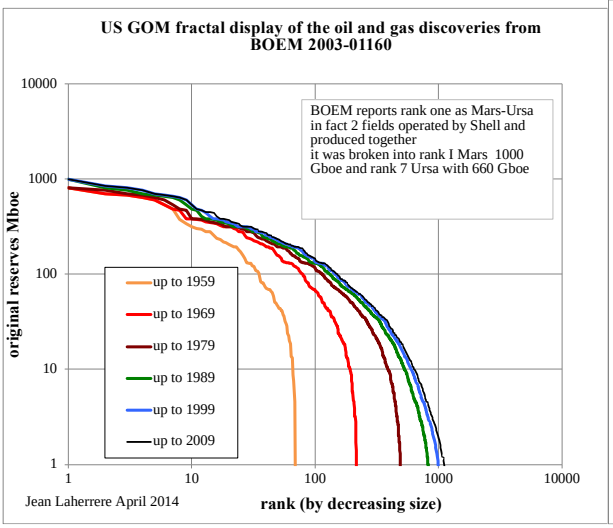
”King effect” in parabolic fractal distributions” 23rd Internat. Conference on Mathematical Geophysics « Extreme earth events » Villefranche June 18-23 2000

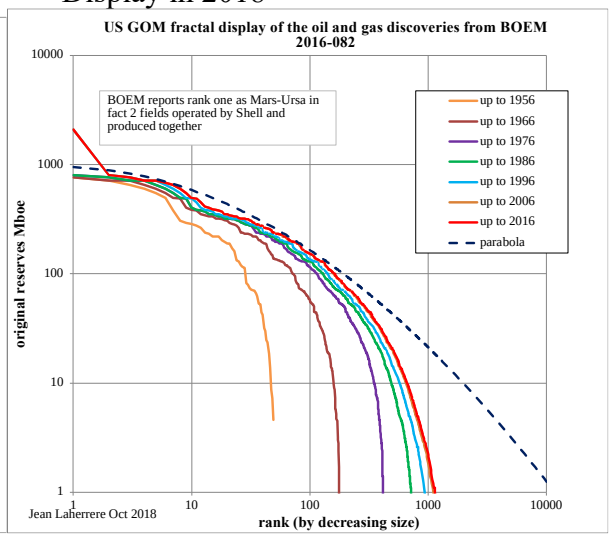
Display of GoM in 1999 compared with Niger delta and Saharan Triassic



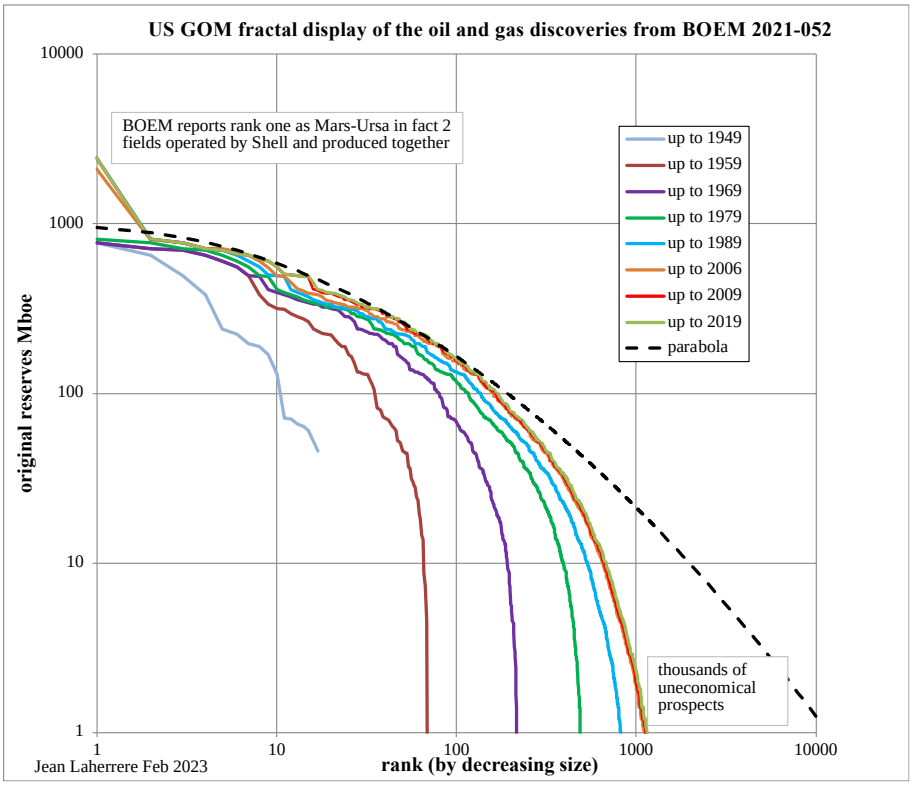


Display in 2014 Display in 2018



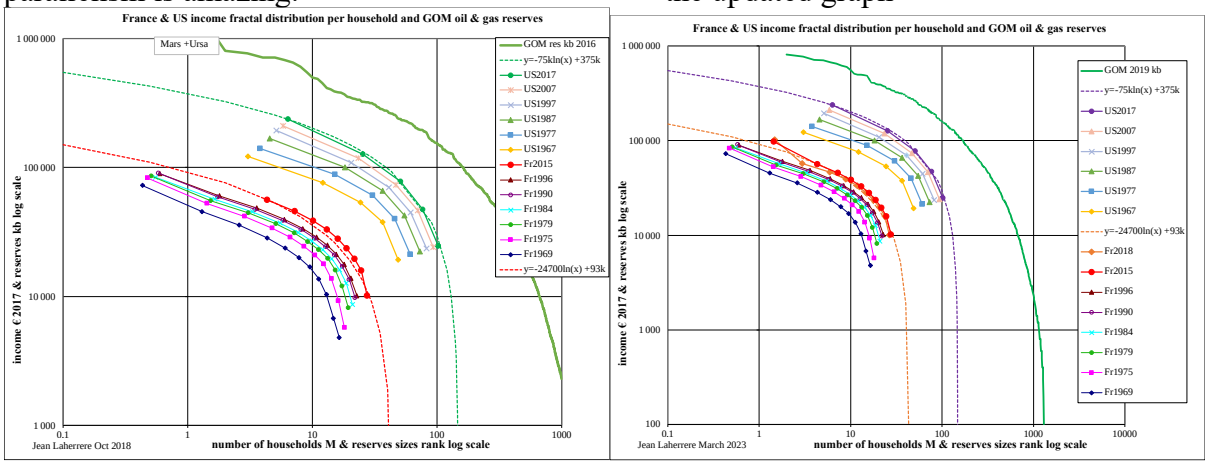


Display in 2023 of GOM oil and gas discoveries disturbed by the rank one being two fields = Mars and Ursa produced together.



The great majority of large fields has been found and the graph shows that thousands of uneconomical fields exist in the ground which will not be drilled.

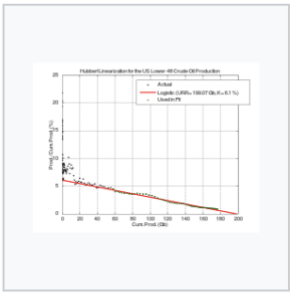
In 2018 in a fractal display I compared France & US incomes with GoM reserves and the parallelism is amazing. the updated graph



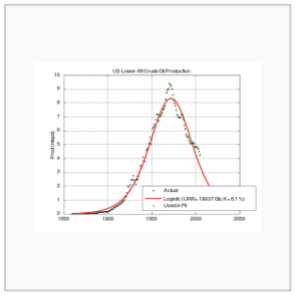
The fractal income distribution in US is parallel with the one in France, the only difference is the number of households, but it is amazing to find a similar parabola with the oil & gas GoM fields.

-Extrapolation of past production data = HL

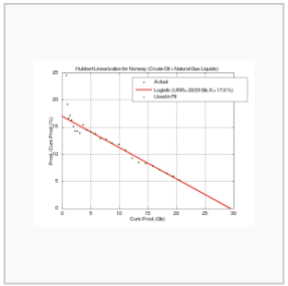
The so-called Hubbert linearization (HL), as reported by Deffeyes, is explained on this site https://en.wikipedia.org/wiki/Hubbert_linearization



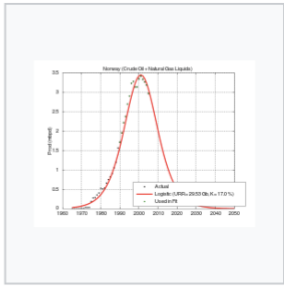
Hubbert Linearization on US's oil production



Hubbert curve on US's oil production



Hubbert Linearization on Norway's oil production



Hubbert curve on Norway's oil production

HL is the only way (outside the volumetric approach) to estimate ultimate reserves before peak from production data. The problems are that, for many countries, there are several production peaks and, even for one peak, that HL is often not linear.
Trying to extrapolate, not a linear plot, but a hyperbolic curve is inaccurate, and it is harder to estimate the range of accuracy.
After peak the annual production in decline can be also linearly extrapolated if even values to estimate the ultimate reserves. Decline ultimate estimates are often higher than HL estimates but it is often some help to plot HL. Both are plotted in the following graphs.
HL should be using production data from start of production, any extrapolation of data not from the beginning of production gives wrong result.

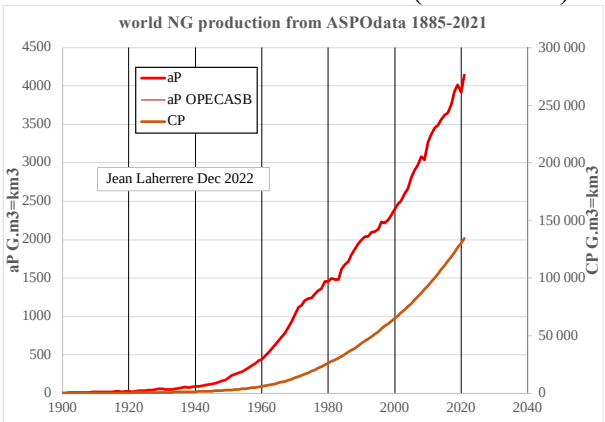
-ASPOFrance data

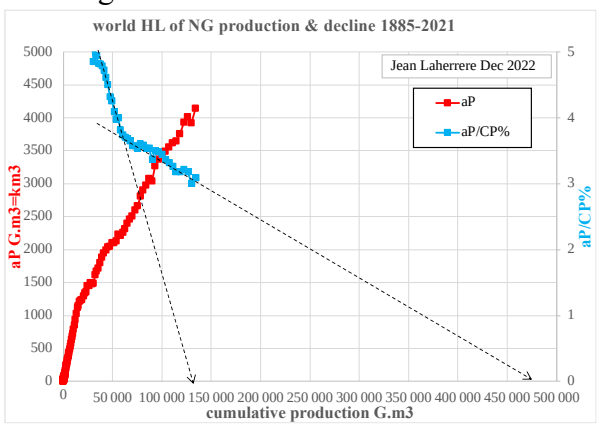
ASPOFrance data reports the NG marketed production since 1900, but US production started in 1885 and this US previous production is added.
The unit is the billion of cubic meter = 10^9 m^3 = Gcm = $G.m^3$ = km^3
As the prefix G is included in the cube exponent, some use for 10^9 m^3 , wrongly $Gm^3 = 10^{27}$ m^3

I have selected the regions and the best countries to display annual & cumulative production, as aP/CP% & annual production versus cumulative production from start to 2021.

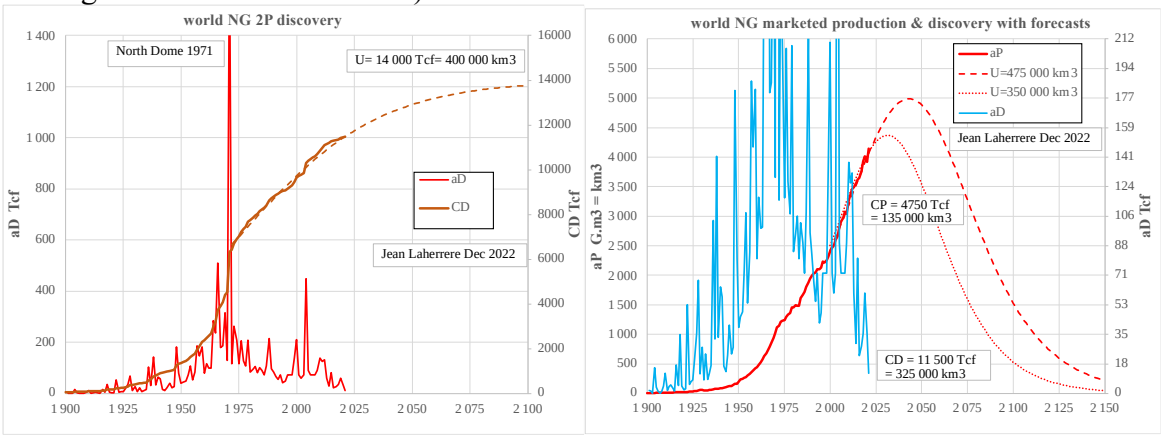
-world

HL of the world NG marketed production could be fairly extrapolated for the last 25 months to an ultimate of 475 000 G.m3 (17 000 Tcf) with a range of a least 450 000- 500 000 G.m3.



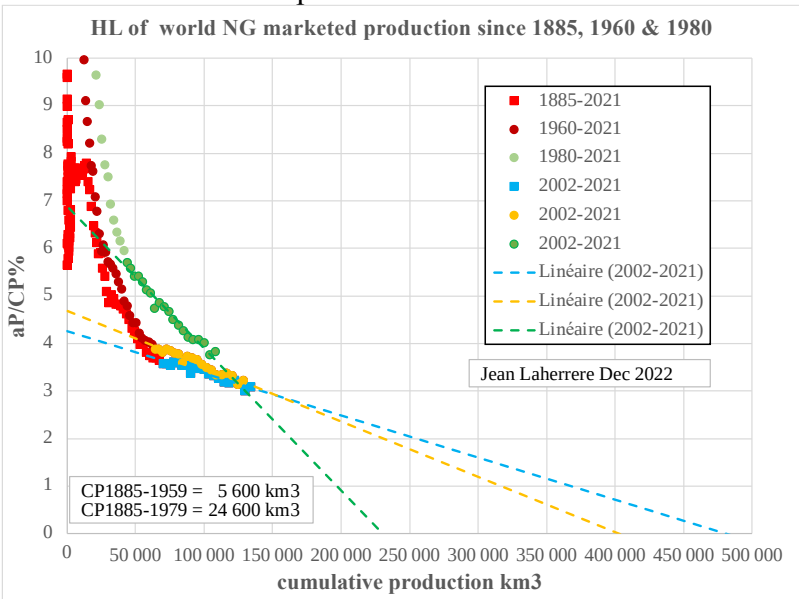


The problem is that the world cumulative NG 2P discoveries at end 2021 is about 11 500 Tcf extrapolated towards 14 000 Tcf against 17 000 Tcf for HL. The discovery in 1971 of North Dome (North Field in Qatar = 2/3 and South Pars in Iran = 1/3) is a super giant (larger than the largest in crude oil =Ghawar)



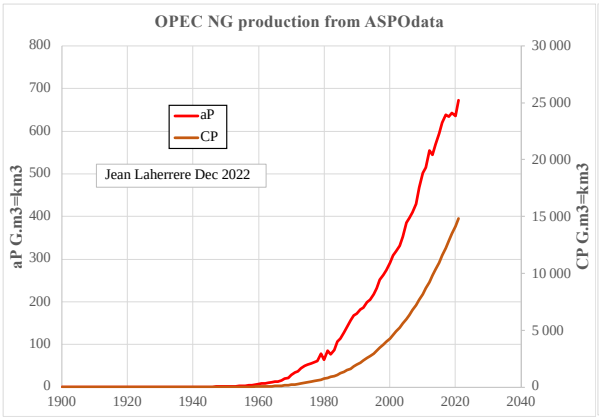
It is hard to find complete historical oil and gas production and it seems logical to believe that HL estimate of uncomplete data could be add to the cumalative production at the beginning of the series.

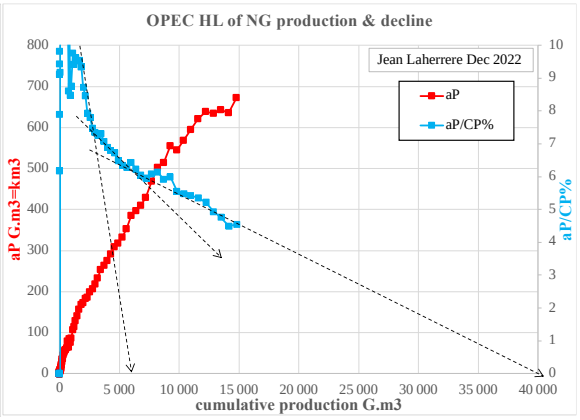
It is wrong to believe so: HL of world marketed NG since 1885, 1960 (OPEC ASB start CP1885-1959 = 5 600 km3) and 1980 (CP1985-1979= 24 600 km3) gives different values Ultimate from HL needs to have the complete historical data



-OPEC

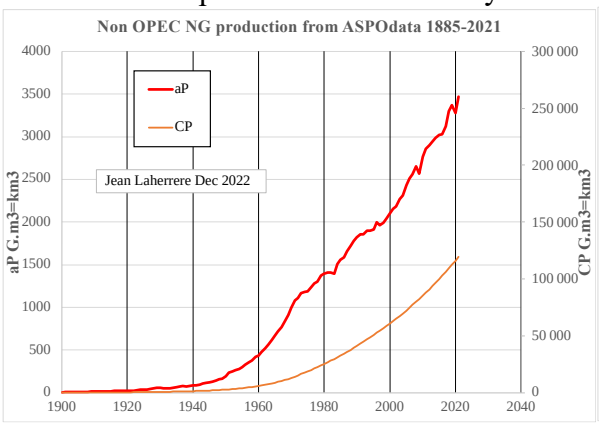
HL of OPEC production trends fairly towards 40 000 km3

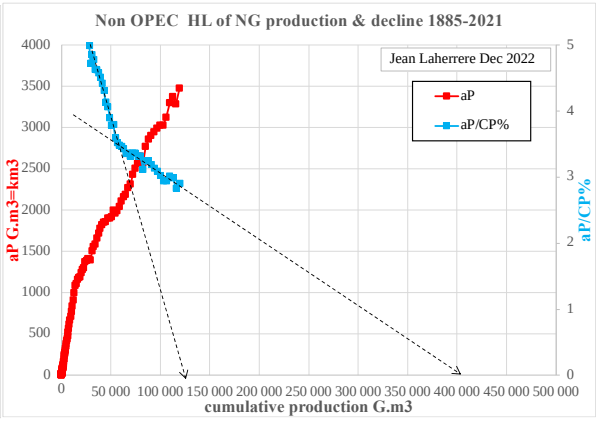




-Non OPEC = NOPEC

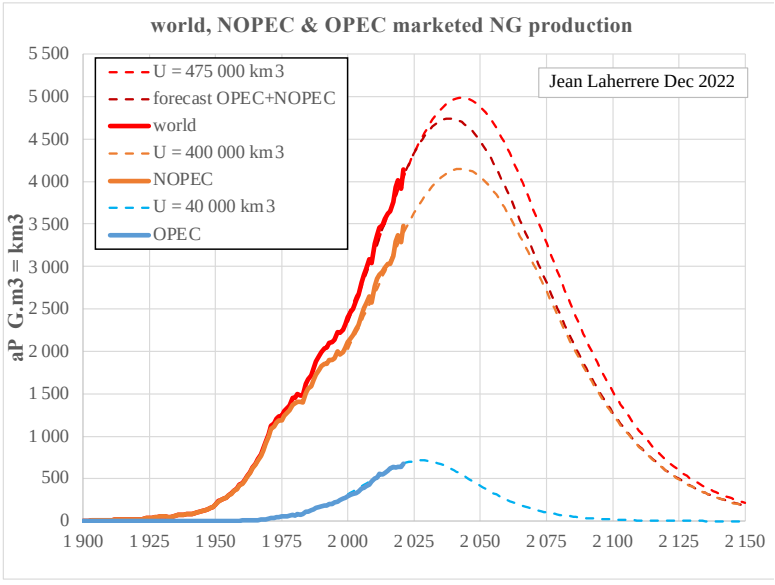
HL of NOPEC production trends fairly towards 400 000 km3



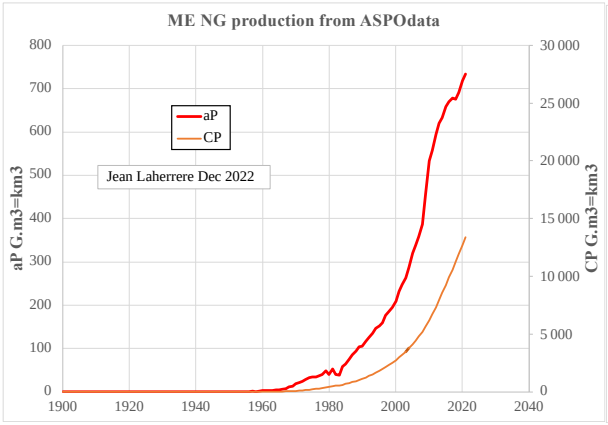


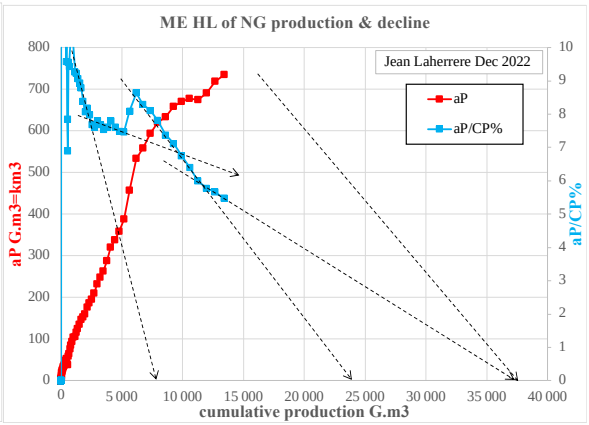
HL of world NG trends towards 480 T.m3, when OPEC trends towards 40 T.m3 and NOPEC trends towards 400 T.m3, giving a total of 440 T.m3, 8 % lower than HL for the world
Despite fair trends, the discrepancy gives a good idea of the uncertainty of HL estimates.

