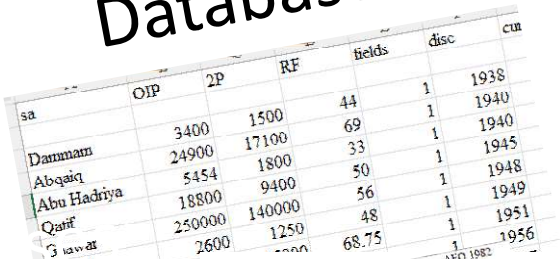
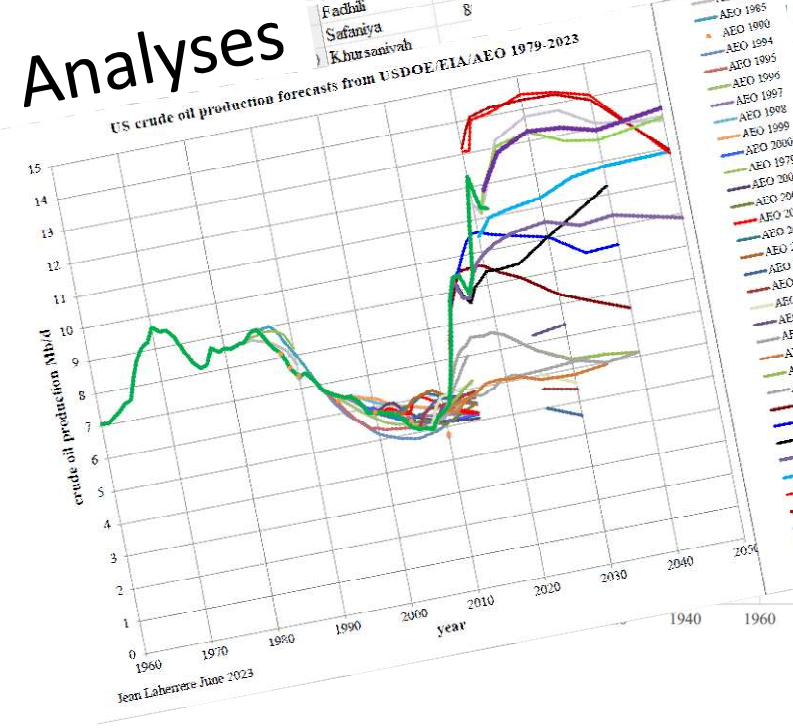
A journey with the Association for the Study of Peak Oil and gas ASPO France

Database

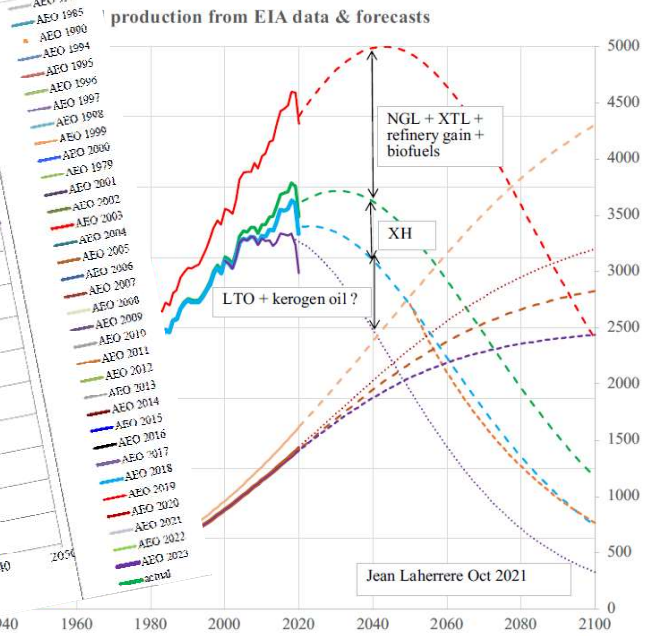


	OIP	2P	RF	fields	disc	cu
Dammam	3400	1500	44	1	1938	
Abqaiq	24900	17100	69	1	1940	
Abu Hadriya	5454	1800	33	1	1940	
Qatif	18800	9400	50	1	1945	
Ghawar	250000	140000	56	1	1948	
Fadhili	2600	1250	48	1	1949	
Safaniya	8		68.75	1	1951	
Khursaniyah				1	1956	

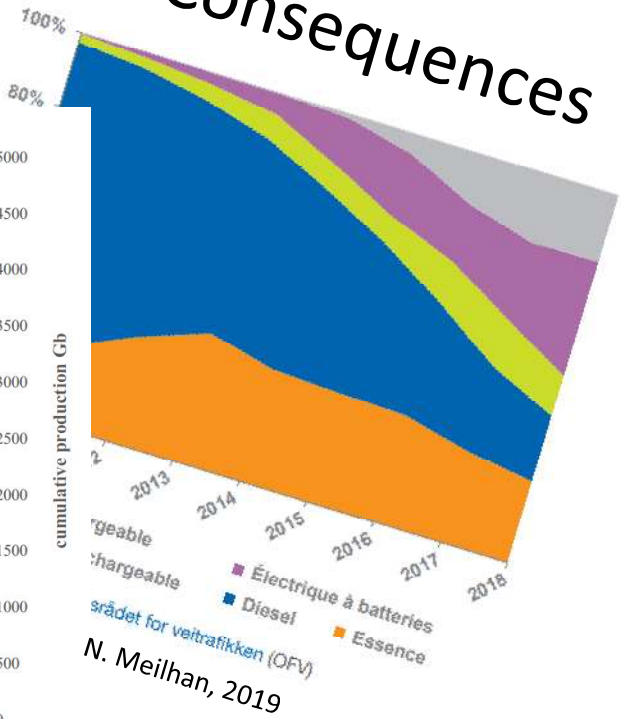
Analyses



Forecasts



Consequences



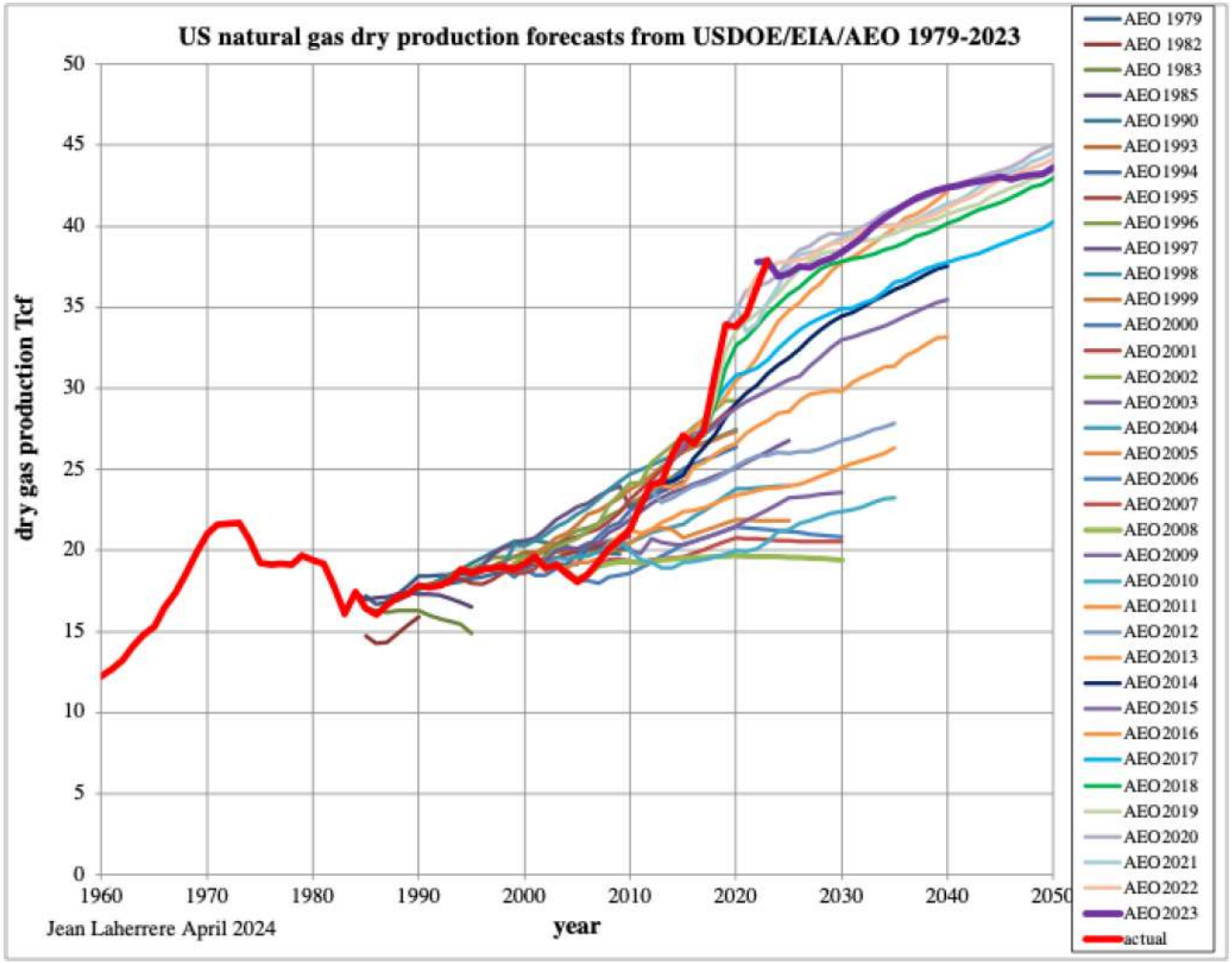
N. Meilhan, 2019

Patrick Brocorens

04 Mars 2025, ASPO France, Paris

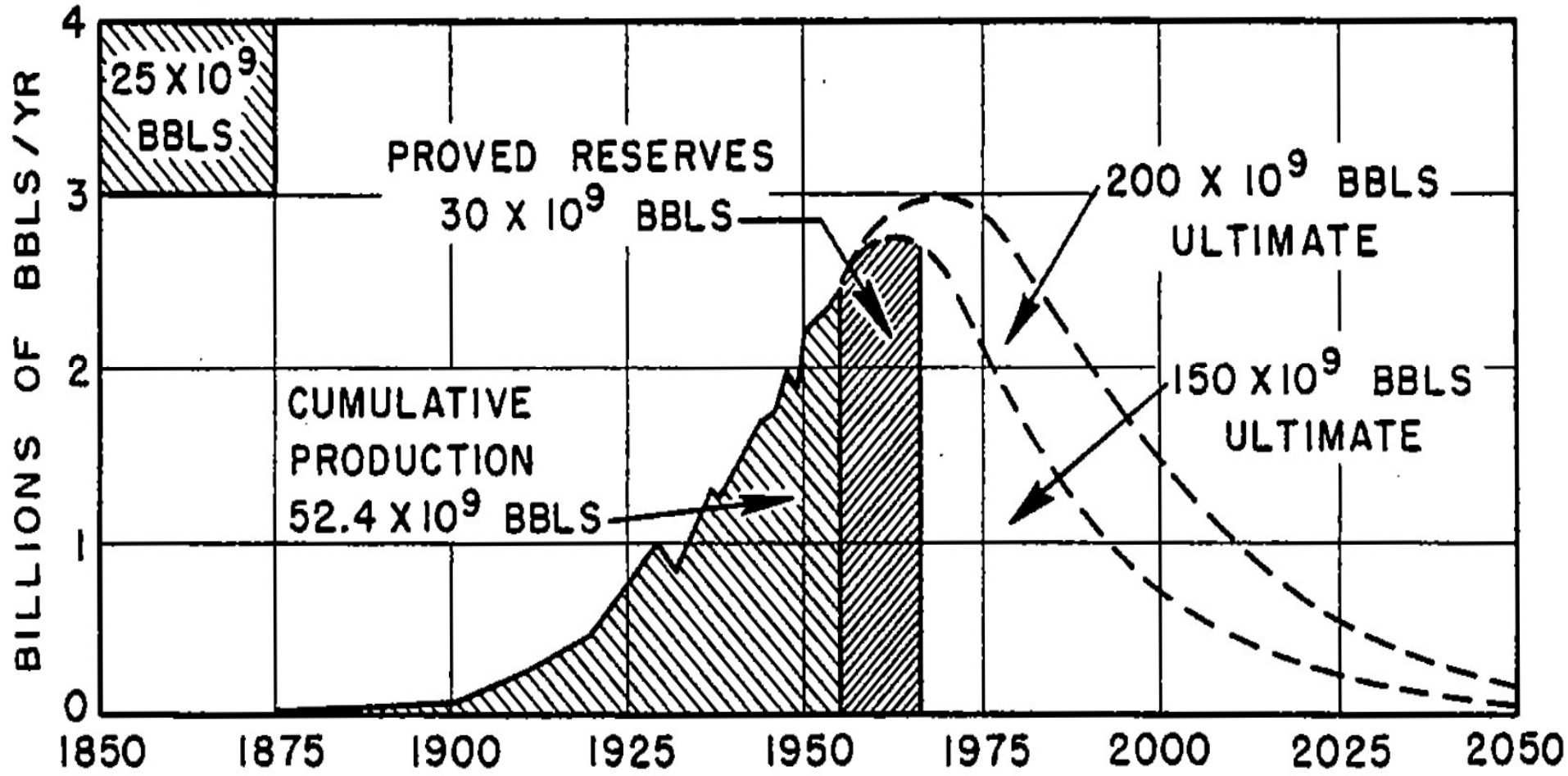
The art of soothsaying, although probably the not the world's oldest profession, can certainly offer strong claims for being its second oldest… Scientific soothsaying, or prediction, consists in trying to foretell as accurately as possible the future evolution of a material system in terms of knowledge of its mechanism, its past history, and of the physical data upon which its evolution depends.

Hubbert 1959



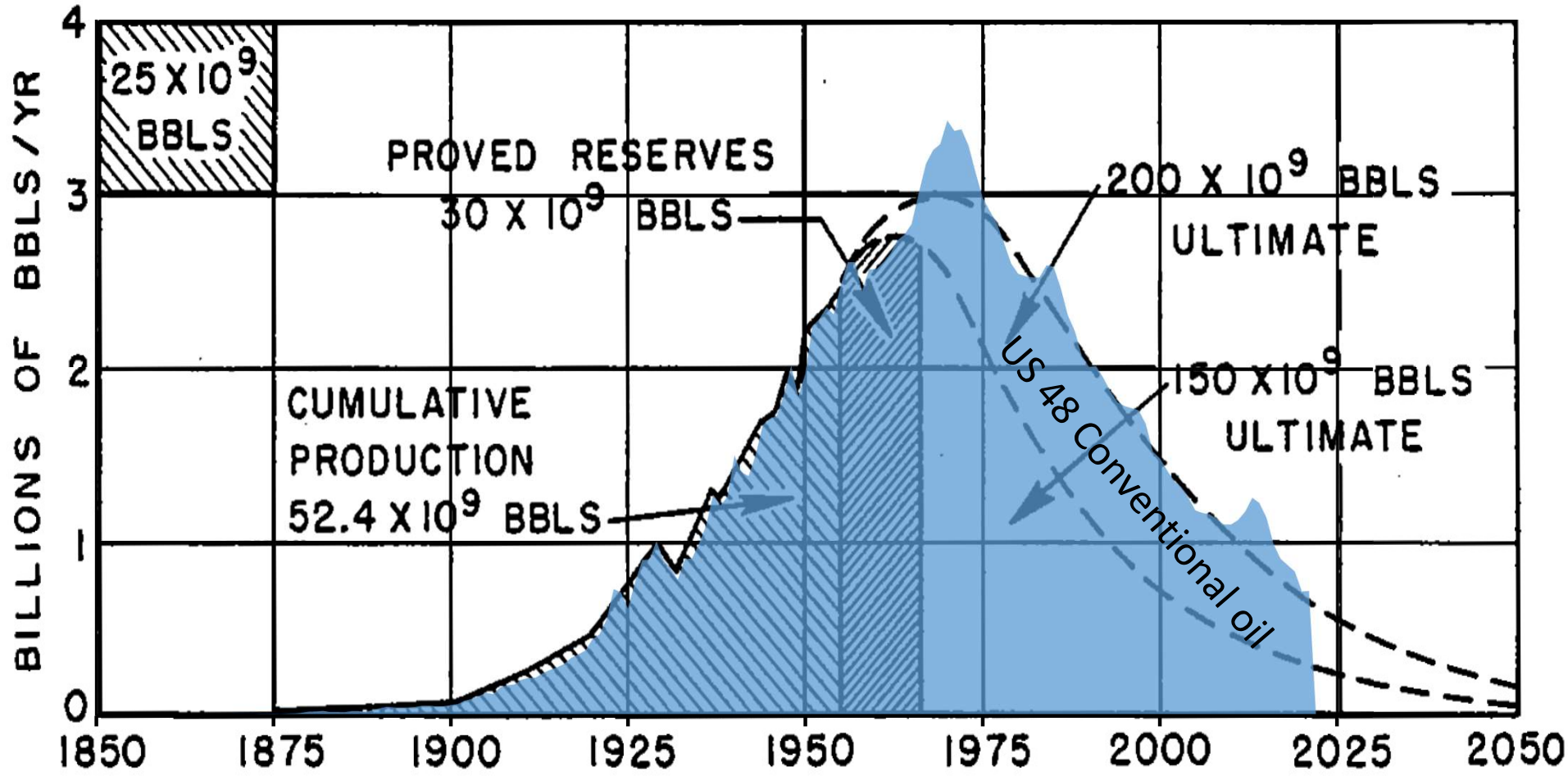
1956

A basic idea: oil being a finite resource, production starts at zero, will end at zero, and between these two moments, will reach one or several maxima. Hubbert is famous for his forecast of a peak for the US-48 conventional oil production.



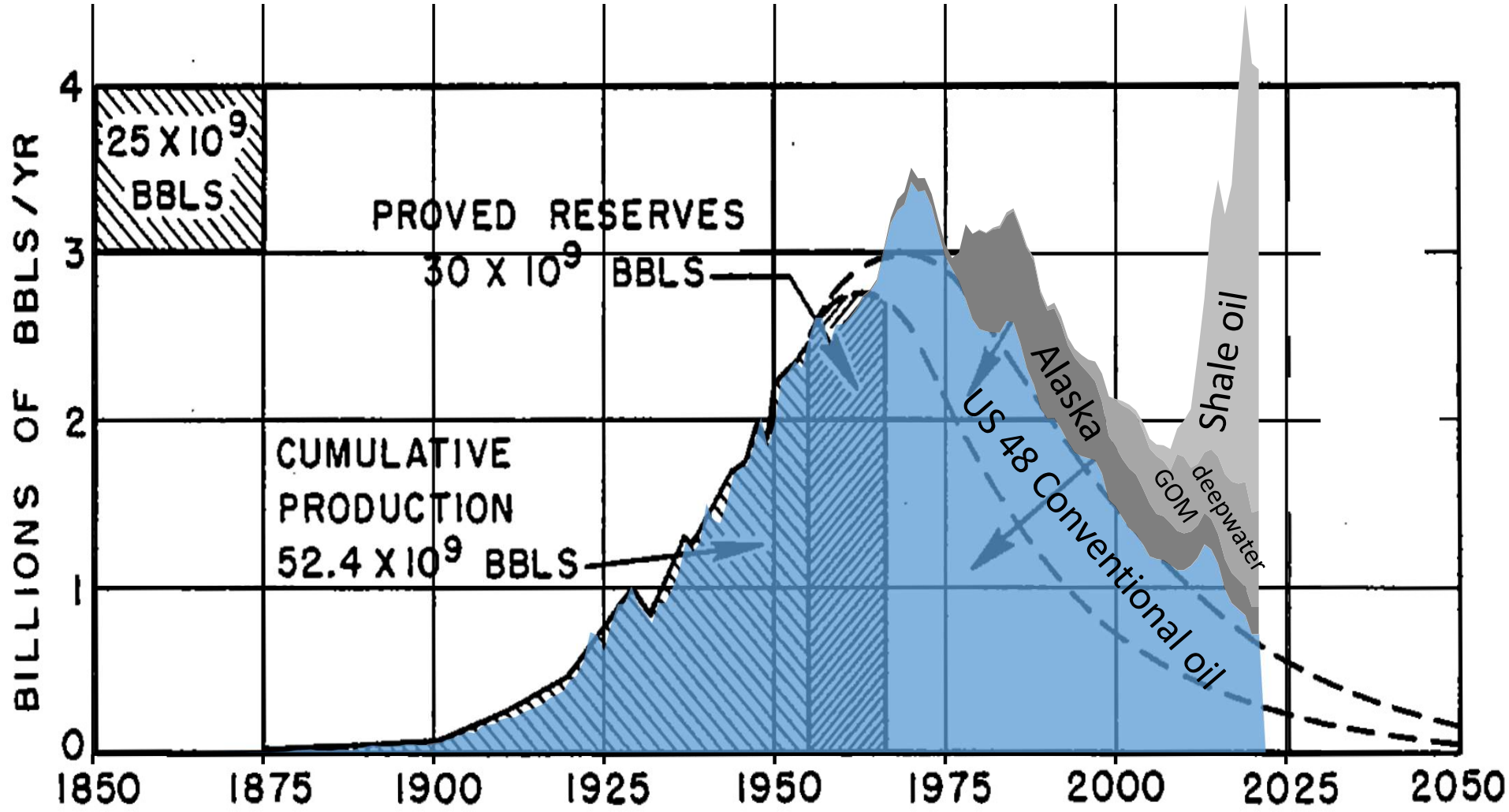
1956

In retrospect, Hubbert was right, showing the usefulness of his methodology.



