ENERGY AND THE ENVIRONMENT

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Total world energy consumption since 1950

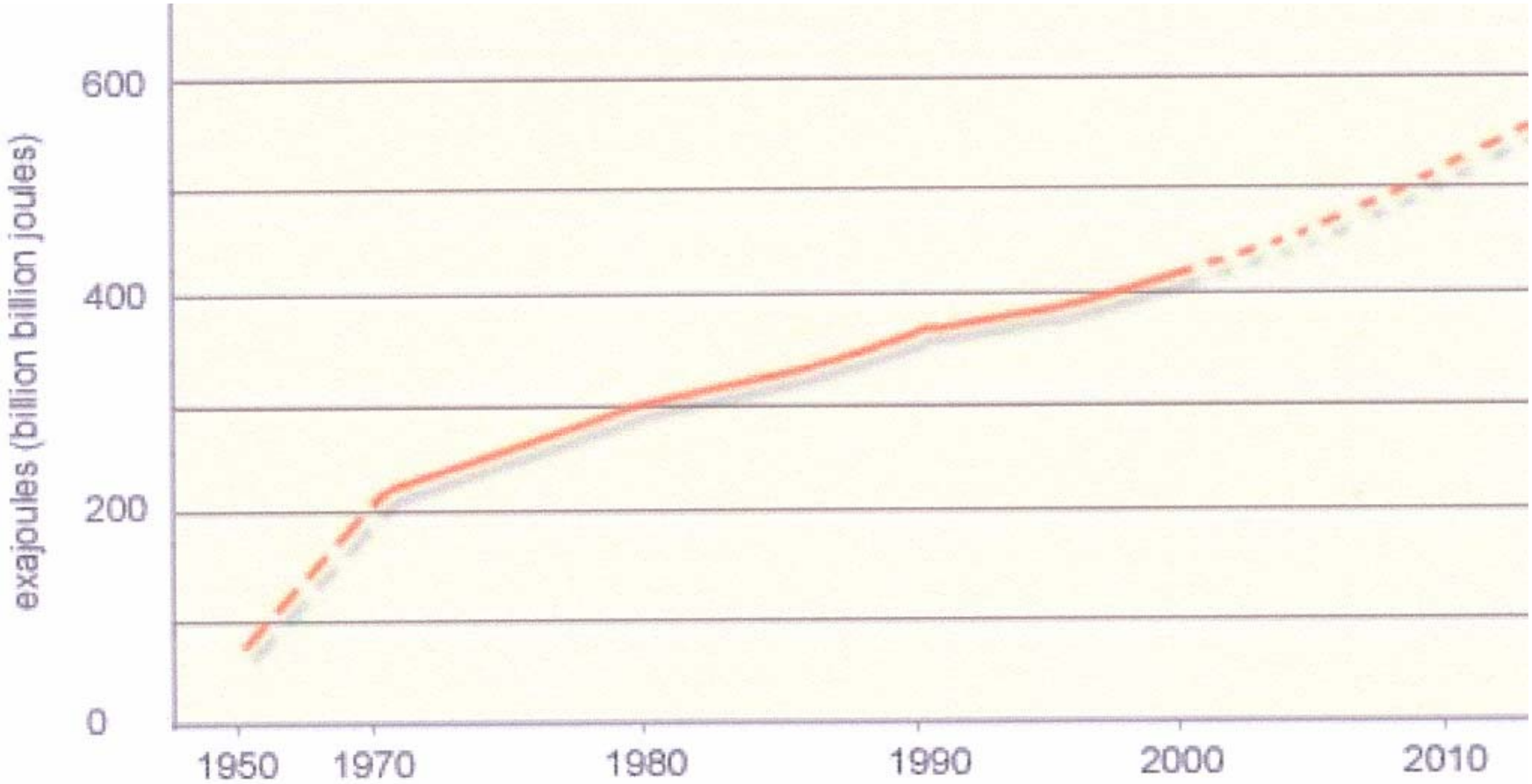
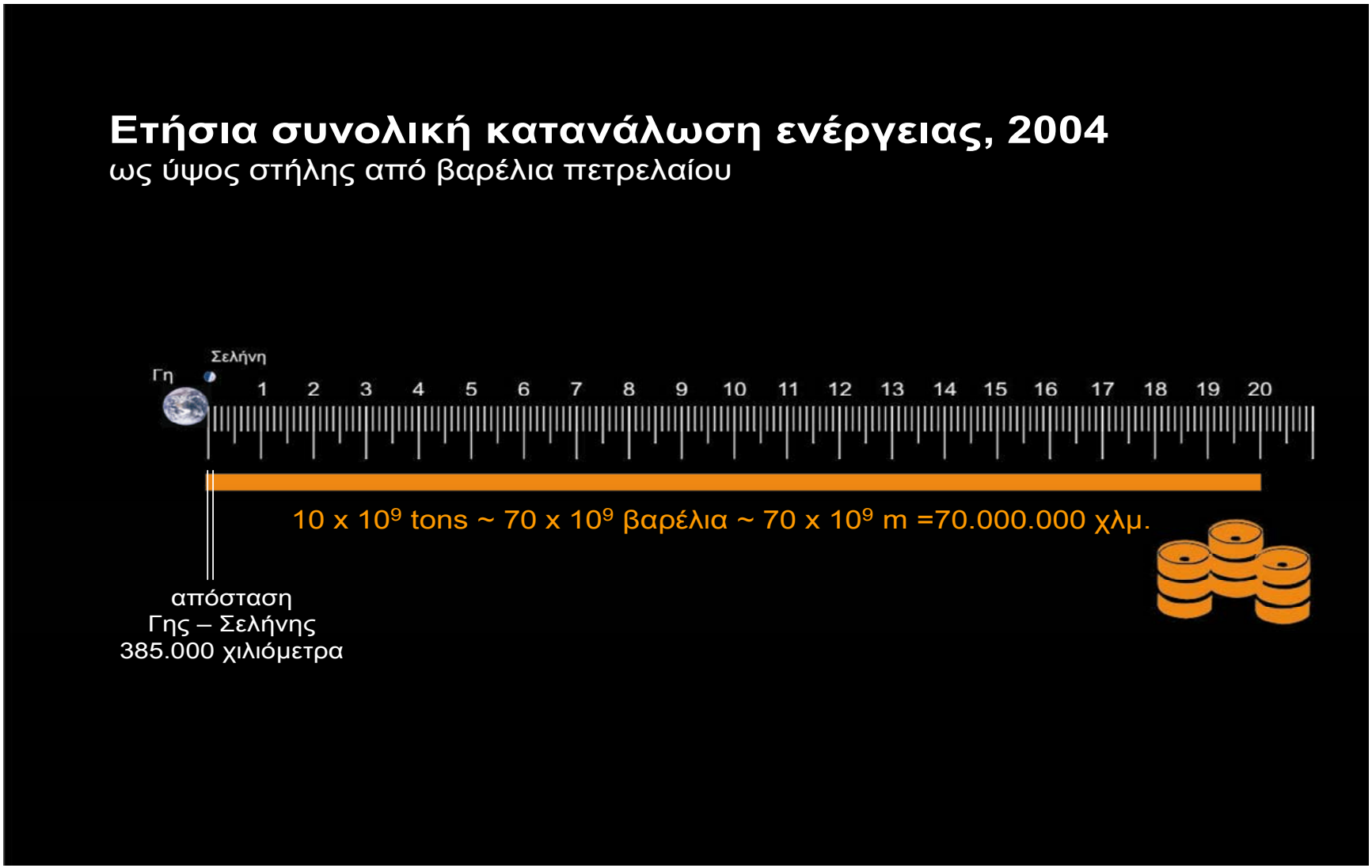
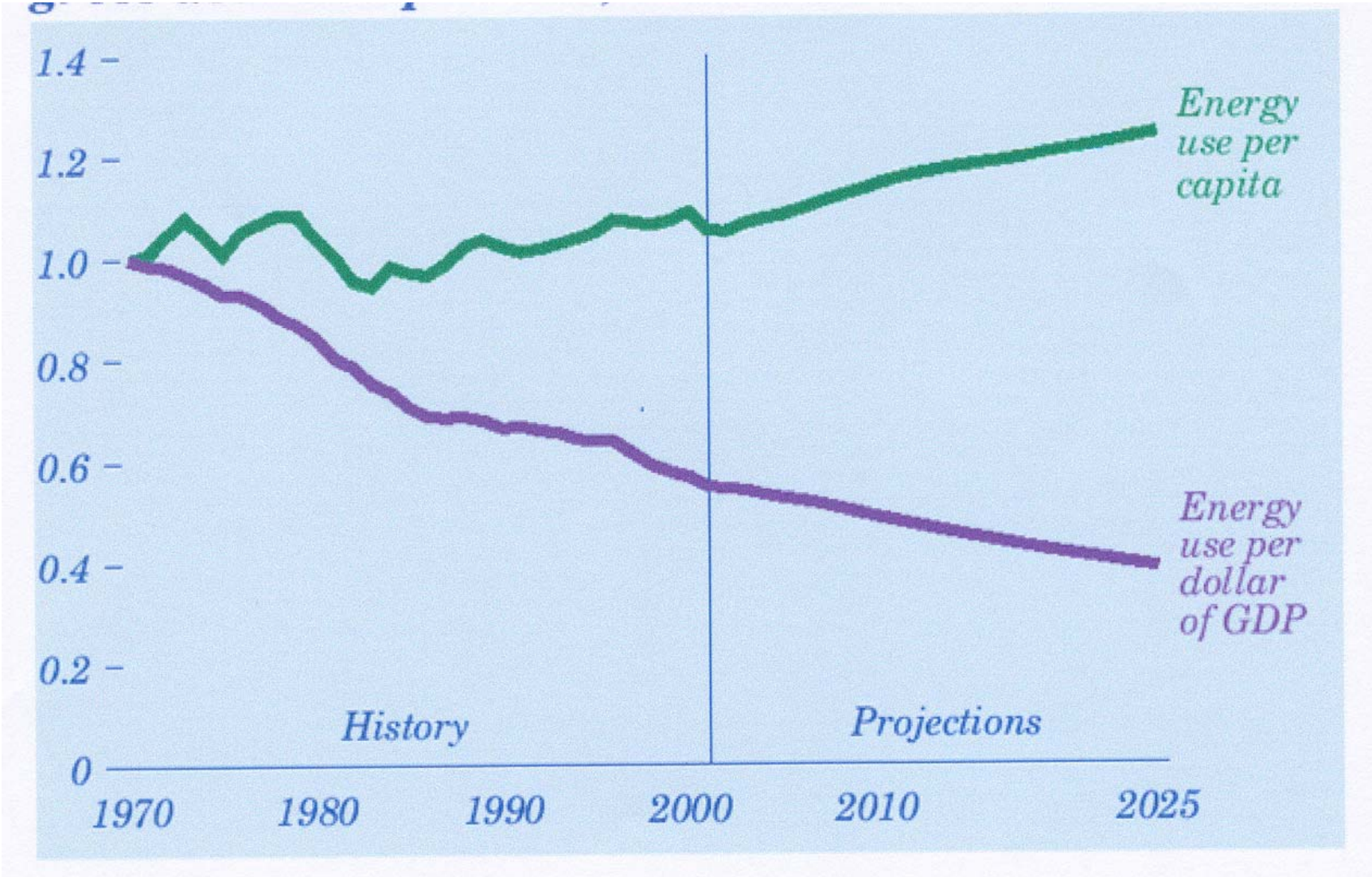