-NOPEC & OPEC compared to the world

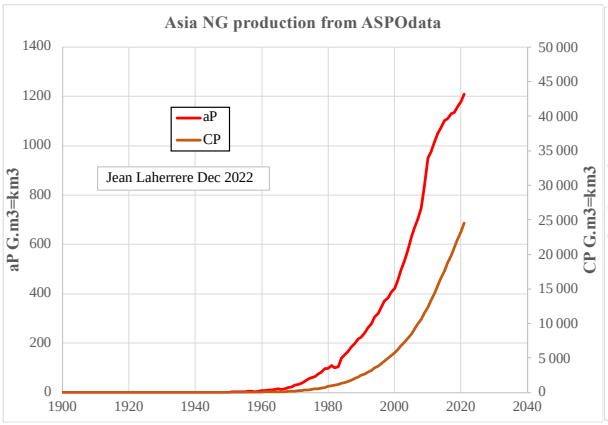


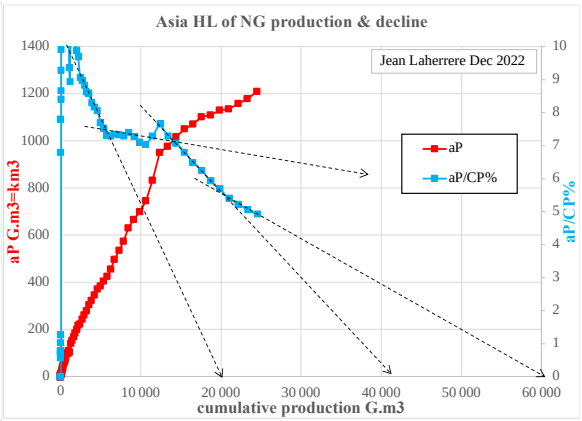
-Middle East



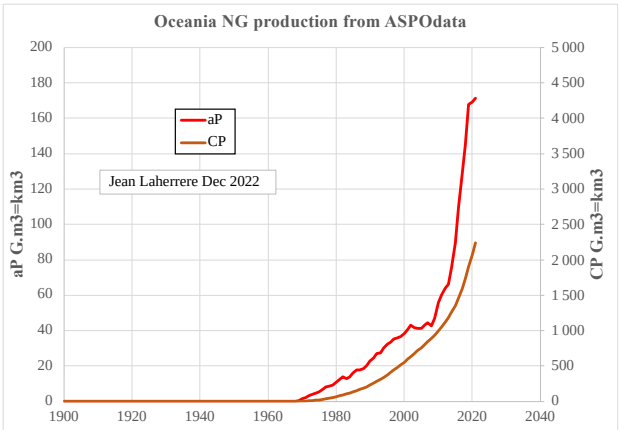


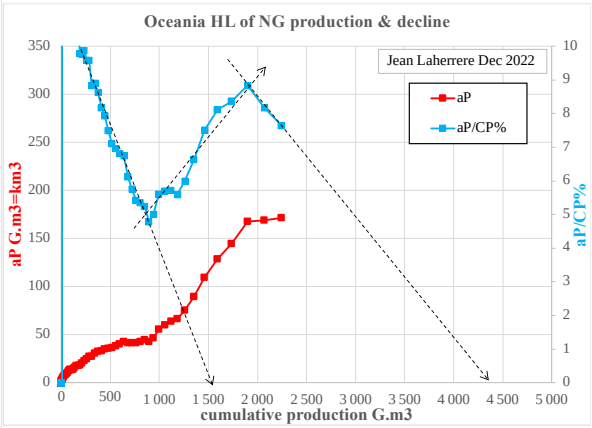
-Asia



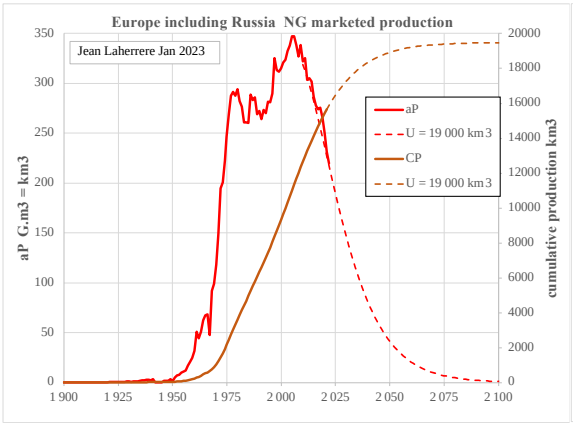


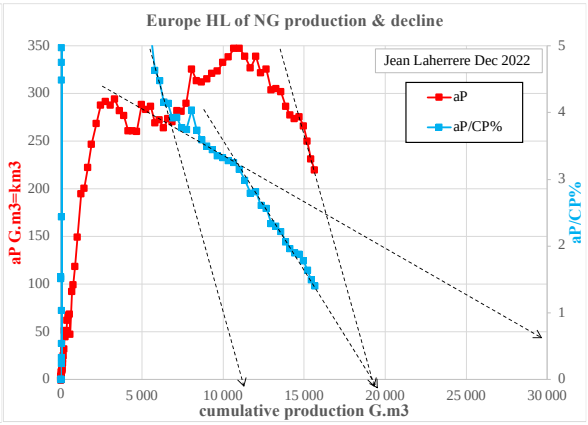
-Oceania



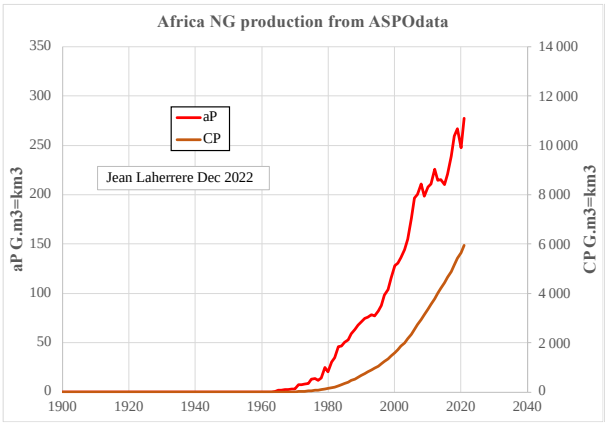


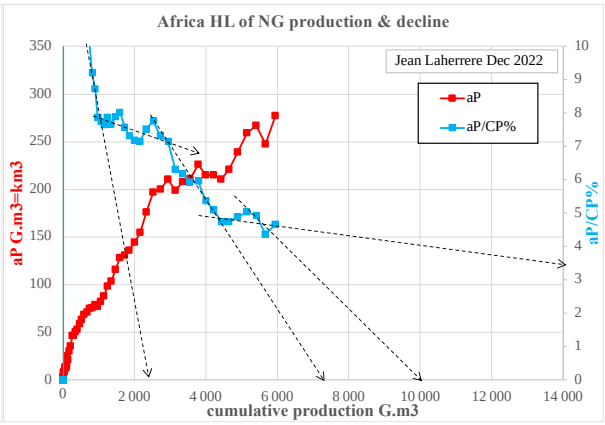
-Europe including Russia



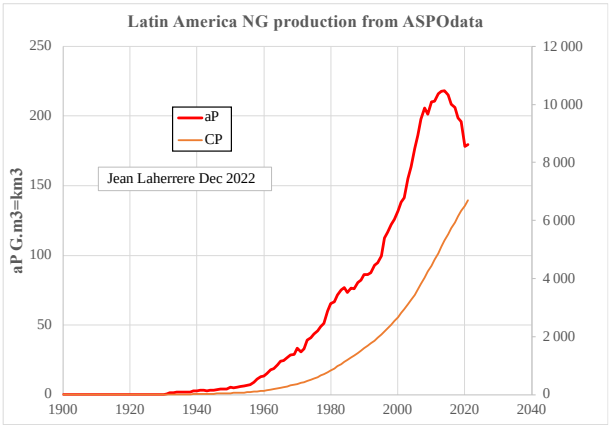


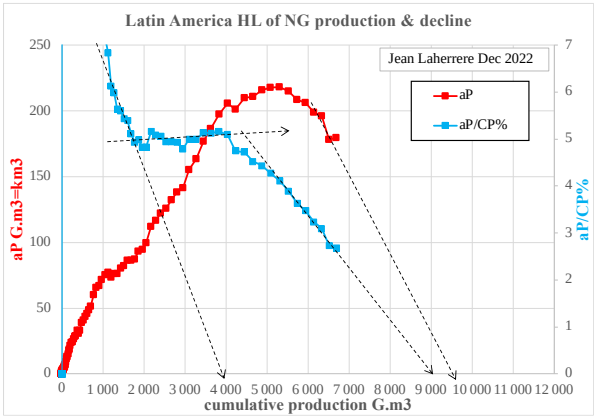
-Africa



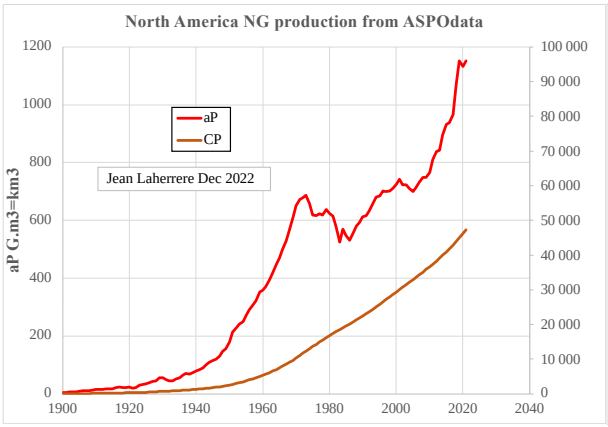


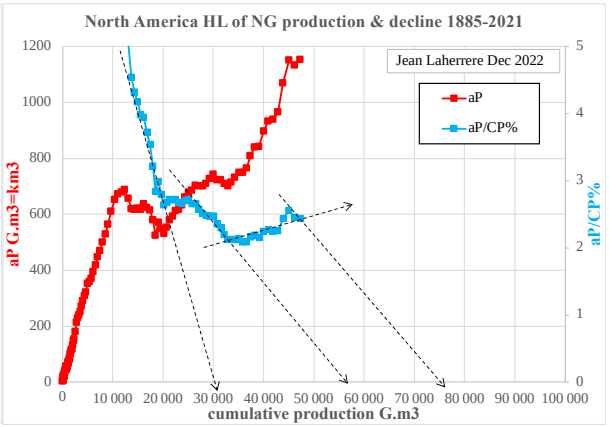
-Latin America



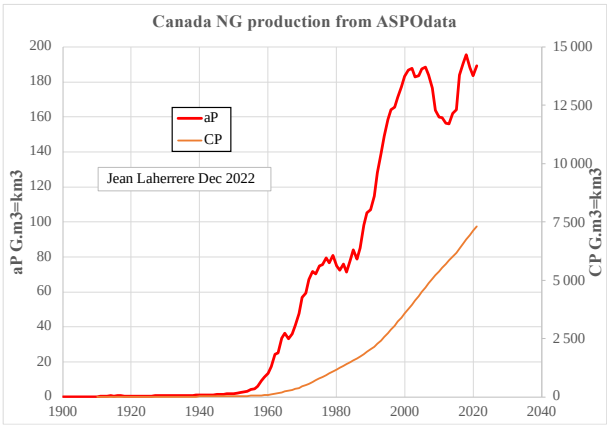


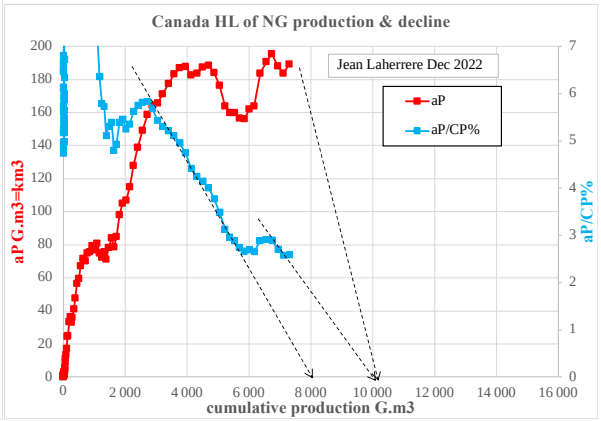
-North America including Mexico



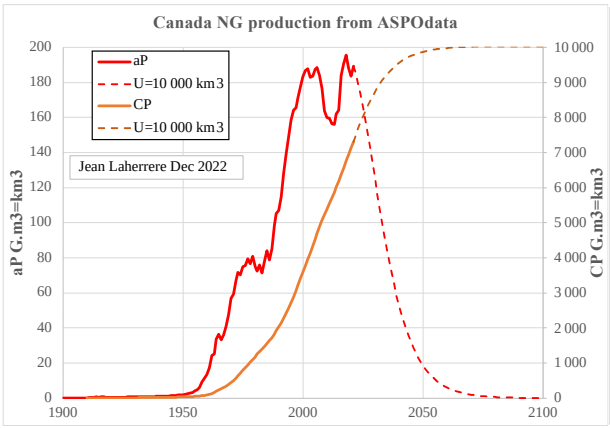


-countries

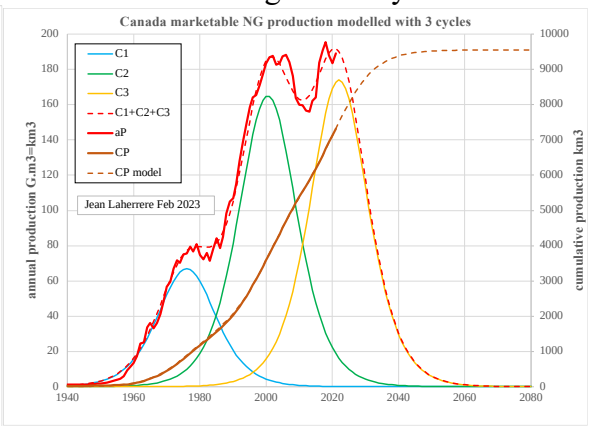


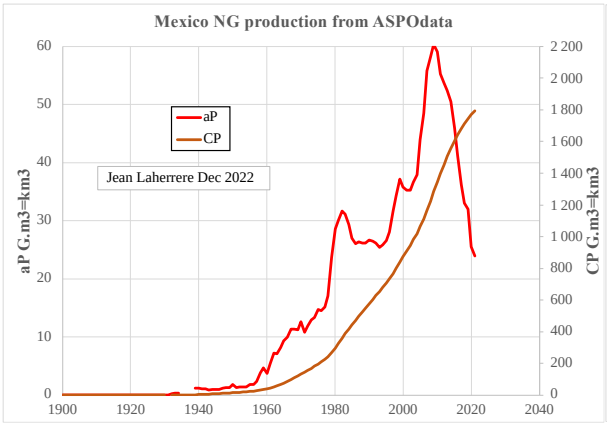


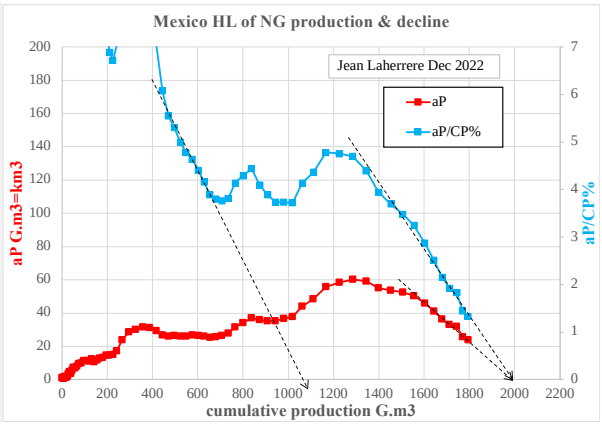
Canada forecast for U = 10 000 km3



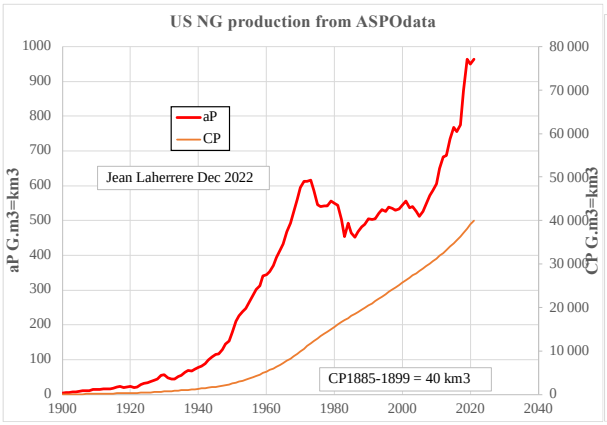
modelling with 3 cycles

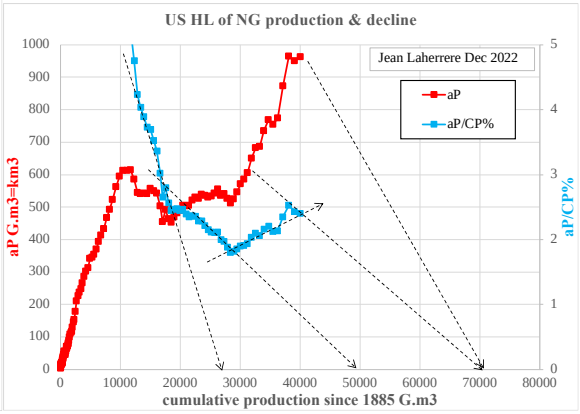


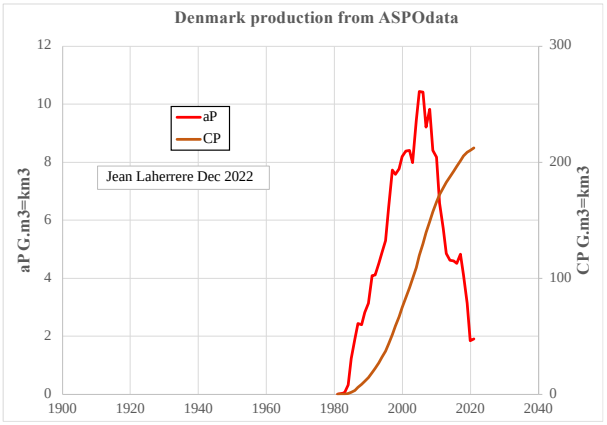


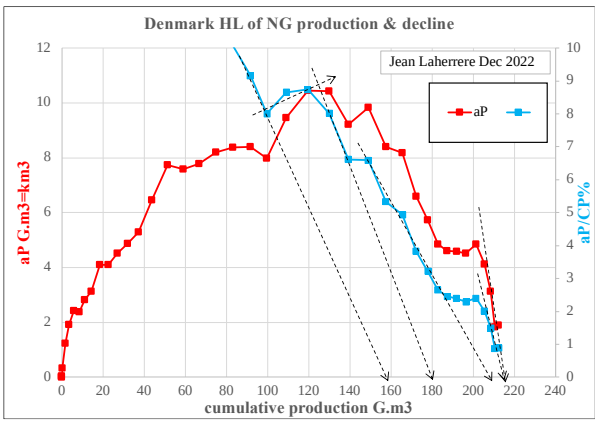


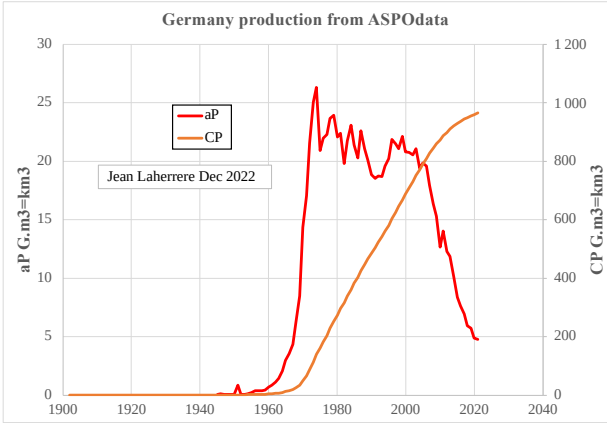
I have selected the countries with a large production, as the ones near abandon

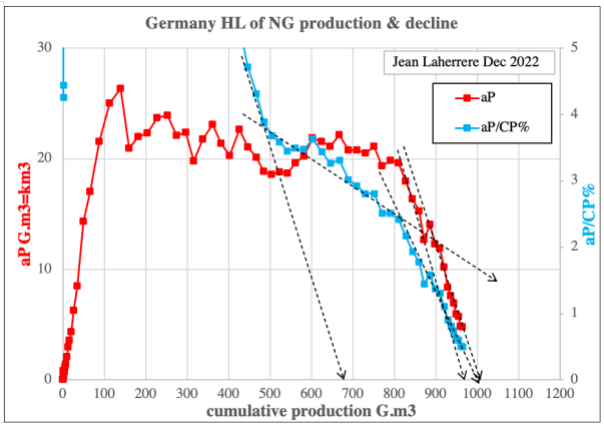


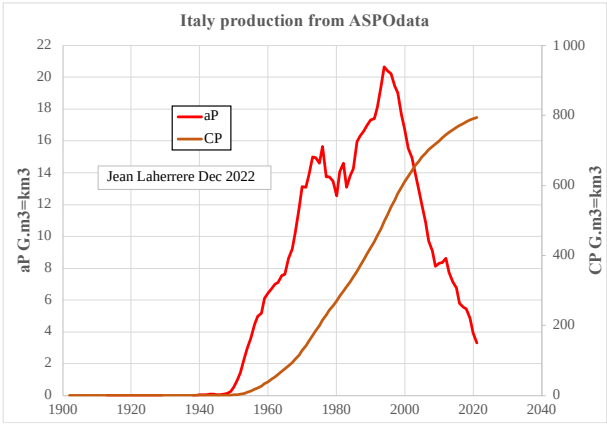


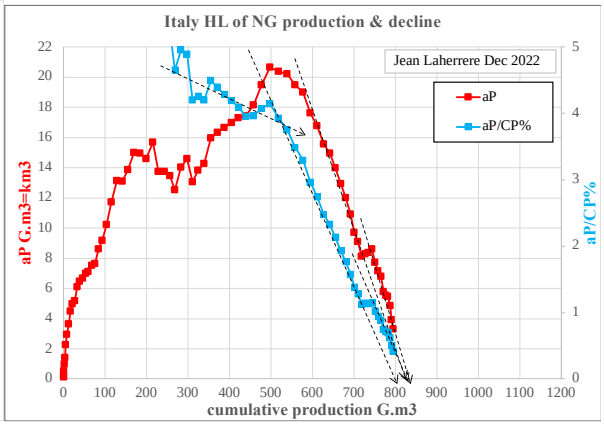


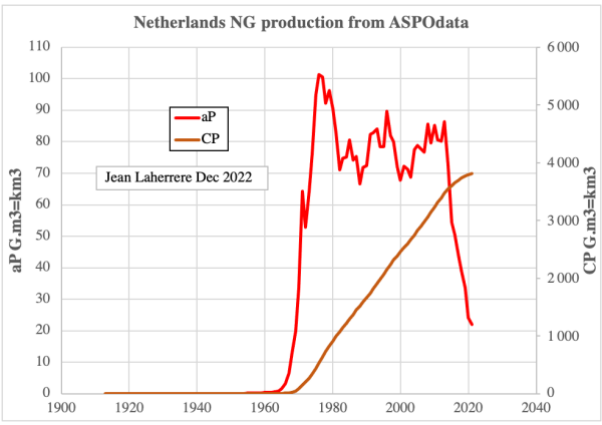


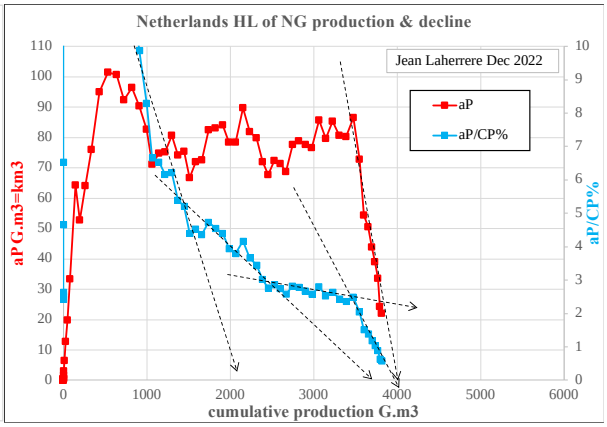


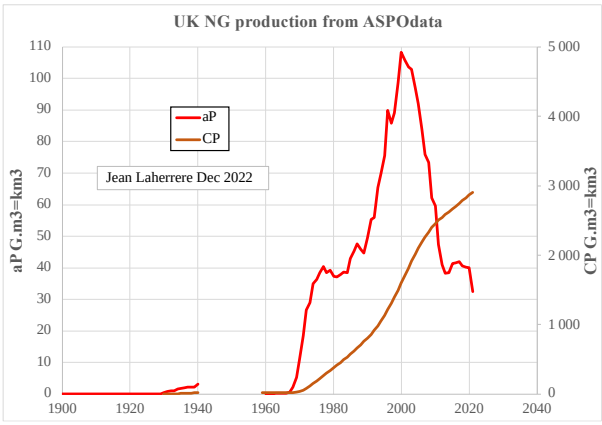


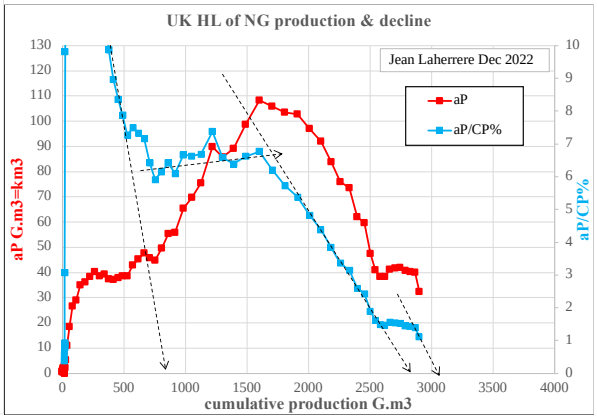

Italy production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

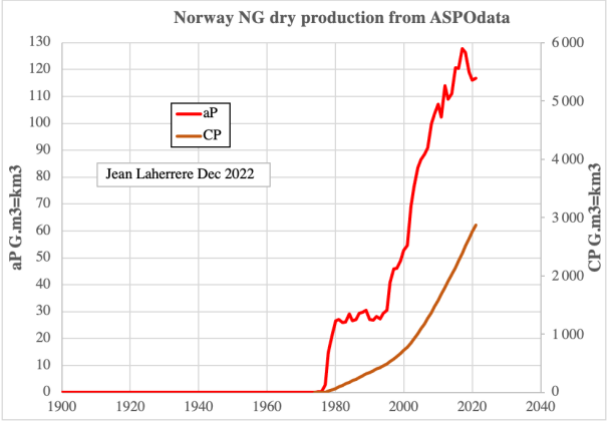

Italy HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

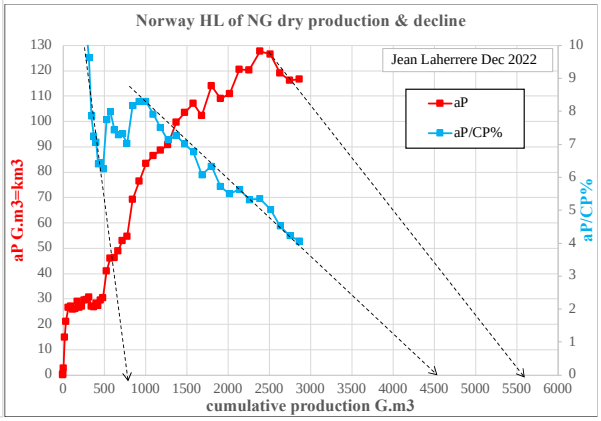

Netherlands NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

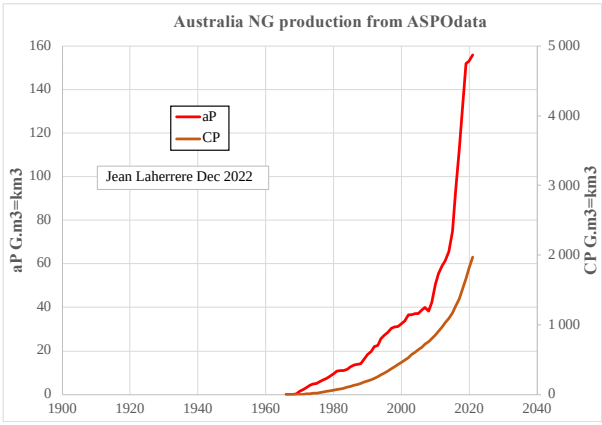

Netherlands HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

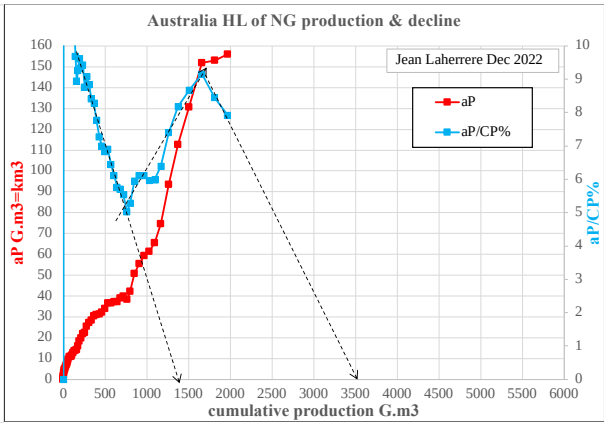

UK NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

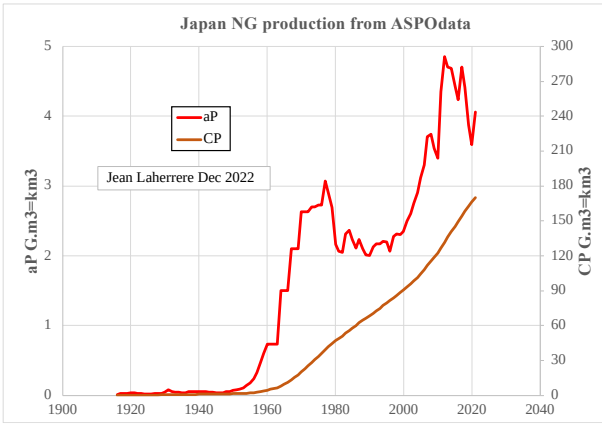

UK HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3


Norway NG dry production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3


Norway HL of NG dry production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3


Australia NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3


Australia HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3


Japan NG production from ASPOdata
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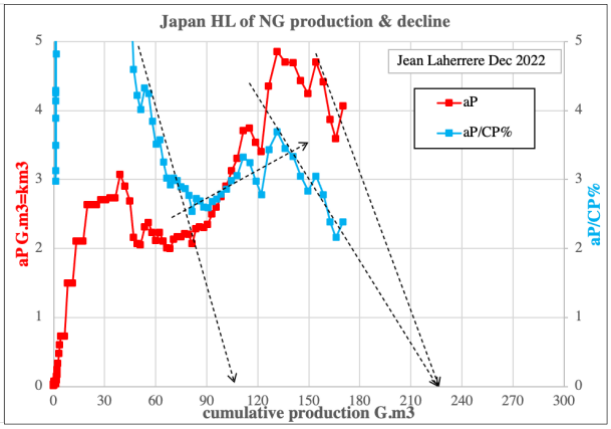
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3


Japan HL of NG production & decline
Jean Laherrere Dec 2022
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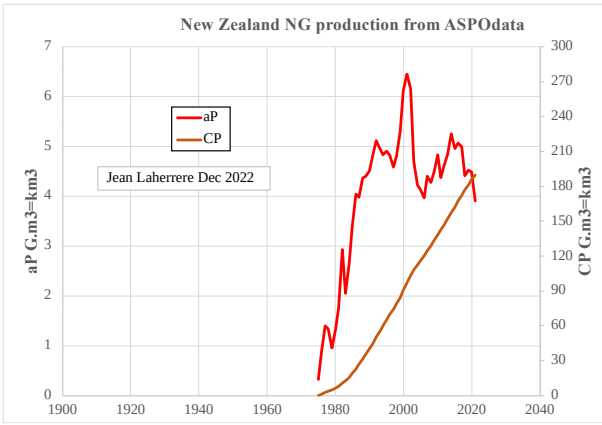
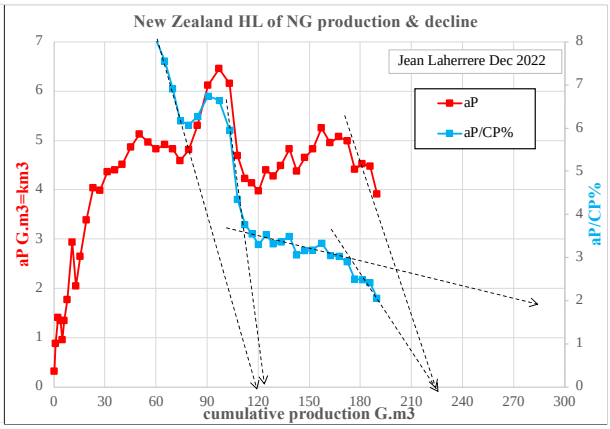
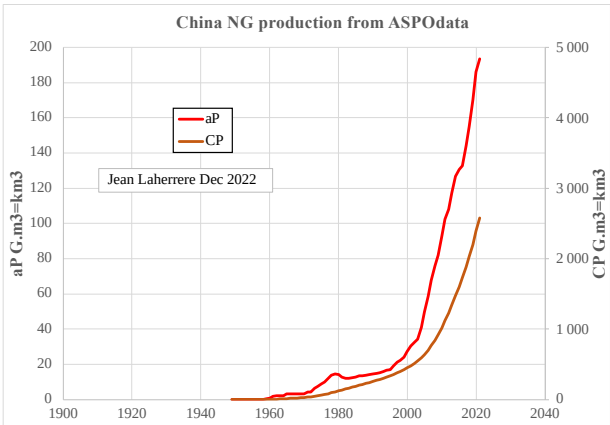
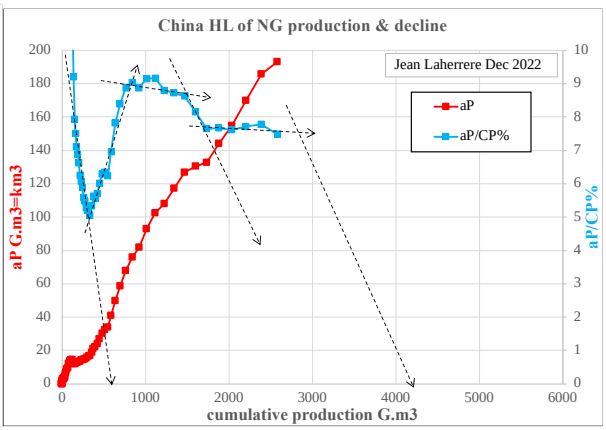
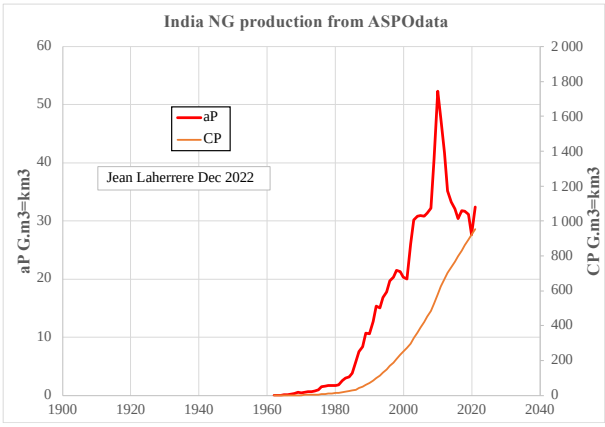
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3


New Zealand NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3


New Zealand HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3


China NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3


China HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3


India NG production from ASPOdata
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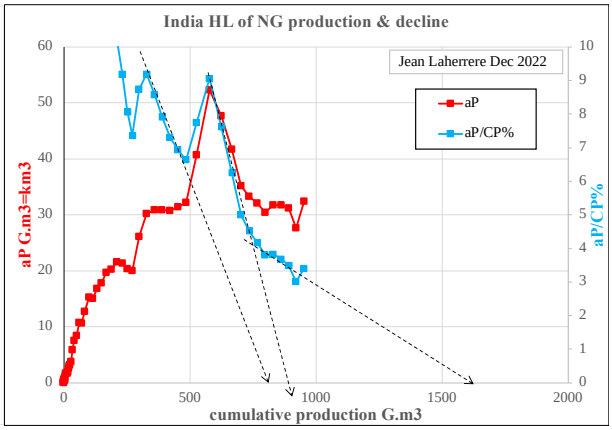
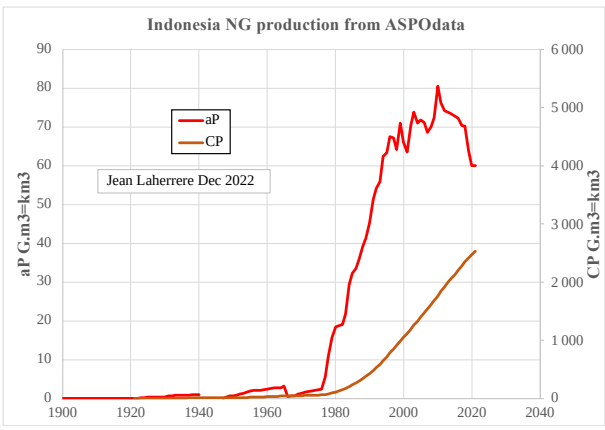
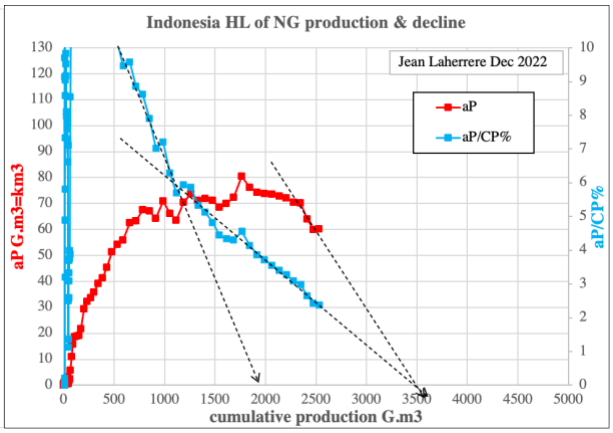
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3


India HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3


Indonesia NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3


Indonesia HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
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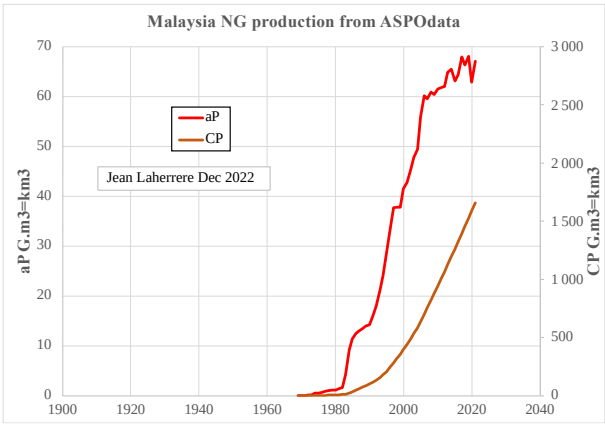
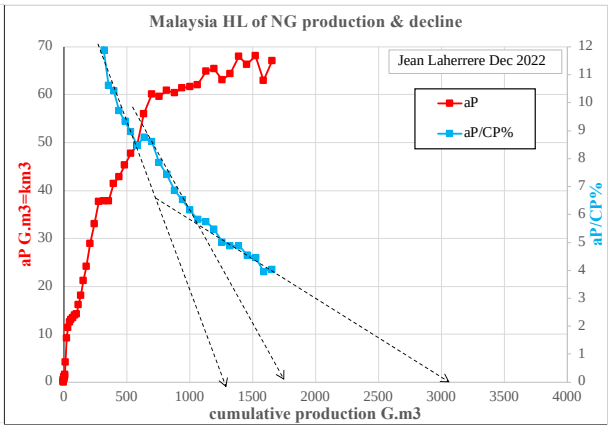
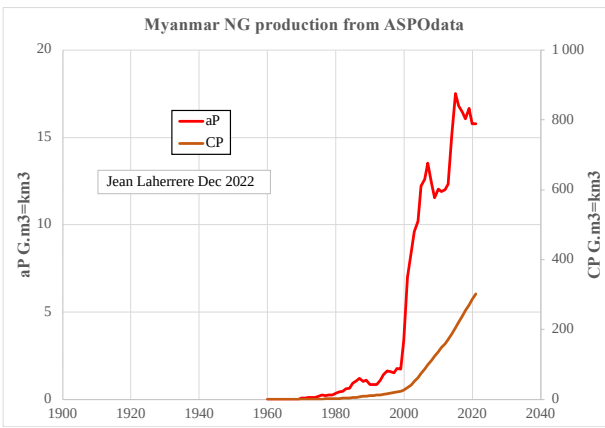
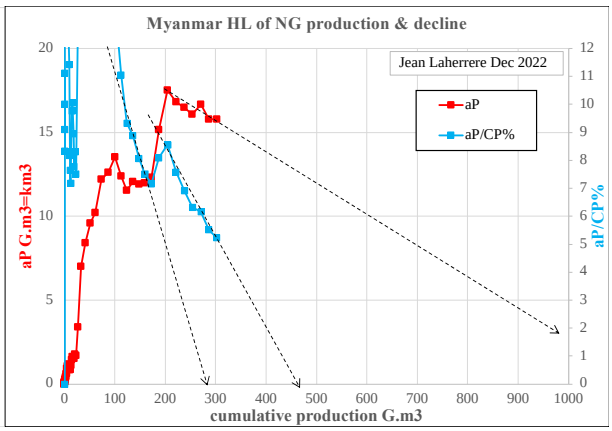
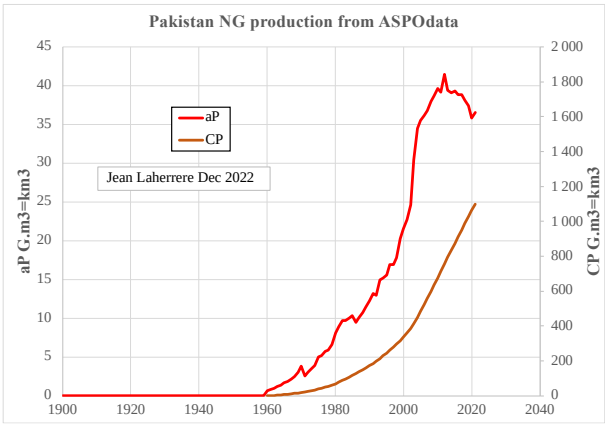
aP/CP%
cumulative production G.m3