1956

Later, new production cycles occured in geographical extensions (Alaska, GOM deepwater) or geological extensions (shale oil). These cycles were not considered in the Hubbert study.



1998

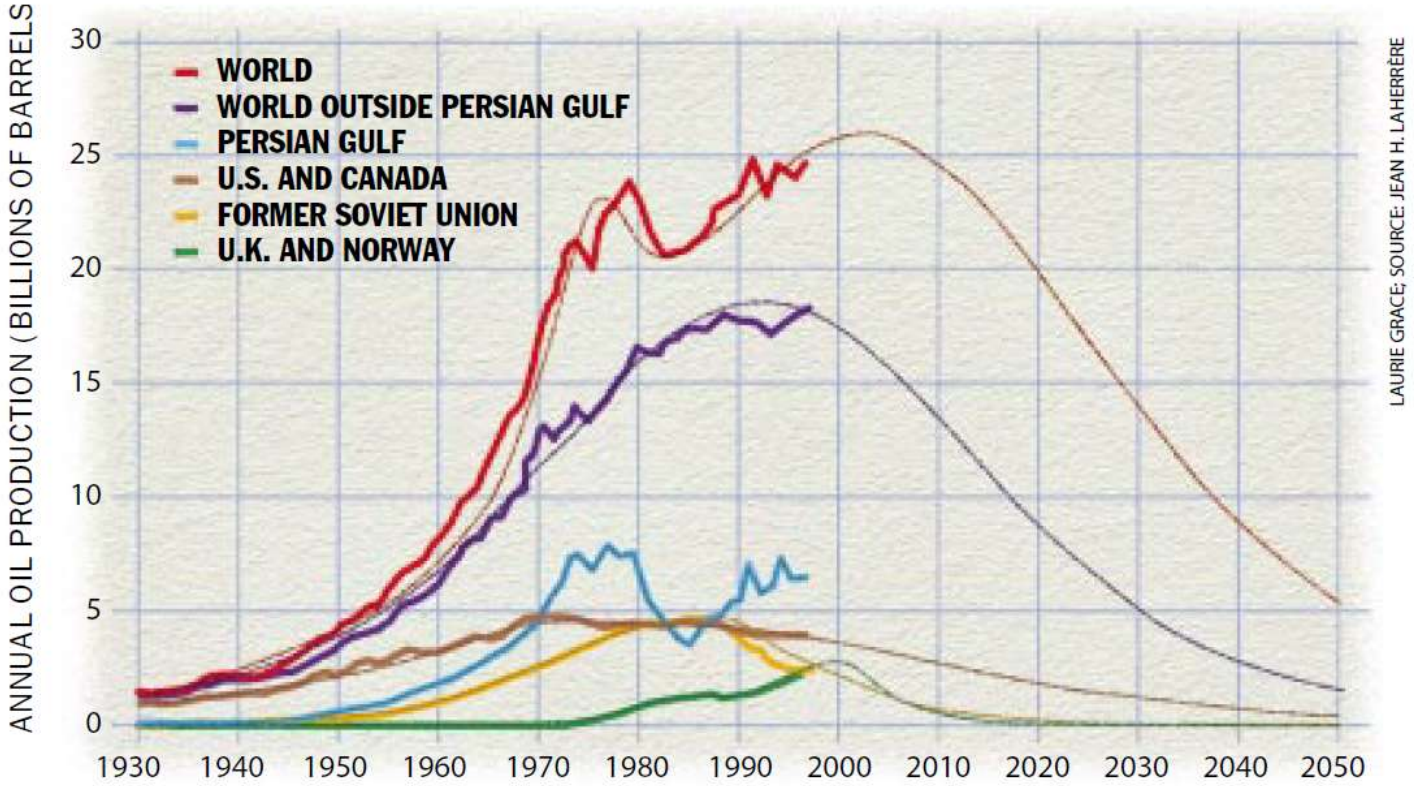
SCIENTIFIC AMERICAN

The End of Cheap Oil

Global production of conventional oil will begin to decline sooner than most people think, probably within 10 years

Jean H. Laherrère

Colin J. Campbell



In the 1990s, Jean Laherrère and Colin Campbell continued the work of Hubbert. Their studies were noticed by the IEA…

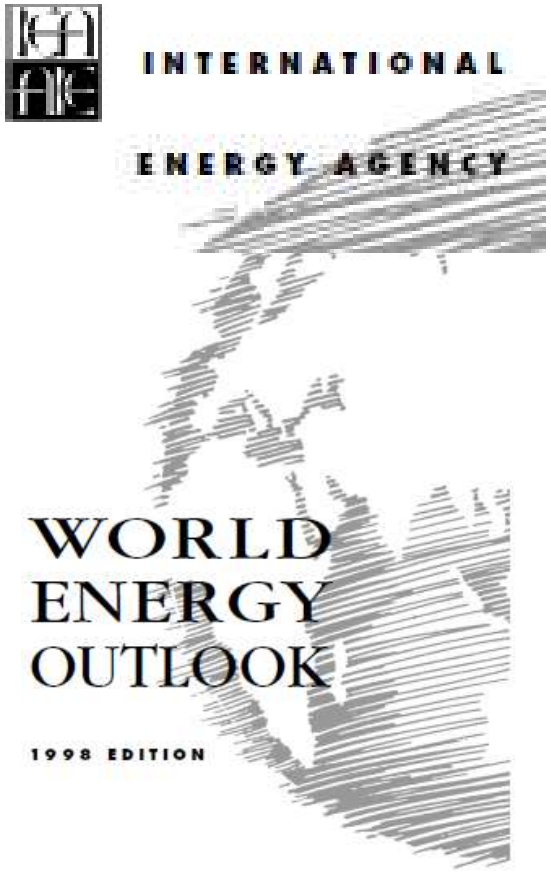
1998

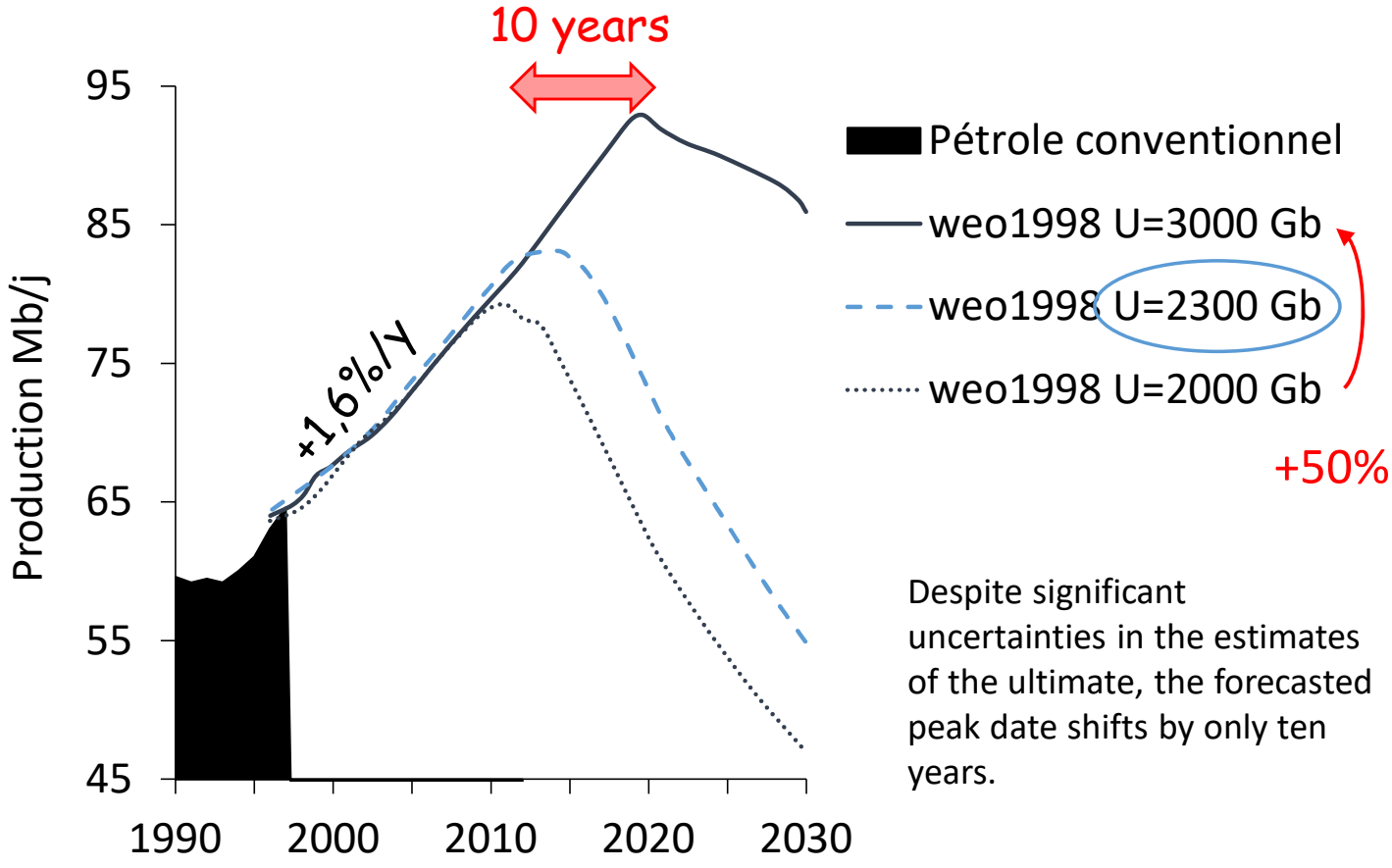
Thanks to Jean-Marie Bourdaire, head of the long term cooperation and policy analysis office at the IEA, peak oil scenarios were introduced in the weo…

Jean-Marie Bourdaire

Jean H. Laherrère

Colin J. Campbell





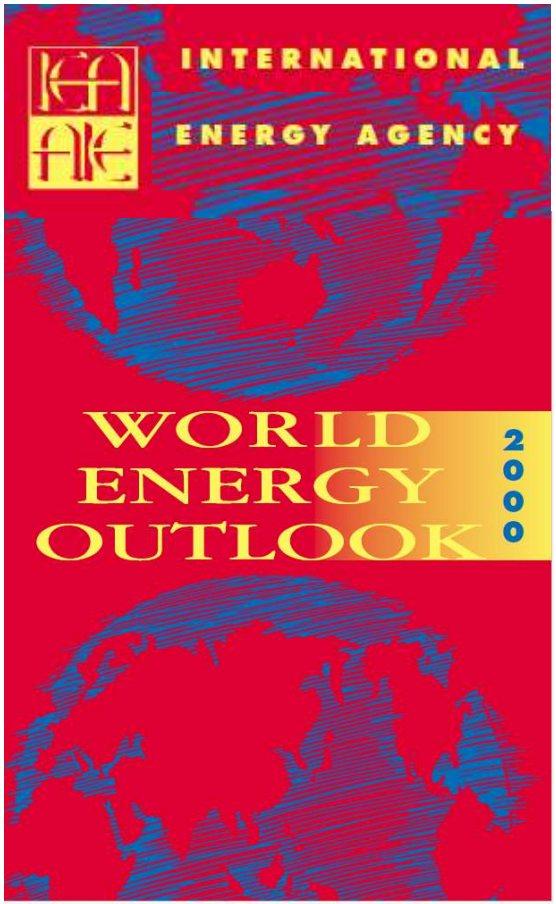
Despite significant uncertainties in the estimates of the ultimate, the forecasted peak date shifts by only ten years.

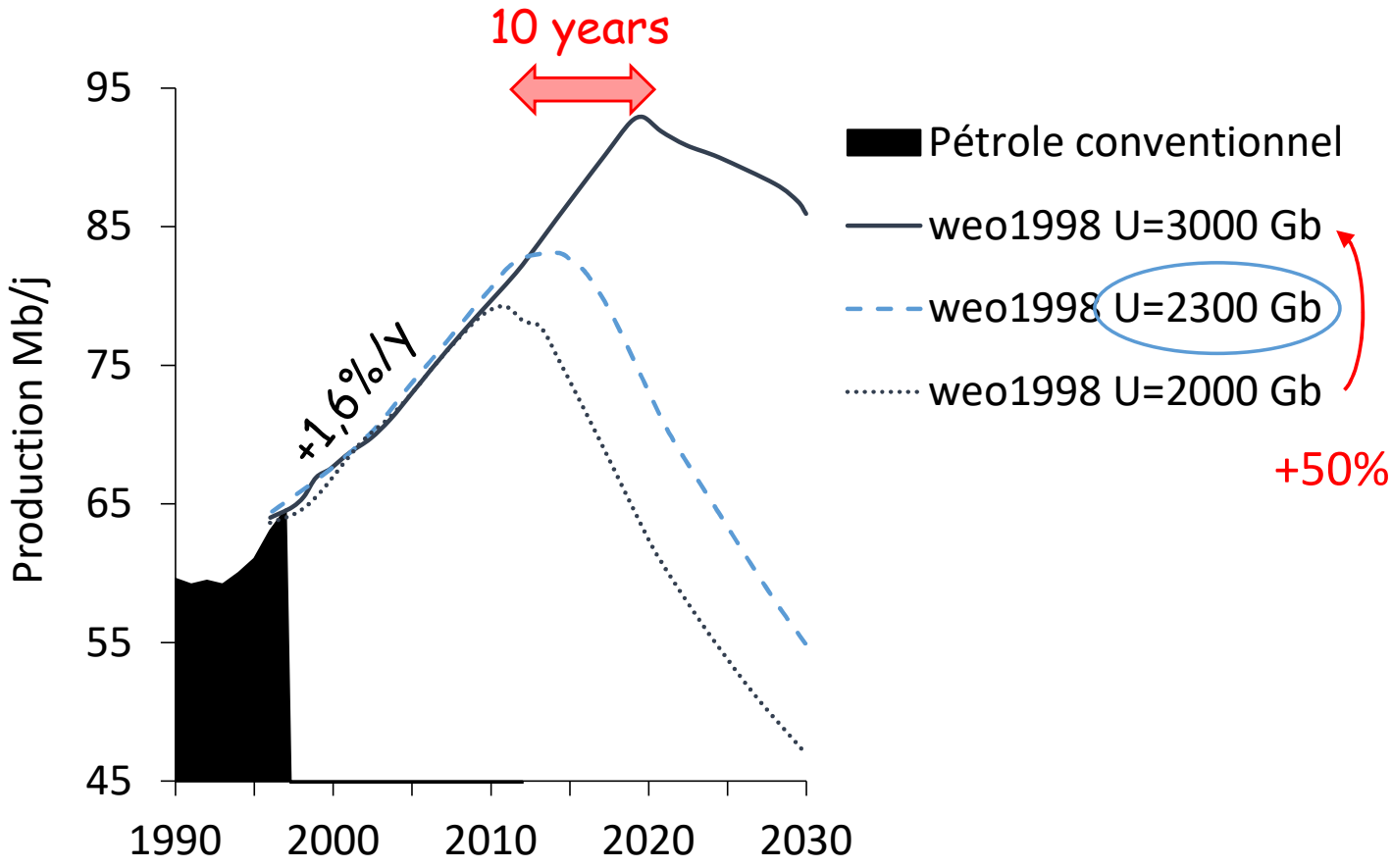
2000

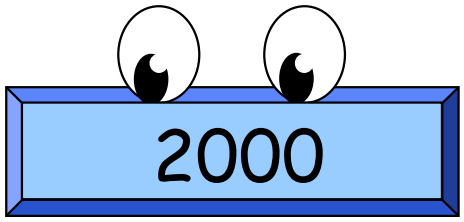
With a new IEA team, a new USGS ultimate, the peak of conventional oil disapears…

…foundation of ASPO : Association for the Study of Peak Oil and gas

Colin J. Campbell





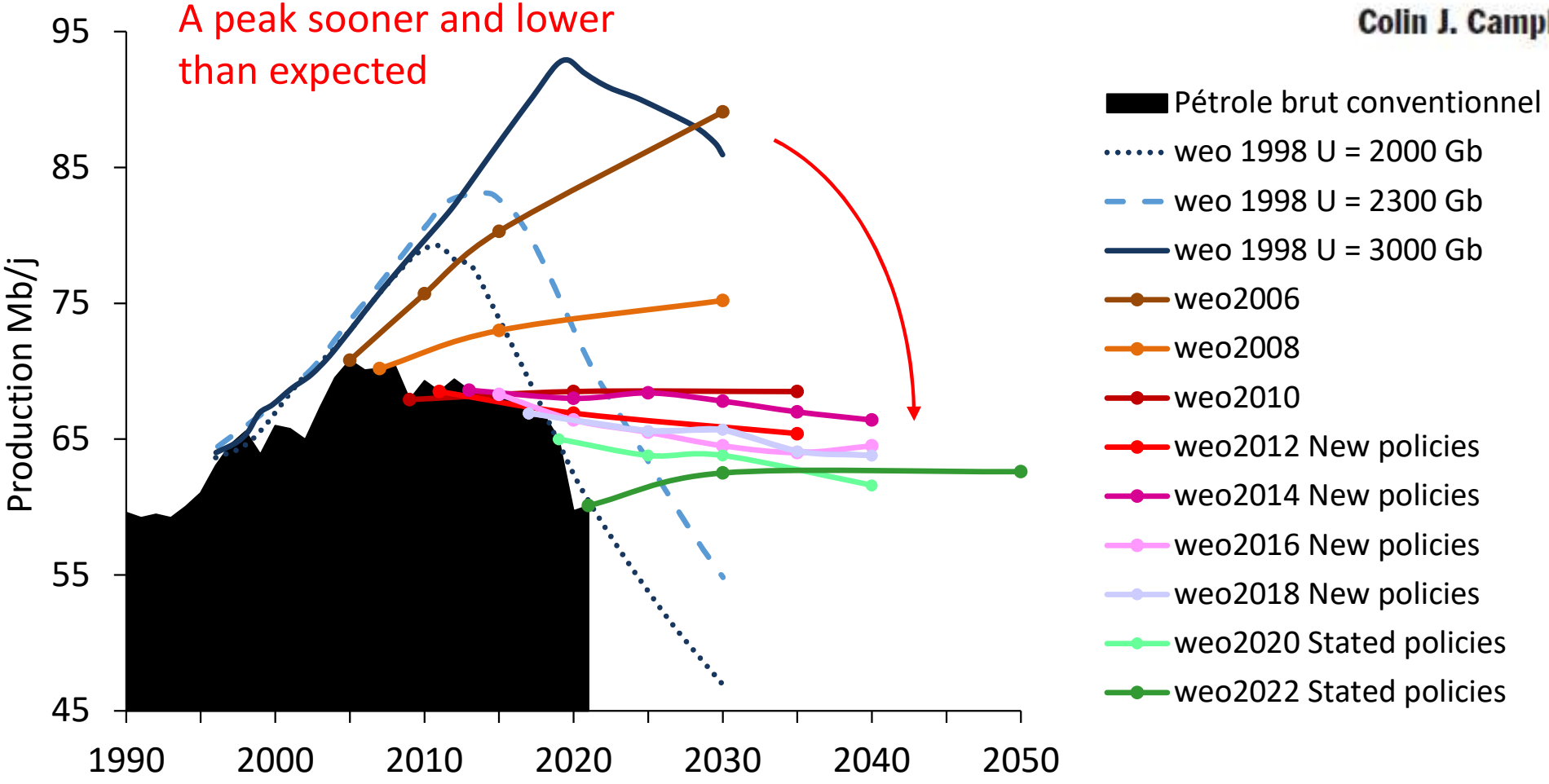


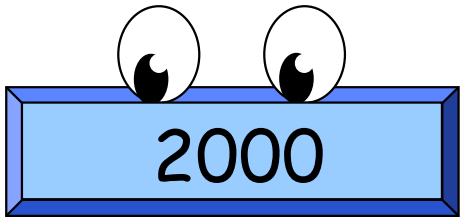
With a new IEA team, a new USGS ultimate, the peak of conventional oil disapears…

In retrospect, the work of Jean and Colin was visionary… and the IEA was – and still is – late to the game.