Chart E1. World energy consumtion since 1950 including projections.

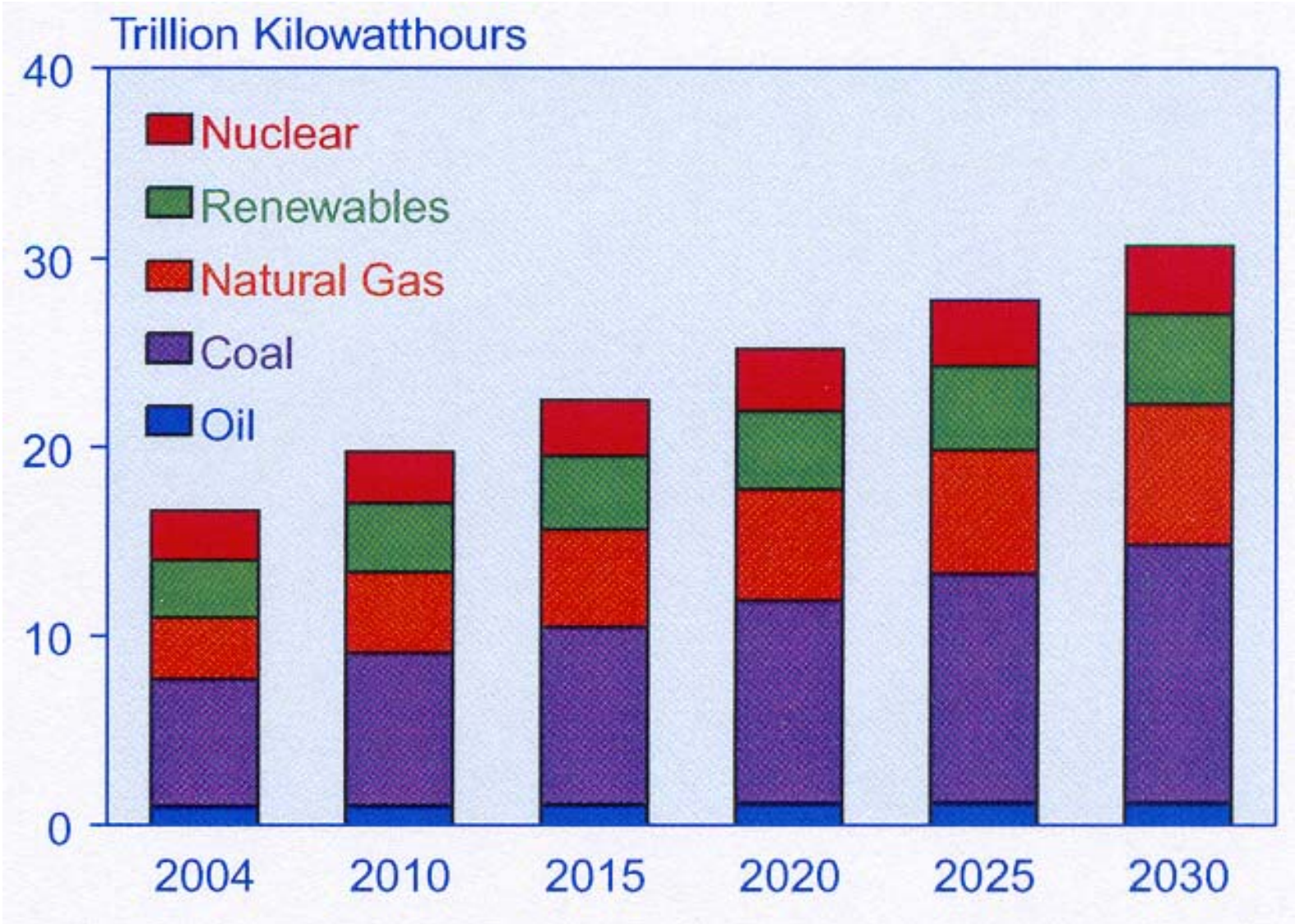
Annual total world energy consumption (2004) expressed as a stack of barrels of oil