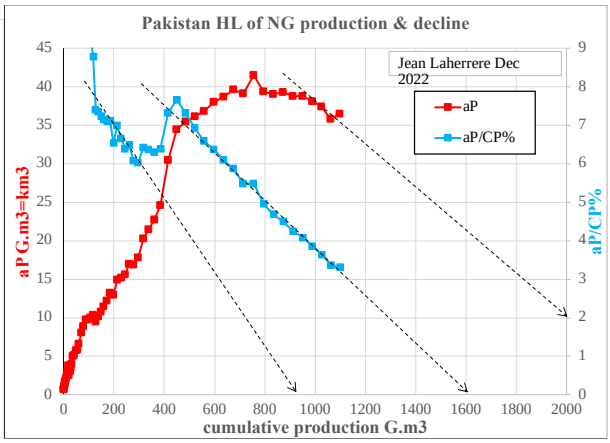

Malaysia NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

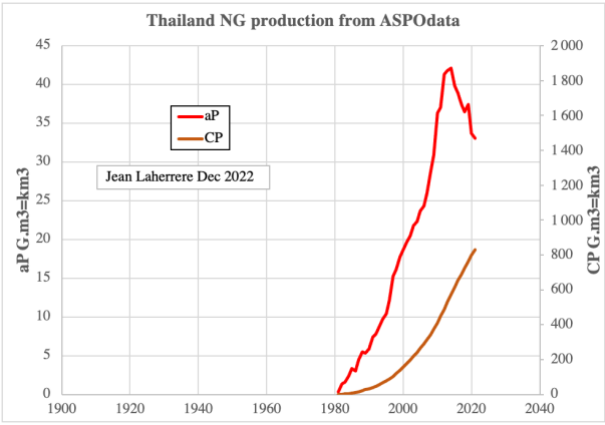

Malaysia HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

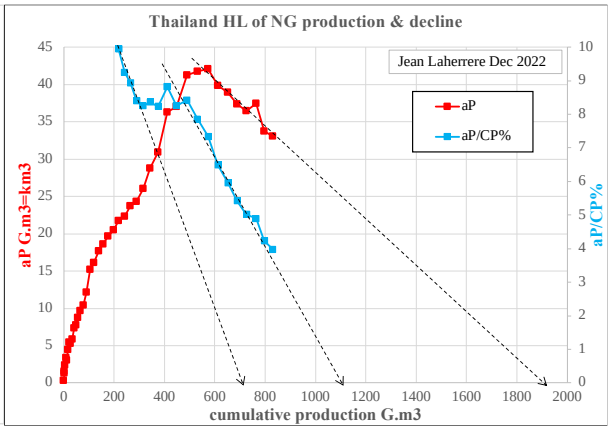

Myanmar NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

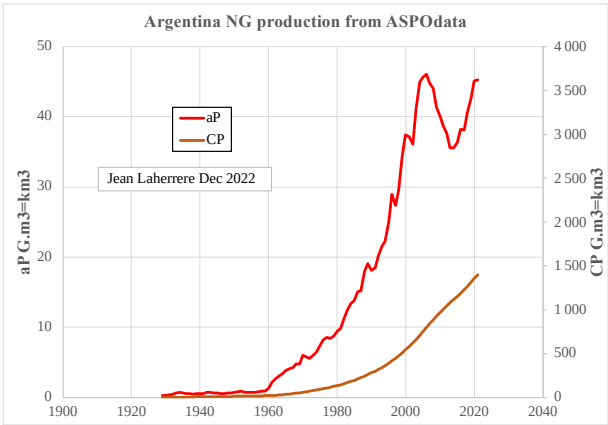

Myanmar HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

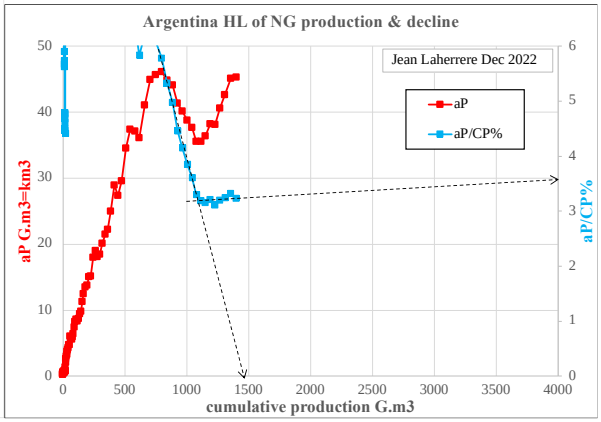

Pakistan NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

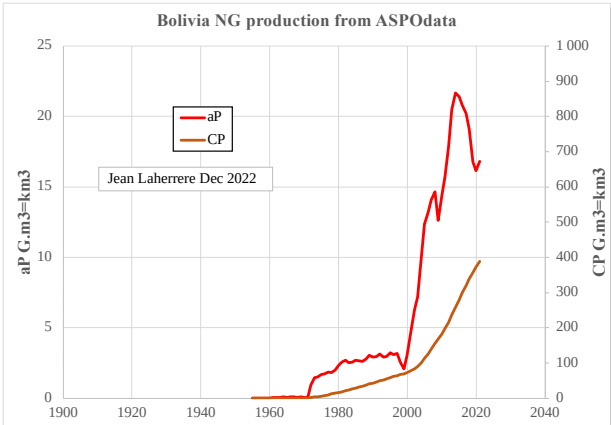

Pakistan HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

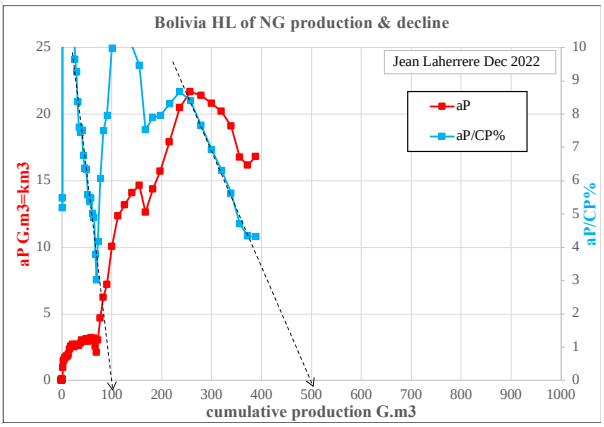

Thailand NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

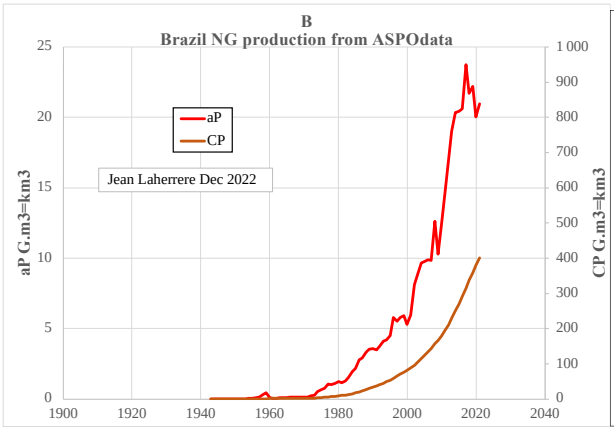

Thailand HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

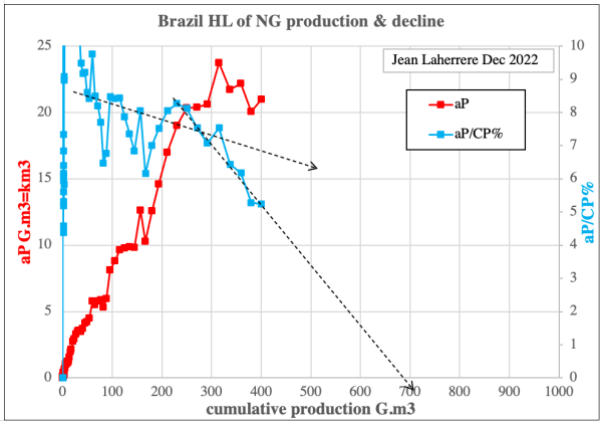

Argentina NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

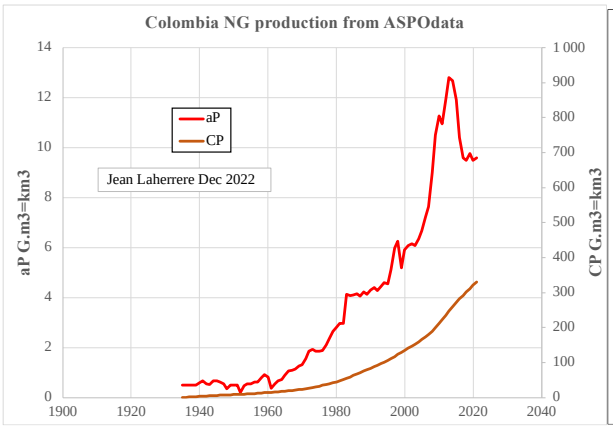

Argentina HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

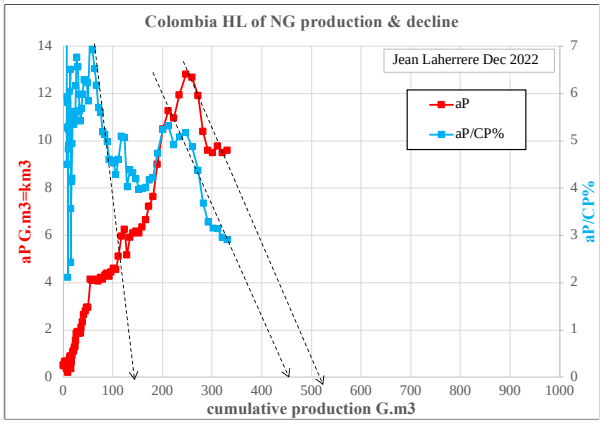

Bolivia NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

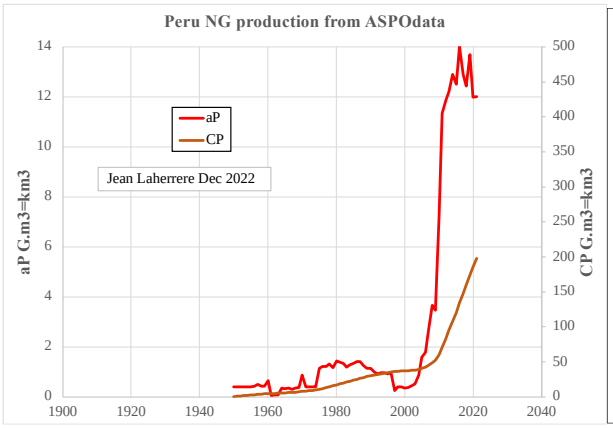

Bolivia HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

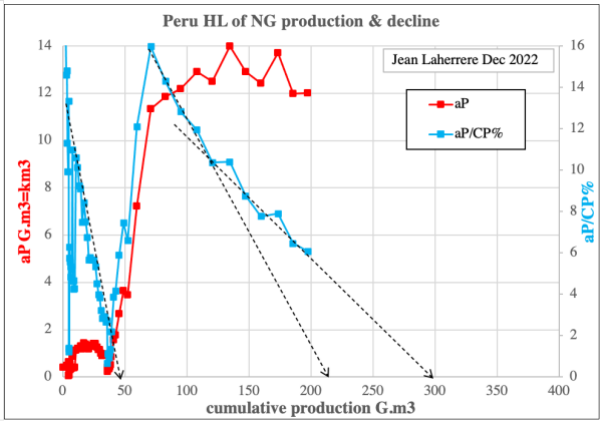

B
Brazil NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

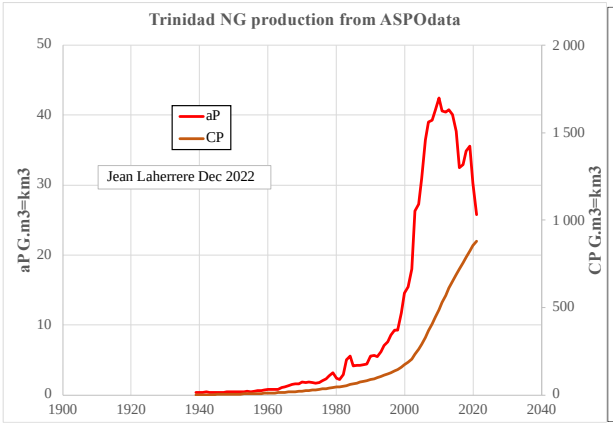

Brazil HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

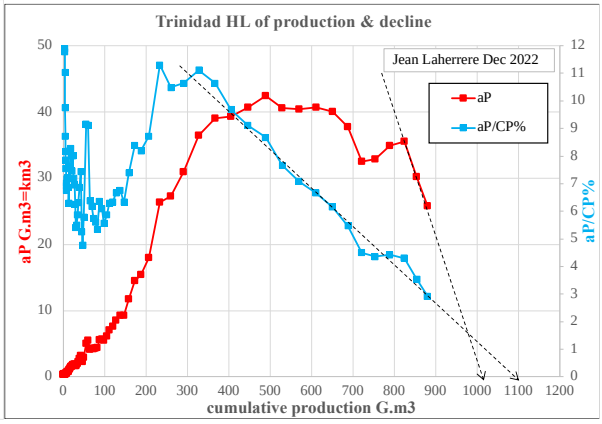

Colombia NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

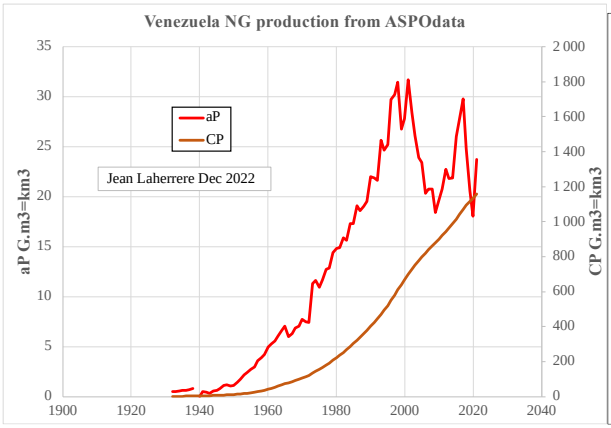

Colombia HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

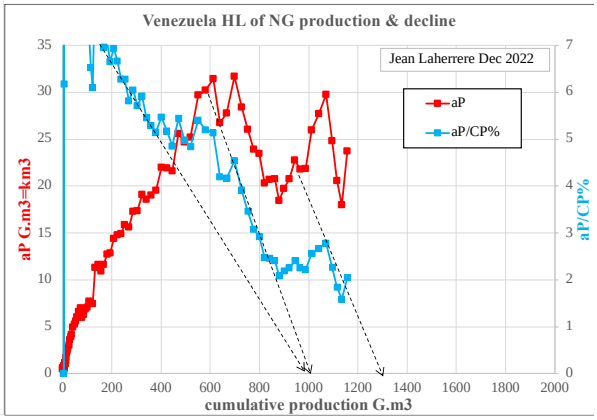

Peru NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

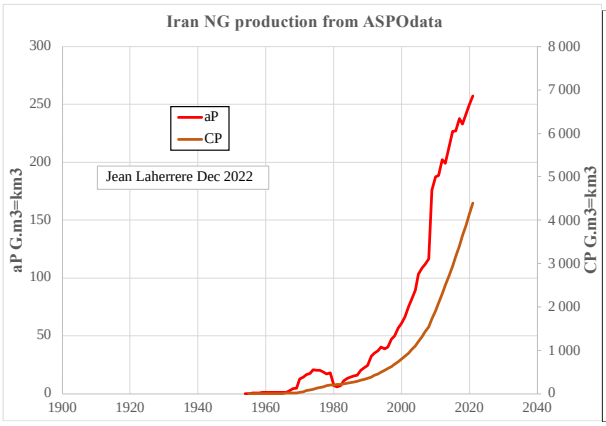

Peru HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

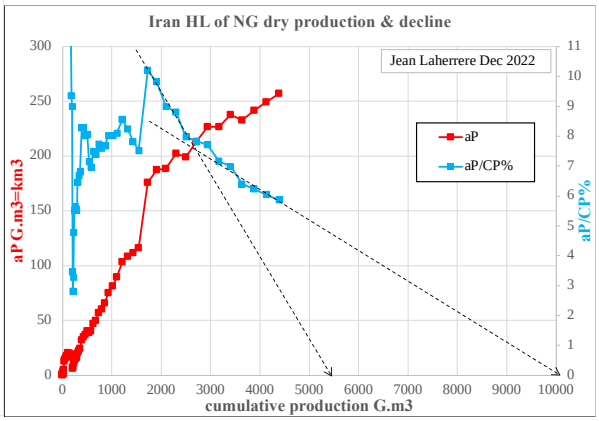

Trinidad NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

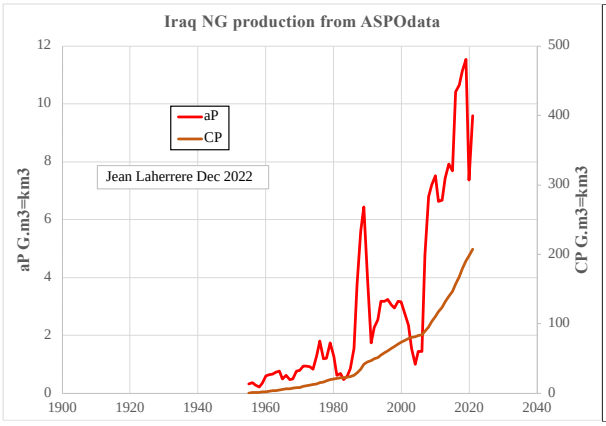

Trinidad HL of production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

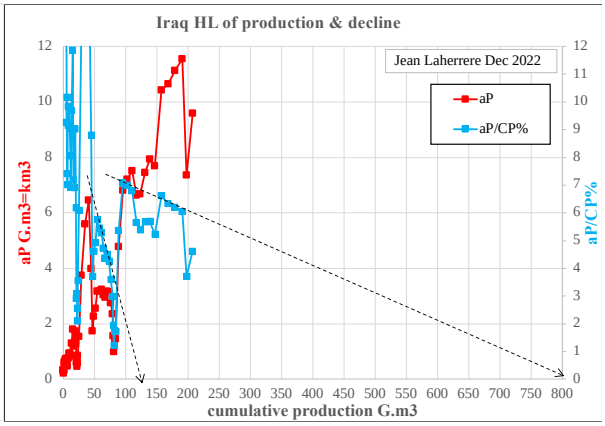

Venezuela NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

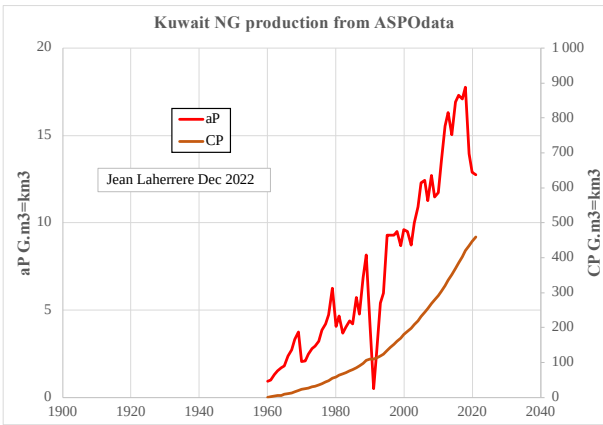

Venezuela HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

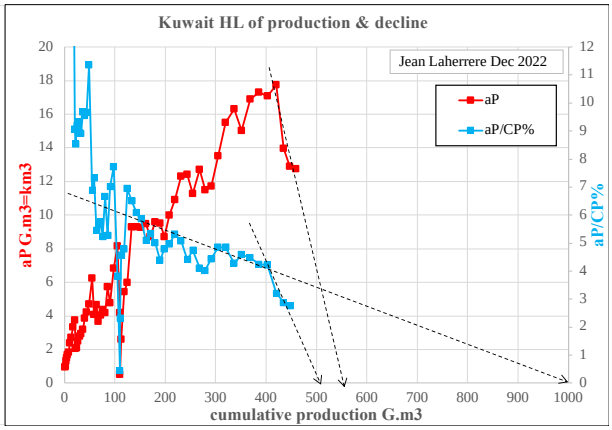

Iran NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

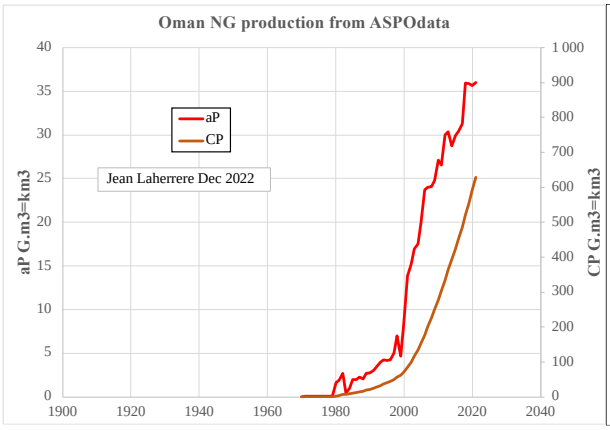

Iran HL of NG dry production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

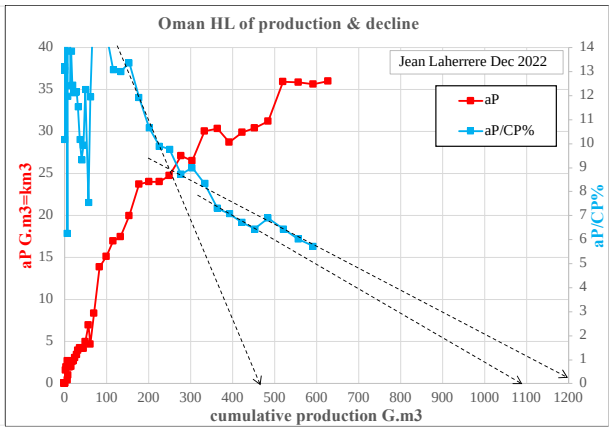

Iraq NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

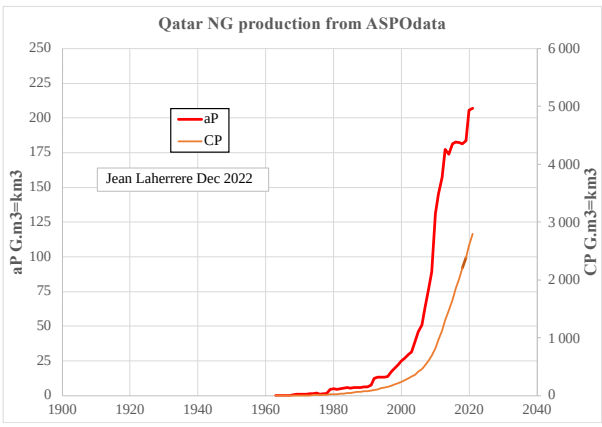

Iraq HL of production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

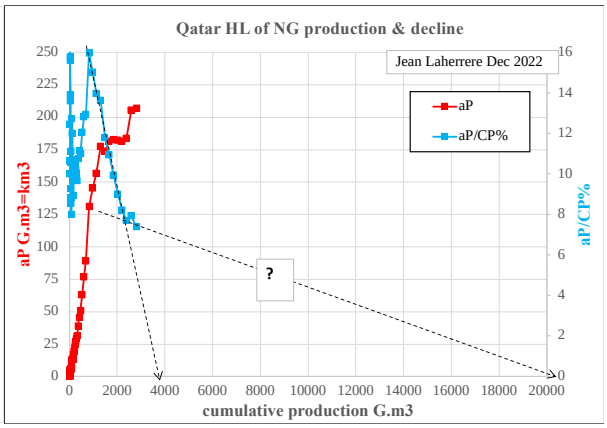

Kuwait NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

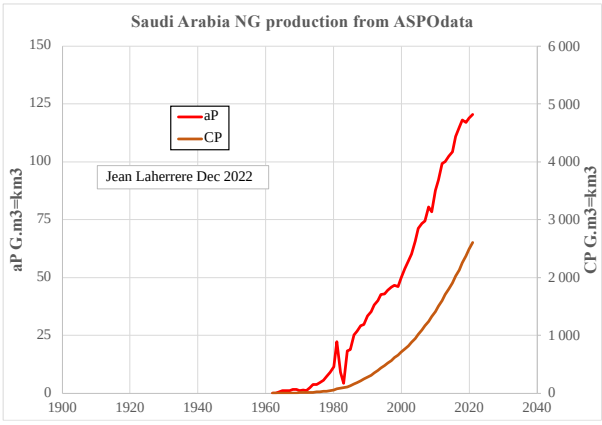

Kuwait HL of production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

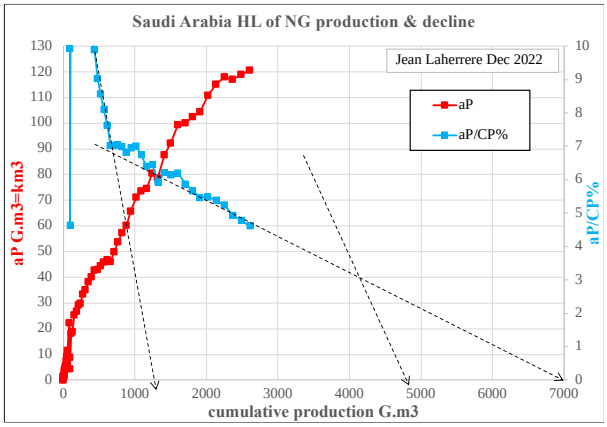

Oman NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

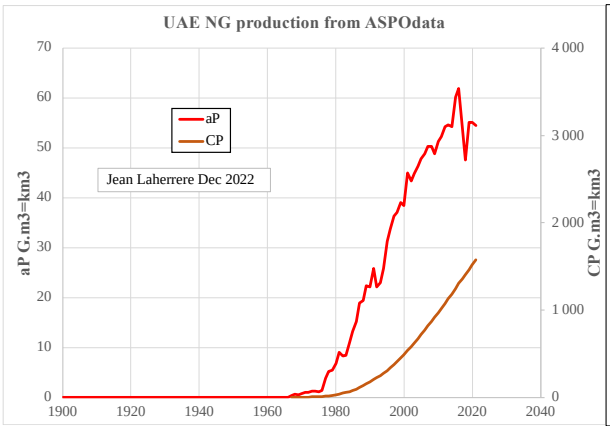

Oman HL of production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

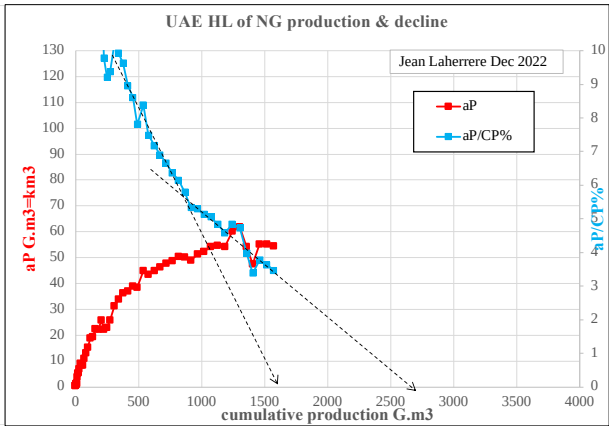

Qatar NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

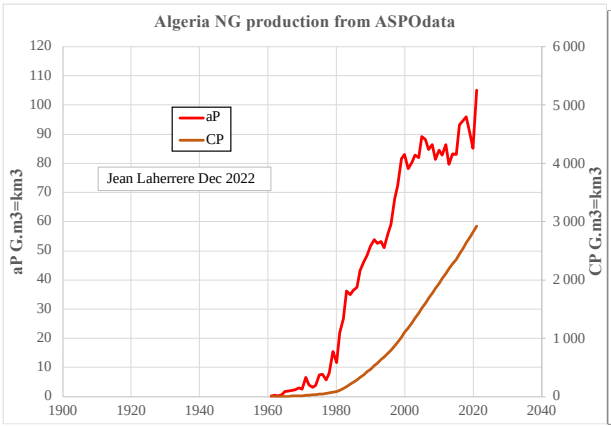

Qatar HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
?
aP G.m3=km3
aP/CP%
cumulative production G.m3

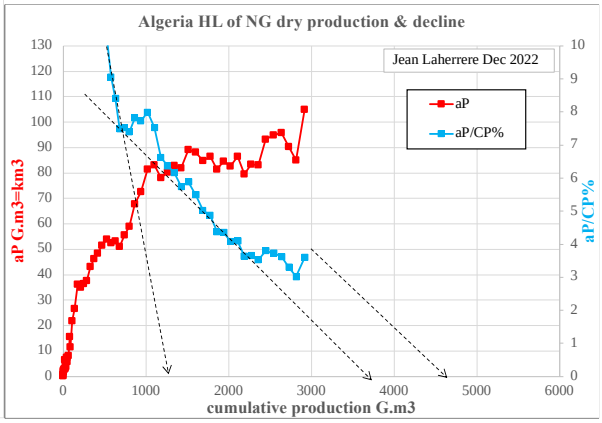

Saudi Arabia NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

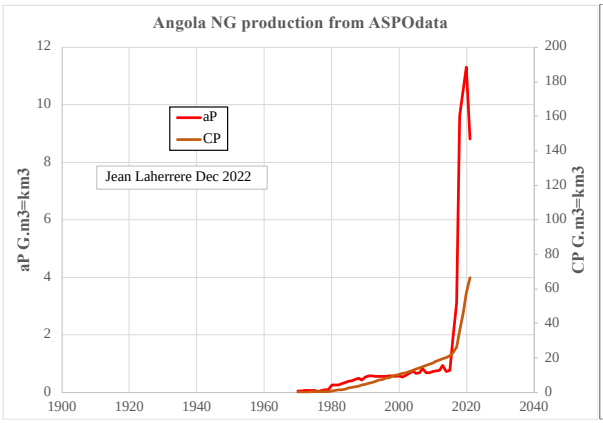

Saudi Arabia HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

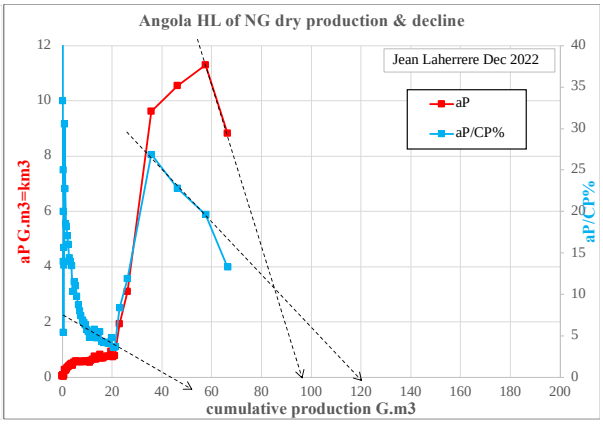

UAE NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

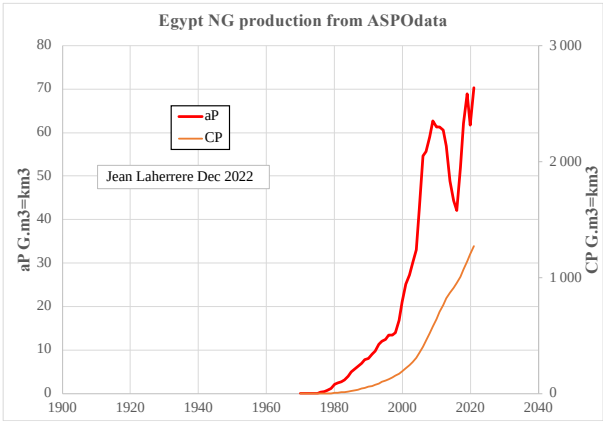

UAE HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

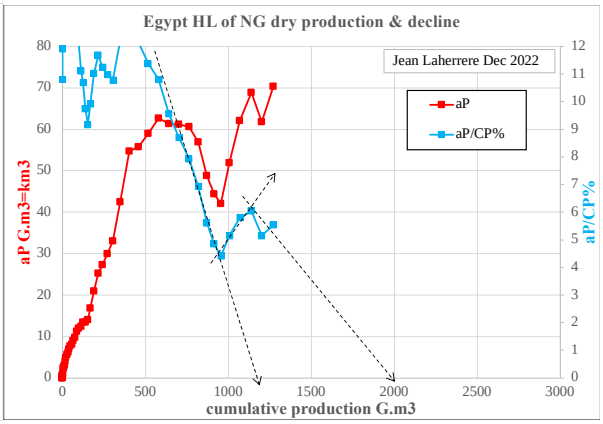

Algeria NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

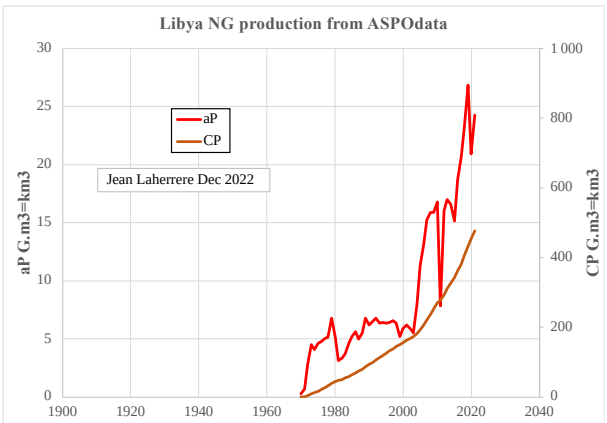

Algeria HL of NG dry production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

