

SLT Europe

**The Student Lecture Tour (SLT) is
to you by the**



What energy future after world oil production peak?

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- 1 Reminding oil fundamentals: a few key points
- 2 Production constraints: oil and gas peaks
- 3 Climate constraints: some key data
- 4 Oil prices: yesterday, today, and tomorrow
- 5 What future for energy: the oil industry in a new world

Key considerations about energy fundamentals

For the last 50 years :

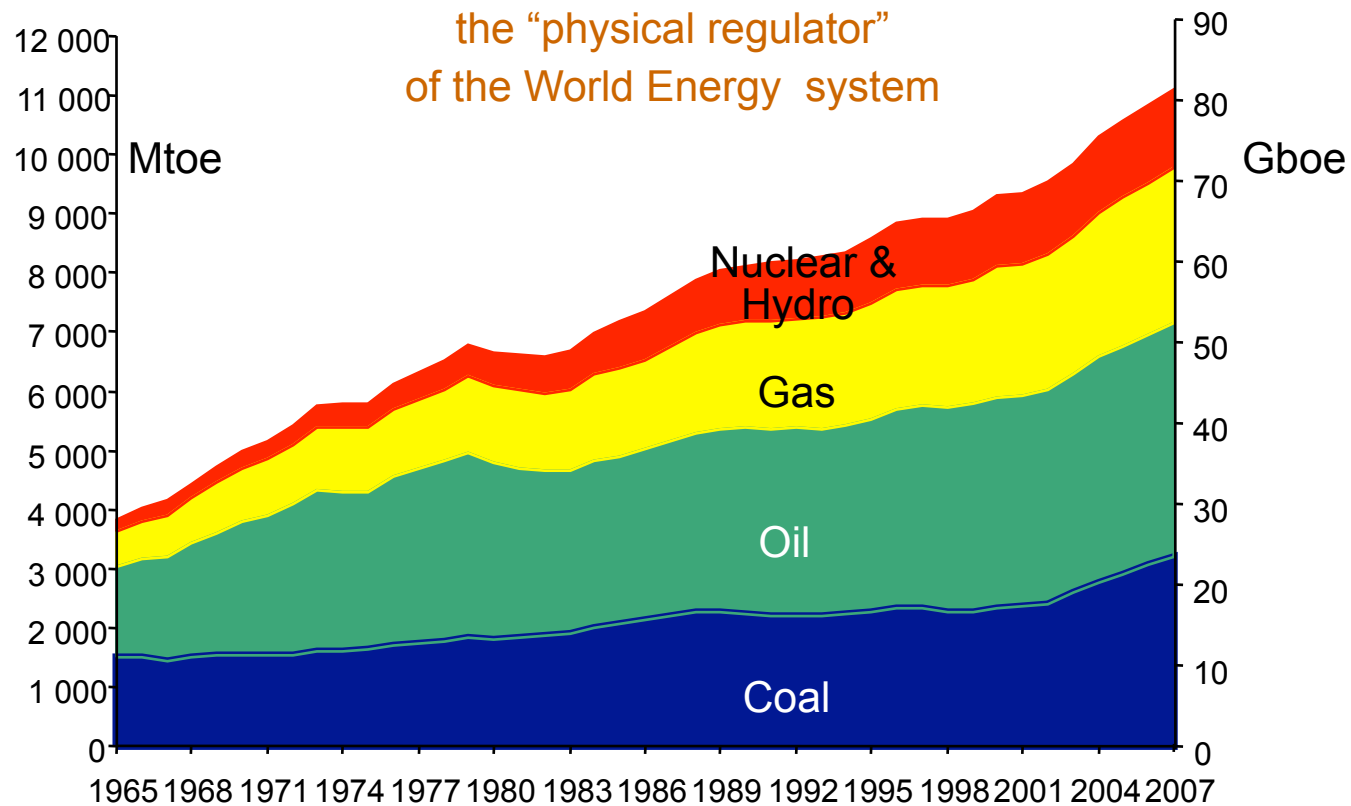
- Oil has been the dominant source of primary commercial energy (40% of world total)
- Oil has been the economic regulator of all energy prices
- Oil has been the physical regulator of the world energy system
- OPEC has been the regulator of world oil system
- Saudi Arabia has been the regulator of OPEC

What about 2020 ? 2050 ? 2100 ?



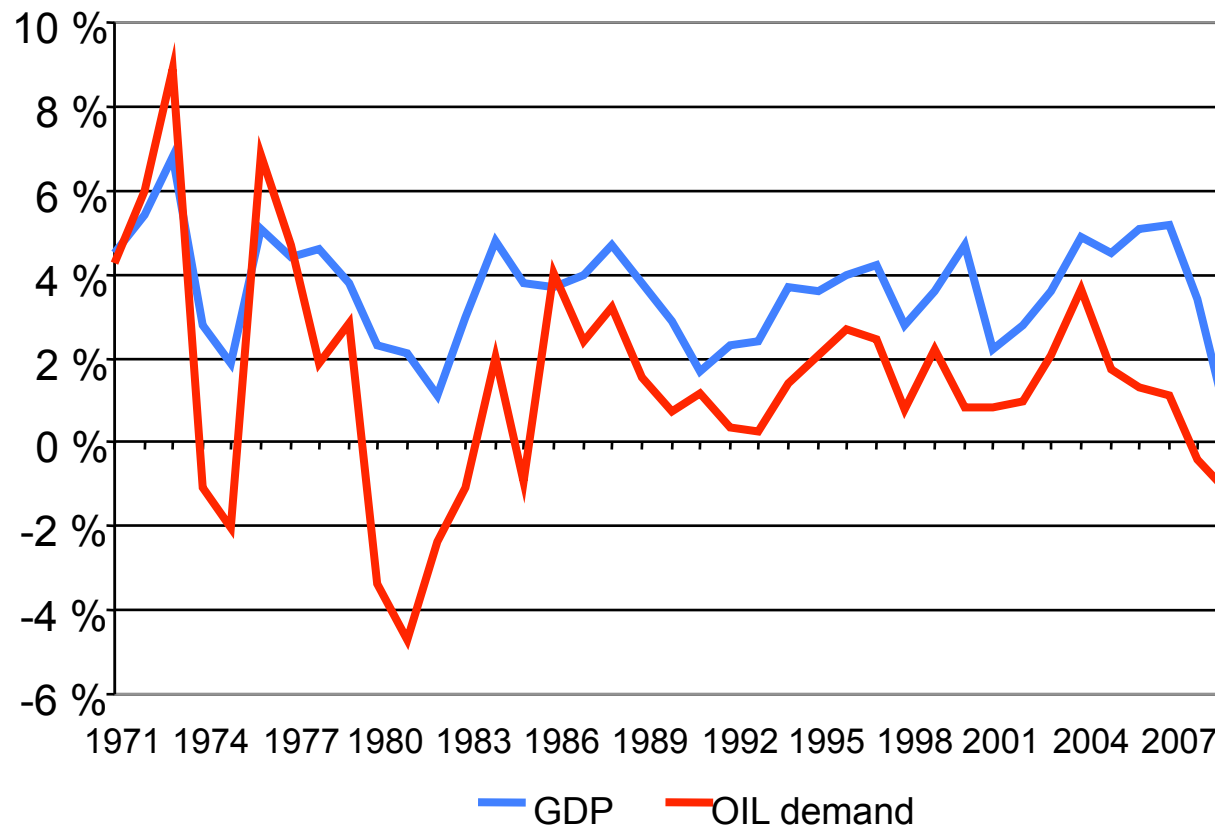
Key considerations about energy fundamentals

Since 2003 coal has become the “physical regulator” of the World Energy system



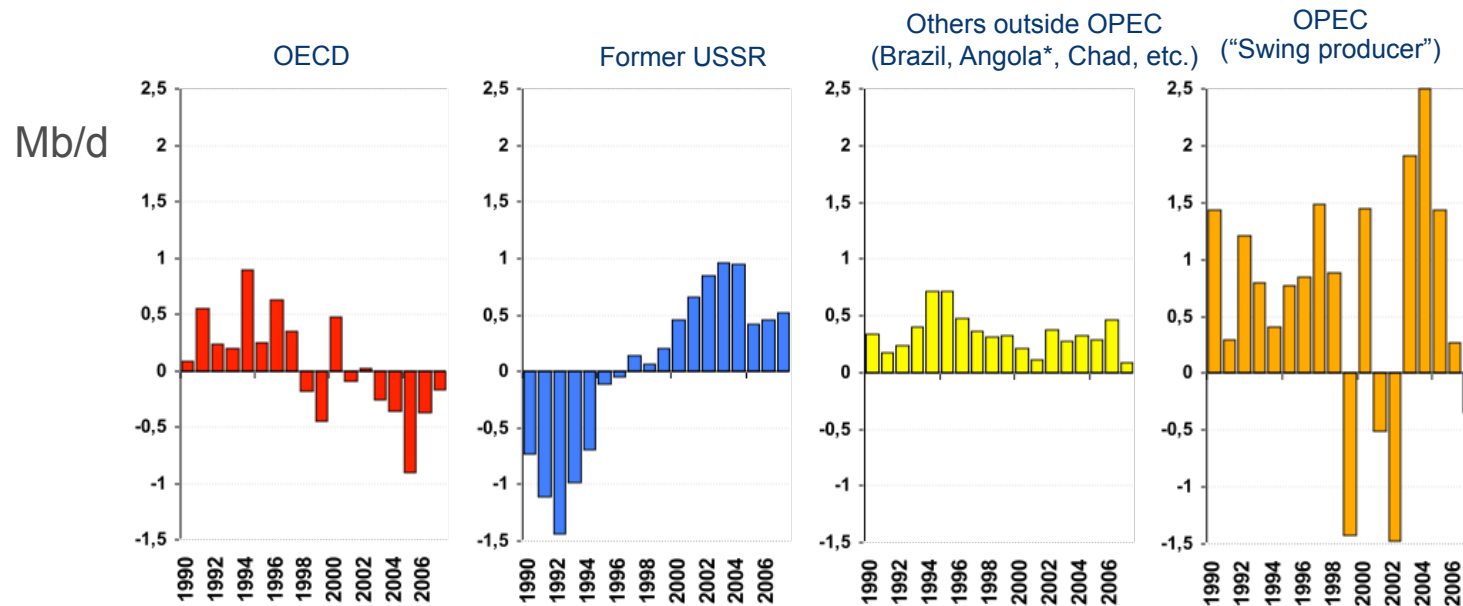
GDP and demand for oil Annual growth rate (% , worldwide)

World Energy in the past was simple: oil was the “physical regulator”



Oil growth is coming exclusively from the OPEC

Annual changes in oil production (Mb/d)

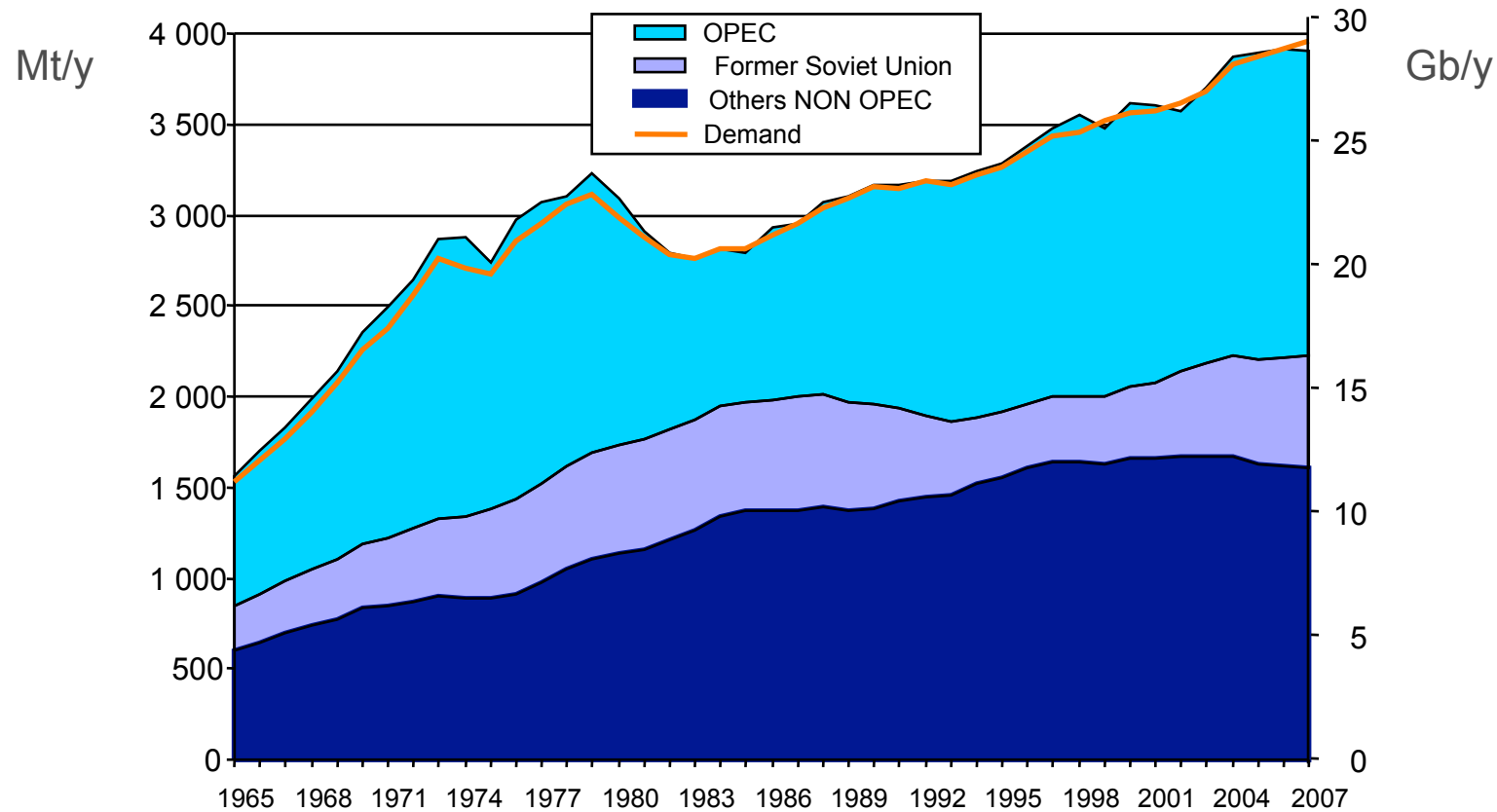


Since 1975 OPEC has become the regulator of the World Oil system.

