Oil: What risks for Europe's supplies ?

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09 october 2023, ERM, Brussels

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Photo: Niederlauterbach, Bas-Rhin, France, 11 août 2017

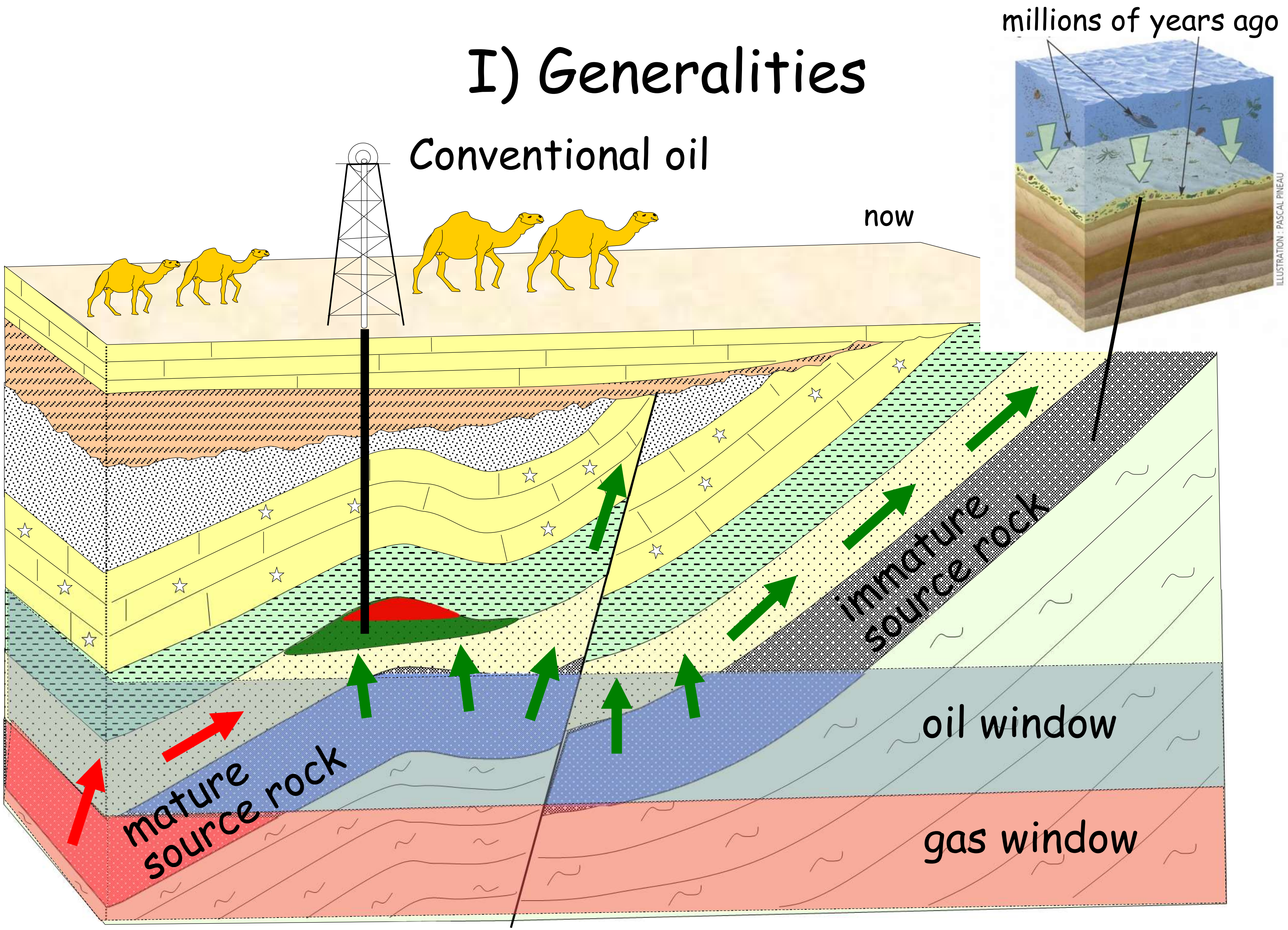
Oil: What risks for Europe's supplies?

- Generalities (P. Brocorens)
  - oil types
  - reserves : 1P vs 2P
  - production : relationship to reserves, production profiles

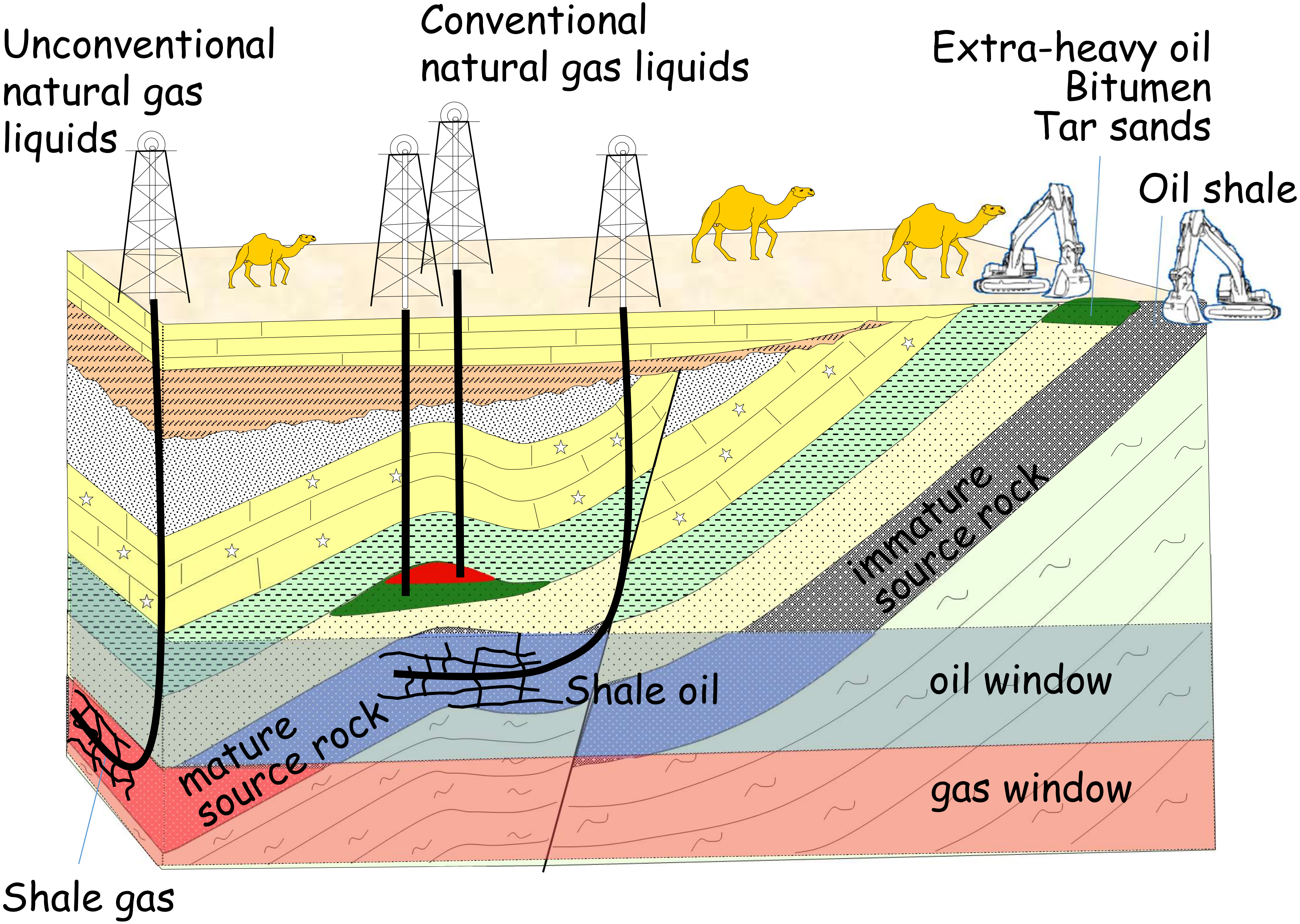
- Middle East, US, Russia (M. Blaizot)
  - Evolution of discoveries, field size, remaining reserves,
    distribution of production in function of discovery year, breakeven price, …
    Exemple of Saudi Arabia
  - Future productions
    - Methodology
    - Saudi Arabia, Iran, Iraq, Kuwait
    - US shale oil
    - Russia

- World Panorama (P. Brocorens)
  - Looking at the production cycle
  - Peaking of conventional oil and consequences
  - Conclusion

I) Generalities



Source: d'après schéma IFP (Institut français du Pétrole) et schéma p.37 dans ''Les Géosciences au service de l'Homme'' –éditions Hirlé et ENS de Géologie, redessiné en Word par Alain Gallien, SVT Dijon, et modifié par P. Brocorens



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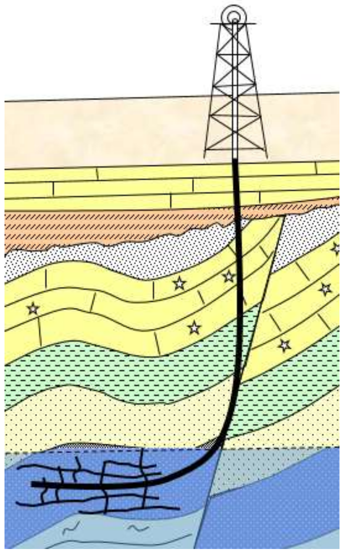
Classification of oil

	Conventional oil		Tar sands Extra heavy	Shale oil		Oil shale
Quality of reservoir						
Quality of oil						



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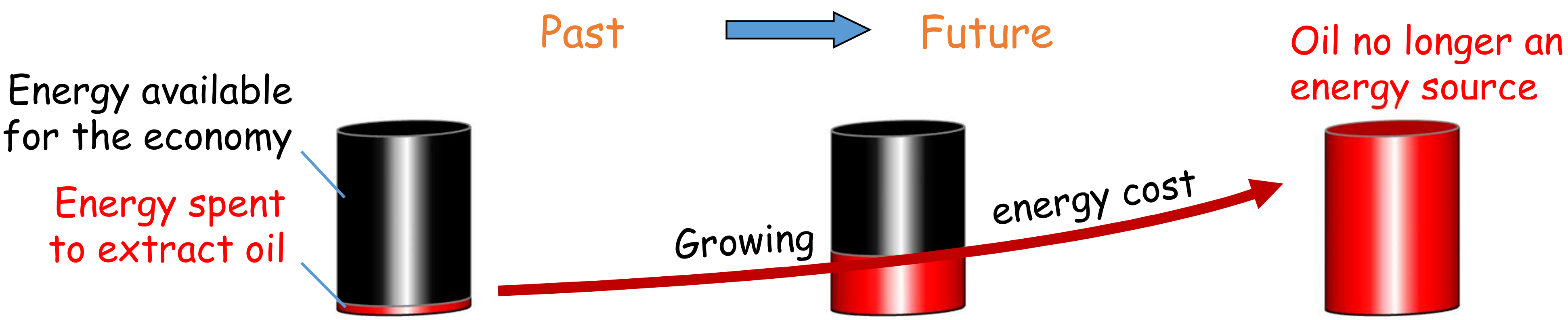
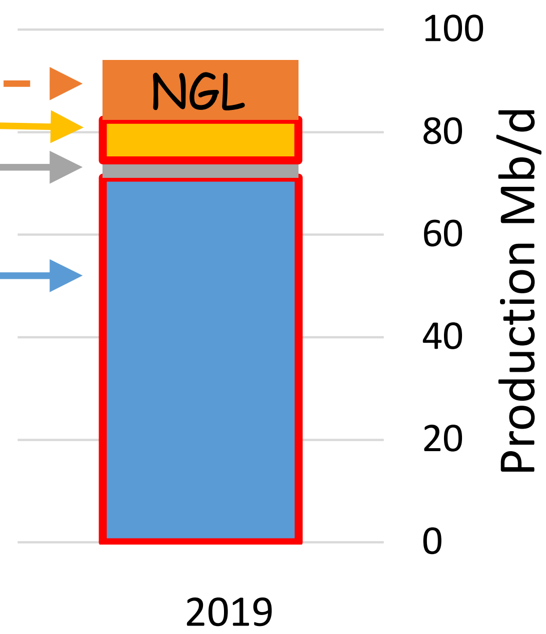


Oil production will not stop because oil is exhausted, but due to energy costs (and thus economical costs).

Classification of oil and gas types

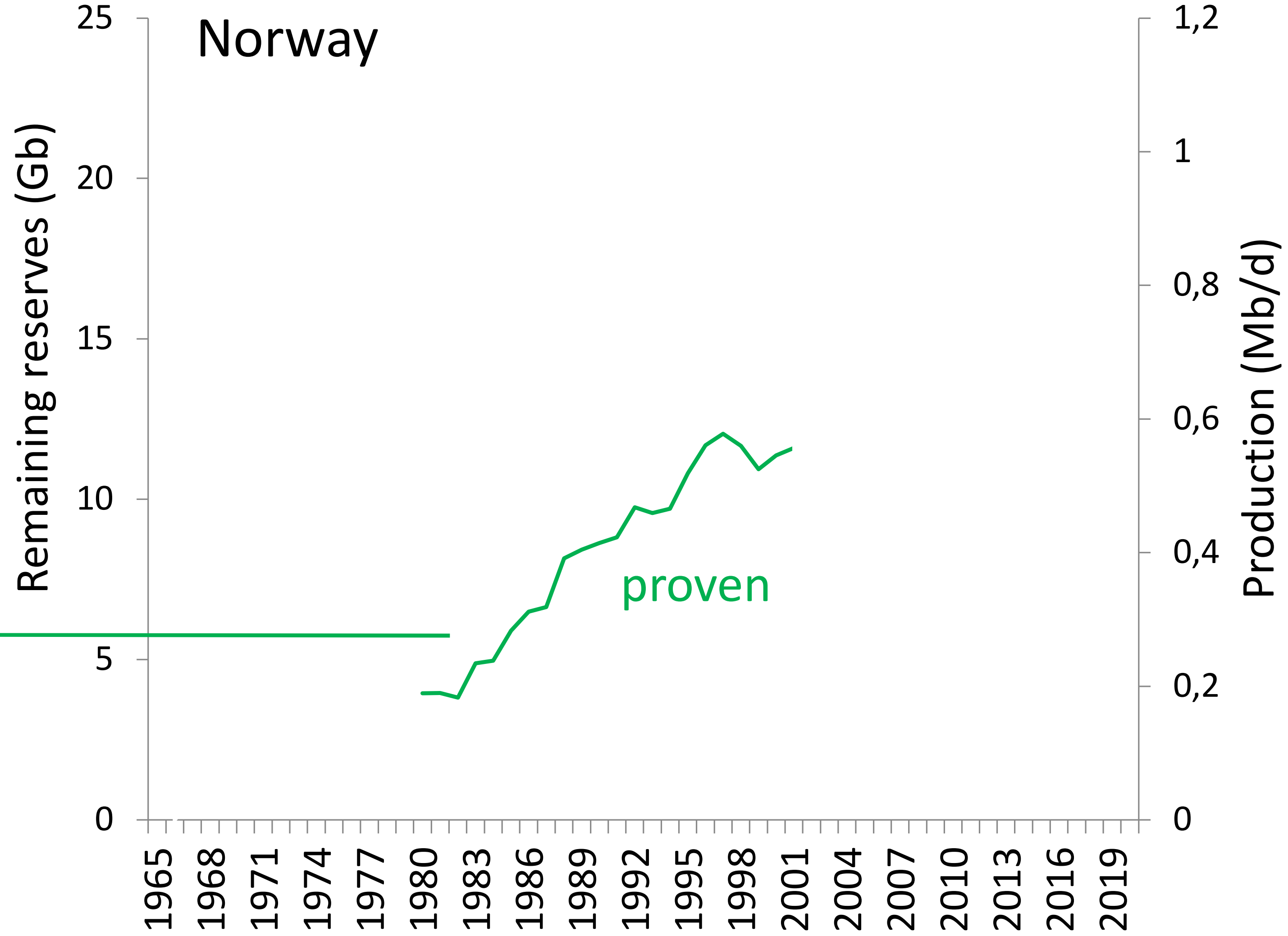
	Conventional oil and gas	Tar sands Extra heavy	Shale oil and gas	Oil shale
Quality of reservoir				
Quality of oil				



Oils with best return on energy/money invested are exploited first

Proven reserves vs proven + probable reserves

1P (90%) 2P(50%)



Publicly available
- EIA
- BP statistical review

Proven reserves are everywhere:
in geography books, newspapers, magazines, economic documents, reports for governments to base their energy policies, …

FOD Economie
https://economie.fgov.be › files › Files › Energy

Ontwerp-prospectieve-studie-gas-2025-2030.pdf

Eind 2013 bedroegen de **bewezen** totale aardgasvoorraden 185,7 Tm³ waarvan 43,2 % in het. Midden-Oosten, 30,5 % in Europa en Eurazië, 8,2 % in het gebied Azië/ ...

DE TIJD

Flanders Investment and Trade
https://www.flandersinvestmentandtrade.com › ...

Kansrijke sectoren - Algerije

Het was ook de derde grootste op het continent in termen van **bewezen oliereserves**, na Libië en Nigeria, en de 16de in de wereld. De scherpe daling van de ...

Brugel
https://www.brugel.brussels › document › etudes

Etude d'initiative

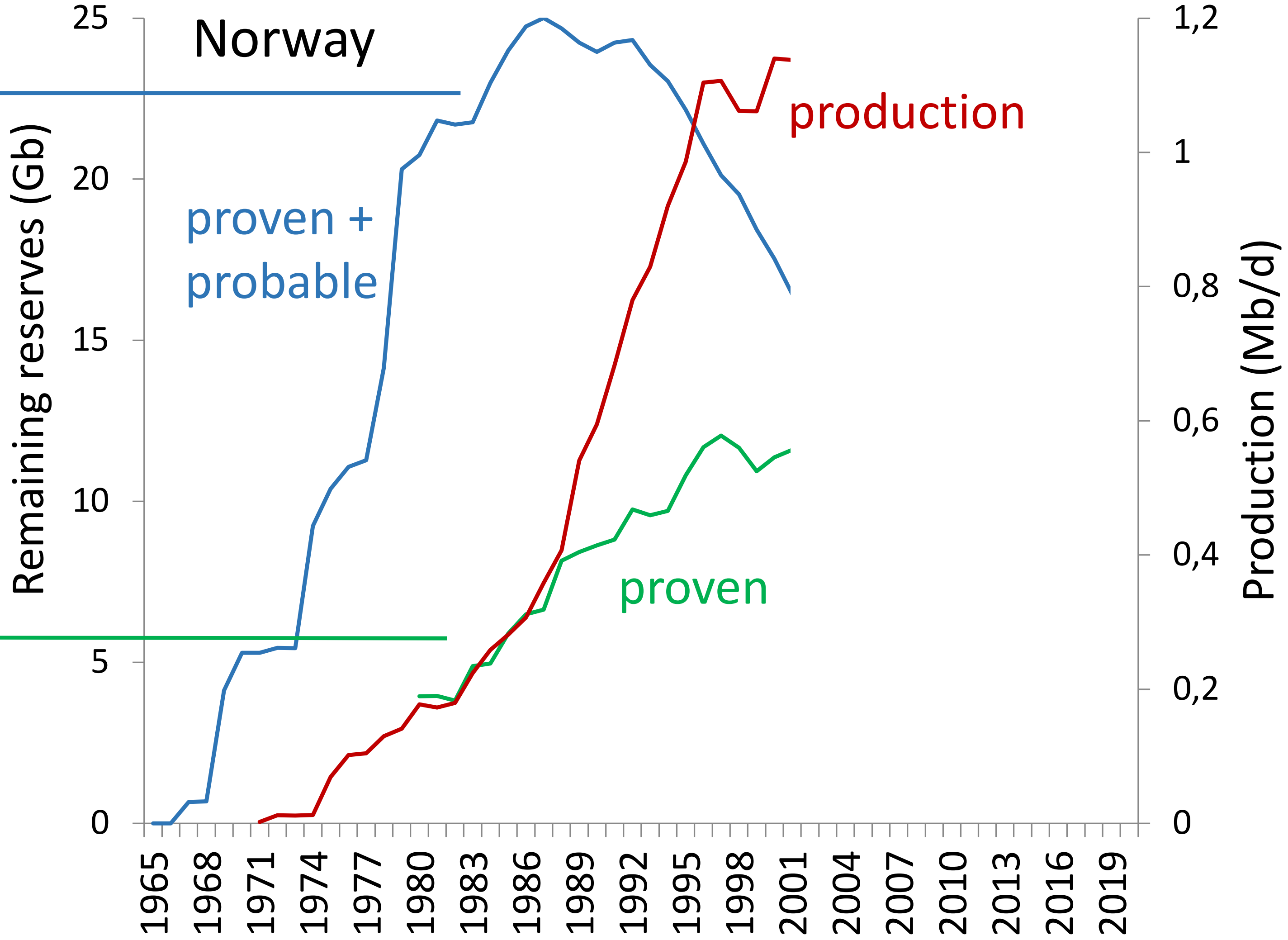
8 sept. 2017 — ***Réserves prouvées**, croissance à venir des réserves connues et ressources non-découvertes jugées techniquement récupérables avec les moyens ...