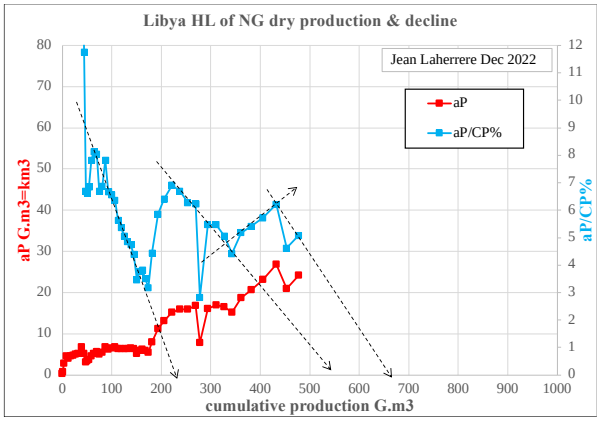

Angola NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

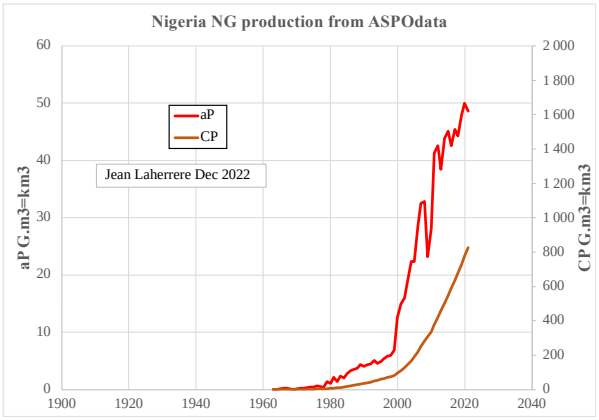

Angola HL of NG dry production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

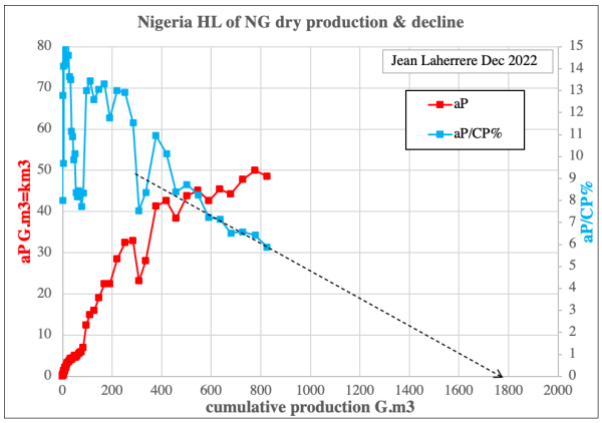

Egypt NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

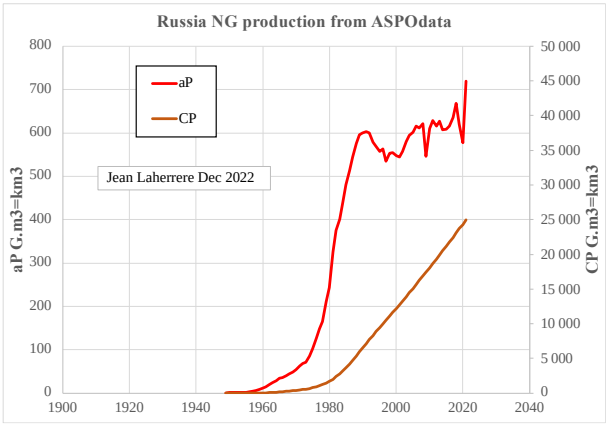

Egypt HL of NG dry production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

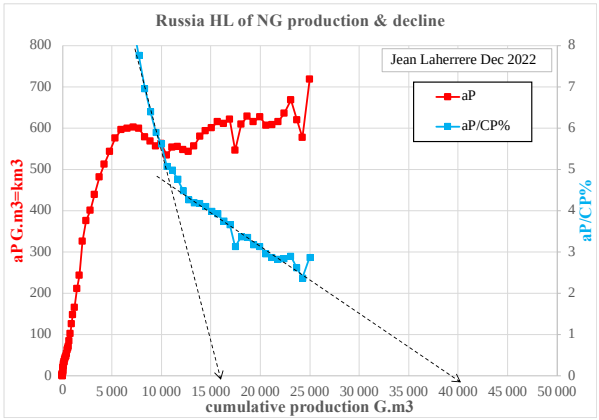

Libya NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

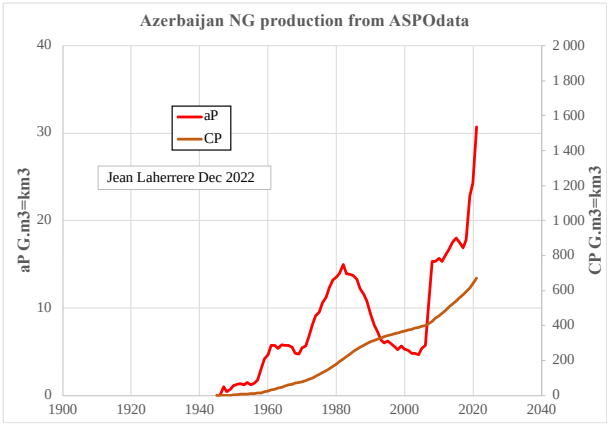

Libya HL of NG dry production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

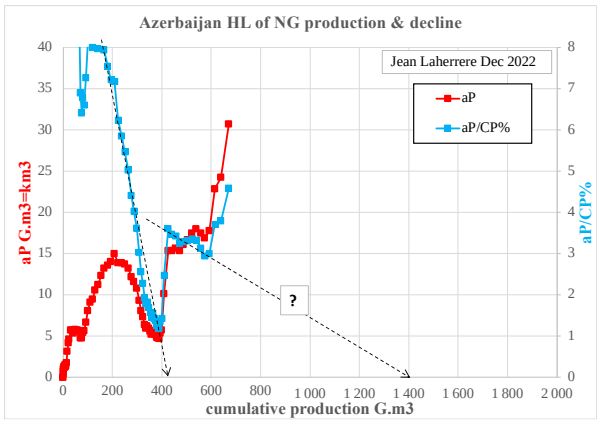

Nigeria NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

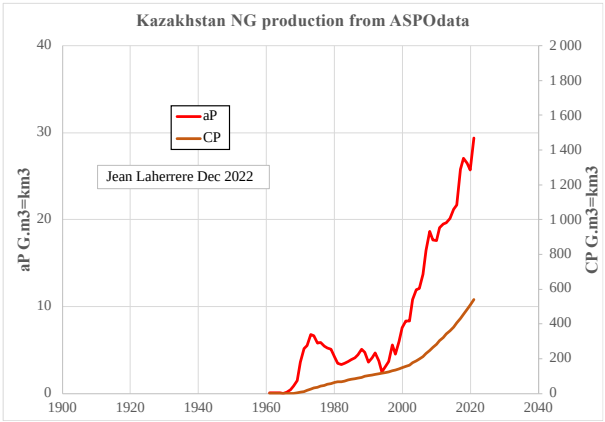

Nigeria HL of NG dry production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

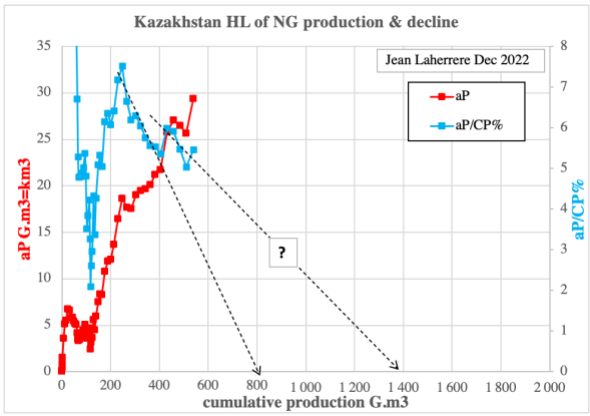

Russia NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

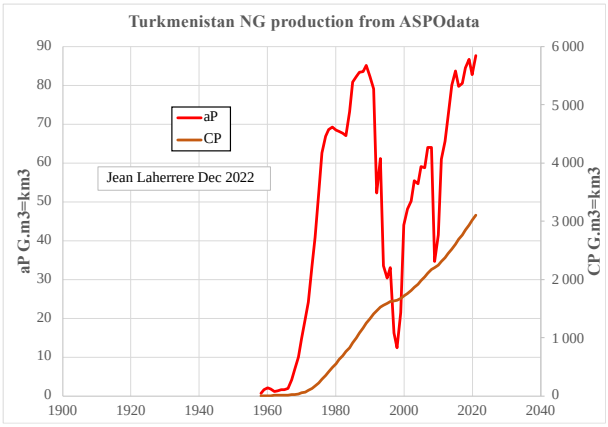

Russia HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

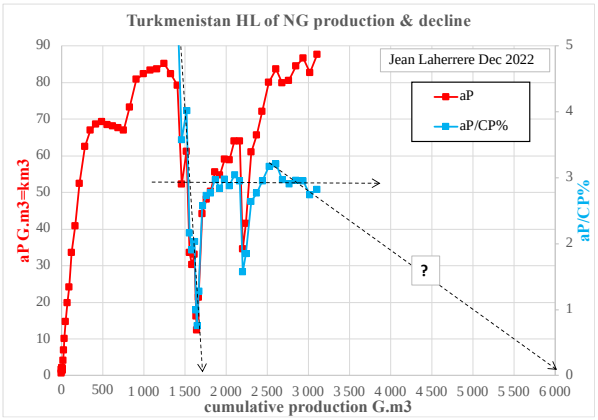

Azerbaijan NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

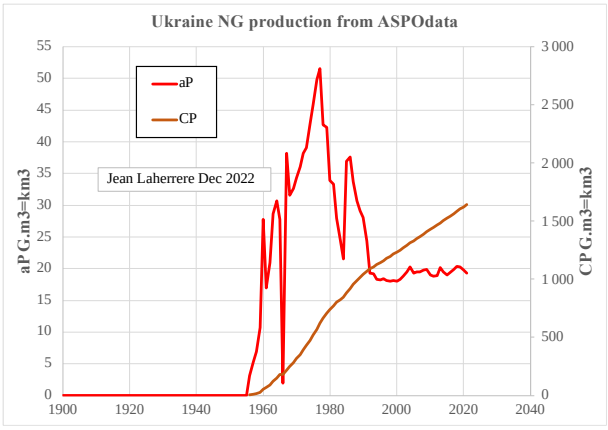

Azerbaijan HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
?
aP G.m3=km3
aP/CP%
cumulative production G.m3

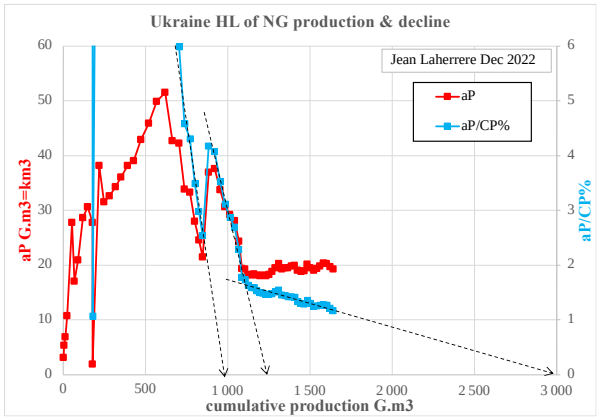

Kazakhstan NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

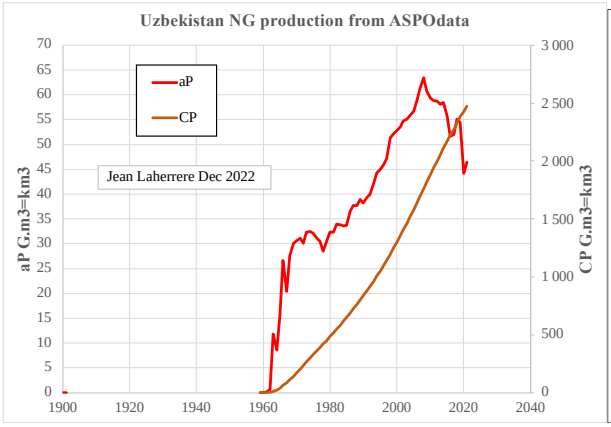

Kazakhstan HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
?
aP G.m3=km3
aP/CP%
cumulative production G.m3

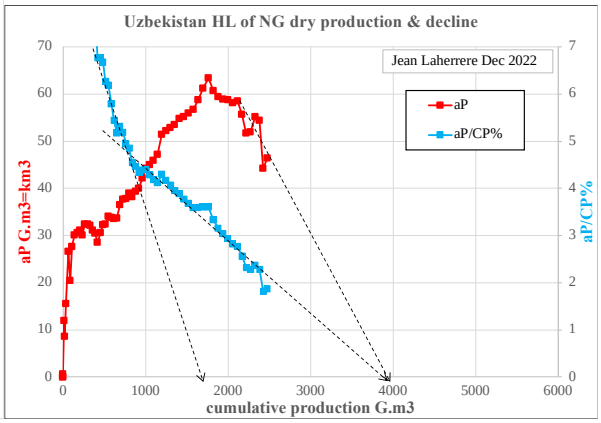


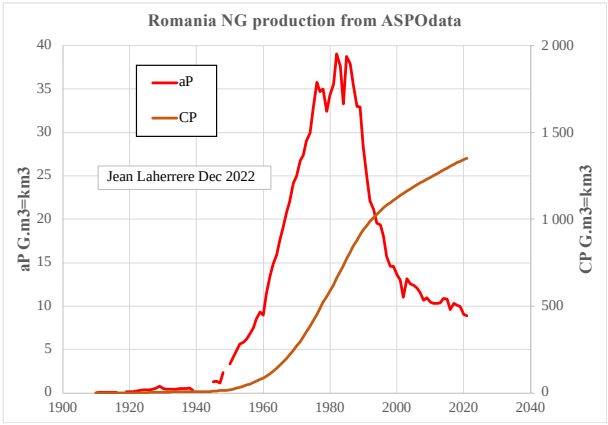


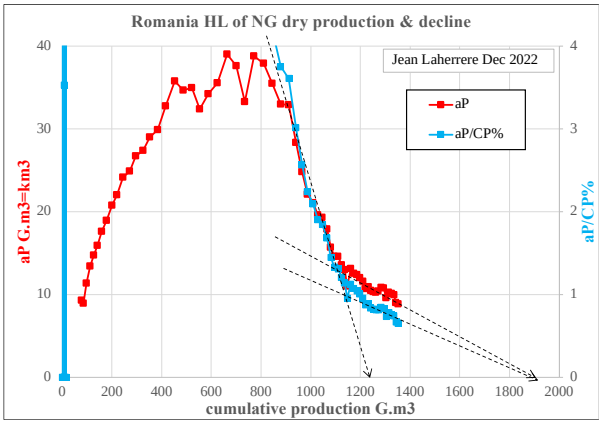




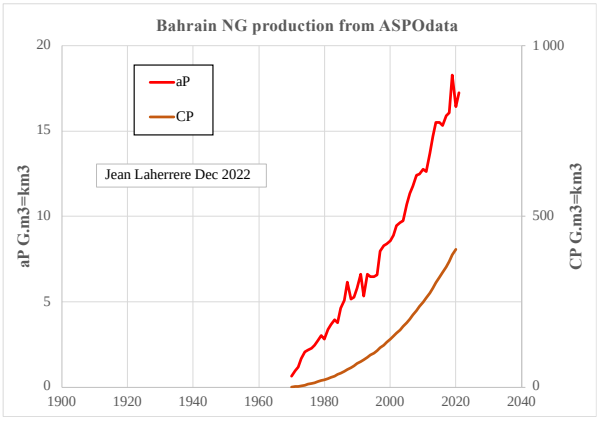


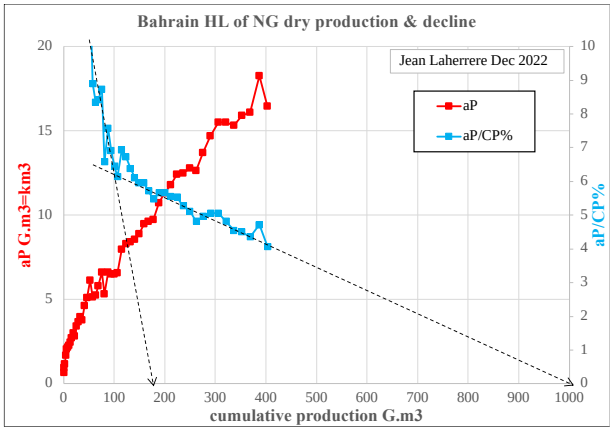


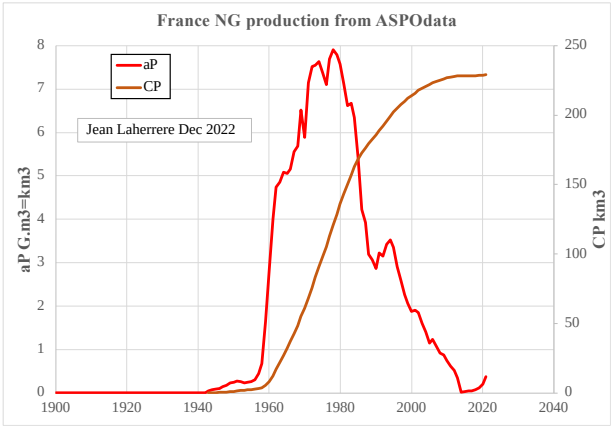


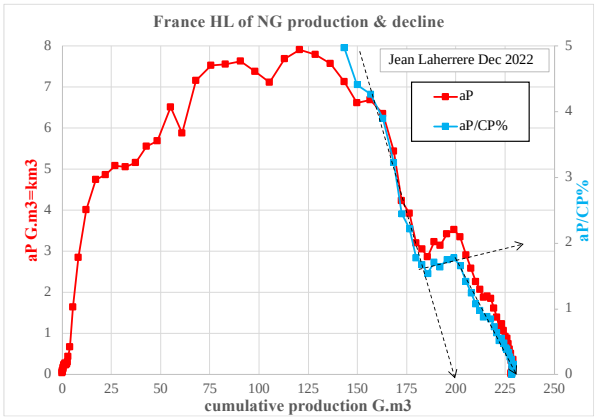


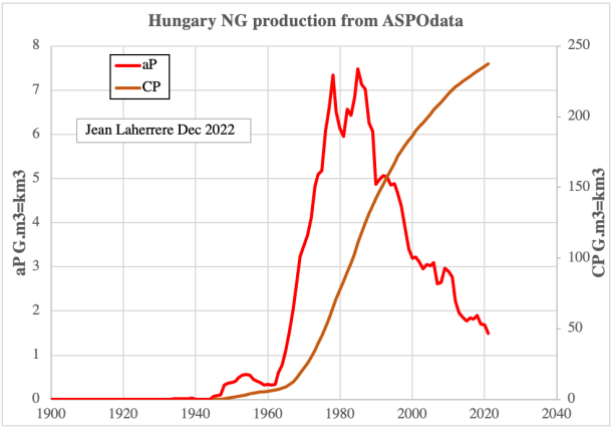
Romania = good example of help from decline to extrapolate HL

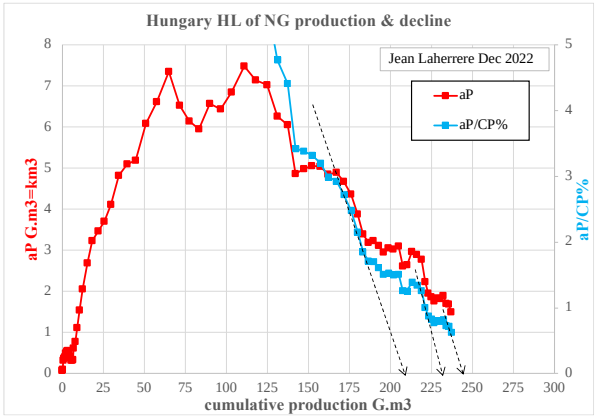

Bahrain NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

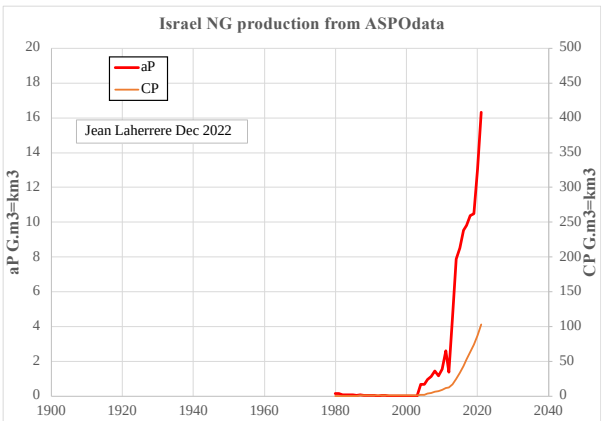

Bahrain HL of NG dry production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

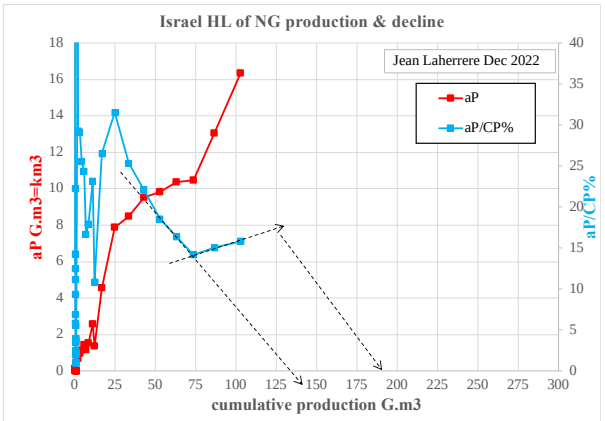

France NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP km3


France HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

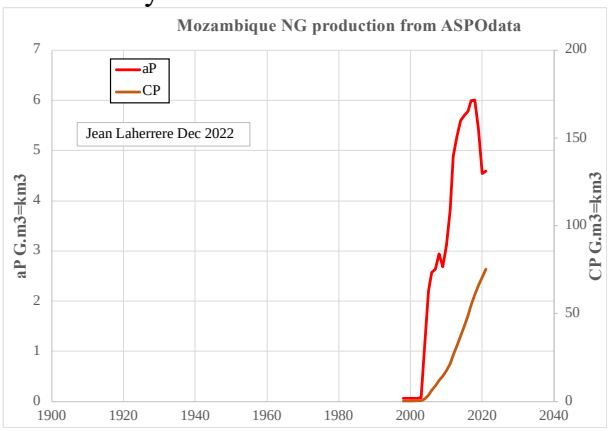

Hungary NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

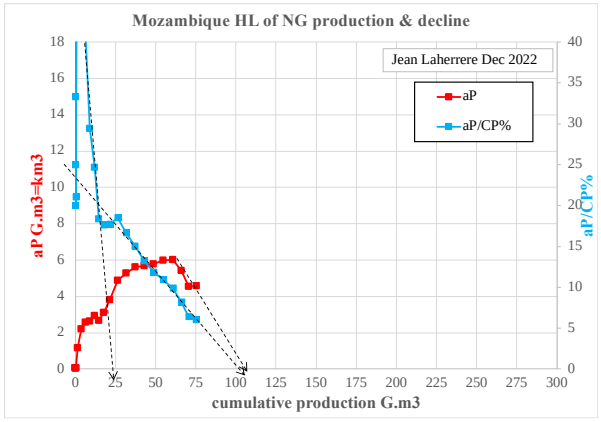

Hungary HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

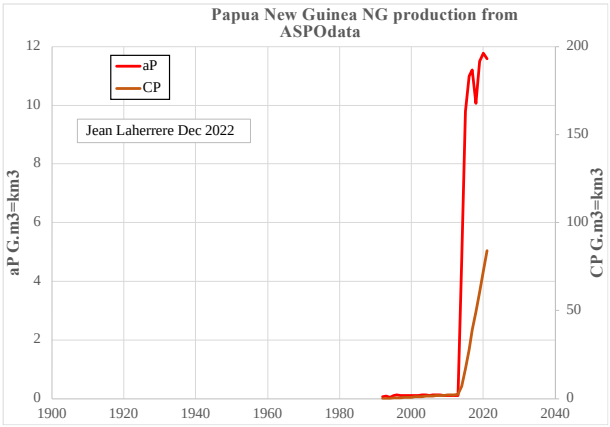

Israel NG production from ASPOdata
aP
CP
Jean Laherrere Dec 2022
aP G.m3=km3
CP G.m3=km3

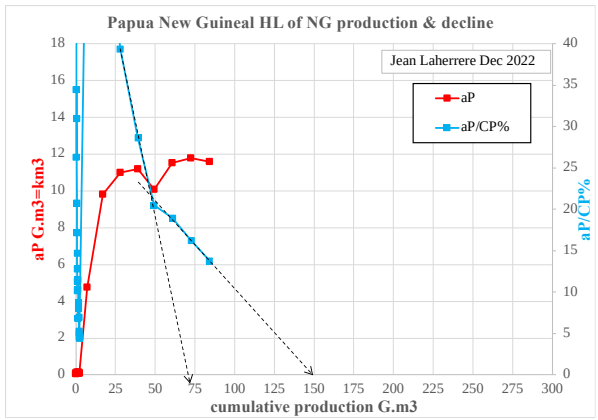

Israel HL of NG production & decline
Jean Laherrere Dec 2022
aP
aP/CP%
aP G.m3=km3
aP/CP%
cumulative production G.m3

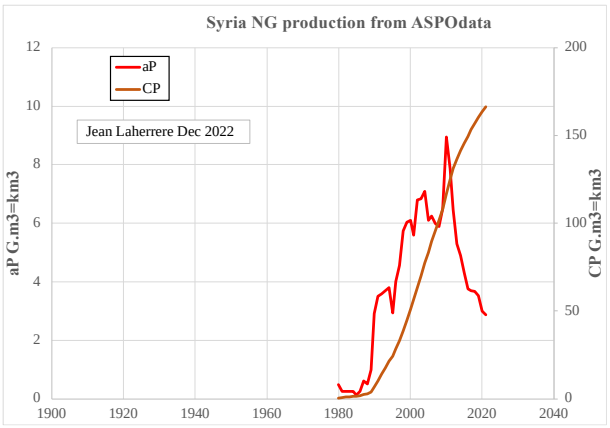
Mozambique past data lacks the future production of developing large offshore gas fields disturbed by terrorism!

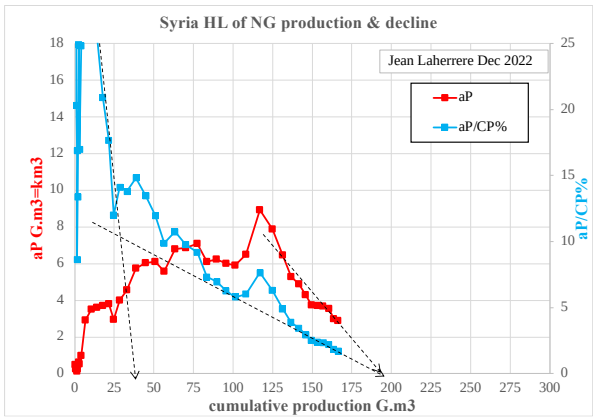












-Recapitulation of ASPO data

For each plotted country or region, are given: the annual production in 2021 (ranked) in G.m3, the cumulative production in 2021 in G.m3, the main peak in G.m3, the peak year, the ultimate from HL in G.m3, the quality of HL, the ultimate from decline in G.m3, the quality of decline, the difference ultimate HL less ultimate decline in G.m3, ultimate HL in Tcf, ultimate cream in Tcf, ratio cream/HL, cumulative production 2021 in Tcf, ultimate HL less cumulative production 2021 in Tcf, remaining proven reserves in 2021 in Tcf from OPEC ASB, remaining proven reserves + cumulative production in 2021 in Tcf, ratio remaining proven reserves + cumulative production/ultimate HL, remaining proven reserves OGJ end

2021 in Tcf, ratio proven reserves OPEC/OGJ, cumulative discovery in 2008 in Tcf, cumulative production in 2008 in Tcf, percentage cumulative production over cumulative discovery in 2008

NG ASPO	G.m3		G.m3	G.m3		G.m3		G.m3		G.m3	Tcf	Tcf		Tcf	Tcf	Tcf	Tcf		Tcf		Tcf	Tcf	%
country, regi	aP2021	rank	CP2021	main peak	peak time	U HL	HL qualit	U decline	decline qualit	UHL-Udec	U HL	U cream	cream/HL	CP2021	U-CP2021	1P 2021 OPEC	RR+CP2021	(RR+CP)/HL	1P 2021 OGJ	P OPEC/OG	CD2008	CP2008	CP/CD 2008
world	4146	1	134201	4146	2021	475000	F	?	NU		16779	13000	0,8	4740	8260	7272	12012	0,7	7297	1,0			
Non OPEC	3473	2	119382	3473	2021	400000	F	?	NU		14129			4217									
Asia	1210	3	24533	1210	2021	60000	VP	?	NU		2119	1380	0,7	867	513								
North Am	1153	4	47299	1153	2021	?	NU	?	NU		#######	3030	#######	1671	1359								
US	963	5	40026	964	2019	40000	VP	?	NU		1413	2600	1,8	1414	1186	433	1847	1,3	445	1,0			
ME	734	6	13407	734	2021	37000	VP	?	NU		1307	?		474		2873	3347	2,6			2982	116	4
Russia	719	7	25001	719	2021	40000	P	?	NU		1413	1700	1,2	883	817	1687	2570	1,8	1688	1,0	1608	590	37
OPEC	673	8	14809	673	2021	40000	P	?	NU		1413			523		2622	3145	2,2					
Africa	277	9	5940	267	2019	?		?	NU		?	840		210	630	639	849				695	175	25
Iran	257	10	4386	257	2021	10000	P	?	NU		353	1400	4,0	155	1245	1201	1356	3,8	1203	1,0	1205	32	3
Europe	220	11	15656	347	2004	19000	F	19000	F		671	850	1,3	553	297								
Qatar	207	12	2800	207	2021	20000	VVP	?	NU		700	1000	1,4	99	901	842	941	1,3	843	1,0	1027	18	2
China	193	13	2583	193	2021	>4000	VP	?	NU		150	270	1,8	91	179	115	206	1,4	247	0,5	192	7	4
Canada	189	14	7313	195	2018	10000	P	?	NU		353	300	0,8	258	42	97	355	1,0	87	1,1			
Oceania	171	15	2241	2241	2021	4400	VP	?	NU		155			79									
Australia	156	16	1968	156	2021	3500	P	?	NU		124	350	2,8	70	280	78	148	1,2	90	0,9	228	1	0
Latin Am	150	17	6693	218	2014	9000	F	9500	VP	-500	318	900	2,8	236	664	?	?	?	?		714	249	35
Saudi Arabia	120	18	2609	120	2021	7000	F	?	NU		247	400	1,6	92	308	301	393	1,6	298	1,0	383	39	10
Norway	117	19	2866	128	2017	4500	F	5500	VP	-1000	159	180	1,1	101	79	70	171	1,1	51	1,4	165	74	45
Algeria	105	20	2921	105	2021	4500	VP	?	NU		159	230	1,4	103	127	159	262	1,6	159	1,0	214	90	42
Turkmenistar	88	21	3108	88	2021	6000	VP	?	NU		212	250	1,2	110	140	493	603	2,8	400	1,2	233	70	30
Egypt	70	22	1271	70	2021	2000	VP	?	NU		71	100	1,4	45	55	78	123	1,7	63	1,2	90	11	12
Malaysia	67	23	1655	67	2019	3000	F	?	NU		106	130	1,2	58	72	77	135	1,3	42	1,8	119	0	0
Indonesia	60	24	2562	80	2010	3500	F	3500	VP	0	124	90	0,7	90	0	90	180	1,5	44	2,1	116	8	7
UAE	54	25	1572	62	2016	2600	P	?	NU		92	190	2,1	56	134	290	346	3,8	273	1,1	179	32	18
Nigeria	49	26	826	50	2020	1800	VP	?	NU		64	240	3,8	29	211	207	236	3,7	203	1,0	211	46	22
Uzbekistan	46	27	2474	63	2008	4000	F	4000	P	0	141	120	0,8	87	33	65	152	1,1	65	1,0	83	55	66
Argentina	45	28	1401	46	2006	2000	VP	?	NU		71	75	1,1	49	26	13	62	0,9	14	0,9	64	40	63
Pakistan	37	29	1098	41	2012	1600	G	?	NU		57	57	1,0	39	18	15	54	1,0	21	0,7	48	0	0
Oman	36	30	628	36	2021	1200	P	?			42	60	1,4	22	38	24	46	1,1	23	1,0	57	7	12
Thailand	33	31	830	42	2014	1100	G	1900	P	-800	39	32	0,8	29	3	3	32	0,8	4	0,8	31	3	9
UK	32	32	2900	108	2000	3000	P	?	NU		106	110	1,0	102	8	6	108	1,0	5	1,3	136	91	67
India	32	33	953	52	2010	1600	VP	?	NU		57	50	0,9	34	16	38	72	1,3	48	0,8	81	15	19
Azerbaijan	31	34	670	31	2021	1400	VP	?	NU		49	60	1,2	24	36	68	92	1,9	60	1,1	57	16	28
Kazakhstan	29	35	539	29	2021	1400	VP	?	NU		49	120	2,4	19	101	65	84	1,7	85	0,8	119	12	10
Trinidad	26	36	881	42	2010	1100	F	1000	P	100	39	50	1,3	31	19	10	41	1,1	10	1,0	50	16	32
Mexico	24	37	1794	60	2009	2000	F	2000	F	0	71	130	1,8	63	67	11	74	1,1	7	1,6	104	62	60
Venezuela	24	38	1158	32	2001	1300	VP	?	NU		46	280	6,1	41	239	196	237	5,2	197	1,0	278	82	29
Libya	24	39	477	24	2021	650	VP	?	NU		23	90	3,9	17	73	53	70	3,0	53	1,0	87	20	23
Netherlands	22	40	3817	85	2010	4000	F	4000	F	0	141	170	1,2	135	35	2	137	1,0	3	0,6	160	109	68
Brazil	21	41	400	24	2017	700	P	?	NU		25	100	4,0	14	86	11	25	1,0	12	0,9	89	11	13
Ukraine	19	42	1643	52	1977	3000	F	?	NU		106	70	0,7	58	12	12	70	0,7	39	0,3	136	91	67
Bahrain	17	43	421	18	2019	1000	F	?	NU		35	21	0,6	15	6				2		21	9	46
Bolivia	17	44	389	22	2014	500	P	?	NU		18	75	4,2	14	61	9	23	1,3	11	0,8	65	9	14
Myanmar	16	45	302	18	2015	460	F	?	NU		16	25	1,5	11	14	8	19	1,1	23	0,4	22	3	15
Israel	16	46	103	16	2021	?	NU	?	NU					4					6		13	0	4
Kuwait	13	47	460	18	2018	500	VP	550	P	-50	18	95	5,4	16	79	63	79	4,5	63	1,0	87	3	4
Peru	12	48	198	14	2017	500	F	?	NU		18	25	1,4	7	18	10	17	1,0	11	0,9	25	2	8
Papua N Gui	12	49	84	12	2020	150	F	?	NU		5			3					6		24	1	4
Iraq	10	50	208	12	2019	800	VP	?	NU		28	150	5,3	7	143	131	138	4,9	131	1,0	162	6	3
Romania	9	51	1352	39	1982	1900	F	1900	P	0	67	55	0,8	48	7	3	51	0,8	4	0,8	48	31	64
Angola	9	52	66	11	2020	120	VP	100	VP	20	4	32	7,5	2	30	11	13	3,1	11	1,0	26	1	4
Germany	5	53	965	24	1979	1000	G	1000	G	0	35	42	1,2	34	8	1	35	1,0	1	1,3	42	42	100
Mozambique	5	54	75	6	2018	100	F	100	P	0	4	100	28	3	97	100	103	29,1	100	1,0	7	1	7
Colombia	5	55	10	13	2013	450	P	500	VP	-50	16	27	1,7	0	27	3	3	0,2	10	0,3	24	17	69
New Zealand	4	56	190	6	2001	225	P	225	VP	0	8	8	1,0	7	1	2	9	1,1	1	1,9	5	3	75
Japan	4	57	170	5	2012	225	F	225	P	0	8	8	1,0	6	2	1	7	0,9	1	1,4	7	0	0
Italy	3	58	795	21	1994	810	G	810	G	0	29	40	1,4	28	12	2	30	1,1	2	1,3	34	25	72
Syria	3	59	166	7	2004	190	F	190	F	0	7	14	2,1	6	8				9		14	0	0
Hungary	2	60	237	7	1978	240	P	240	P	0	8	10	1,2	8	2						10	8	73
Denmark	2	61	212	10	2005	215	F	215	F	0	8	10	1,3	7	3	2	9	1,2	1	2,0	9	7	78
France	0,4	62	229	8	1978	230	F	230	F	0	8	12	1,5	8	4				1		12	12	97
country, regi	aP2021	rank	CP2021	main peak	peak time	U HL	HL qualit	U decline	decline qualit	UHL-Udec	U HL	U cream	cream/HL	CP2021	U-CP2021	1P 2021 OPEC	RR+CP2021	(RR+CP)/HL	1P 2021 OGJ	P OPEC/OG	CD2008	CP2008	CP/CD 2008
world	4146		134201	4146	2021	475000	F				16779	13000	0,8	4740	8260	7272	12012	0,7	7297	1,0			
OPEC+NOP	4146		134191	4146	2021	440000	F				15542			4740									
continents	3915		115769			?					?			4089									

The ratio over 2 are in red and below 0.5 in blue.

