Quel avenir pour les énergies fossiles ?

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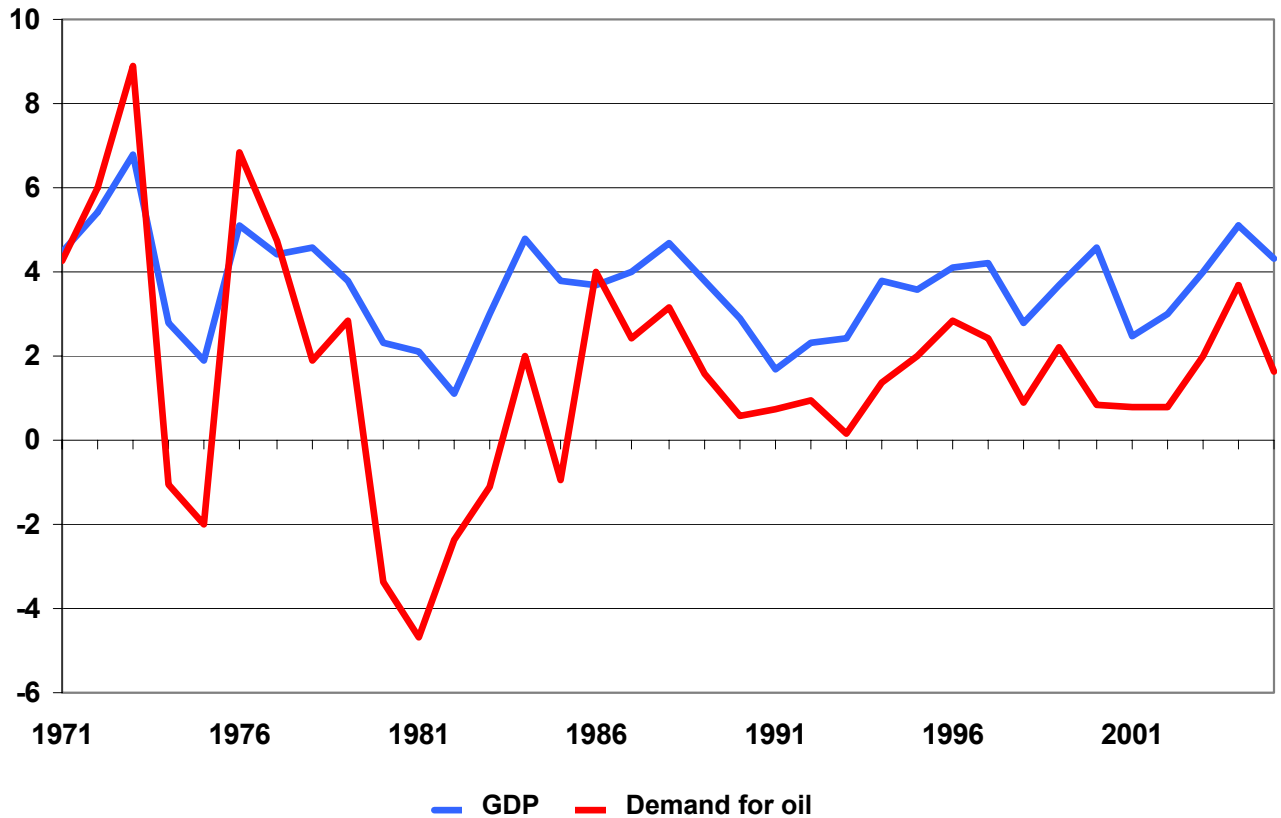
What future for hydrocarbons with the incoming peaks of oil and gas ?

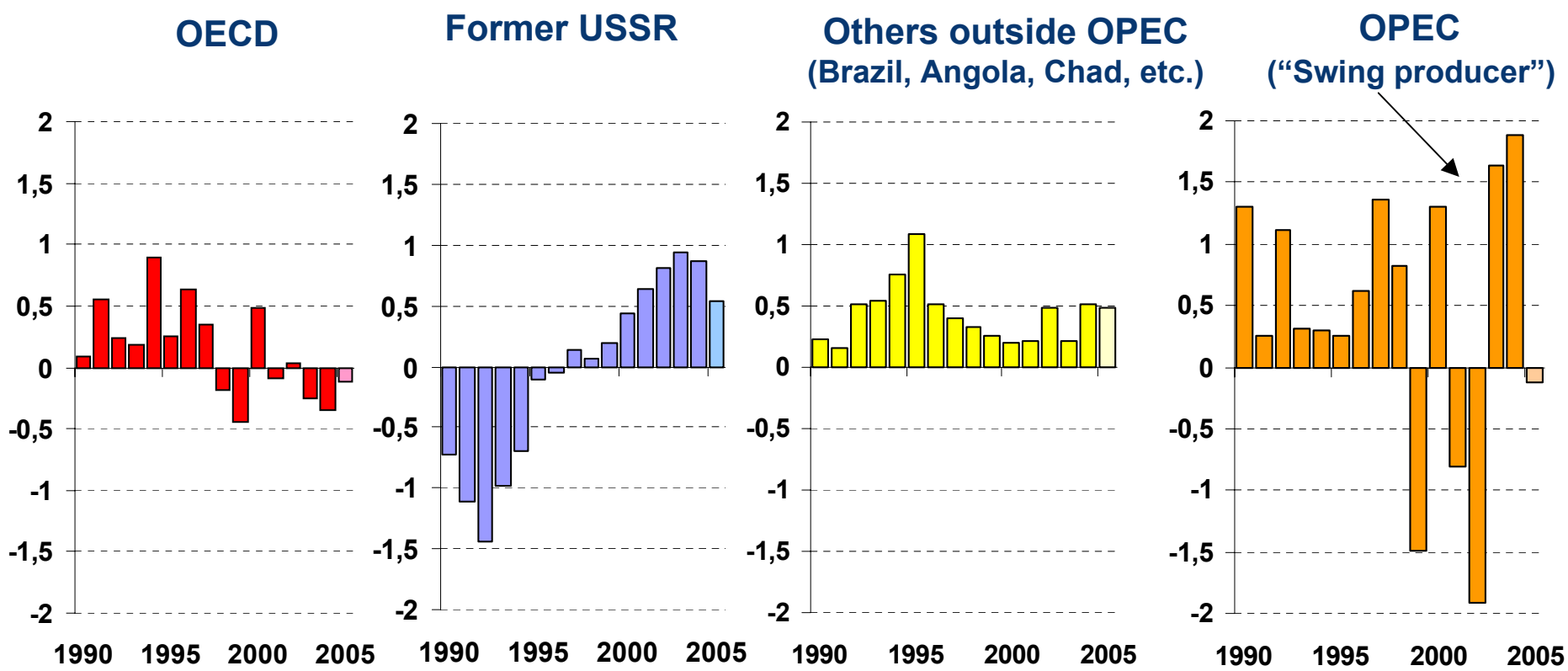
GDP and demand for oil
Annual growth rate (%, worldwide)



Oil growth is coming from outside the OECD exclusively

Mb/d

Annual changes in oil production



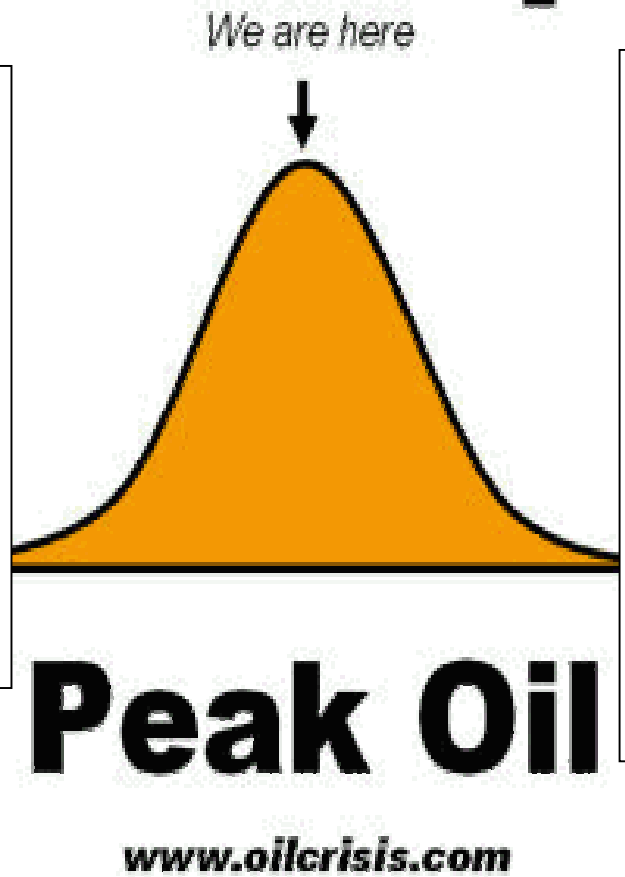
Source: AIE

2000 – 2005 : a historical warning by ASPO

Wake up!!!

A few 'peak oil' websites

3w.peakoil.net
3w.aspofrance.org
3w.oilcrisis.com
3w.peakoil.com



ASPO France members (June 2006):

Jean Laherrère (formerly Total)
Pierre-René Bauquis (fy Total)
Carlos Cramez (fy Total)
Jean-Luc Wingert
Jean-Marc Jancovici (fy Envt)
Alain Perrodon (fy Elf)
Paul Alba (fy Elf)
Maurice Allègre (fy IFP)
Jacques Varet (BRGM)
Adolphe Nicolas (Montpellier Uni)
Jean-Marie Bourdaire (ex Total)
Bernard Rogeaux (EDF)