Proven reserves vs proven + probable reserves

1P (90%) 2P(50%)

Confidential, in private paid databases
- Rystad
- IHS
- Wood Mackenzie

Publicly available
- EIA
- BP statistical review

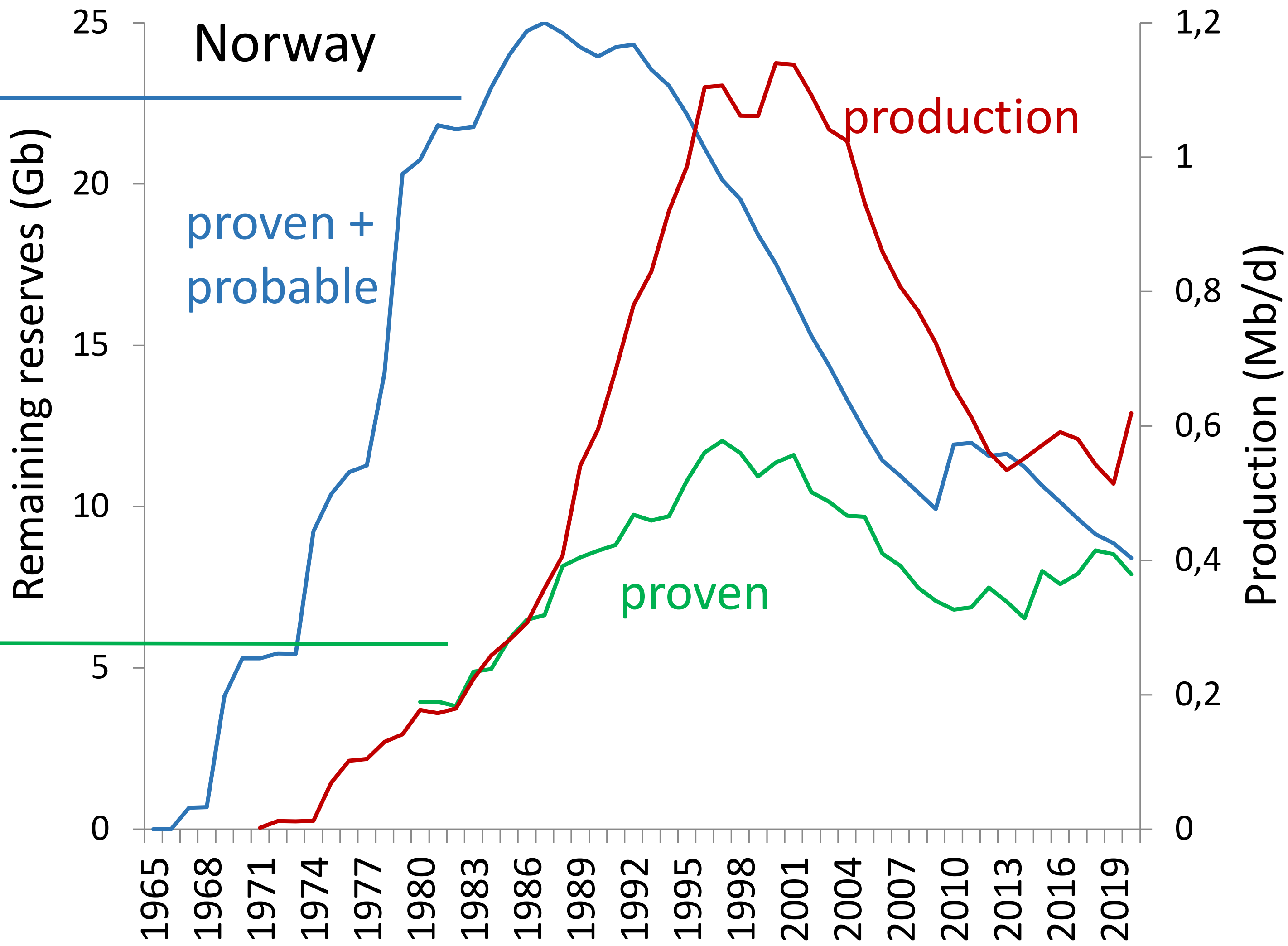


proven + probable reserves are more appropriate to estimate what oil companies expect to extract, and their evolution with time is more informative. In this example, their decline warns of production difficulties ahead, while proven reserves continue growing, providing no warning. This drawback of proven reserves is a consequence of their definition. Unfortunately, most people do not have access to proven + probable reserves.

Proven reserves vs proven + probable reserves
1P (90%) 2P(50%)

Confidential, in private paid databases
- Rystad
- IHS
- Wood Mackenzie

Publicly available
- EIA
- BP statistical review



In this example, proven reserves follow the production decline and do not anticipate it.

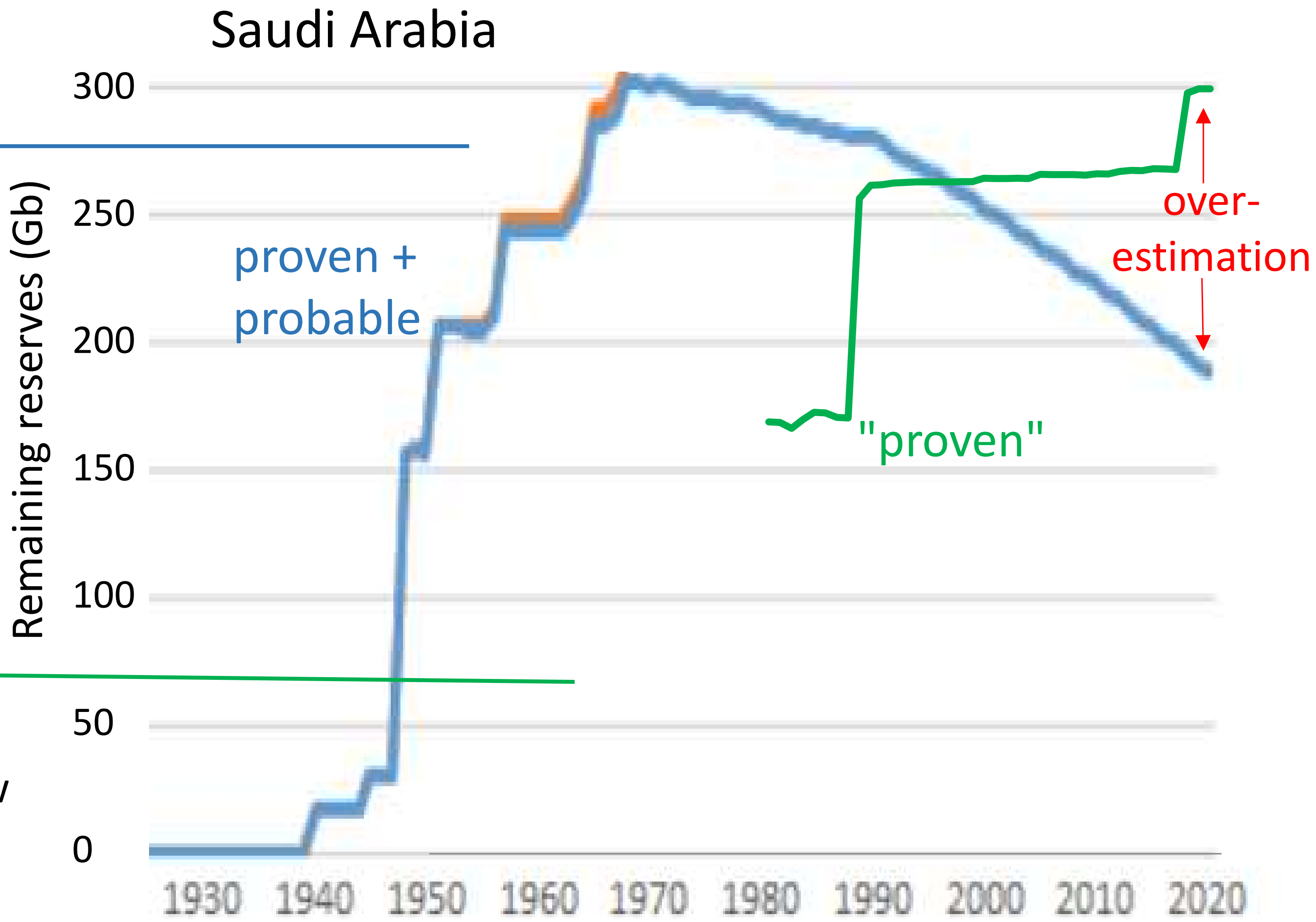
Proven reserves are useless to monitor depletion and forecast production.

Proven reserves vs proven + probable reserves

1P (90%) 2P(50%)

Technical data
Confidential, in private paid databases
- Rystad
- IHS
- Wood Mackenzie

Political data
Publicly available
- EIA
- BP statistical review

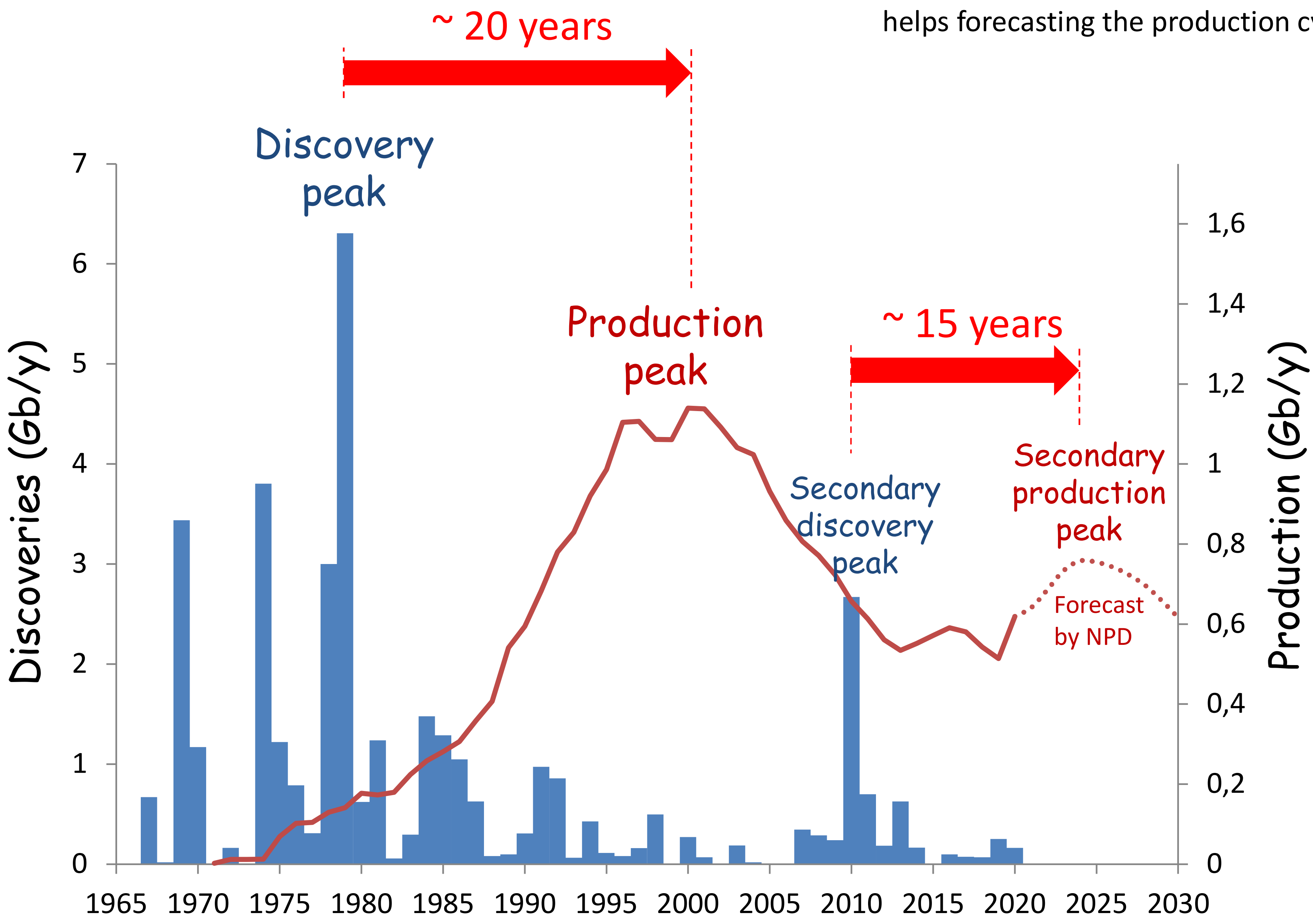


For most countries, proven reserves are not proved !!

Much worse, as proven reserves are the only numbers that countries publish, they have become political tools; they seldom correspond to definitions of proven reserves. In the rest of the presentation, we will show data of proven + probable reserves only.

History of discoveries and production for norwegian crude.

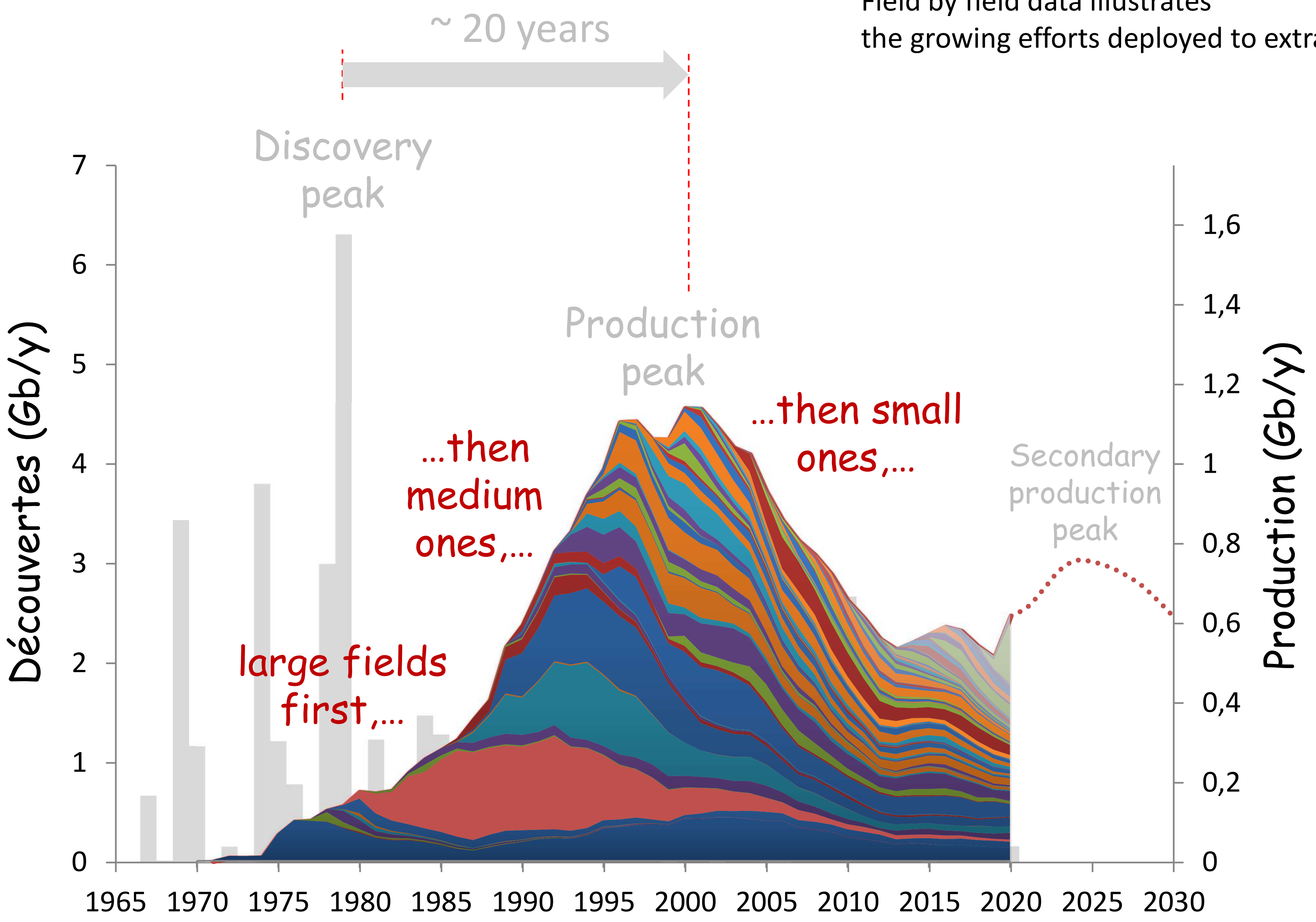
Knowing the discovery cycles
helps forecasting the production cycles.



data from Norwegian Petroleum Directorate, graphic from P. Brocorens

History of discoveries and production for norwegian crude.

Field by field data illustrates
the growing efforts deployed to extract oil



data from Norwegian Petroleum Directorate, graphic from P. Brocorens

II)

State of reserves and production forecasts for

Middle-East

US shale oil

Results of a Shift Project study (2021) made for DGRIS, using the private Rystad Energy database.
See https://www.aspo.be/petrole-quels-risques-pour-les-approvisionnements-de-leurope-une-etude-du-shift-project-mai-2021/

Russia

Based on Rystad Energy. (2022, May 2). Lifting the curtain on Russia's oil and gas sectors that will bring in an estimated $260 billion in 2022.

DGRIS
Direction générale des relations internationales et de la stratégie
MINISTÈRE DE LA DÉFENSE

THE SHIFT PROJECT
THE CARBON TRANSITION THINK TANK

Jean-Marc Jancovici*
Chairman

Matthieu Auzanneau*
Executive director

Olivier Rech*, consultant;
co-author of the IEA World Energy Outlook 2007, 2008 and 2009

Author, with Hugo Duterne

Alain Lehner, Engineer, Director of the Reservoir Development division and Chairman of the Reservoir Committee at Total from 2004 to 2011

Marc Blaizot*, Engineer geologist, Director of Exploration at Total from 2009 to 2015

Associated experts

* Member of ASPO France

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THE FUTURE OF OIL SUPPLY IN THE EUROPEAN UNION:
STATE OF RESERVES AND PRODUCTION PROSPECTS FOR MAJOR SUPPLIERS

SUMMARY
MAY 2021

Report from the *Shift Project*, for the General Direction of International Relations and Strategy (DGRIS), French Ministry of the Army.

Jacques Percebois, Economist, Honorary Professor at the University of Montpellier, director of the Center for Research in Energy Economics and Law (CREDEN)

Francis Perrin, Senior Research Fellow at IRIS, specialised in energy issues

Philippe Sébille-Lopez*, Director of Géopolia, specialised in energy geopolitics

reviewers

Didier Pillet*, Chief Engineer from Ecole des Mines, member of Conseil Général de l'Economie, de l'Industrie, de l'Energie et des Technologies (CGE).