The quality of the HL estimates is 23 fair, 18 very poor, 13 poor, 4 good, 2 very very poor and 1 useless.
The quality of the decline is 38 useless, 8 poor, 6 very poor, 6 fair and 2 good.

Most of agencies report only proven reserves, like most of oil and gas producers obliged to follow the SEC rules where the proven reserves = future production are estimated with the economy and technology of today and not of the future.

The US practice leads to a significant upward proven reserve revision.
For the period 1977-2000 the annual average of positive revisions was more ten times the new discovery and the percentage of these positive revisions versus the total of all revisions was about 64% for oil and 55 % for gas and NGL.

average 1977-2000	positive revisions	negative revisions	% positive vs all revisions	proved reserves	new discovery	new reservoirs in old fields
oil	2.6 Gb	1.5 Gb	64 %	26 Gb	0.17 Gb	0.14 Gb

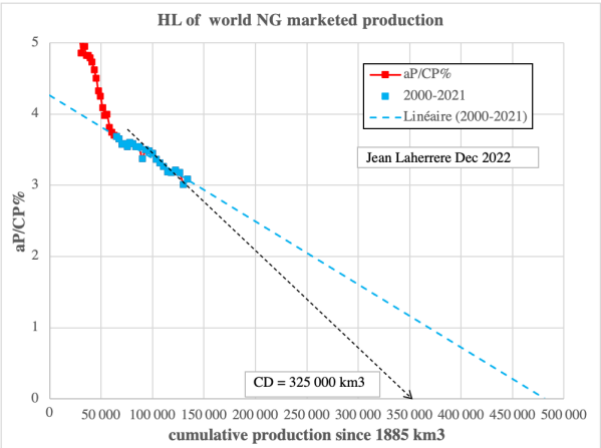
gas	20 Tcf	18 Tcf	54 %	182 Tcf	1.9 Tcf	2.6 Tcf
NGL	1 Gb	0.8 Gb	56 %	7.6 Gb	0.06 Gb	0.08 Gb

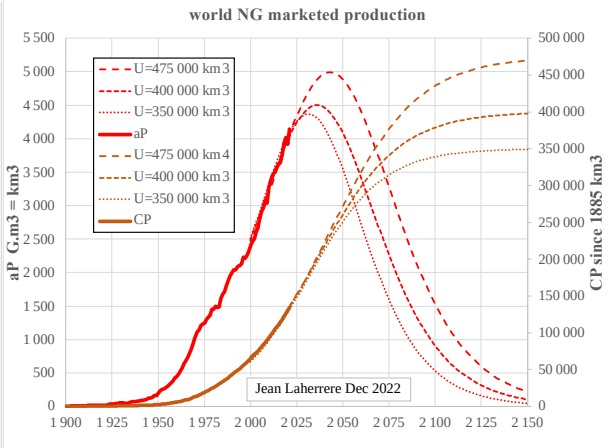
Usually, oil and gas producers publish their proven reserves in their annual report: ExxonMobil published their proven reserves at end 2021 on February 2022.
On January 31 2023, ExxonMobil announces full-year 2022 results except oil and gas reserves.
The anomalies on proven reserves come from the fact that OGJ data is an enquiry in the fall of the year asking the national agencies for estimate for the first of the next year before any serious study waiting to have the full data until year end, when no answer OGJ concludes no change: OGJ proven reserves are not reliable, but they are often recopied by EIA.
On 5 December 2022, OGL reported 107 countries, but only 29 countries (27%) with changes from 2021 to 2022: it means that 73% of the countries find in 2022, exactly the same amount of oil and gas that they have produced: it is impossible!
OPEC ASB data is much better and available in one page since 1960: on T91 it is reported for NG proven reserves from end 2020 to end 2021, 26 countries change their estimates and 36 countries (58 %) report no change: it is too much, but less bad than OGJ.
On T31 OPEC ASB reports 21 countries with change on oil proven reserves and 26 countries (55%) with no change

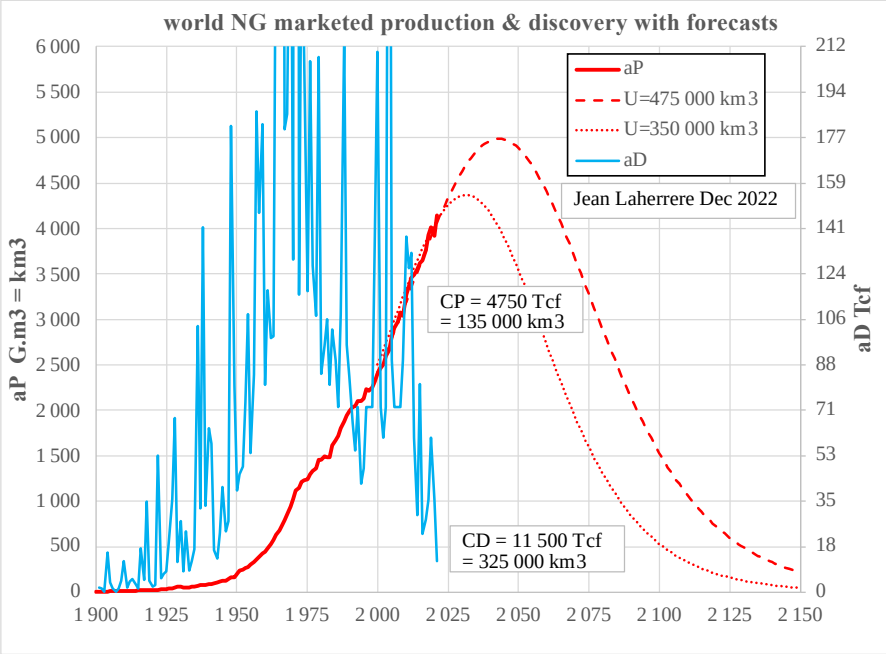
-Forecasts

-world

HL of world marketed NG production trends towards 475 000 km3 (fair)

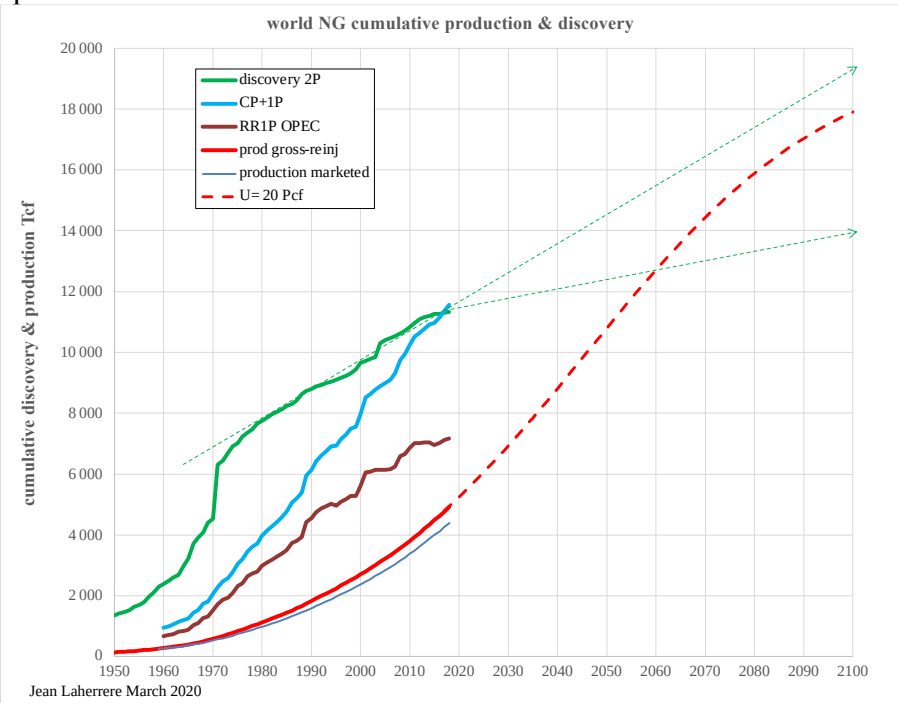






The world NG marketed production (146 Tcf in 2021) will peak between 155 and 175 Tcf between 2030 and 2045

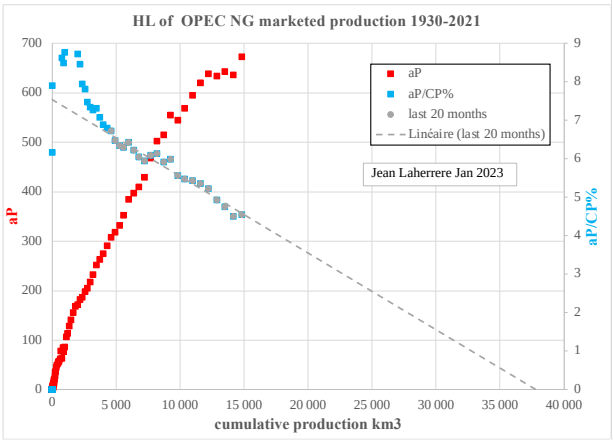
My 2020 graph

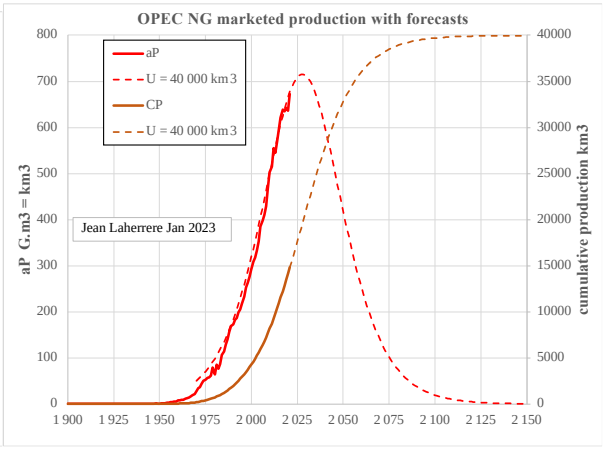


-OPEC

OPEC countries includes Algeria, Angola, Congo, Equatorial Guinea, Gabon, Iran, Iraq, Kuwait, Libya, Nigeria, Saudi Arabia, United Arab Emirates, Venezuela

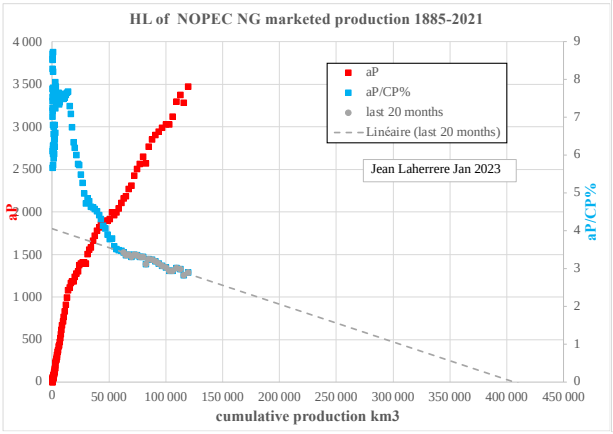
HL of OPEC production trends towards 40 000 km3 (fair); leading to a peak in 2028

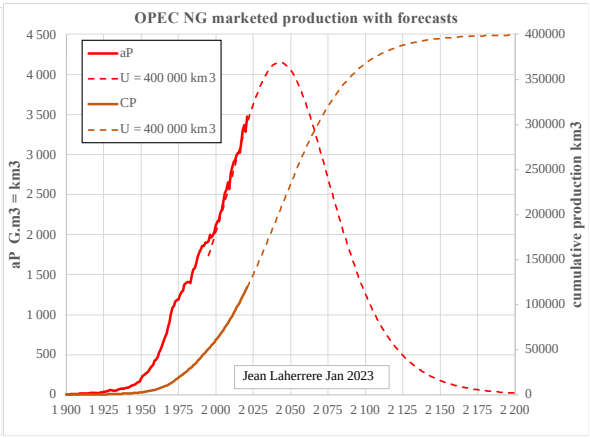




-NOPEC

HL of NOPEC NG marketed production trends towards 400 000 km3 (fair), leading to a peak in 2043.





The sum of ultimates OPEC= 40 000 km3 and NOPEC= 400 000 km3 is 440 000 km3, being lower than the ultimate 475 000 km3 of the world.
It means that the inaccuracy is at least 10 % even when the estimates are judged fair!

-Inventory of the world (outside USL48 onshore and WCSB) discoveries in 2010

discoveries in 2010	basins	fields	oil CD C	NG CD	cond CD	CD Gbo	oil CP G	NG CP	cond CP	CP Gbo	oil RR G	NG RR	cond RR	RR Gbo
Fareast	282	4683	6	683	1	11	3	49	0	4	2	327	1	7
Afghanistan	4	31	0,0	7,3	0,0	0,0	0,0	2,2	0,0	0,0	0,0	5,2	0,0	0,0
Brunei	1	37	3,8	23,5	0,4	8,2	2,6	9,1	0,0	4,1	1,2	14,3	0,4	4,0
Cambodia	1	7	0,1	0,2	0,0	0,2				0,0	0,1	0,2	0,0	0,2
China	95	1491	2,0	192,1	0,2	0,5	0,0	7,3	0,0	0,0	0,1	103,9	0,1	0,2
India	40	603	0,0	80,8	0,0	0,1	0,0	15,3	0,0	0,0	0,0	54,2	0,0	0,1
Indonesia	52	1349	0,0	115,6	0,2	0,1	0,0	8,4	0,0	0,0	0,0	91,5	0,2	0,0
Japan	13	154	0,0	6,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,0	0,0
Malaysia	15	337	0,3	113,4	0,0	0,0	0,0	0,2	0,0	0,0	0,3	14,3	0,0	0,0
Malaysia/Thailand JDA	1	19	0,0	11,6	0,1	2,1		0,3	0,0	0,1	0,0	11,3	0,1	2,0
Mongolia	2	7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Myanmar	8	84	0,0	21,9	0,0	0,0	0,0	3,3	0,0	0,0	0,0	14,6	0,0	0,0
North Korea	1	1	0,0			0,0				0,0	0,0			0,0
Pakistan	13	236	0,0	47,7	0,1	0,0	0,0	0,2	0,0	0,0	0,0	0,3	0,0	0,0
Philippines	9	42	0,0	3,8	0,1	0,0	0,0	0,0	0,0	0,0	0,0	3,8	0,1	0,0
South Korea	1	7		0,5	0,0	0,1		0,0		0,0		0,5	0,0	0,1
Taiwan	3	45	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Thailand	16	132	0,0	31,3	0,0	0,0	0,0	2,9	0,0	0,0	0,0	3,5	0,0	0,7
Turkmenistan	1	1		0,2		0,0				0,0		0,2		0,0
Vietnam	6	100	0,1	26,5	0,0	0,0	0,0	0,0	0,0	0,0	0,1	8,1	0,0	0,0
Australasia	103	1446	1	260	0	2	0	6	0	0	0	168	0	2
Australia	85	1344	0,0	227,9	0,3	2,1	0,0	0,7	0,0	0,0	0,0	140,8	0,3	2,1
East Timor	1	2	0,0			0,0				0,0	0,0			0,0
New Caledonia	1	1		0,0		0,0				0,0		0,0		0,0
New Zealand	11	51	0,0	4,6	0,0	0,0	0,0	3,4	0,0	0,0	0,0	1,1	0,0	0,0
Papua New Guinea	3	35	0,7	24,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0	23,9	0,0	0,0
Timor Sea JPDA	2	13	0,0	3,6	0,0	0,0	0,0	1,3	0,0	0,0	0,0	2,3	0,0	0,0
Latam	180	4606	406	714	9	534	140	249	2	184	266	478	7	352
Argentina	19	1092	13,0	63,8	0,7	24,3	9,6	40,2	0,5	16,8	3,3	24,1	0,2	7,5
Barbados	1	28	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Belize	1	3	0,0	0,0		0,0	0,0			0,0	0,0	0,0		0,0
Bolivia	7	104	0,3	65,2	1,3	12,5	0,3	9,3	0,3	2,1	0,1	56,0	1,0	10,4
Brazil	42	779	56,5	88,7	1,2	72,4	11,2	11,5	0,0	13,1	45,3	77,3	1,2	59,3
Chile	4	165	0,4	10,1	0,1	2,2	0,3	7,9	0,1	1,7	0,1	5,8	0,0	1,1
Colombia	19	444	9,9	24,0	1,0	14,9	6,7	16,6	0,5	10,0	3,2	16,2	0,5	6,4
Cuba		35	0,5	0,5	0,0	0,6	0,2	0,0	0,0	0,2	0,3	0,4	0,0	0,4
Dominican Republic	1	2	0,0			0,0				0,0	0,0			0,0
Ecuador	6	160	8,7	2,6	0,0	9,1	4,5	1,2	0,0	4,7	4,2	1,4	0,0	4,4
Falkland Islands	1	3	0,2	1,7	0,0	0,5				0,0	0,2	1,7	0,0	0,5
Guatemala	2	15	0,2	0,0	0,0	0,3	0,1	0,0	0,0	0,1	0,1	0,0	0,0	0,1
Guyana	1	1	0,0			0,0				0,0	0,0			0,0
Mexico	26	1029	60,6	104,5	0,2	78,2	38,1	62,2	0,0	48,5	22,5	42,3	0,2	29,7
Nicaragua	2	4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Paraguay	1	3		0,0	0,0	0,0				0,0		0,0	0,0	0,0
Peru	12	135	4,7	25,3	0,5	9,4	2,5	2,1	0,1	2,9	2,2	23,1	0,4	6,4
Suriname	1	3	0,2	0,0		0,2	0,1			0,1	0,1	0,0		0,1
Trinidad and Tobago	7	133	4,0	49,6	0,5	12,8	3,5	15,8	0,1	6,2	0,5	34,0	0,5	6,7
Venezuela	27	468	246,9	277,8	3,2	296,4	63,0	81,8	0,4	77,1	183,8	196,0	2,8	219,3
CIS	181	4785	332	3025	31	866	163	802	5	302	168	2223	26	565
Azerbaijan	5	119	18,4	56,9	2,3	30,2	11,4	16,2	0,2	14,3	7,0	40,7	2,1	15,8
Belarus	1	67	1,2	0,7	0,0	1,4	0,7	0,3	0,0	0,8	0,5	0,3	0,0	0,6
Georgia	19		0,4	0,3	0,0	0,4	0,2	0,1	0,0	0,2	0,1	0,2	0,0	0,2
Kazakhstan	15	314	36,8	119,3	6,0	62,8	8,6	12,2	1,0	11,6	28,3	107,1	5,0	51,1
Kyrgyzstan	22	22	0,3	0,9	0,0	0,5	0,1	0,5	0,0	0,2	0,2	0,5	0,0	0,3
Moldova	3	5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Russia	72	3402	264,0	2296,6	18,4	665,1	136,4	589,8	2,4	237,0	127,6	1706,8	16,0	428,1
Tajikistan	7	26	0,1	0,4	0,0	0,2	0,1	0,3	0,0	0,1	0,0	0,2	0,0	0,1
Turkmenistan	9	193	5,0	332,6	1,2	61,6	3,2	70,3	0,3	15,1	1,8	262,3	0,9	46,4
Ukraine	20	399	3,9	98,5	1,1	21,4	1,9	57,9	0,3	11,9	1,9	40,6	0,8	9,5

Africa	152	3409	198,5	695,3	14,5	328,8	93,7	174,6	3,9	126,7	104,8	551,3	10,5	207,2
Algeria	24	448	25,3	213,9	5,4	66,3	13,4	89,7	2,4	30,8	11,9	153,9	2,9	40,5
Angola	5	279	23,2	25,6	0,2	27,7	5,4	0,9	0,0	5,5	17,8	24,7	0,2	22,2
Angola/Congo Unitize	1	2	0,1	0,1		0,1				0,0	0,1	0,1		0,1
Benin	1	4	0,1	0,2	0,0	0,2	0,0			0,0	0,1	0,2	0,0	0,1
Cameroon	2	85	1,6	6,1	0,1	2,7	1,0	0,0	0,0	1,0	0,6	6,1	0,1	1,7
Chad	4	22	1,2	0,3	0,0	1,3	0,3	0,0	0,0	0,3	0,9	0,3	0,0	1,0
Congo	2	89	4,3	4,9	0,1	5,2	2,1	0,0	0,0	2,1	2,2	4,9	0,1	3,1
Cote d'Ivoire	1	29	0,5	2,2	0,0	0,9	0,2	0,5	0,0	0,3	0,3	1,6	0,0	0,6
Democratic Republic o	1	20	0,4	0,6	0,0	0,5	0,3	0,4	0,0	0,4	0,1	0,2	0,0	0,1
Egypt	17	613	13,0	90,1	1,7	29,7	8,7	10,8	0,2	10,8	4,3	79,3	1,5	19,0
Equatorial Guinea	3	38	2,3	10,9	0,7	4,8	1,0	2,7	0,2	1,6	1,3	8,2	0,6	3,2
Eritrea	1	1		0,0		0,0				0,0		0,0		0,0
Ethiopia	1	4	0,0	3,8	0,0	0,6				0,0	0,0	3,8	0,0	0,6
Gabon	4	175	4,9	5,7	0,0	5,9	3,5	0,3	0,0	3,6	1,4	5,4	0,0	2,3
Ghana	2	15	1,6	3,0	0,1	2,2	0,0	0,0	0,0	0,0	1,6	2,9	0,1	2,2
Guinea-Bissau	1	1	0,0	0,0		0,0				0,0	0,0	0,0		0,0
Kenya	1	1	0,0			0,0				0,0	0,0			0,0
Libya	28	497	53,0	86,6	1,2	68,6	28,0	19,9	0,0	31,4	25,0	66,6	1,1	37,3
Madagascar	2	5	0,2	0,2	0,0	0,2	0,0	0,0	0,0	0,0	0,2	0,2	0,0	0,2
Mauritania	2	10	0,1	2,3	0,0	0,5	0,0	0,0	0,0	0,0	0,1	2,3	0,0	0,5
Morocco	7	42	0,0	0,3	0,0	0,1	0,0	0,1	0,0	0,0	0,0	0,2	0,0	0,0
Mozambique	5	9	0,0	7,3	0,0	1,2	0,0	0,5	0,0	0,1	0,0	6,8	0,0	1,2
Namibia	1	1		3,8		0,6				0,0		3,8		0,6
Niger	1	5	0,0	0,0		0,0				0,0	0,0	0,0		0,0
Nigeria	5	703	59,5	211,5	4,3	99,0	28,0	45,8	1,0	36,6	31,6	166,5	3,3	62,6
Nigeria/Sao Tome and	1	5	0,1	1,3	0,0	0,3				0,0	0,1	1,3	0,0	0,3
Senegal	1	11	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0
Sierra Leone	1	1	0,0	0,0		0,0				0,0	0,0	0,0		0,0
Somalia	1	3	0,0	0,2	0,0	0,0				0,0	0,0	0,2	0,0	0,0
South Africa	5	43	0,1	5,0	0,1	1,1	0,1	1,0	0,0	0,3	0,1	3,9	0,1	0,8
Sudan	4	101	3,7	1,2	0,1	4,0	0,2	0,0	0,0	0,2	3,5	1,2	0,1	3,8
Tanzania	4	6	0,0	2,0	0,0	0,3	0,0	0,1	0,0	0,0	0,0	1,9	0,0	0,3
Togo	1	1	0,0	0,0		0,0				0,0	0,0	0,0		0,0
Tunisia	11	124	2,1	5,8	0,3	3,3	1,4	1,8	0,0	1,7	0,7	4,0	0,2	1,6
Uganda	1	16	1,0	0,4		1,1				0,0	1,0	0,4		1,1
ME	93	1471	949	2982	82	1348	271	116	10	305	678	3029	72	1255
Bahrain	1	1	1,5	20,8	0,2	5,1	1,1	9,5	0,1	2,7	0,4	11,3	0,1	2,4
Divided Zone	3	9	12,9	12,2	0,1	15,0	6,2	1,0	0,0	6,4	6,7	11,2	0,1	8,7
Iran	12	169	169,7	1205,0	29,1	399,7	56,6	0,0	0,3	62,2	113,1	1173,1	28,9	337,5
Iraq	6	109	155,4	162,1	0,7	183,0	28,3	5,5	0,0	29,2	127,1	156,5	0,7	153,8
Israel	5	31	0,0	13,2	0,0	2,2	0,0	0,5	0,0	0,1	0,0	12,8	0,0	2,1
Jordan	3	10	0,0	0,0	0,0	0,1	0,0	0,2	0,0	0,0	0,0	0,2	0,0	0,0
Kuwait	2	24	95,6	86,5	3,8	113,8	28,3	3,1	0,0	28,8	67,3	83,4	3,8	85,0
Lebanon	1	1		0,0		0,0				0,0		0,0		0,0
Oman	11	319	14,5	57,2	0,9	24,9	6,2	6,6	0,2	7,5	8,2	50,6	0,8	17,4
Qatar	3	17	14,2	1026,6	26,8	0,0	8,4	17,7	0,5	11,9	5,8	1009,0	26,2	200,2
Saudi Arabia	11	120	395,1	383,3	13,4	472,4	101,3	39,5	6,9	114,8	293,7	344,1	6,5	357,6
Syria	6	183	7,3	13,8	0,2	9,8	3,4	0,0	0,0	3,6	3,9	12,6	0,2	6,2
Turkey	9	263	1,2	1,4	0,0	1,4	0,9	0,4	0,0	1,0	0,3	1,0	0,0	0,4
UAE	12	90	78,1	0,0	6,2	114,1	27,8	32,1	1,4	34,6	50,2	147,2	4,8	79,6
Yemen	8	125	3,2	0,0	0,4	6,3	2,2	0,0	0,2	2,4	1,0	16,4	0,2	3,9