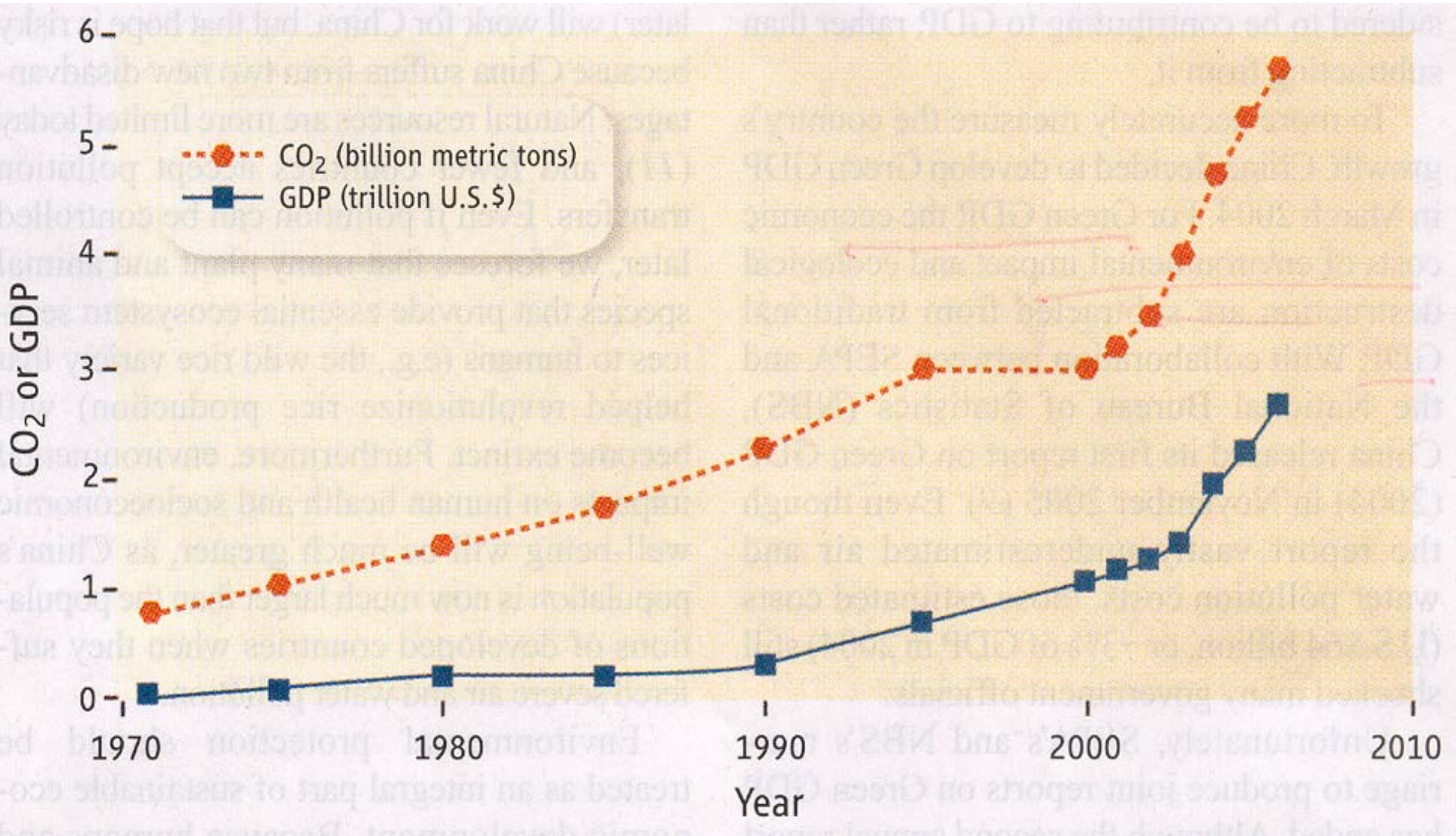
Energy use per capita and per dollar of GNP in the USA 1970-2025 (1970=1)



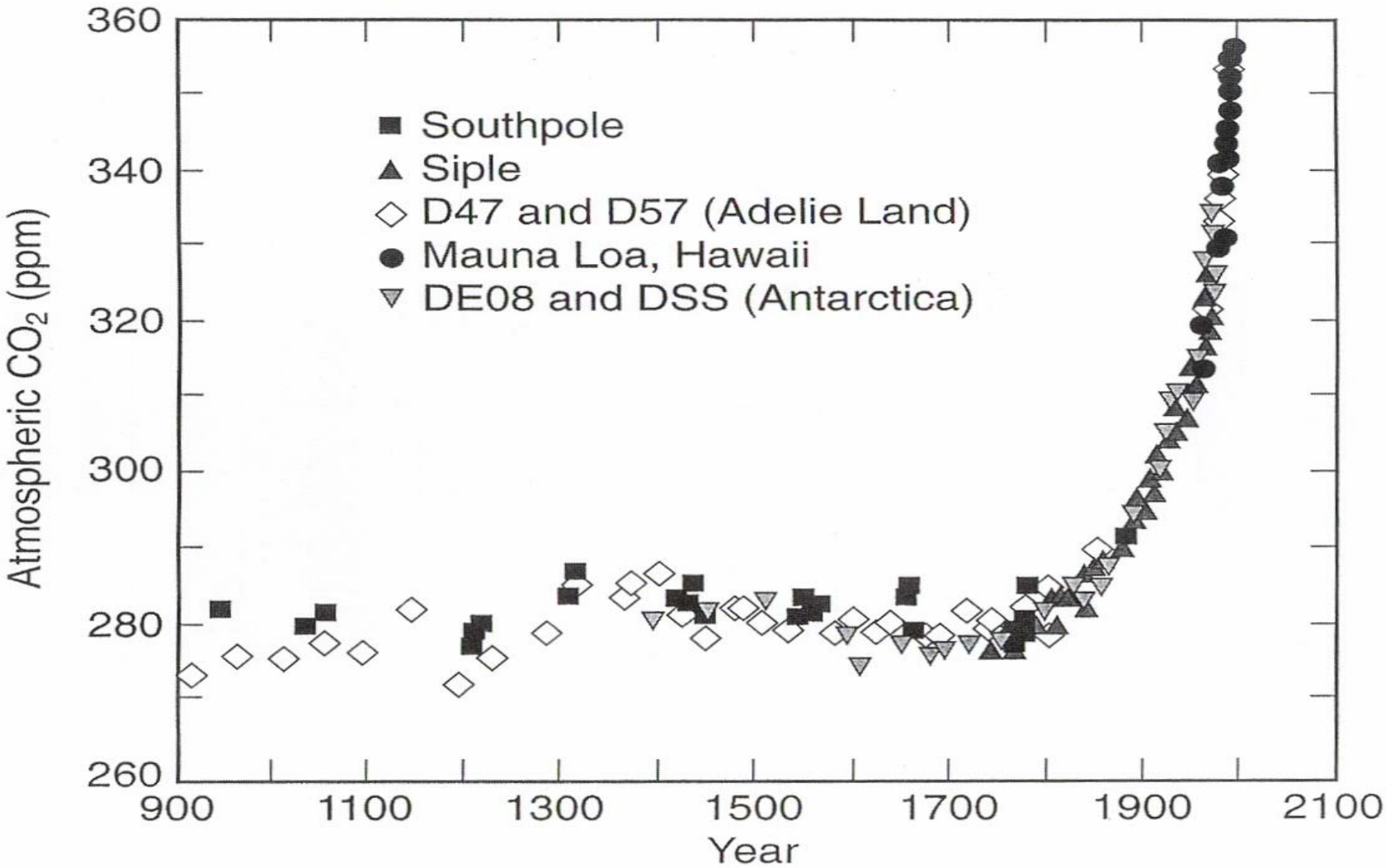
World production of electrical energy from various primary energy sources