* Member of ASPO France

Methodology

Contribution to the analysis of the short to long-term supply risk

- Discoveries and Production outlook for the 16 main supplying countries (95% net imports EU-27 and 70% global oil production)
- Time horizon: 2030 to 2050

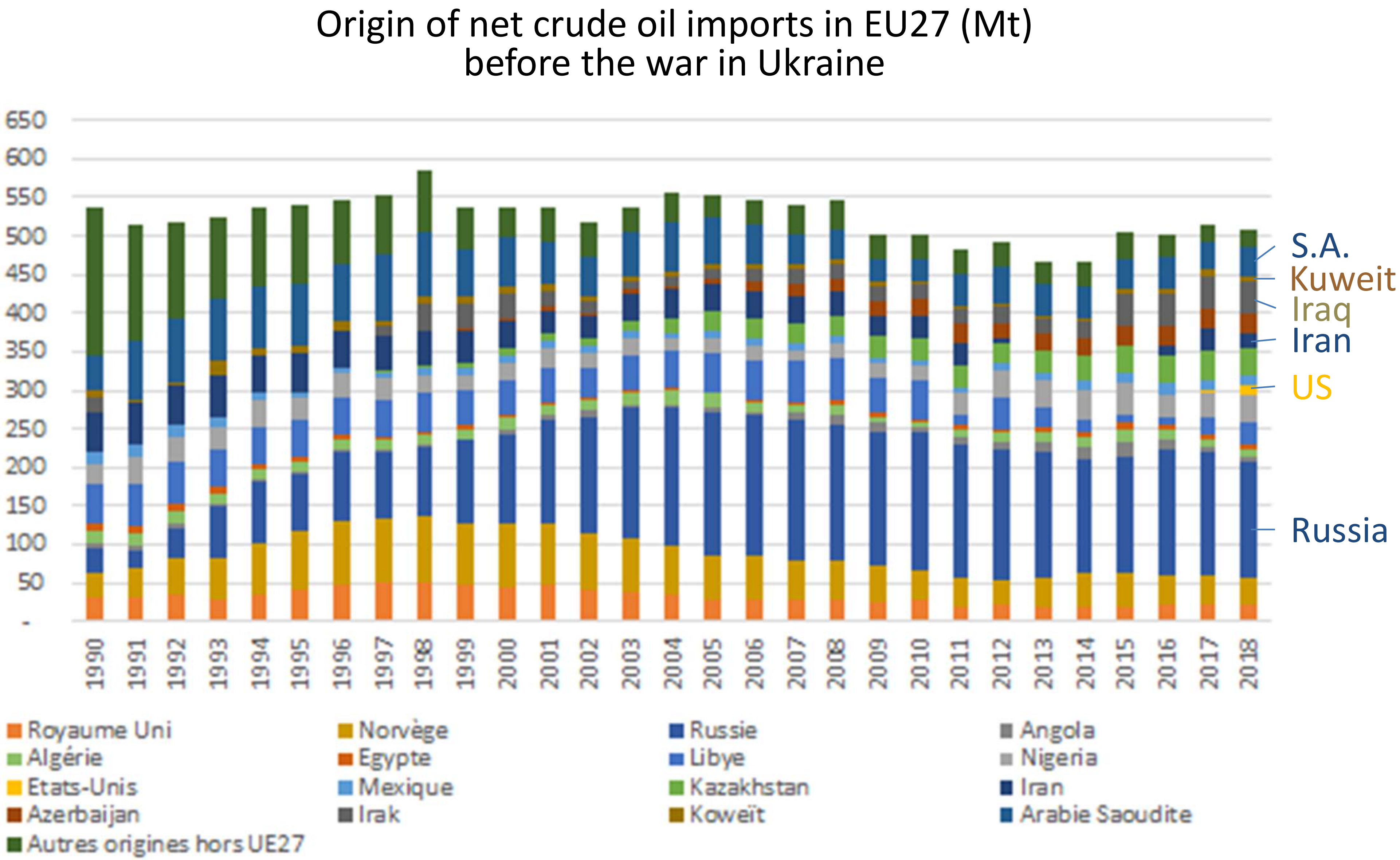
Sources

- Ucube database from Rystad Energy
- Independent expertise from the authors and associated experts

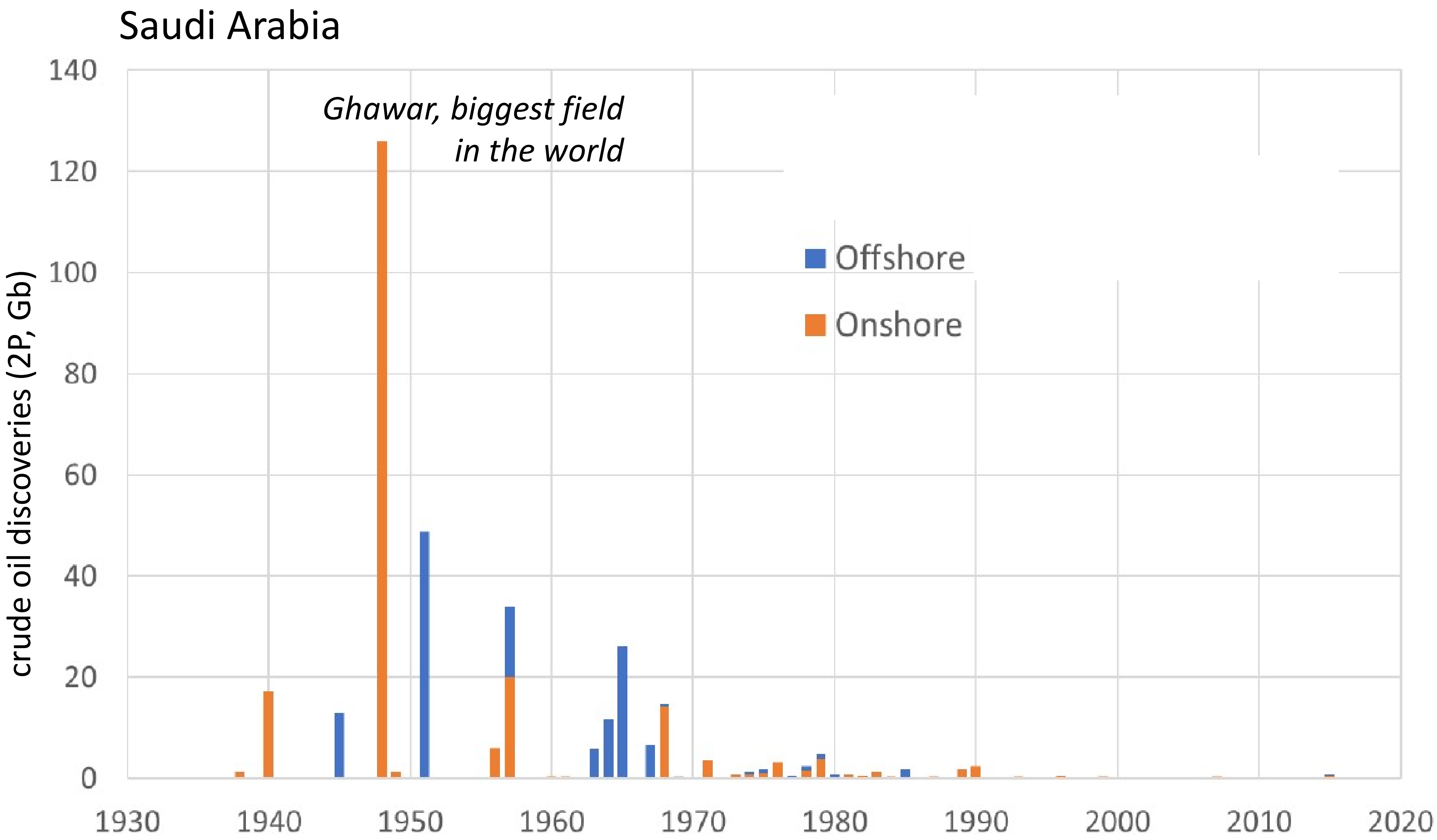
Production forecast by comprehensive analysis of the exploration-production cycle

- Producing fields
- Undeveloped resources (Discovered Resources Opportunities)
- Prospective resources (Yet To Find)
- Synthetic diagnosis on Light Tight Oil

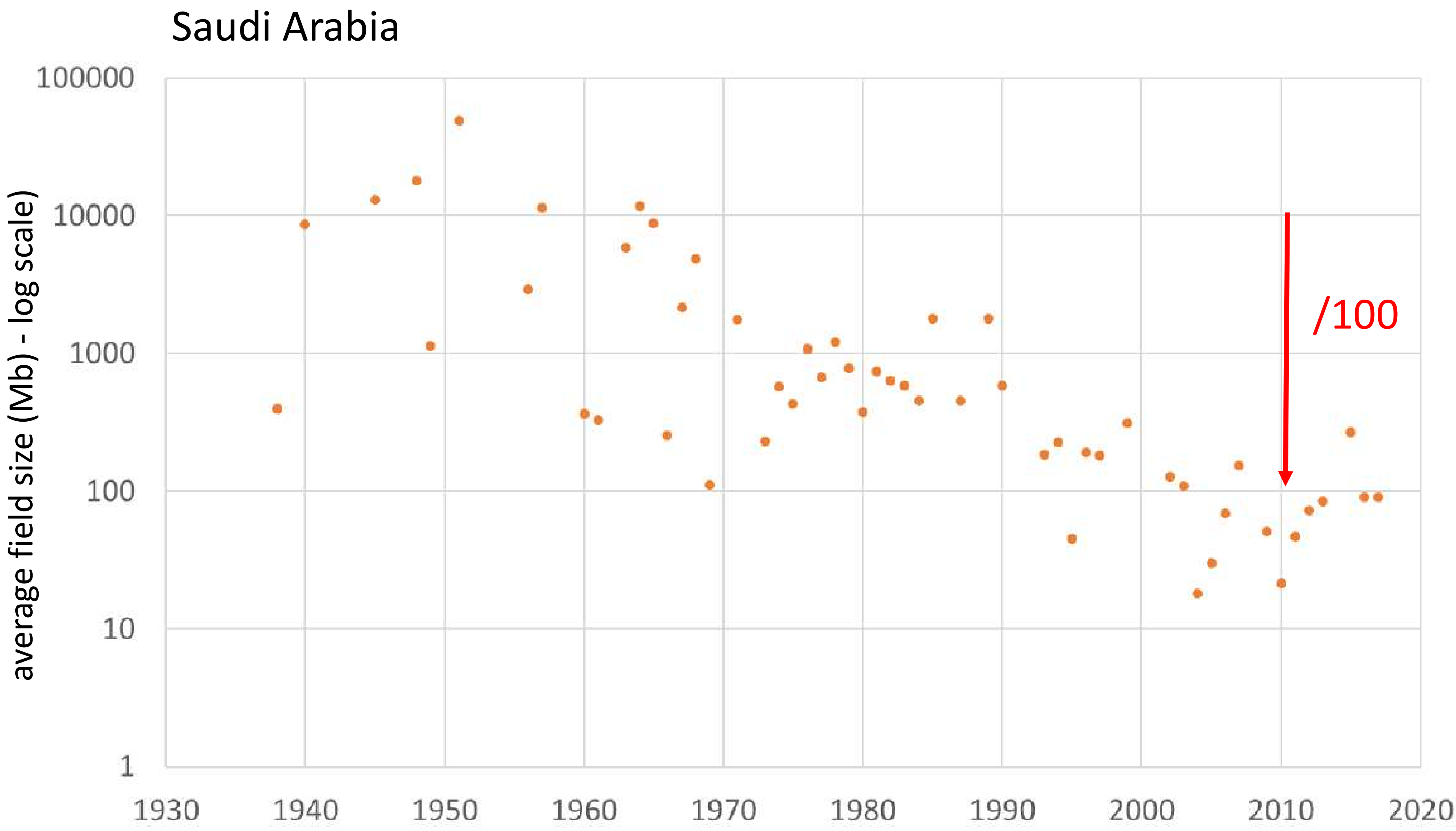
UE27-Oil imports by countries



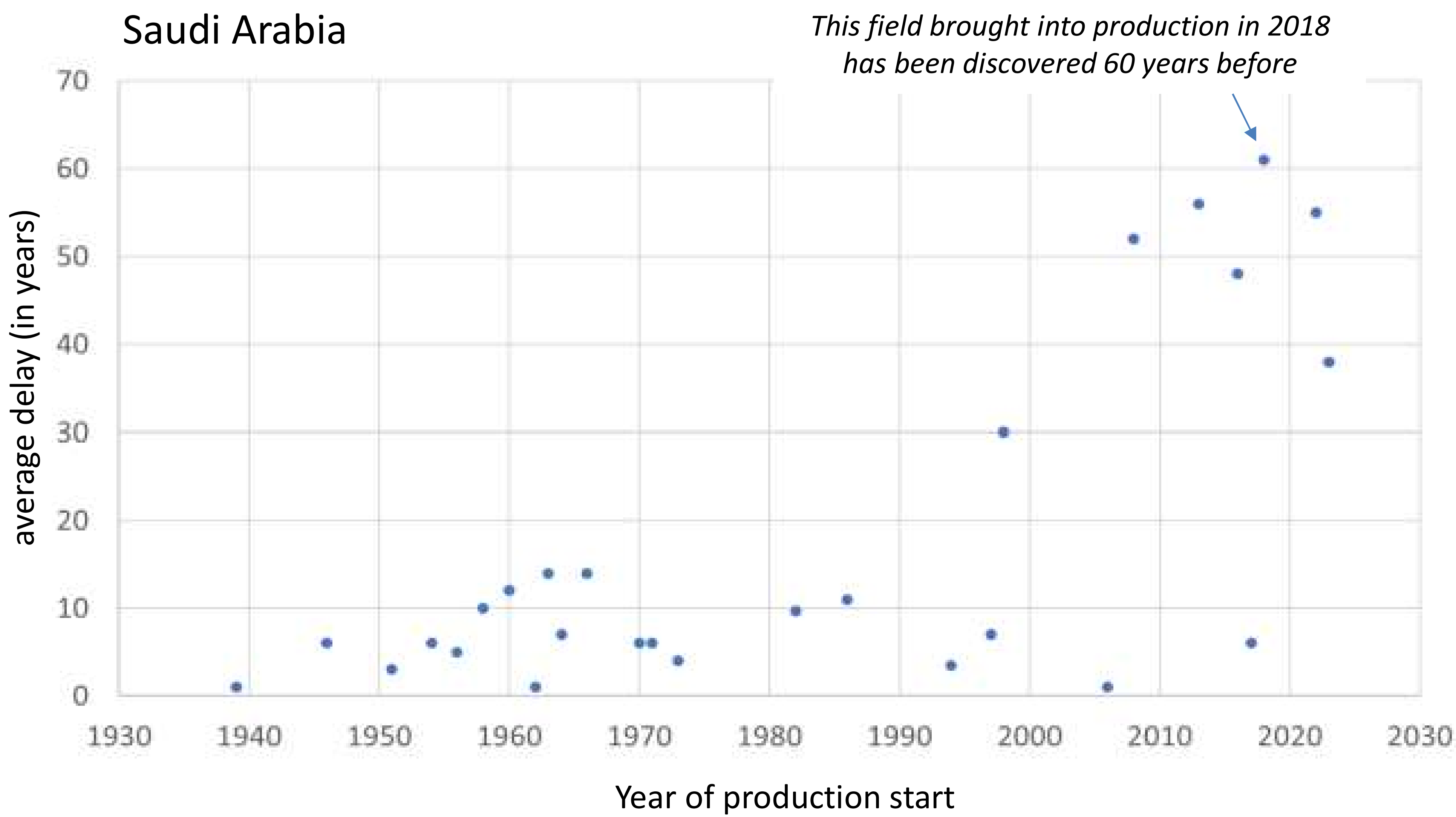
Oil discoveries are in long-term decline



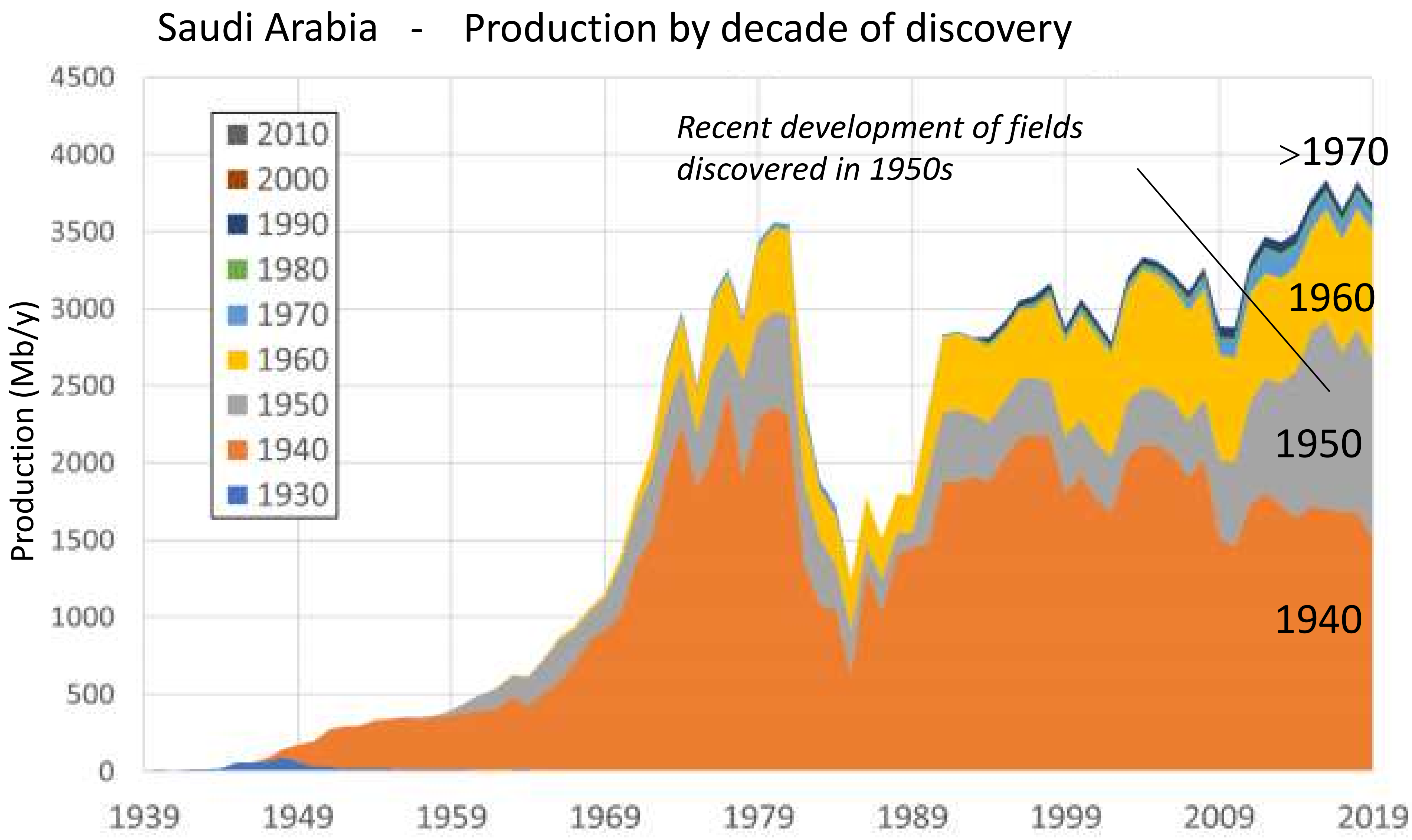
Oil discoveries are getting smaller



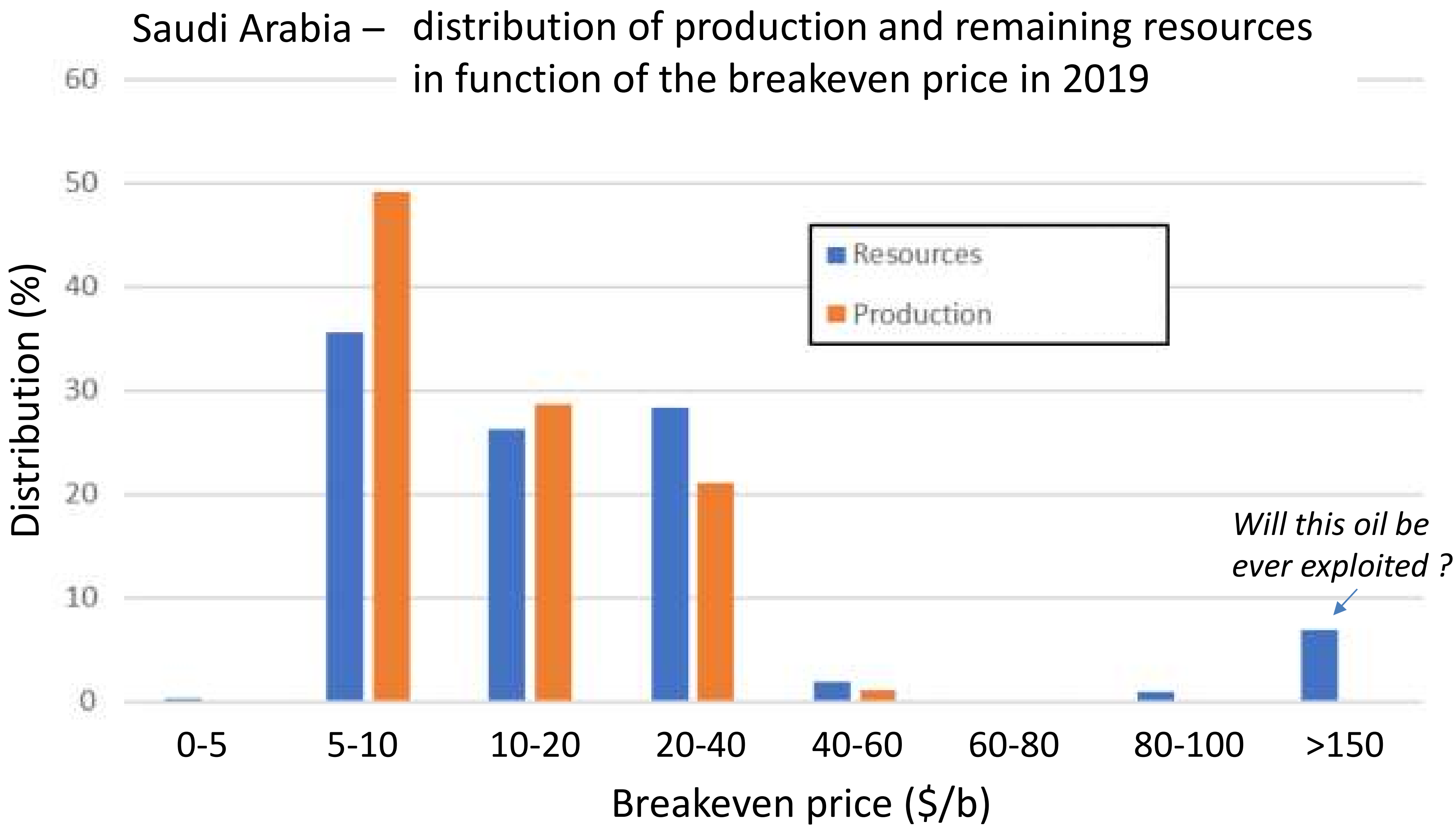
The delay between discovery and "first oil" increases in all countries, without exception