Latam	180	4606	406	714	9	534	140	249	2	184	266	478	7	352
Argentina	19	1092	13,0	63,8	0,7	24,3	9,6	40,2	0,5	16,8	3,3	24,1	0,2	7,5
Barbados	1	28	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Belize	1	3	0,0	0,0		0,0	0,0			0,0	0,0	0,0		0,0
Bolivia	7	104	0,3	65,2	1,3	12,5	0,3	9,3	0,3	2,1	0,1	56,0	1,0	10,4
Brazil	42	779	56,5	88,7	1,2	72,4	11,2	11,5	0,0	13,1	45,3	77,3	1,2	59,3
Chile	4	165	0,4	10,1	0,1	2,2	0,3	7,9	0,1	1,7	0,1	5,8	0,0	1,1
Colombia	19	444	9,9	24,0	1,0	14,9	6,7	16,6	0,5	10,0	3,2	16,2	0,5	6,4
Cuba		35	0,5	0,5	0,0	0,6	0,2	0,0	0,0	0,2	0,3	0,4	0,0	0,4
Dominican Republic	1	2	0,0			0,0				0,0	0,0			0,0
Ecuador	6	160	8,7	2,6	0,0	9,1	4,5	1,2	0,0	4,7	4,2	1,4	0,0	4,4
Falkland Islands	1	3	0,2	1,7	0,0	0,5				0,0	0,2	1,7	0,0	0,5
Guatemala	2	15	0,2	0,0	0,0	0,3	0,1	0,0	0,0	0,1	0,1	0,0	0,0	0,1
Guyana	1	1	0,0			0,0				0,0	0,0			0,0
Mexico	26	1029	60,6	104,5	0,2	78,2	38,1	62,2	0,0	48,5	22,5	42,3	0,2	29,7
Nicaragua	2	4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Paraguay	1	3		0,0	0,0	0,0				0,0		0,0	0,0	0,0
Peru	12	135	4,7	25,3	0,5	9,4	2,5	2,1	0,1	2,9	2,2	23,1	0,4	6,4
Suriname	1	3	0,2	0,0		0,2	0,1			0,1	0,1	0,0		0,1
Trinidad and Tobago	7	133	4,0	49,6	0,5	12,8	3,5	15,8	0,1	6,2	0,5	34,0	0,5	6,7
Venezuela	27	468	246,9	277,8	3,2	296,4	63,0	81,8	0,4	77,1	183,8	196,0	2,8	219,3
Europe	336	5173	82	653	10	201	59	416	3	132	22	248	7	71
Albania	2	20	0,6	1,2	0,1	0,9	0,3	0,4	0,0	0,4	0,3	0,8	0,1	0,5
Austria	7	233	0,9	4,9	0,0	1,7	0,8	3,2	0,0	1,4	0,1	1,7	0,0	0,4
Bosnia and Herzegovi	2	2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Bulgaria	9	35	0,1	0,7	0,0	0,2	0,1	0,3	0,0	0,1	0,0	0,4	0,0	0,1
Croatia	8	134	0,8	4,3	0,1	1,6	0,7	1,7	0,1	1,0	0,1	2,6	0,0	0,6
Czech Republic	5	71	0,1	0,6	0,0	0,2	0,1	0,3	0,0	0,1	0,0	0,3	0,0	0,1
Denmark	10	40	2,8	9,4	0,3	4,6	2,0	7,4	0,2	3,4	0,8	3,7	0,0	1,5
Faroe Islands	1	1	0,1	0,0		0,1				0,0	0,1	0,0		0,1
France	16	168	0,9	12,0	0,1	3,0	0,8	11,7	0,1	2,8	0,1	0,3	0,0	0,2
Germany	14	560	2,4	41,9	0,1	9,5	2,0	41,9	0,0	9,0	0,4	0,1	0,1	0,5
Greece	4	10	0,2	0,2	0,0	0,2	0,1	0,2	0,0	0,2	0,1	0,0	0,0	0,1
Hungary	15	248	0,9	10,4	0,1	2,7	0,6	7,6	0,0	1,9	0,3	2,8	0,1	0,8
Ireland	5	22	0,1	5,2	0,2	1,2	0,0	1,8	0,0	0,3	0,1	3,5	0,2	0,9
Italy	30	575	2,0	34,2	0,1	7,7	0,9	24,5	0,0	5,0	1,1	9,7	0,0	2,7
Latvia	1	2	0,0	0,0		0,0				0,0	0,0	0,0		0,0
Lithuania	2	27	0,1	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Macedonia	1	1	0,0	0,0		0,0				0,0	0,0	0,0		0,0
Malta	1	1		0,0		0,0				0,0		0,0		0,0
Netherlands	10	483	1,2	160,4	0,5	28,4	0,9	109,3	0,1	19,1	0,3	51,2	0,4	9,2
Norway	56	288	30,2	165,0	4,7	62,4	22,3	74,1	1,3	35,9	7,9	97,6	3,4	27,5
Poland	12	466	0,4	14,6	0,0	2,8	0,2	7,7	0,0	1,5	0,2	6,9	0,0	1,4
Portugal	3		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Romania	33	682	7,2	47,8	0,3	15,5	4,5	30,6	0,0	9,6	2,8	17,2	0,3	5,9
San Marino	1	1		0,0		0,0		0,0		0,0		0,0		
Serbia	1	115	0,4	1,4	0,0	0,7	0,3	0,7	0,0	0,4	0,1	0,7	0,0	0,2
Slovakia	6	49	0,0	1,6	0,0	0,3	0,0	1,2	0,0	0,2	0,0	0,4	0,0	0,1
Slovenia	2	6	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Spain	9	71	0,3	0,8	0,0	0,4	0,3	0,5	0,0	0,3	0,0	0,3	0,0	0,1
Svalbard and Jan May	2	2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sweden	2	26	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Switzerland	1	5	0,0	0,0	0,0	0,0		0,0	0,0	0,0	0,0	0,0	0,0	0,0
United Kingdom	65	829	30,2	136,2	3,7	56,6	22,7	91,1	1,5	39,3	7,5	48,1	2,3	17,8
Nam	48	598	48	142	2	74	23	8	0	30	25	59	2	54
Canada exc WCSB	31	175	5,3	50,1	0,5	14,1	1,4	3,9	0,0	2,0	3,9	46,9	0,5	12,2
US exc L48 onshore	17	423	42,9	91,9	1,3	59,5	21,9	3,7	0,2	28,3	20,9	12,0	1,1	42,0

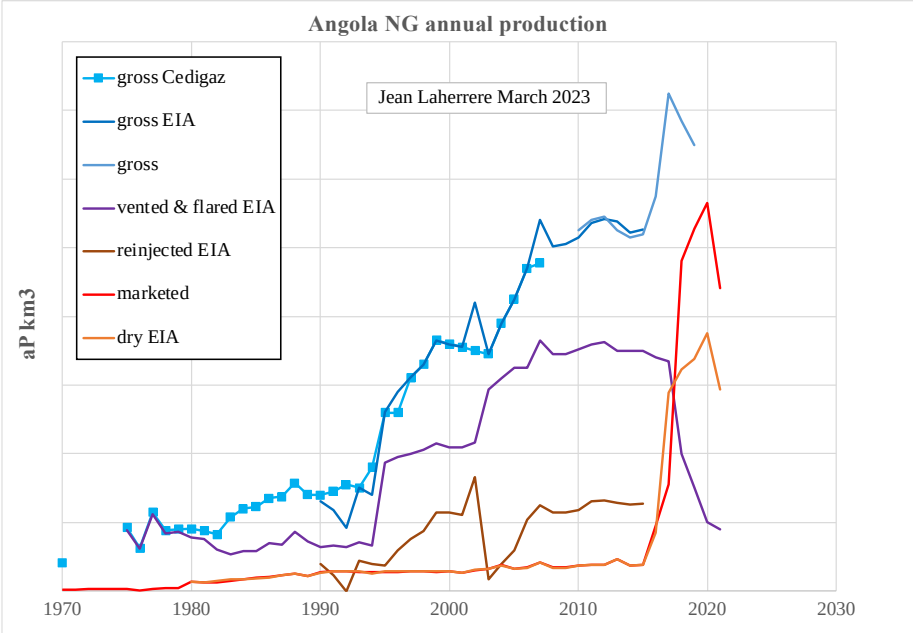
-Country NG remaining reserves end 2021 1P from OGJ, OPEC and U-CP from HL

The comparison of remaining 1P at end 2021 from OGJ (Tcf) and from OPEC ASB (km3) is given in the next table, as the ultimate from HL & the CP2021: I remind 1 Tcf = 28.31 km3 (G.m3 or Gcm).

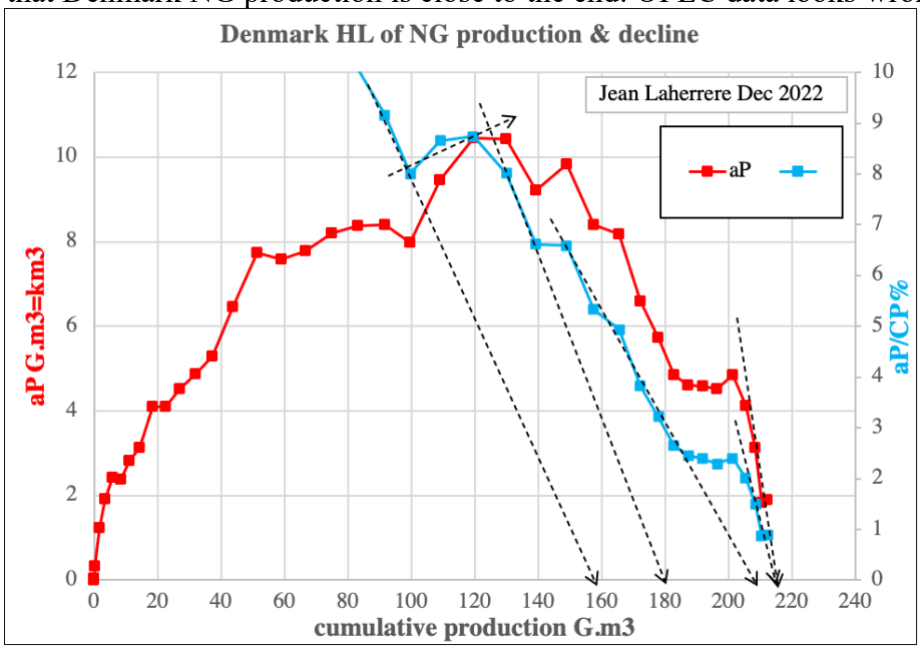
China 1P is double from OGJ compared with OPEC, when Indonesia 1P is half from OGJ compared with OPEC.

	Tcf	Tcf	Tcf	km3	km3	km3	km3	1P OPEC
country	OPEC ASB	OGJ 1P2021	OPEC-OGJ	OPEC ASB	U HL km3	CP2021 km3	U-CP km3	1P/U-CP
Algeria	159	159	0	4504	4500	2921	1579	2,9
Angola	11	11	0	301	120	66	54	5,6
Argentina	13	14	-1	377	?	1401		
Australia	78	96	-18	2218	3500	156	3344	0,7
Azerbaijan	68	60	8	1917	?	670		
Bahrein		2			1000	421	579	
Bangladesh	10	4	6	269				
Bolivia	9	11	-2	253	500	389	111	2,3
Brazil	11	12	-1	312	700	400	300	1,0
Brunei	8	9	-1	233				
Bulgaria	0	0	0	4				
Cameroon	6	5	2	179				
Canada	97	87	10	2758	10000	7313	2687	1,0
Chile	0	3	-3	8				
China	115	247	-132	3269	?	2582		
Colombia	3	3	0	79	450	330	120	0,7
Congo	10	10	0	284				
Denmark	2,2	1,0	1	63	215	212	3	23,9
Ecuador	0	0	0	10				
Egypt	78	63	15	2209	2000	1271	729	3,0
Equatorial Gui	1	1	0	39				
Gabon	1	1	0	26				
Germany	1	1	0	20	1000	965	35	0,6
India	38	48	-11	1071	1600	953	647	1,7
Indonesia	90	44	47	2553	3500	2532	968	2,6
Iran	1201	1203	-3	33988	10000	4386	5614	6,1
Iraq	131	131	0	3714	800	208	592	6,3
Italy	2	2	0	44	815	795	20	2,2
Japan	1	1	0	24	225	170	55	0,4
Kazakhstan	65	85	-20	1830	1400	539	861	2,1
Kuwait	63	63	0	1784	1000	460	540	3,3
Libya	53	53	0	1505	650	477	173	8,7
Malaysia	77	42	35	2179	3000	1655	1345	1,6
Mexico	11	7	4	305	2000	1795	205	1,5
Mozambique	100	100	0	2840				
Myanmar	8	23	-14	240				
Netherlands	2	3	-1	63	3950	3817	133	0,5
New Zealand	2	1	1	52	225	190	35	1,5
Nigeria	207	203	4	5848	1750	826	924	6,3
Norway	70	51	19	1991	4500	2866	1634	1,2
Oman	24	23	1	673	1200	628	572	1,2
Pakistan	15	21	-6	428	1600	1098	502	0,9
Peru	10	10	0	287	300	198	102	2,8
Poland	3	3	0	88				
Qatar	842	843	-1	23831	20000	2800	17200	1,4
Romania	3	4	-1	77	1900	1352	548	0,1
Russia	1687	1688	-1	47759	40000	25001	14999	3,2
Saudi Arabia	301	298	3	8507	7000	2609	4391	1,9
Thailand	3	4	-1	85	1100	830	270	0,3
Trinidad & Tol	10	11	-1	279	1100	881	219	1,3
Turkmenistan	493	400	93	13950	6000	3108	2892	4,8
Ukraine	12	39	-27	338	3000	1643	1357	0,2
UAE	290	273	17	8200	2650	1572	1078	7,6
UK	6	5	1	172	3000	2900	100	1,7
US	433	445	-13	12246	70000	40026	29974	0,4
Uzbekistan	65	65	0	1846	3900	2474	1426	1,3
Venezuela	196	197	-2	5541	1300	1158	142	38,9
Vietnam	7	25	-18	186				
world	7272	7297	-25	205865	475000	134241	340759	0,6
Africa	639	620	19	18098	?	5940		
Middle East	2873	2868	5	81321	37000	13407	23594	3,4
OPEC	2622	2604	18	74242	40000	14809	25191	2,9

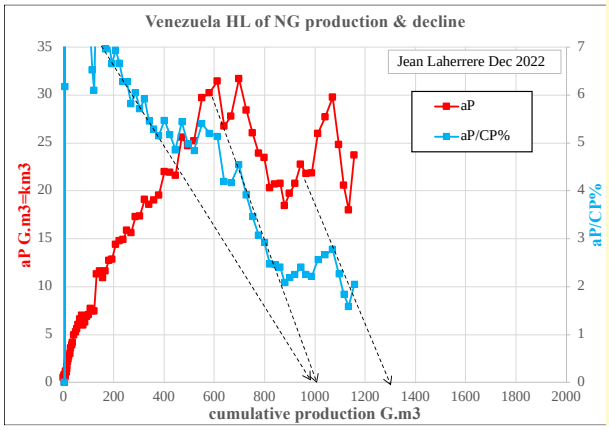
The ratio of 1P2021 (OPEC) versus U-CP2021 is reported and in red when over 5. Anomalous data is found for Angola, but when most of agreements (mainly production sharing contract) between state and companies, oil and gas are produced by the contractor when in Angola Sonangol was the only entity who has ownership rights on natural gas. Most of the Angola gas was reinjected or flared and the surplus is owned by Sonangol. Angola LNG plant at Soyo (Chevron 36.4%, Sonangol, ENI, BP, Total 13.6%) was developed to commercialize natural gas. The LNG plant started in June 2013, but faced an extended plant shutdown in 2016.It is only after 2016 that flaring was reduced and that marketed gas increases. Gross NG production peaked in 2017?

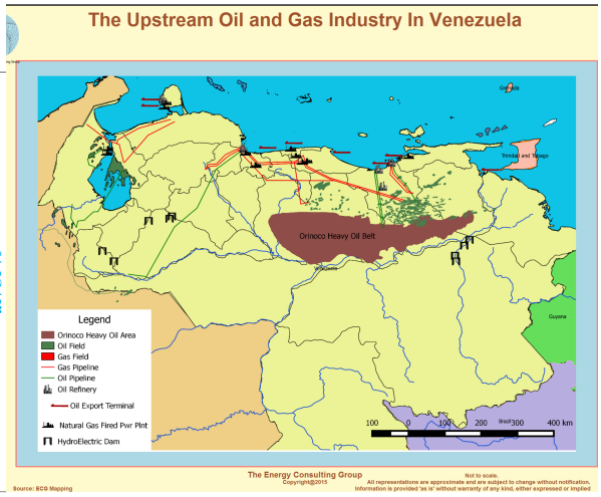


Denmark 1P OPEC is the double of OGJ 1P and 24 times more than U-CP: it is obvious on the HL plot that Denmark NG production is close to the end: OPEC data looks wrong.



Another anomaly is Venezuela where 1P is very high (196 Tcf) when HL trends towards a smaller volume: it appears that most of the NG reserves are located in the remote Maturin basin (where the Orinoco extra-heavy oil stands) with no gas pipeline.





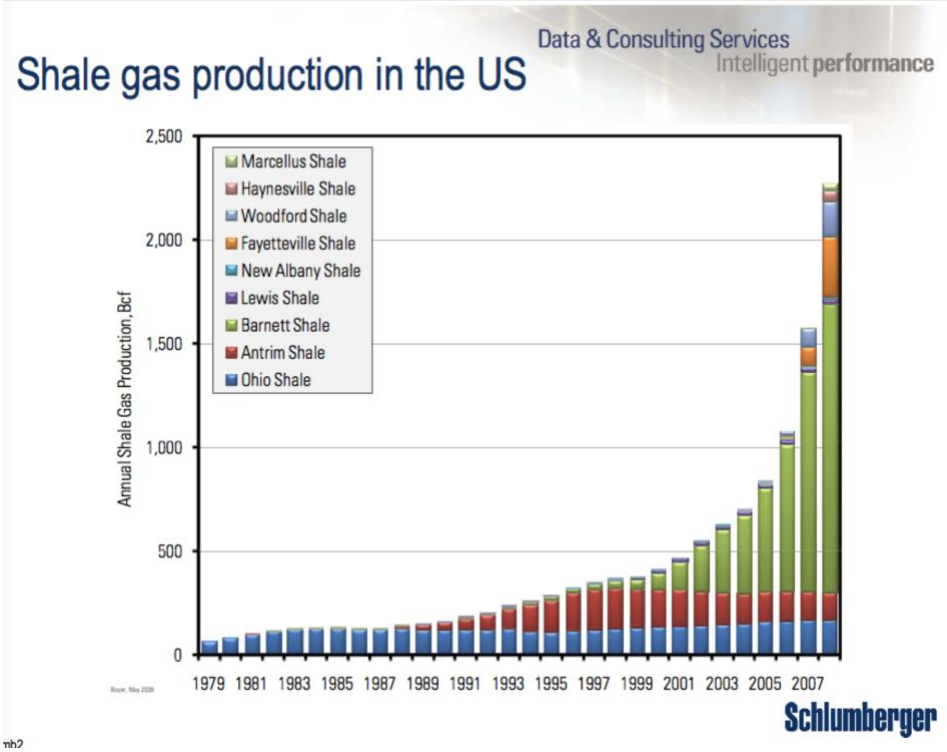
-US shale gas

The first well drilled in the US was for gas in 18 at Fredonia producing from the Devonian shale, but this shale gas production was abandoned in 1860 because cheap conventional gas.
Then in 1880 Big Sandy field was from the Ohio shale.
The Eastern Gas Shales Project, a series of public-private shale drilling demonstration projects, was in the 1970s.
Then in 1982 Barnett shale production.
http://www.all-llc.com/publicdownloads/ALL-GWPC_prudent-sustain.pdf
Prudent and Sustainable Water Management and Disposal Alternatives Applicable to Shale Gas Development J. Daniel Arthur, P.E., ALL Consulting

Shale Gas History

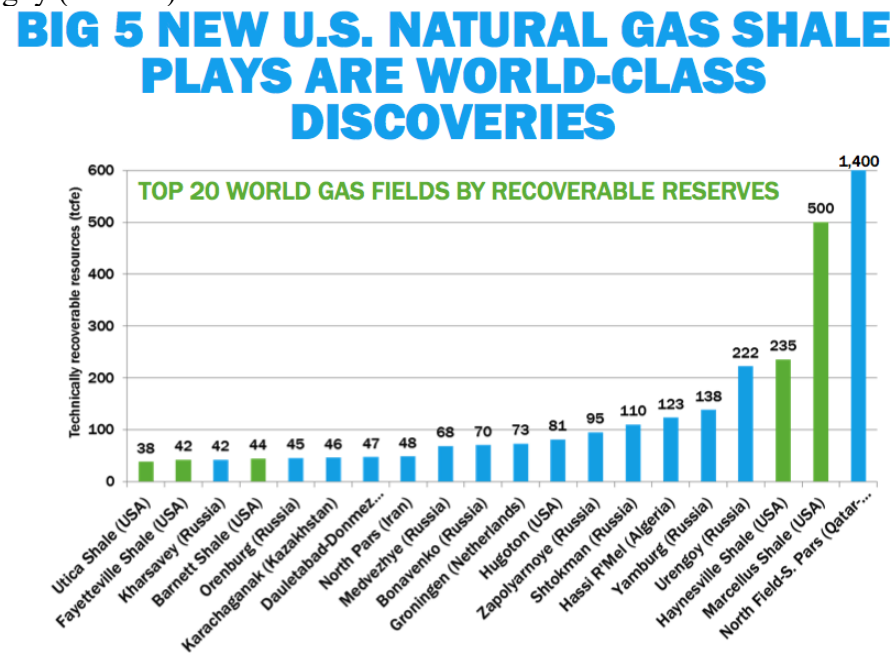
- First Commercial Gas well – Fredonia, NY (1821)
  - New York's "Dunkirk Shale" at a depth of less than 30 feet
- Ohio Shale – Big Sandy Field (1880)
- Hydraulic Fracturing used in the Oil & Gas Industry (1950-60s)
- Barnett Shale – Ft. Worth Basin Development (1982)
- Horizontal wells in Ohio Shales (1980s)
- Successful Horizontal Drilling in Barnett Shale (2003)
- Horizontal Drilling Technology Applied in Appalachian Basin, Ohio and Marcellus Shales (2006)
- Horizontal Drilling and Hydraulic Fracturing are key technologies in the economic success of modern Shale Gas Development

Schlumberger plots US shale gas production since 1979 with Ohio shale



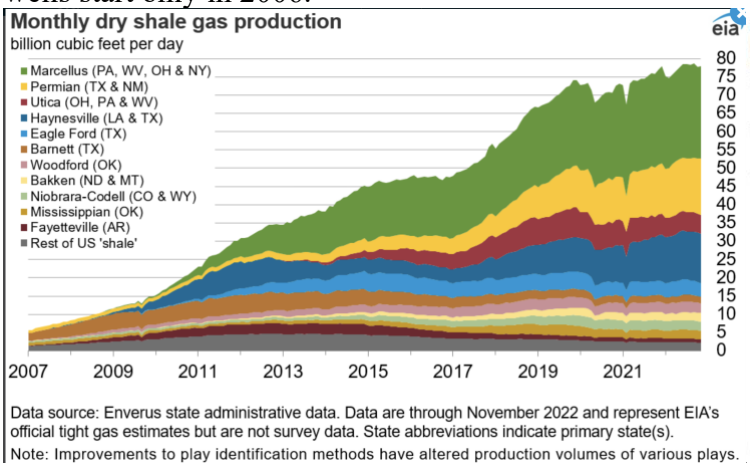
It is important to distinguish shale gas production without horizontal wells and hydraulic fracking and with horizontal + fracking.

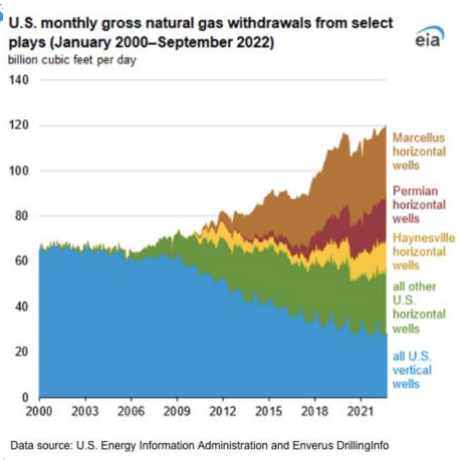
In 2011 «Réserves et ressources des *shale oil & shale gas* » Club de Nice http://aspofrance.viabloga.com/files/JL_Nice2011long.pdf, I displayed this Chesapeake graph stating that the Marcellus shale gas (500 Tcf) was the second world gas field after North Dome =North Field Qatar-South Pars Iran (1400 Tcf), the third being Haynesville (235 Tcf) before Urengoy (222 Tcf) in Russia



On page 51 Marcellus ultimate is estimated at 130 Tcf and not 500 Tcf.
EIA reports monthly shale gas production on Excel since January 2000 to November 2021 for 11 plays plus a rest of US shale, giving 12 series; but the EIA graph starts only since 2007,

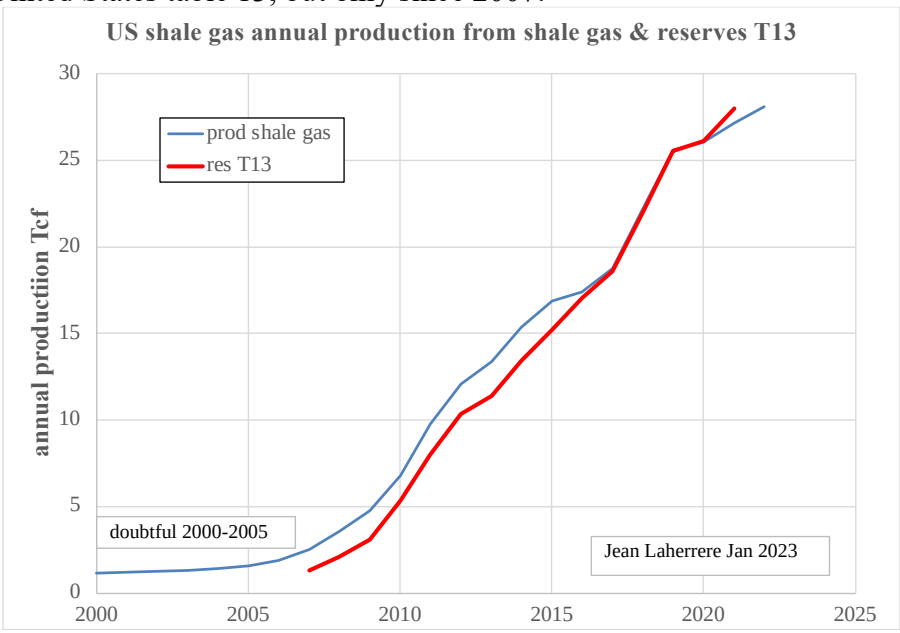
However shale gas production is reported before 2007 when gas withdrawals from horizontal wells start only in 2006.





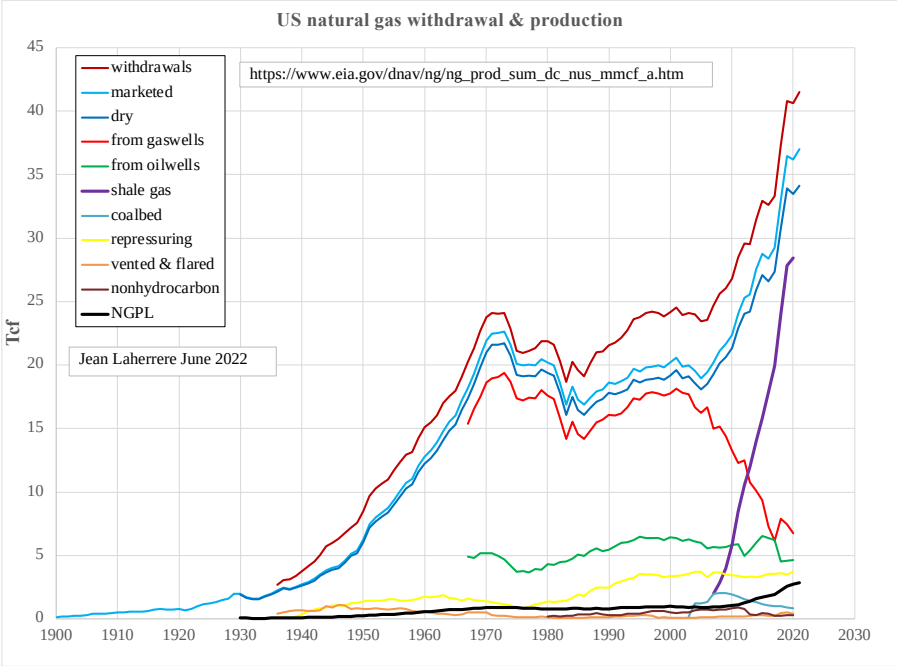
Unfortunately, EIA reports 3 different shale gas production values from 3 sources: production, drilling and reserves!

EIA reports annual shale gas production in their " Proved Reserves of Crude Oil and Natural Gas in the United States table 13, but only since 2007.

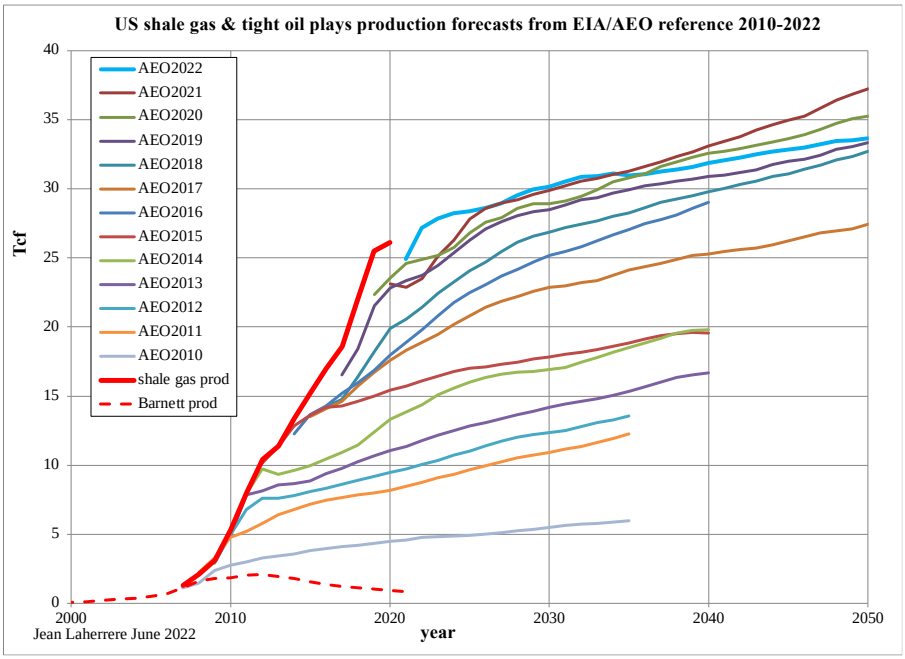


EIA annual shale gas production is similar only from 2017 to 2020, before they differ and before 2005 the data is doubtful.
Before 2007, EIA confuses shale gas and tight gas as already indicated in my papers and they still confuse them in their AEO forecast see page 59.

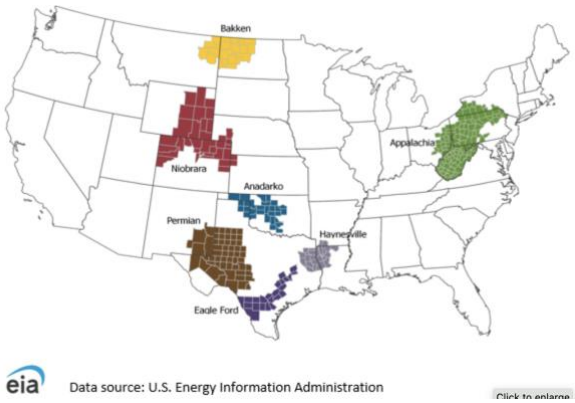
Shale gas production represents in 2022 a large part of the US NG production, when before 2005



EIA in their annual energy outlook forecast shale gas and tight oil plays gas production with a forecast.



EIA also reports shale gas production in their drilling productivity report for 7 shale gas regions (against 12 plays for the



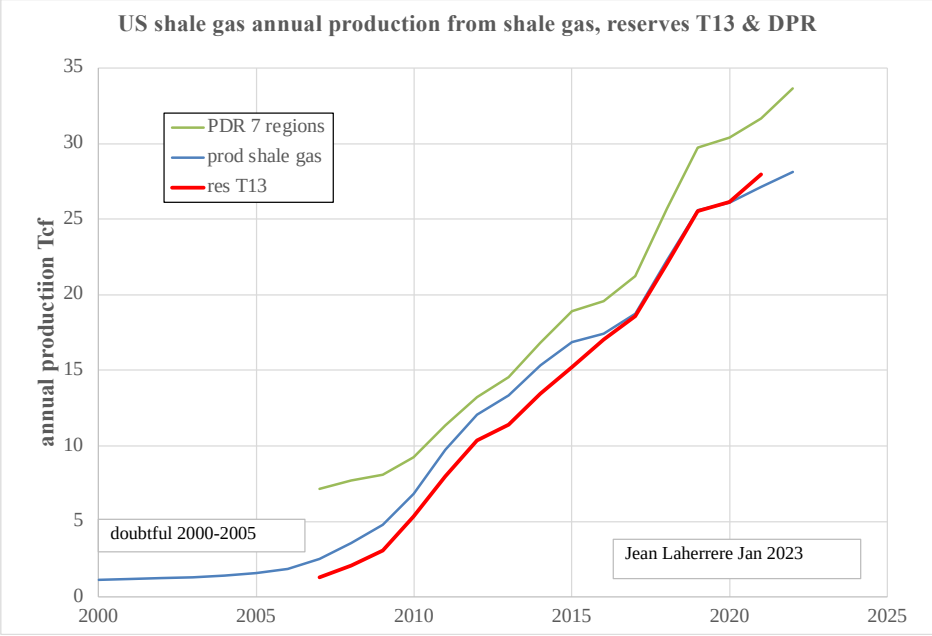
Drilling Productivity Report

Release Date: December 12, 2022 | **Next Release Date:** January 17, 2023 | full report

NEW-WELL PRODUCTION PER RIG BY REGION | PRODUCTION BY REGION | DUC WELLS BY REGION

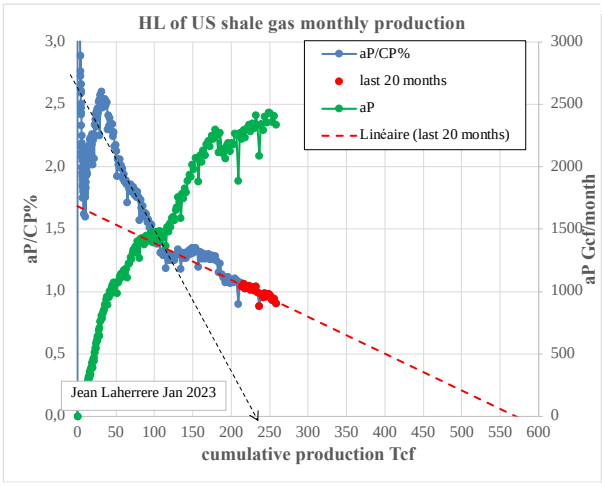
	Oil production thousand barrels/day			Gas production million cubic feet/day		
Region	**December 2022**	**January 2023**	**change**	**December 2022**	**January 2023**	**change**
Anadarko	427	438	11	6,967	6,991	24
Appalachia	126	129	3	35,417	35,530	113
Bakken	1,200	1,221	21	3,323	3,356	33
Eagle Ford	1,231	1,241	10	7,390	7,459	69
Haynesville	37	37	-	16,257	16,409	152
Niobrara	662	674	12	5,124	5,149	25
Permian	5,542	5,579	37	21,268	21,387	119
Total	**9,225**	**9,319**	**94**	**95,746**	**96,281**	**535**

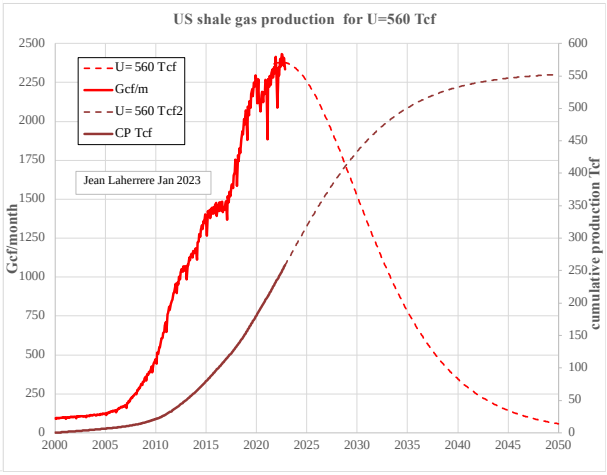
DPR data on the us is quite higher than the shale gas data and is unreliable, not being data but guesses, the best proof is that this data reports end Jan 2023 production value before the end of the month. It appears that EIA provides several data on the same product as if there is no one to check the discrepancy (I often said in some previous papers on EIA: where is the boss?)