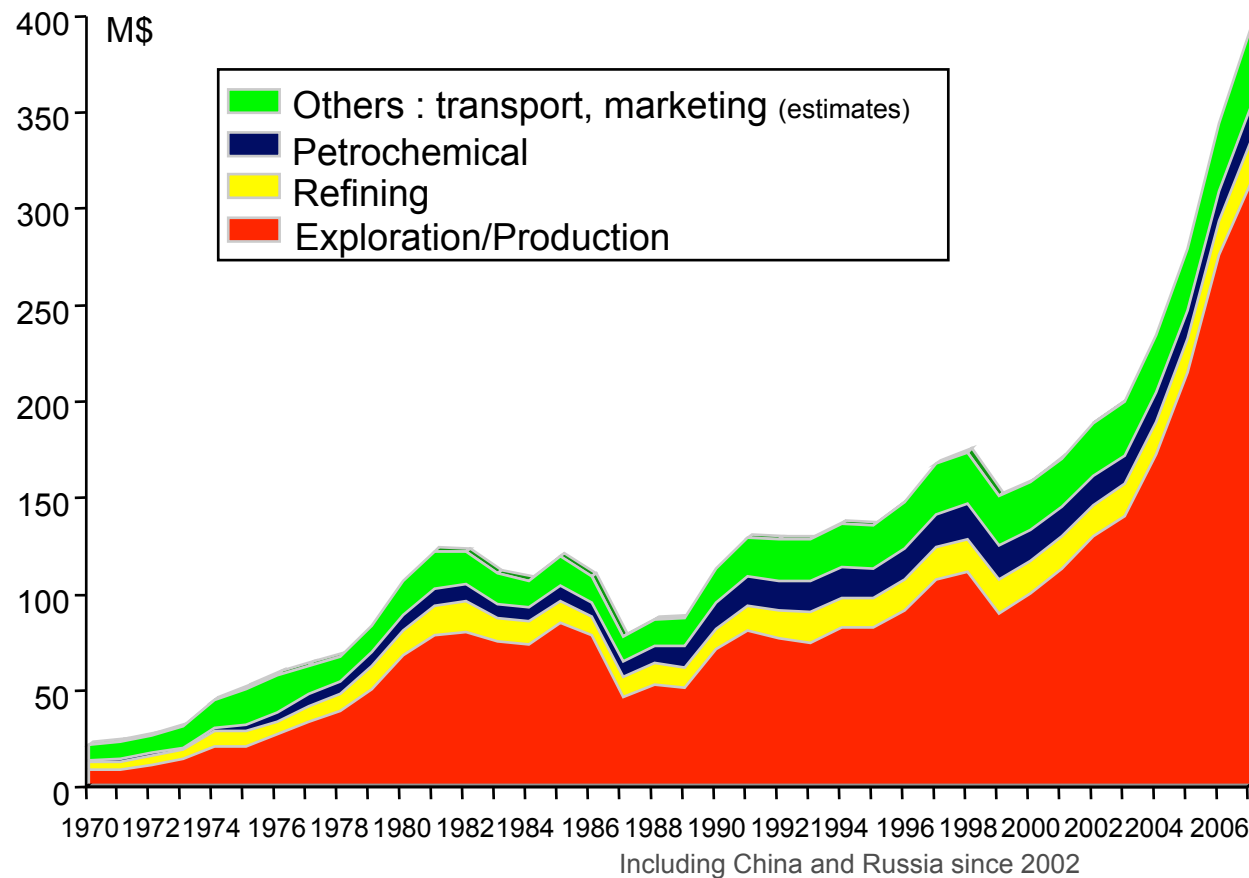


*Angola left outside the OPEC for consistency purpose

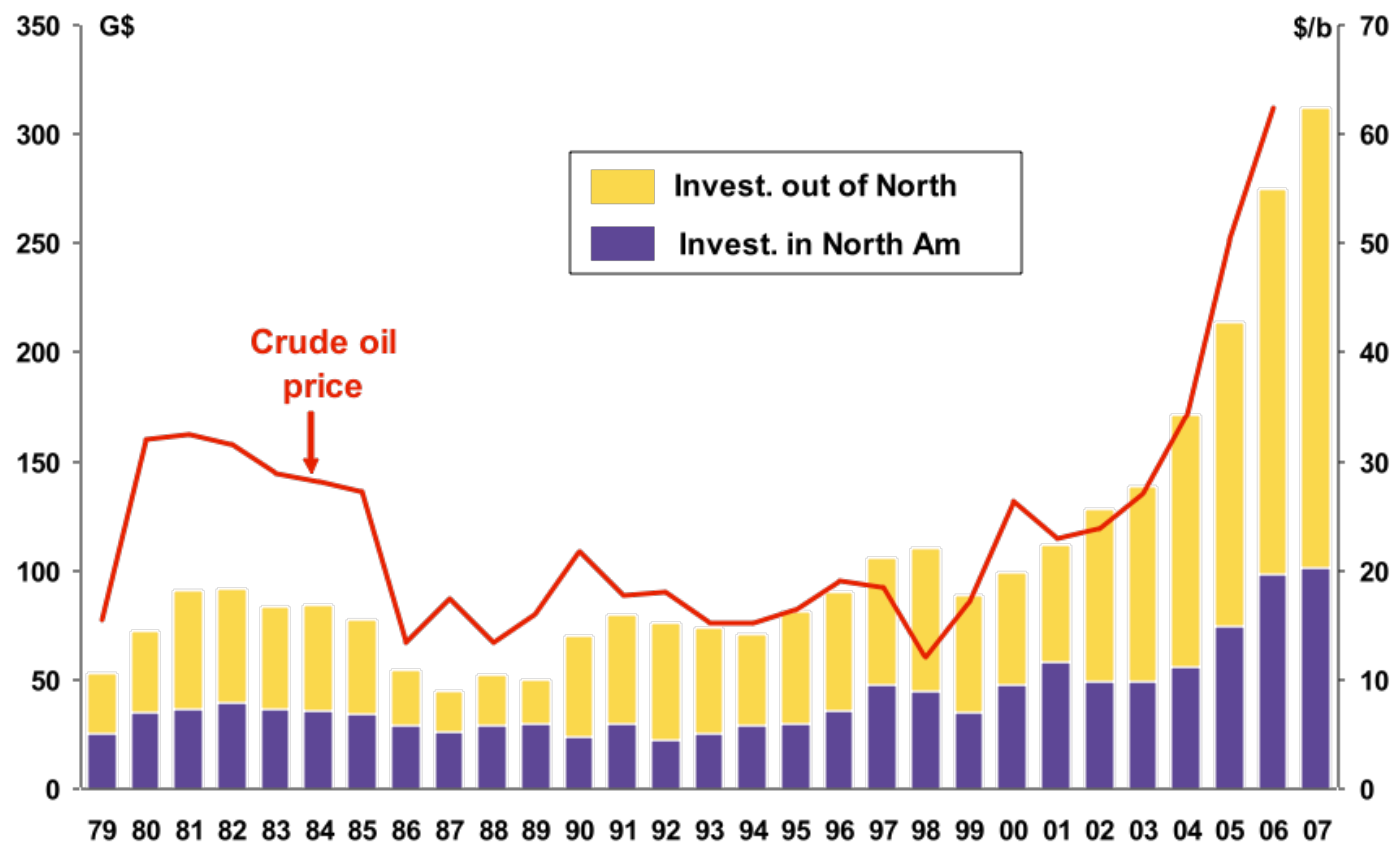
Crude oil production - production almost equal to demand



Upstream: E&P represent 80% of the global oil industry investment

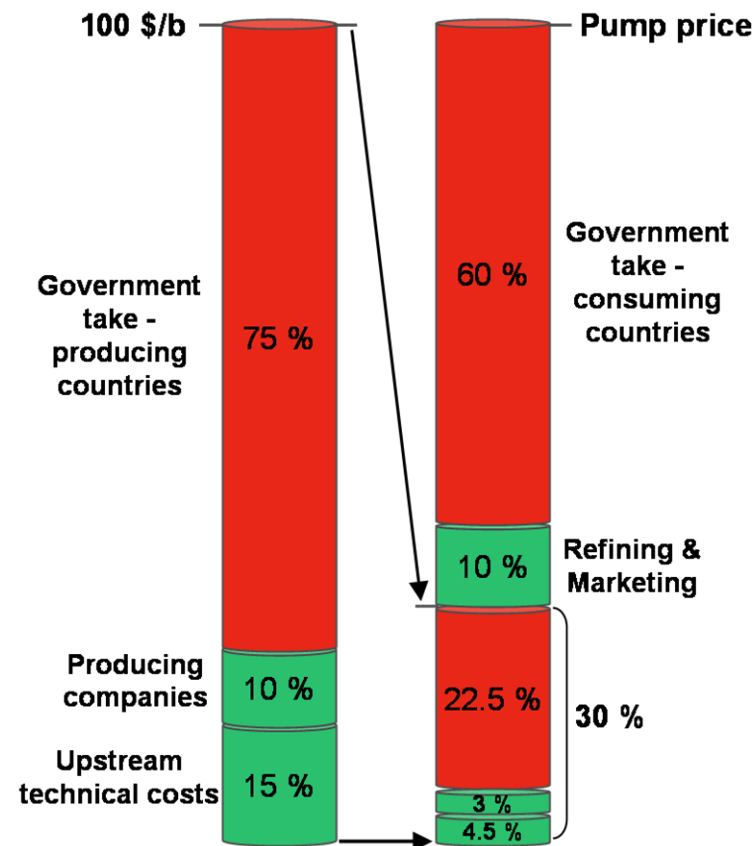


History of investment in exploration-production



The key paradoxes of the oil industry

- At 100 \$/b crude oil, the upstream worldwide average technical costs represent 15%, while 10% are for the producing companies and around 75% for the **producing countries** « government take ».
- These 100 \$/b « crude oil cost » represent an average 30% of the pumps prices in the E.U. The other 70% consist of 60% for the **consuming countries** « government take », and 10% for downstream costs (refining and marketing).

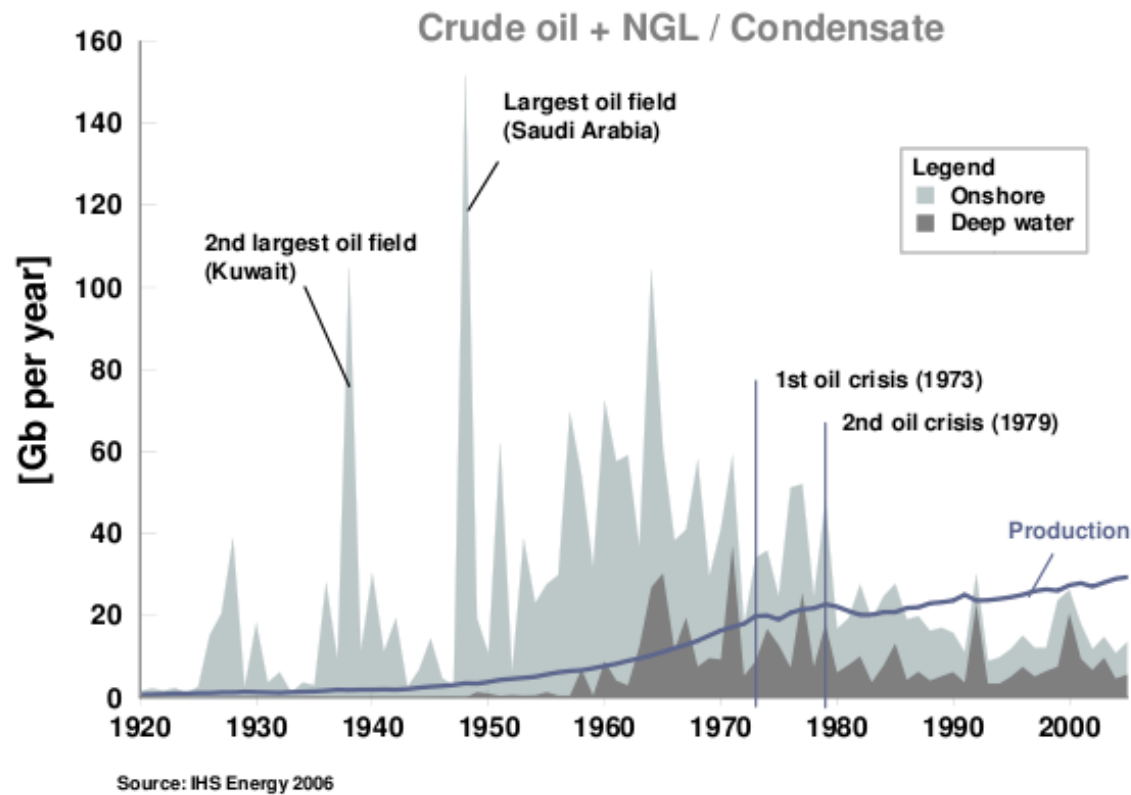


What energy future after world oil production peak?

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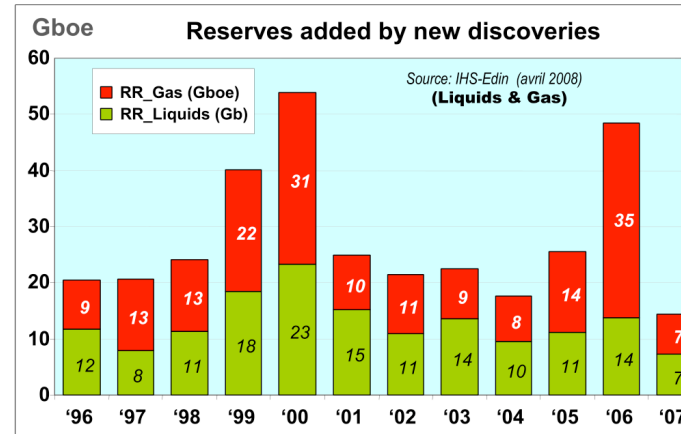
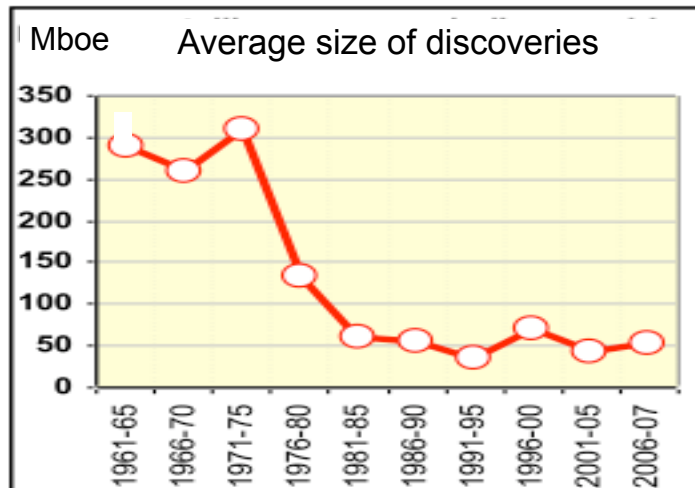
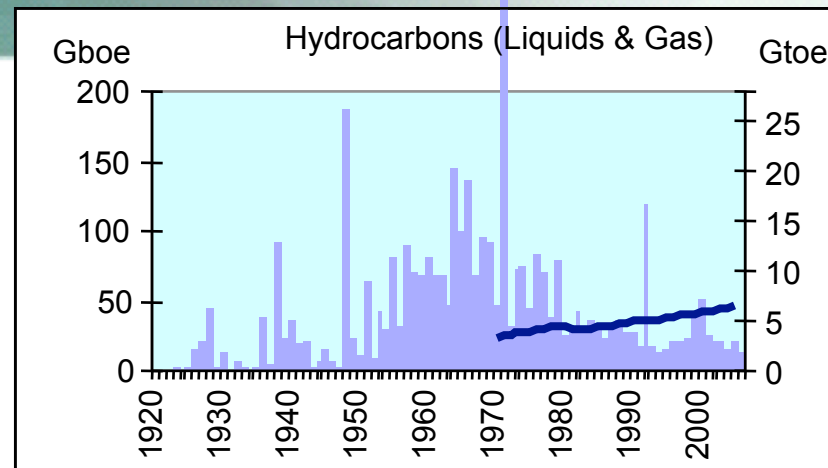
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History of oil discoveries (proved and probable) and production



History of recent discoveries

- World demand reaches 50Gboe per year
- World discoveries flat since 1996 at 20Gboe per year (excluding the nugget effect).
- 10 Gb oil and 10 Gboe gas
- 8 Gboe discovered by NOC
- 10 Gboe discovered by IOC
- 2 Gboe discovered by others



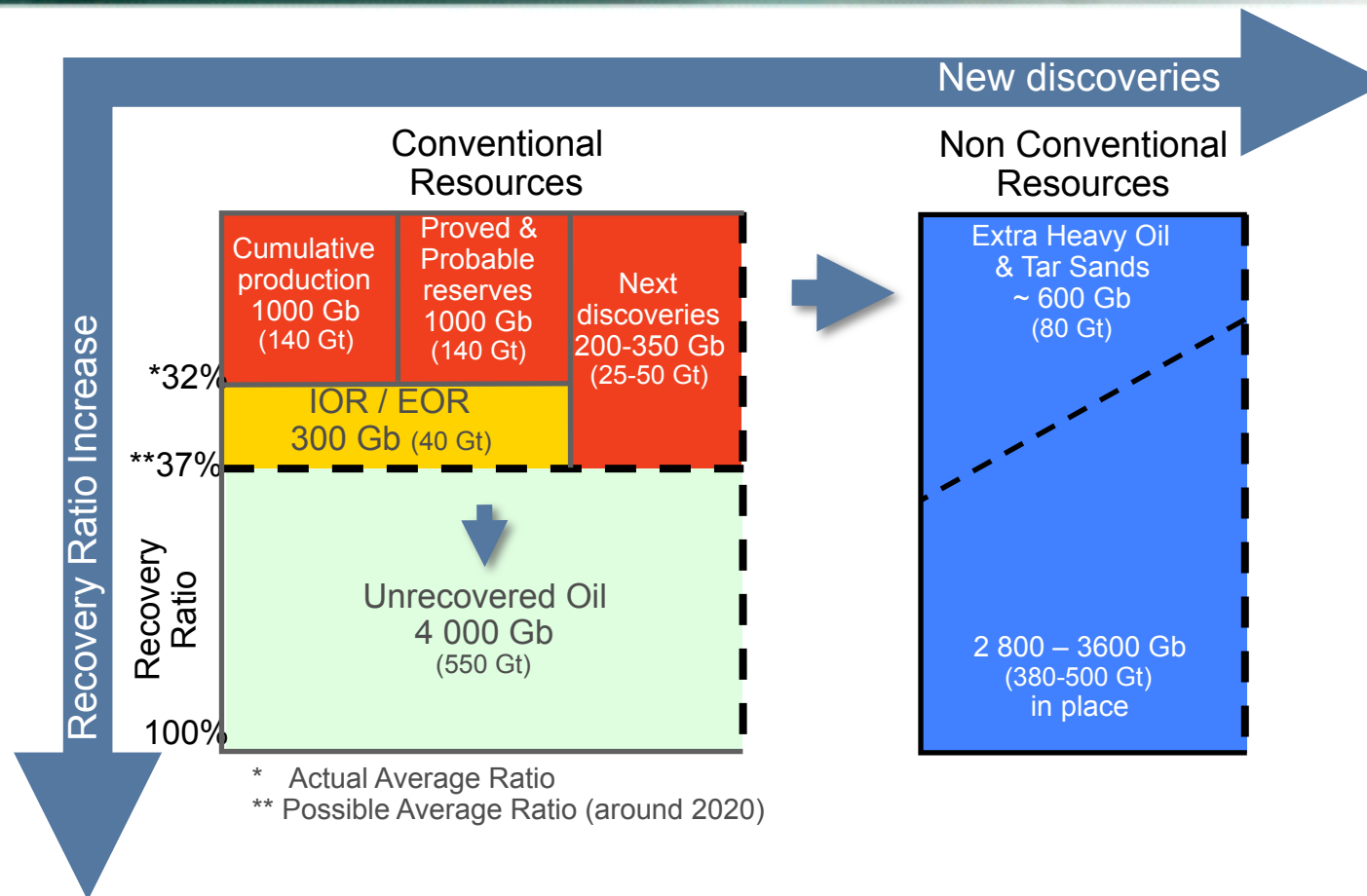
- size of average discovery : constant since 1980