Most oil is produced from old discoveries (even decades ago)



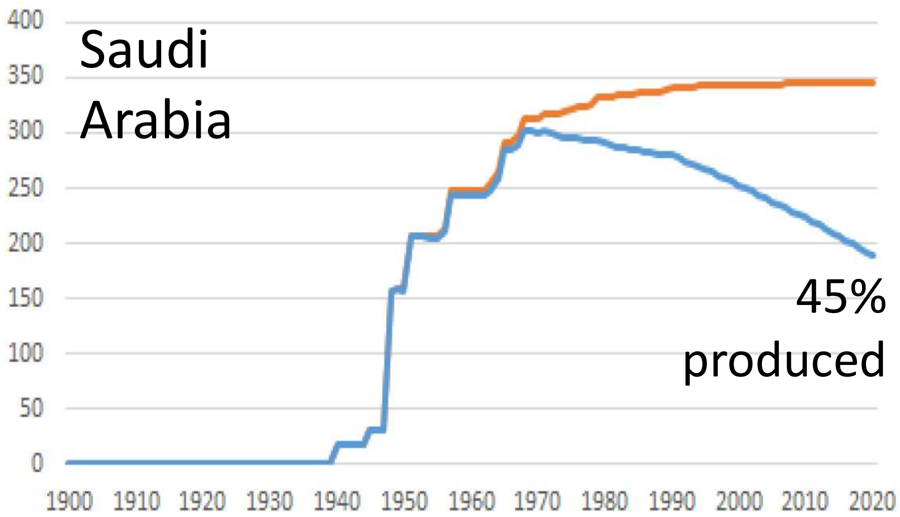
Production is shifting towards resources of higher breakeven price

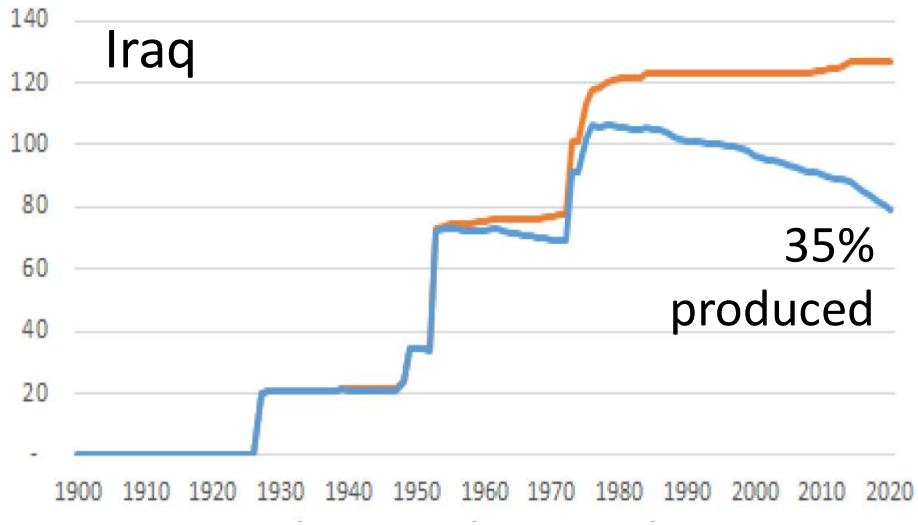


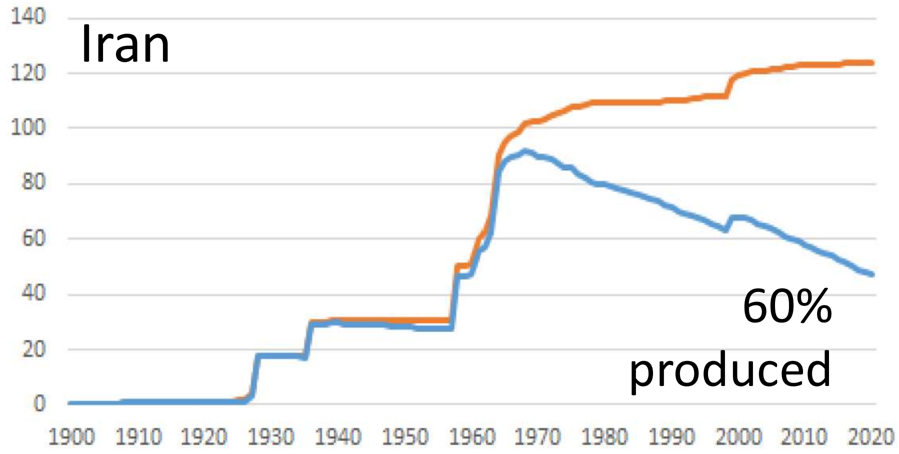
Same trends in other countries

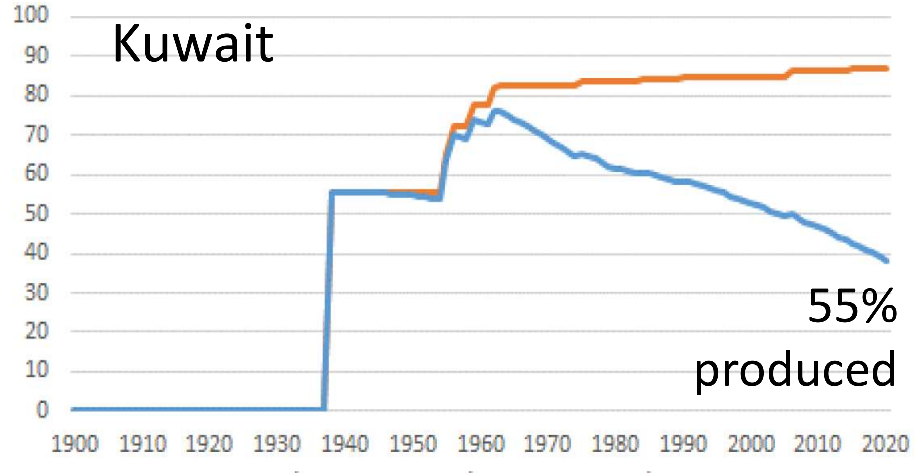
Exemple

Evolution of cumulated discoveries (→ flattening) and remaining reserves (→ decreasing) of crude oil (Gb, 2P)









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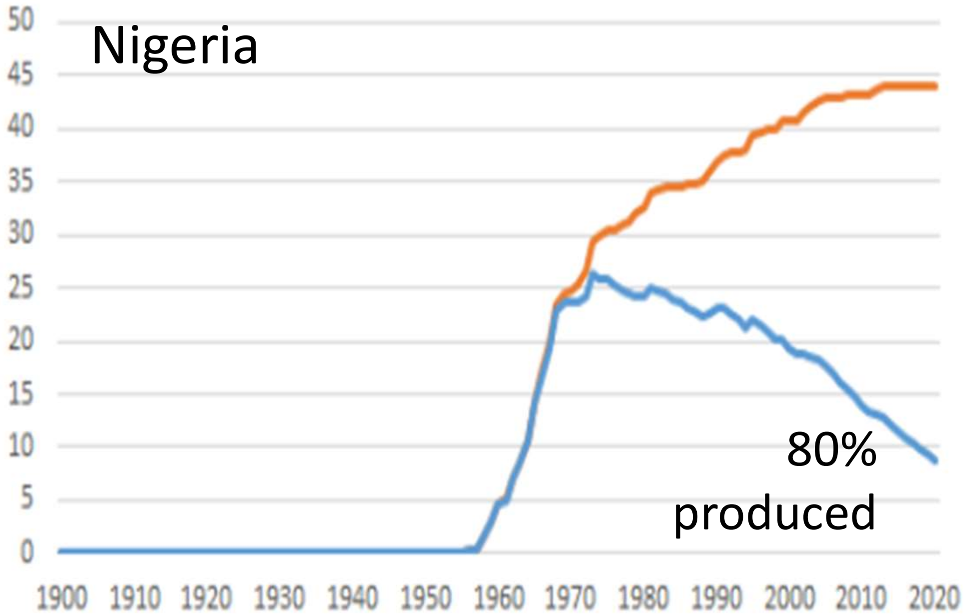

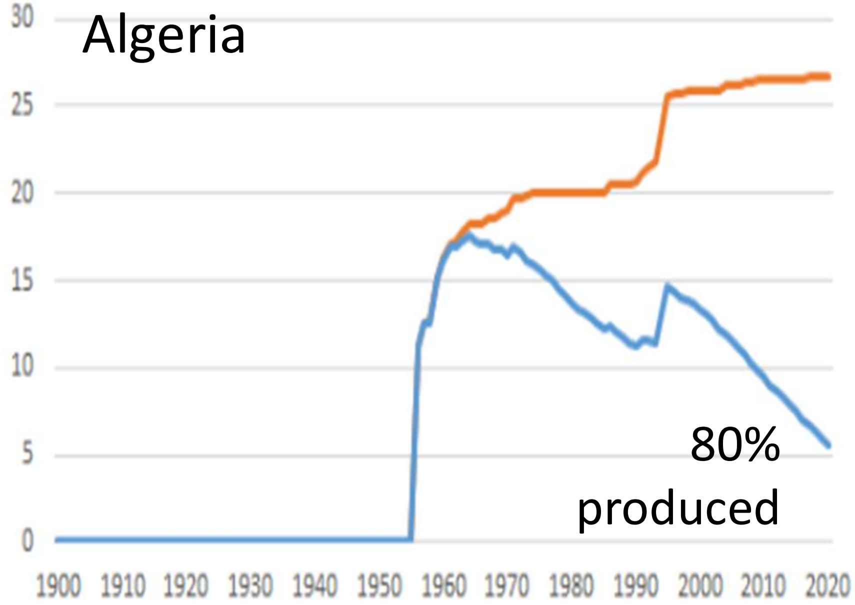

Depletion rate of the cumulative discoveries to date across the 16 countries is close to 70%.

14 out of 16 countries are experiencing a decline
or a production level lower than the maximum observed in the past.

Methodology

Contribution to the analysis of the short to long-term supply risk

- Discoveries and Production outlook for the 16 main supplying countries (95% net imports EU-27 and 70% global oil production)
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Production forecast by comprehensive analysis of the exploration-production cycle

- Producing fields
- Undeveloped resources (Discovered Resources Opportunities)
- Prospective resources (Yet To Find)
- Synthetic diagnosis on Light Tight Oil

Rystad Data Base Highlights

Pros:

- Field by Field oil production history and forecast data
- Oil types (crude, condensates, etc.)
- Field type : onshore/offshore ; conv/non conv…
- CAPEX and OPEX based on wells drilled : past and future

and cons:

- No water and gas production and injection history
- No geological reservoir data (carbonates/sandstones ; porosity/permeability
- No reservoir depth

⇨ Able to derive initial and remaining reserves with associated costs

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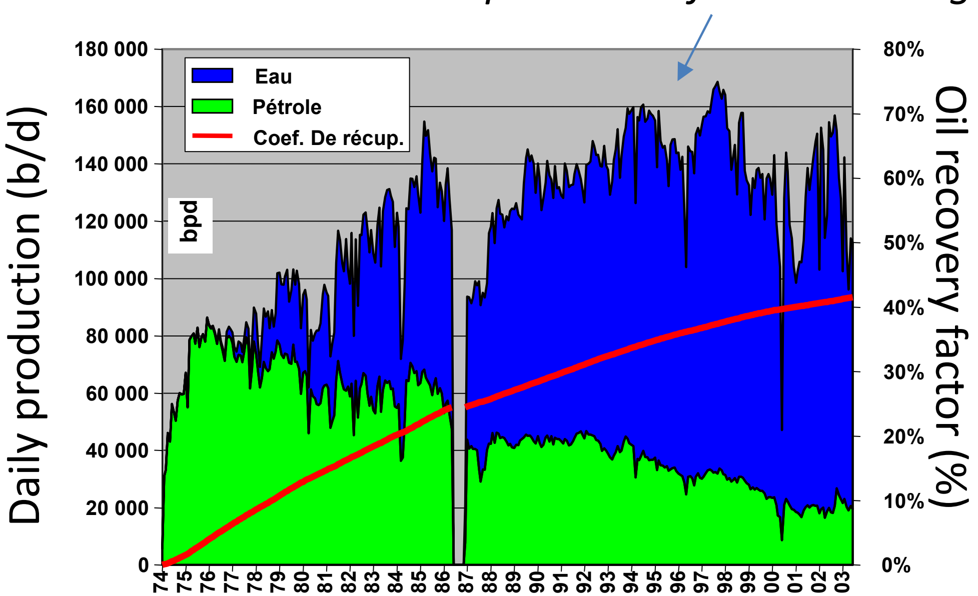
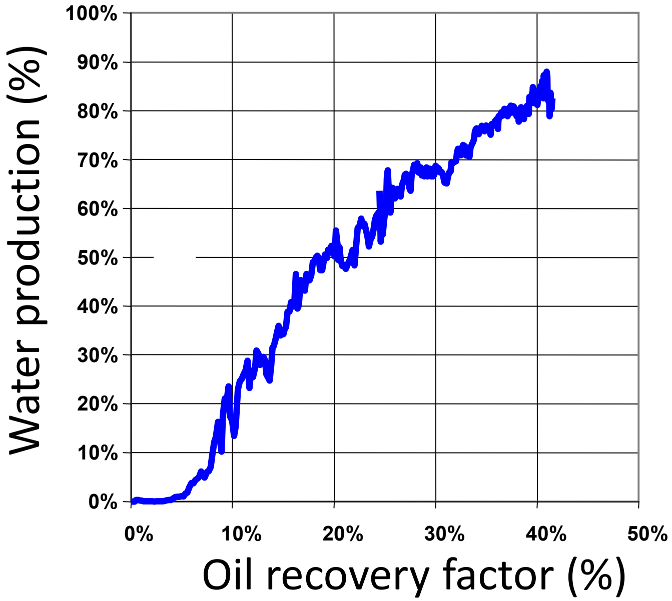
Producing fields	Found but undeveloped fields	Yet To Find fields	Light Tight Oil

- Use of a proprietary decline model calibrated to some known fields
- Use of reserves and well capex data from the Rystad database
- In addition to Rystad data, integration of water and gas production, and calculation of the number of water and gas injectors required for field management

Importance of water management (need to drill wells to reinject water)





Example of carbonate reservoirs in the Middle East

Authors : P. Carpentier et al.

- Use of the proprietary model to analyze 18 fields of the 16 relevant countries and comparison with Rystad's forecasts.

Producing fields	Found but undeveloped fields	Yet To Find fields	Light Tight Oil

Several important points to highlight:

- Importance of oil price changes on reserves (higher prices significantly increase reserves, and vice versa). We observed a variation of + to -20% on reserve estimates.
- The database assumes that fields will be well-managed (good monitoring, allowing for optimal oil recovery).
- This will be very challenging for deep offshore fields > 500m
- Higher number and costs of the measures (difficulties in allocating oil, water, and gas production to wells and thus optimizing).
- **Therefore, there may be either an overestimation of reserves or an underestimation of future costs.**

Producing fields	**Found but undeveloped fields**	**Yet To Find fields**	**Light Tight Oil**

In conclusion

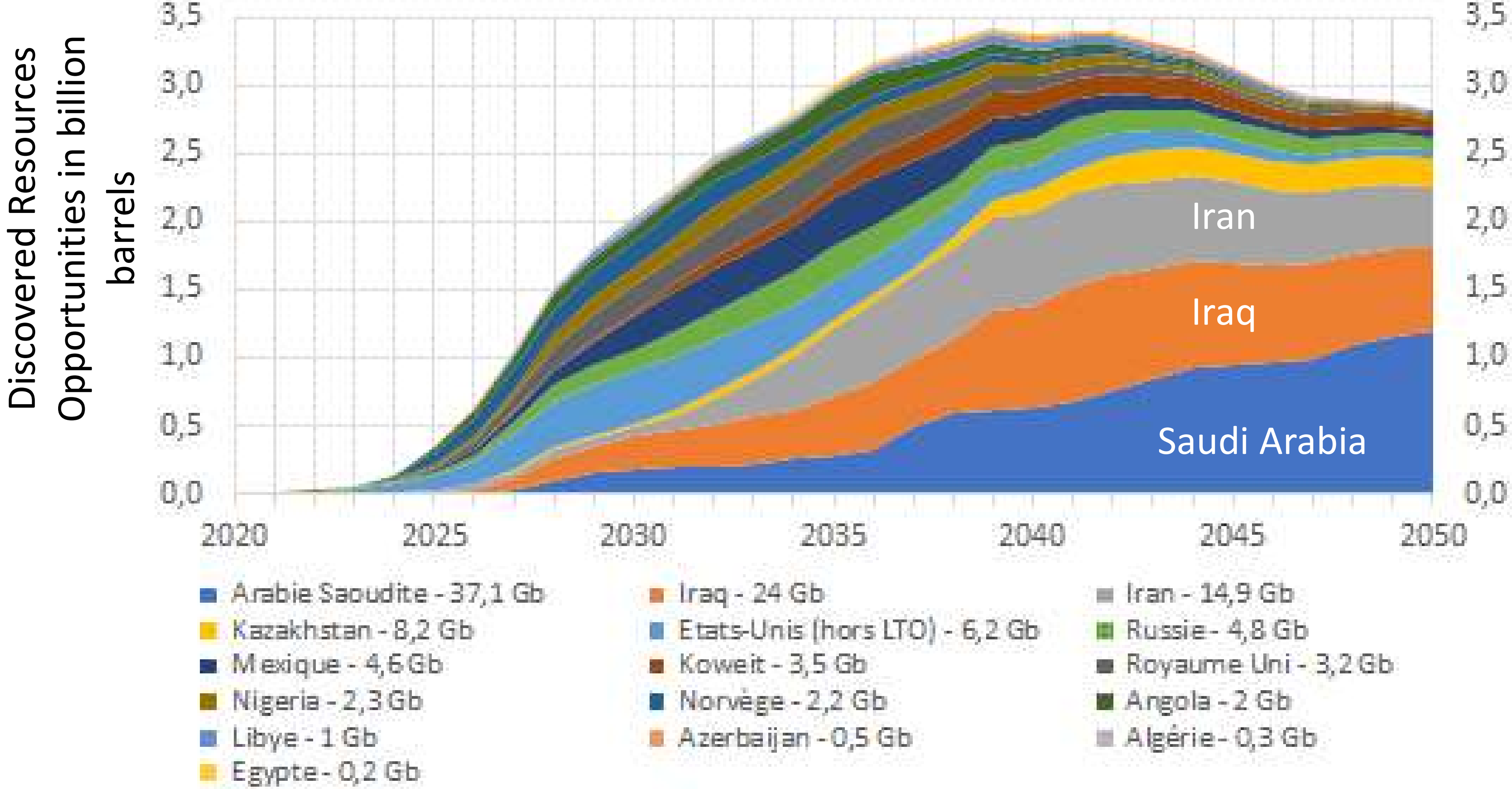
Based on the study of the 18 fields, the profiles in the Rystad database have been adjusted to account for these technical considerations:

- Costs are likely underestimated (number of necessary wells, surface facilities, etc.). For instance, in the Middle East, many fields are still producing with relatively little associated water or gas , but this will change and complicate their management.

- Profiles are probably too optimistic in general (insufficient integration of complexity in some fields, H_2S issues, challenging EOR techniques to implement), especially for deep offshore fields.