…foundation of ASPO : Association for the Study of Peak Oil and gas

Colin J. Campbell

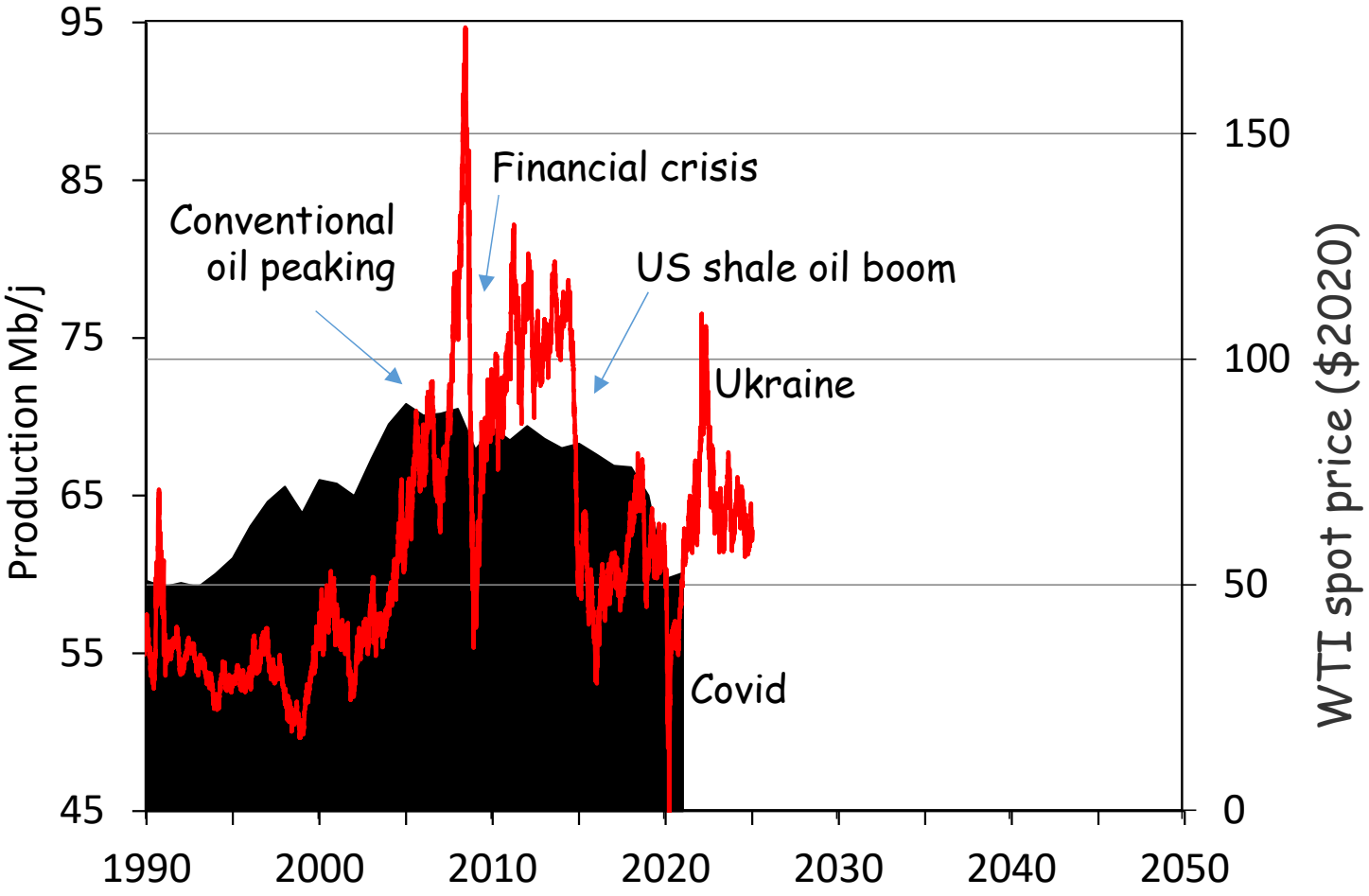




With a new IEA team, a new USGS ultimate, the peak of conventional oil disapears…

…foundation of ASPO : Association for the Study of Peak Oil and gas

Colin J. Campbell



Due to the IEA's lack of anticipation, the peaking of conventional oil production produced an oil shock.

But the warnings were forgotten when, after 2014, US shale oil opened a window of lower oil prices.

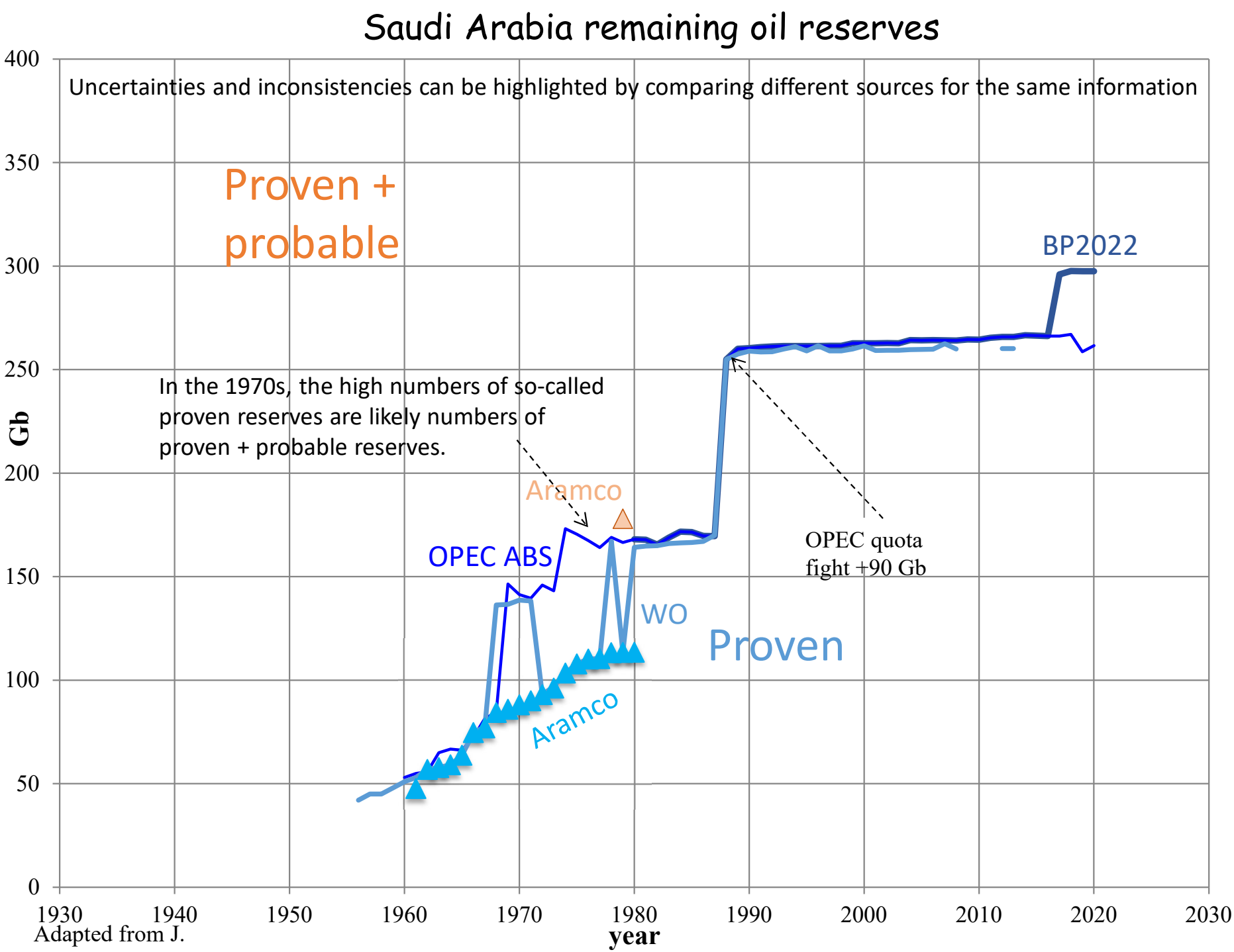
2006

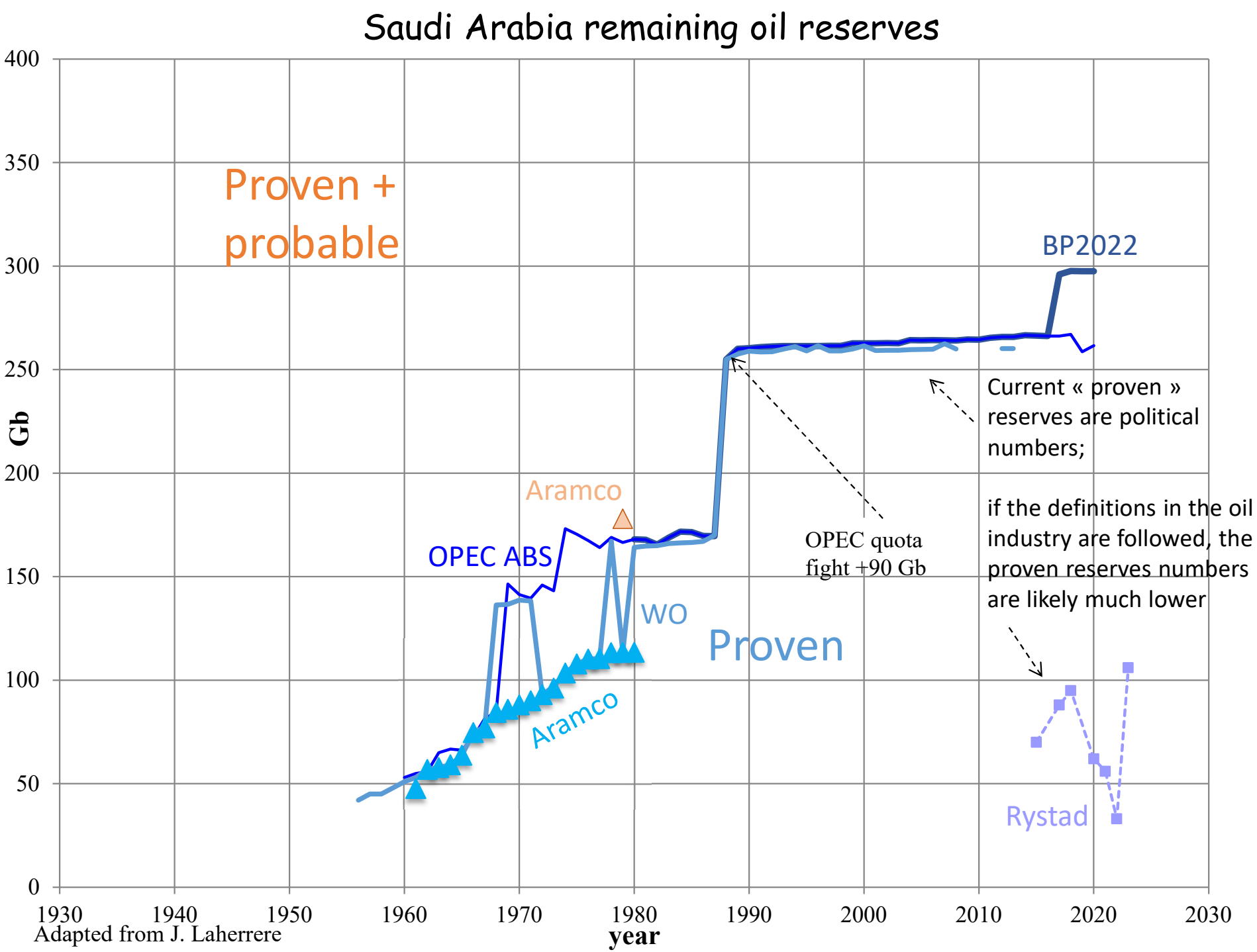
ASPO France

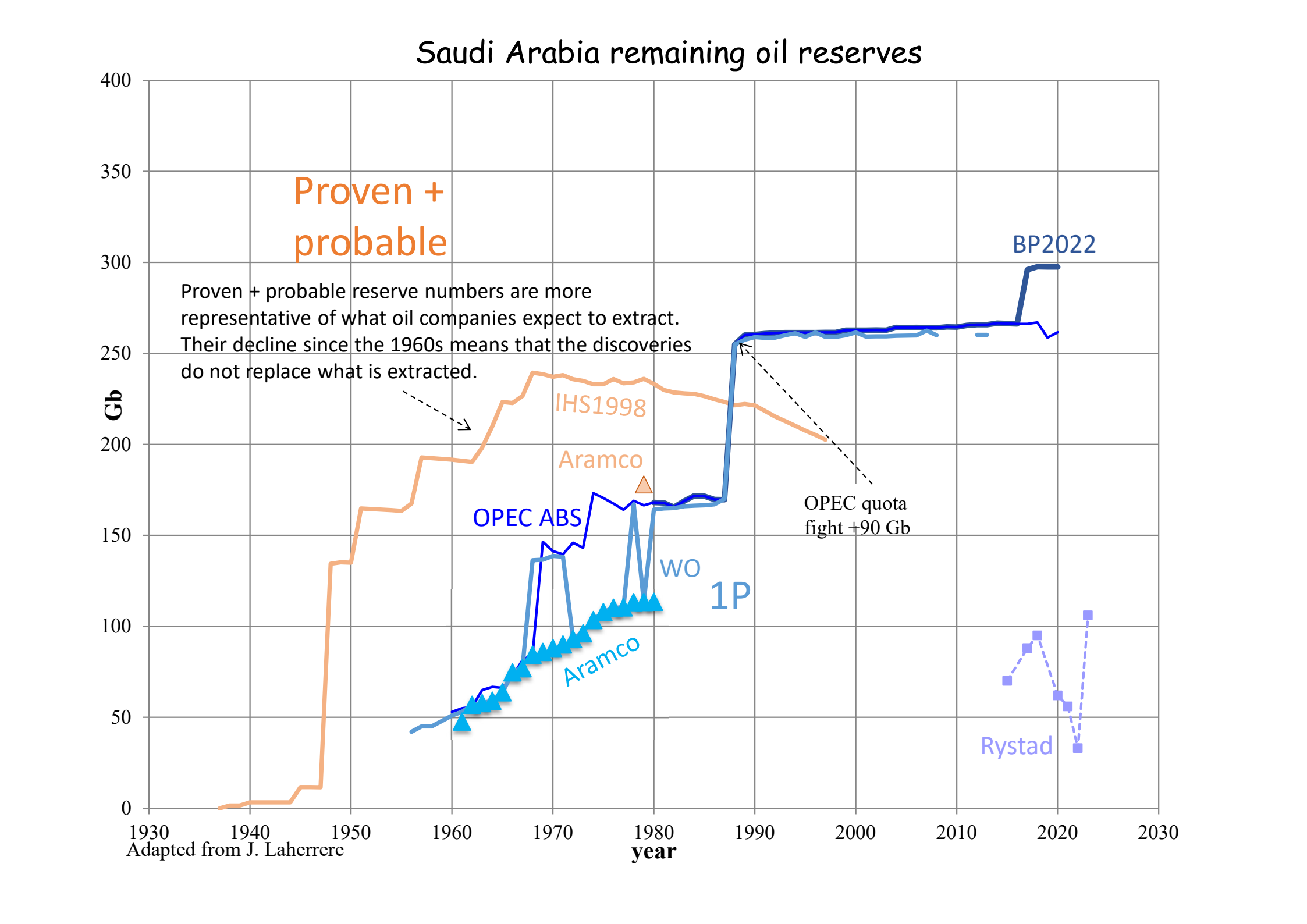
Foundation of ASPO France

Jean H. Laherrère

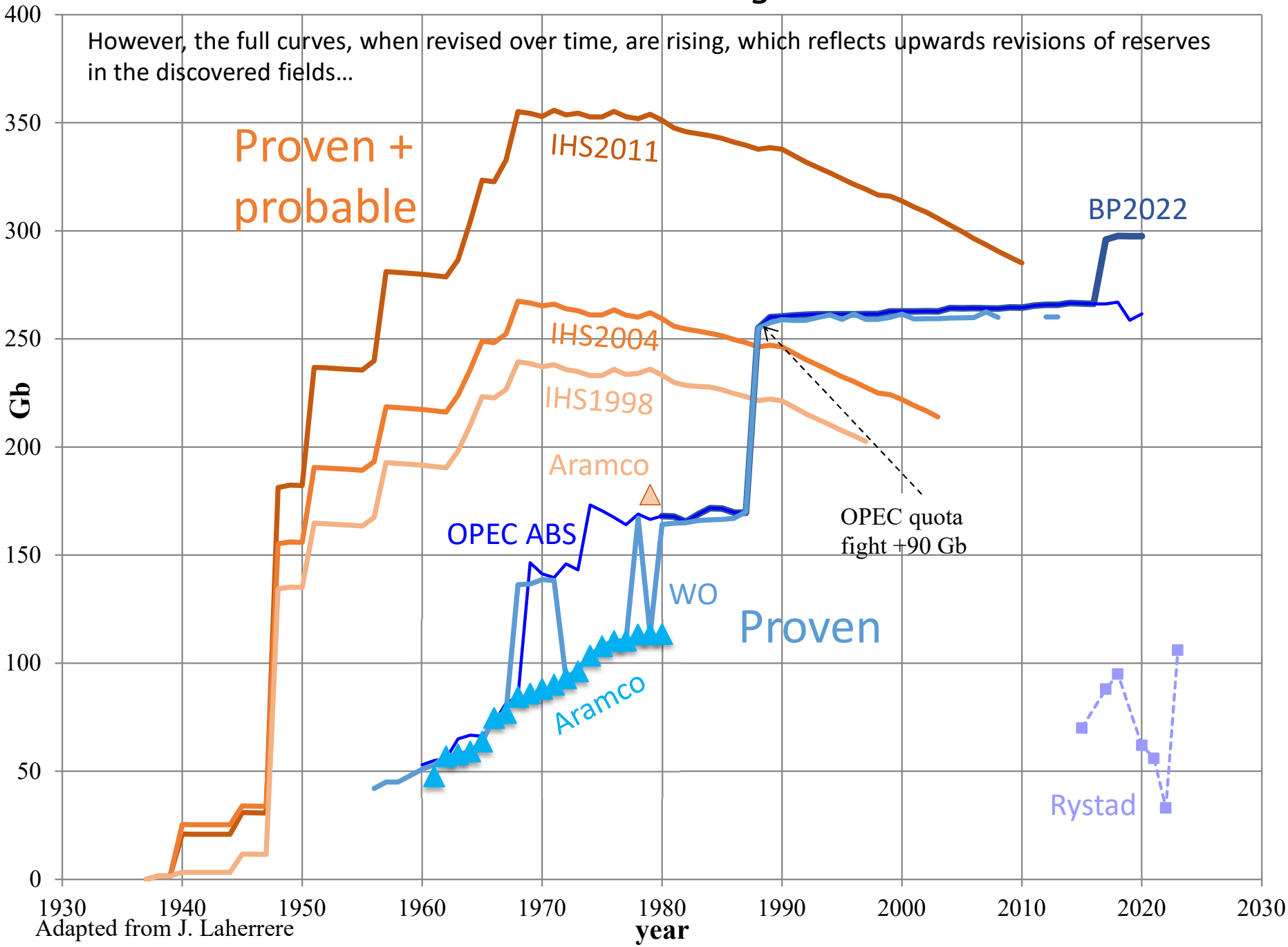
1) To give information about world resources of oil and gas and their uncertainties.