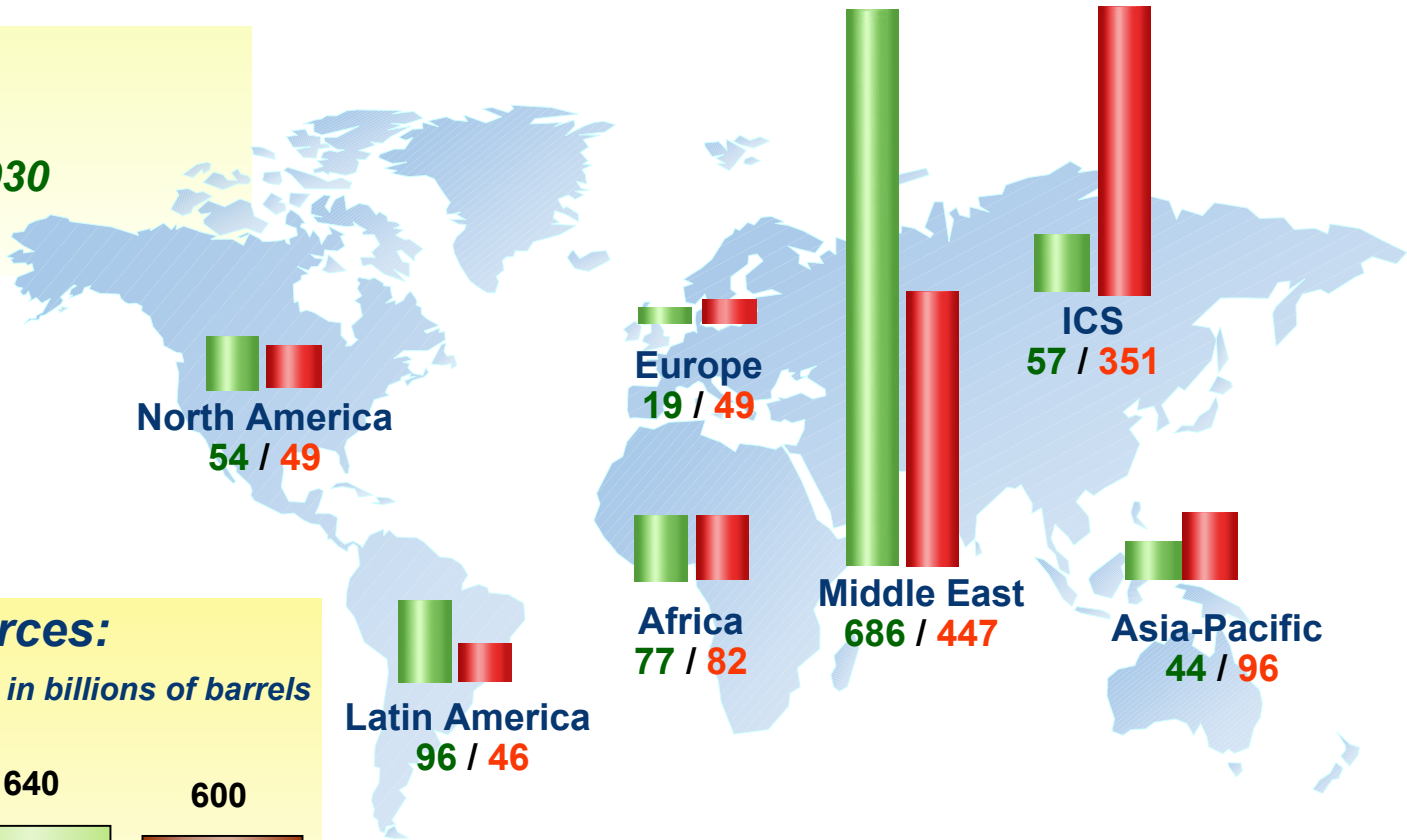
Oil reserves are concentrated in the Middle East

Proven reserves:

Gas: 1120

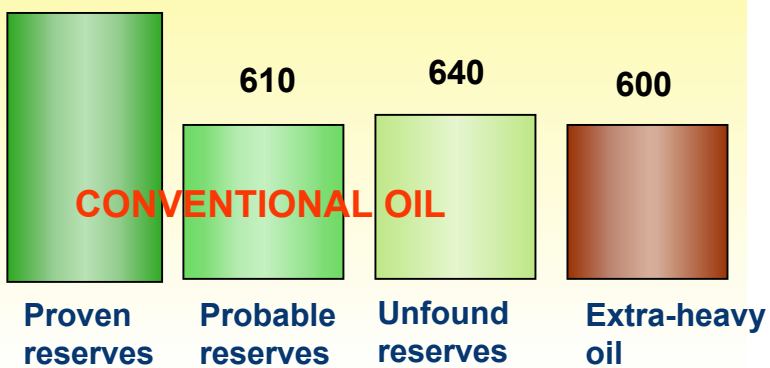
Conventional oil: 1030

billion BOEs, 1/1/2004



Oil resources:

USGS F95 and AIE in billions of barrels



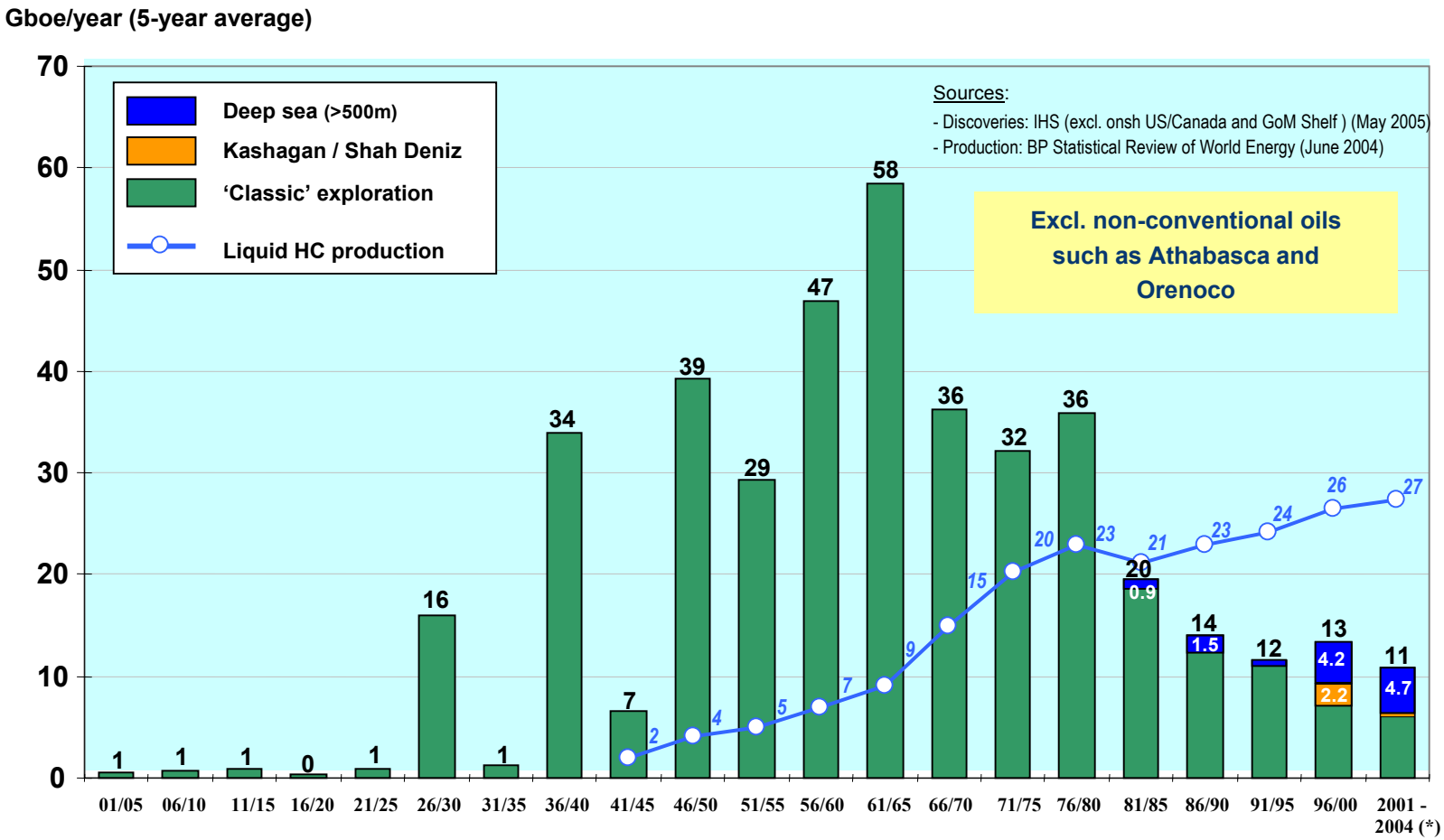
- Oil: proven reserves cover 40 years of demand
- Gas: proven reserves cover 60 years of demand

Source: O&G, Cedigaz, USGS 2000 F50, AIE

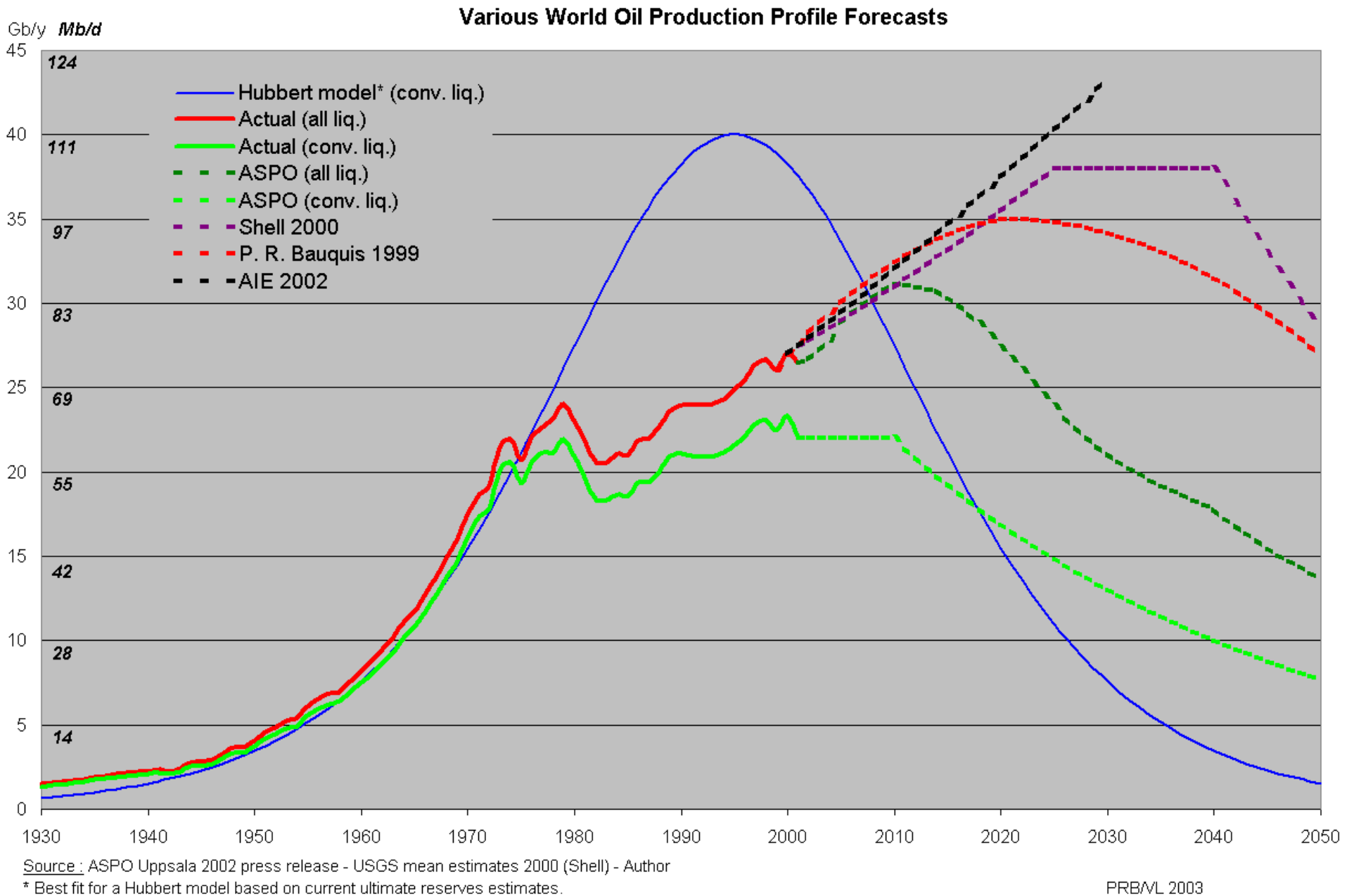
Brief summary of past findings and views on peak oil