- **We can assume a 10 (onshore) to 20 % (deep offshore) less remaining reserves**

Producing fields	Found but undeveloped fields	Yet To Find fields	Light Tight Oil

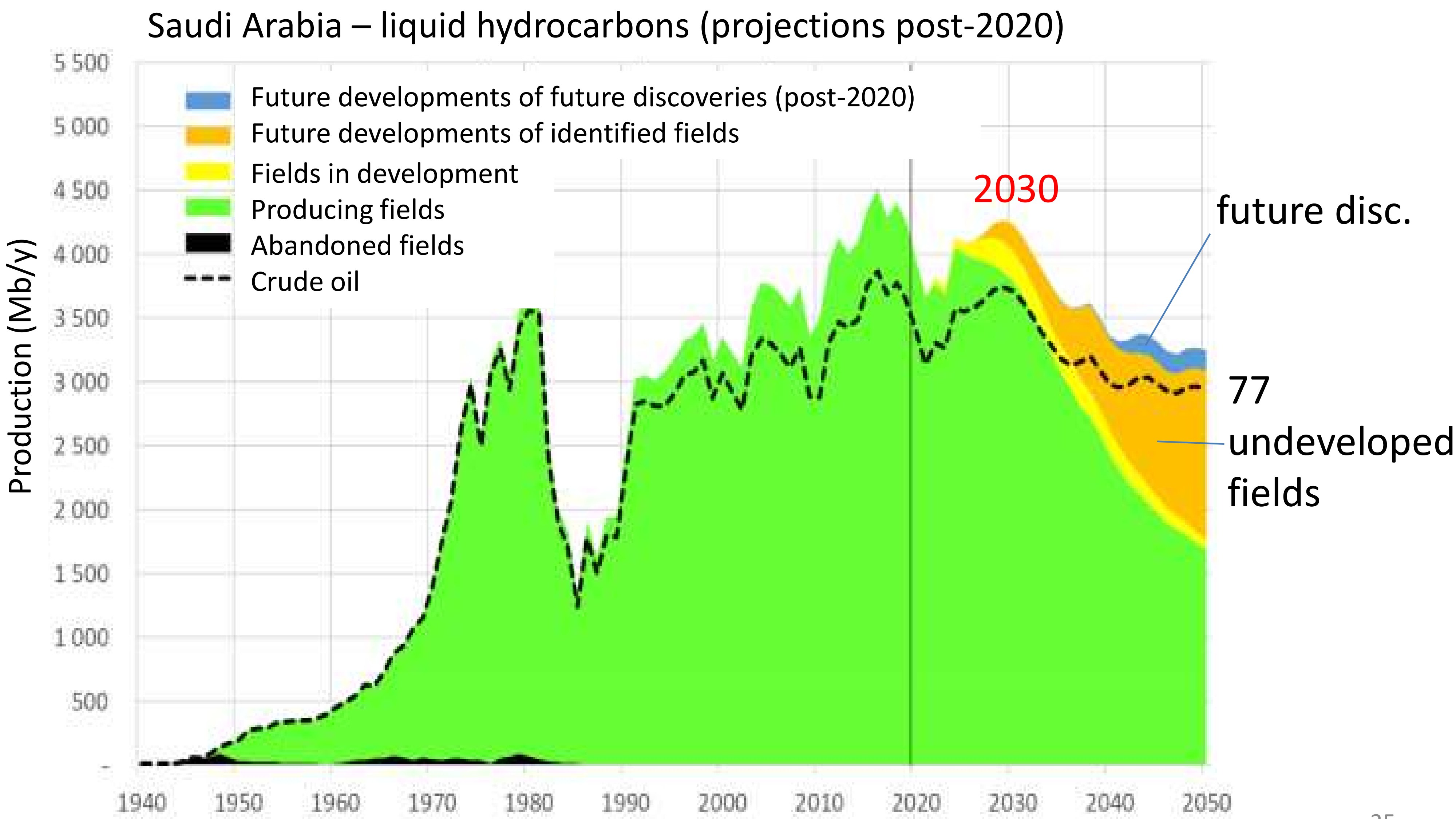


Producing fields	Found but undeveloped fields	Yet To Find fields	Light Tight Oil

Limited overall revisions (+2 Gb) from Rystad estimates (88 Gbo) in the 16 studied counties, but significant for some.

RESSOURCES PROSPECTIVES - Estimations 2P (milliards de barils)				
Pays	Bassins	Source Rystad Energy *	Source auteurs rapport	Révision auteurs
Iran	Central Arabian Offshore	4,3	1,7	+6,8
	Rub al Khali Offshore	0,3	0,6	
	South Caspian Basin Offshore	0,5	1,1	
	Zagros Foldbelt Onshore	1,2	9,7	
Irak	Widyan Onshore	1 ,1	5	+4,5
	Zagros Foldbelt Onshore	0,8	4,8	
	Western Arabian Onshore	1,2	0,2	
	Central Arabian Onshore	5,1	1,6	
Arabie Saoudite	Central Arabian Offshore	13,8	1,7	-14,3
	Central Arabian Onshore	8,5	6	
	Rub al Khali Onshore	0,7	1	
Koweït	Central Arabian Onshore	7,1	1,7	-5,4

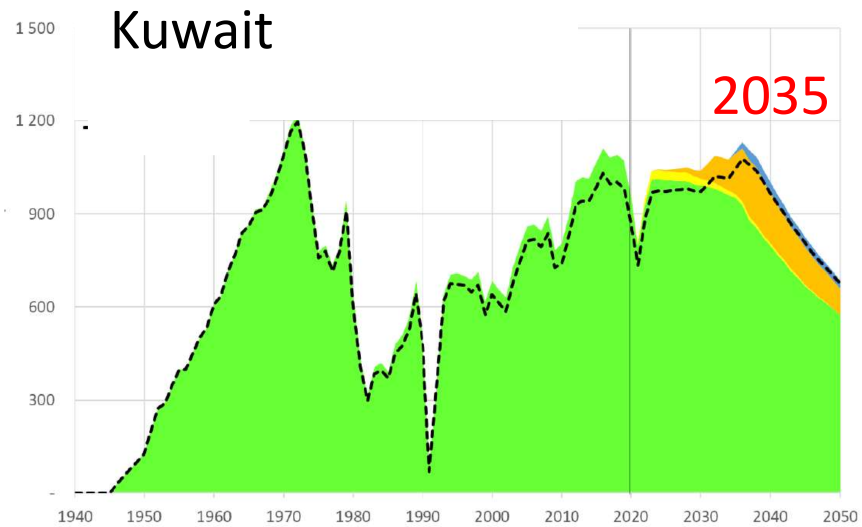
Producing fields	Found but undeveloped fields	Yet To Find fields	Light Tight Oil

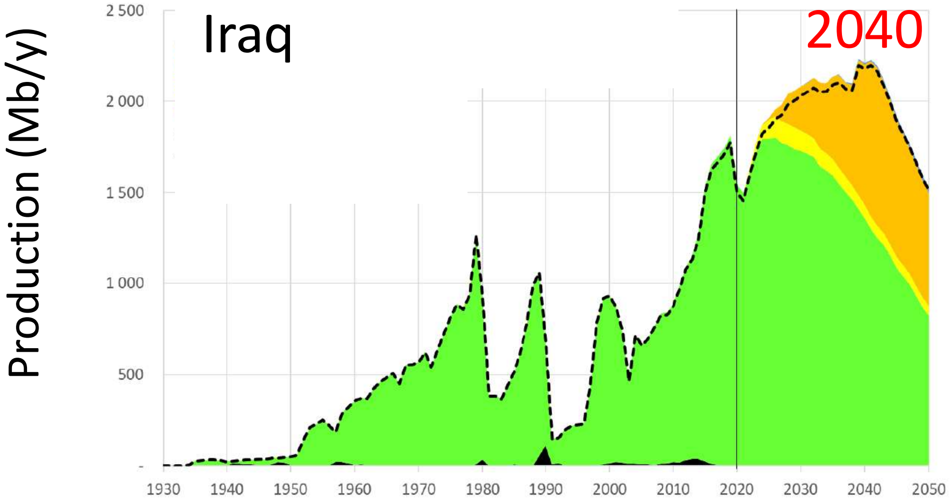


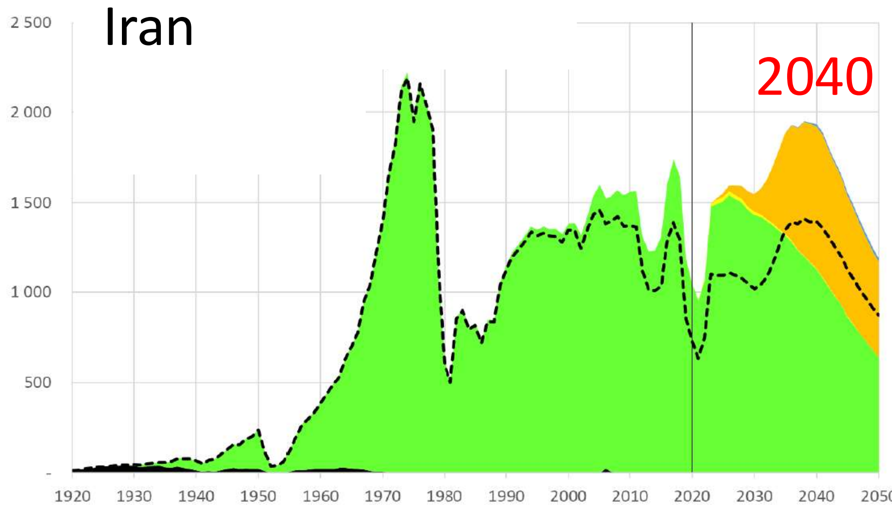
Producing fields	Found but undeveloped fields	Yet To Find fields	Light Tight Oil

liquid hydrocarbons (projections post-2020)

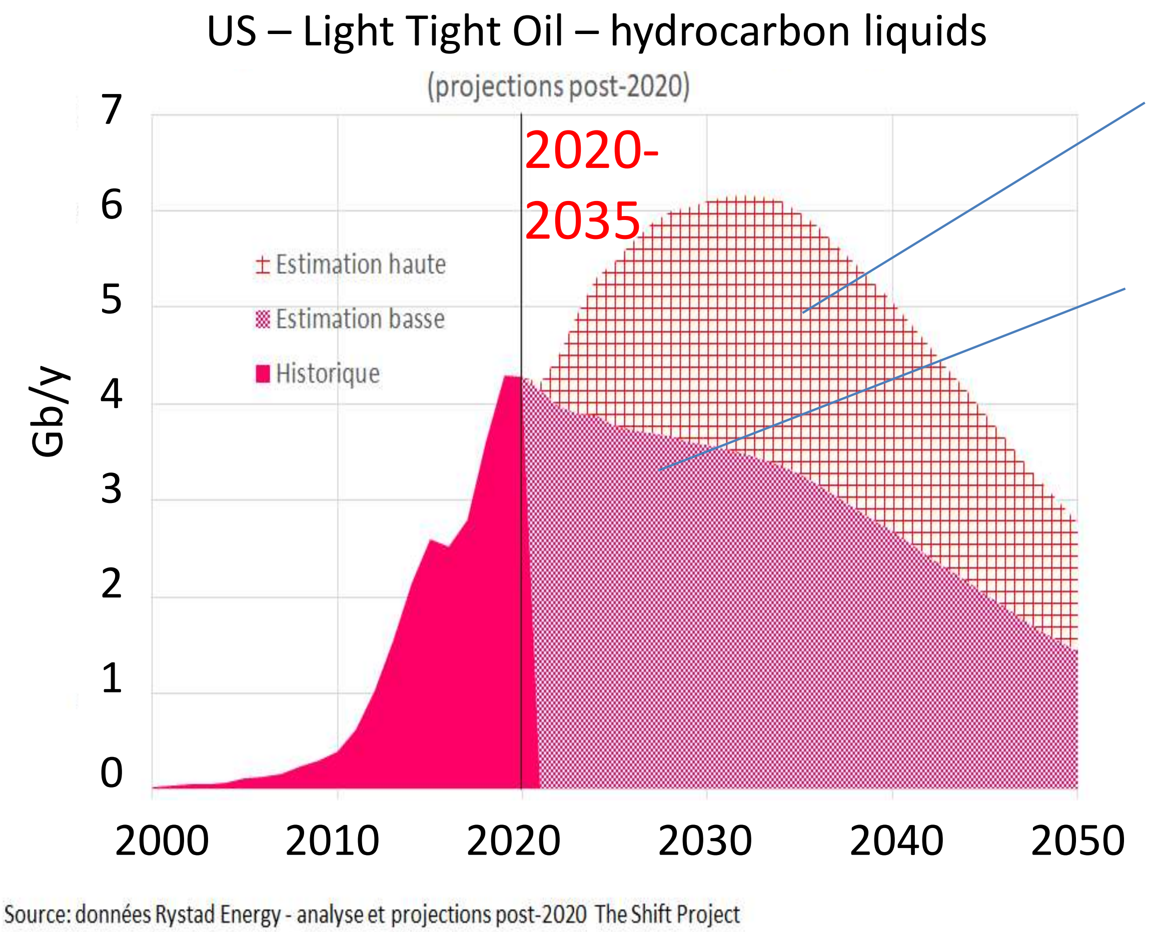
- Future developments of future discoveries (post-2020)
- Future developments of identified fields
- Fields in development
- Producing fields
- Abandoned fields
- Crude oil







Producing fields	Found but undeveloped fields	Yet To Find fields	Light Tight Oil



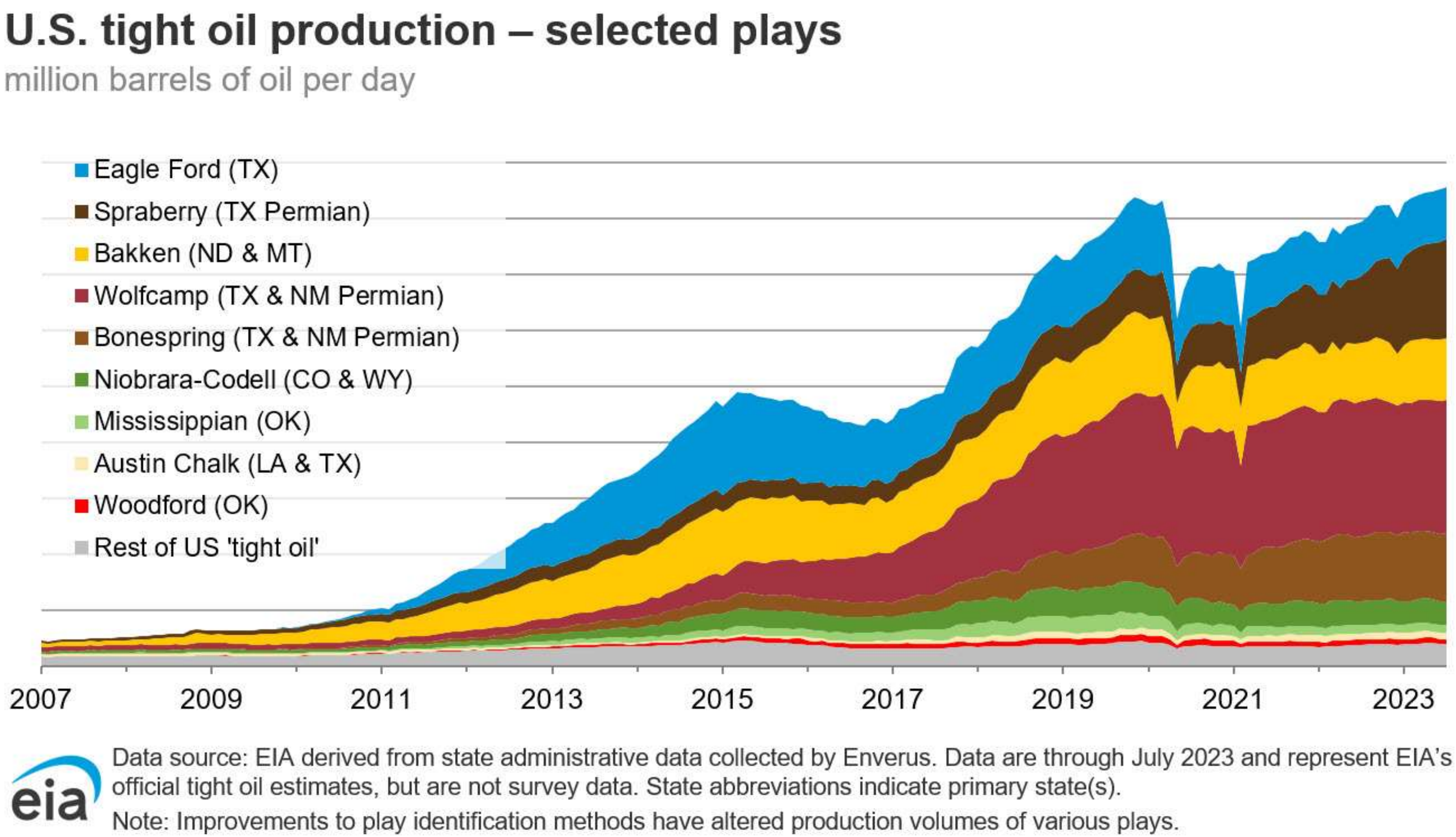
High estimate
from Rystad Energy (April 2020)

Low estimate
from authors and associated experts

Uncertainties:

- geological (sweet spots)
- economic (funding flows and costs)
- political (between US federal and local)