History of important discoveries in the world

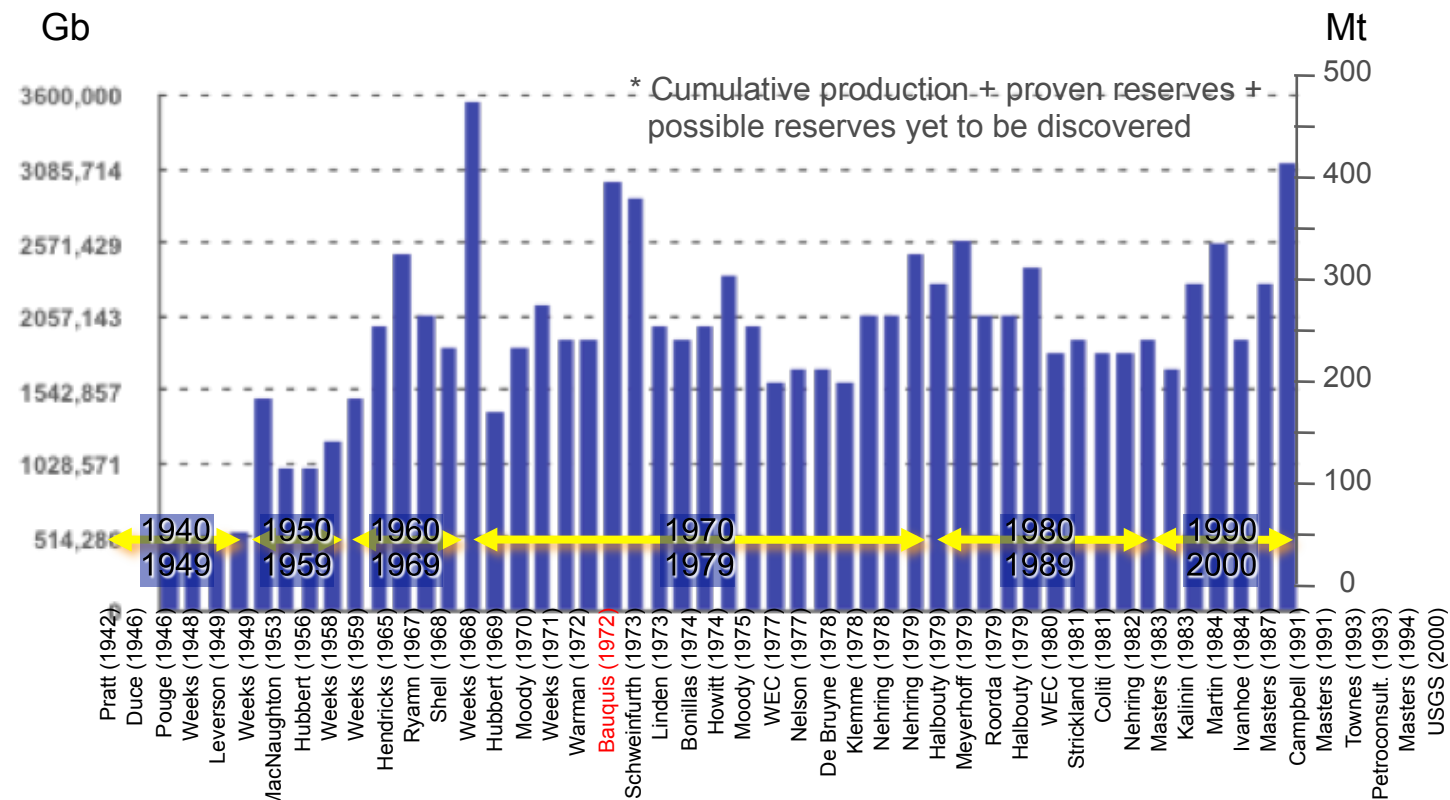
A few figures illustrating Peak Oil and Peak Gas

Size	Number of Discoveries			
Mboe	1960s	1970s	1980s	1990s
50 - 100	235	261	300	314
100 - 200	105	162	113	90
200 - 500	179	208	170	154
500 - 1000	90	95	66	52
+1000	129	116	90	20

Oil resources (Gt)

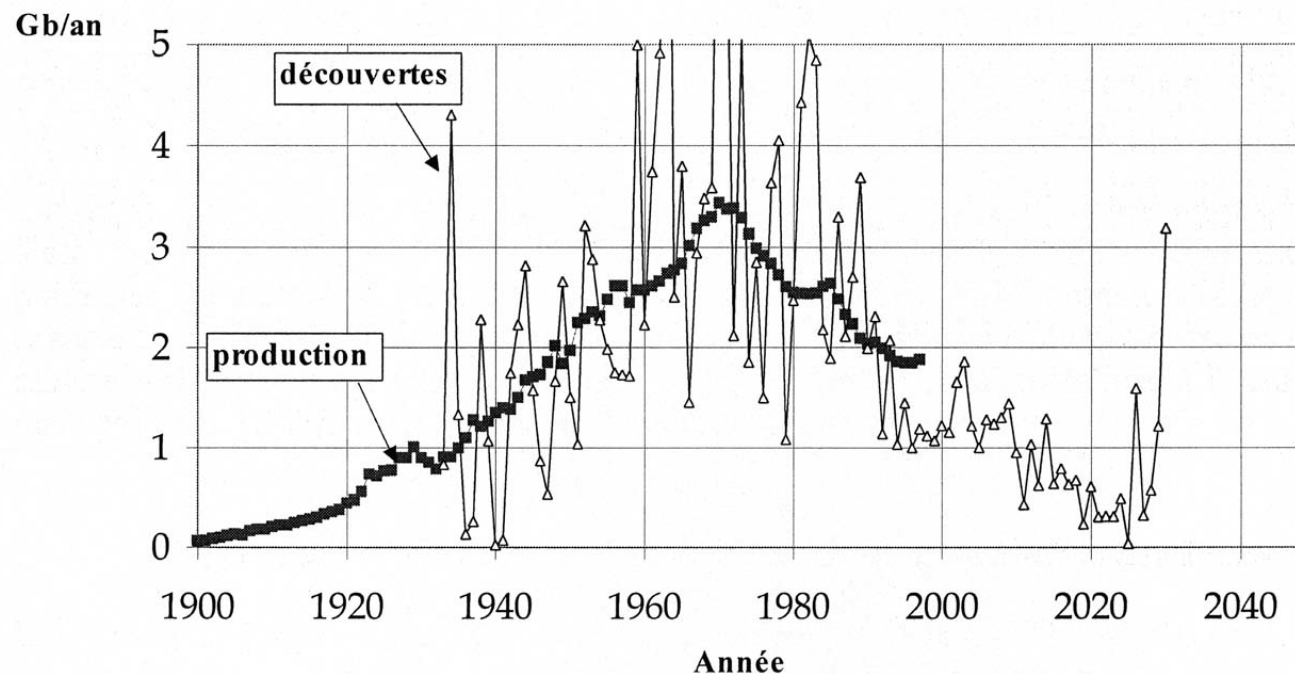


Historical views on ultimate reserves



The irreversible decline of oil productions in the USA

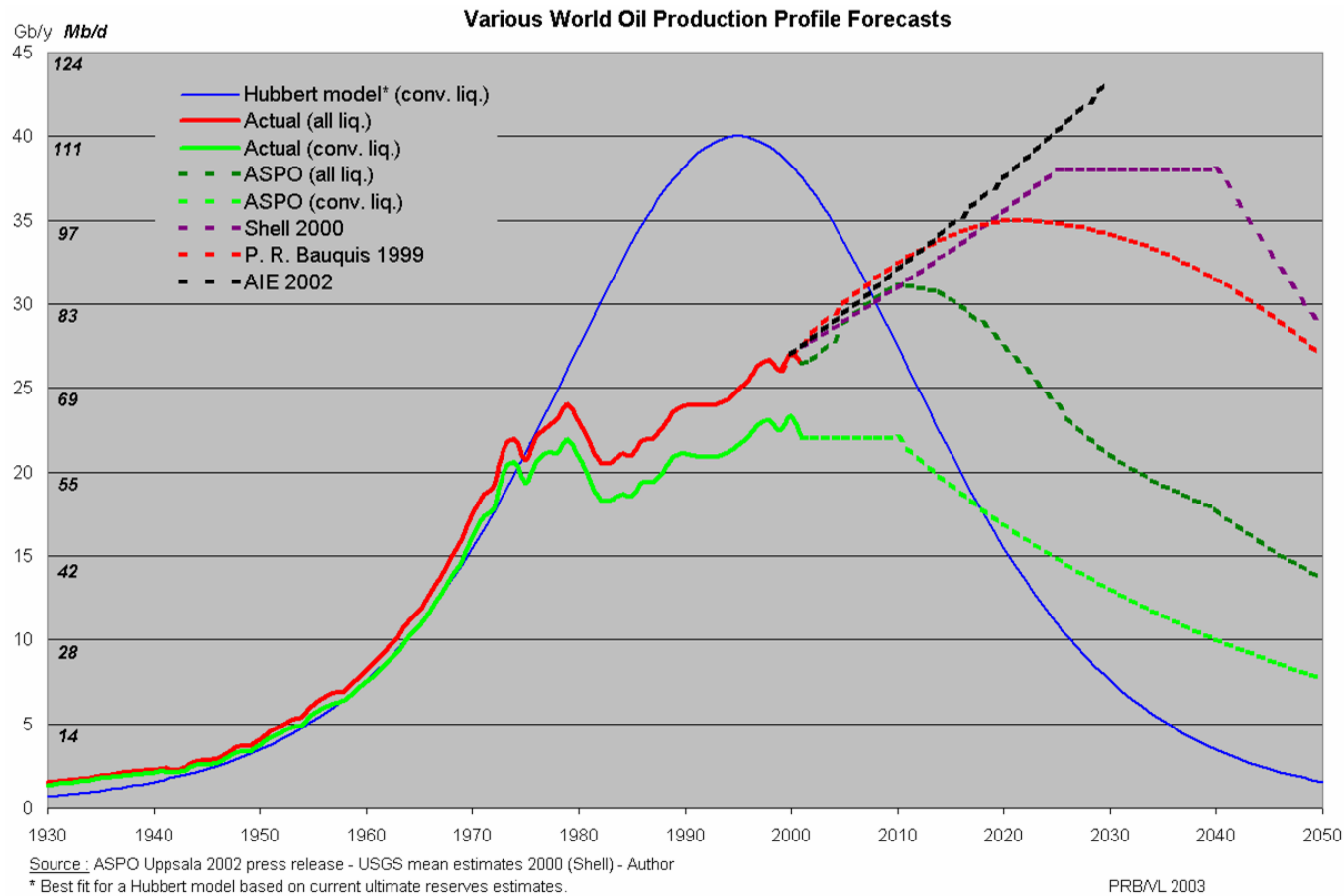
Peak oil is not a theory: it's a fact...



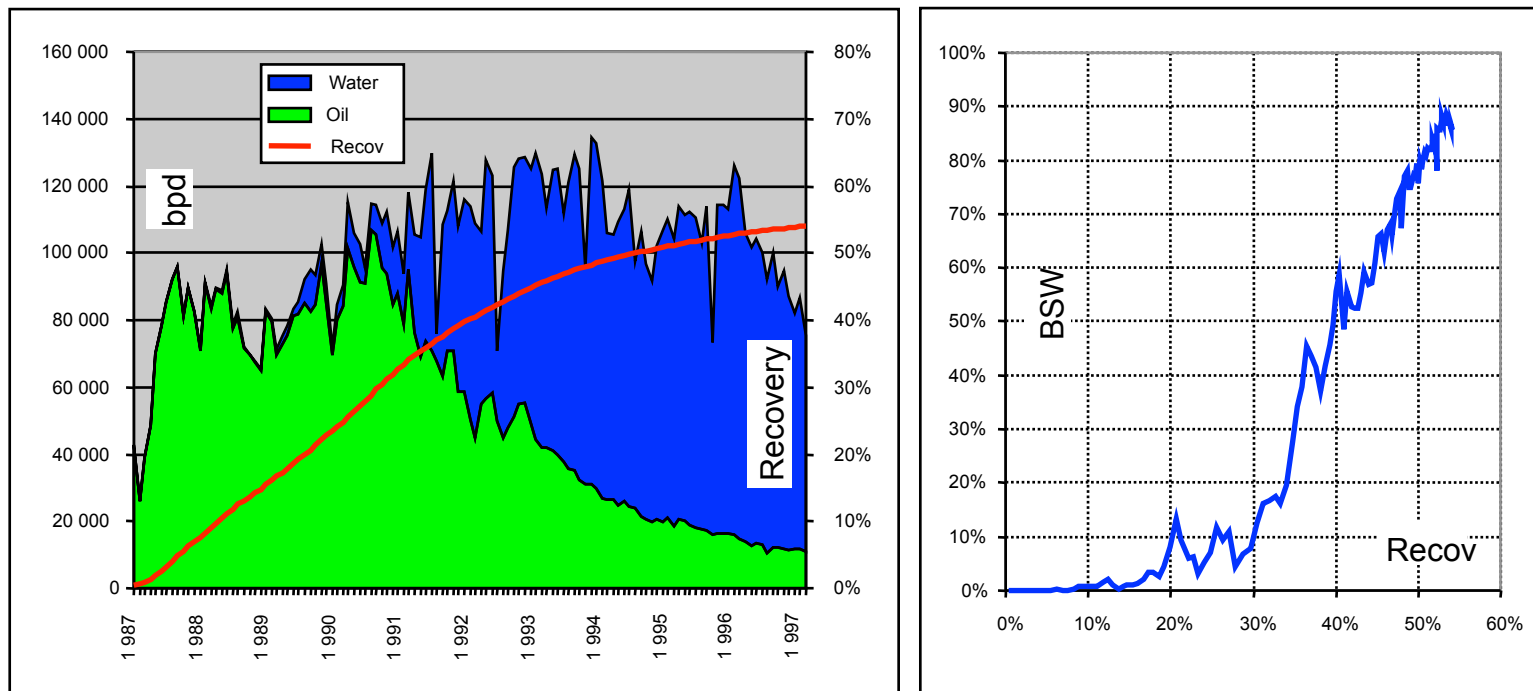
(*) Discoveries are registered as per their initially declared sizes and their timing is « forwarded » by 33 years

Source : King Hubbert 1956 - Updated by Jean Laherrere

Various World Oil Profile Forecasts



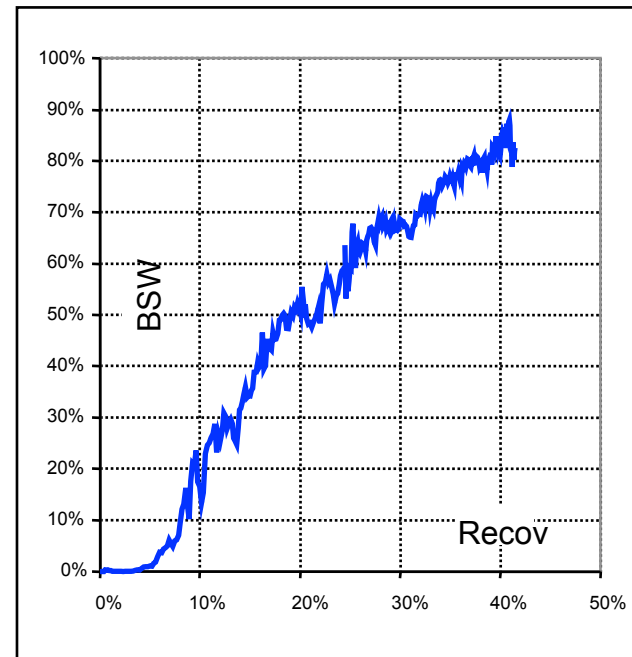
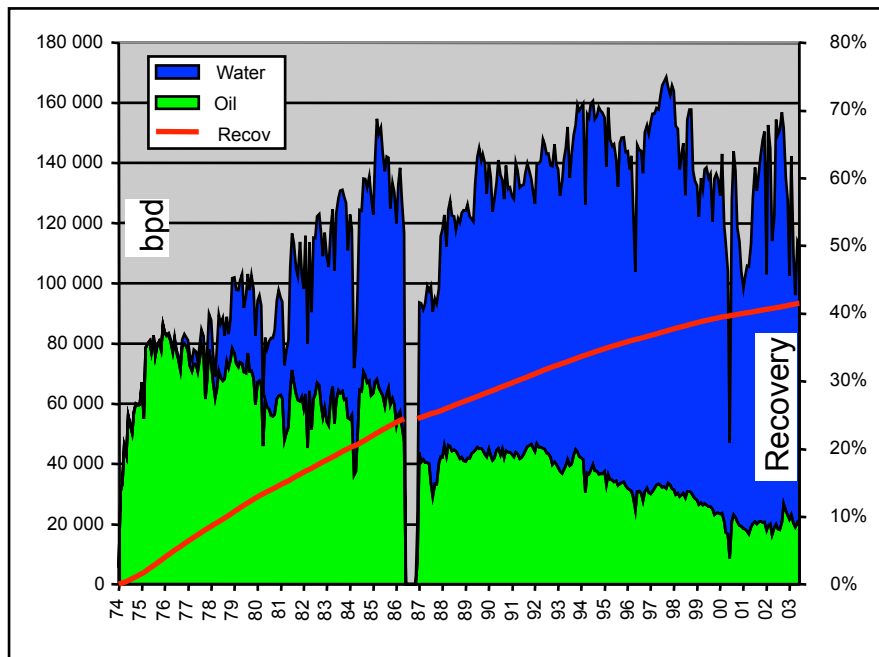
Production profiles liquids: North Sea clastics