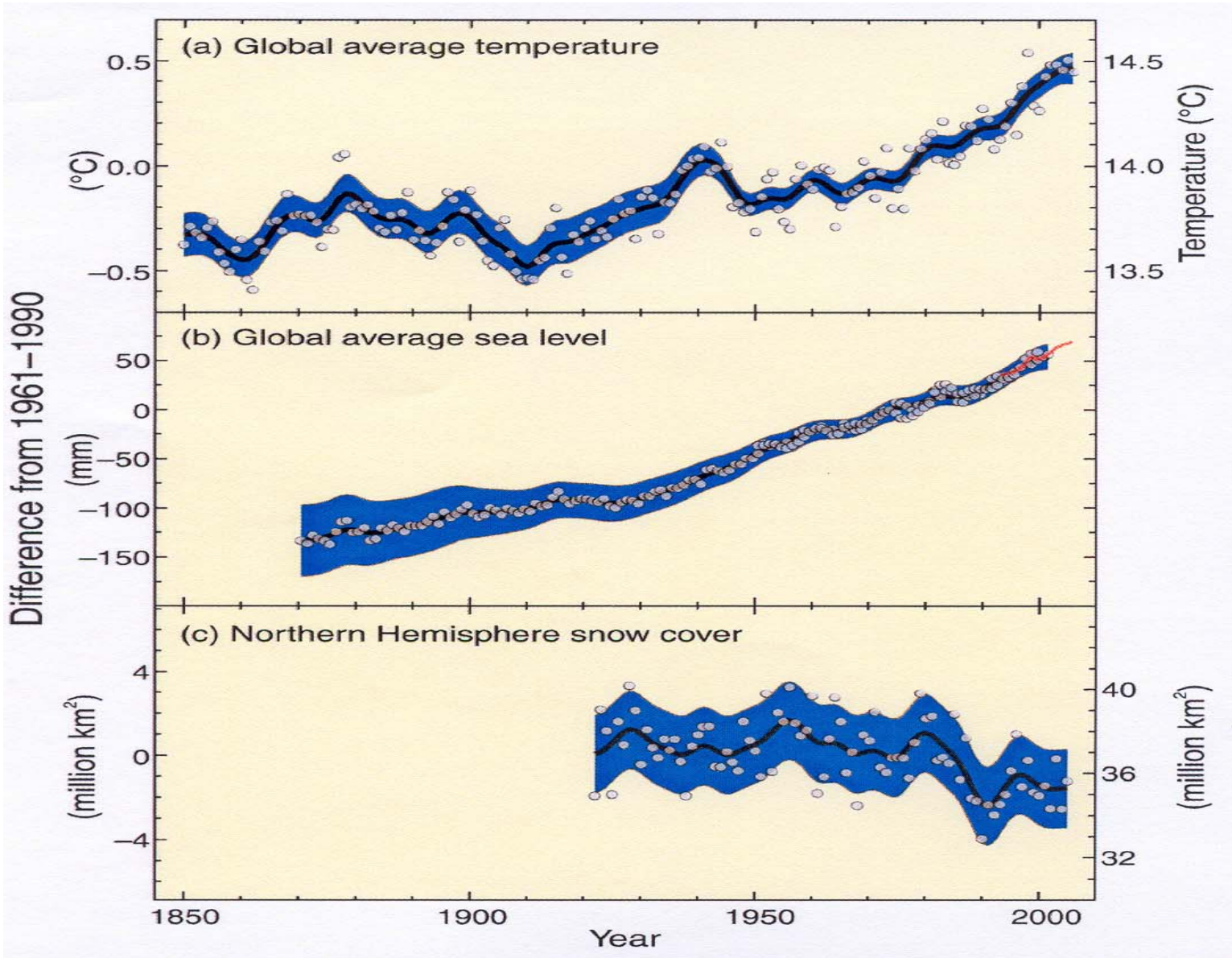
The GDP of China has increased substantially over the last 30 years, but a parallel increase has resulted in the emissions of CO_2



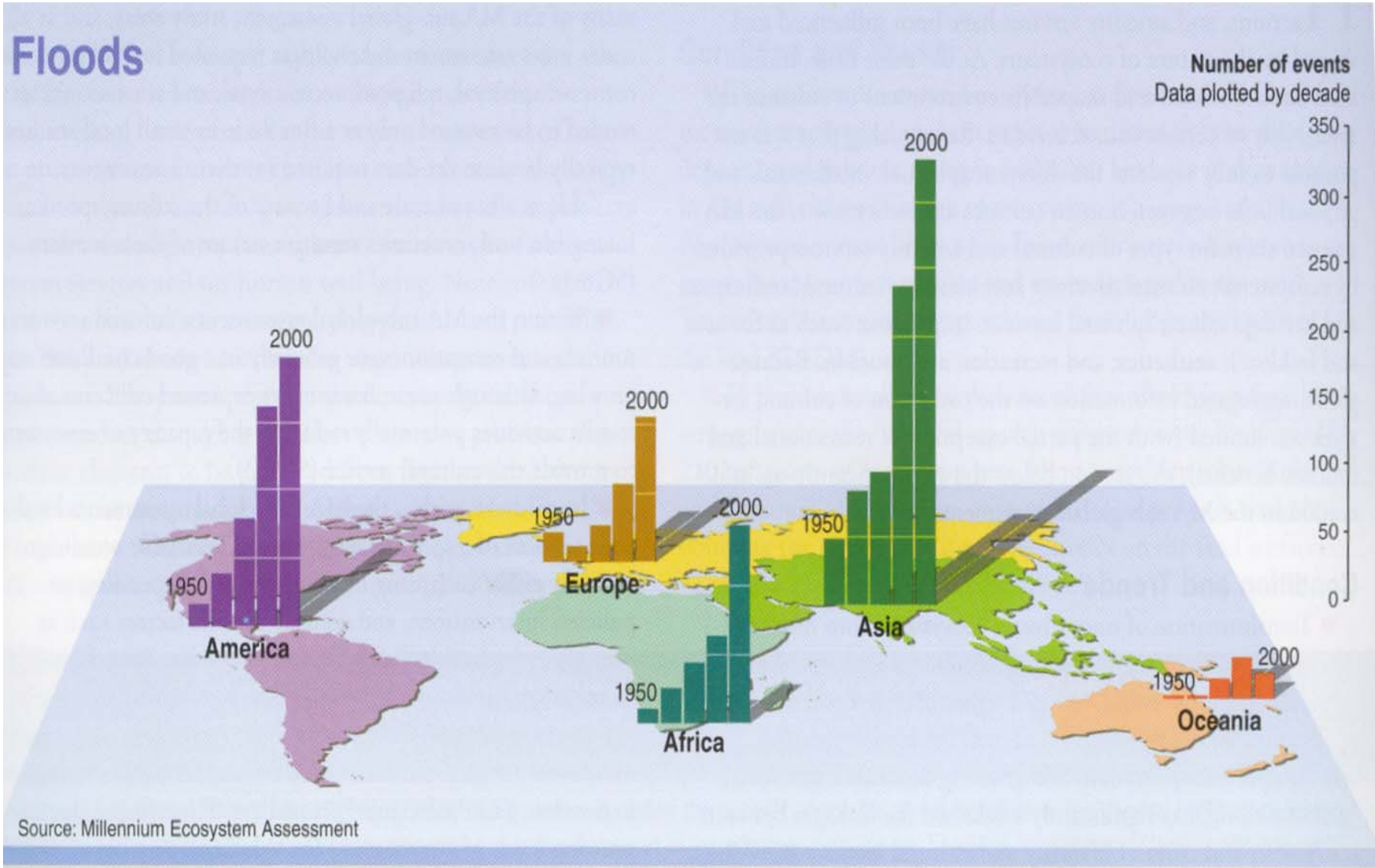
Increase of CO_2 in the atmosphere in the last two centuries (from the constant value of 280 ppm it has reached 400 ppm today)



Measurements of the global average temperature, global average sea level, and Northern Hemisphere snow cover



Floods per decade in the various continents since 1950



- **The main categories of primary sources of energy at our disposal today**

  - ***Fossil fuels***, mainly coal, oil and natural gas.

  - ***Renewable energy sources***, mostly hydroelectric, solar, wind, geothermal, and biomass.

  - ***Nuclear power***, from nuclear fission and, in the future from nuclear fusion.

- **Energy potential and corresponding environmental/climatic impacts of the primary sources of energy**