- The only "publically available data" on oil reserves are the so called "proven reserves".
- Unfortunately, they are totally useless to study and predict "Peak Oil".
- The only "usable" concepts for "peak oil estimation", at oil basins levels, countries levels or world level are :
  - Evolution of past exploration performances and production curves
  - Creaming curves
  - King Hubbert methodology.
  - Ultimate reserves concept

Oil and condensate discoveries and worldwide production of liquid hydrocarbons



(*) 4-year average

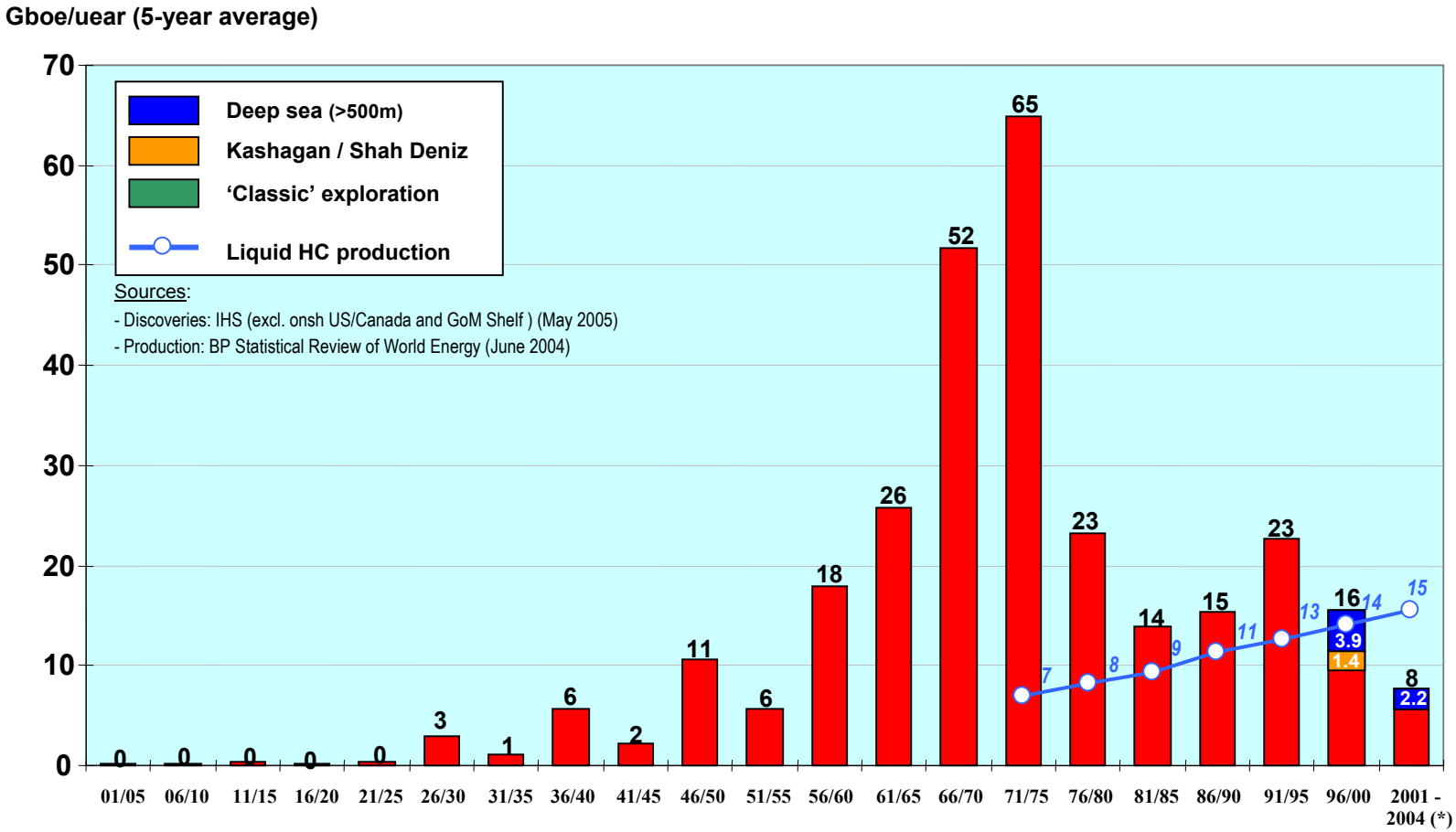


Source : ASPO Uppsala 2002 press release - USGS mean estimates 2000 (Shell) - Author

* Best fit for a Hubbert model based on current ultimate reserves estimates.

PRB/VL 2003

Gas-hydrocarbon discoveries and production worldwide



(*) 4-year average

Conclusions about "peak oil" - ①

- **Since June 2006 it can be considered that views about Peak Oil in France have become reasonnably similar :**
  - **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 20150/2030 – less than 100 Mb/d**

- **This point of view is widely different from those among the "optimists" who believe that Peak Oil is not "reserves related" but 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**
  - **USGS, DOE, EIA, IEA…**

conclusions about peak oil -②

- The oil production peak (between 2015 and 2025, most probably) and gas production peak (between 2020 and 2040) will trigger radical changes in the oil and gas industries.
- 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.
- Long term oil "stabilized price" after world peak could be around 100$/bbl real terms (year 2000 US$) and gas CIF border prices (US, UE, Japan) at 15$/MM BTU.

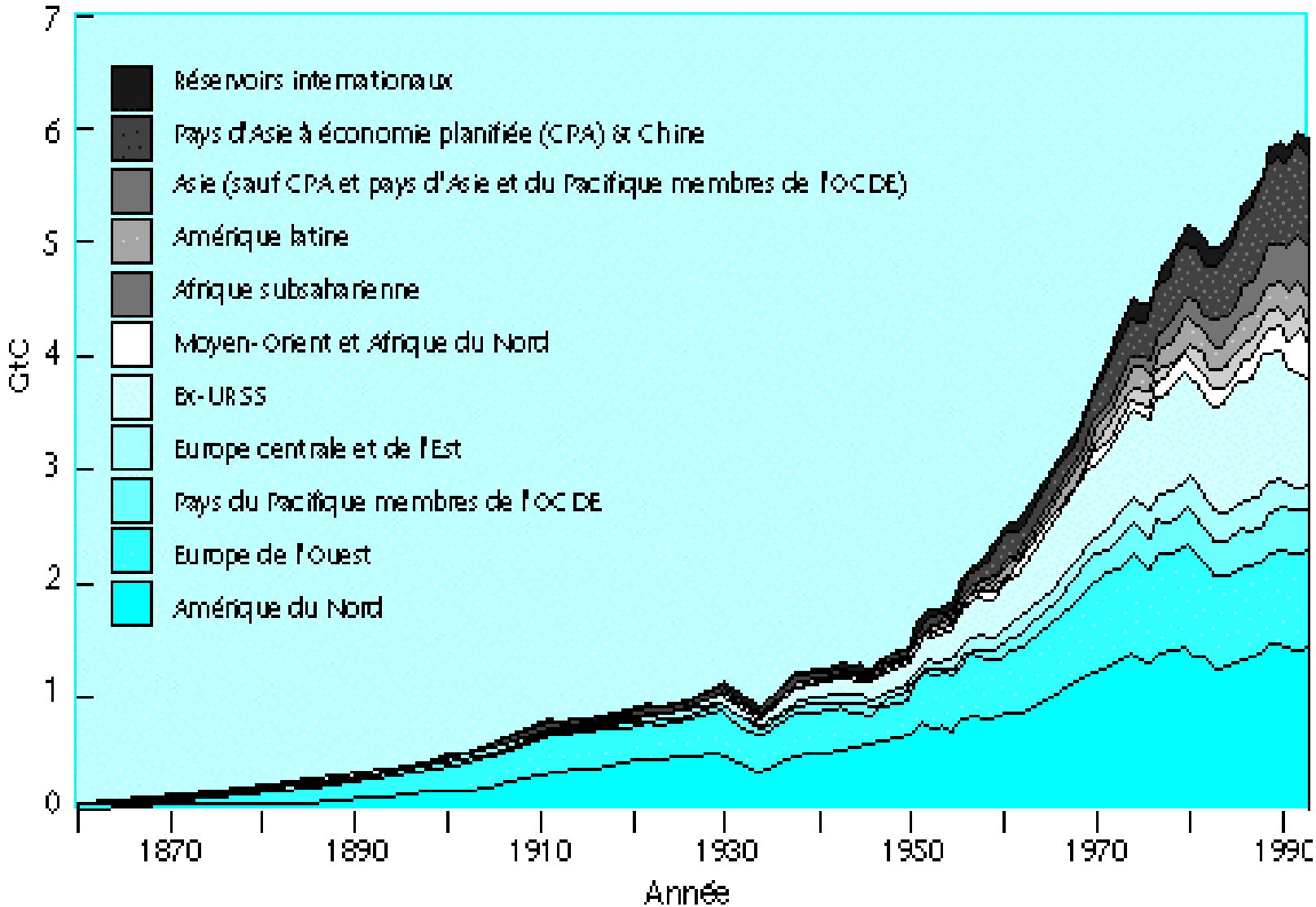
Conclusions about peak oil - ③

- Oil and gas will still be produced beyond the end of the 21st century.
- Paradoxically, it will be the oil and gas industry's golden age (high prices, little political interference in those prices).
- It will be a golden age for oil companies – and for the service companies and contractors.
- A progressive "marriage" between the oil industry and the nuclear industry will develop all along the 21st century and they will become more and more complementary.
- If I had children going to university, I would advise them to consider careers in the oil and gas industries or in the nuclear industry.