Saudi Arabia remaining oil reserves
Uncertainties and inconsistencies can be highlighted by comparing different sources for the same information
Proven + probable
BP2022
In the 1970s, the high numbers of so-called proven reserves are likely numbers of proven + probable reserves.
Aramco
OPEC ABS
OPEC quota fight +90 Gb
WO
Proven
Aramco
Gb
year
400
350
300
250
200
150
100
50
0
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
Adapted from J.

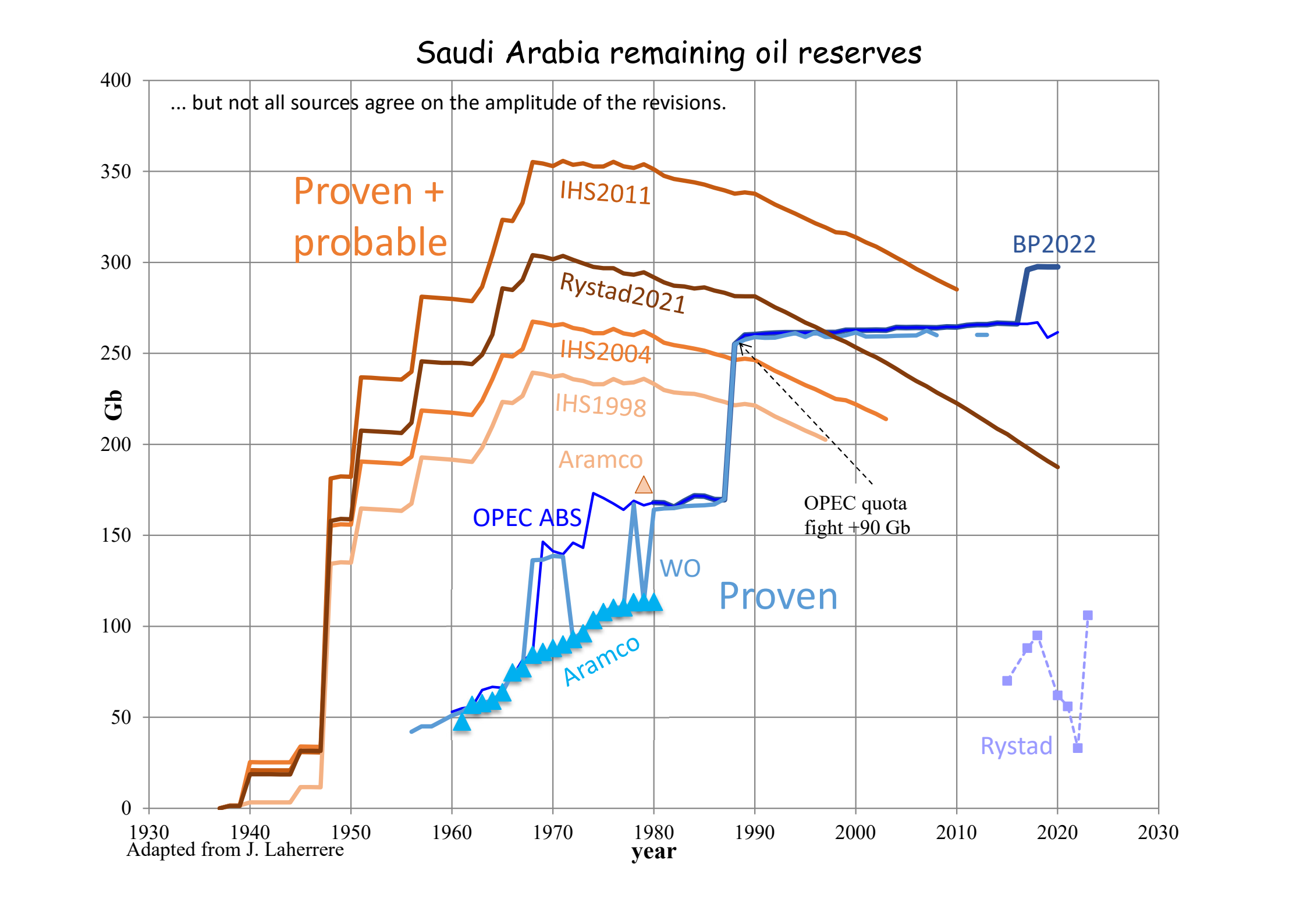

Saudi Arabia remaining oil reserves
Proven + probable
BP2022
Current « proven » reserves are political numbers;
if the definitions in the oil industry are followed, the proven reserves numbers are likely much lower
Aramco
OPEC ABS
WO
Proven
OPEC quota fight +90 Gb
Aramco
Rystad
Gb
year
400
350
300
250
200
150
100
50
0
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
Adapted from J. Laherrere


Saudi Arabia remaining oil reserves
Proven + probable
Proven + probable reserve numbers are more representative of what oil companies expect to extract. Their decline since the 1960s means that the discoveries do not replace what is extracted.
BP2022
IHS1998
Aramco
OPEC ABS
OPEC quota fight +90 Gb
WO
1P
Aramco
Rystad
Gb
year
Adapted from J. Laherrere

Saudi Arabia remaining oil reserves



Adapted from J. Laherrere


Saudi Arabia remaining oil reserves
... but not all sources agree on the amplitude of the revisions.
Proven + probable
IHS2011
Rystad2021
IHS2004
IHS1998
Aramco
BP2022
OPEC ABS
WO
Proven
Aramco
OPEC quota fight +90 Gb
Rystad
Gb
year
Adapted from J. Laherrere

2006

ASPO France

Foundation of ASPO France

Jean H. Laherrère

1) To give information about world resources

2) To explain the reality of depletion.

2006

ASPO France

Foundation of ASPO France

Jean H. Laherrère

1) To give information about world resources

2) To explain the reality of depletion.

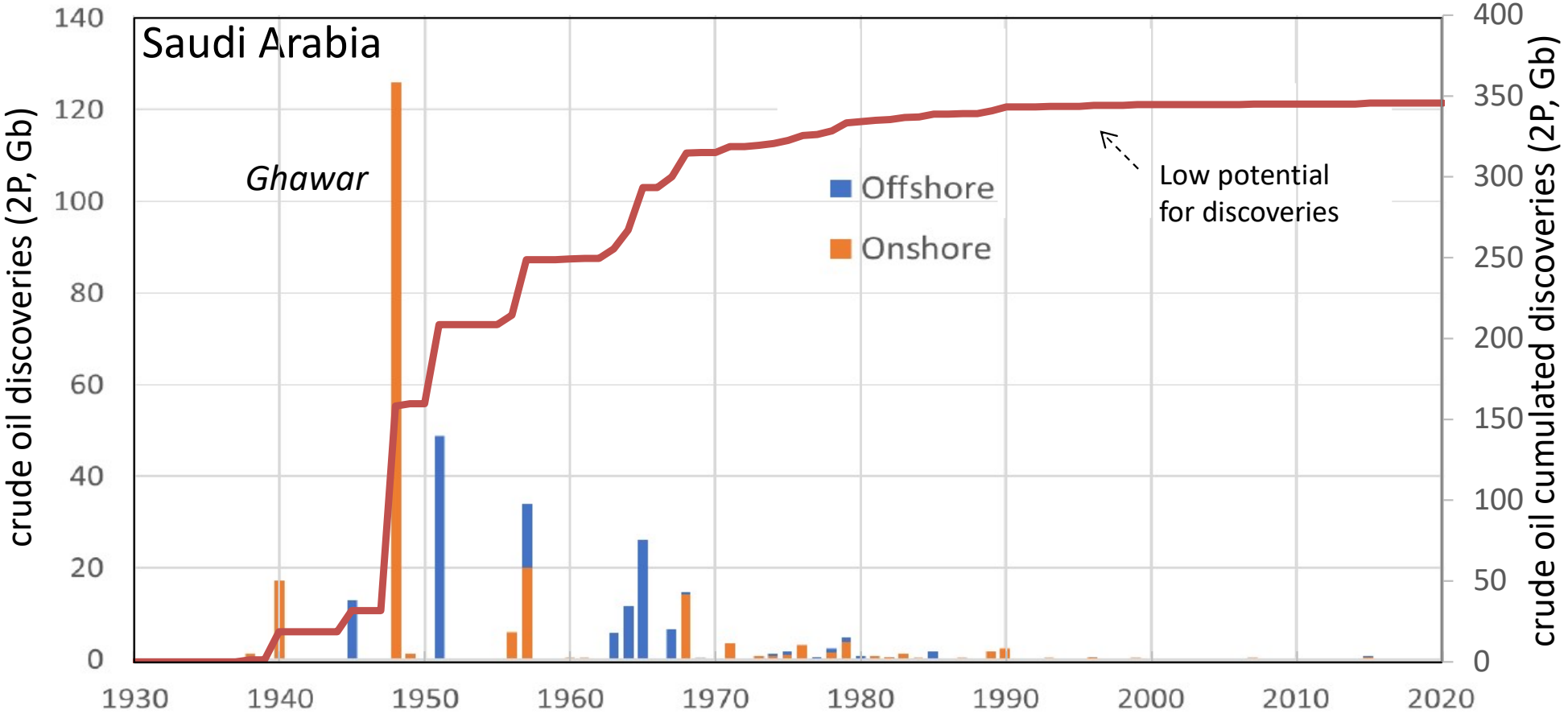
3) To study depletion

… and to forecast future production, by :
I) a field by field approach
II) a macro-level approach.

I) Field by field analysis

A good database of 2P oil data

- Evolutions of discoveries, remaining reserves, depletion level, field size, delays between discoveries and production, productions by year of first flow, breakeven prices, …

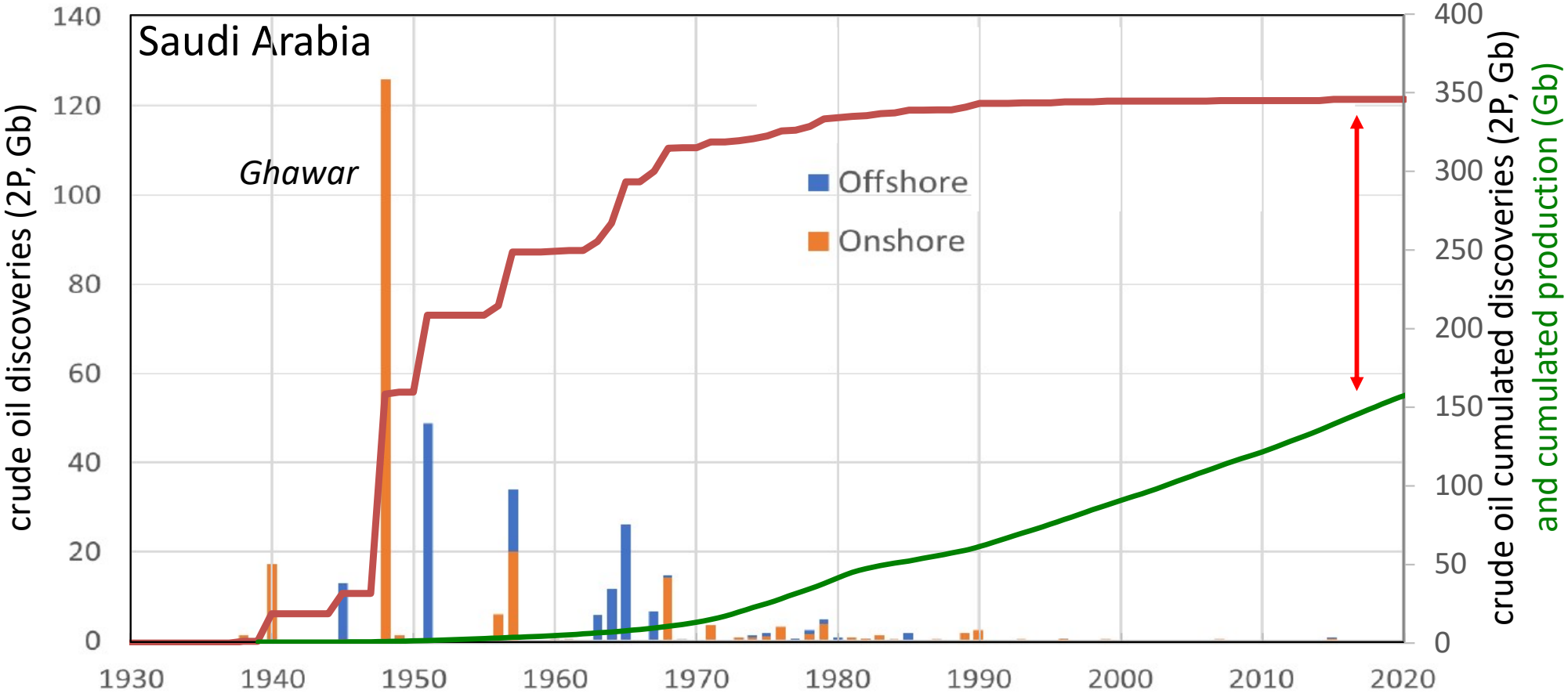


Shift Project (2021; study with the contribution from 8 members of ASPO France

I) Field by field analysis

A good database of 2P oil data

- Evolutions of discoveries, remaining reserves, depletion level, field size, delays between discoveries and production, productions by year of first flow, breakeven prices, …



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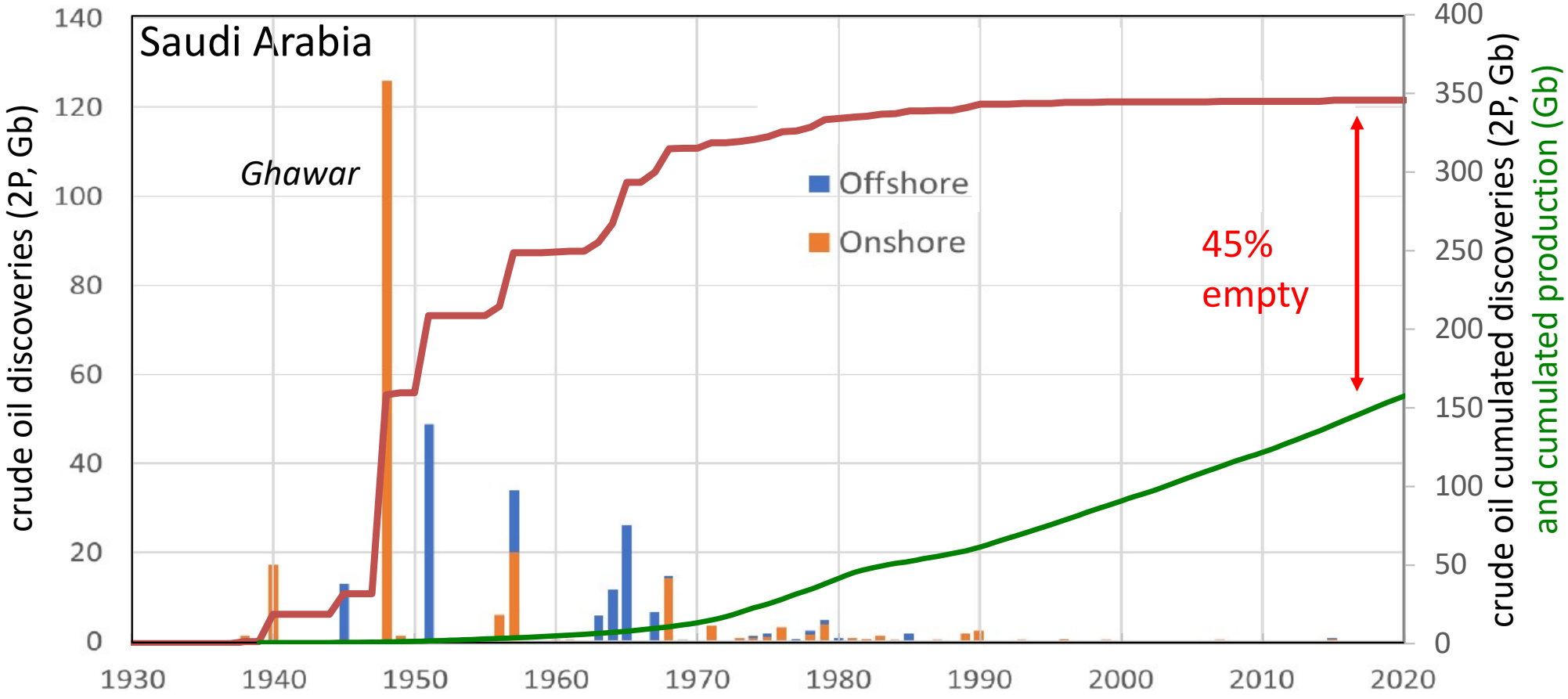