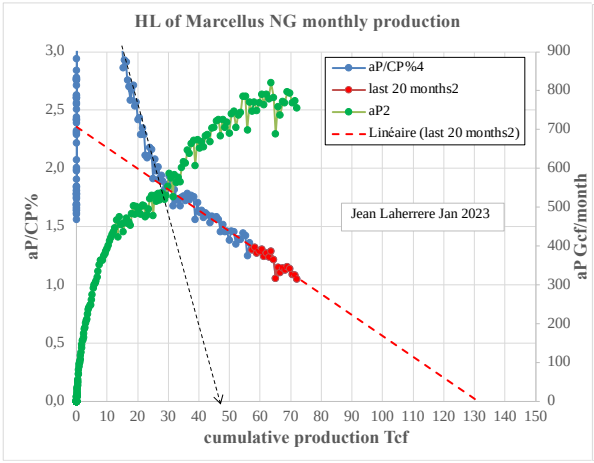
My 2021 paper "US shale plays production from EIA Jan2007-Sept2021 & forecasts" November https://aspofrance.org/2021/11/18/us-shale-plays-production-from-eia-jan2007-sept2021-forecasts/ was based on poor data and then not very good.

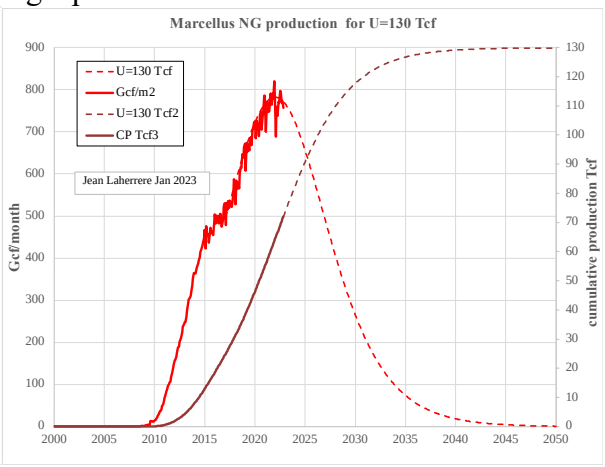
HL of US shale gas production Jan2000-Nov2022 trends towards 560 Tcf meaning a peak in July 2022



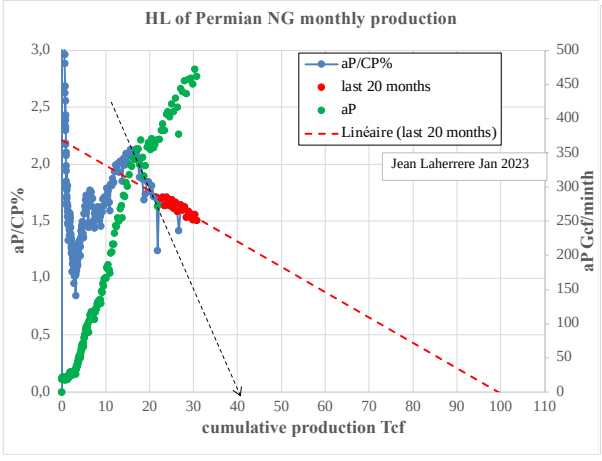


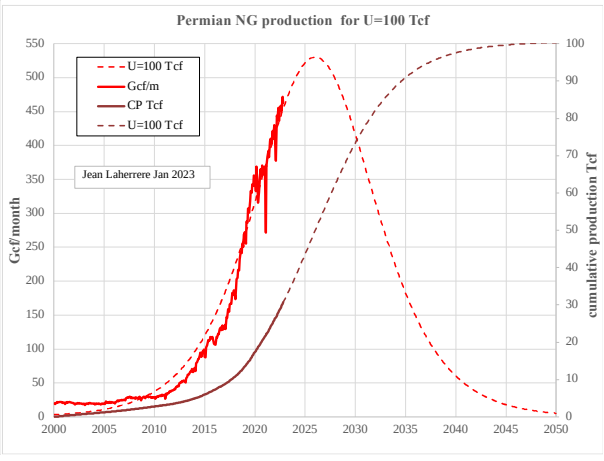
HL of Marcellus trends towards 130 Tcf meaning a peak in December 2021



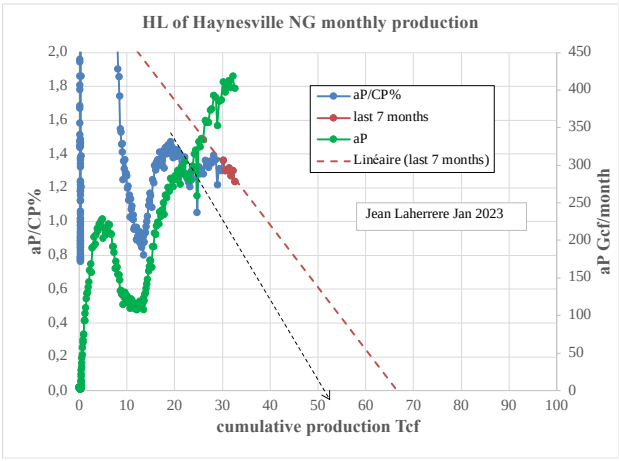


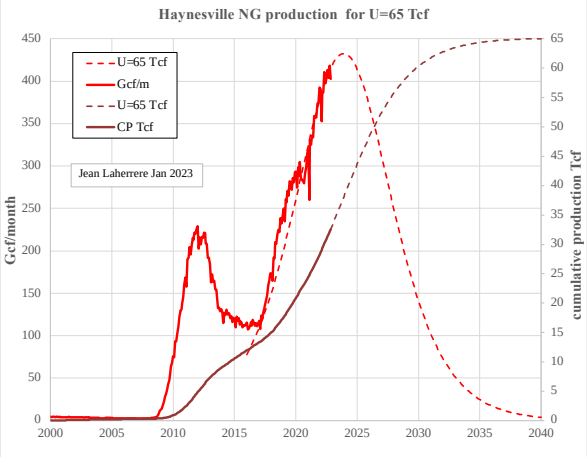
HL of Permian trends towards 100 Tcf (55 Tcf in 2021 paper) meaning a peak in 2026: there is still some undrilled locations in New Mexico in contrary to most shale plays.



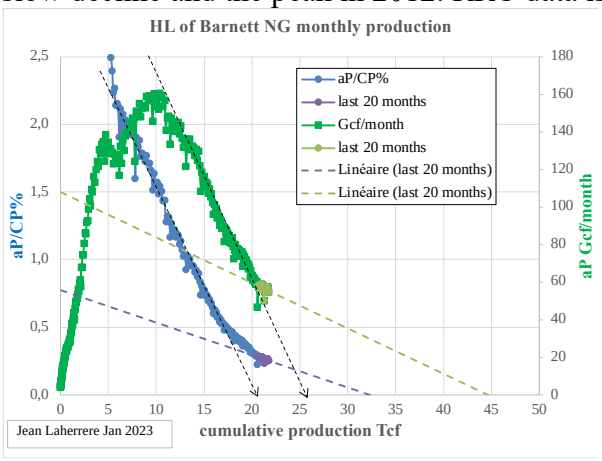


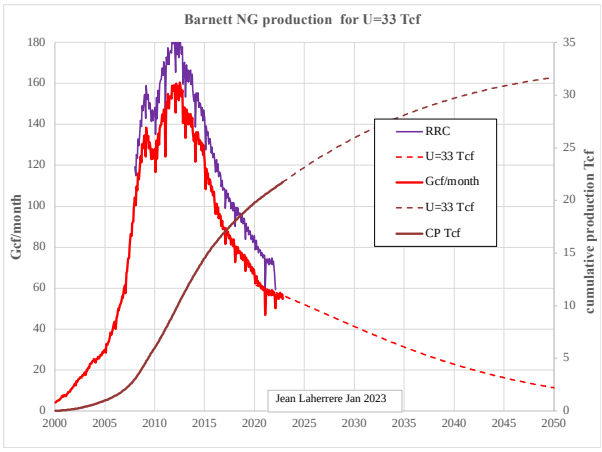
HL of Haynesville trends towards 65 Tcf, meaning a peak at end 2023



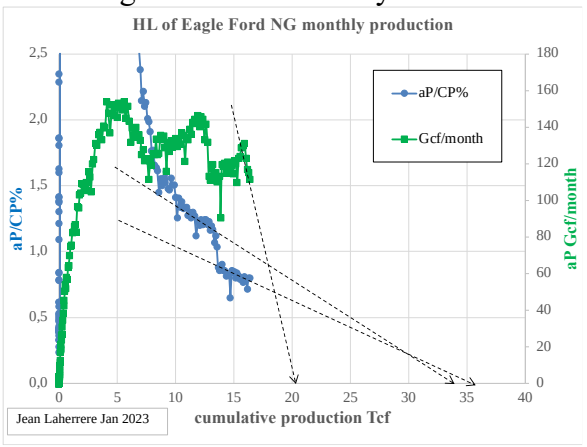


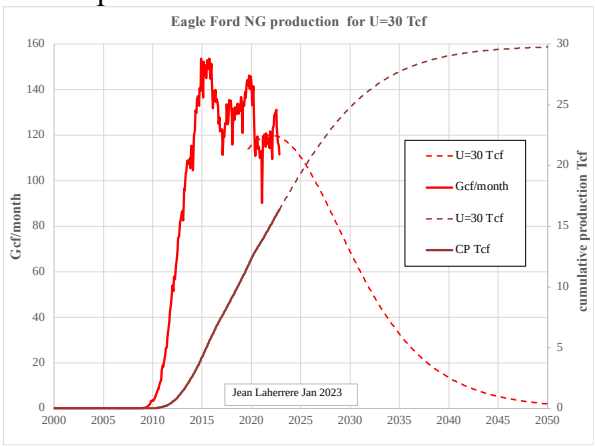
HL of Barnett trends towards 33 Tcf (but decline trends towards 45 Tcf) , meaning a long slow decline and the peak in 2012. RRC data is higher!



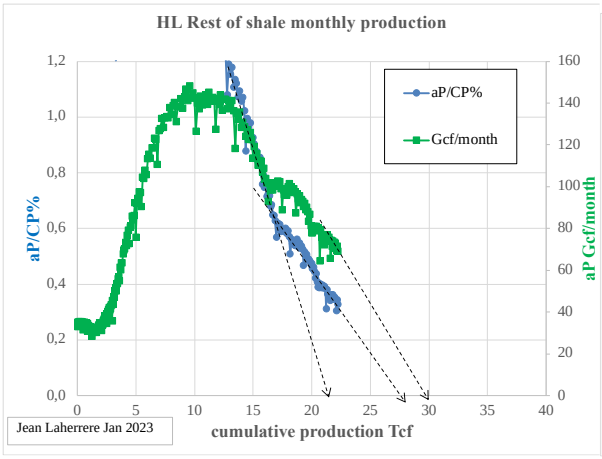


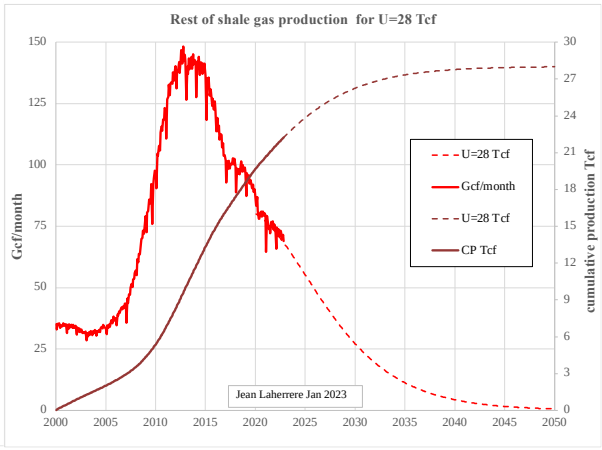
HL of Eagle Ford trends badly towards 30 Tcf with a peak in 2015



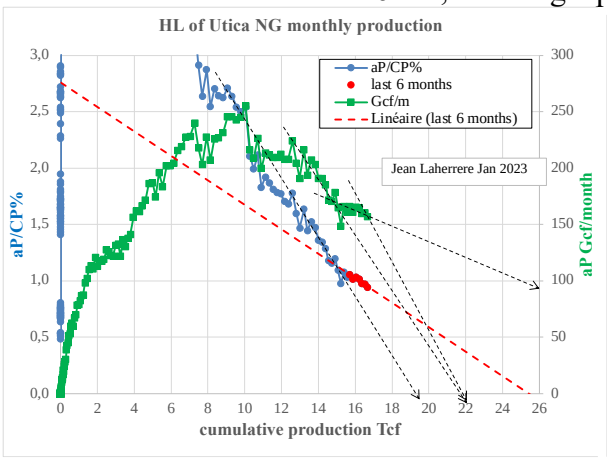


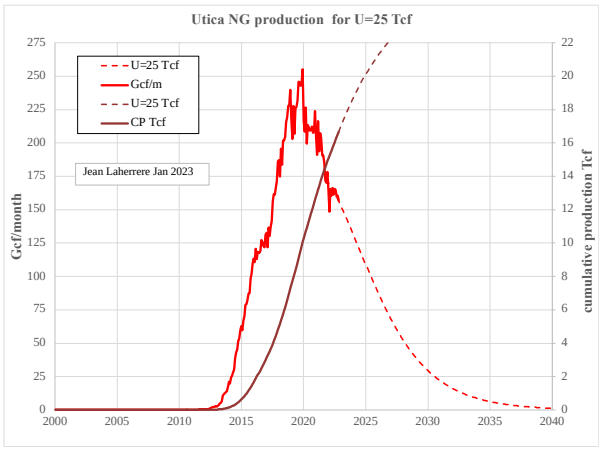
HL of rest of shale gas trends towards 28 Tcf, meaning a peak in 2012. The production data on Jan 2000 at 33 Gcf per month is much higher than the other shale regions, meaning that this production is more from horizontal wells than from present fracking.



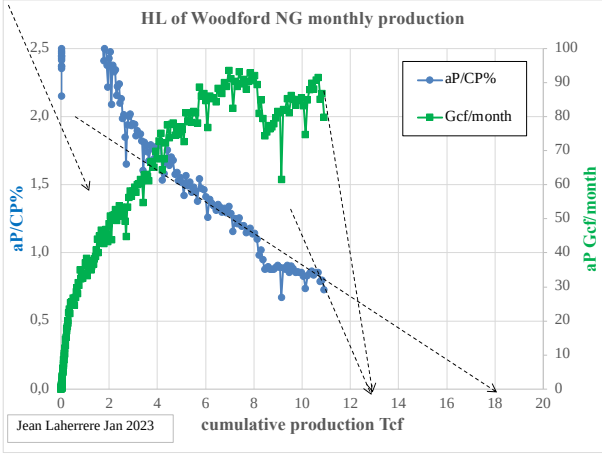


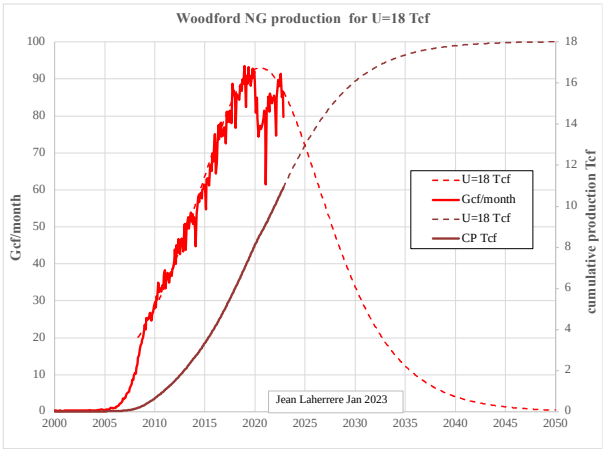
HL of Utica trends towards 26 Tcf, meaning a peak in 2020



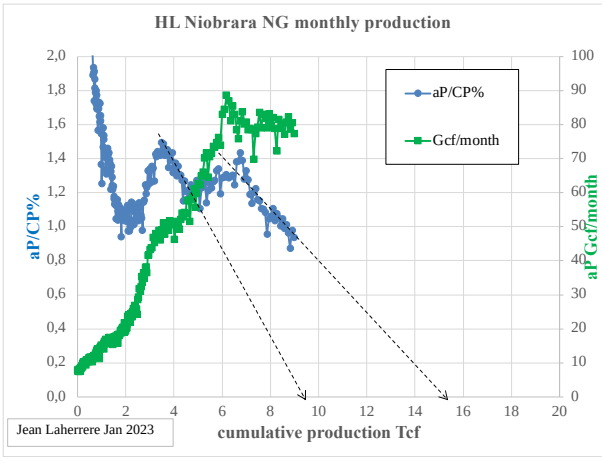


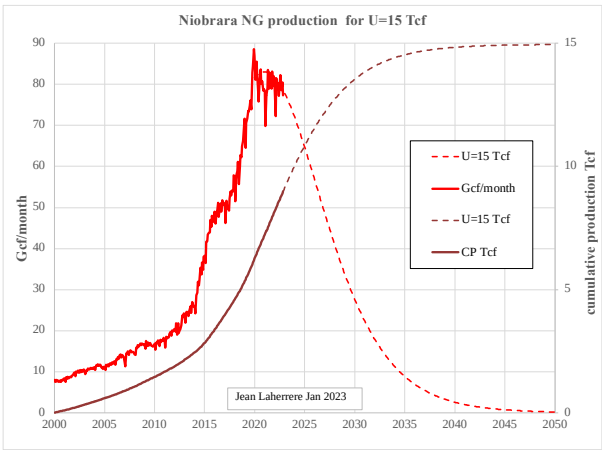
HL of Woodford trends towards 13-18 Tcf, meaning a peak in 2020



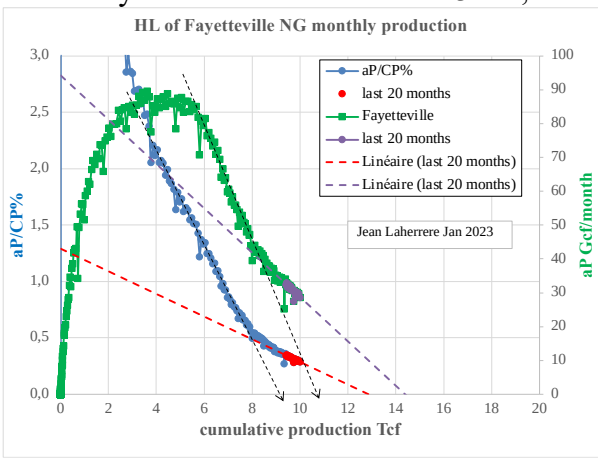


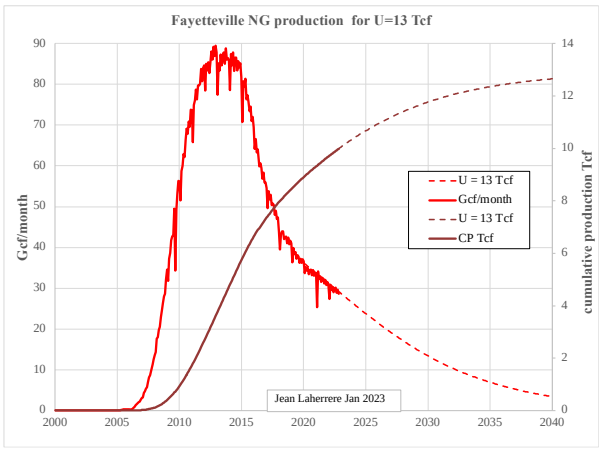
HL of Niobrara trends towards 15 Tcf, meaning a peak in 2020



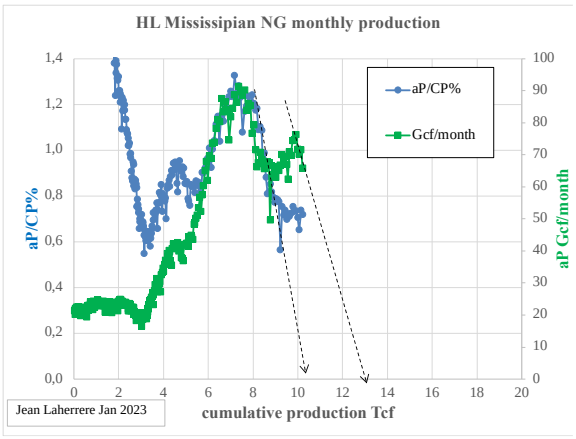


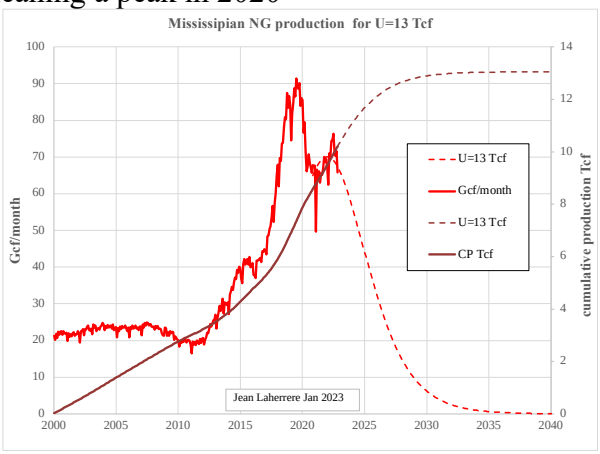
HL of Fayetteville trends towards 13 Tcf, meaning a peak in 2013



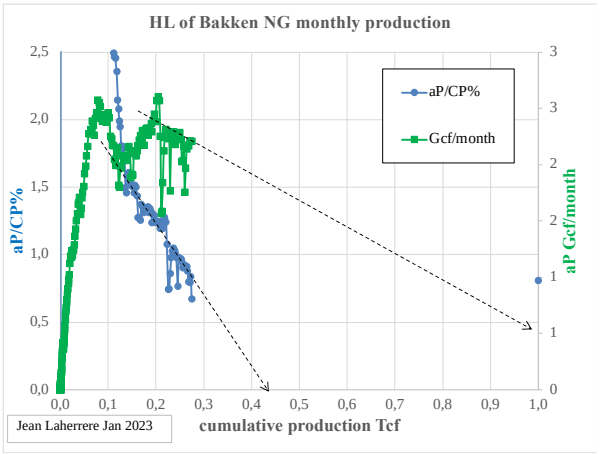


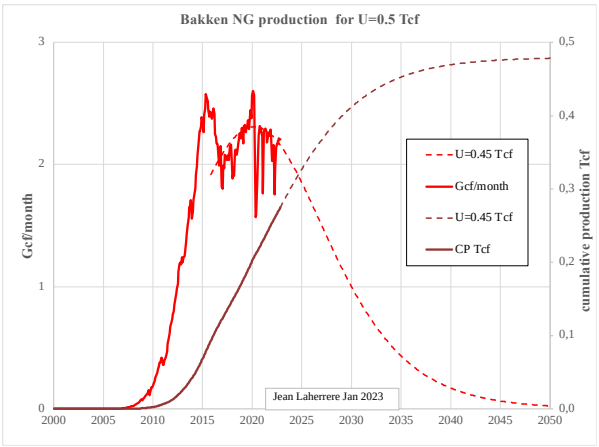
HL of Mississippian trends towards 13 Tcf meaning a peak in 2020





HL of Bakken (a LTO play) trends towards 0.5 Tcf meaning a peak in 2020.





USGS 2008 FS08-3021_058 (see page 4) was estimating the undiscovered NG Bakken at 1.85 Tcf, our NG ultimate is 0.8 Tcf with CP2007 being almost zero, giving in 2008 a "yet to find" of 0.8 Tcf about half of USGS 2008 estimate!

The recapitulation of these 12 regions shows that the HL of the US shale gas (fair quality) is quite higher than the sum of the 12 HL ultimates which have some very poor quality.
It means that the ultimates of these VP quality = Eagle Ford, Woodford & Mississippian must be increased.
These HL ultimates are compared with my estimations in 2021, USGS 2013 and AAPG 2010

shale gas	Gcf/month	Gcf/month	Tcf	Tcf	Tcf				year	Gcf/month	Tcf	Tcf	
Tcf	aPJan2000	aPNov2022	CPNov22	U HL	U-CP	quality	U decline	quality	peak	peak	U JL2021	USGS2013	AAPG 2010
US	93	2335	258	560	302	F	?		2022,5	2400	400-700		
Marcellus	0	756	72	130	58	G	?		2022	820	130	84,2	490
Permian	20	462	31	100	69	F	?		2026	530	55	35,4	
Haynesville	4	402	33	65	32	P	?		2024	430	60-70	65,9	
Barnett	4	55	22	33	11	P	38	VP	2012	160	26	56,2	44
Eagle Ford	0	111	16	30	14	VP	20	VP	2015	150	30-32	51,9	
Rest	35	69	22	28	6	P	30	P	2013	140			
Utica	0	157	17	25	8	P	22	VP	2020	250	24-25	38,2	
Woodford	0	80	11	18	7	VP	13	VP	2020,5	93		29,7	
Niobrara	8	77	9	15	6	F	?		2020	88			
Fayetteville	0	29	10	13	3	F	14	P	2014	44		14,9	
Mississipian	21	66	10	13	3	VP	13	P	2019,5	91			
Bakken	0	70	0,3	0,5	0,2	P	?		2020	2		6,7	
sum	93	2333	253	471	218								

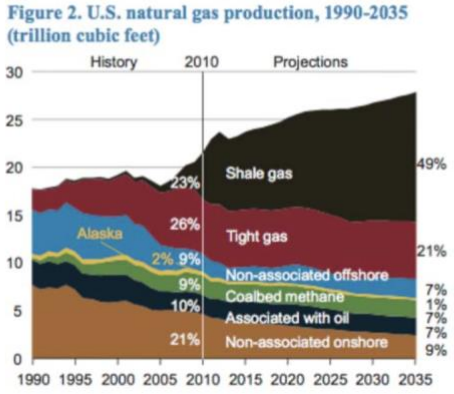
It appears that the uncertainty on these regions ultimates is large, less on Marcellus and on the total.

-US NG forecast

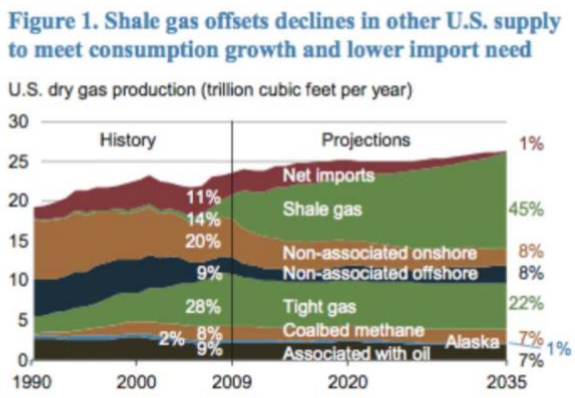
US shale gas production represents today a large part of the US NG production.
EIA in the past confused shale gas and tight gas, as displayed in AEO 2009 to AEO20
-Laherrere J.H. 2012 « Point de vue d'un géologue pétrolier» table ronde sur les gaz de schiste » Club de Nice 5 décembre
http://aspofrance.viabloga.com/files/JL_2012_NICE-gazrochemere.pdf,
http://www.clubdenice.eu/2012/Jean_Laherrere_Gaz_de_Schiste.pdf

-Fig 12: **US: production de gaz EIA AEO 2009 à AEO 2012**

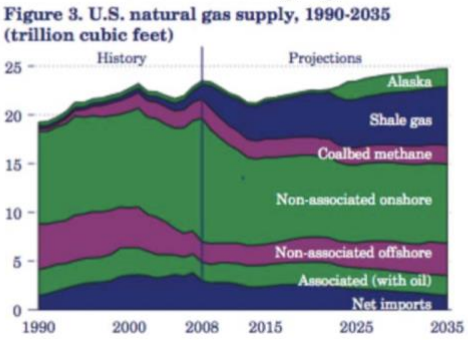
AEO 2012



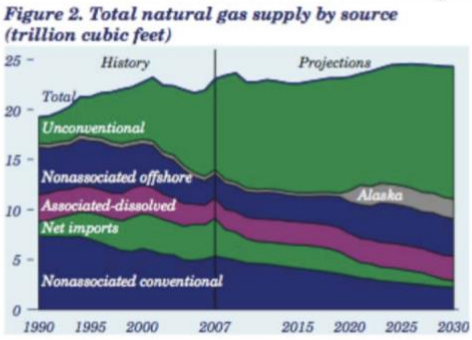
AEO 2011



AEO 2010 sans “tight gas”

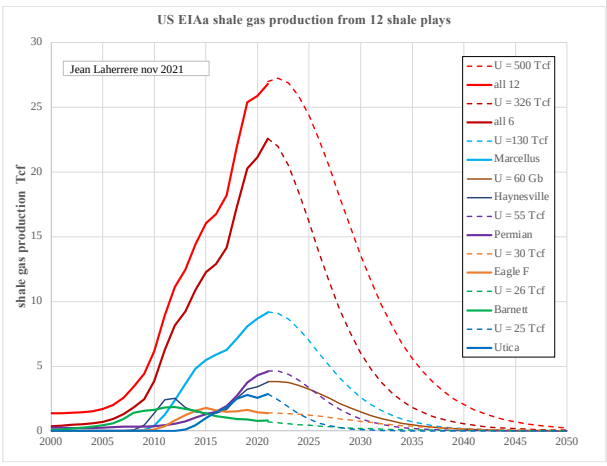


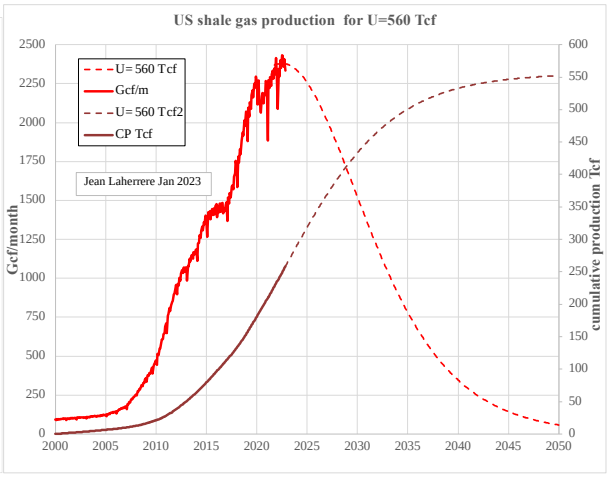
AEO 2009 non conventionnel groupé



My 2021 forecast "US shale plays production from EIA Jan2007-Sept2021 & forecasts" November https://aspofrance.org/2021/11/18/us-shale-plays-production-from-eia-jan2007-sept2021-forecasts/ is compared to the present forecast.