World consumption of energy from primary sources per fuel kind, 2004

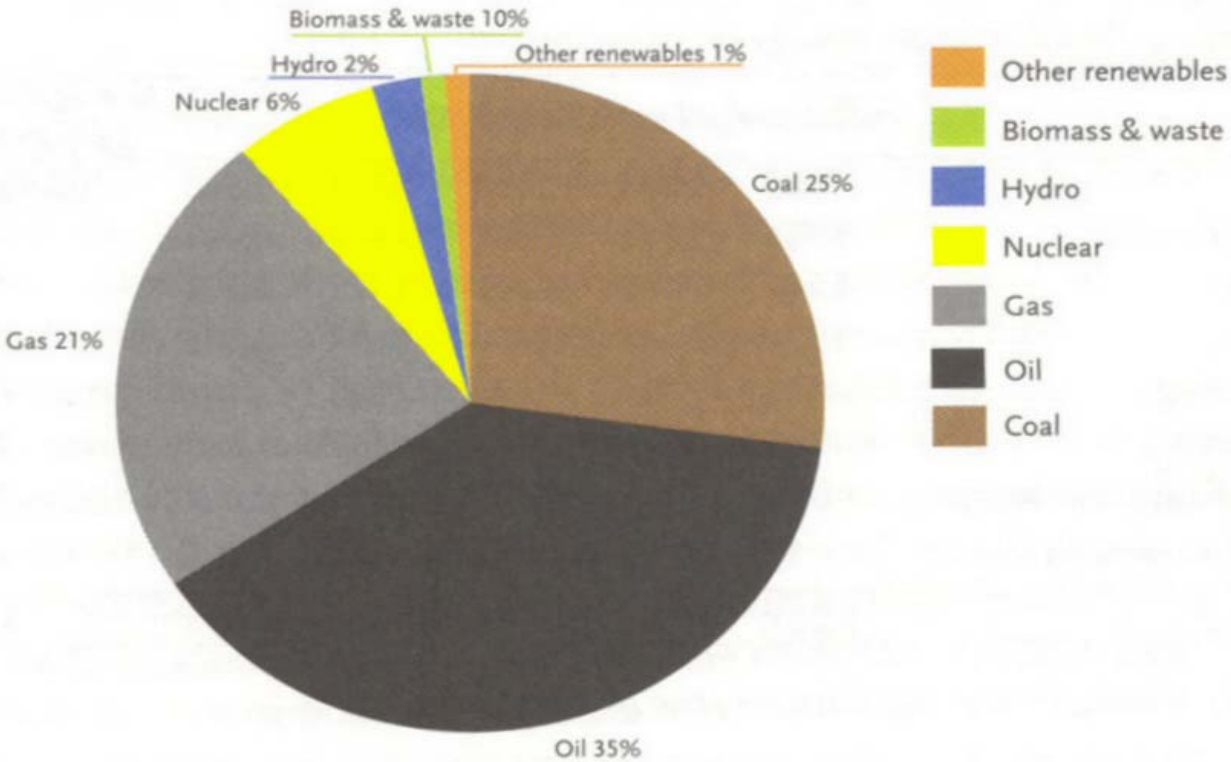
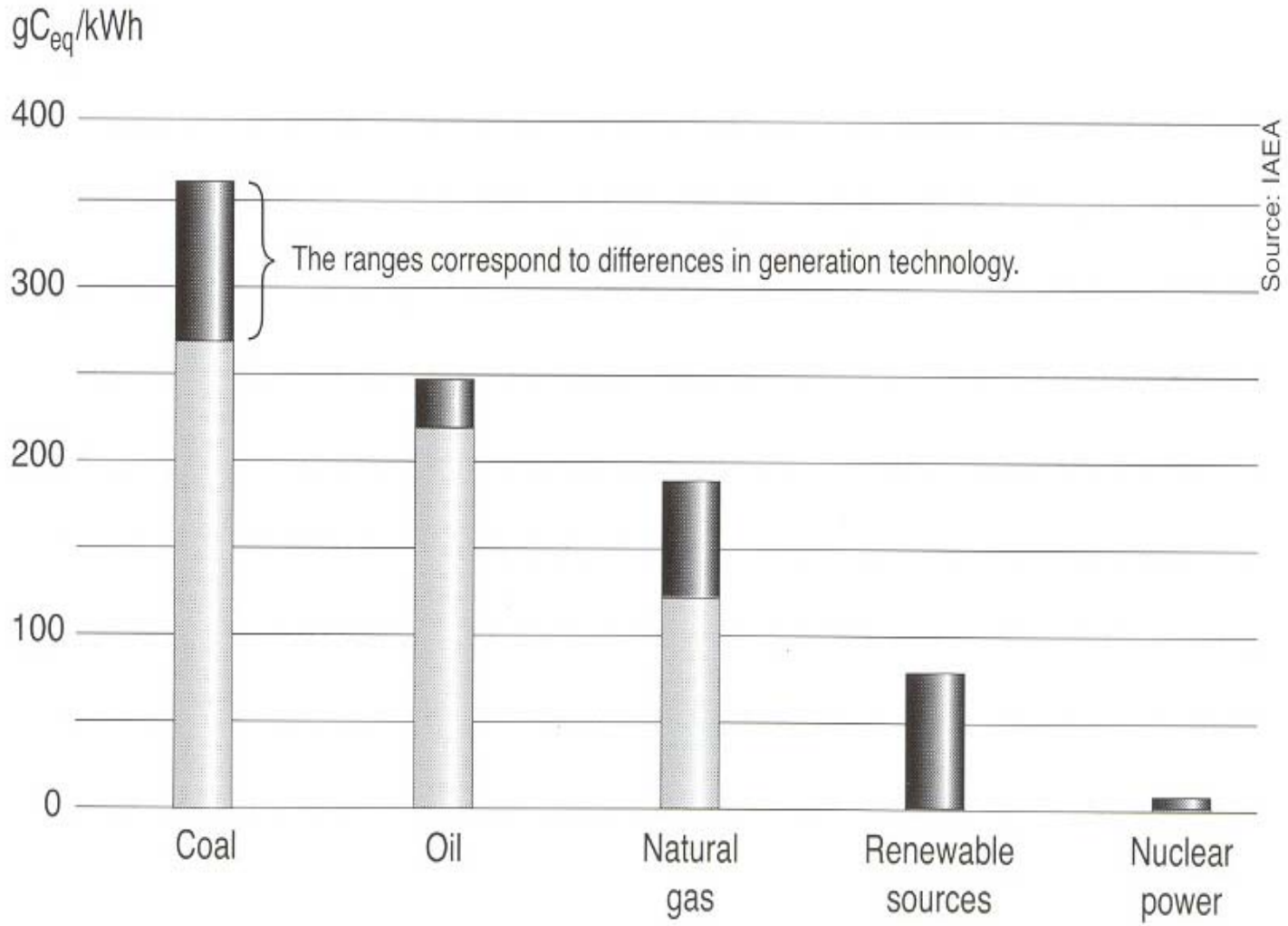


Figure 1.3 World primary energy consumption by fuel, 2004

Note: Total world primary energy consumption in 2004 was 11,204 megatons oil equivalent (or 448 exajoules).

Total emission of greenhouse gases in the production of electricity from various primary sources



Consumption, proven reserves, and lifetime of fossil fuels

Fossil fuel	Consumption (EJ) (1860-2006)	Proven reserves (EJ) (end of 2006)	Lifetime of proven reserves at present consumption (years)
Oil	6.380	6.888	41 (92%)
Natural Gas	3.163	7.104	63 (45%)
Coal	6.867	19.404	147 (35%)

- Even if the burning of fossil fuels is limited to the now known reserves, the consequence of burning these fuels will double the amount of CO_2 in the atmosphere.

- *The substantial increase in the use of coal in the future is incompatible with efforts to stabilize CO_2 concentrations in the atmosphere and carries with it unacceptable risks for climate change.*

- New technologies are needed, which will allow the use of fossil fuels in ways compatible with the reduction of environmental and climatic risks.

  - Better combustion and more effective capture and storage of CO_2.
  - Energy conservation and higher energy efficiency.
  - Sources of energy more environmentally friendly.