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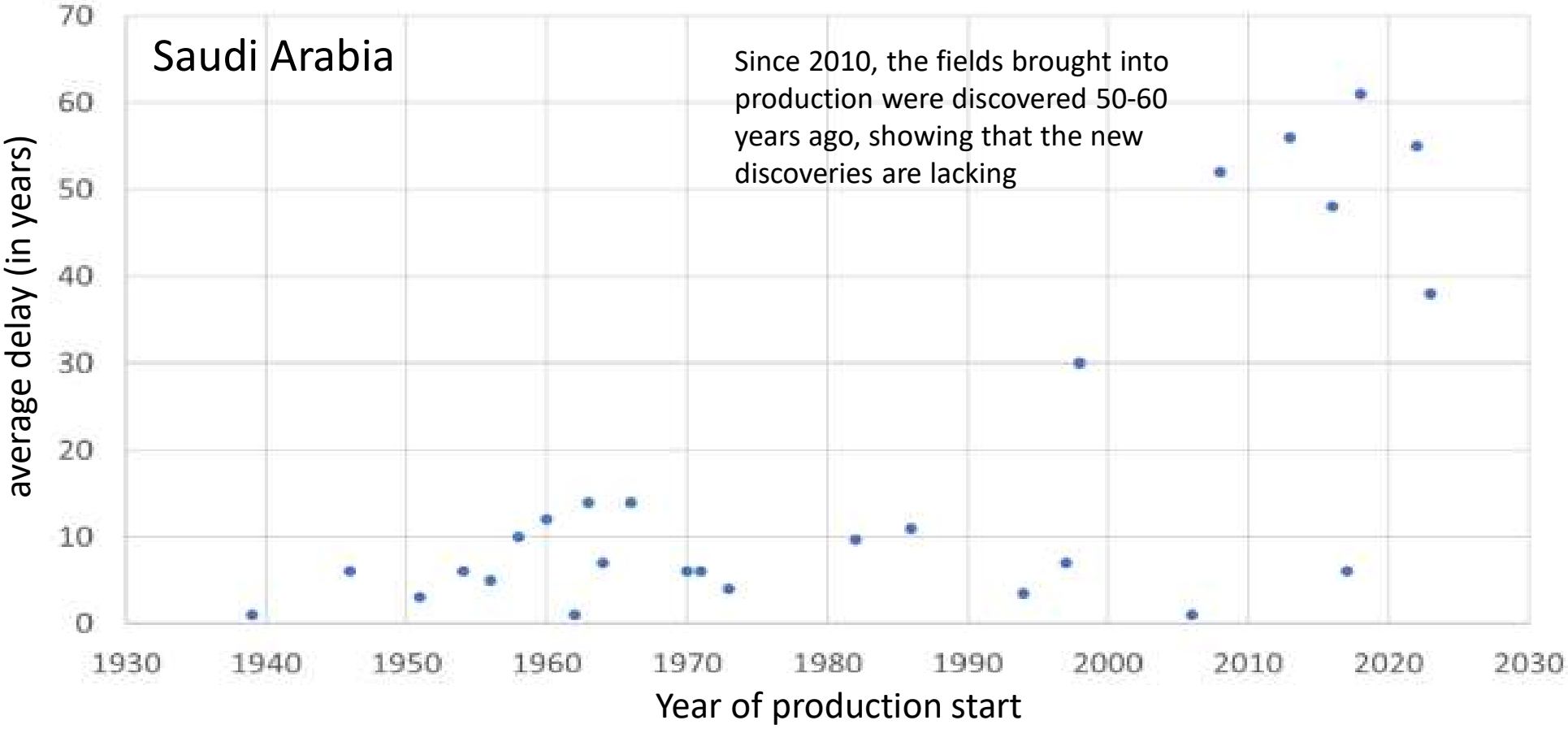


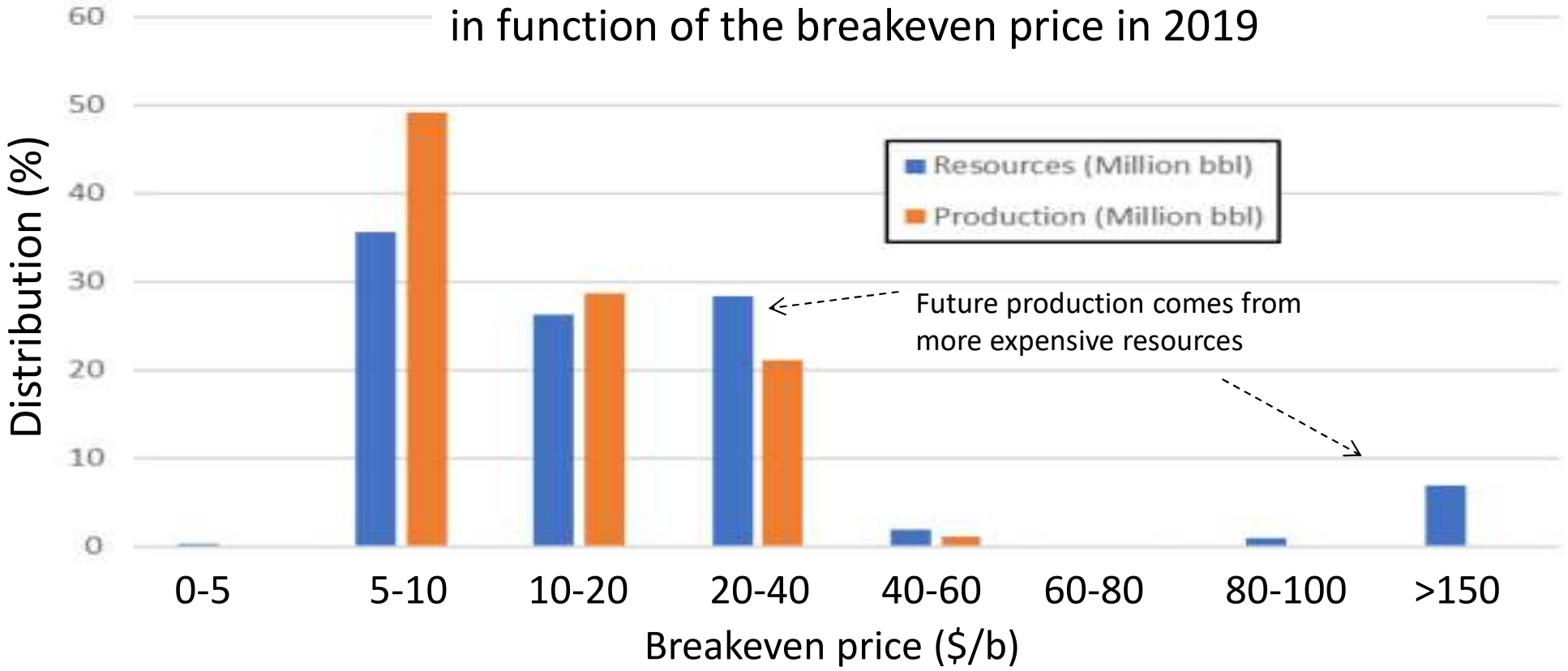
Shift Project (2021; study with the contribution from 8 members of ASPO France

I) Field by field analysis

A good database of 2P oil data

- Evolutions of discoveries, remaining reserves, depletion level, field size, delays between discoveries and production, productions by year of first flow, breakeven prices, …

Saudi Arabia – distribution of production and remaining resources in function of the breakeven price in 2019



Shift Project (2021; study with the contribution from 8 members of ASPO France

I) Field by field analysis

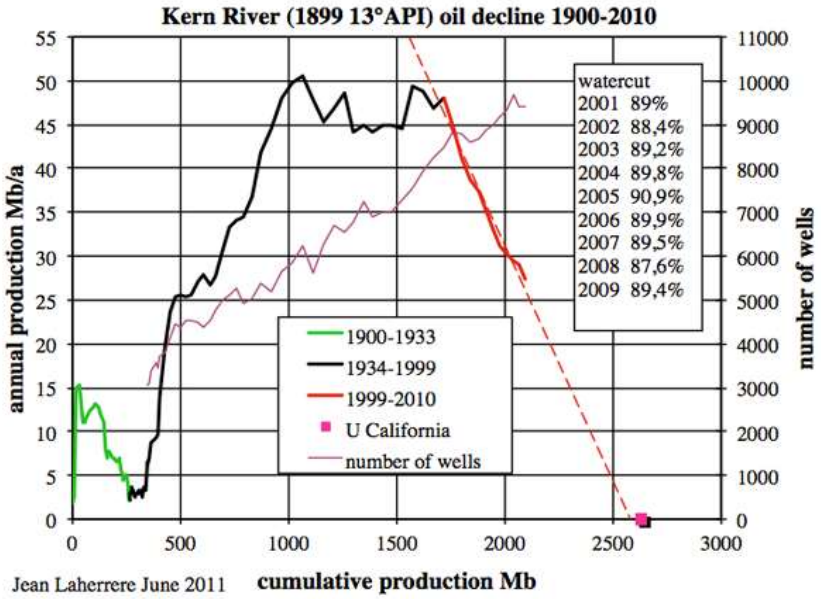
A good database of 2P oil data

- Evolutions of discoveries, field size, delays between discoveries and production, productions by year of first flow, breakeven prices, depletion level, remaining reserves …

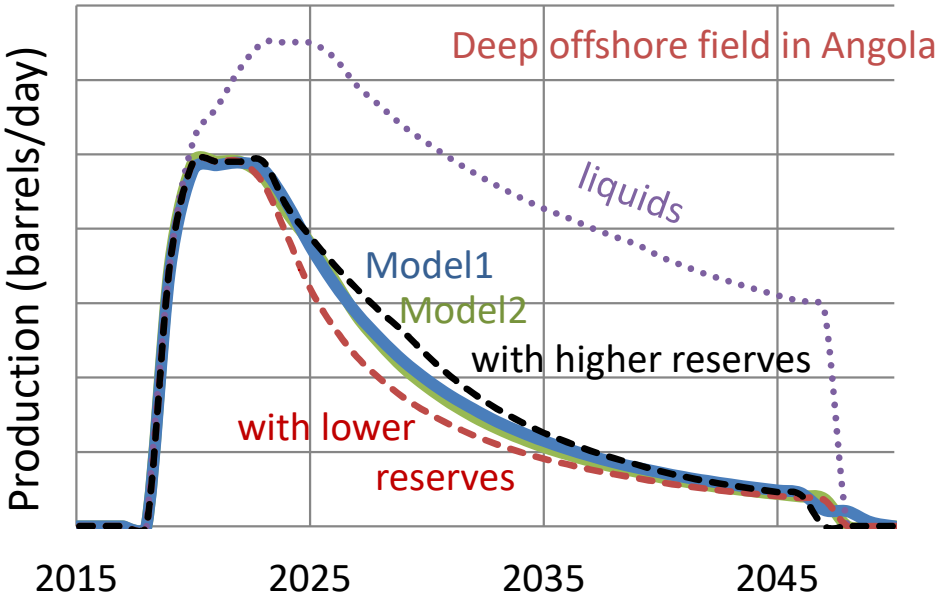
Production forecast by a comprehensive analysis of the exploration-production cycle

- Producing fields
- Undeveloped resources (Discovered Resources Opportunities)
- Prospective resources (Yet To Find)

Curve fitting to evaluate the ultimate and compare it to values obtained by other methods…

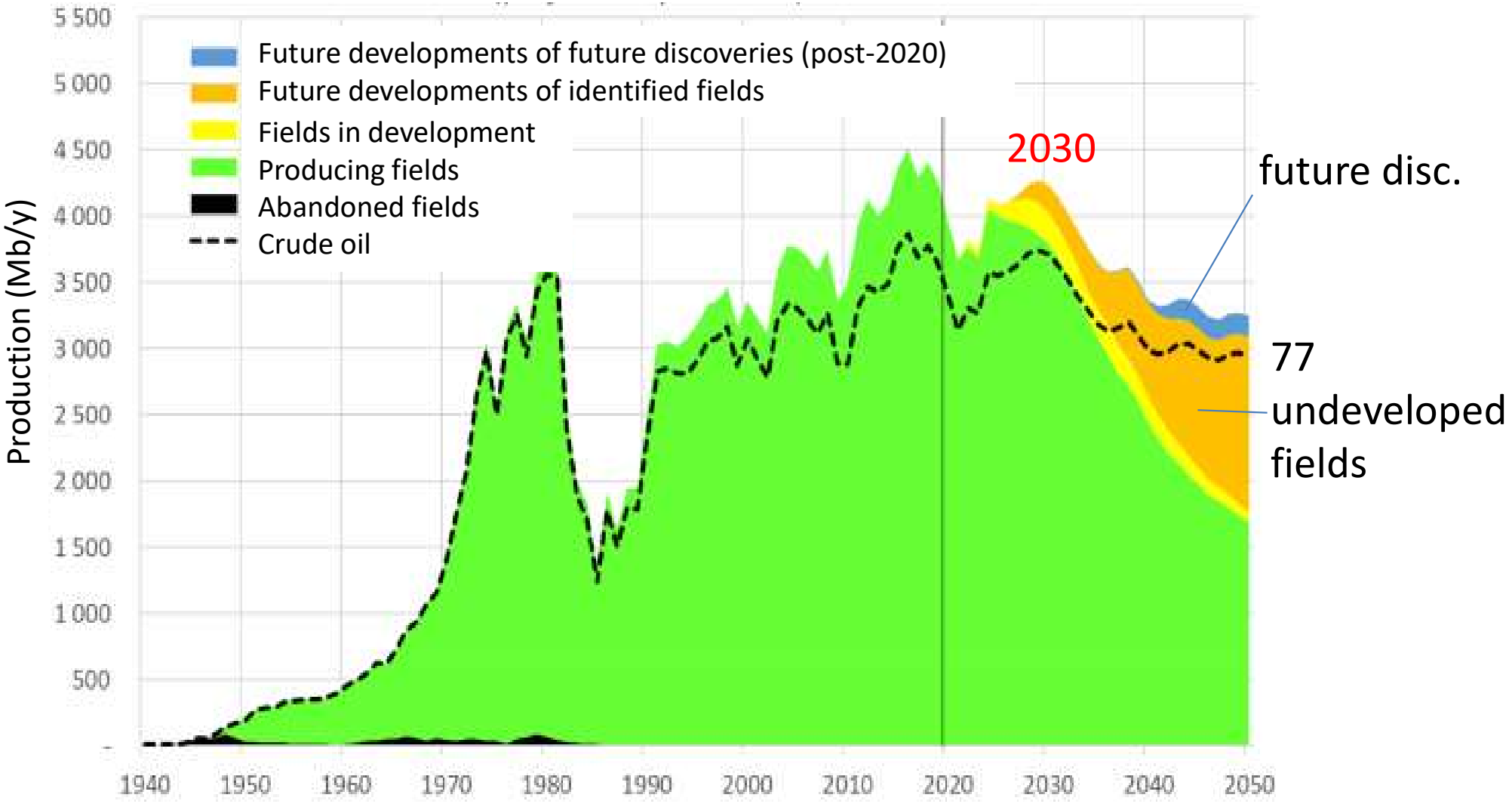


Decline curves are built from models based on the knowledge accumulated from depleted fields.



I) Field by field analysis

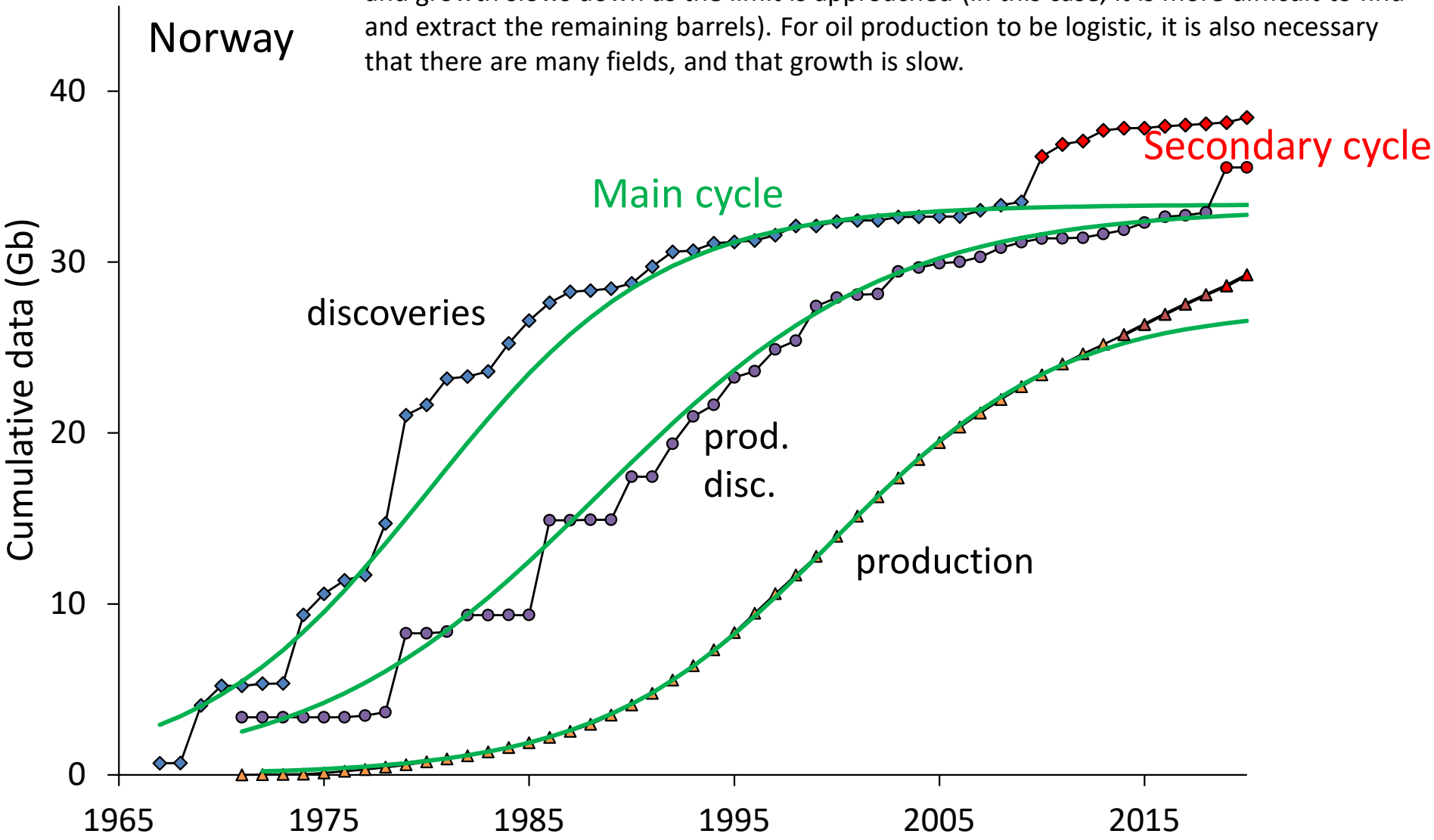
Saudi Arabia – liquid hydrocarbons (projections post-2020)



Shift Project (2021). Approvisionnement pétrolier futur de l'Union européenne : état des réserves et perspectives de production des principaux pays fournisseurs, report for DGRIS, Ministère des Armées; ; study with the contribution from 8 members of ASPO France.

II) Macro-level analysis
The logistic approach

Growth phenomena are logistic when there is a limit (in this case, oil is non-renewable) and growth slows down as the limit is approached (in this case, it is more difficult to find and extract the remaining barrels). For oil production to be logistic, it is also necessary that there are many fields, and that growth is slow.