Source GSR Total P.Carpentier et al

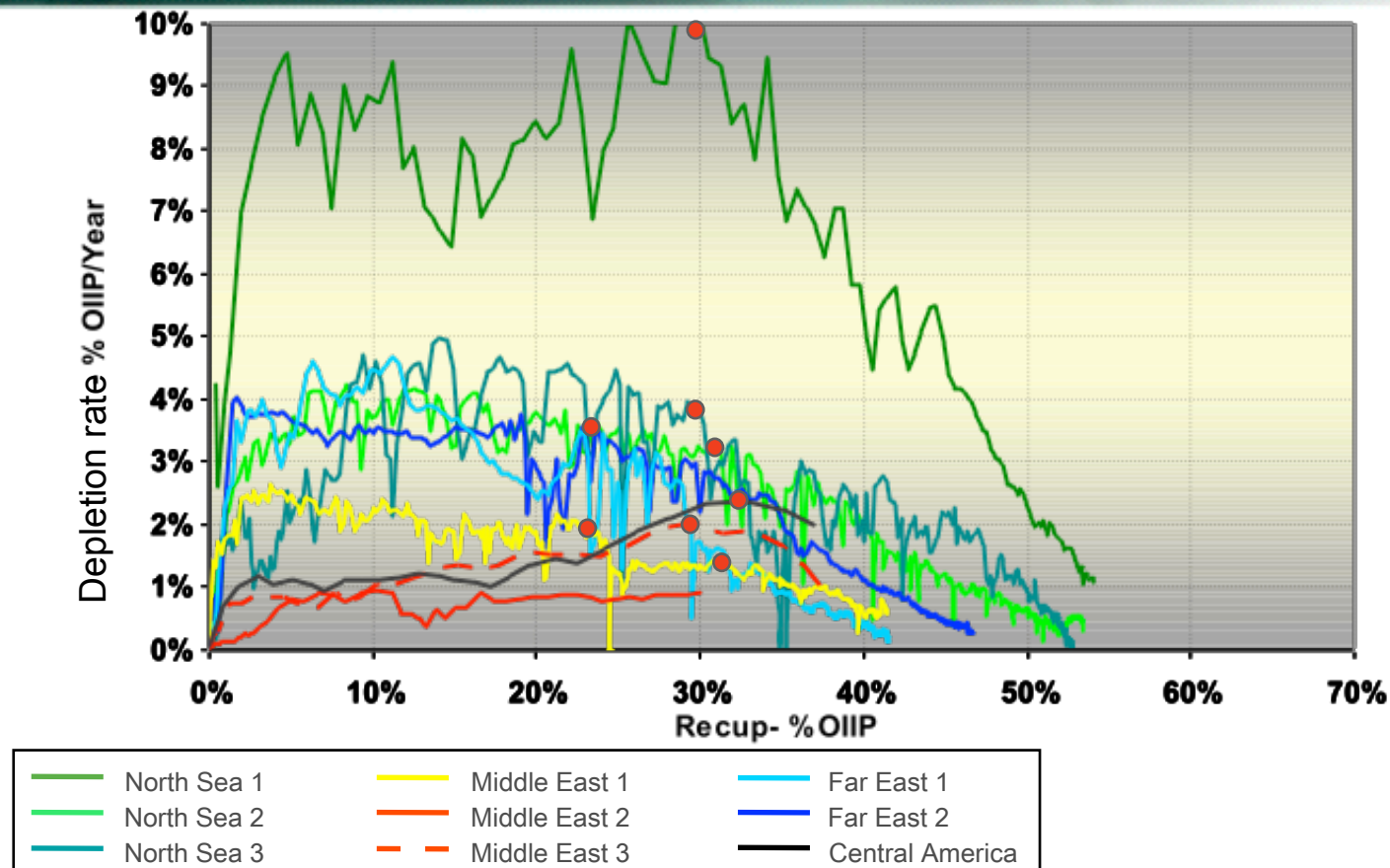


Production profiles liquids: Middle East carbonates

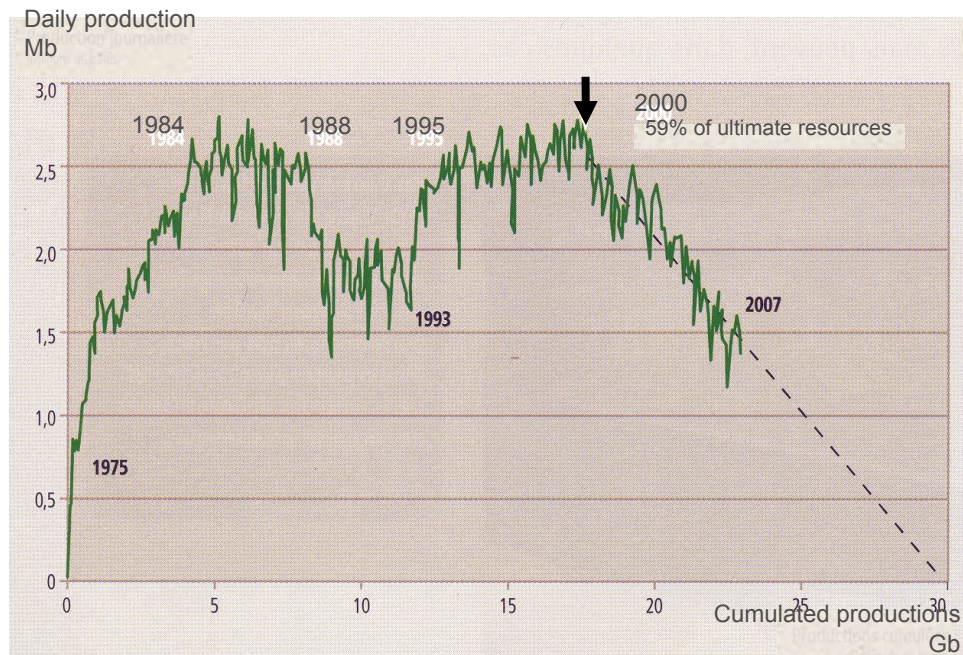


Source GSR Total P.Carpentier et al

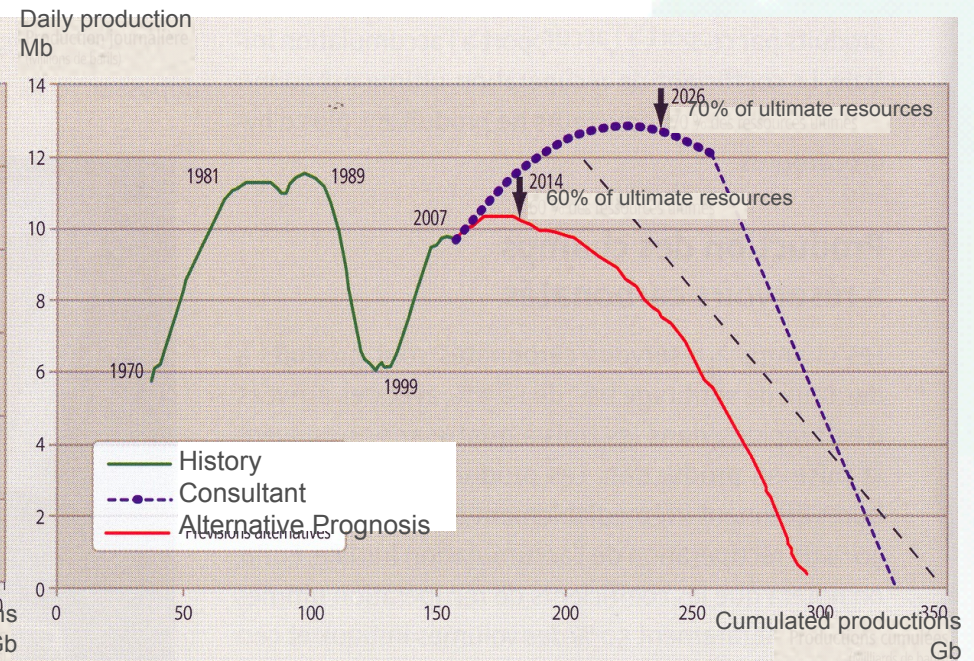
Depletion rate versus recovery factors for various type of oil fields



Foreseeable drop in productions

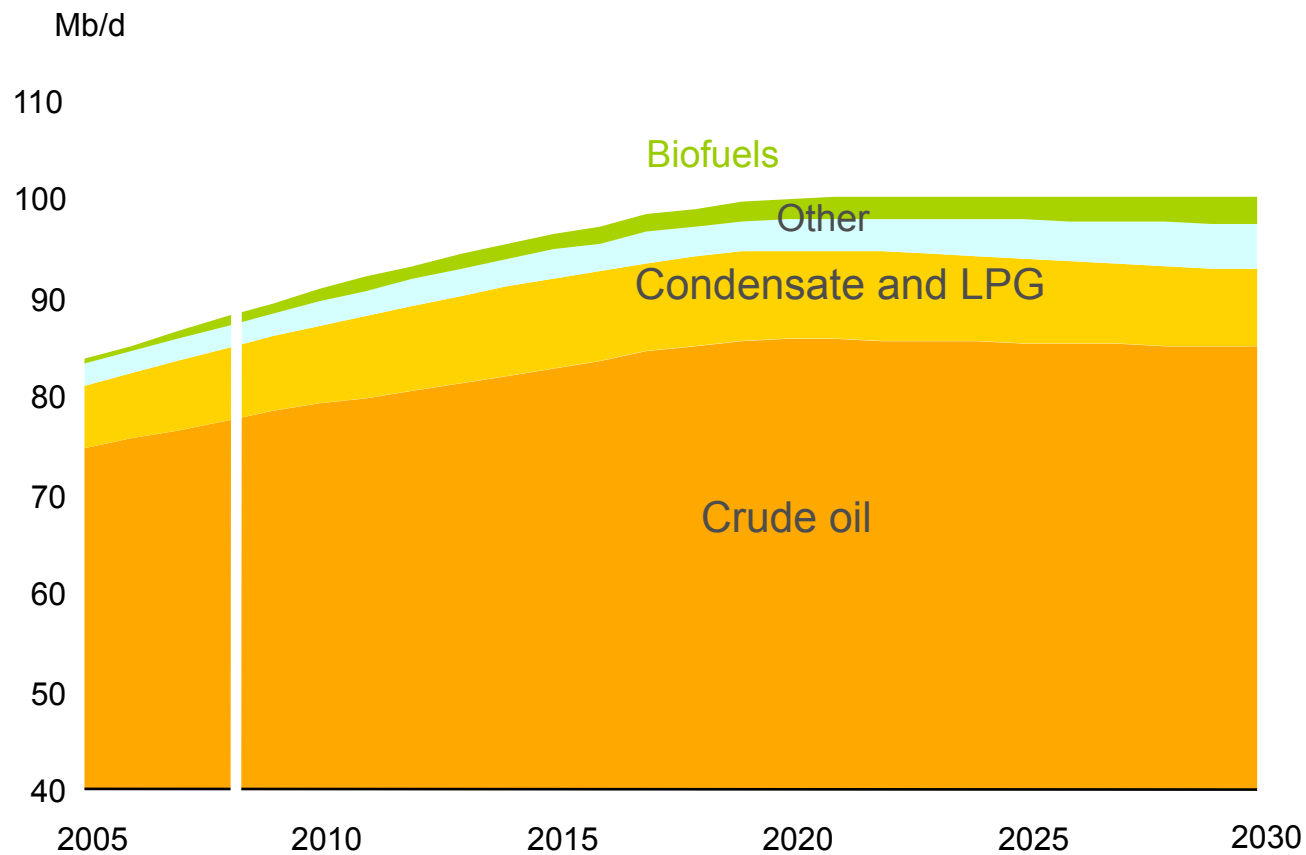


UK



Russia

The 2009 « TOTAL view » of future World Petroleum Production



Summary of opinions about "peak oil"

- Since June 2006 it can be considered that views about Peak Oil in France have become reasonably similar : it is a production problem (fluids and reservoir)
 - TOTAL : Thierry Desmarest – around 2020 / around 100 Mb/d
 - ASPO France : J. Laherrère – around 2015 / less than 100 Mb/d
 - P.R. Bauquis – around 2020 / around 100 Mb/d
 - IFP : Y. Mathieu – ondulated plateau 2015/2030 – less than 100 Mb/d
- This point of view is widely different from those who believe that Peak Oil is only a political problem : insufficient investments and restrictive policies about investments by OPEC countries, Russia and Mexico :
 - Exxon Mobil – June 2006 – "no sign of peak oil"
 - Aramco – June 2006 - "no reserve problem"
 - ENI (Maugeri – Early 2006 - "no foreseeable oil peak"
 - BP : John Browne – May 2006 - "There is no reserves problem"
 - Mike Lynch (ex MIT) – "similar and above 120 Mb/d"
 - CERA (Cambridge Energy Research Associates) – 2007 study "Denying peak-oil"
 - USGS, DOE, EIA, IEA...
- IEA started changing their views in 2006 and accentuated this change in 2007 :
they now seem to realize that peak oil is not only a political or "above ground" problem but also a geological one.

Summary of opinions about "peak oil"

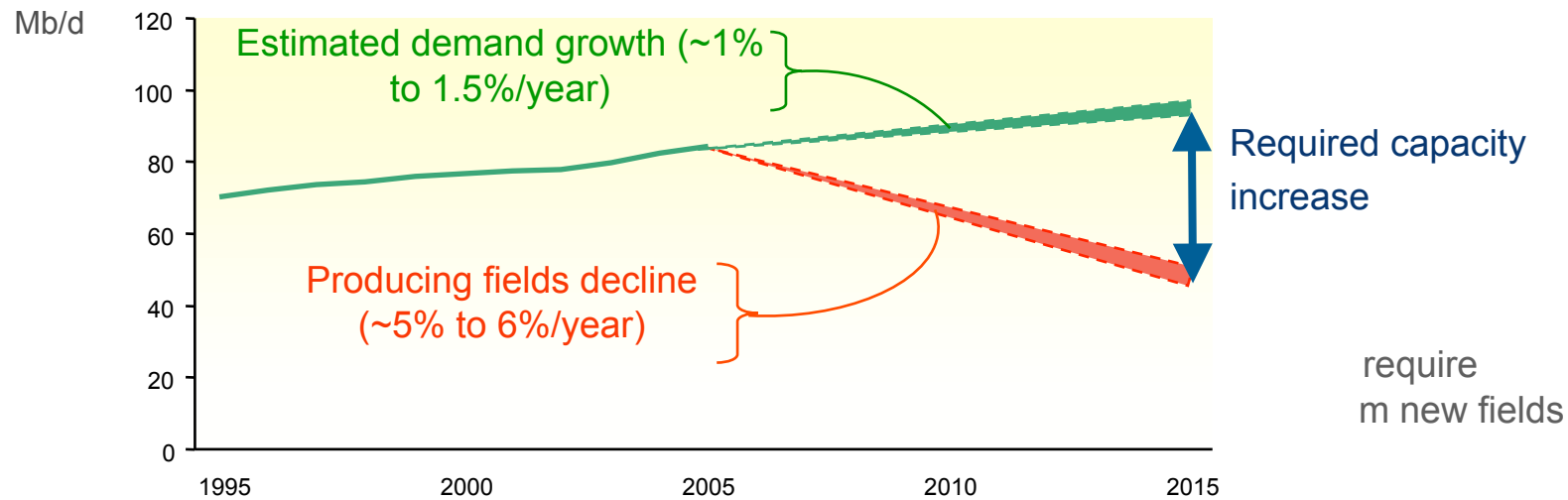
- ▶ Oil and gas will still be produced beyond the end of the 21st century
- ▶ However the oil production peak (between 2015 and 2025, most probably) and gas production peak will trigger radical changes
- ▶ Paradoxically, it will be the oil and gas industries golden age (high prices, little political interference in those prices).
- ▶ After the oil peak, oil and gas prices will see a change of logic: they will become related to those of their substitutes (reversal from the past).
- ▶ As soon as world oil production starts declining, OPEC will lose its price-policing role but could keep other roles.



The production capacity challenge

World oil production

Mb/d = Million barrels per day



- Geopolitical constraints or local troubles in producing countries

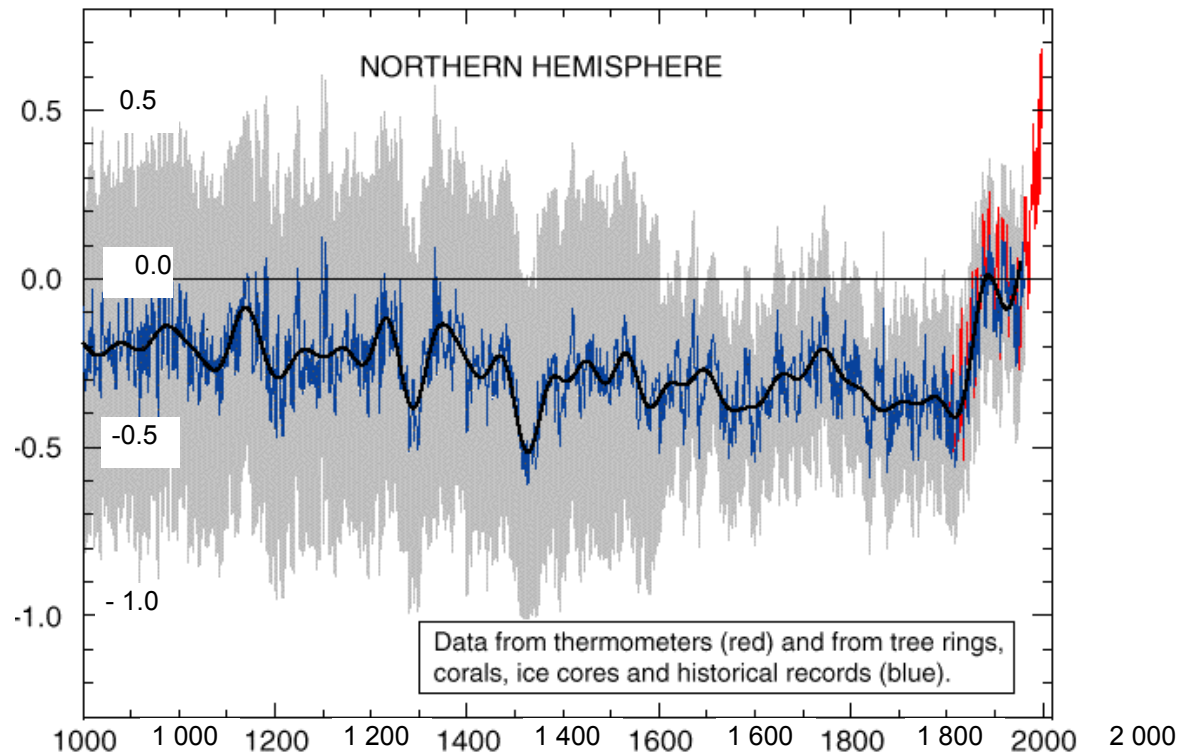
What energy future after world oil production peak?