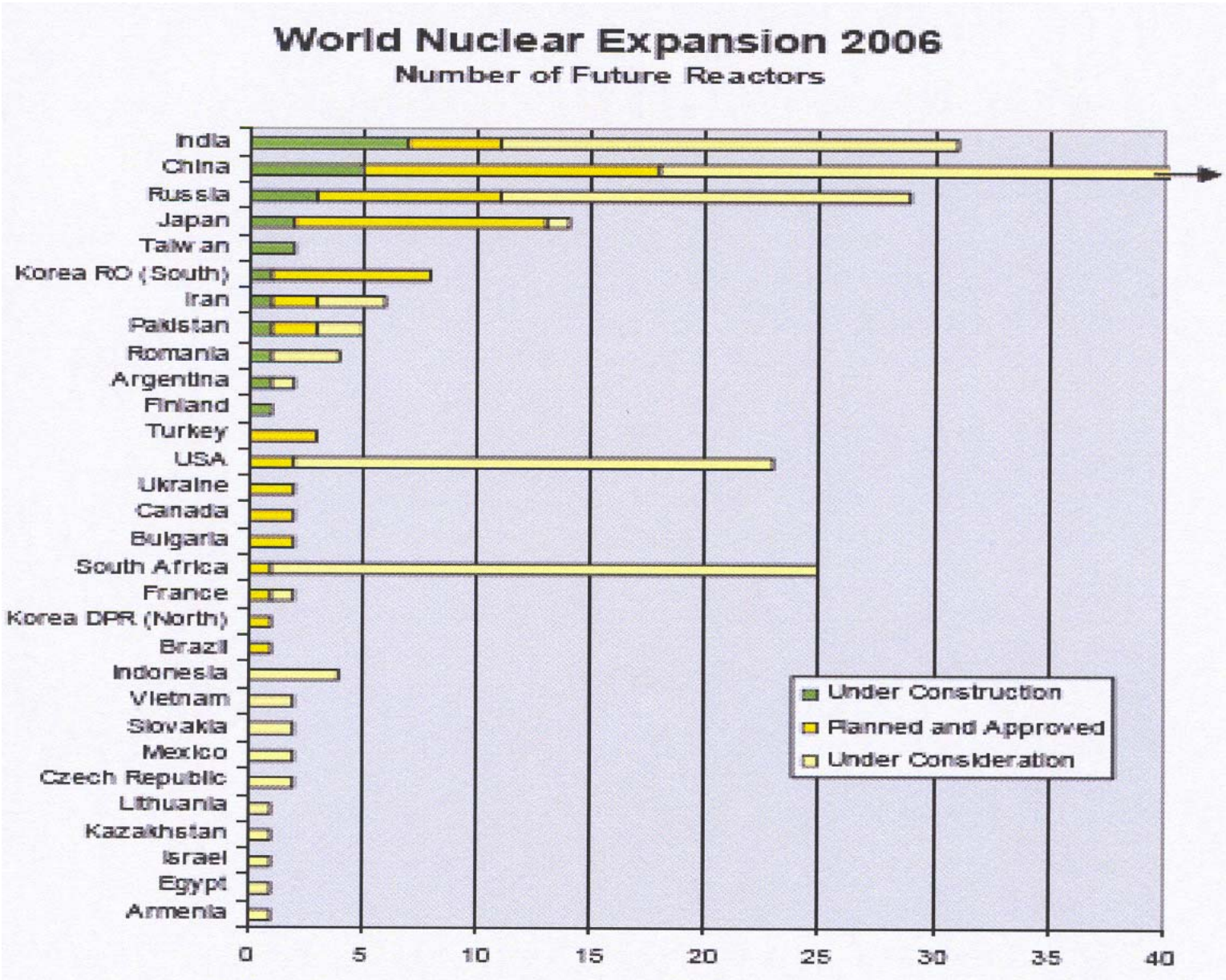
Renewable energy sources

Modern renewable energy: production (EJ) and growth rate (2001-2005) in % per year (InterAcademy Council, 2007)

Source/Technology	**Production** (2005)	Growth rate (2001-2005)
• Modern biomass energy	9,18	2,5
• Geothermal energy	1,18	18,4
• Small hydropower	2,08	27,5
• Wind electricity	1,86	26,6
• Solar energy	2,96	41,8
• Marine energy	0,01	0,5
• Total Modern Renewables (**TMR**)	**17,3**	11,5
• Total Primary Energy Supply (**TPES**)	**477,1**	1,6
• **TMR / TPES (%)**	**3,6 (13,6)[a]**	

Nuclear power from fission

Tens of new nuclear reactors are today under construction in many countries and hundreds have been approved or are planned



Nuclear power from nuclear fusion

- $D + T \rightarrow He_4 + n$

- **Most difficult problem: thermonuclear plasma confinement**

- **Unlikely before the middle of the 21rst century**

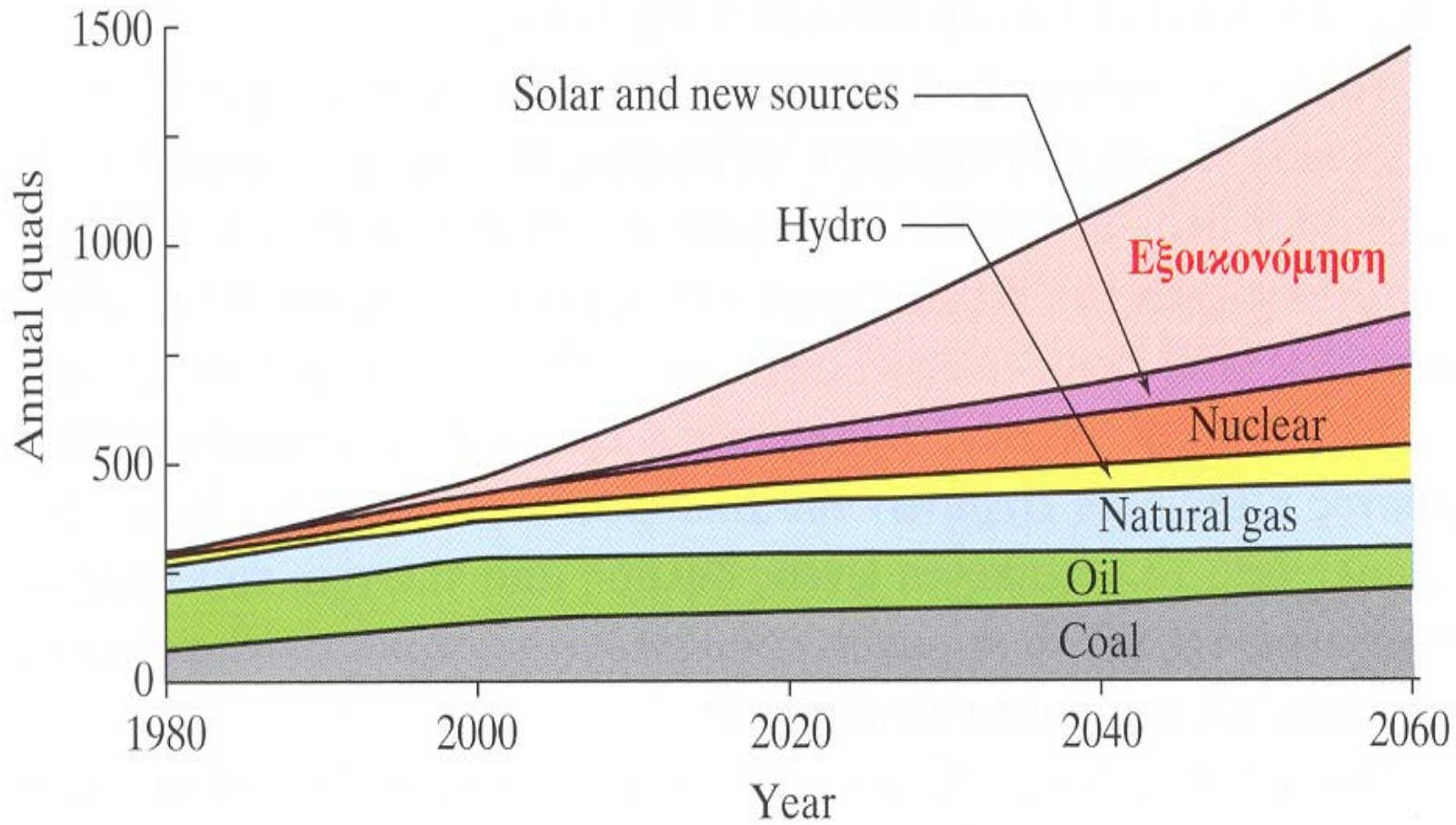
- **Inexhaustible; Possibly the principal sustainable source of energy for humankind in the future**

- **Man's efforts to generate on Earth conditions for fusion, such as those occurring naturally on the sun, will one day be realized. For this kind of fire, as for that from fission, man has to become more responsible.**