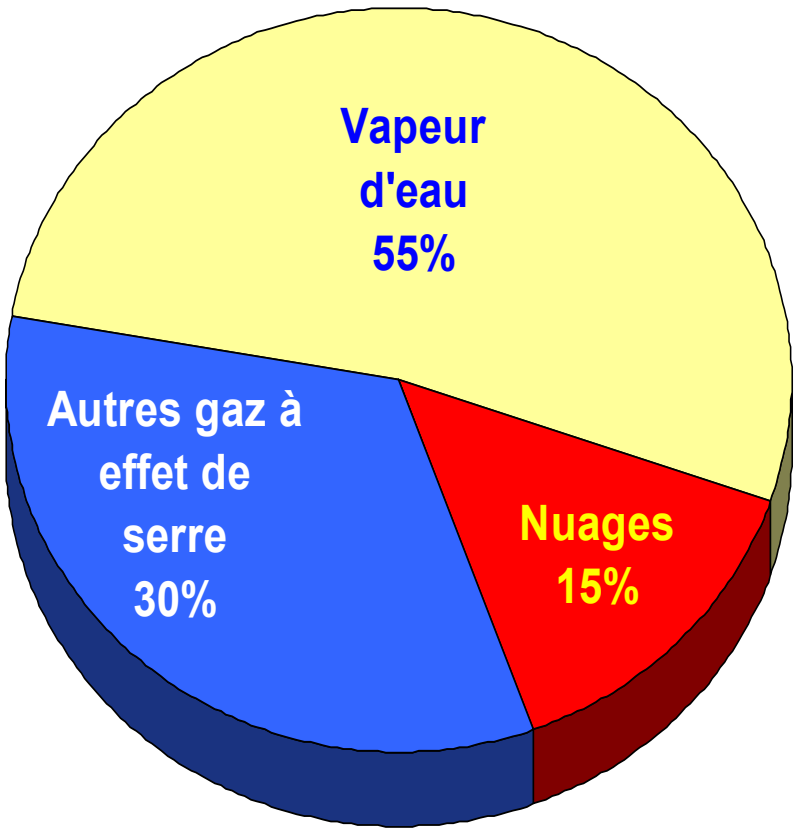
②

Impact of global warming on the world energy mix

Anthropic emissions of carbon dioxyde

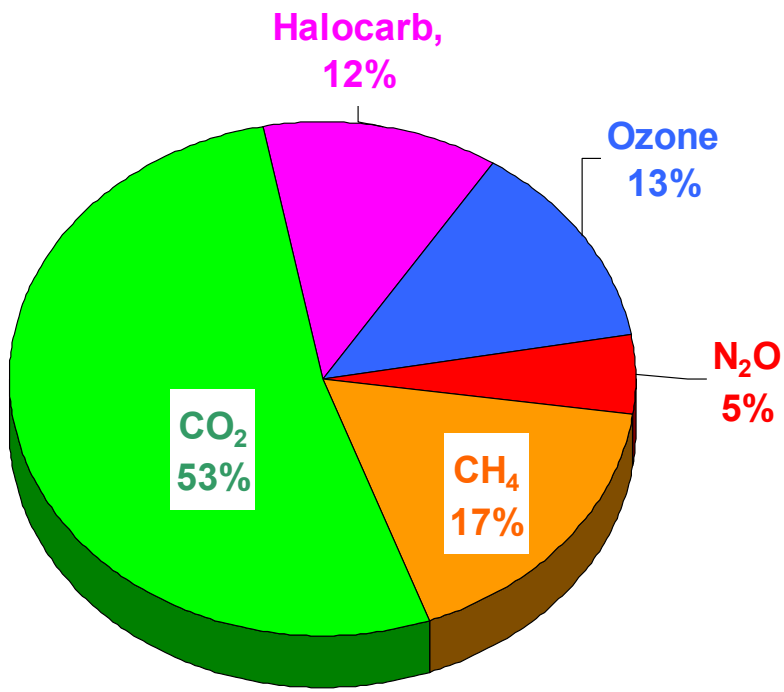


Atmospheric contributions to greenhouse effect



Naturel

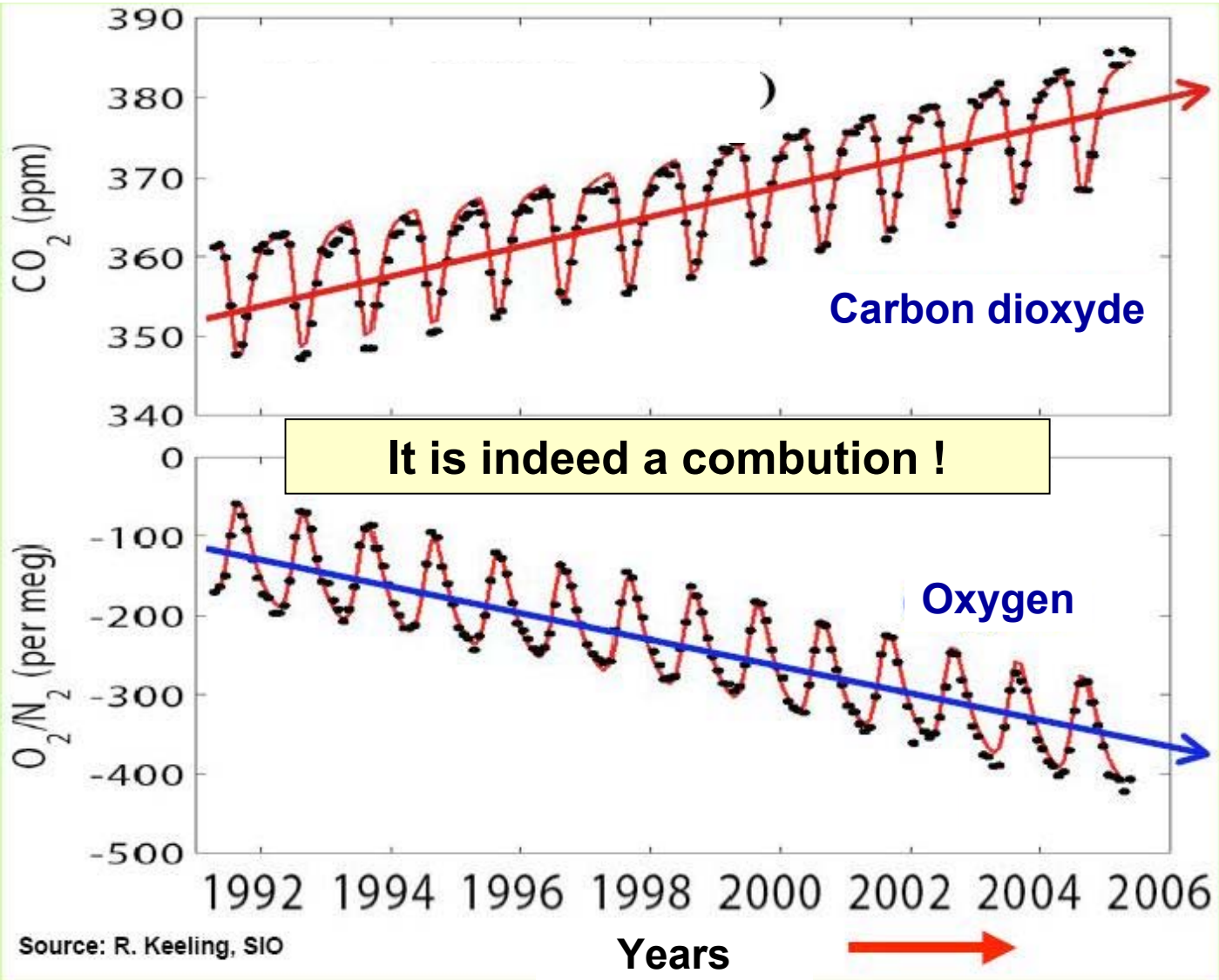
(155 W/m²)



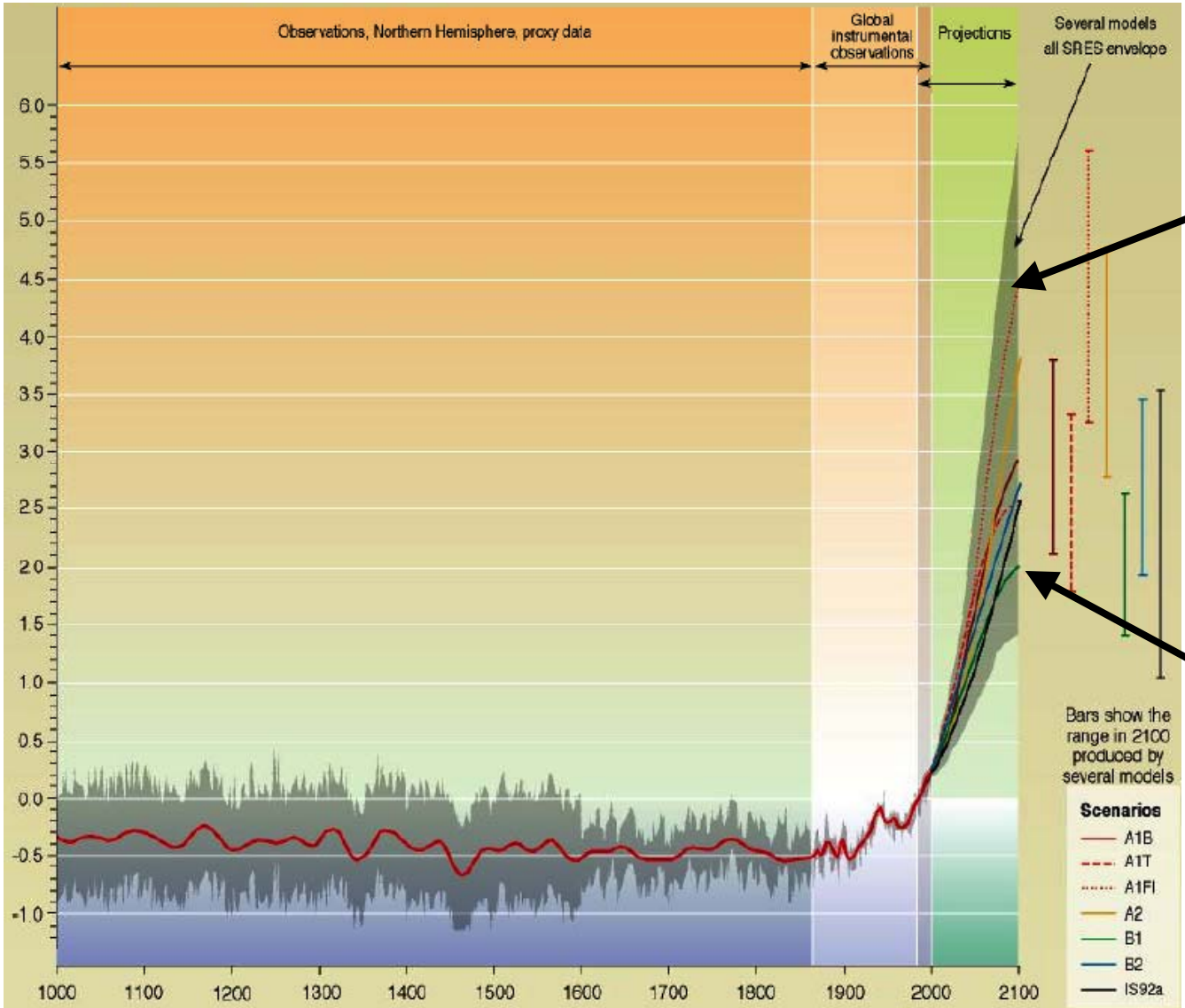
Anthropique

(2.8 W/m²)