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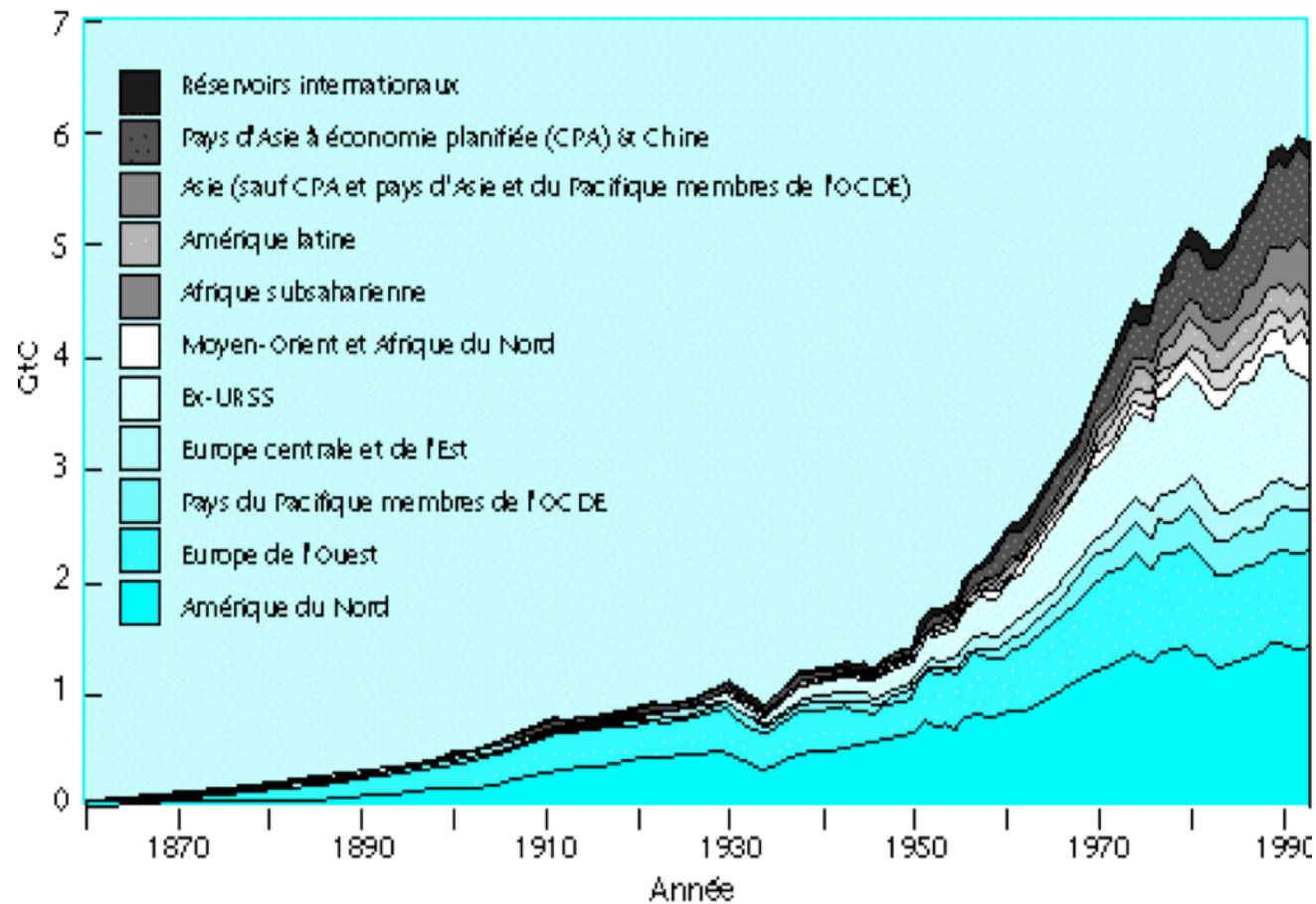
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Climate change: the earth's evolving temperature

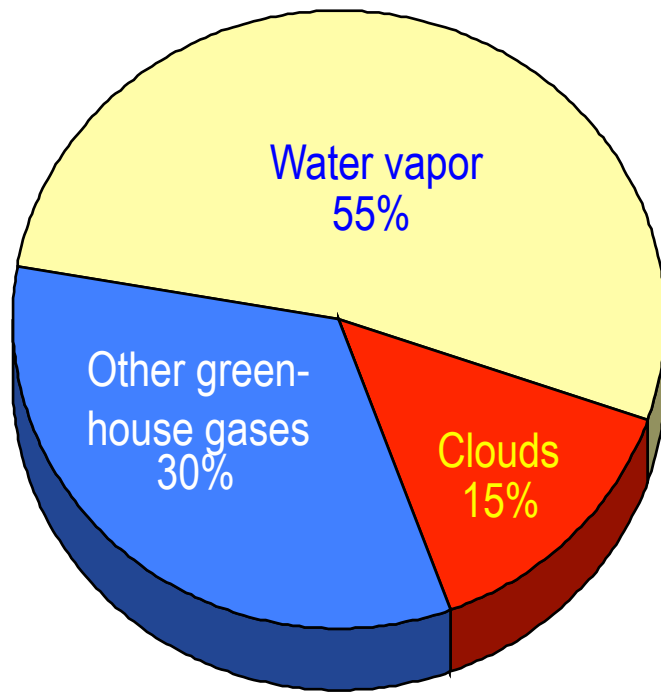
- ▀ Variation in global temperatures over 1000 years (in °C)
The zero reference is the period 1961-1990



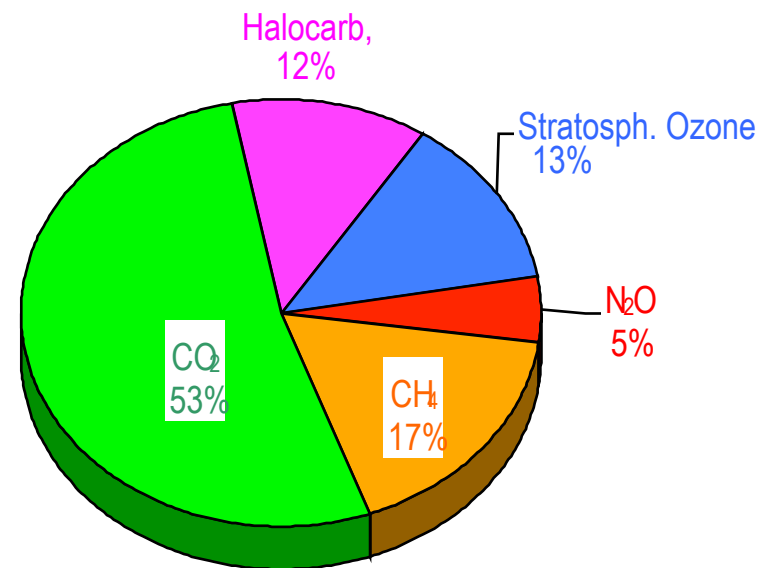
Anthropic emissions of carbon dioxide



Atmospheric contributions to greenhouse effect



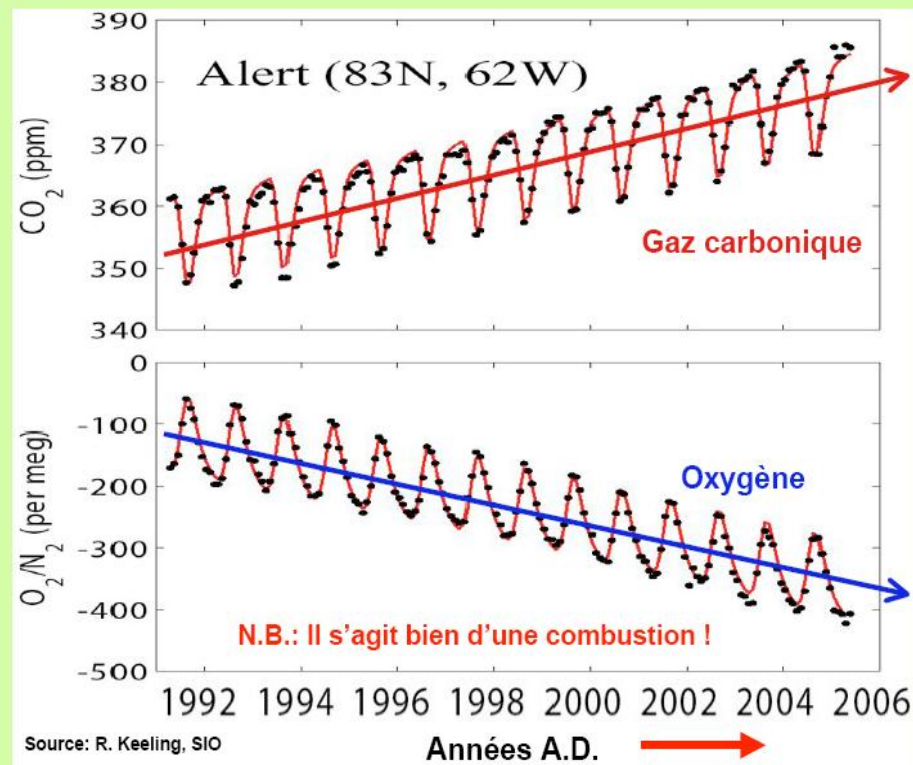
Natural
(155 W/m²)



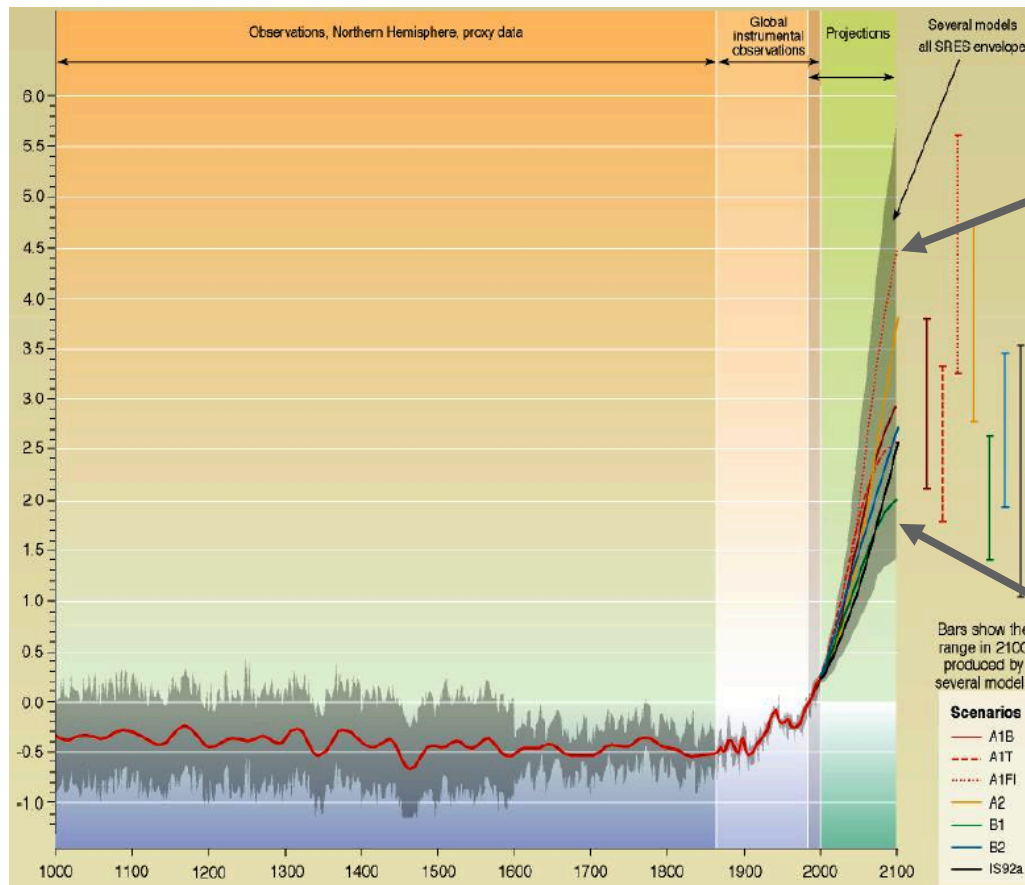
Anthropogenic
(2.8 W/m²)

Human activities modify greenhouse effect

Les activités humaines actuelles perturbent l'effet de serre



Projections are heavily scenario-dependant



10 billion humans raise their average emissions to those of a Pole of 2000

World emissions remain constant

For those who do not believe in
Science...



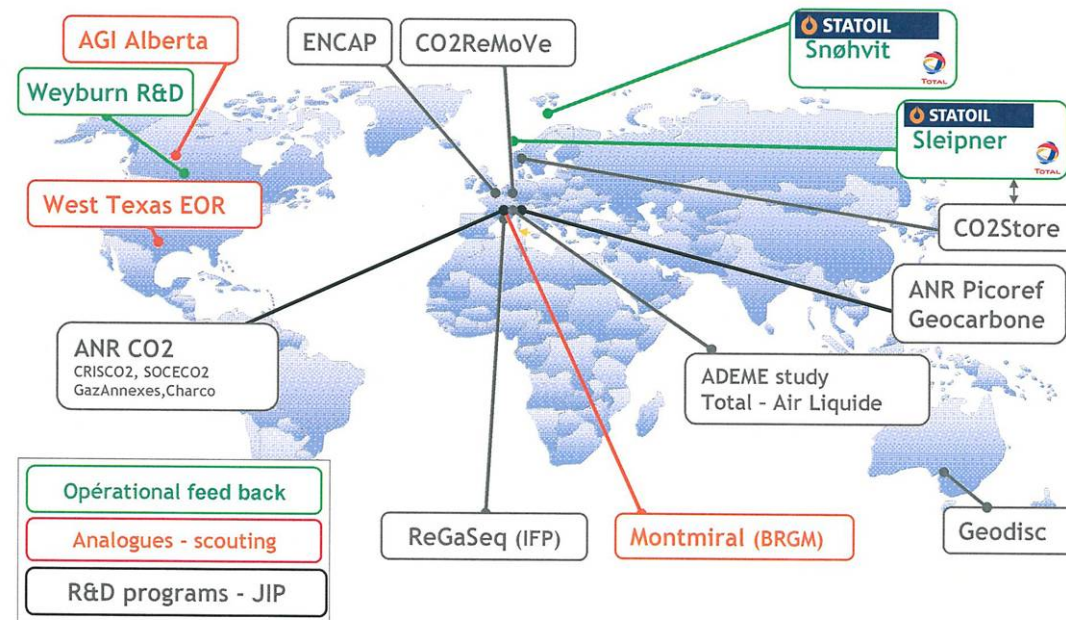
Climate change: what can an oil company do about it ?

- ▶ Promote a better understanding of climate change mechanisms and use it's industrial competences to develop potential solutions
- ▶ Better control greenhouse gas emissions from it's own facilities
- ▶ Help its clients to manage their greenhouse gas emissions
- ▶ Promote alternatives: renewable energies non CO₂ or low CO₂ emitting and nuclear energy
- ▶ Imagine and validate efficient and reliable solutions to capture and store CO₂ (Lacq Pilot scheme and others)
 - ... while continuing to meet the world's energy demand (deep offshore, unconventional oil, mature fields, LNG...)



Capture and Storage of CO₂

- ▀ Dedicated CCS program and partnership since 2001
 - Capture technology development:
IPCC – 20-40% of world CO₂ emissions by 2050
 - CO₂ injection and storage
 - Storage integrity
 - Well integrity
 - Long term fate of CO₂
 - P&R, monitoring

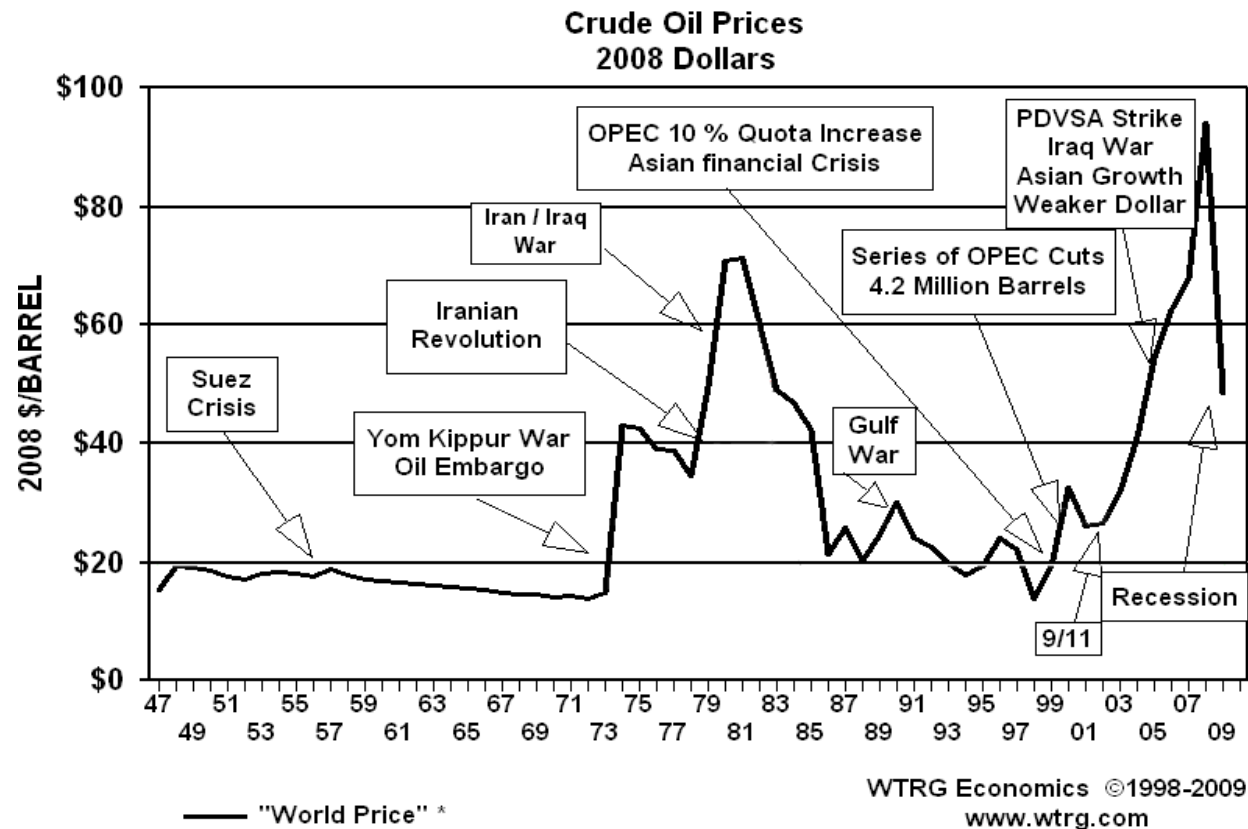


What energy future after world oil production peak?