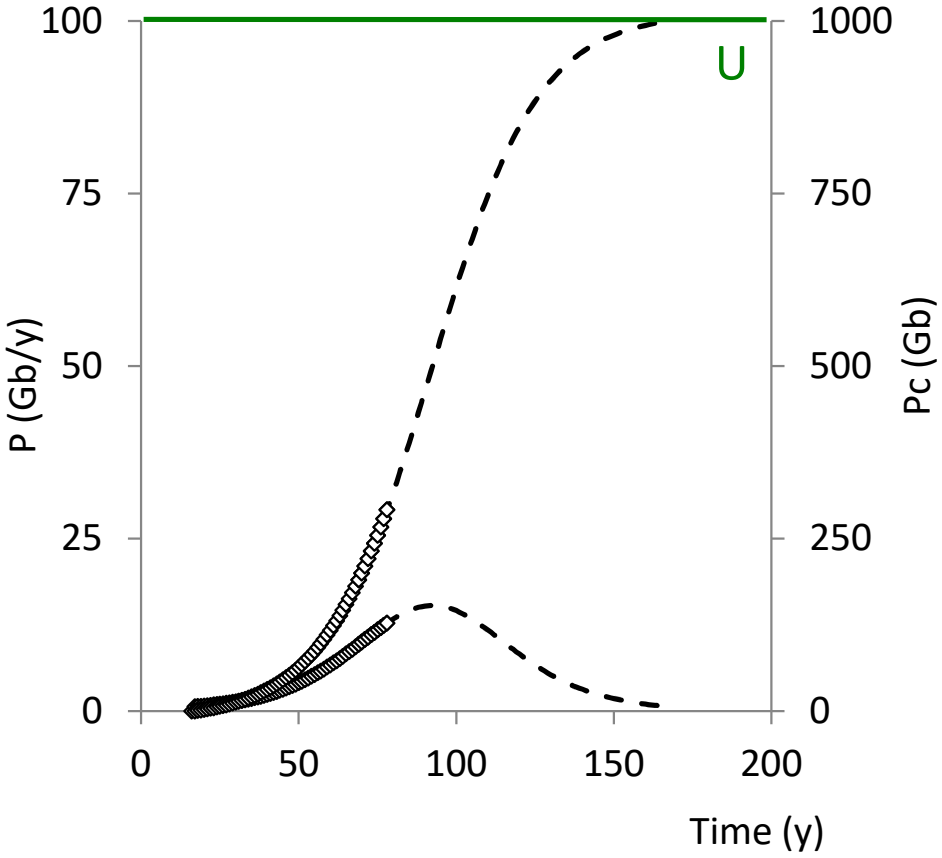


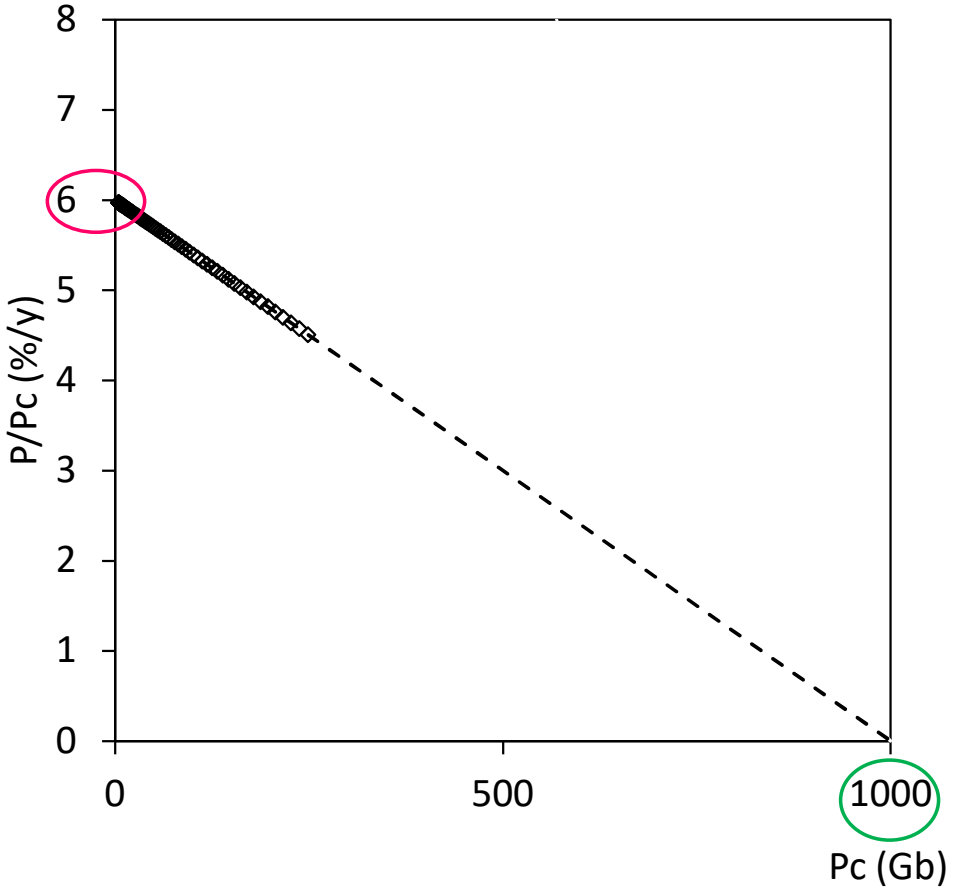
II) Macro-level analysis

A logistic can be linearized.

$$P_c = \frac{U}{1 + (\frac{U}{P_{c0}} - 1)e^{-rt}}$$

$$\frac{P}{P_c} = -\frac{r}{U}P_c + r$$



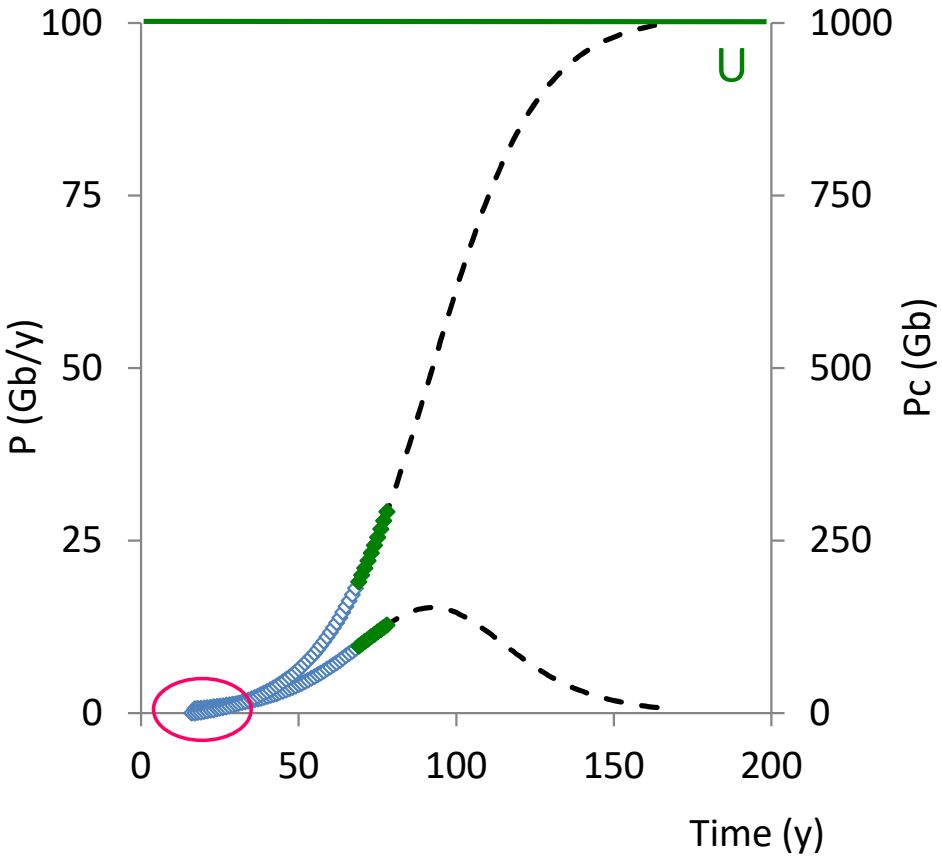


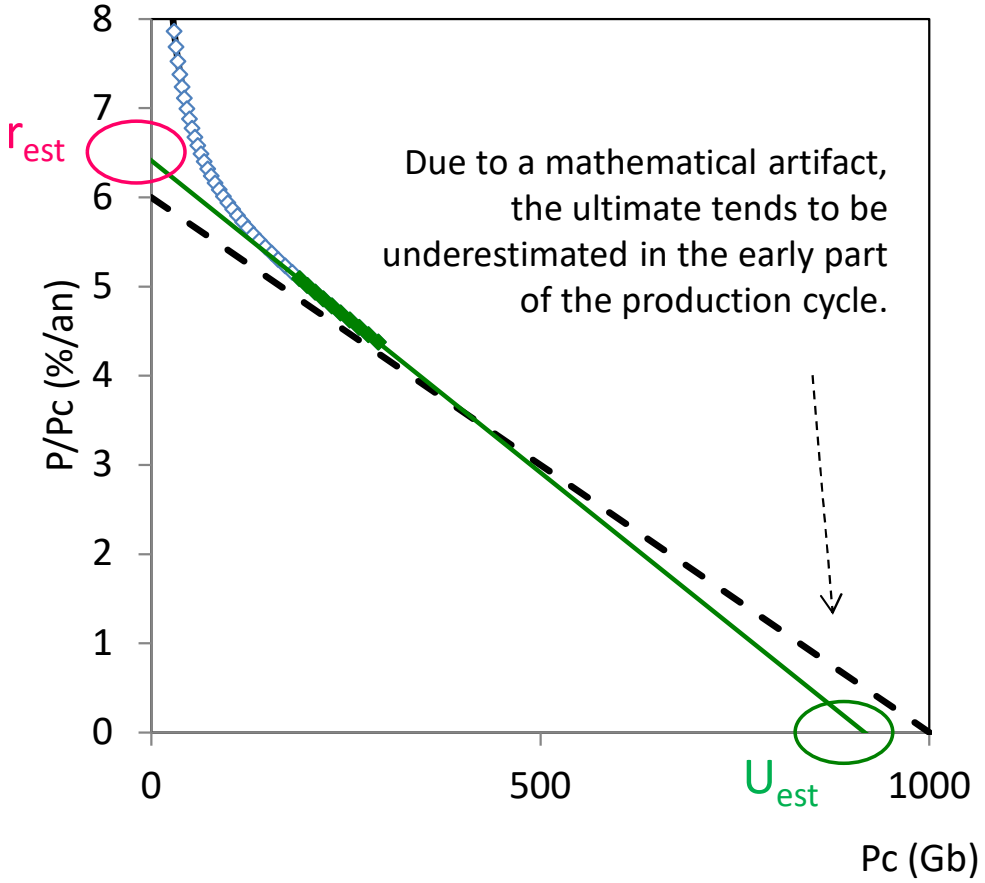
Useful to estimate the ultimate reserves (U) and the logistic growth rate (r)

II) Macro-level analysis

A logistic can be linearized.

$$P_c = \frac{U}{1 + (\frac{U}{P_{c0}} - 1)e^{-rt}} \quad \Rightarrow \quad \frac{P}{P_c} = -\frac{r}{U}P_c + r$$



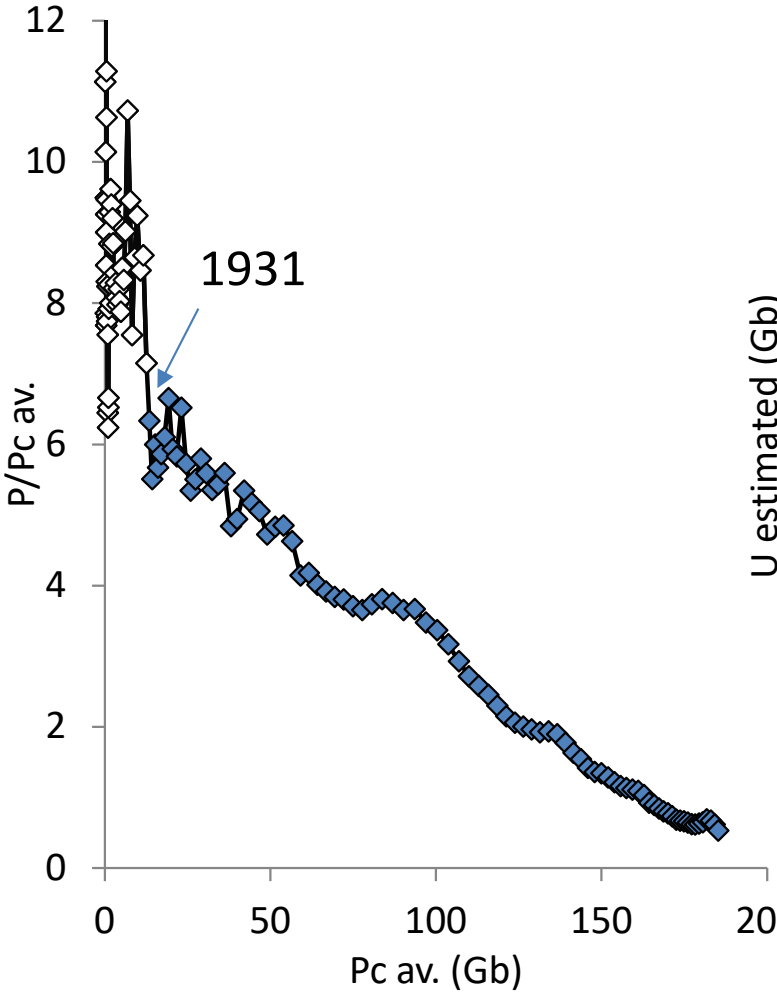


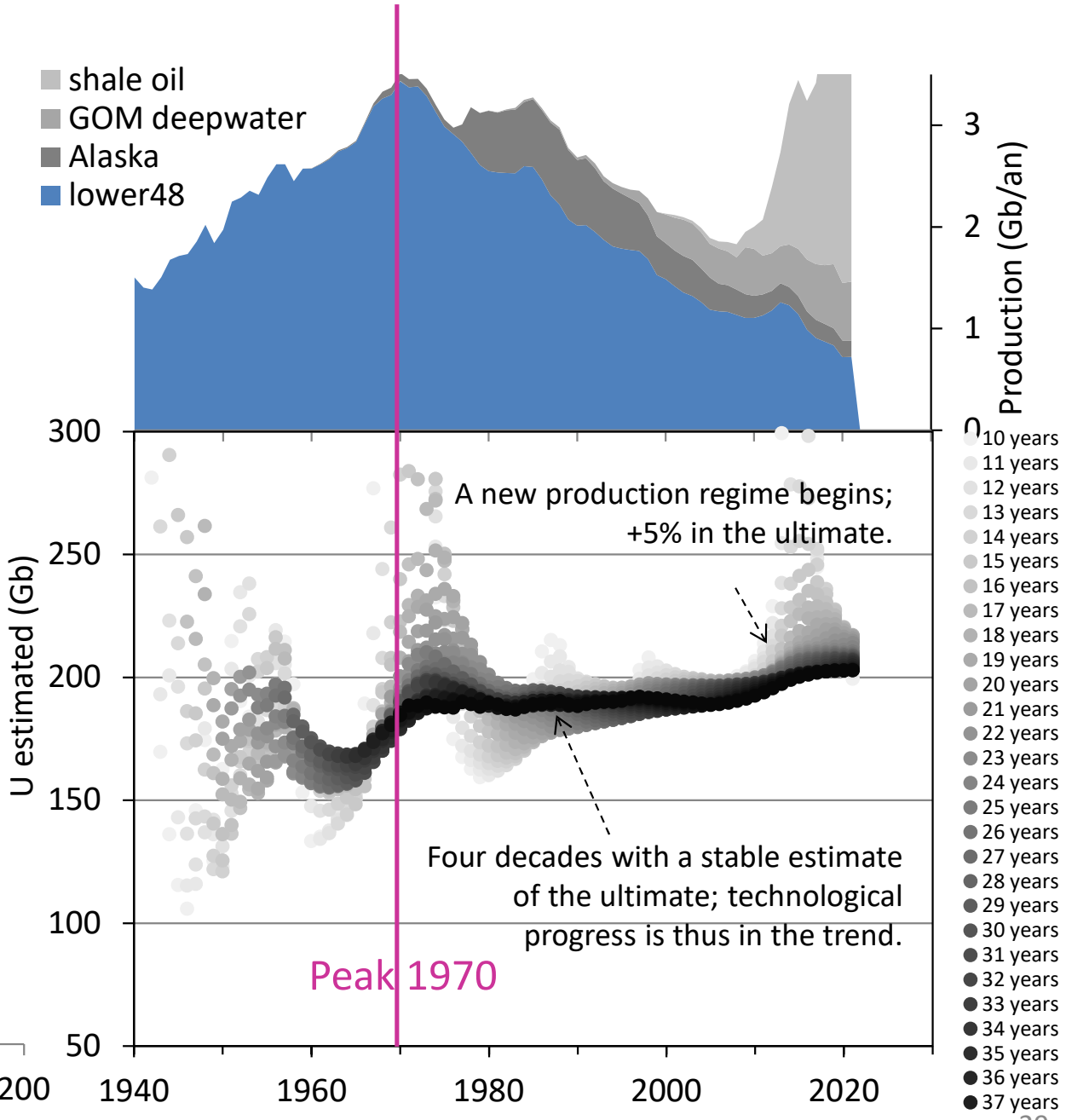
Useful to estimate the ultimate reserves (U) and the logistic growth rate (r)