Producing fields	Found but undeveloped fields	Yet To Find fields	Light Tight Oil

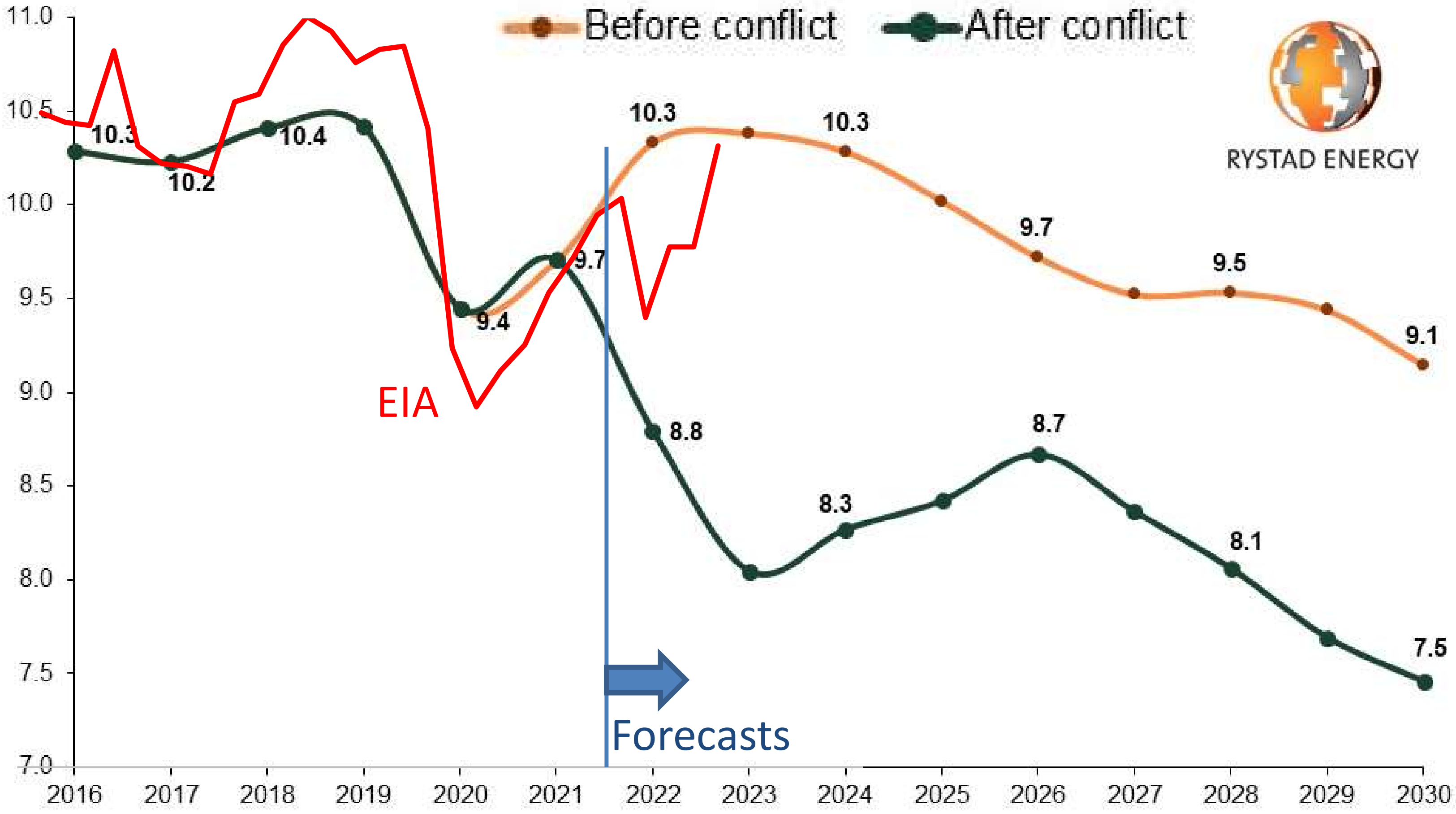


Last Results from EIA –July 2023- Closer to High estimate trend

Russia

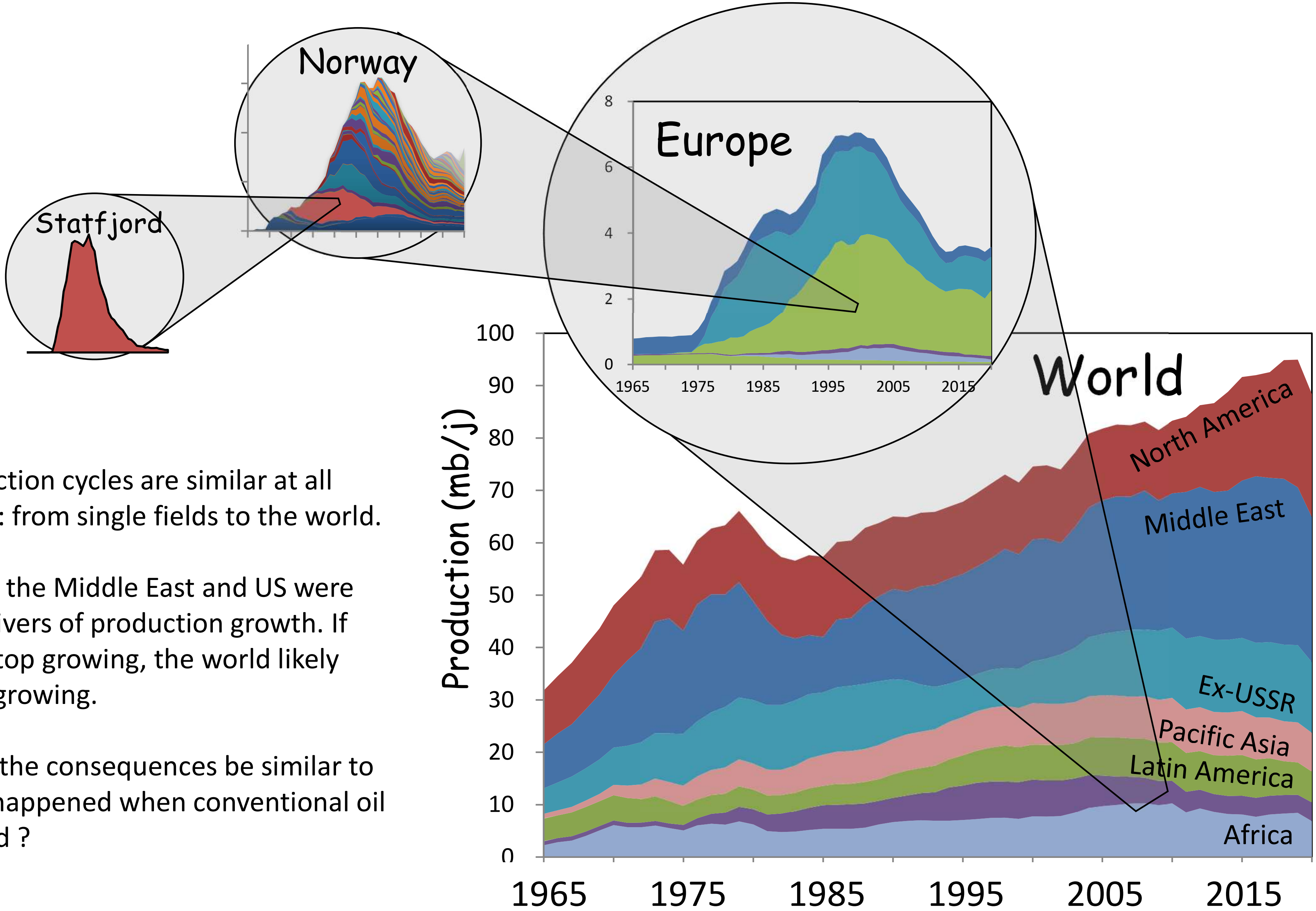
Expected decline, but uncertain long-term effects of sanctions and exit of occidental oilfield services companies

Russia crude production outlook before and after invasion of Ukraine
Million bpd



Source: Rystad Energy research and analysis; Rystad Energy UCube May 2022

III) World panorama



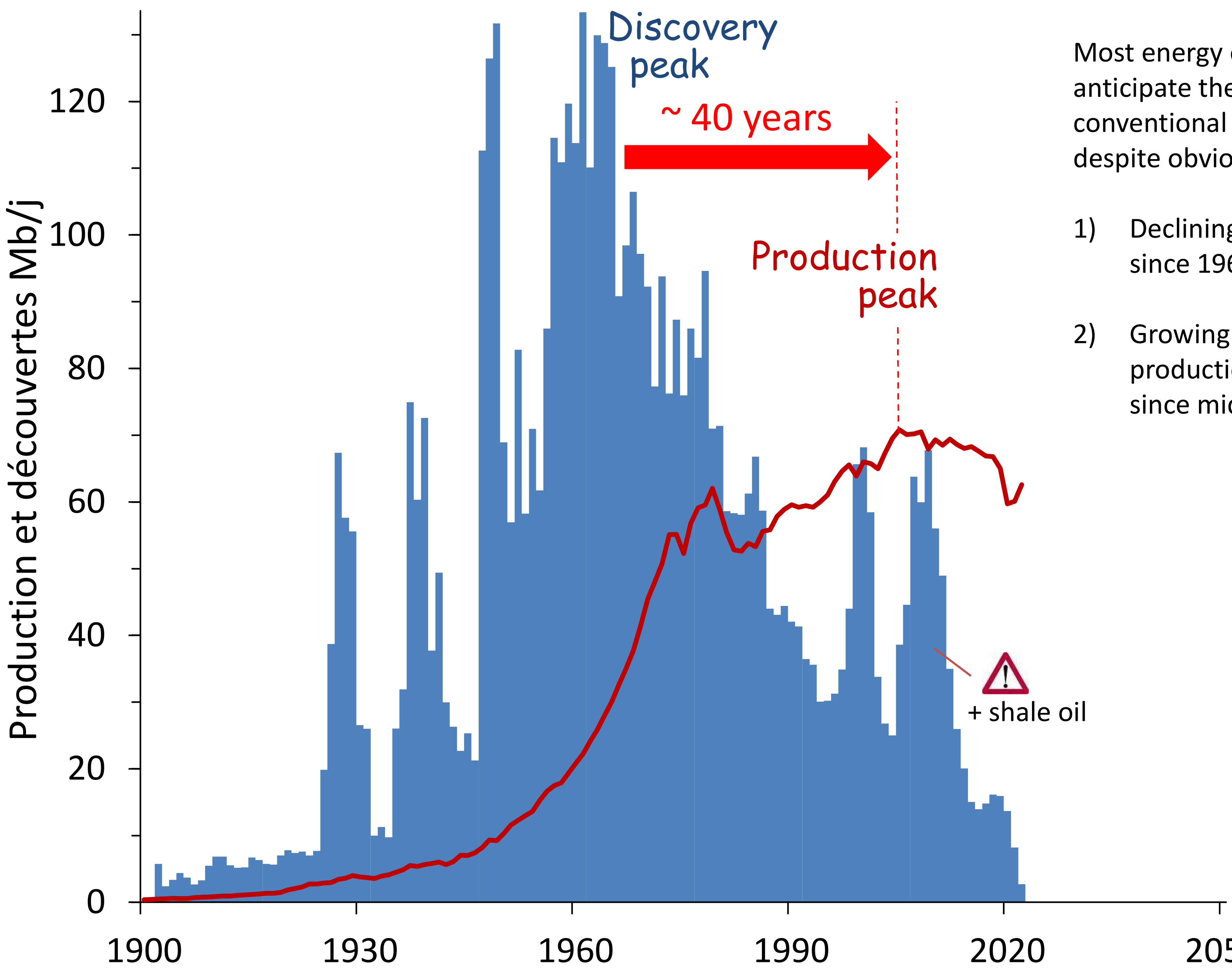
Production cycles are similar at all levels : from single fields to the world.

Lately, the Middle East and US were the drivers of production growth. If they stop growing, the world likely stops growing.

Could the consequences be similar to what happened when conventional oil peaked ?

Graphic: P. Brocorens, source: NPD for Statfjord, Norway; BP for Europe, World, all liquids

History of discoveries and production for world conventional crude oil



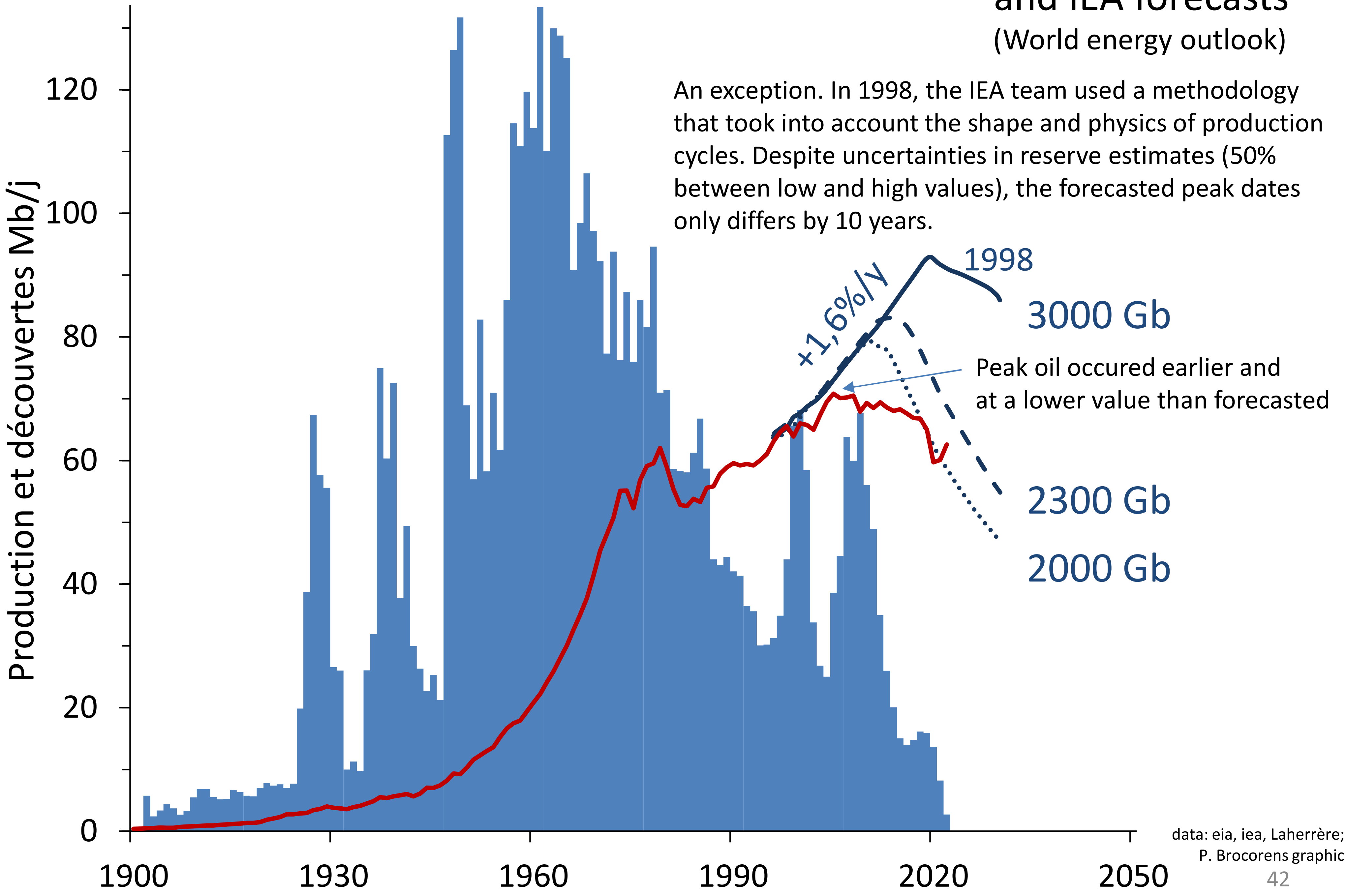
Most energy experts did not anticipate the peaking of conventional oil production despite obvious warnings

1) Declining discoveries since 1960s

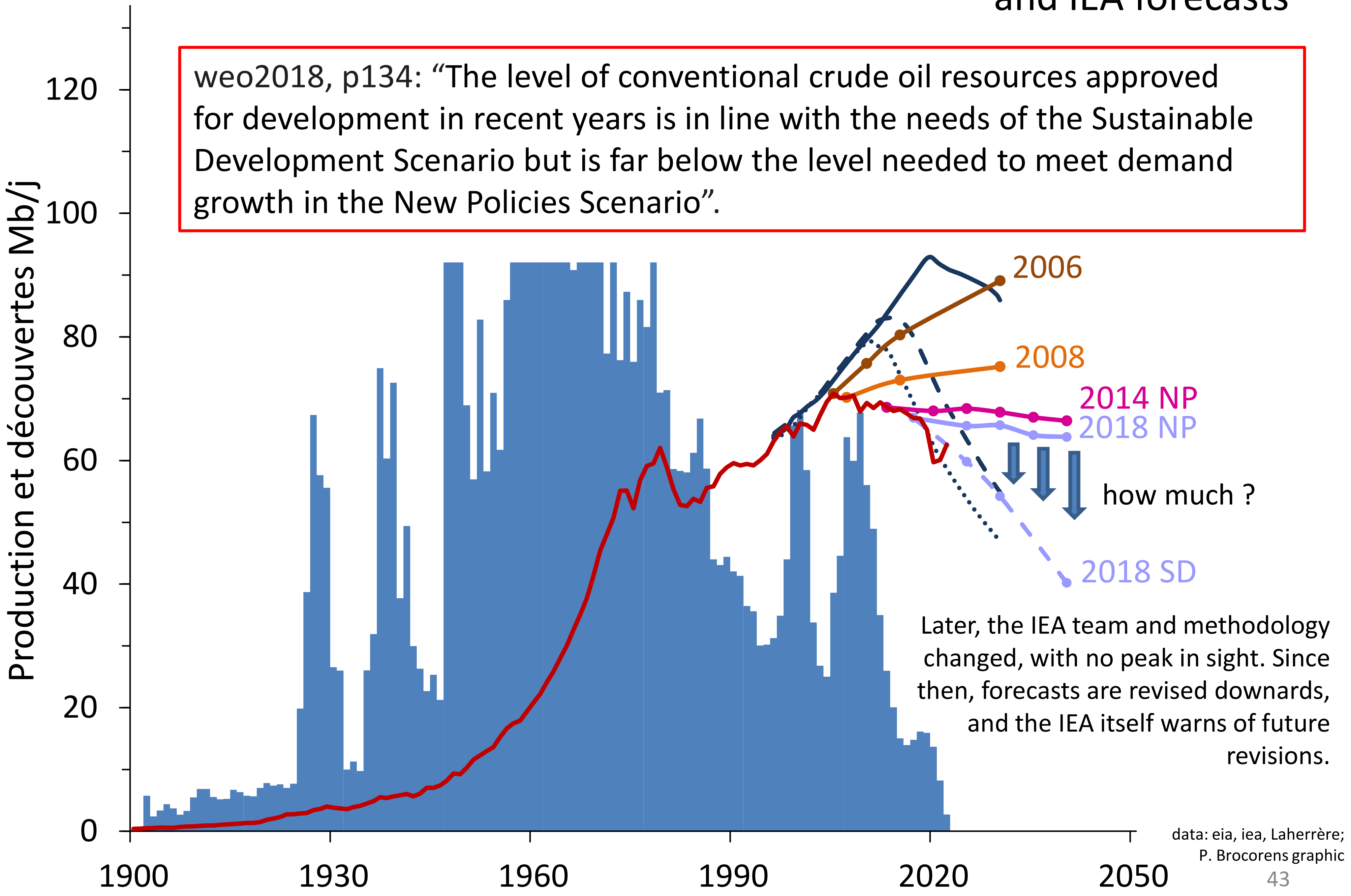
2) Growing gap between production and discoveries since mid-1980s

data: eia, iea, Laherrère; P. Brocorens graphic

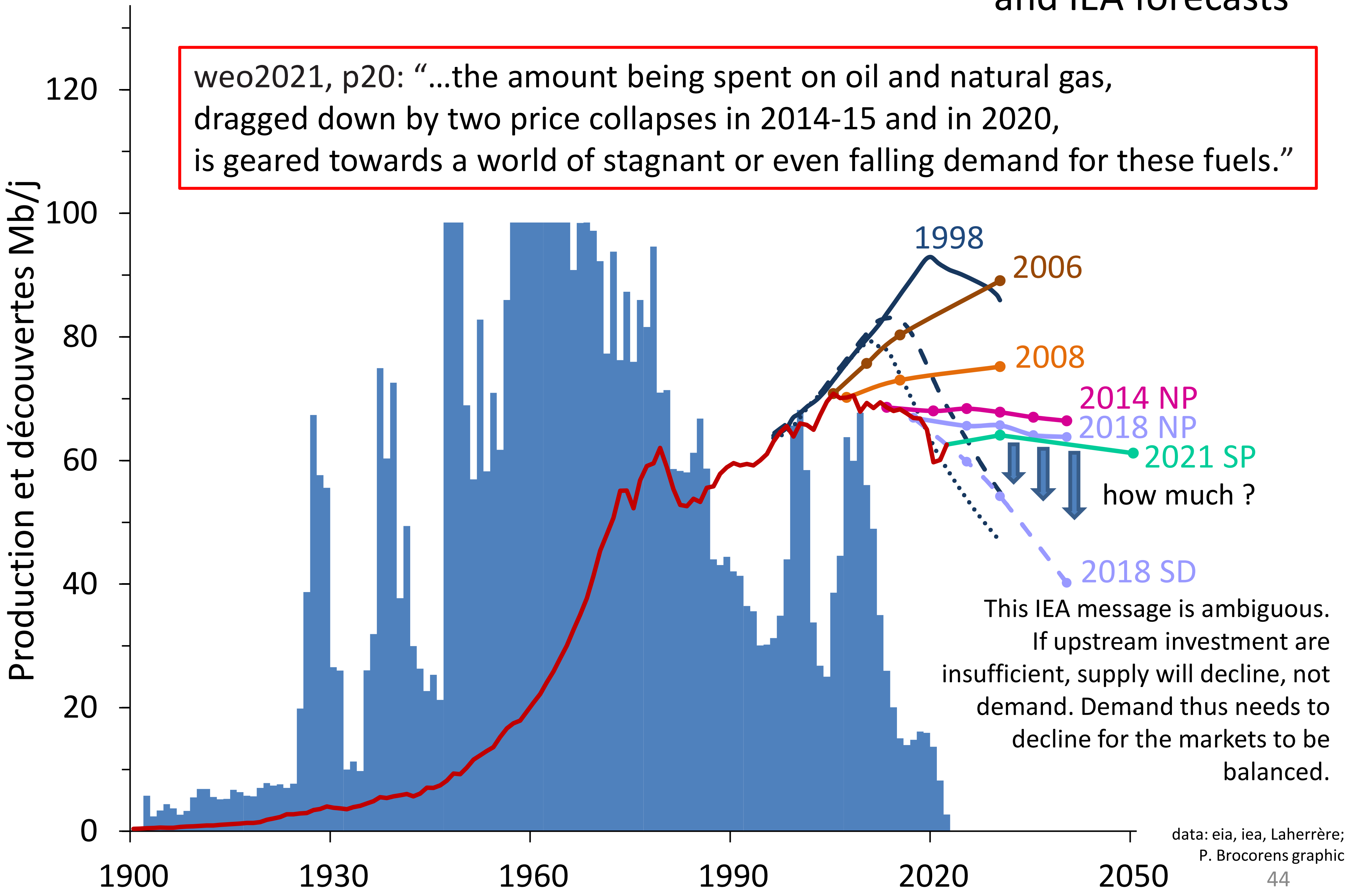
History of discoveries and production for world conventional crude oil, and IEA forecasts
(World energy outlook)