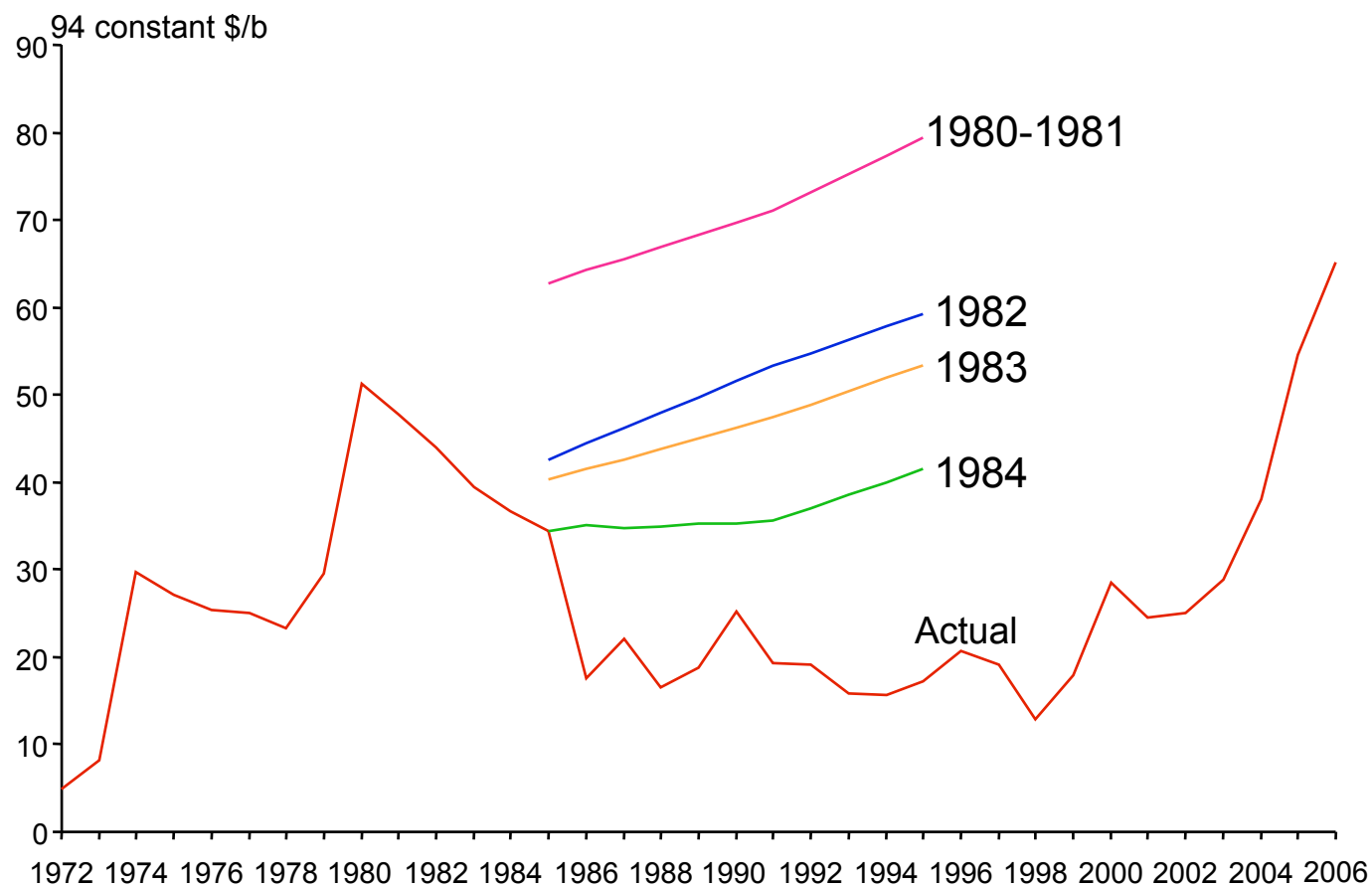
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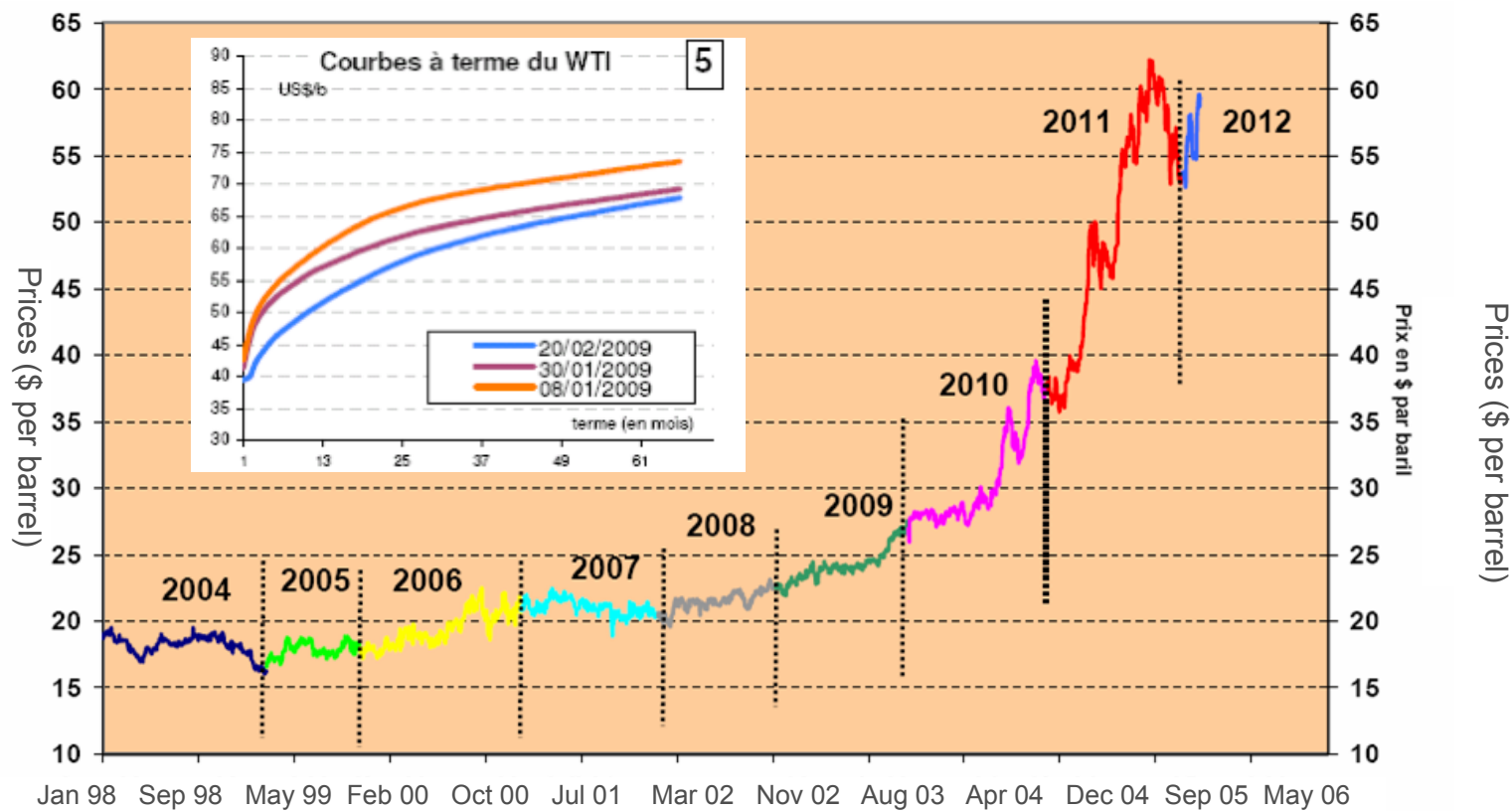
Crude oil price and crisis



Brent price evolution forecasts



Long-term West Texas Int. barrels (NYMEX) : 6-year futures market, New York



What is driving oil prices ?

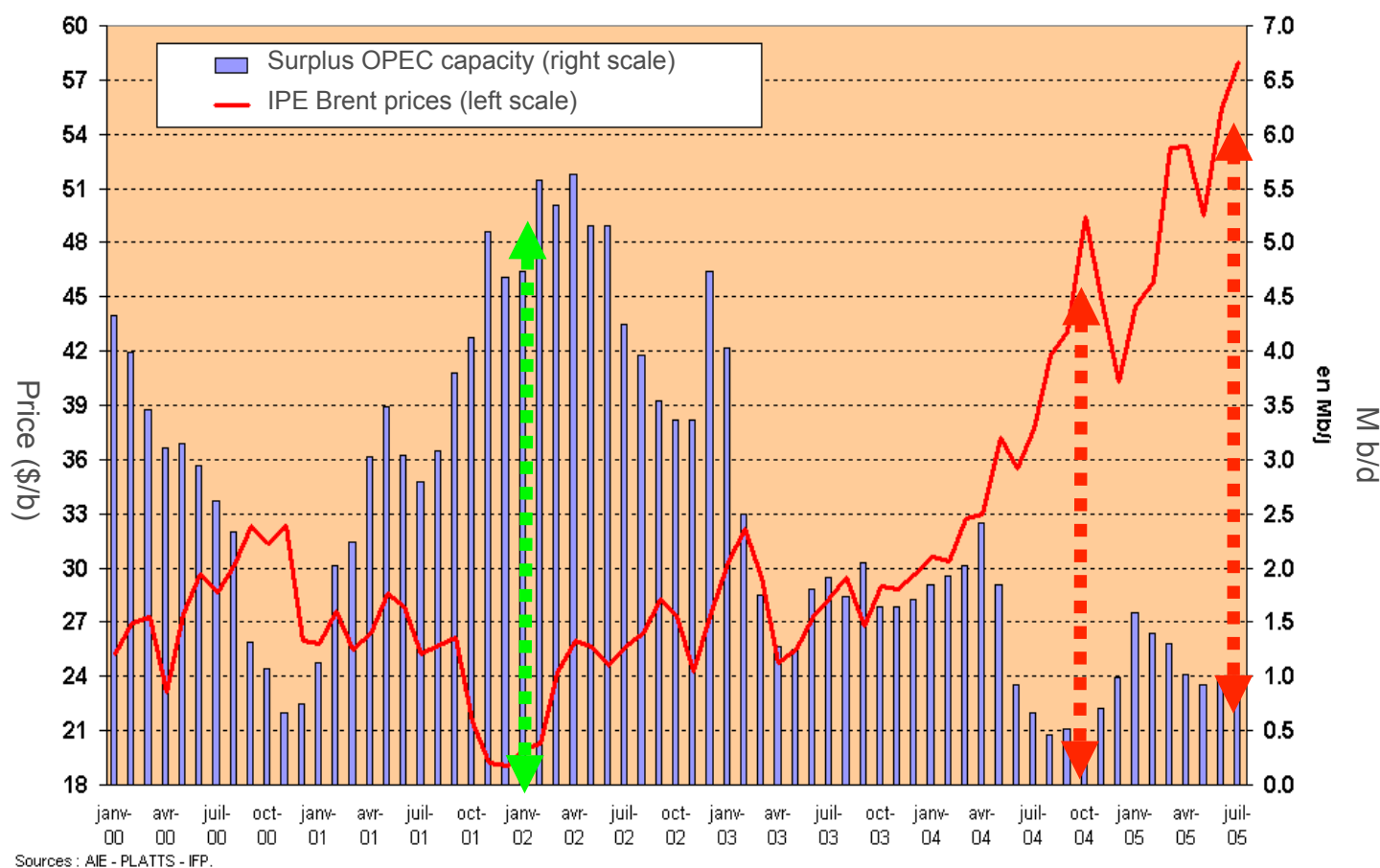
It depends upon which newspaper you read...

- Financial press → stocks, stocks market anticipations...
- Economic press → investment, economic growth,....
- Green/red press → speculation, speculation, greed....

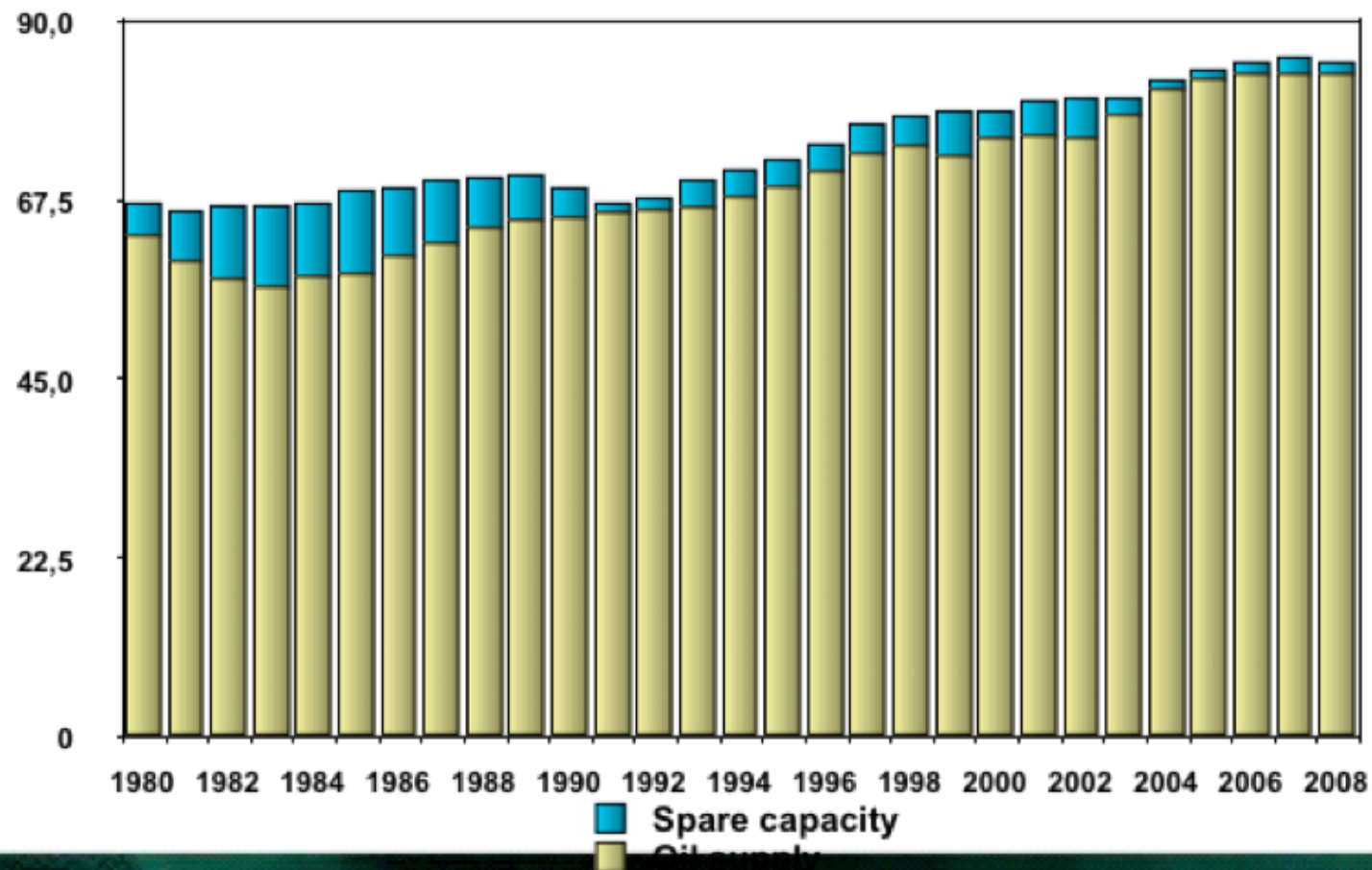
All these explanations are very partially relevant:
world unused surplus capacity is the Key factor