Human activities modify greenhouse effect



Projections are heavily scenario-dependant



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

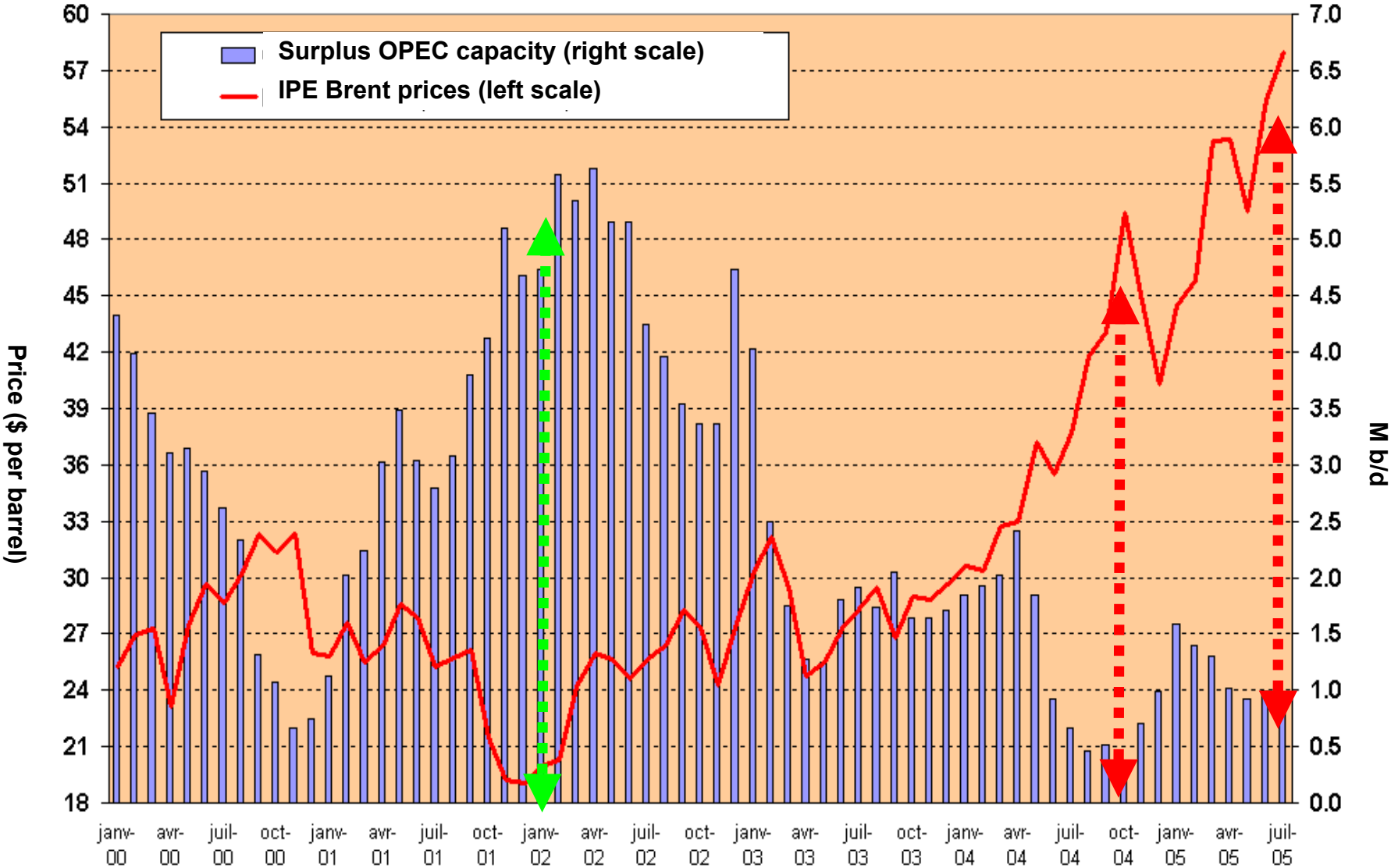
World emissions remain constant


Positive proof of global warming.
18th Century
1900
1950
1970
1980
1990

③

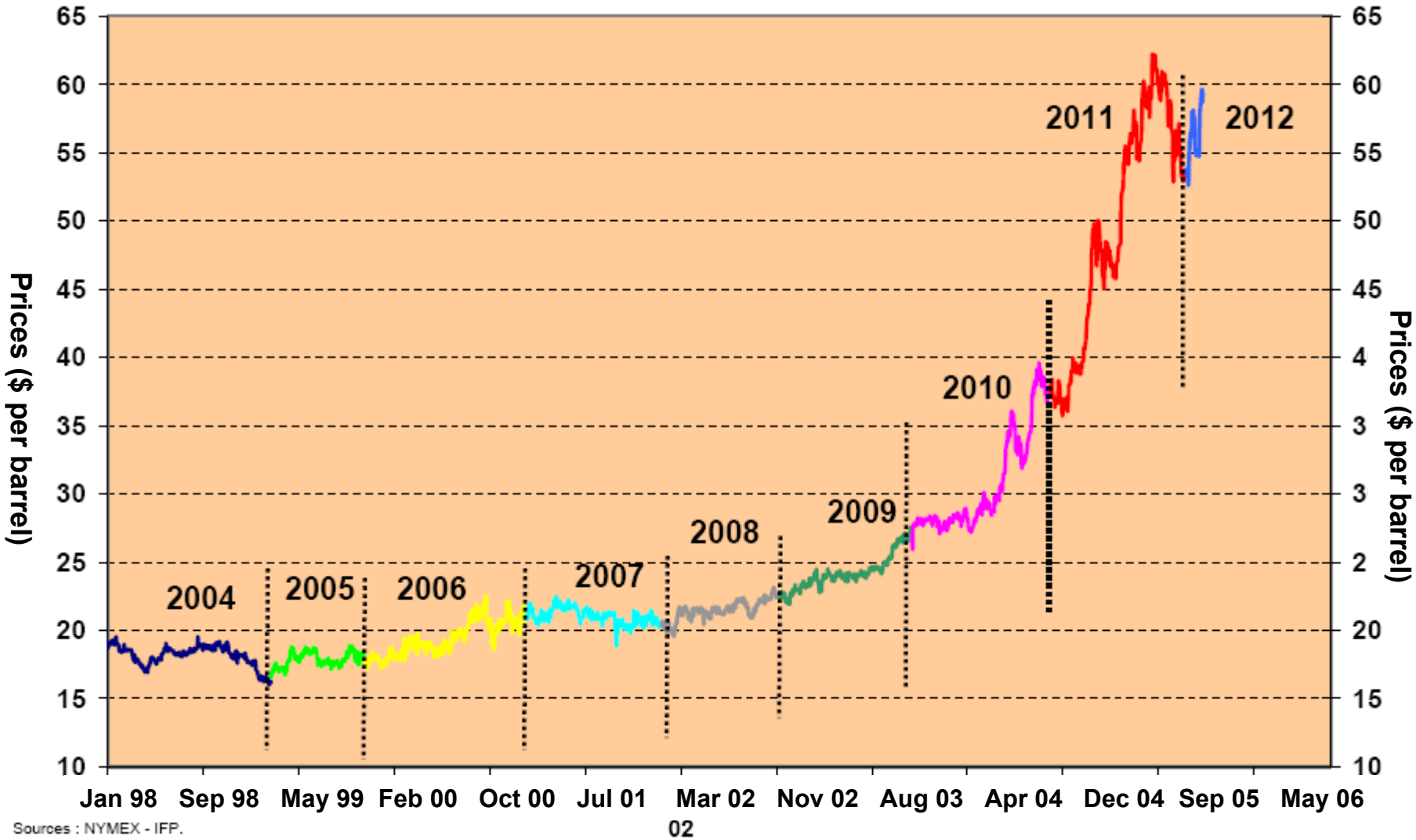
What about future oil prices ?

The price impact of OPEC surplus production capacity



Sources : AIE - PLATTS - IFP.