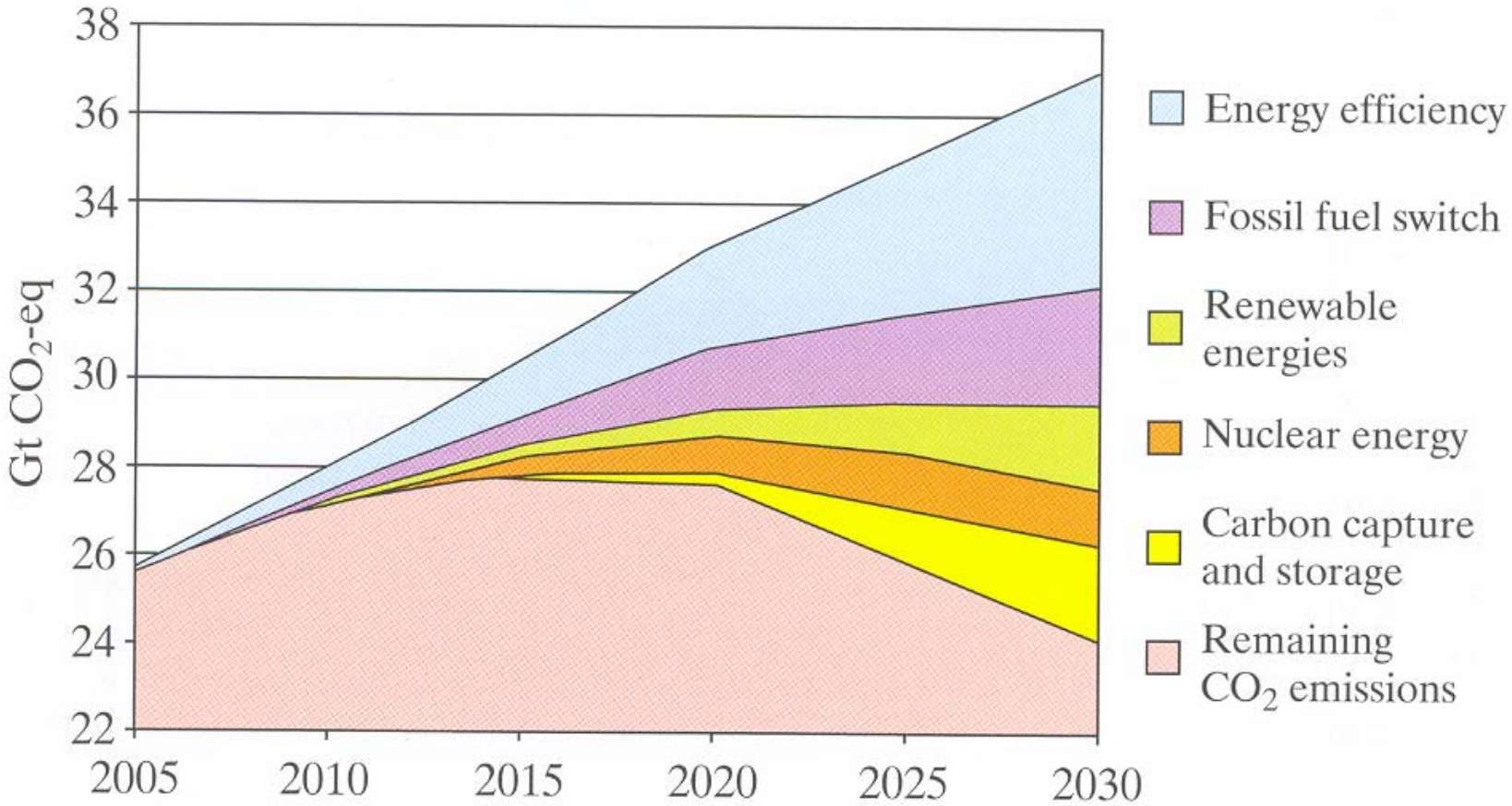
Energy conservation

As an energy source and as a “technology” for reduction of greenhouse gases

Energy conservation: possibly the most important source of energy



Energy conservation is predicted to be the most significant "technology" for reducing CO_2 emissions from combustion (European Commission, 2007)

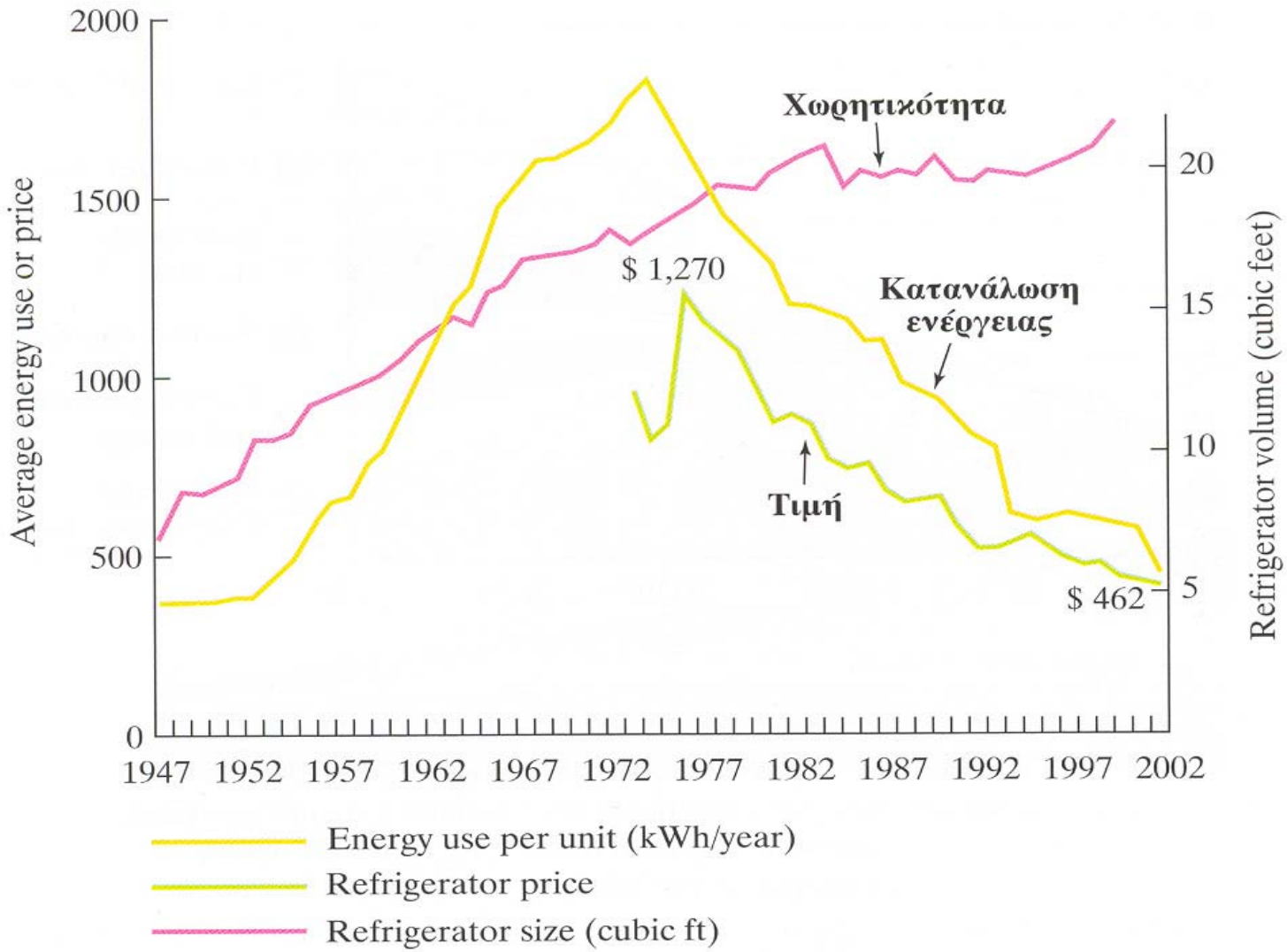


Source: JRC-IPTS, POLES

The importance of technology and scientific research

- **Refrigerators**
- **Environmentally friendly and efficient ways to transmit and distribute electrical energy**
- **Efficient ways to convert the photons of solar radiation to electrical energy, fuels, or heat.**

Energy use per unit, refrigerator price, and refrigerator size in the USA



Gas-insulated cables for transmission of electricity located in a tunnel, insulated with gaseous dielectrics developed by recent basic and applied research