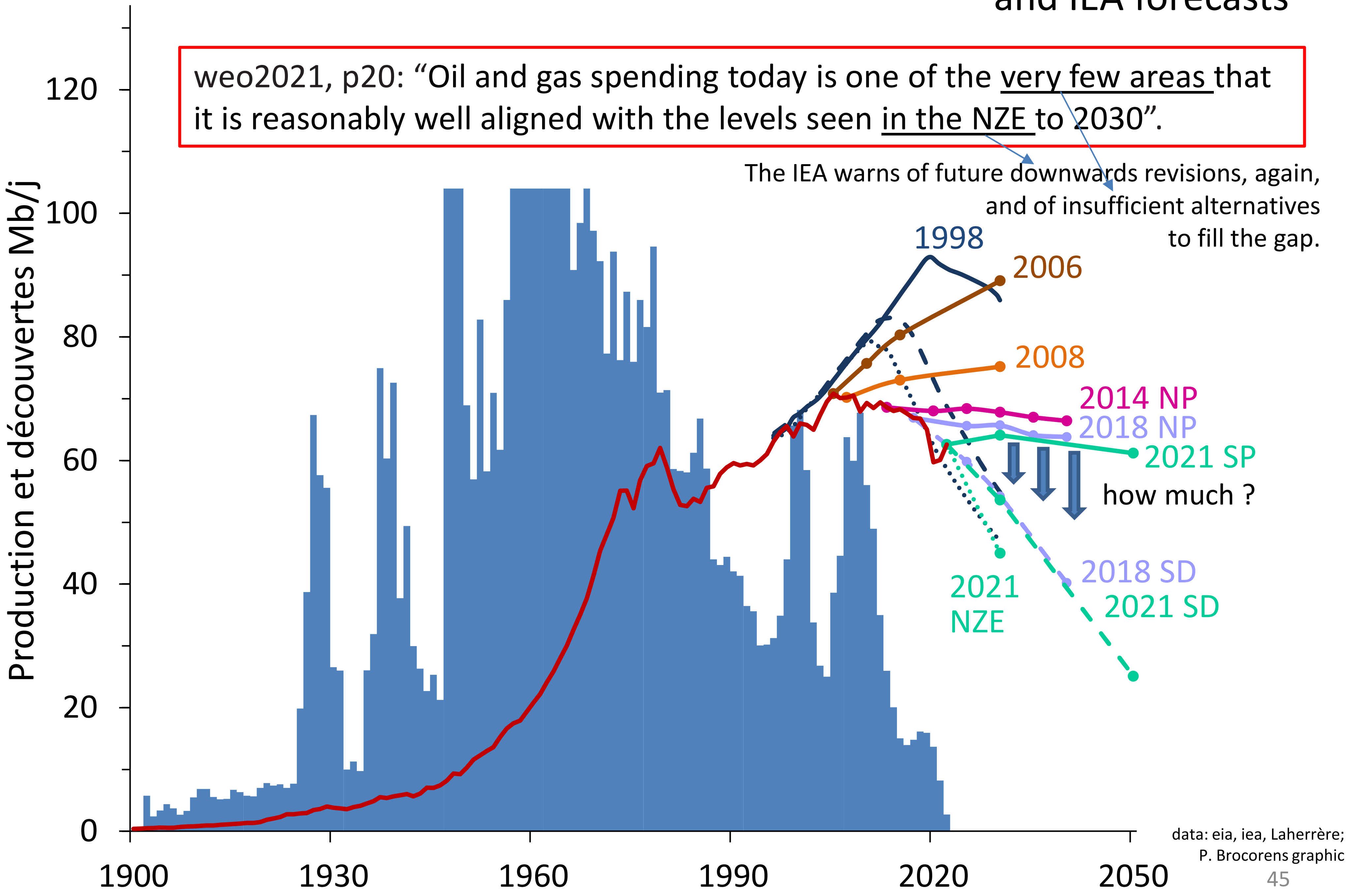
History of discoveries and production for world conventional crude oil, and IEA forecasts



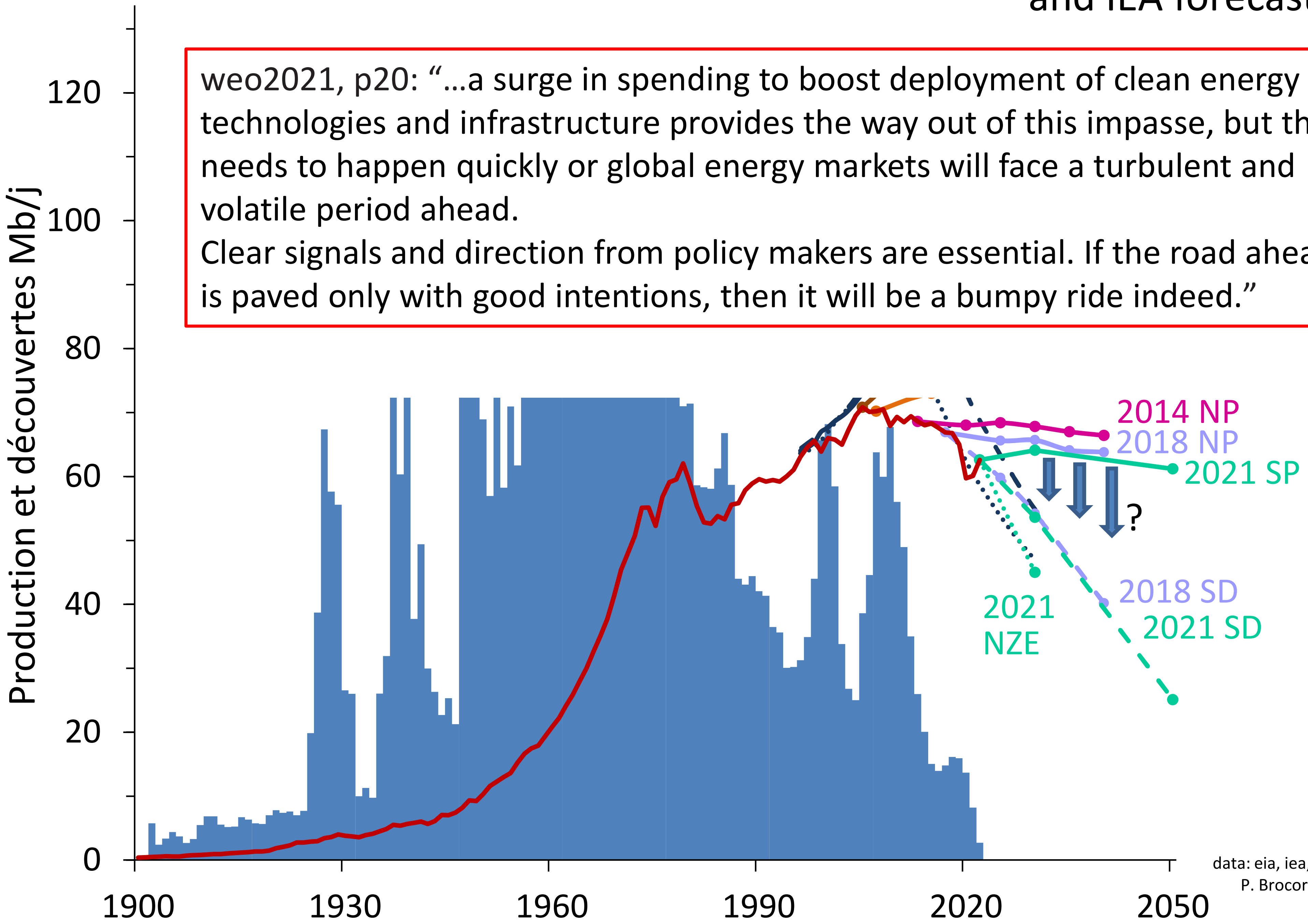
History of discoveries and production for world conventional crude oil, and IEA forecasts



History of discoveries and production for world conventional crude oil, and IEA forecasts

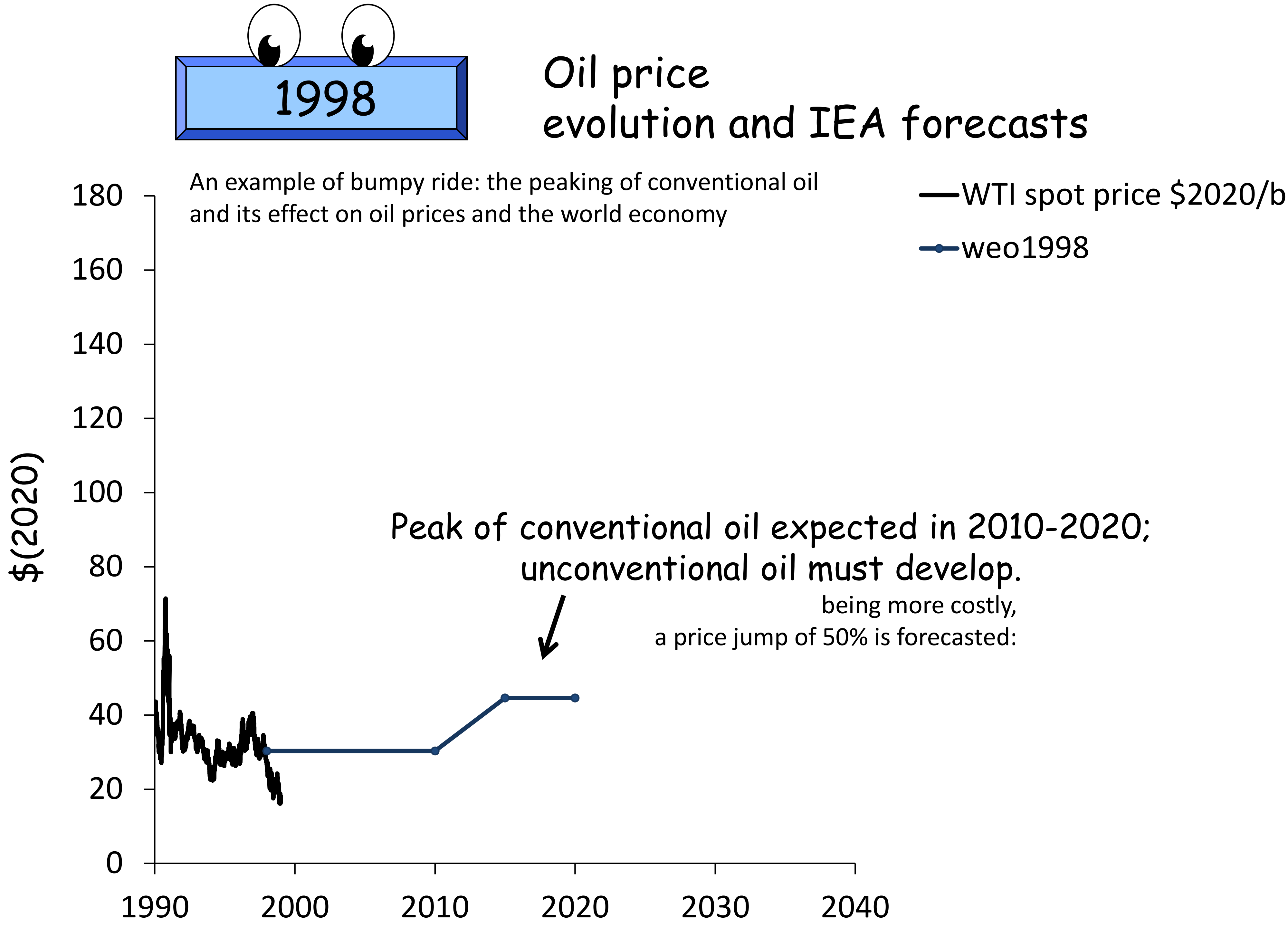


History of discoveries and production for world conventional crude oil, and IEA forecasts

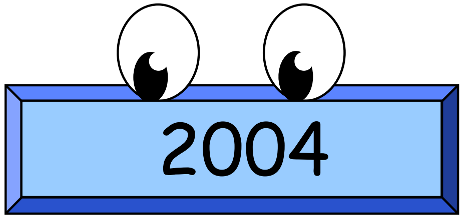


data: eia, iea, Laherrère;
P. Brocorens graphic

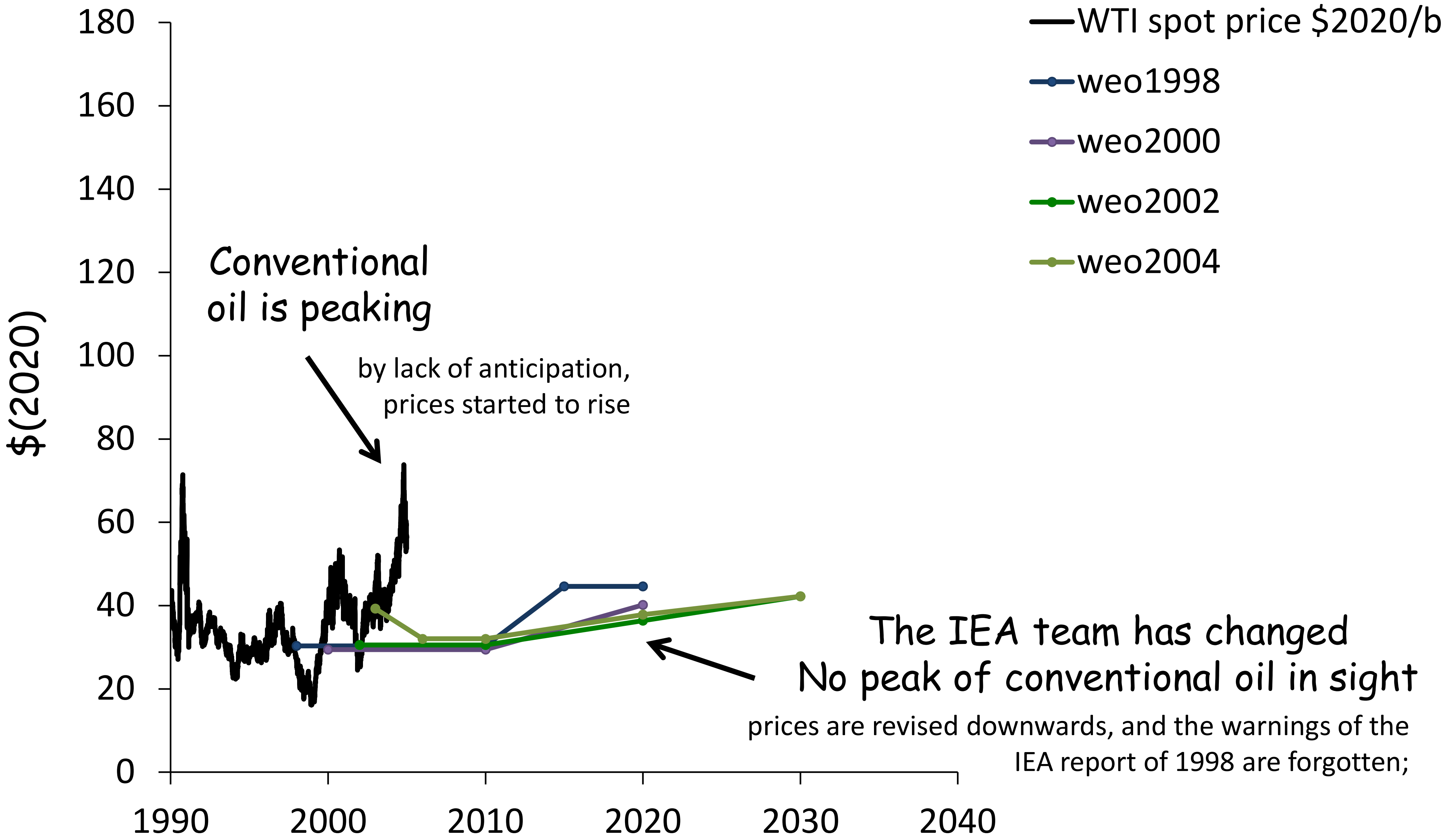
Oil price evolution and IEA forecasts



Source du prix du pétrole: eia



Oil price evolution and IEA forecasts



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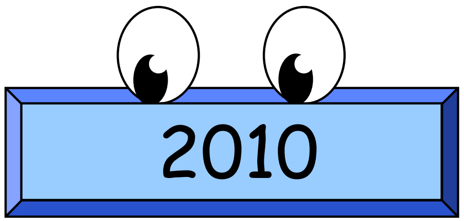
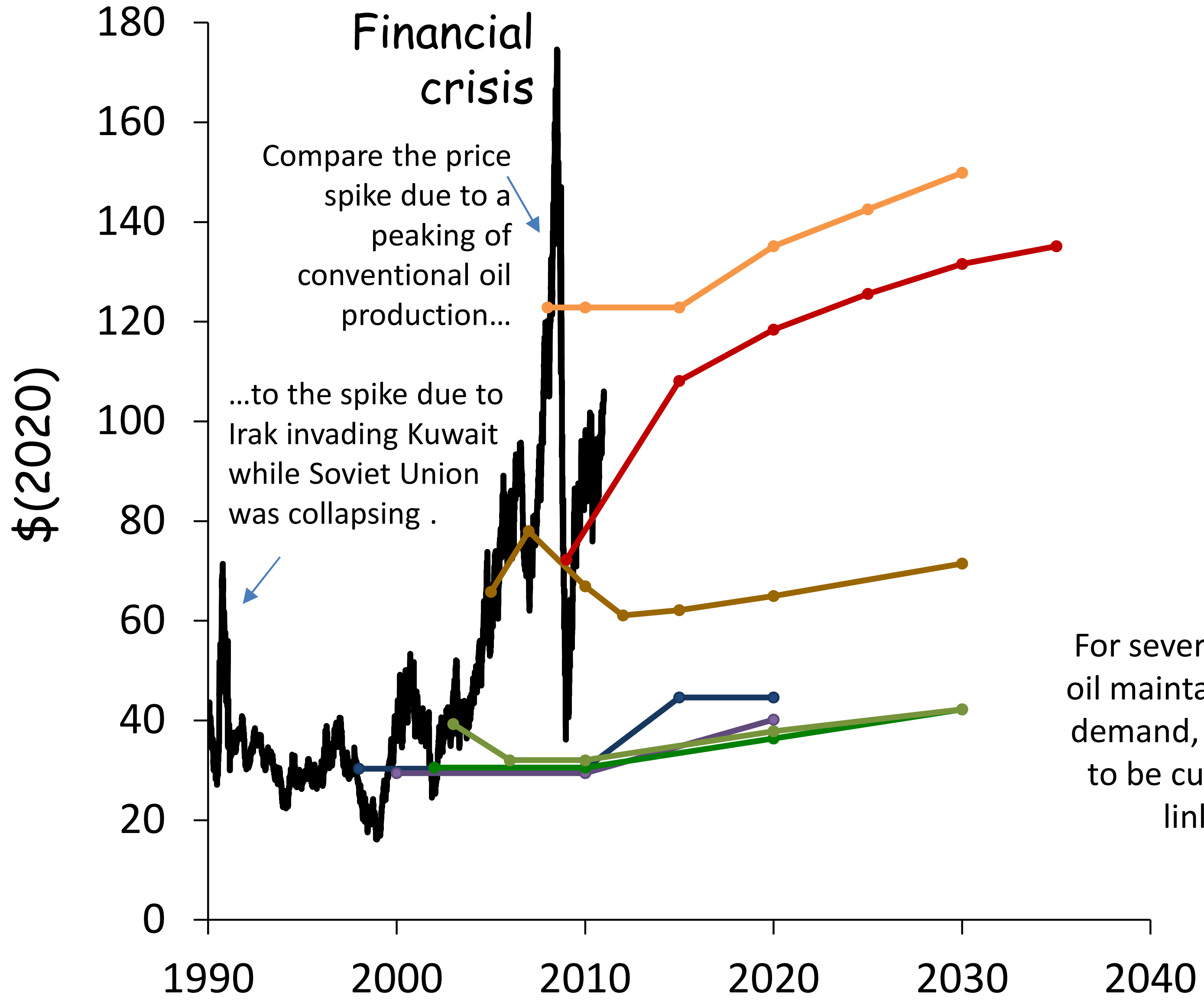


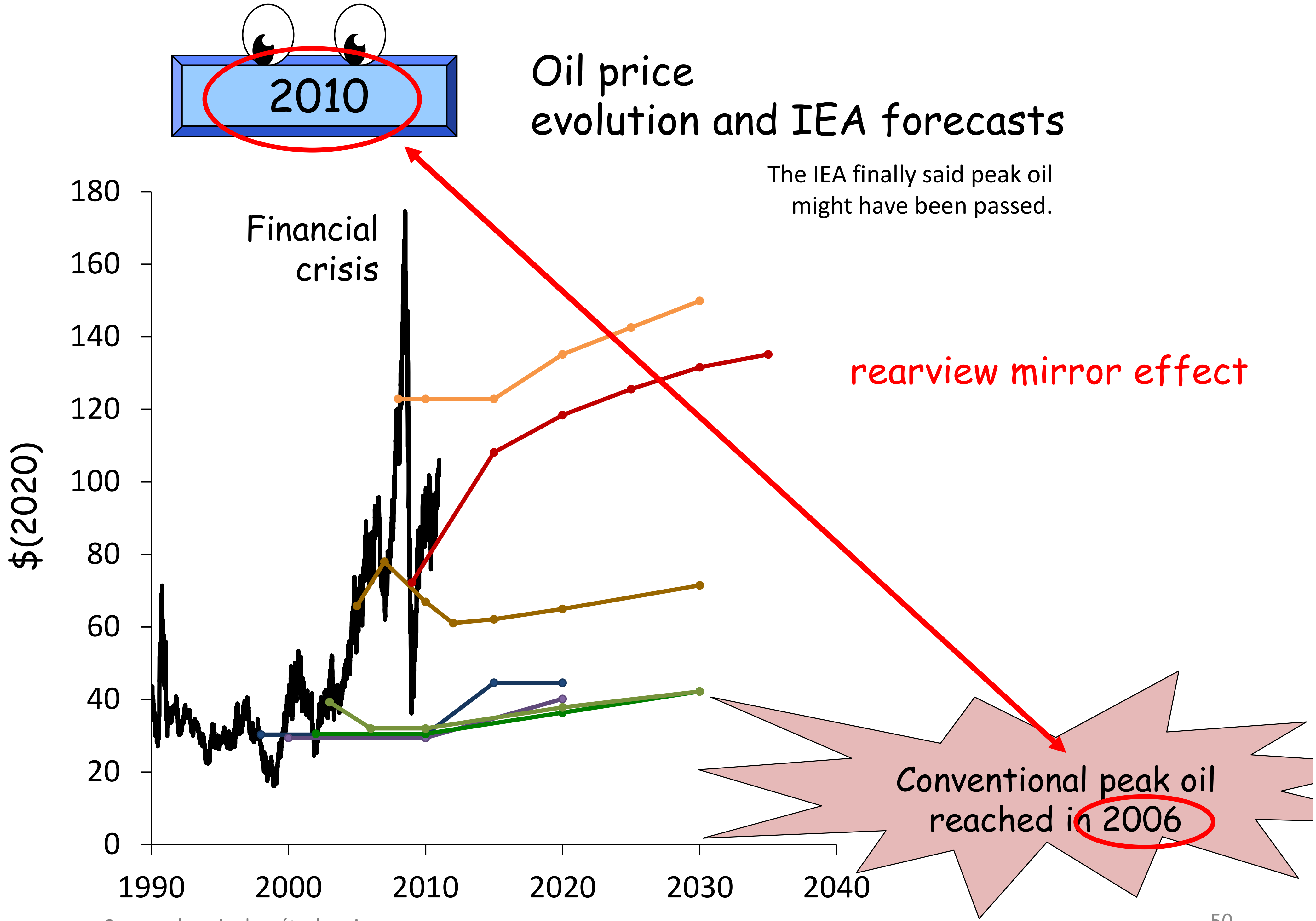
Oil price evolution and IEA forecasts



For several years, the peaking of conventional oil maintained flat the global oil supply. Excess demand, stimulated by economic growth, had to be curbed by rising oil prices. The weakest link of the world economy finally broke. It was the financial crisis.