II) Macro-level analysis

IIa) Estimating the ultimate

USA : Lower-48

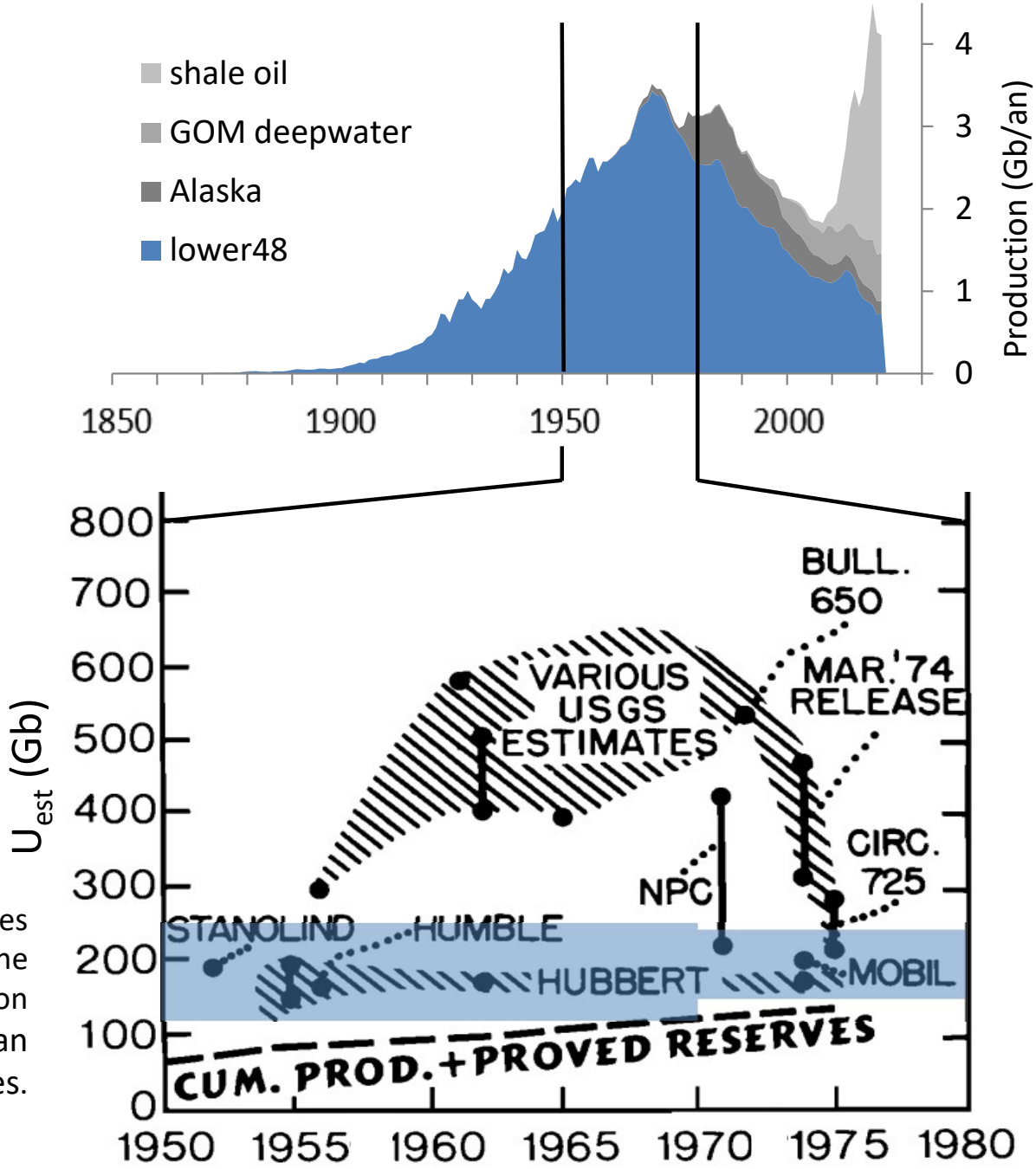




II) Macro-level analysis

IIa) Estimating the ultimate

USA : Lower-48

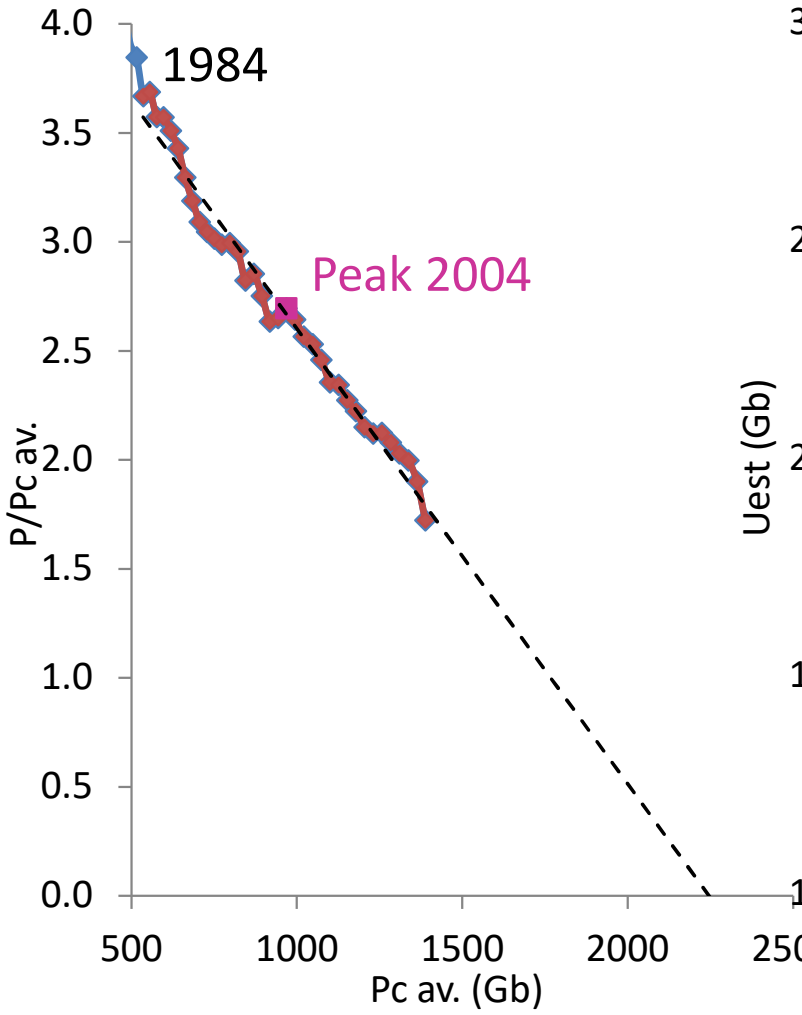


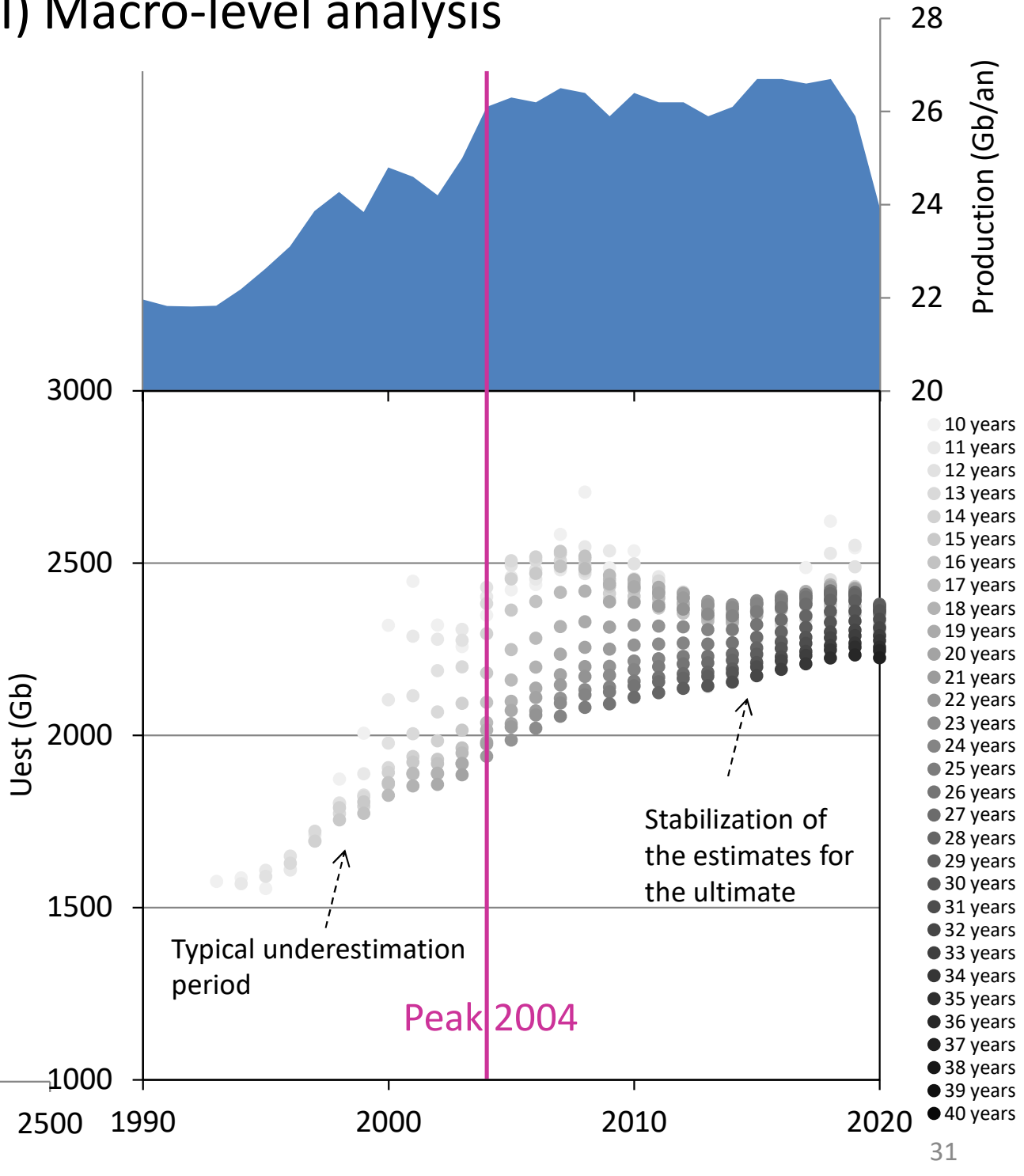
In the 1950s-80s, the range of estimates for the ultimate obtained by the linearization method reflects production behavior, and is significantly lower than those from some other studies.

II) Macro-level analysis

IIa) Estimating the ultimate

World conventional crude oil

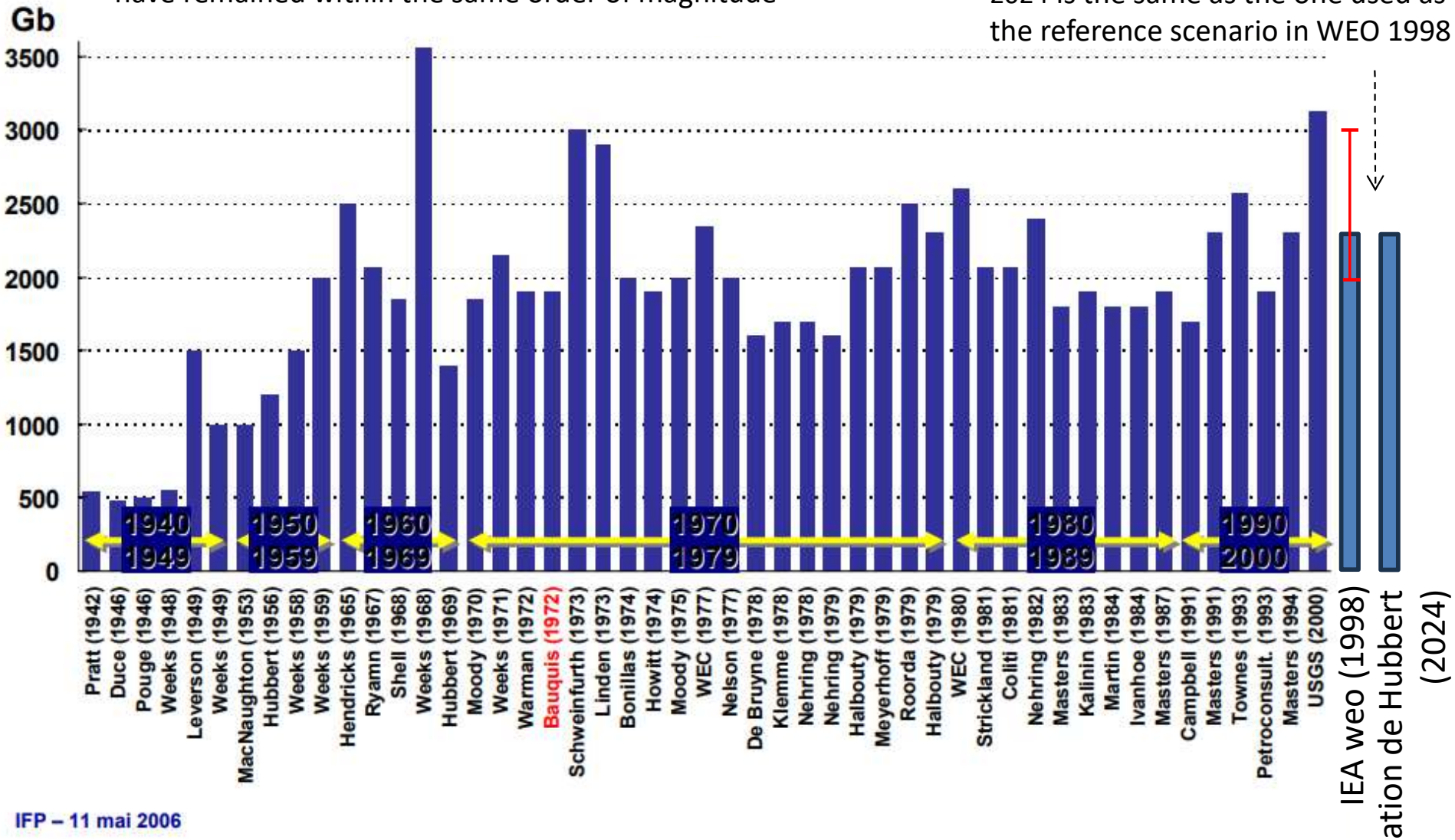




HISTORICAL VIEWS ON ULTIMATE RESERVES

Since the 1960s, the estimates for the ultimate of conventional oil have remained within the same order of magnitude

The ultimate obtained by linearization in 2024 is the same as the one used as the reference scenario in WEO 1998



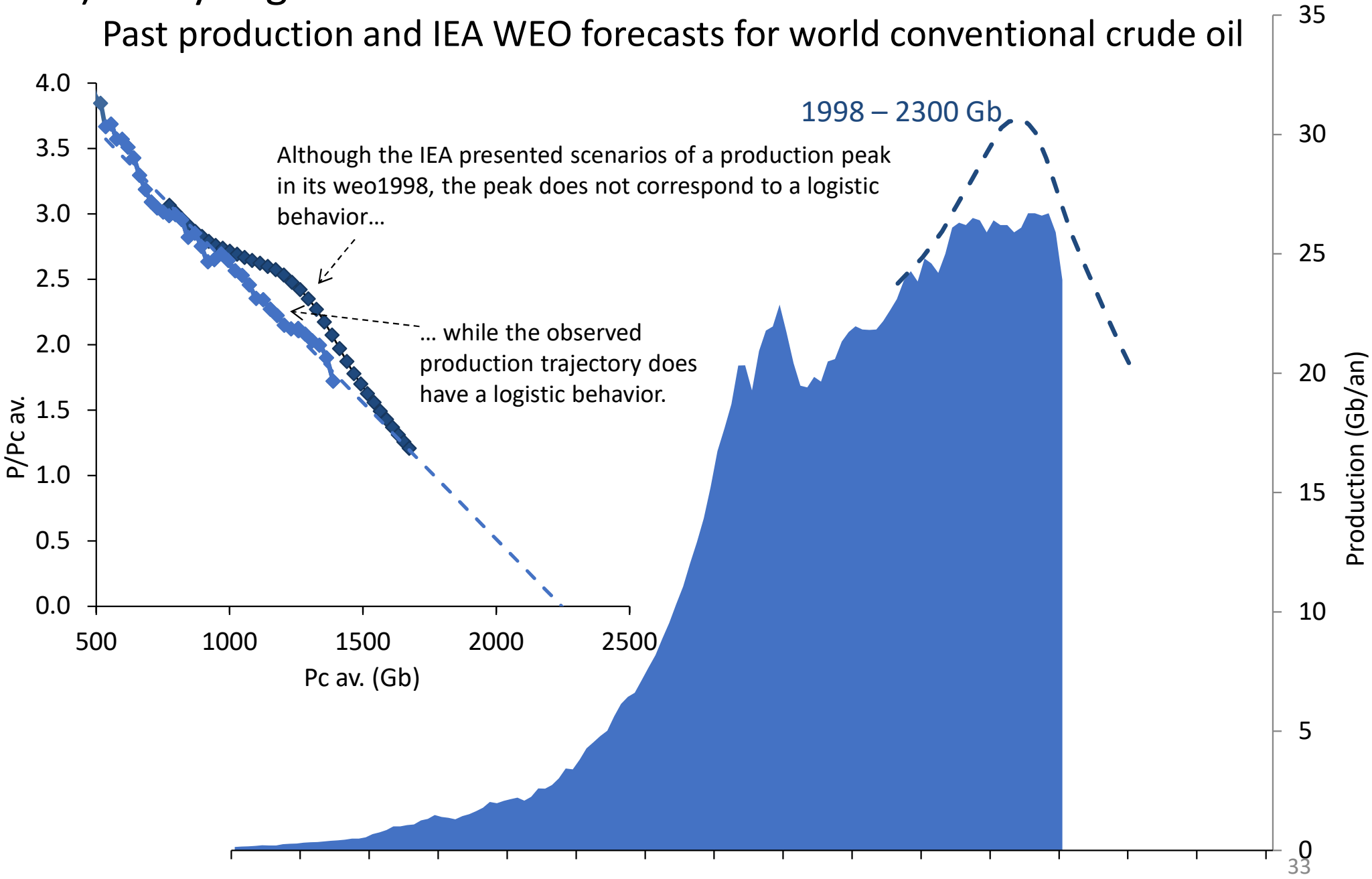
Source: IFP/DSEP adapted from Martin (1985) and Campbell (1992) - Updated 2000

Graphic P. R. Bauquis

II) Macro-level analysis

IIb) Analyzing forecasts

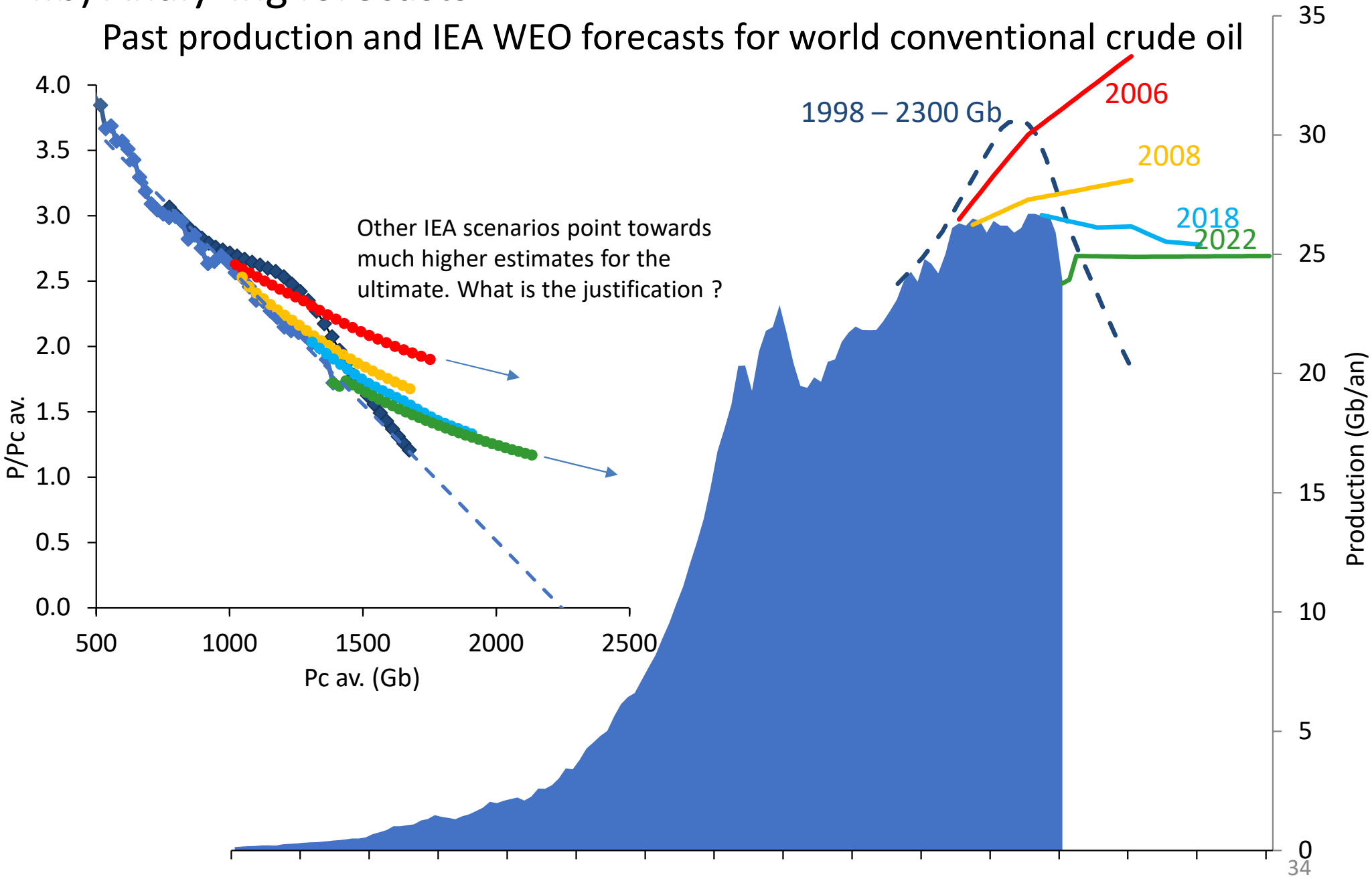
Past production and IEA WEO forecasts for world conventional crude oil