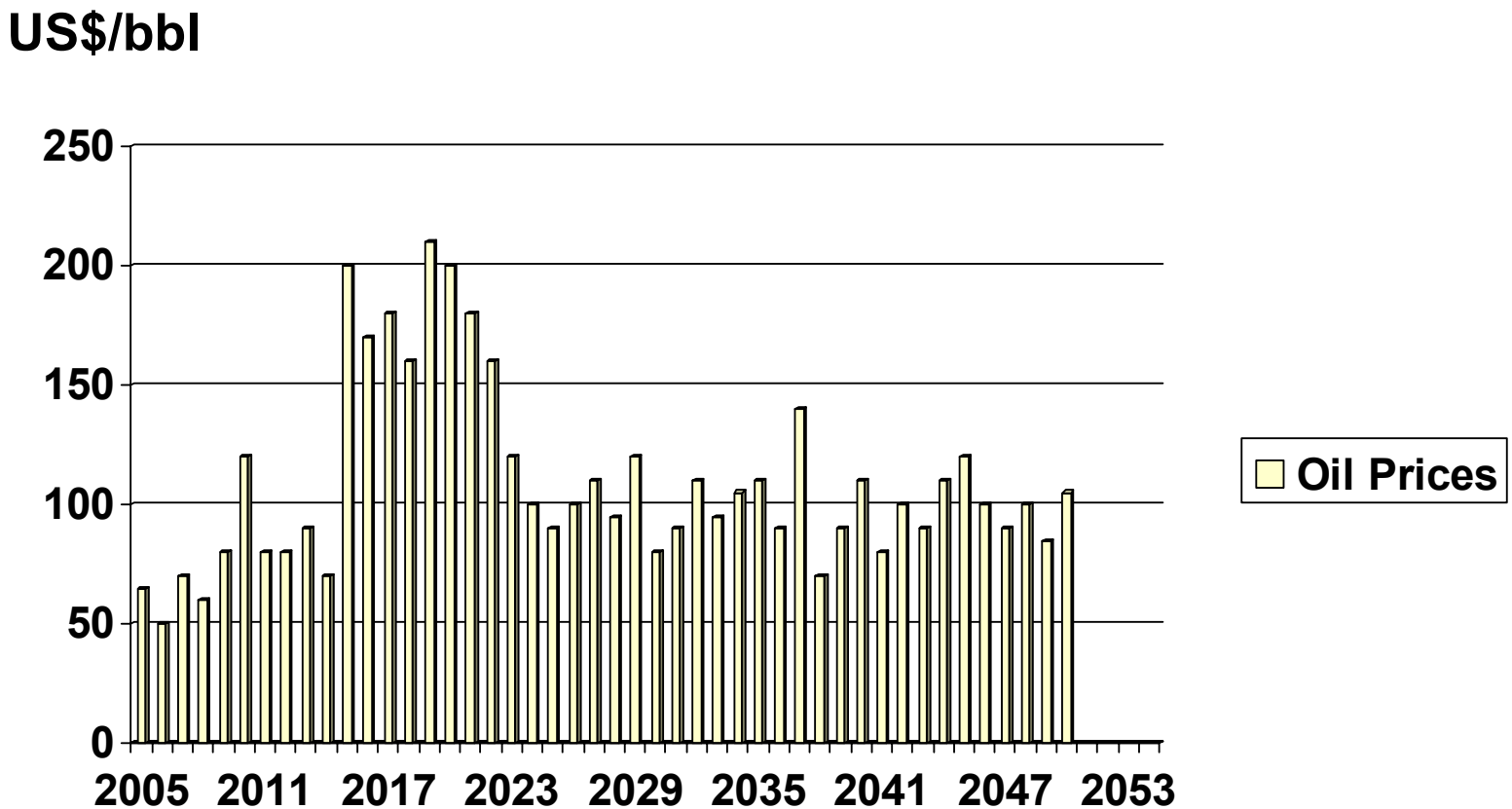
Long-term WTI barrels (NYMEX): 6-year futures market, New York



Sources : NYMEX - IFP.

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

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



④

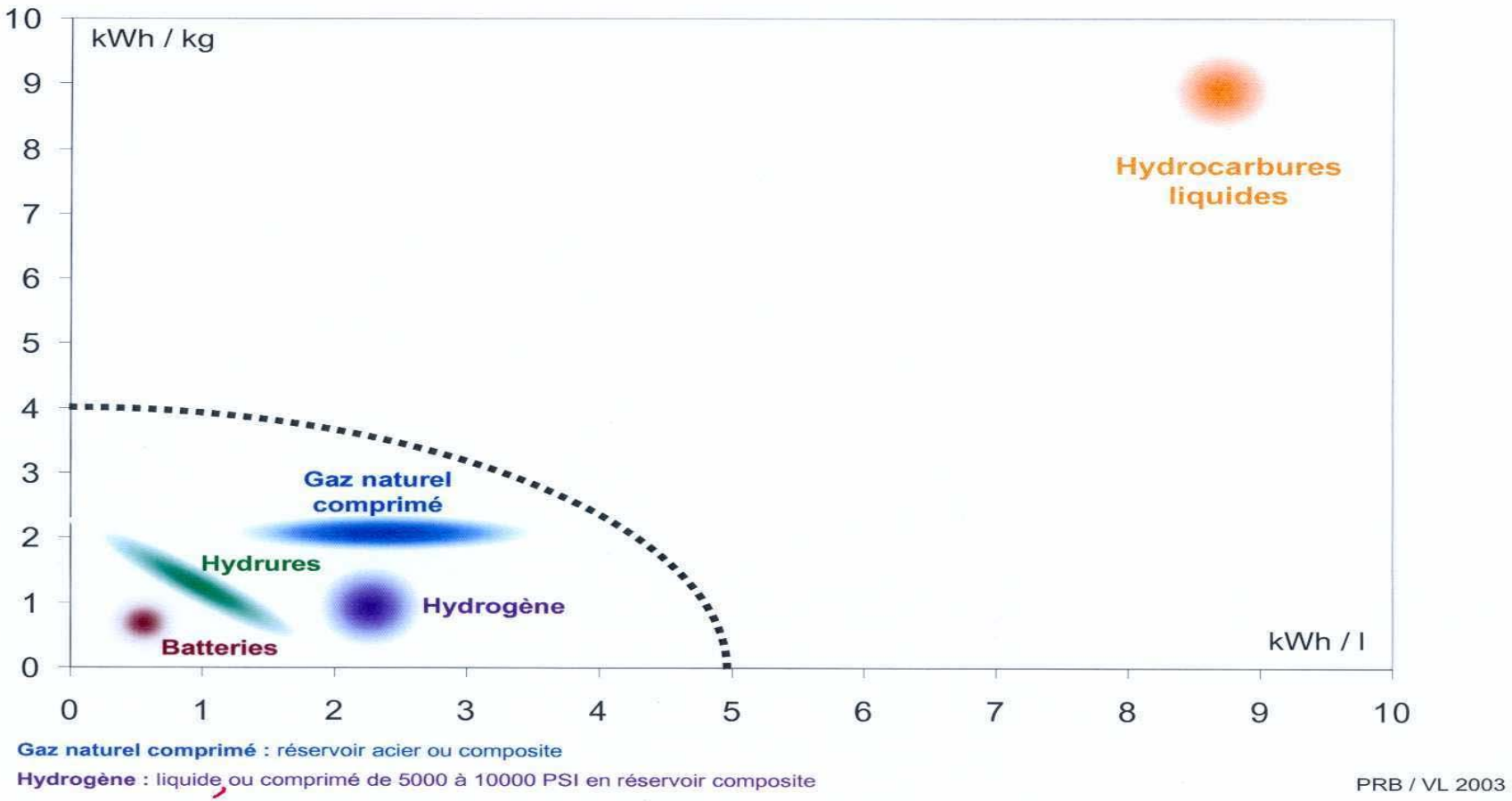
Which energy sources will power Transport in the 21st century ?

Automobiles of the past and present: a few key dates

Hydrogen	Coal	Electricity	Biofuel
1805	1892	1899	1903
The first internal combustion engine running on hydrogen: Isaac de Rivaz (Switzerland)	The first diesel engine running on pulverized coal; patented by Rudolf Diesel (Germany)	The first car to exceed 100 km/hour was an electric car: the “Jamais Contente” designed by Camille Jenatzy (Belgium)	The world speed record (177 km/hour) is achieved by a Gobron-Brillié vehicle runnng on agricultural ethanol (France)

Nearly every automotive technology destined for use on cars of the future has a long history