The price impact of OPEC surplus production capacity

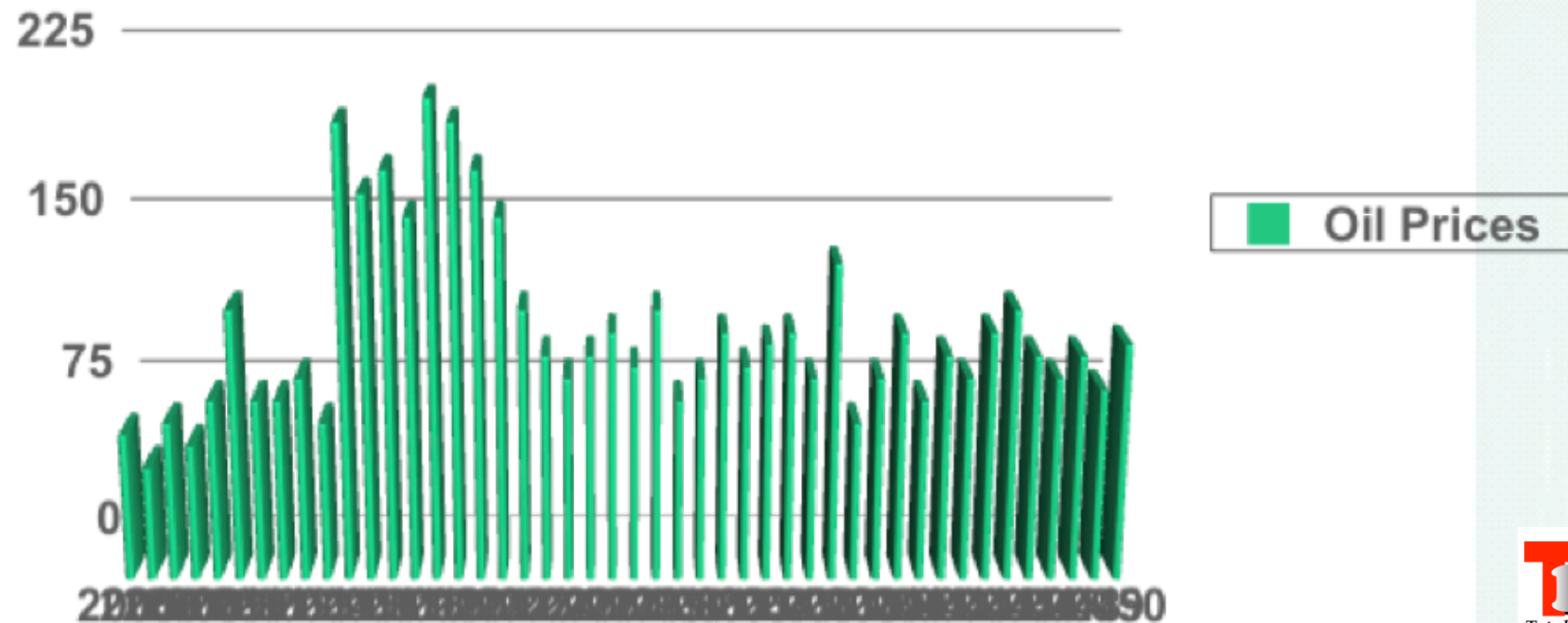


World excess production capacities: 100% within OPEC

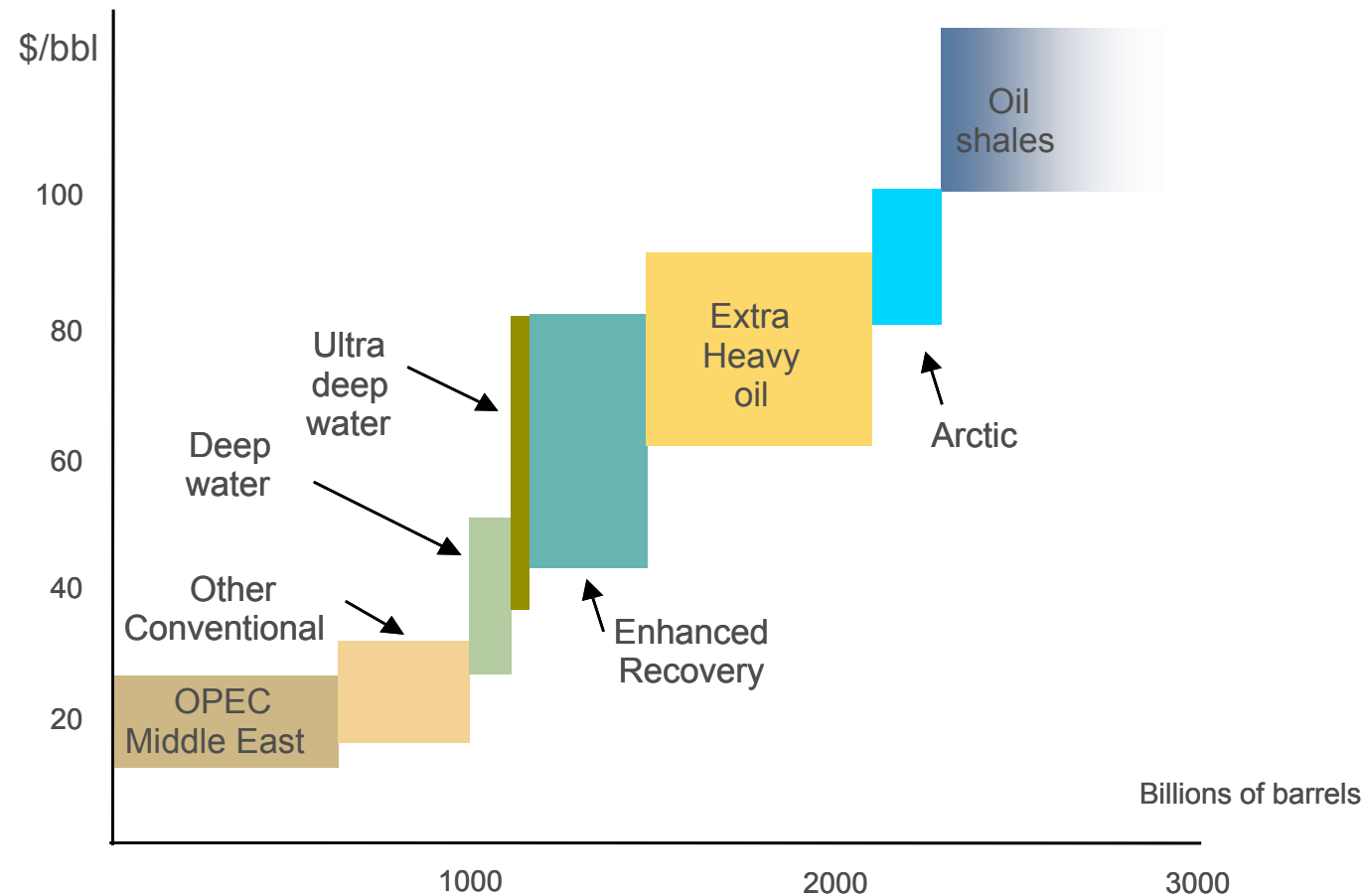


Oil Prices 2005 – 2050 (Arabian Light in US \$ 2000/bbl)

300 A dream view presented in Cambridge by P.R. B on 15/03/06



Production costs are increasing... ... necessitating a relatively high oil



Key considerations about future oil and energy prices

- ▶ High oil prices are a favourable factor:
 - To ensure stability and economic growth of oil producers
 - To ensure energy conservation of oil importers
 - To ensure development of energy substitutes (Renewable and Nuclear)
 - To ensure development of “High Tech.” costly oil.
- ▶ High oil prices means around 100 \$ bbl in US 2000 \$ (order of magnitude)
- ▶ However before prices could stabilize in this price range a new oil shock with temporary very high prices (200 to 400 \$ / bbl) is a likely scenario

What energy future after world oil production peak?

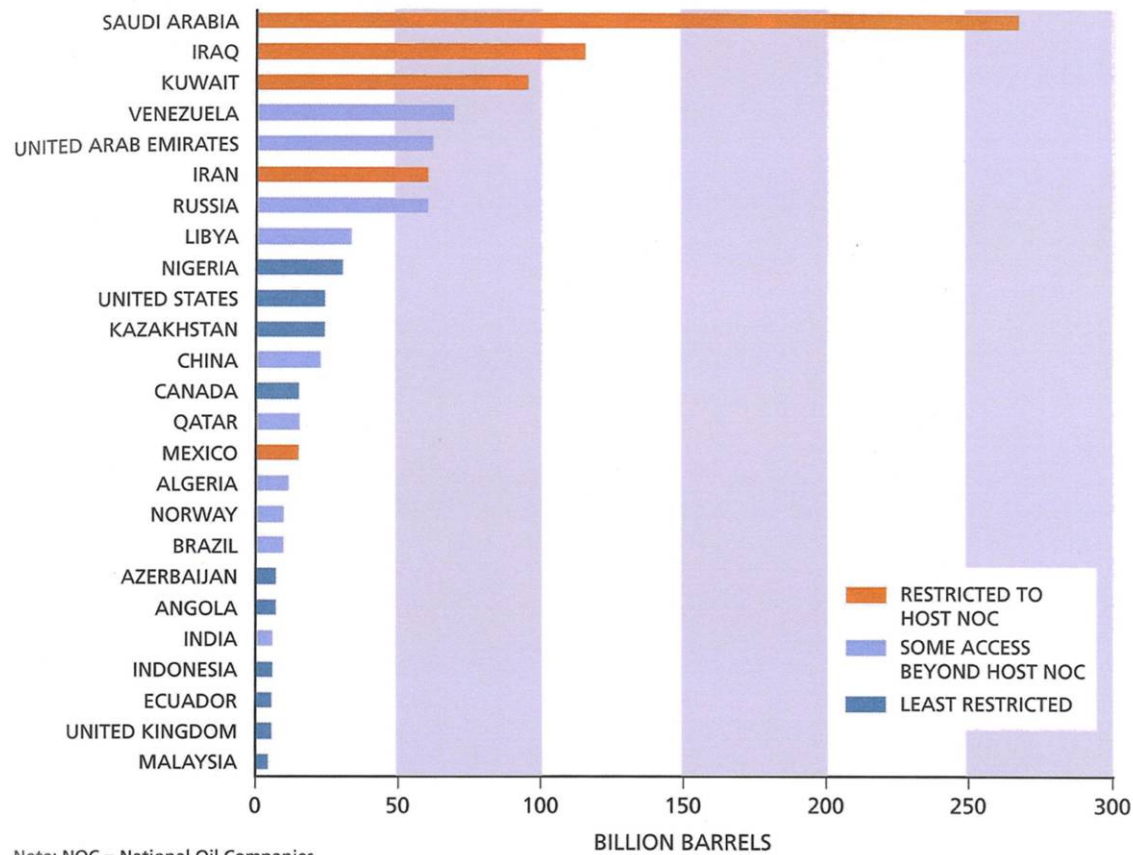
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The 4 main drivers for oil industry structural changes

- geopolitics
- Peak oil and Peak gas
- Carbon emission costs (climate issue)
- The financial/economic crisis

Geopolitics: Access to Proved reserves

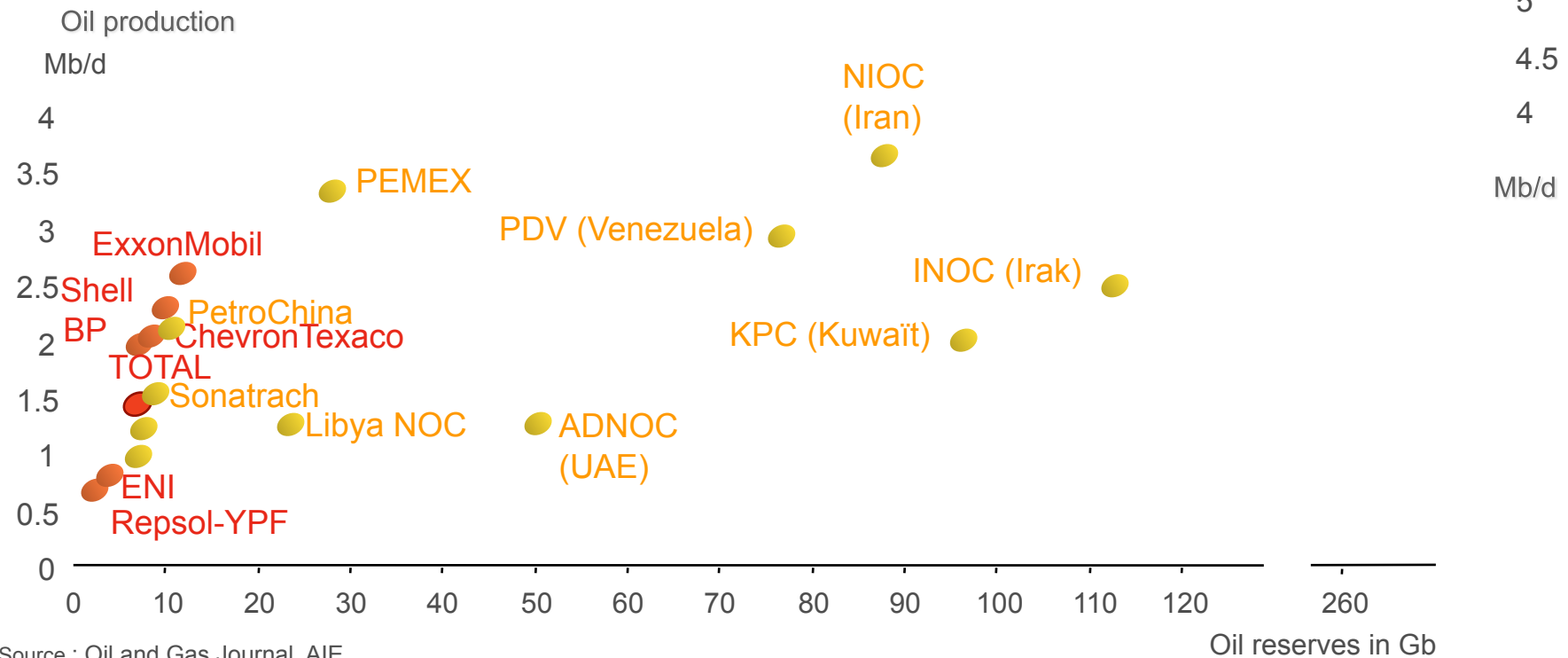


Note: NOC = National Oil Companies.
Source: U.S. Department of Energy.

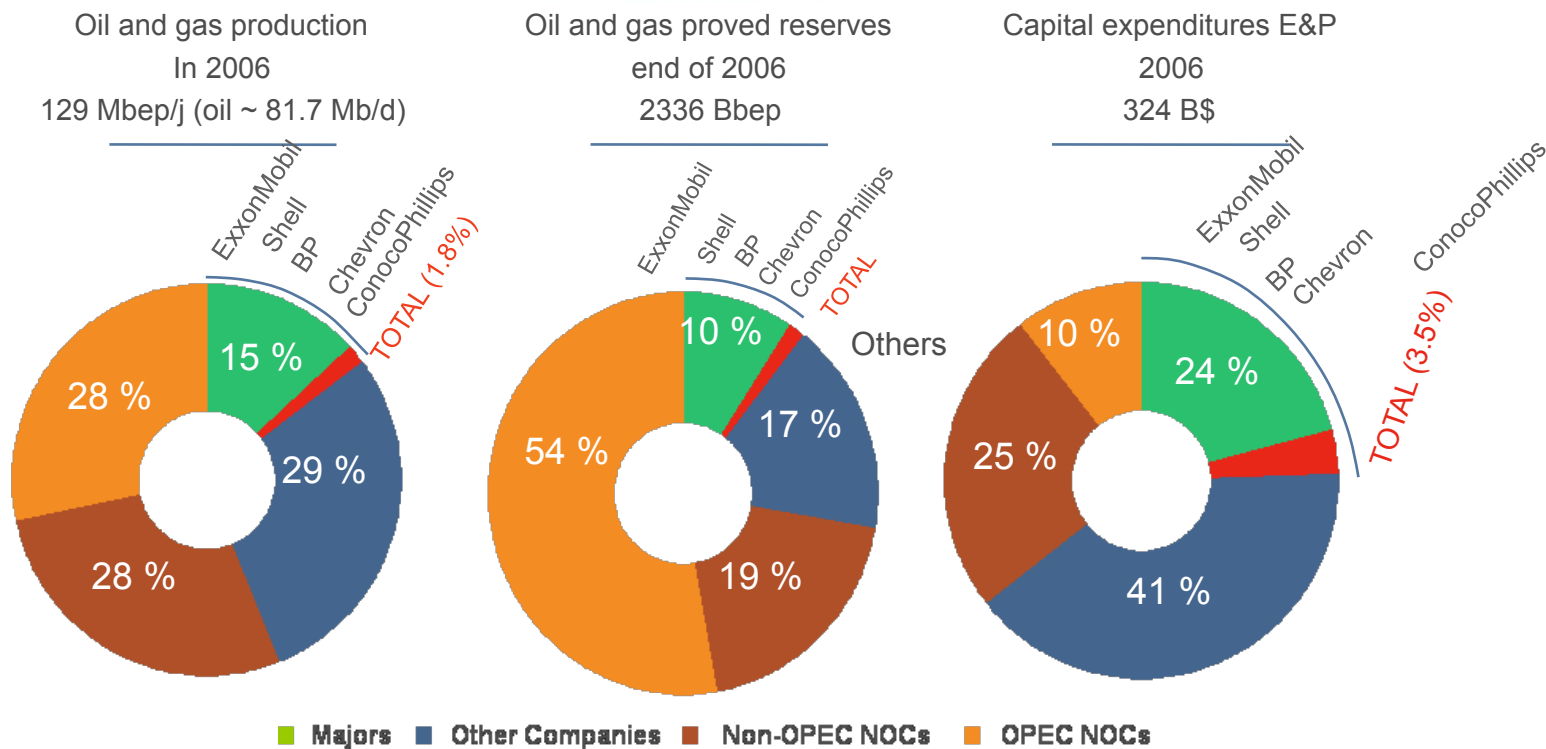
World Oil Players

- International companies
- National companies

Large difference in terms of Reserves /Production ratio



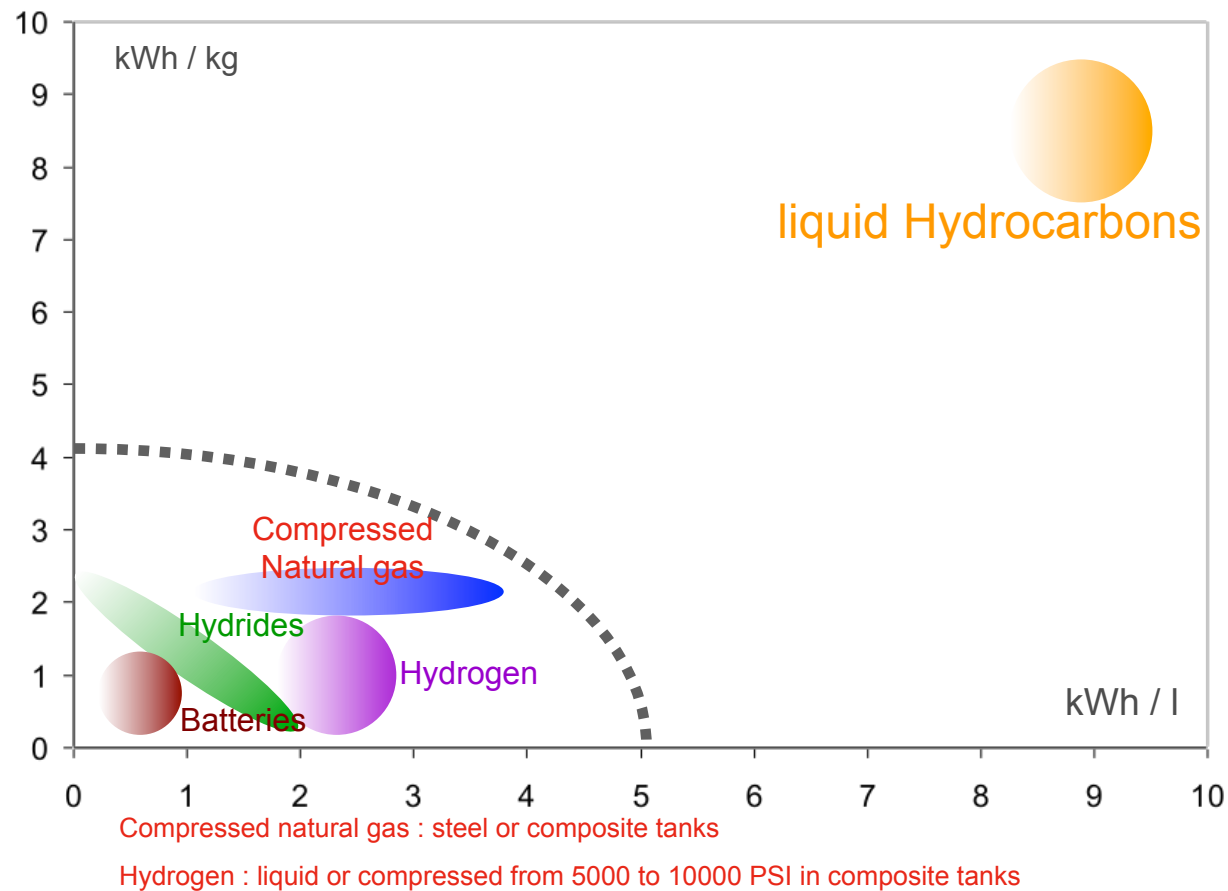
National Oil Companies dominate oil and gas industry