II) Macro-level analysis

IIb) Analyzing forecasts

Past production and IEA WEO forecasts for world conventional crude oil

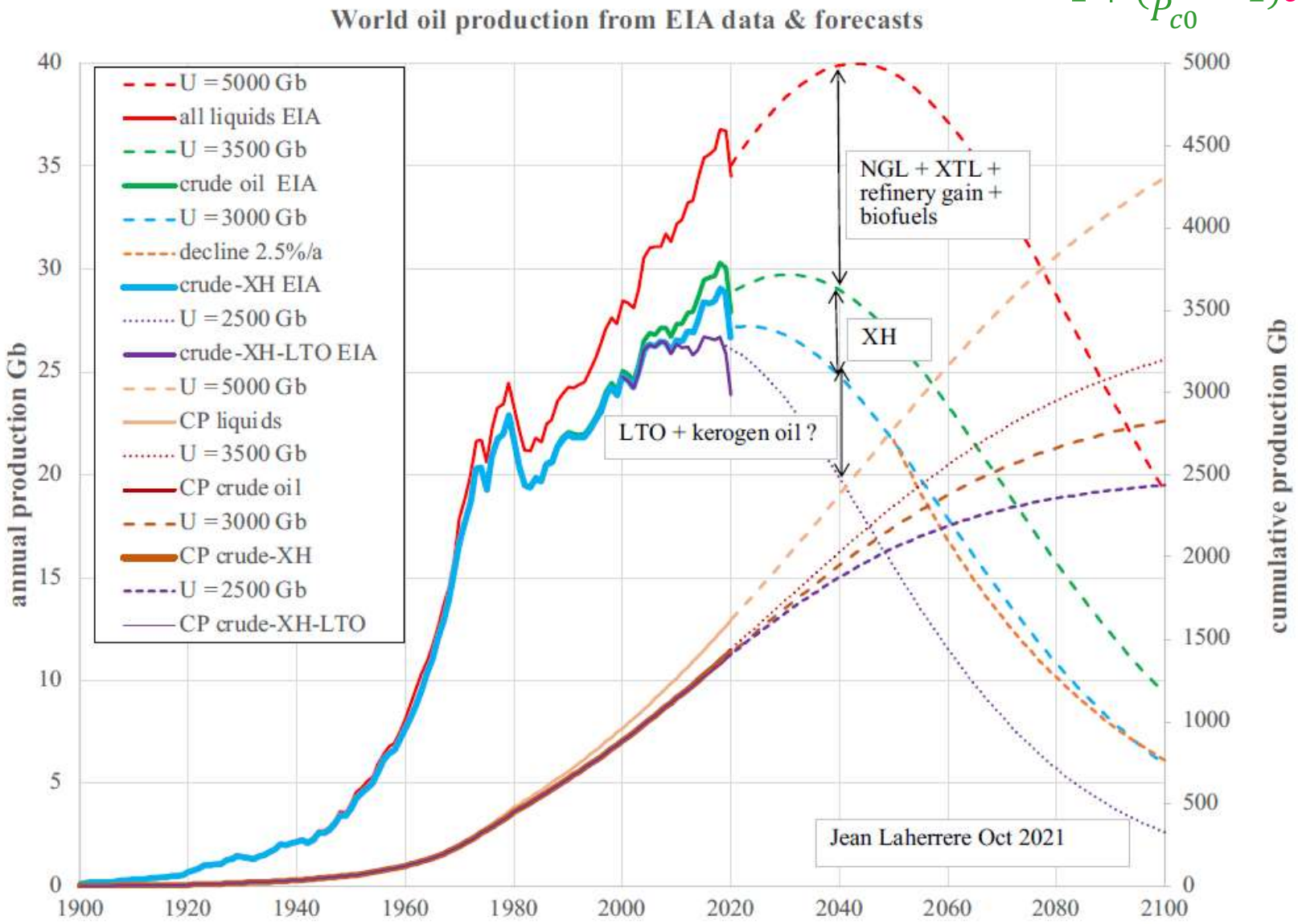


II) Macro-level analysis

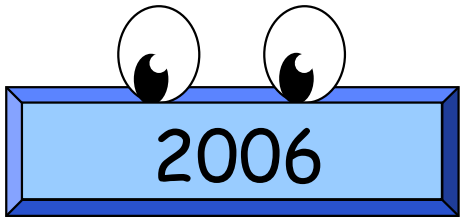
IIc) Forecasting future production

Different estimates for the ultimate can be tested.

$$P_c = \frac{U}{1 + (\frac{U}{P_{c0}} - 1)e^{-rt}}$$



Laherrère, J., Hall, C. A., & Bentley, R. W. (2022). How much oil remains for the world to produce? Comparing assessment methods, and separating fact from fiction. *Current Research in Environmental Sustainability, 4*(100174), 1-19. doi:10.1016/j.crsust.2022.100174



ASPO France

Foundation of ASPO France

Jean H. Laherrère

1) To give information about world resources of oil and gas and their uncertainties.

2) To explain the reality of depletion.

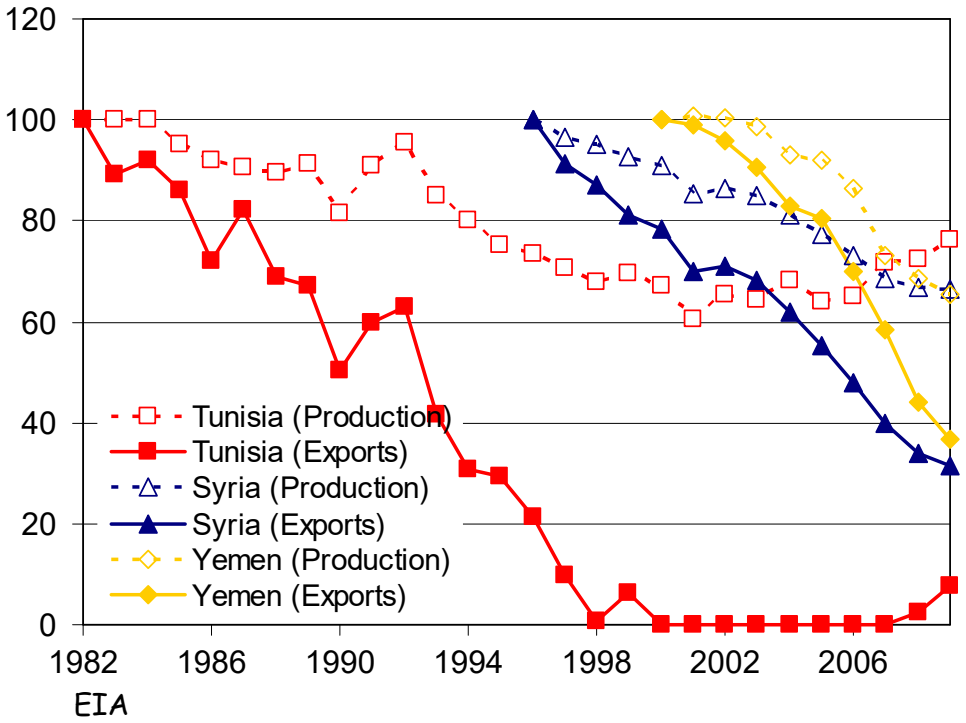
3) To study depletion and its consequences, taking count of energy demand as well as technological, economical, social and political aspects.

The next slides show a few examples of subjects studied by ASPO members

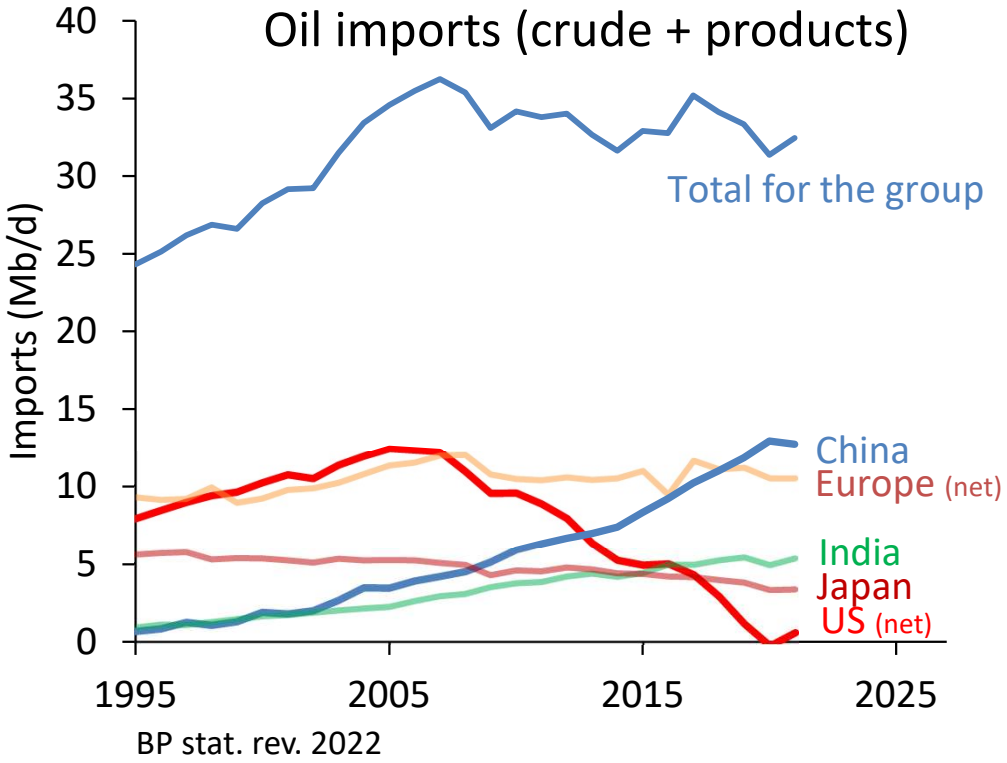
What about the evolution of oil exports and their consequences ?

For exporters

Evolution of production and exports since "peak exports" (from a normalized value of 100).



For importers



Exports tend to decline faster than production

Less oil exports = less earnings for the governments,
and oil subsidies used to buy social peace must be removed.

→ Rise in local fuel prices

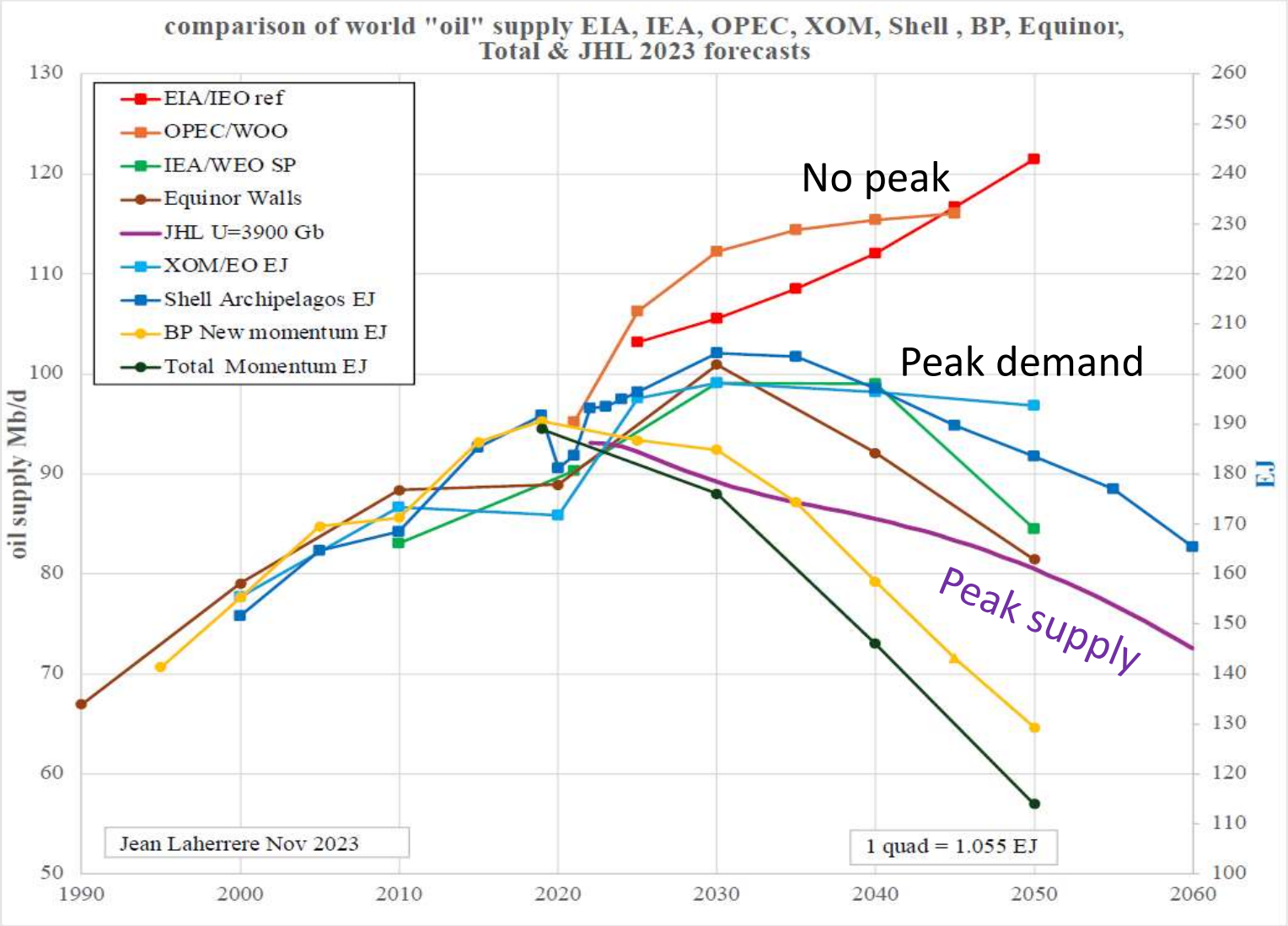
→ Destabilization of the country (cf Indonesia 2005, Arab Springs 2010)

For Syria, between 2006 and 2008, the net value of Syria's oil exports and imports has dropped from +1.9 G$ to -100 M$. Syria thus announced a long-term plan to phase out the subsidies, but these plans were delayed when the political situation turned sour in 2011.

reduction of oil imports by the US
= increase of oil imports by China

What will happen when the US shale oil production peaks ?

Peak demand
or
Peak supply ?



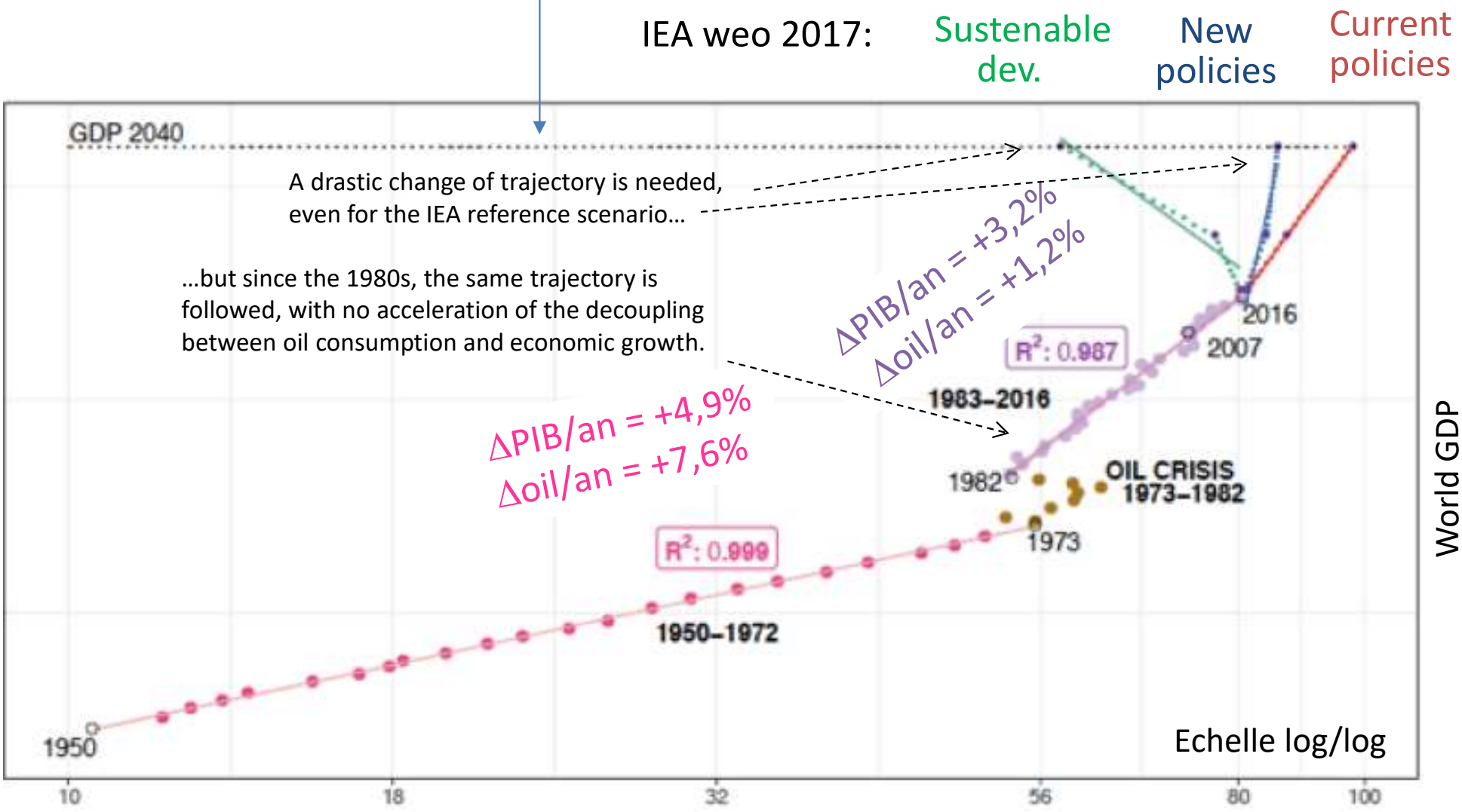
Some peak demand forecasts come with warnings that supply could be insufficient..

BP energy outlook 2023: Importance of an orderly transition away from hydrocarbons, “such that the demand for hydrocarbons falls in line with available supplies”.

IEA weo2021, p20: “…a surge in spending to boost deployment of clean energy technologies and infrastructure […] needs to happen quickly or global energy markets will face a turbulent and volatile period ahead.

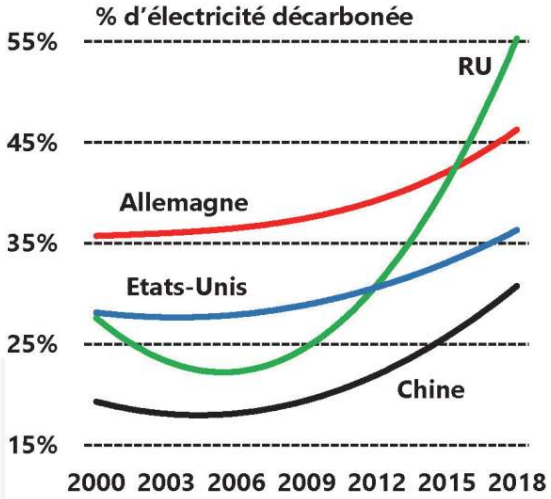
Is the transition easy ?

GDP independent of the energy mix ?

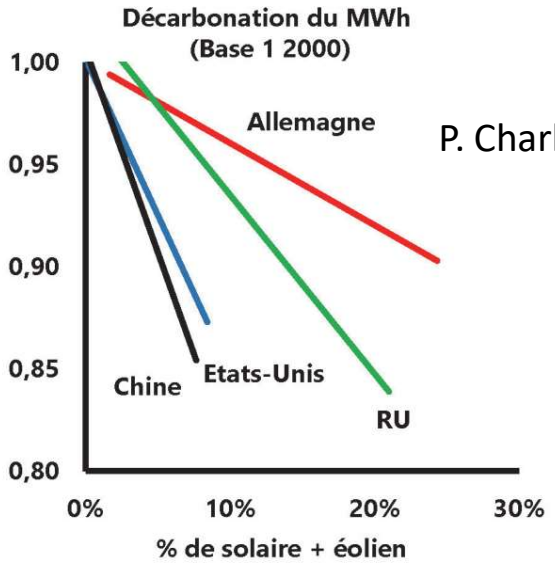


Source: Michel Lepetit

What will be the future energy mix ?



Data from bp stat. rev. 2019



P. Charlez, 2020

Up until now, there has been no replacement of fossil fuels with alternative energies, only an accumulation of growing energy sources.

Evolution of the world primary energy consumption,
N. Meilhan, 2024