Source du prix du pétrole: eia

Oil price evolution and IEA forecasts



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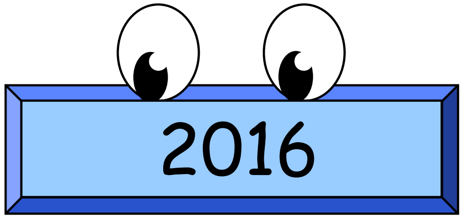
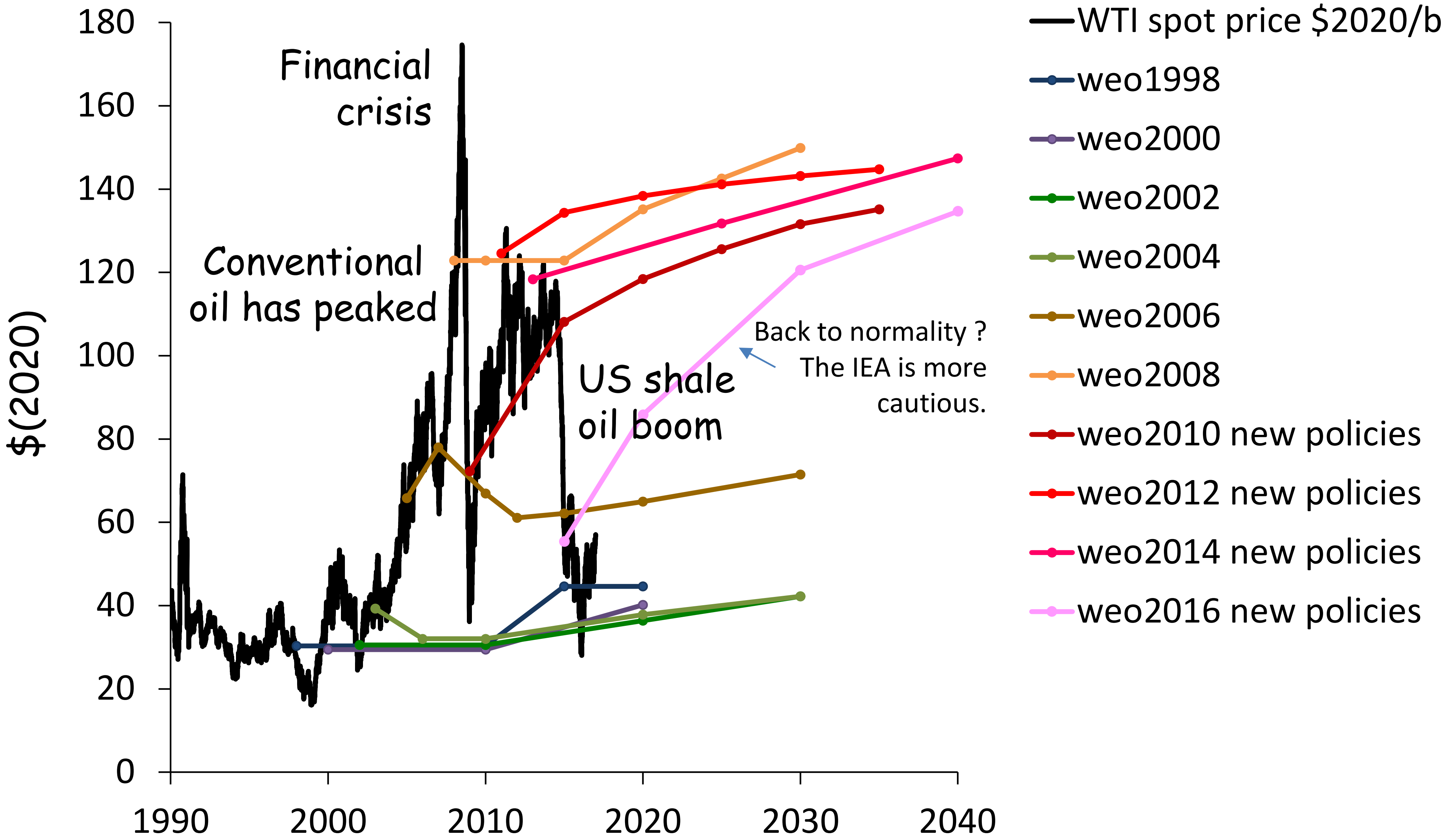


Oil price evolution and IEA forecasts



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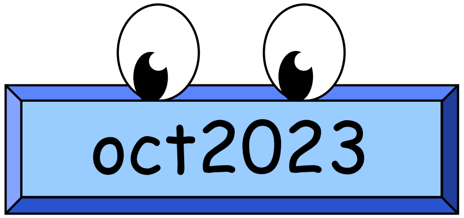
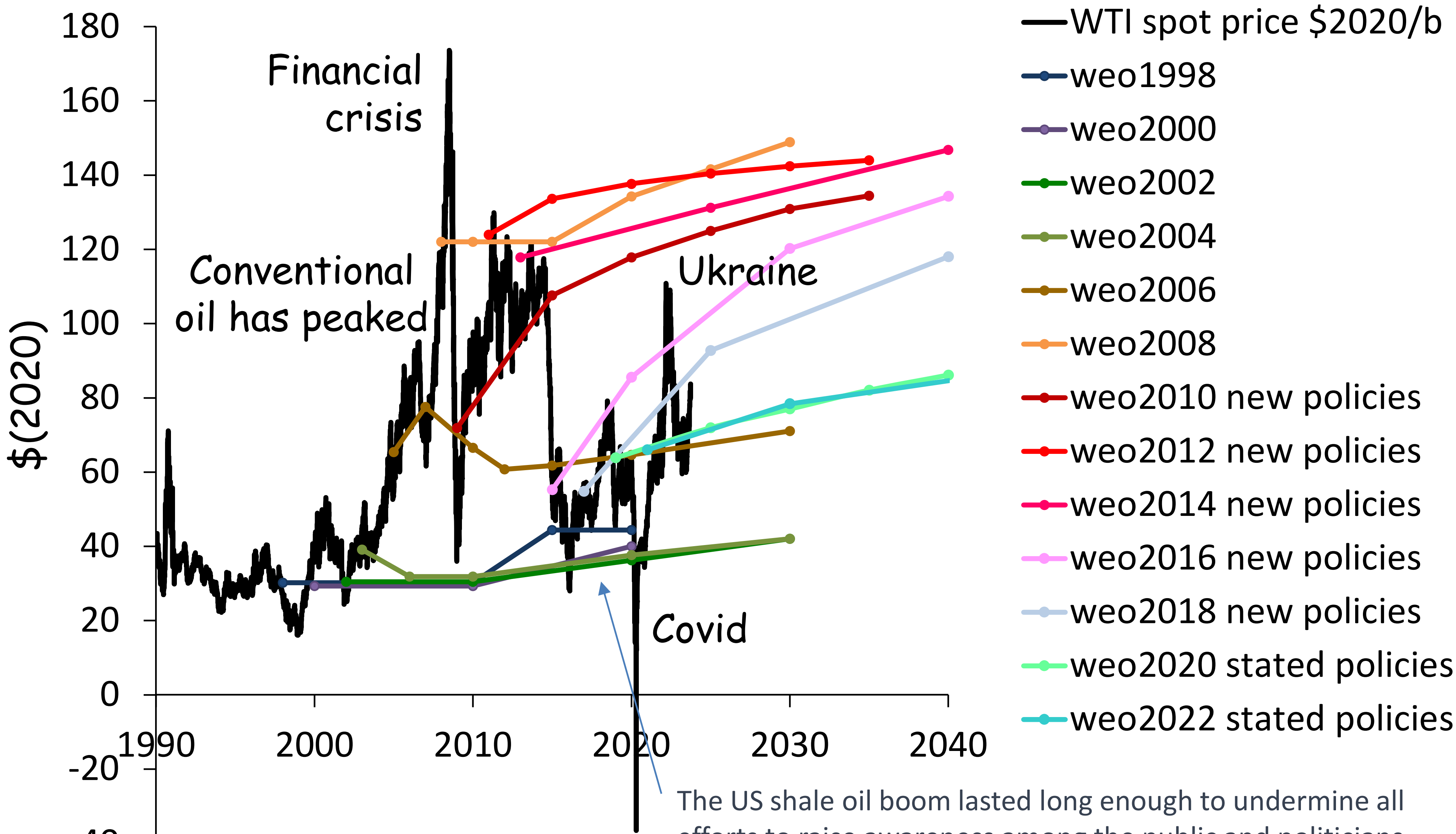


Oil price evolution and IEA forecasts



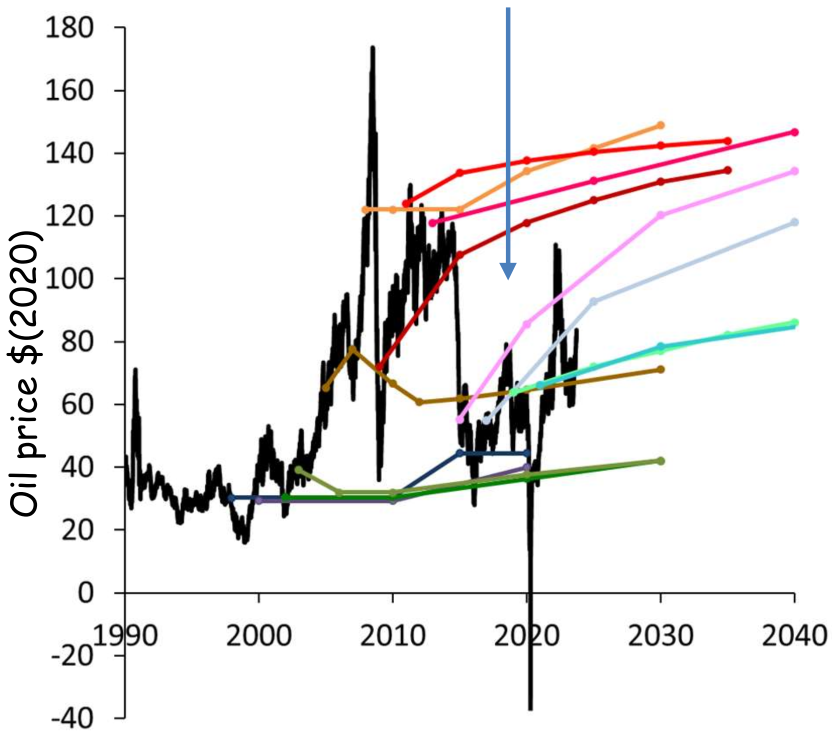
The US shale oil boom lasted long enough to undermine all efforts to raise awareness among the public and politicians about the need to take peak oil seriously.

Source du prix du pétrole: eia

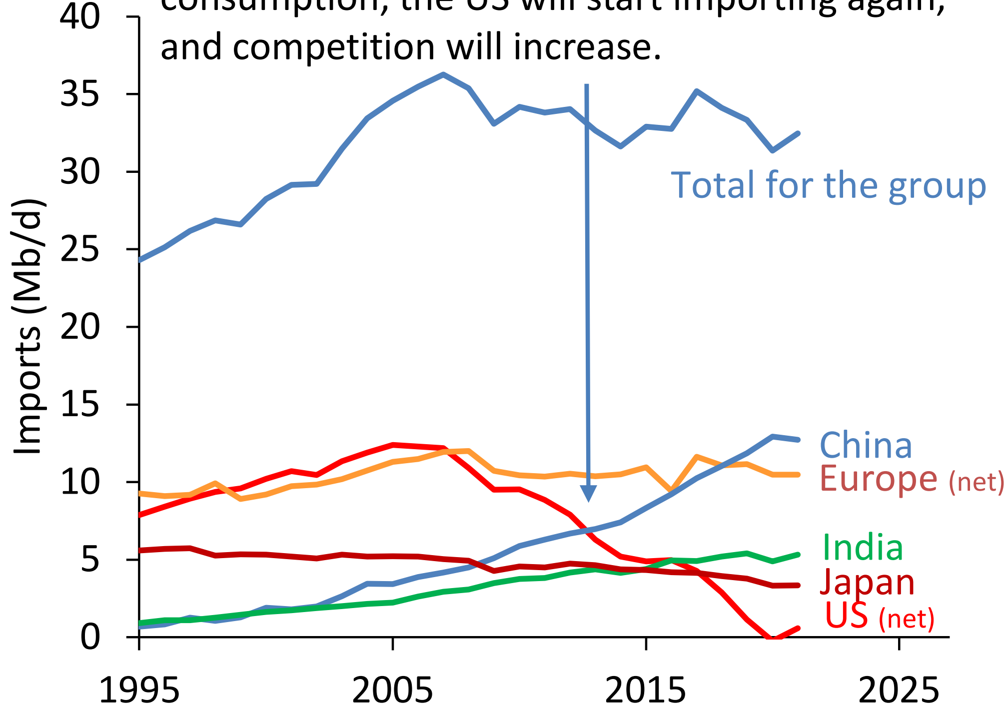
	2025-2030	2030-2040
US	Production peaks ….	… then declines

➡ The US progressively falls back to the situation prior to the shale oil revolution

In 2014, the US replaced Saudi Arabia as « swing producer » thanks to the reactivity of the shale oil companies to oil prices. This ability to stabilize markets will progressively disappear.



In 15 years, the US reduced their net oil imports by 12 million barrels. Oil from exporting countries was redirected to other countries, allowing China and India to grow their consumption with limited competition. Without reduction of domestic consumption, the US will start importing again, and competition will increase.



	2025-2030	2030-2040
Europe	for the block of the 16 main oil exporters to EU, production peaks…	… then declines

→ Search of new exporters (deep offshore from Brasil, Guyana, Surinam, Austral Africa; Andean foothills from Colombia-Ecuador-Peru-Bolivia-Argentina)

The peak and decline of US oil production, along with similar trends in other countries, collectively drive the overall production for the group of 16 major exporters to the EU towards a peak and decline. Competition between importers for declining exports from those countries will be somewhat mitigated by rising exports from countries that have recently initiated production cycles.

	2025-2030	2030-2040
Middle East	Conventional production peaks…	… and stays on a plateau

→ Growing importance to supply markets

Effect on exports of growing local consumption

With production peaking and declining in other parts of the world, the Middle East's market share is likely to increase. However, with production remaining stagnant and local consumption expected to rise due to economic growth and demography, there may be less oil for export than expected. This is especially true for countries experiencing declining production. For them, declining exports could become a significant destabilizing factor, as observed in Syria and Yemen prior to the Arab Spring. Algeria is a country facing a similar risk.

	2025-2030	2030-2040
World	Production peaks….	… then declines

➡ Volatile markets, price spikes….

unless unconventional or synthetic oil generalizes (Canada-Mexico-Colombia-Argentina-Russia-Kazakhstan-Libya-Venezuela…. Middle East ?)

or the transition starts seriously

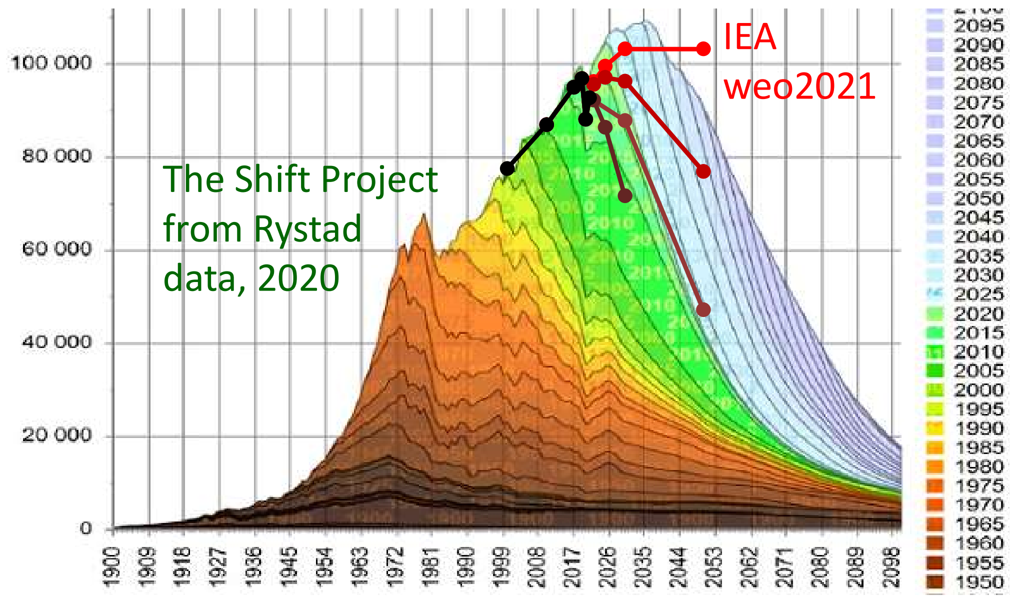
The scenario of a peak and decline in world production may be postponed if unconventional or synthetic oils, particularly shale oil, become widespread. Wherever conventional oil is found, shale oil is also present nearby, and developments in other countries than in the US are likely to occur. However, below-ground characteristics (geology,…) are not always suitable and above-ground conditions (economy, politics,…) are not as favorable as in the US. US shale oil companies operated for years with negative free cash-flow. This model differs from the oil rent model followed in the Middle East. Significant development in such countries could necessitate an increase of the oil price to a new level, which could be painful for importing countries.

Also, the scenario of a peak and decline in world production could be mitigated in its negative consequences if the transition finally starts seriously.

Peak supply

vs

peak demand



In the past, there was much controversy to know whether a peak and decline of world oil production would occur and when.

Today, many energy experts say peak oil is imminent and show similar oil production trajectories (see figure above), but the controversy is now on the nature of the peak. Peak supply is driven by physical and geological factors, and is accompanied by price spikes. In this presentation, we presented arguments that support that view. Peak demand is driven by consumers leaving oil faster than oil leaves them, and is accompanied by soft prices. The IEA scenarios are presented as peak demand, but at the same time the IEA warns of production constraints that are characteristic of peak supply.

In a peak supply, excess capacity generally disappears for long periods, and any event that disturbs production (geopolitics, accident, storm,…) then has an amplified effect on prices. People’s attention often becomes fixated on these events, causing them to overlook the underlying causes : depletion and reduced energy return for the remaining resources.