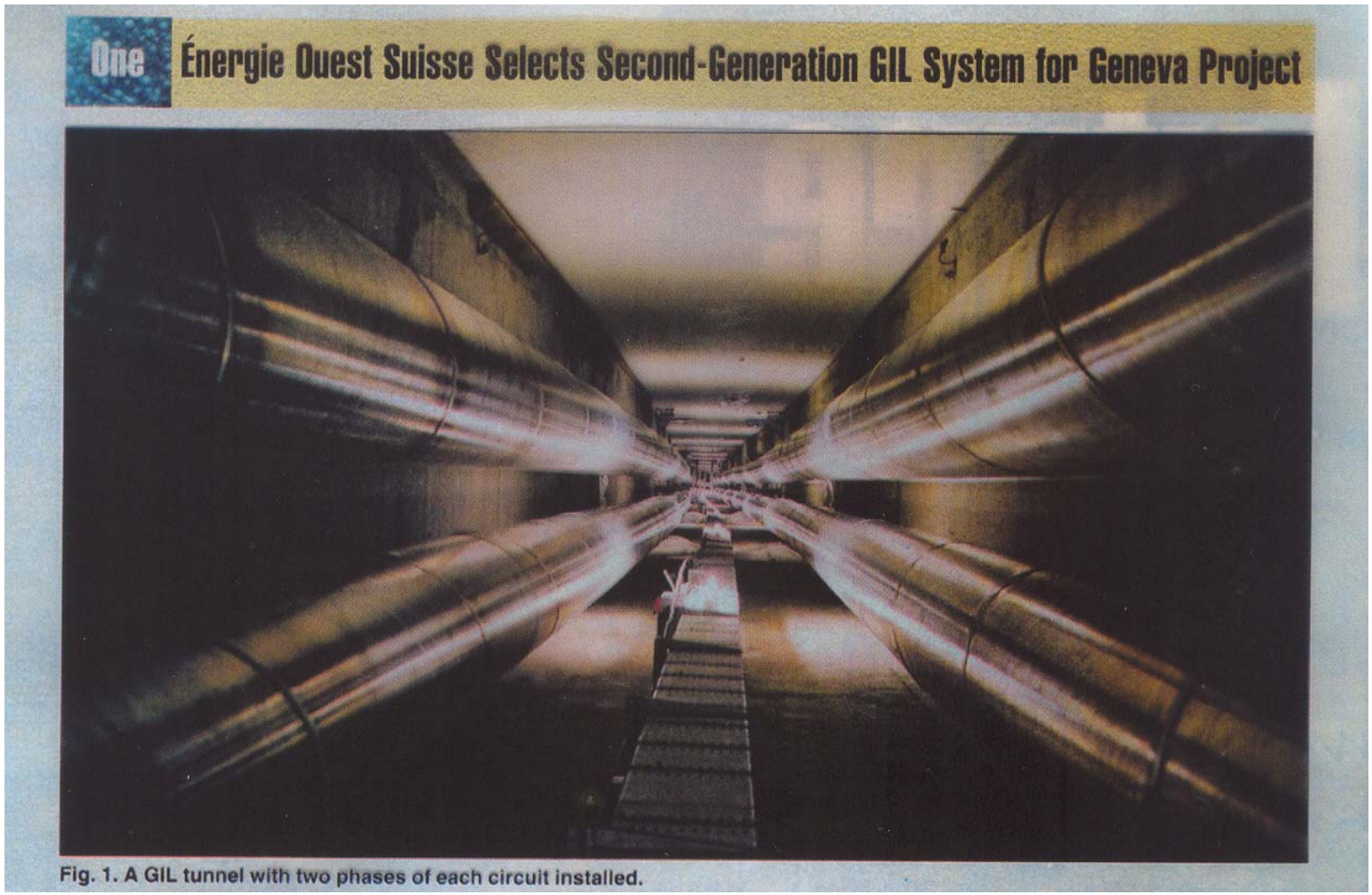


Fig. 1. A GIL tunnel with two phases of each circuit installed.

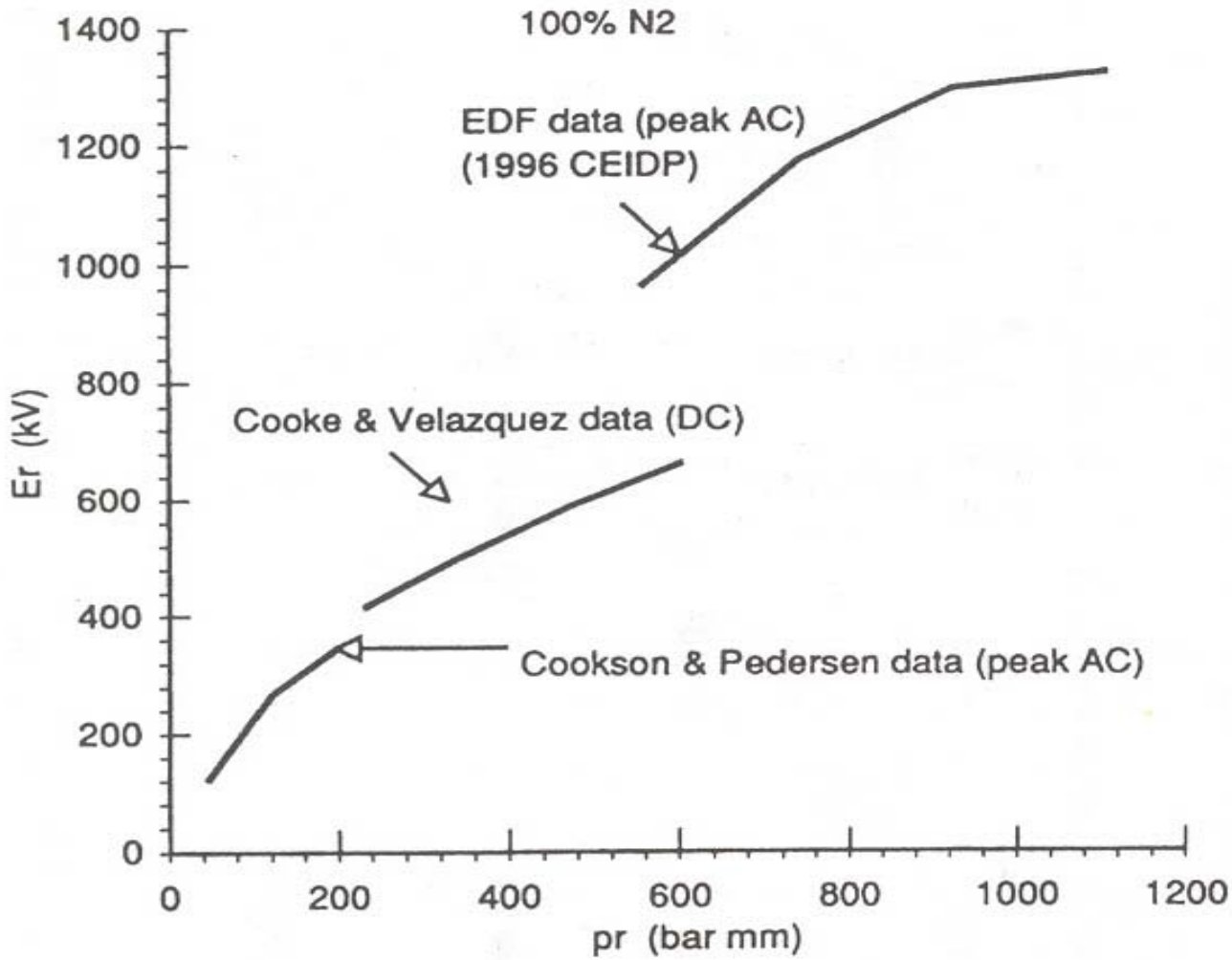


FIG. 16. Breakdown voltage Er vs Pr (r is the radius of the inner conductor) for cylindrical electrode geometries (similarity plot) for pure nitrogen [34]. Data of Pace et al. [34], Cooke and Velazquez [95], and Cookson and Pedersen [37].

Conclusions

- **There are no easy and simple answers to the problems of energy and the environment. There are only needs, potential solutions and hard choices.**

- **To choose wisely we would need every energy source we can develop and knowledge to assess its societal benefit and its impact on the environment.**

- **The fundamental character of energy and the environment, their significance for sustainable development, and their mutual dependence require coordinated and sustained action by both government and society.**

- **As the actions of each one of us, in their totality, are responsible for the deterioration of the environment and the climatic changes, so the prudent and wise use of energy by each one of us can, in its totality, help the environment recover and slow down the climatic change.**