LIQUID HYDROCARBONS: UNMATCHED ENERGY COMPACTNESS

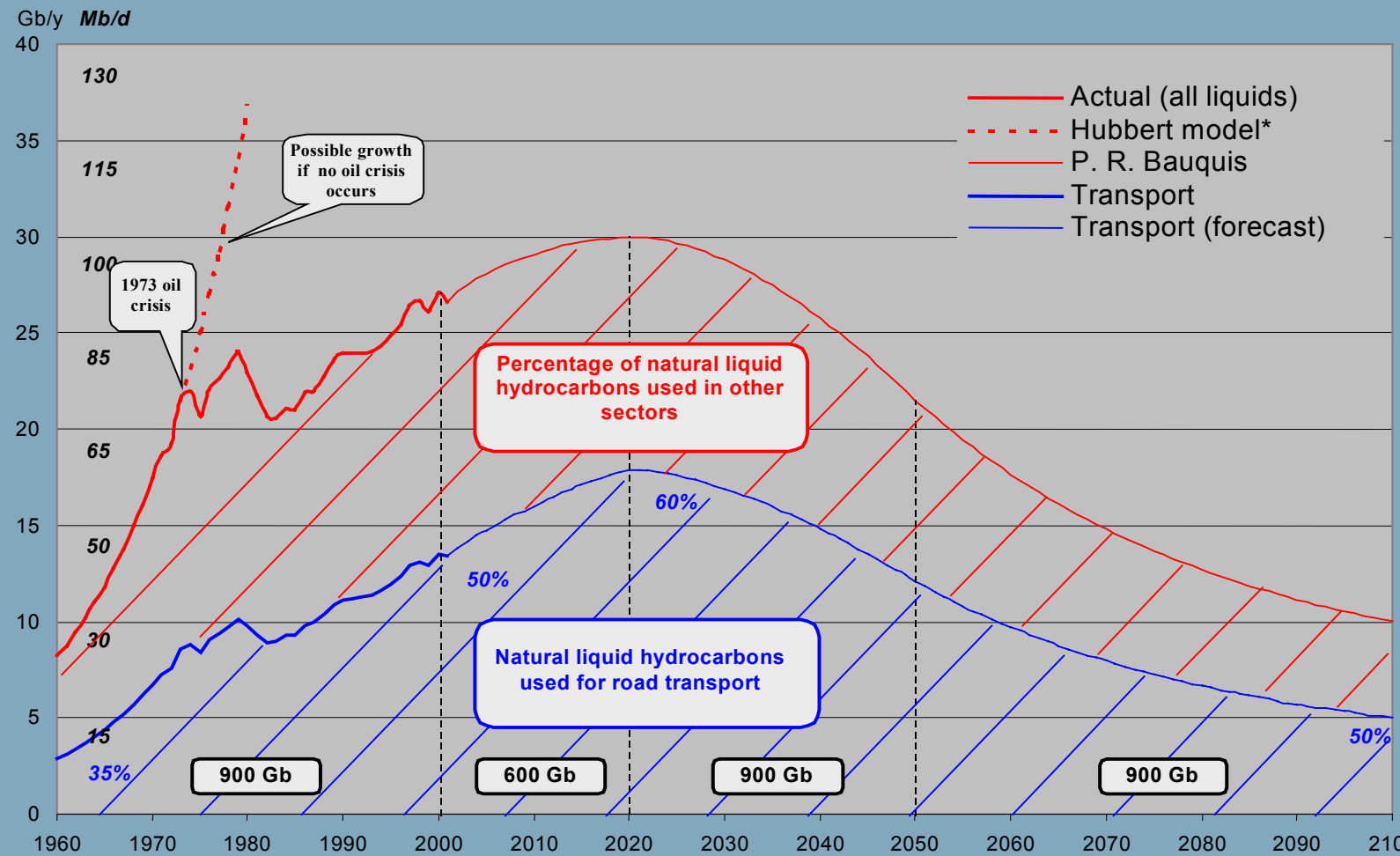


Gaz naturel comprimé : réservoir acier ou composite

Hydrogène : liquide ou comprimé de 5000 à 10000 PSI en réservoir composite

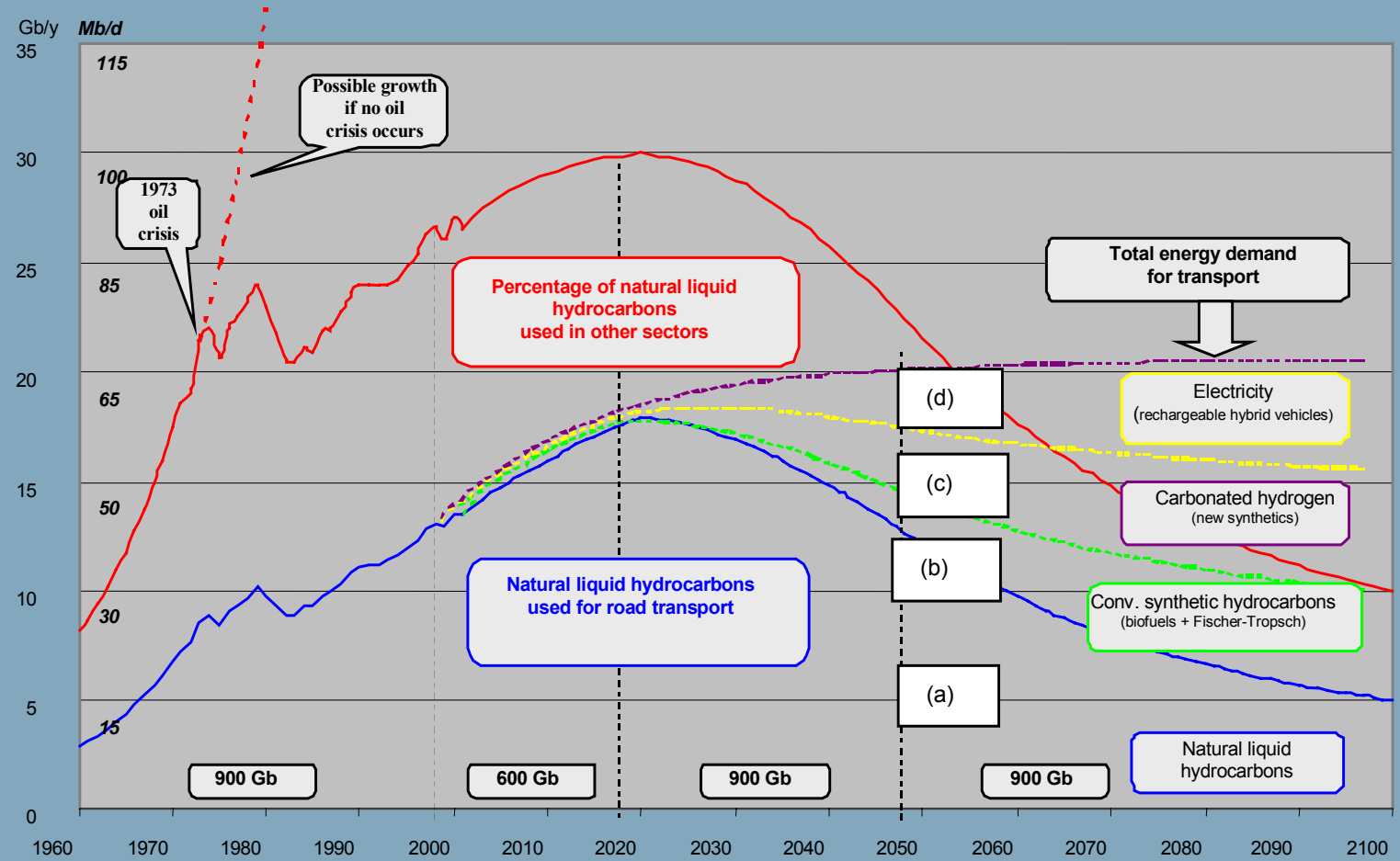
PRB / VL 2003

World production and share consumed by transport



Source:

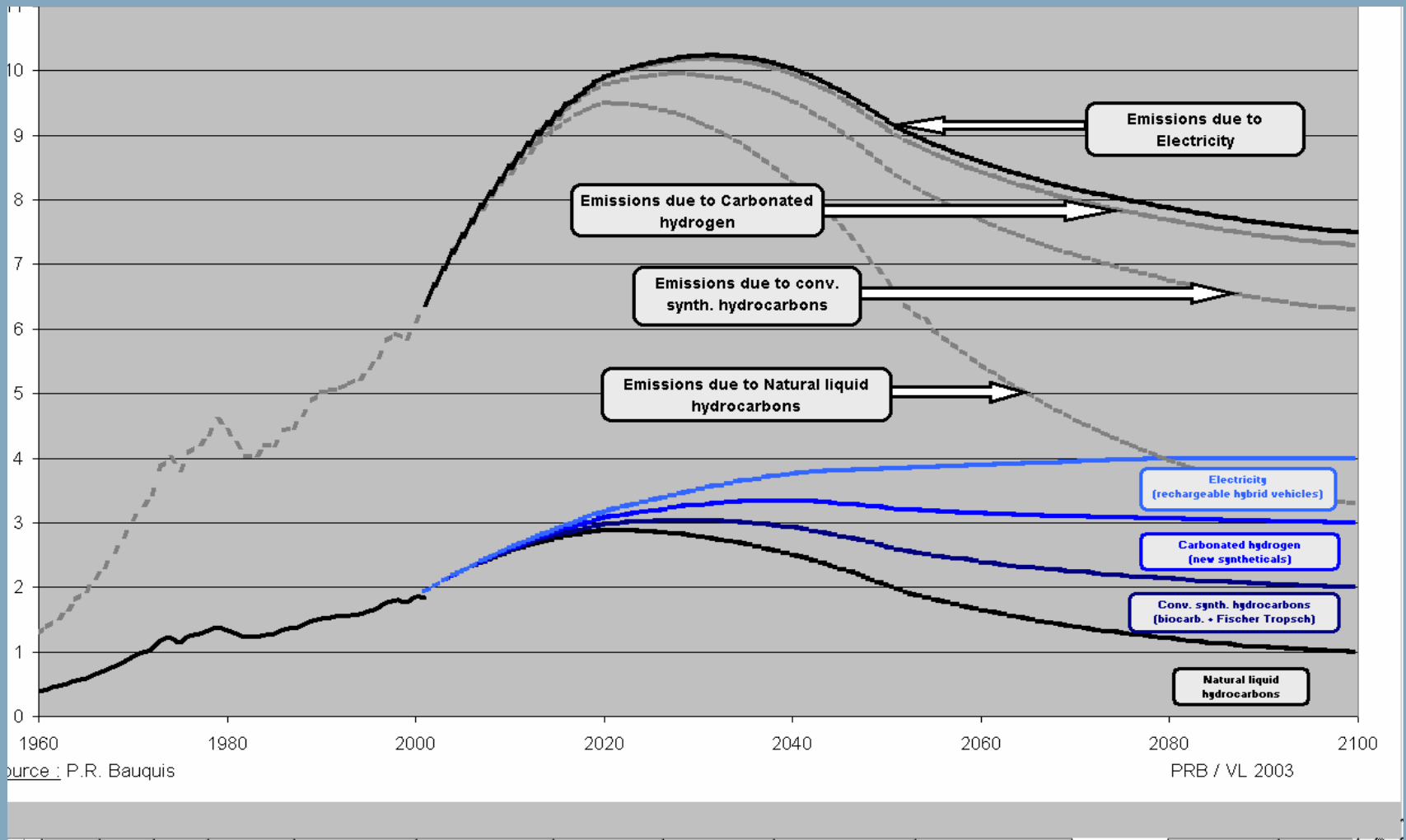
Which energy sources will power transport?
1960 - 2000 - 2100



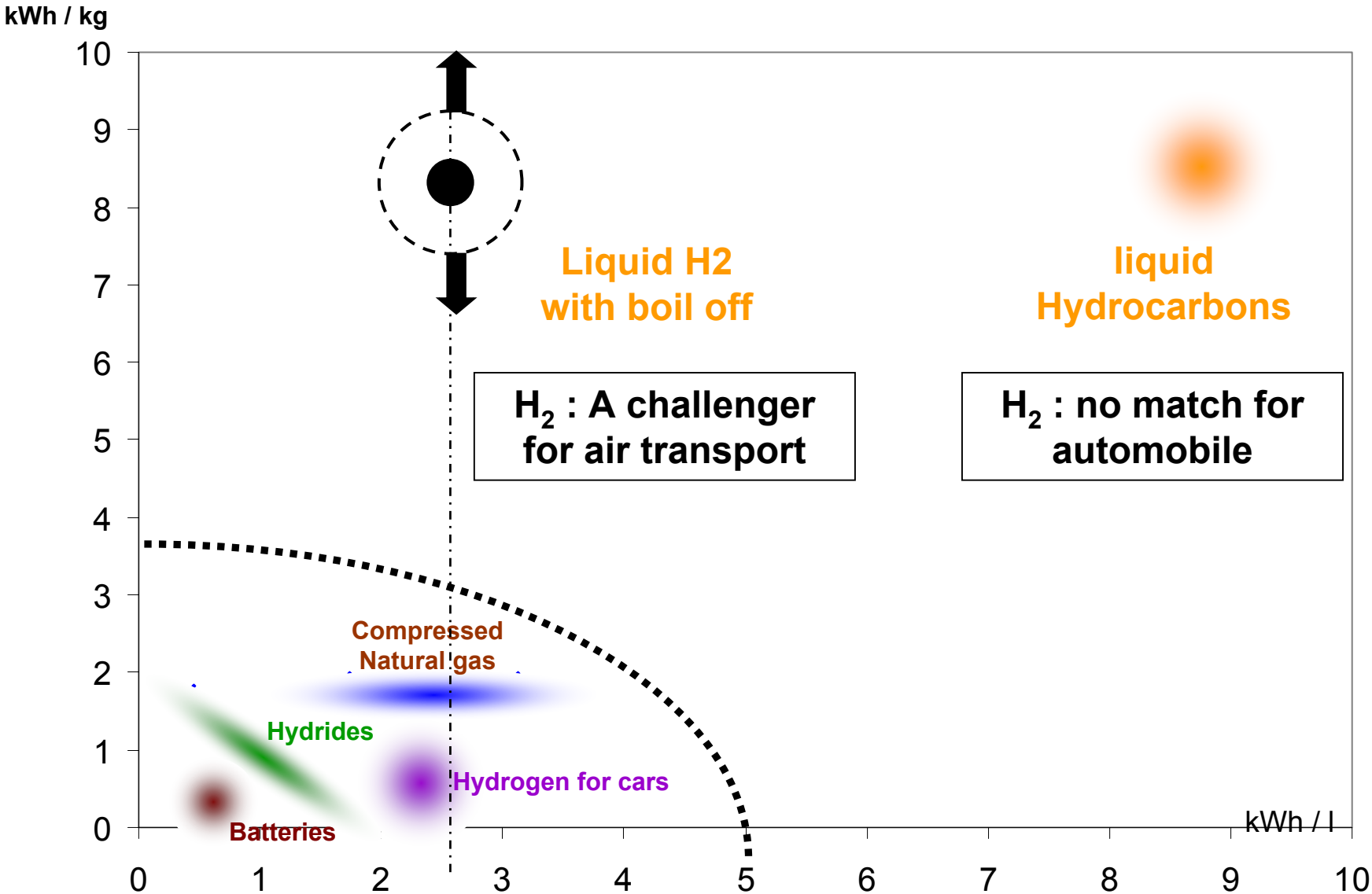
Source: ASPO data, P.R. Bauquis, October 2002

Energies for Road transports and Carbon Emissions

1960 – 2000 - 2100



Hydrogen : a potential challenger for aviation ?