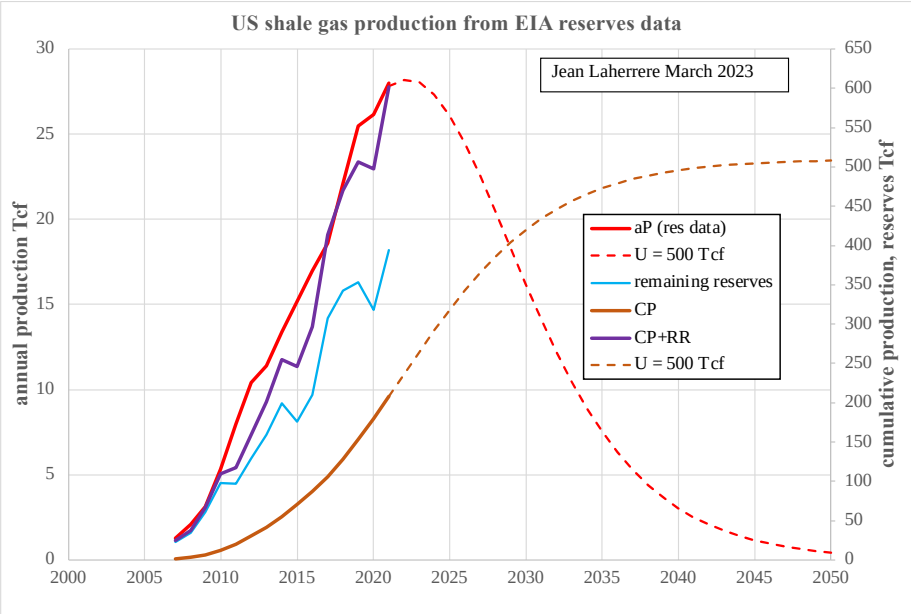
The problem is that EIA reports annual shale gas production in their reserves data lower than with the shale plays, as in 2000 EIA confused real shale gas with fracking with horizontal wells without fracking. In fact, shale gas ultimate is 500 Tcf, and not 560 Tcf. EIA shale gas production is reported only since 2007 in US shale plays: natural gas production and proved reserves table 4.



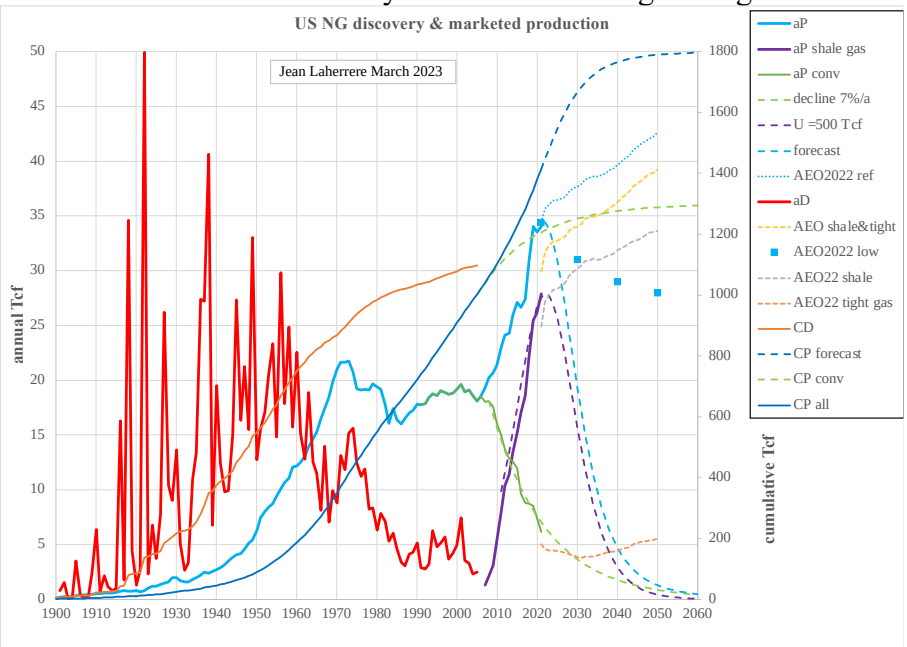


US NG discovery peaked in the 1920s when the peak of conventional NG was in 1973, US shale gas is peaking in 2022 with an ultimate of 500 Tcf, the conventional is forecasted declining at 7%/a since 2008.

US shale gas production is taken from EIA table 13 on reserves and production.



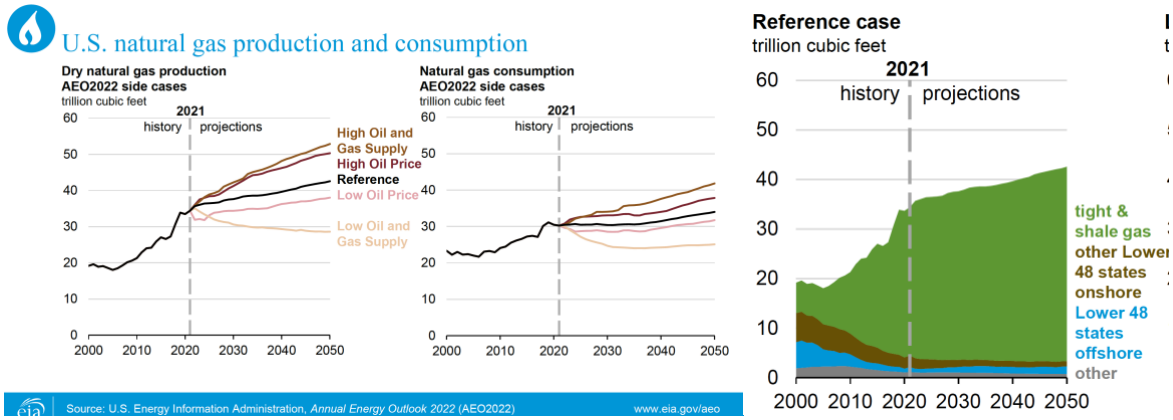
US NG ultimate is then 1800 Tcf with only 1300 Tcf excluding shale gas.



AEO2022 reference is reported for US NG, as for US tight gas, US shale gas & tight oil plays.
Tight gas is not included in my shale gas (purple) being not reported in the reserve data.

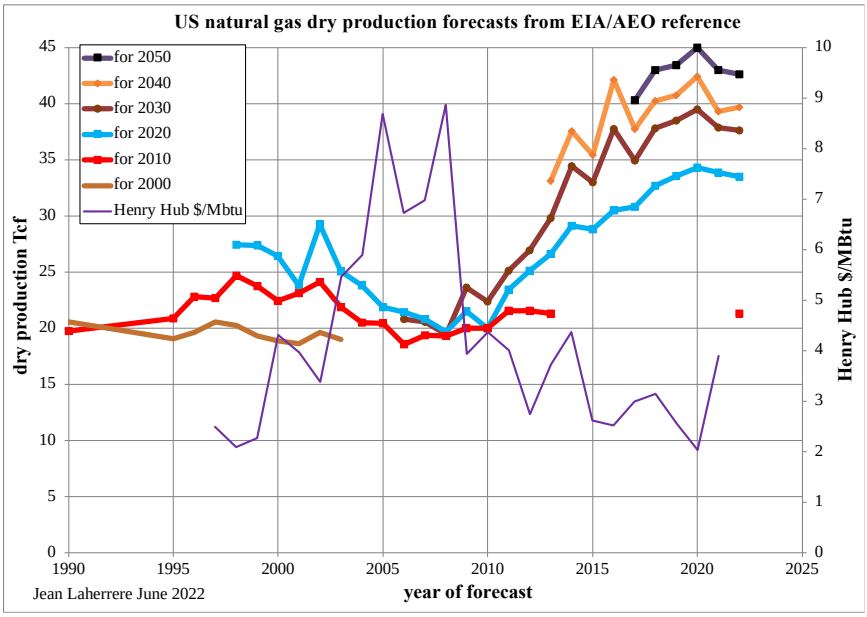
My forecast for 2050 NG production is 1.3 Tcf when AEO2022 reference forecasts 43 Tcf (unrealistic) and AEO2022 low gas supply 28 Tcf (more than 20 times my forecast)!
I know that it is likely that US production will be in 2050 higher than my possible forecast, but I want to show that the difference could be drastic.

AEO2022 different scenarios forecast that US NG production will be over US NG consumption, meaning no import but export, when my forecast needs NG import before 2030!



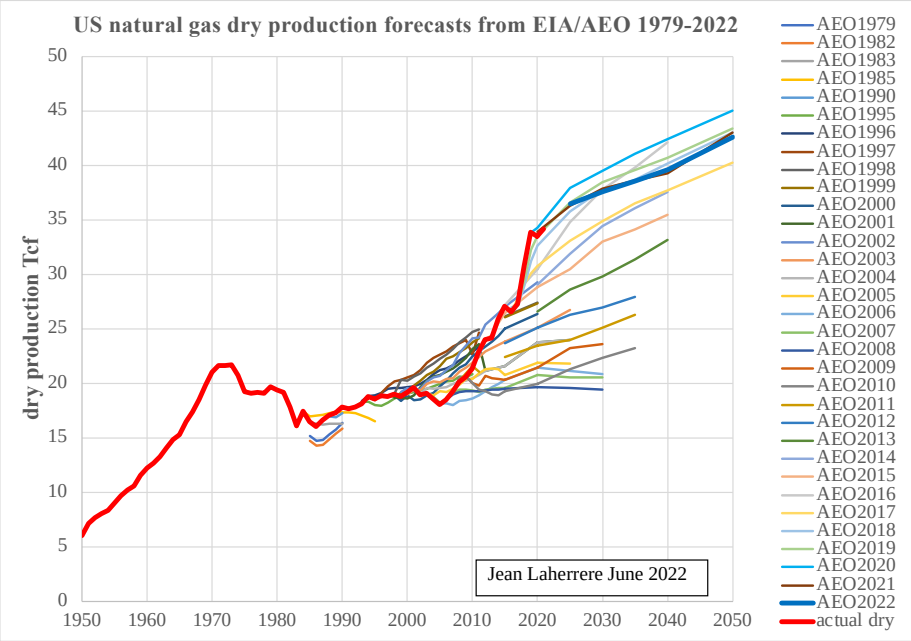
AEO2022 reference NG forecasts give separately "tight gas" and "shale gas & tight oil plays" when the graph give the total.

The evolution of AEO NG reference forecasts from 1979 to 2022 shows that the shale burst was not forecasted in 2010: see the forecast for 2020 in blue.

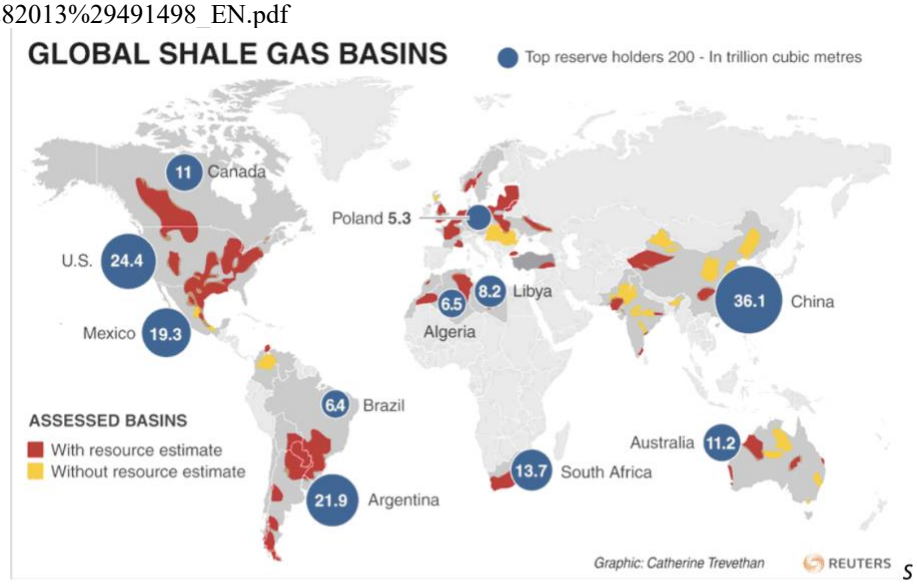


The NG price appears of poor impact!

The AEO2022 forecast of "no peak" before 2050 could be as bad as the forecast in 2010 for 2020.
However, AEO2022 is less optimistic than AEO2020.



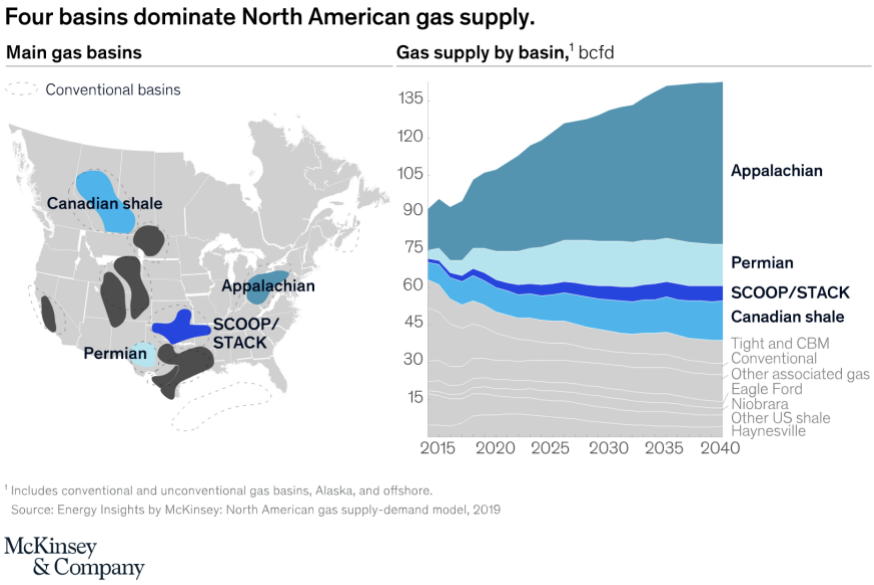
In 2013 EIA estimated world shale gas resources with China first with 36 T.m3, US second 24 T.m3 and Argentina third 25 T.m3: in 2023: these estimates appear unrealistic!
https://www.europarl.europa.eu/RegData/etudes/briefing_note/join/2013/491498/EXPO-AFET_SP%282013%29491498_EN.pdf



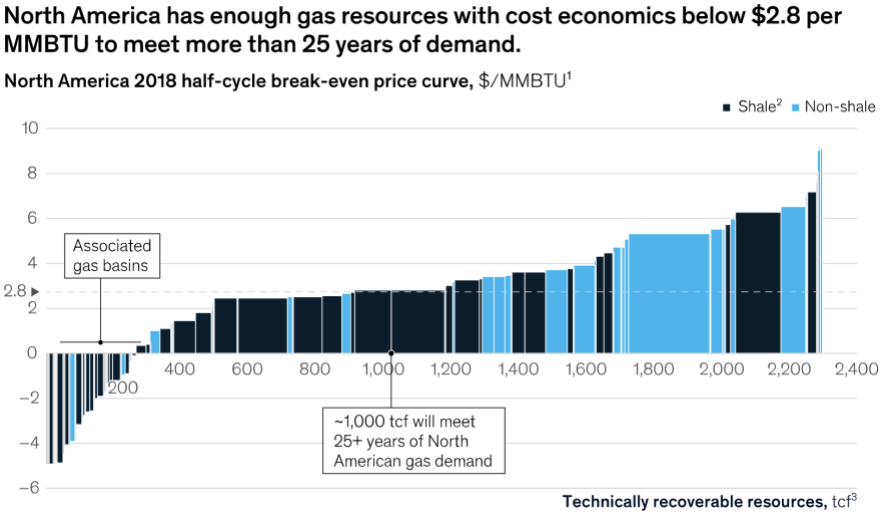
ource: US Energy Information Administration (EIA)

http://blog.thomsonreuters.com/index.php/global-shale-gas-basins-graphic-of-the-day

McKinsey 2020 report "the future of natural gas in North America"
https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/the-future-of-natural-gas-in-north-america is very optimistic, in particular on the Appalachian basin (Marcellus), based on huge resources of 2300 Tcf.

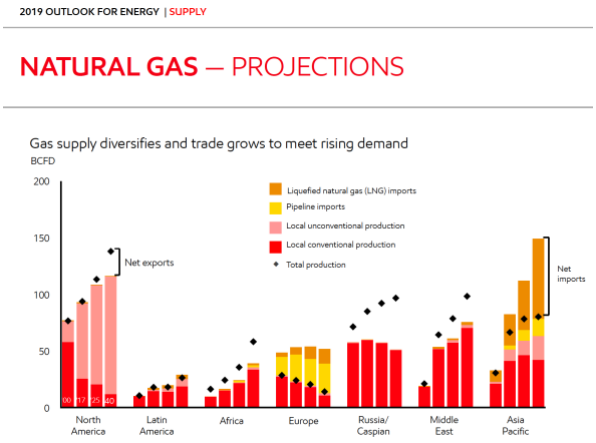


North America resources of 2300 Tcf ?

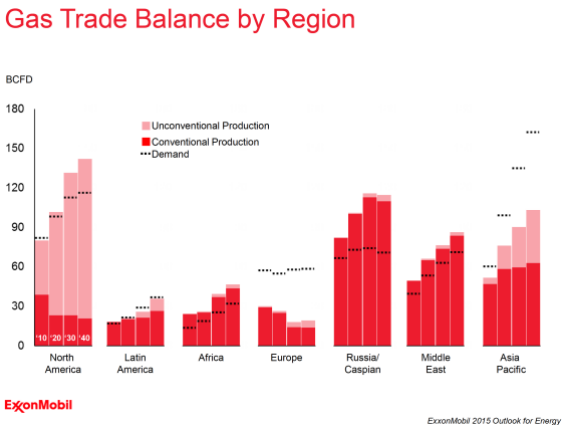


ExxonMobil in Outlook for energy in 2015 and 2019 is very optimistic on North America NG export, but they confuse in 2019 production and demand: result no graph in 2022:

2019 edition



2015 edition



It appears that my forecast of US NG production in the medium and long term disagrees with EIA, McKinsey, ExxonMobil forecast and the industry investing in the extension of LNG

plants: Sempra https://cameronlng.com/wp-content/uploads/2023/03/Cameron-LNG-Amended-Expansino-Project-Factsheet.pdf
It is hard to tell who has the best arguments by just looking at conclusions and more work should be done. I should be happy to receive comments on this subject.

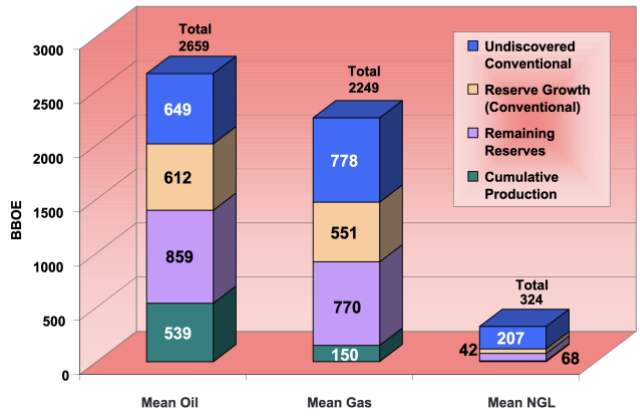
-Conclusion

To forecast future NG production, it is necessary to estimate the NG ultimate (reserves) which is the cumulative real (2P) present discoveries plus yet to find.
Published current proven reserves are political (OPEC) or financial (SEC rules) and their arithmetic aggregation (plain sum) is wrong.
Proven reserves are current, meaning that the errors (in fact few data) of the past are corrected later and that most of the "new discoveries" are corrections of past poor practices.
2P present backdated (field original reserves are estimated with today data and backdated to their year discovery) discoveries are confidential (except in UK and GoM) and it is necessary to buy them from scout companies, but they need to be corrected (in particular, for former USSR being ABC1 = 3P and not 2P as also from OPEC members lying on their reserves as Saudi Arabia, which, remaining reserves around 260 Gb for the last 30 years, pretends finding every year as much oil as they produce: it is a joke!))
The extrapolation of 2P present discoveries to get the ultimate could be done with creaming curves or parabolic fractal, but the uncertainty is large!
The linear extrapolation of HL (annual/cumulative production % versus cumulative number of fields) is the best way to estimate ultimates, but the uncertainty is large, because the last data is very often not linear, but hyperbolic or several slopes.
After peak, the linear extrapolation of annual production versus cumulative production can help estimating the HL.
The goal of this paper is to show the maximum of HL extrapolations and the difficulty to extrapolate them.
The range of uncertainty to estimate NG ultimates is large for many countries, but less on some continents.
The most important is to doubt about the interpretation of present data and to wait for more data in the medium term to check the present conclusions.
The more I know, the more I know that I do not know and the others neither!

The world NG marketed production (146 Tcf in 2021) will peak between 155 and 175 Tcf between 2030 and 2045.There are still in the world some giant gas fields waiting to be produced and many to be found, mainly in deep water.
From HL estimates, US NG production will decline beyond 2023 and US will need to import NG before 2030. This forecast disagrees with EIA forecast (no NG peak before 2050 for AEO2022 ref) and industry LNG extension: more study and more data are needed.

-Annex

USGS reports since 2000 their undiscovered resources assessments of geologic provinces and displays the aggregation; some assessments report rightly only mean aggregation (like for the world or W Siberian), but some (like for Mac Kenzie Delta) report wrongly all aggregations for F95 (minimum) and F5 (maximum)
For the world Assessment 2000 https://certmapper.cr.usgs.gov/data/PubArchives/WEcont/chaps/ES.pdf



only mean aggregation!

Table 1. World level summary of petroleum estimates for undiscovered conventional petroleum and reserve growth for oil, gas, and natural gas liquids (NGL).

[BBOE, billions of barrels of oil equivalent. Six thousand cubic feet of gas equals one barrel of oil equivalent. F95 represents a 95 percent chance of at least the amount tabulated. Other fractiles are defined similarly. Production and reserves normalized to 1/1/96. Shading indicates not applicable]

	Oil				Gas					NGL			
	Billion Barrels				Trillion Cubic Feet				BBOE	Billion Barrels			
	F95	F50	F5	Mean	F95	F50	F5	Mean	Mean	F95	F50	F5	Mean
World (excluding United States)													
Undiscovered conventional	334	607	1,107	649	2,299	4,333	8,174	4,669	778	95	189	378	207
Reserve growth (conventional)	192	612	1,031	612	1,049	3,305	5,543	3,305	551	13	42	71	42
Remaining reserves*				859				4,621	770				68
Cumulative production*				539				898	150				7
Total				2,659				13,493	2,249				324
United States													
Undiscovered conventional**	66		104	83	393		698	527	88	Combined with oil			
Reserve growth (conventional)**				76				355	59	Combined with oil			
Remaining reserves				32				172	29	Combined with oil			
Cumulative production				171				854	142	Combined with oil			
Total				362				1,908	318				
World Total (including United States)				3,021				15,401	2,567				

For West Siberia 2008 FS08-3064-508 only mean aggregation!

Table 1. West Siberian Basin Province assessment results, north of the Arctic Circle.

[MMBO, million barrels of oil. BCFG, billion cubic feet of gas; MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included as NGL (natural gas liquids). Undiscovered gas resources are the sum of nonassociated and associated gas. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. AU probability is the chance of at least one accumulation of minimum size within the AU. Largest expected oil field size in MMBO; largest expected gas field size in BCFG. TPS, total petroleum system; AU, assessment unit. Gray shading indicates not applicable; oil field sizes in MMBO; gas field sizes in BCFG]

Total Petroleum Systems (TPS) and Assessment Units (AU)	AU Probability	Field Type	Largest Expected Oil Field Size	*Total Undiscovered Resources*											
				Oil (MMBO)				*Gas (BCFG)*				*NGL (MMBNGL)*			
				F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Northern West Siberian Mesozoic Composite TPS															
Northern West Siberian Onshore Gas AU	1.00	*Oil*	431	223	901	2,930	1,152	1,241	5,304	17,744	6,859	25	109	369	142
		Gas	5,560					6,242	18,831	50,642	22,418	194	594	1,613	708
South Kara Sea Offshore AU	1.00	*Oil*	712	572	2,053	6,023	2,507	3,183	12,064	36,779	14,933	64	248	763	308
		Gas	189,354					154,681	513,304	1,372,510	607,289	4,799	16,000	44,090	19,171
Total Conventional Resources							3,659				651,499				20,329

For the Mackenzie Delta FS-2006-3002 all aggregations!

Table 1. *Mackenzie Delta Province assessment results.*

[AU, assessment unit; BCFG, billion cubic feet of gas; MMBNGL, million barrels of natural gas liquids; MMBO, million barrels of oil; NGL, natural gas liquids; TPS, total petroleum system. For geologic elements of the AU, results shown are fully risked estimates rounded to the nearest unit. For gas accumulations, all liquids are included as NGL. F95 denotes a 95 percent chance of at least the amount tabulated. Other fractiles defined similarly. Fractiles are additive only under the assumption of perfect positive correlation. Gray shading indicates not applicable]

	Total petroleum systems and assessment units	Field type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Conventional oil and gas resources	Jurassic and Lower Cretaceous Composite TPS													
	Jurassic and Lower Cretaceous AU	Oil	10	22	40	23	46	108	215	117	3	6	14	7
		Gas					3,429	9,954	19,476	10,518	169	512	1,092	556
	Upper Cretaceous and Tertiary Composite TPS													
	Normal Fault Zone AU	Oil	1,544	3,622	6,957	3,867	6,605	16,573	35,048	18,176	108	291	667	327
		Gas					6,269	15,099	28,568	16,001	304	779	1,616	847
	Outer Fault and Foldbelt AU	Oil	1,746	4,868	9,656	5,197	7,530	22,245	48,537	24,431	418	1,295	3,082	1,465
		Gas					3,107	9,630	20,775	10,488	153	497	1,167	556
	Inner Fault and Foldbelt AU	Oil	320	1,221	2,929	1,373	836	3,326	8,600	3,842	14	58	162	69
		Gas					710	2,699	6,448	3,028	35	139	359	161
	Deep Water Delta AU	Not quantitatively assessed												
	Total conventional resources	Oil	3,621	9,734	19,582	10,460	15,016	42,252	92,399	46,566	543	1,651	3,924	1,868
		Gas					13,515	37,382	75,266	40,035	661	1,927	4,234	2,121
	Total undiscovered oil and gas resources	Oil and gas	3,621	9,734	19,582	10,460	28,532	79,634	167,666	86,601	1,204	3,578	8,158	3,989

In 2006 USGS estimates 10.5 Gb of undiscovered crude oil and 87 Tcf of undiscovered gas in the Mackenzie delta
In 2015 CAPP estimated Mackenzie-Beaufort ultimate at 8 Gb and 57 Tcf

For the Bakken in North Dakota FS-2021-058 all aggregations

Table 3. Results for 15 continuous assessment units in the Bakken and Three Forks Formations of the Williston Basin Province, North Dakota and Montana.

[Results shown are fully risked estimates. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. Gray shading indicates not applicable. MMBO, million barrels of oil; BCFG, billion cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids]

Total petroleum system and assessment units (AUs)	AU probability	Accumulation type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Bakken Total Petroleum System														
Elm Coulee Bakken Continuous Oil	1	Oil	49	156	276	159	49	156	278	159	4	13	24	14
Billings Nose–Bakken Fairway Continuous Oil	1	Oil	22	70	137	74	30	98	192	103	3	8	16	9
Eastern Transitional–Parshall Bakken Continuous Oil	1	Oil	52	164	240	157	41	130	194	125	4	11	17	11
Northern Nesson Bakken Continuous Oil	1	Oil	69	220	354	216	96	307	497	303	8	26	42	26
Central Nesson–Little Knife Bakken Continuous Oil	1	Oil	25	80	138	80	35	111	193	112	3	9	16	10
Southeastern Little Knife Transitional Bakken Continuous Oil	1	Oil	95	313	608	330	57	187	368	198	5	16	31	17
Central Basin Bakken Continuous Oil	1	Oil	185	581	882	561	221	695	1,062	673	19	59	90	57
Western Central Basin Bakken Continuous Oil	1	Oil	11	37	88	42	11	37	89	42	1	3	8	4
Northern Transitional Bakken Continuous Oil	1	Oil	93	308	614	327	93	308	616	327	8	26	53	28
Total Bakken undiscovered continuous oil resources			**601**	**1,929**	**3,337**	**1,946**	**633**	**2,029**	**3,489**	**2,042**	**55**	**171**	**297**	**176**
Central Basin Three Forks Fairway Continuous Oil	1	Oil	432	1,378	2,146	1,340	562	1,789	2,797	1,742	48	152	238	148
Northern Transitional Three Forks Continuous Oil	1	Oil	66	218	427	230	66	218	428	230	6	19	36	20
Central Basin Pronghorn–Three Forks Continuous Oil	1	Oil	152	474	774	469	198	616	1,010	610	17	52	86	52
Southern Pronghorn–Three Forks Continuous Oil	1	Oil	69	231	474	247	55	184	380	198	5	16	32	17
Western Central Basin Three Forks Continuous Oil	1	Oil	8	42	122	51	8	38	111	46	1	3	9	4
Northwestern Three Forks Continuous Oil	0.5	Oil	0	0	22	5	0	0	17	4	0	0	2	0
Eastern Three Forks Continuous Oil		Oil	Not quantitatively assessed											
Total Three Forks undiscovered continuous oil resources			**727**	**2,343**	**3,965**	**2,342**	**889**	**2,845**	**4,743**	**2,830**	**77**	**242**	**403**	**241**
Total Bakken-Three Forks undiscovered continuous oil resources			**1,328**	**4,272**	**7,302**	**4,288**	**1,522**	**4,874**	**8,232**	**4,872**	**132**	**413**	**700**	**417**

2

But the Bakken in North Dakota and Montana was in FS08-2021_508 with only mean aggregation!

Table 1. *Bakken Formation, Williston Basin Province assessment results.*

(MMBO, million barrels of oil. BCFG, billion cubic feet of gas. MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. F95 represents a 95 percent chance of at least the amount tabulated; other fractiles are defined similarly. TPS, total petroleum system; AU, assessment unit)

	Total Petroleum System and Assessment Unit	Field Type	Total Undiscovered Resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Continuous Oil Resources	**Bakken-Lodgepole TPS**													
	Elm Coulee-Billings Nose AU	Oil	374	410	450	410	118	198	332	208	8	16	29	17
	Central Basin-Poplar Dome AU	Oil	394	482	589	485	134	233	403	246	10	18	35	20
	Nesson-Little Knife Structural AU	Oil	818	908	1,007	909	260	438	738	461	19	34	64	37
	Eastern Expulsion Threshhold AU	Oil	864	971	1,091	973	278	469	791	493	20	37	68	39
	Northwest Expulsion Threshold AU	Oil	613	851	1,182	868	224	411	754	440	16	32	64	35
	Total Continuous Resources					3,645				1,848				148
Conventional Oil Resources	Middle Sandstone Member AU	Oil	1	4	8	4	1	1	3	2	0	0	0	0
	Total Conventional Resources					4				2				0
	Total Undiscovered Oil Resources					3,649				1,850				148

Where is the boss to check the discrepancies?
In an exploration company, the geologist who has proposed a new field wildcat is obliged after a dry hole (almost 9 times out of 10) to show to his boss a postmortem explaining what was wrong?
It appears that USGS geologists who estimate undiscovered resources never report any comment on their past estimates compared with new data.
I visited USGS headquarters in Reston in 1998 and I met several times Tom Ahlbrandt and Don Gautier outside the US
I wrote several papers on USGS:
-Laherrere J.H. 2012 « avis sur USGS Reserve growth» 22 Mai
http://aspofrance.viabloga.com/files/JL_USGSreservegrowth2012.pdf
-Laherrère J.H. 2002-2003 " Les prévisions USGS confrontées à la réalité de la production " Pétrole et Gaz Informations Nov.-Dec. n°1761 p73-74, Jan.-Fev.n°1762 p58-60
-Laherrère J.H. 2002 "Do the last 6 years production confirm the USGS forecast for the period 1996-2025?" http://www.hubbertpeak.com/laherrere/ConfUSGS_27_08.pdf
-Laherrère J.H. 2000 “Is the USGS 2000 assessment reliable? “ Cyberconference by the World Energy Council, May 19, Strategic Options http://www.energyresource2000.com, or http://wwww.oilcrisis.com/laherrere/usgs2000/
-Laherrère J.H. 1998 " Report to a visit to USDOI/MMS and USDOI/USGS Sept"
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NB
Sorry for my broken English.

My excel follows SI rules.
I remind that the USDOC/NIST 881 rule for writing thousand is to use a space and not a comma:

10.5.3 Grouping digits

Because the comma is widely used as the decimal marker outside the United States, it should not be used to separate digits into groups of three. Instead, digits should be separated into groups of three, counting from the decimal marker towards the left and right, by the use of a thin, fixed space. However, this practice is not usually followed for numbers having only four digits on either side of the decimal marker except when uniformity in a table is desired.

Examples:	76 483 522	*but not:*	76,483,522
	43 279.168 29	*but not:*	43,279.168 29
	8012 or 8 012	*but not:*	8,012
	0.491 722 3	*is highly preferred to:*	0.4917223
	0.5947 or 0.594 7	*but not:*	0.59 47
	8012.5947 or 8 012.594 7	*but not:*	8 012.5947 or 8012.594 7

Note: The practice of using a space to group digits is not usually followed in certain specialized applications, such as engineering drawings and financial statements.

EIA ignores USDOC rule, it is not the same department!

I remind that 95 % of the world population (world outside US and Liberia) follows SI rules by law and buy their gasoline by liter. In the European Union https://single-market-economy.ec.europa.eu/single-market/goods/building-blocks/legal-metrology_en

The European system of units of measurements stems from the international system of units (SI). The SI serves as a global standard and EU law makes the SI units the legal units of measurements to be used for expressing quantities in the EU.