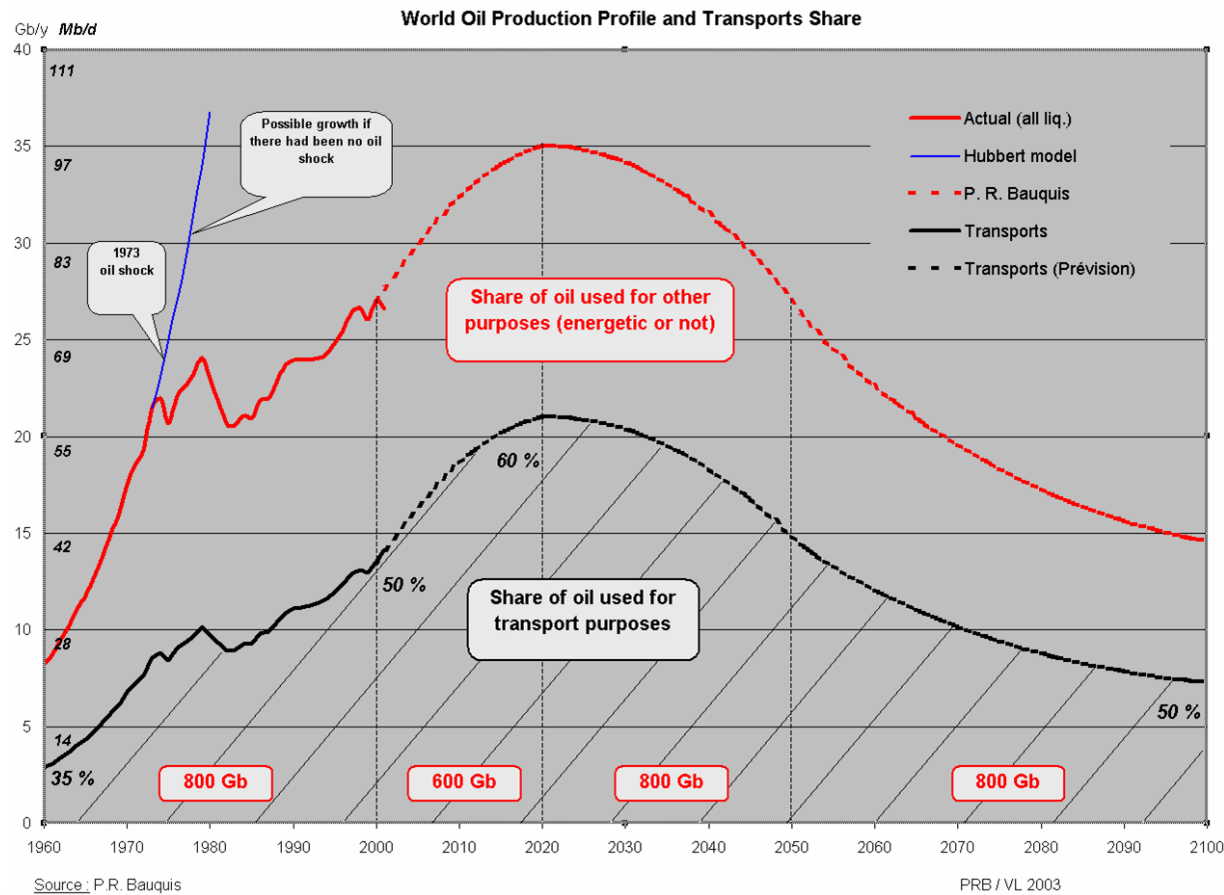
OPEC NOCs: Saudi Aramco, PDVSA, NNPC, QatarPetroleum, Sonatrach, NIOC, ADNOC, NOC, KPC, Pertamina, Sonangol
 Non-OPEC NOCs: PEMEX, Petrochina, Petrobras, Statoil, Sinopec, Petronas, ONGC, Gazprom, CNOOC, CNPC, Ecopetrol, etc.
 Sources: BP Statistical Review, Wood Mackenzie, Total estimates, IFP, Lehman Brothers & Citigroup surveys



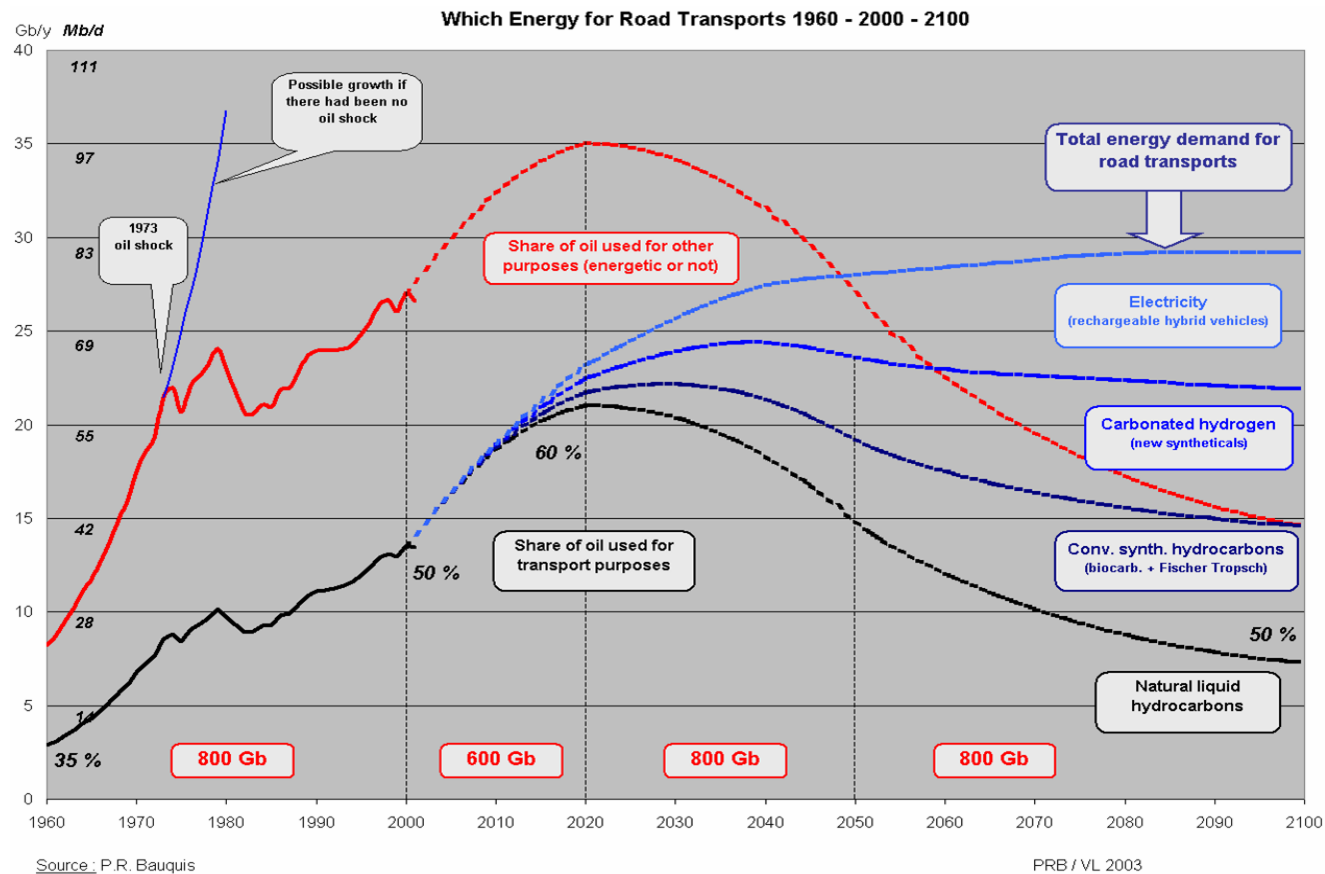
Liquid hydrocarbons: an energy compactness that no other sources can match, neither today nor in the future



World Oil Production Profile and Transports Share



Which Energy for Road Transports 1960 – 2000 - 2100

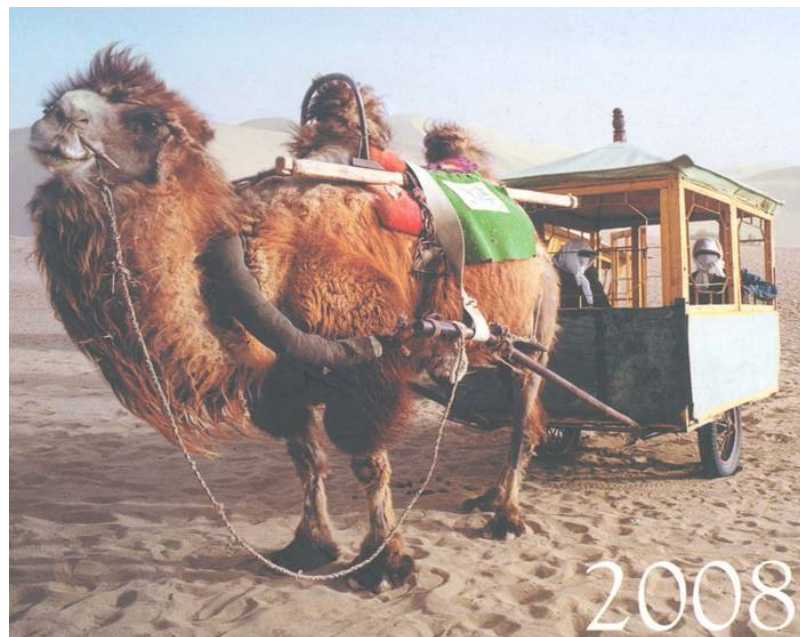


What future for energy: the oil industry in a new world

Primary energy for transport in 2000 and 2100 (in percentages)		
Primary energy sources	2000	2100
Oil	98	25
Biomass	<1	5-10
Nuclear	<1	60
Others	<1	5-10
Total:	100	100

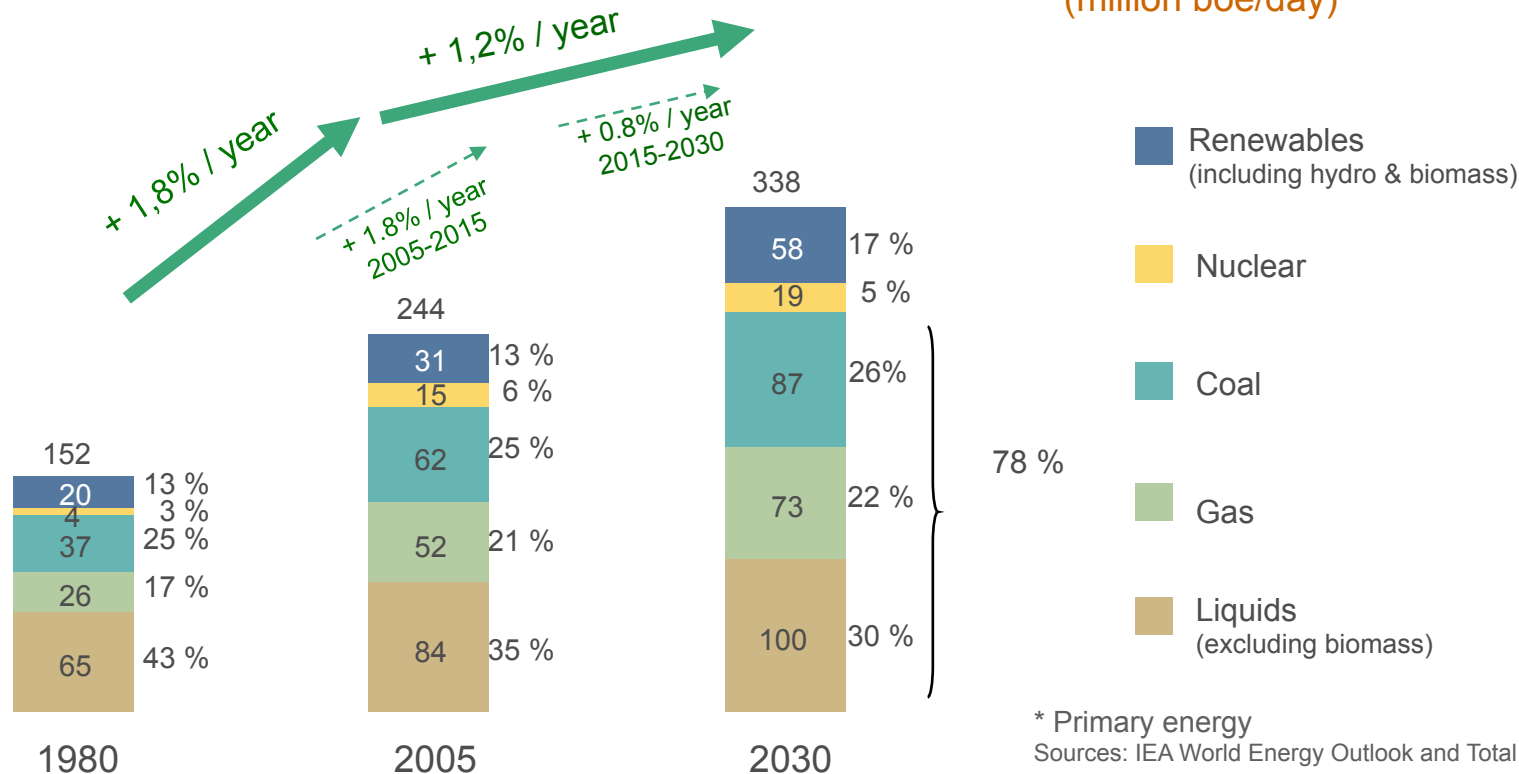
What future for energy: the oil industry in a new world

For the future of automobile, if you believe neither in « peak oil » nor in « climate change », alternative strategies are available....



Still 80% of the energy mix still derived from fossil fuels in 2030

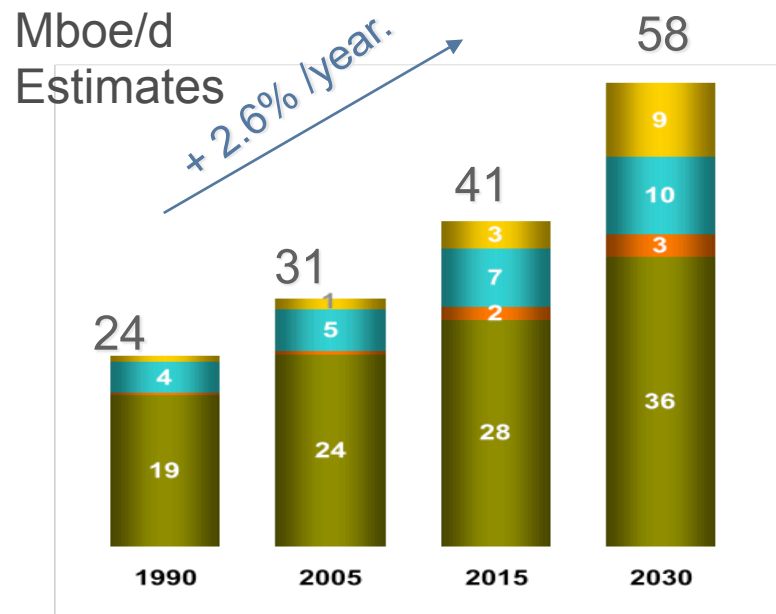
World energy demand*
(million boe/day)



... no easy retreat from strong medicine to sunshine, spring water and meditation.

Renewable energies will grow but not enough

Annual growth 2005 – 2030



- Solar, wind, etc + 8.3 %
- Hydroelectric power + 2.5 %
- Biofuels (incl BtL) + 7.6 %
- Biomass (incl. forest use in developing countries) + 1.7 %



Conclusion: what future of oil industry ?

- ▶ It should be bright for all players: IOC's, NOC's, independants, but also contractors, major Service Cies, specialized Service Cies... not forgetting R and D Institutes and Training Specialists!
- ▶ Twenty years down the road this industry will have been deeply « redesigned » both because of the ressources/production constraints and the climate change issues
- ▶ Like always the most adaptable and the best will not only survive: they will do fascinating jobs and make money!!