Gaz naturel comprimé : réservoir acier ou composite

Summary conclusions of Part 4

Oil peak and gas peak :

How will it influence energy uses for transportation

and how will it trigger a "marriage" between

oil industry and nuclear industry

2000 ; Energy for Ground Transportation	**98% oil and gas** **1% nuclear** **1% others**
2100 : Energy for ground Transportation	**30% oil and gas** **60% nuclear** **10% others**

⑤

Renewable energies vs nuclear energy

Potential of renewable energies versus nuclear energy :

Different views and options among European countries.

A typical example : France versus Germany

wind power vs nuclear power

WIND

- no CO2 emission
- max 10 MW installed per km2
- 0.01 TWh / km2
- not available on call
- unit investment small
- equipment life 20 years
- free fuel
- 10 to 20% max in electrical mix

NUCLEAR

- no CO2 emission
- 1000 to 1500 MW per km2
- 10 TWh / km2
- base load
- unit investment large
- equipment life 40 years
- fuel cost
- security and waste problems

wind power vs nuclear power

GERMANY

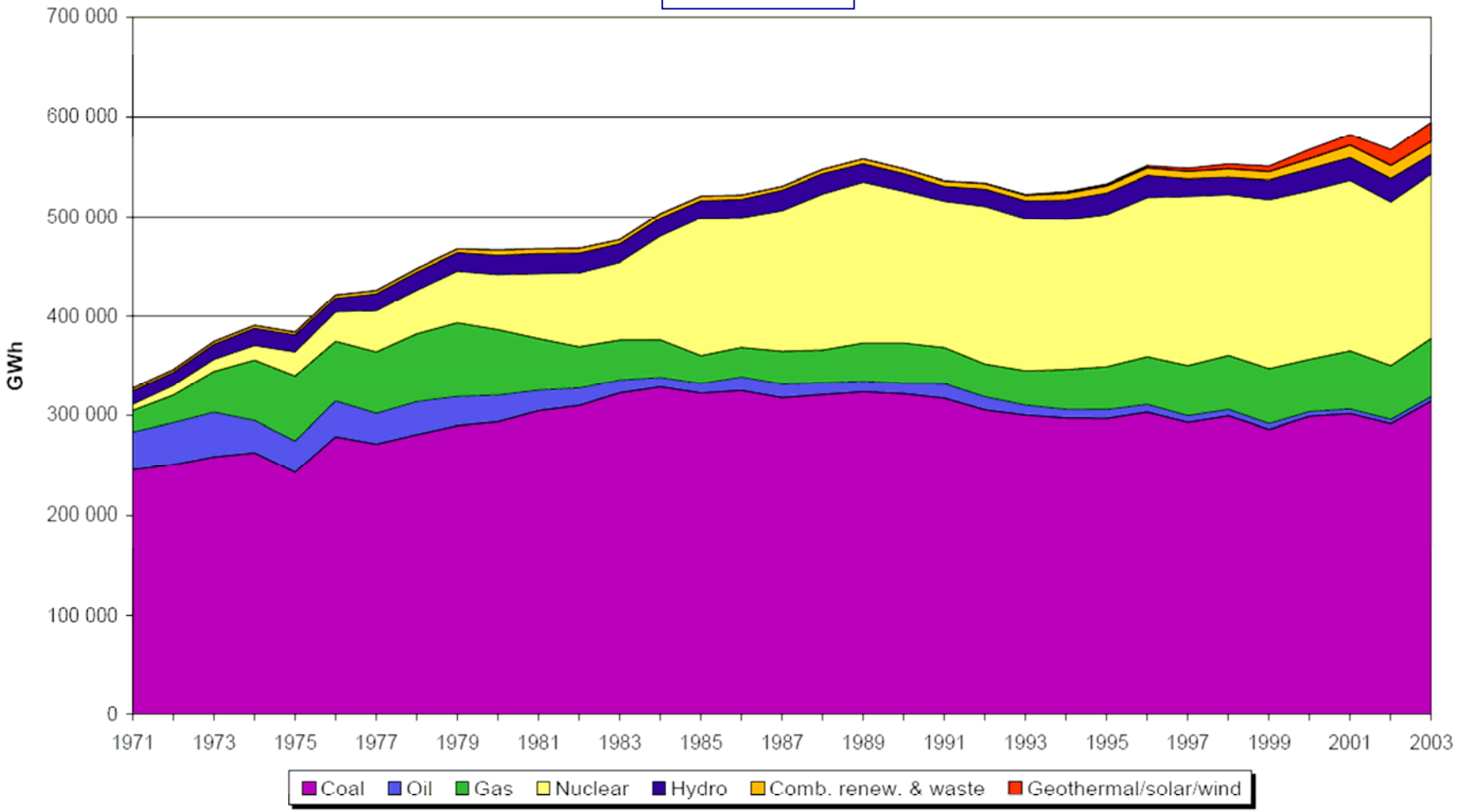
- 18 nuclear units
- phasing out nuclear plants
- total elec capa installed 120 GW
- wind capa installed 18 GW
- nuke capa installed 21 GW
- total elec prod 600 TWh/yr
- wind prod 19 TWh/yr
- nuke prod 165 TWh/yr
- wind % of total elec 3 %
- nuke % of total elec 28 %

FRANCE

- 58 nuclear units
- replacing old plants with EPR
- total elec capa installed 112 GW
- wind capa installed ≤ 1 GW
- nuke capa installed 63 GW
- total elec prod 567 TWh/yr
- wind prod ≤ 1 TWh/yr
- nuke prod 441 TWh/yr
- wind % of total elec ≤ 0.1 %
- nuke % of total elec 78 %

Evolution of Electricity Generation by Fuel from 1971 to 2003

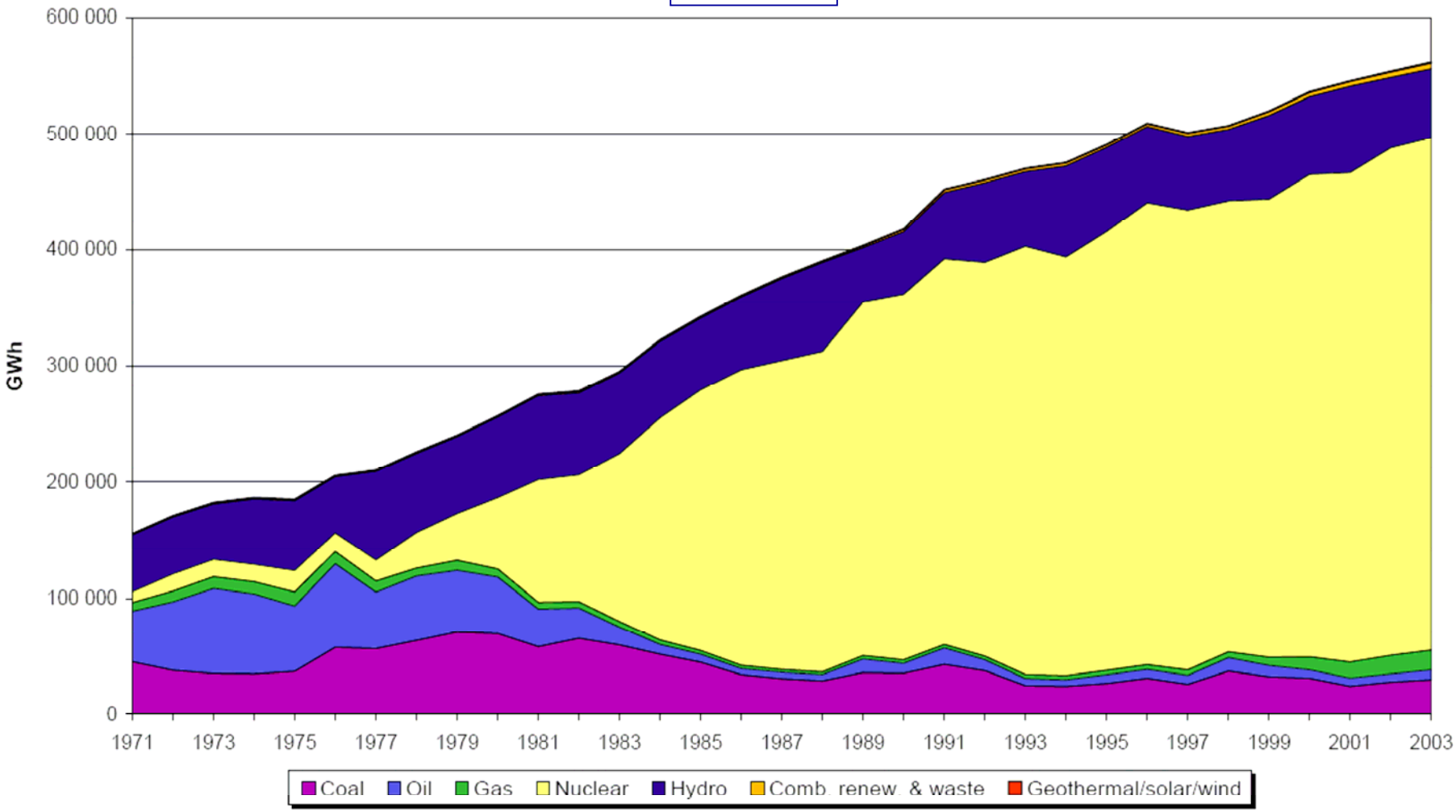
GERMANY



For more detailed data, please consult our on-line data service at http://data.iea.org.

Evolution of Electricity Generation by Fuel from 1971 to 2003

FRANCE



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Thank you for your attention