

# Long-term potential of fusion power in Western Europe - retrospect of an earlier study

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# Introduction

- Socio Economic Research on Fusion: SERF, 1998, EU sponsored
- Macro task ‘Long-term scenarios’, with contributions from:
  - \* ECN Policy Studies
  - \* FZ Jülich
  - \* AG Wärmetechnik (Gilli & Kurz, Austria)
  - \* Risø (Denmark)
  - \* CEA-Lemme (France)
- Activities showed some overlap, e.g., analysis of long-term scenarios. However, this proved to be advantageous after all
- ECN Policy Studies integrated work of FZ Jülich and AG Wärmetechnik with special emphasis on the environment



# Views from long-term energy scenarios

- Reasons for neglect of fusion power:
  - not commercially available before 2050
  - technical feasibility to be demonstrated
- Two main types of scenarios:
  - high-demand driven scenario
  - ecologically driven scenario
- Not obvious that fusion power is more favoured in high-demand driven scenario than in ecologically driven scenario



# Competitors

- Several fossil fuel fired options, e.g.:
  - Coal fired power (conventional, IGCC)
  - Lignite fired power (BoA-Plus, IGCC)
  - Gas fired power:
    - combined cycle
    - fuel cell combined with gas turbine
- Several fission options:
  - Light Water Reactor (EPR, SWR 1000)
  - Fast breeder reactor (EFR)



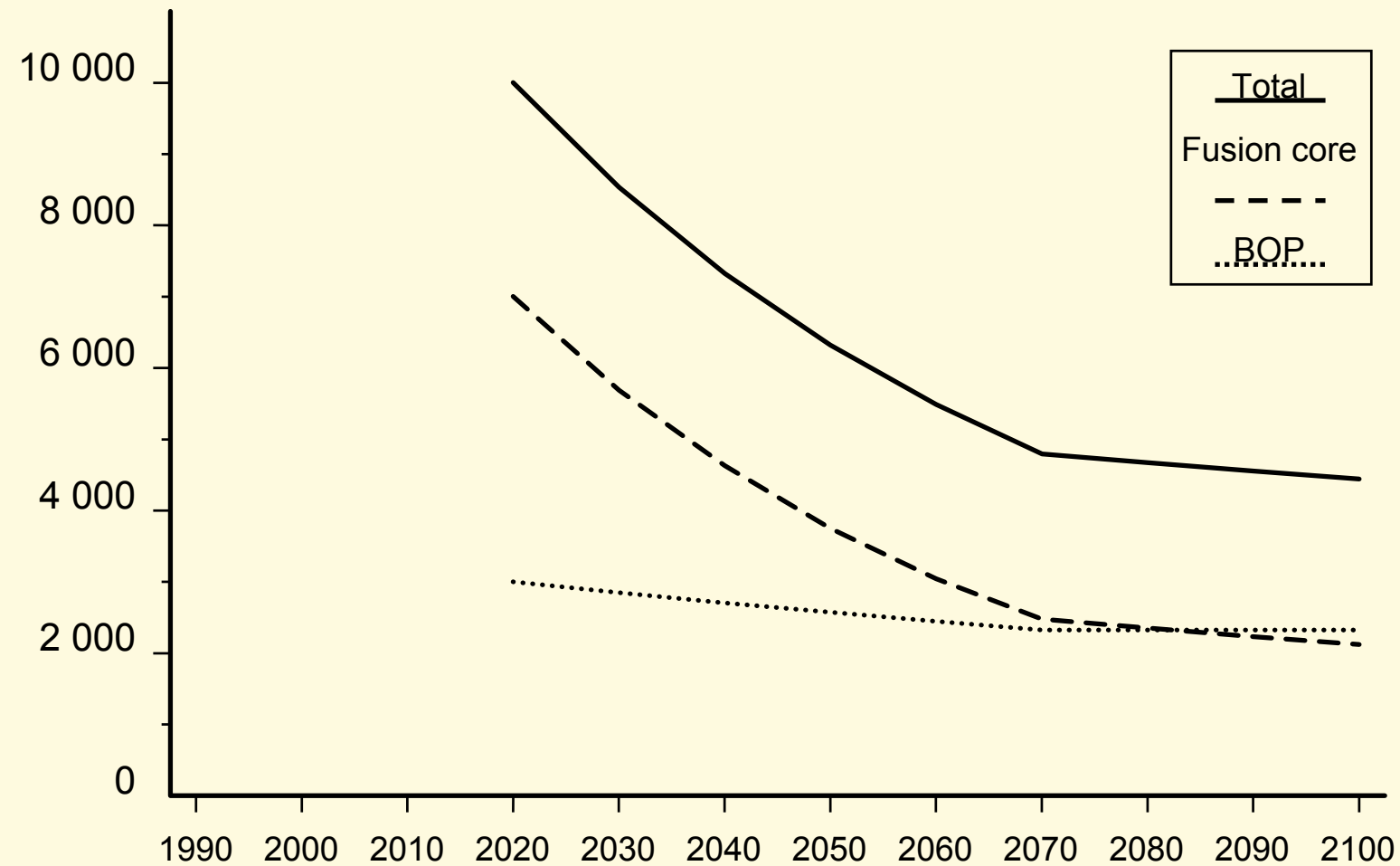
# Exotic power generation options

- ‘Energy Amplifier’ (Carlo Rubbia):
  - Risk of core melt accident eliminated
  - Nuclear waste reduced by 4 orders of magnitude
  - Potential: 10,000 times current world power generation
- ‘MegaPower Tower’, using temperature difference between sea level and at high altitude
- Very large-scale photovoltaic power generation
- Space-based solar power

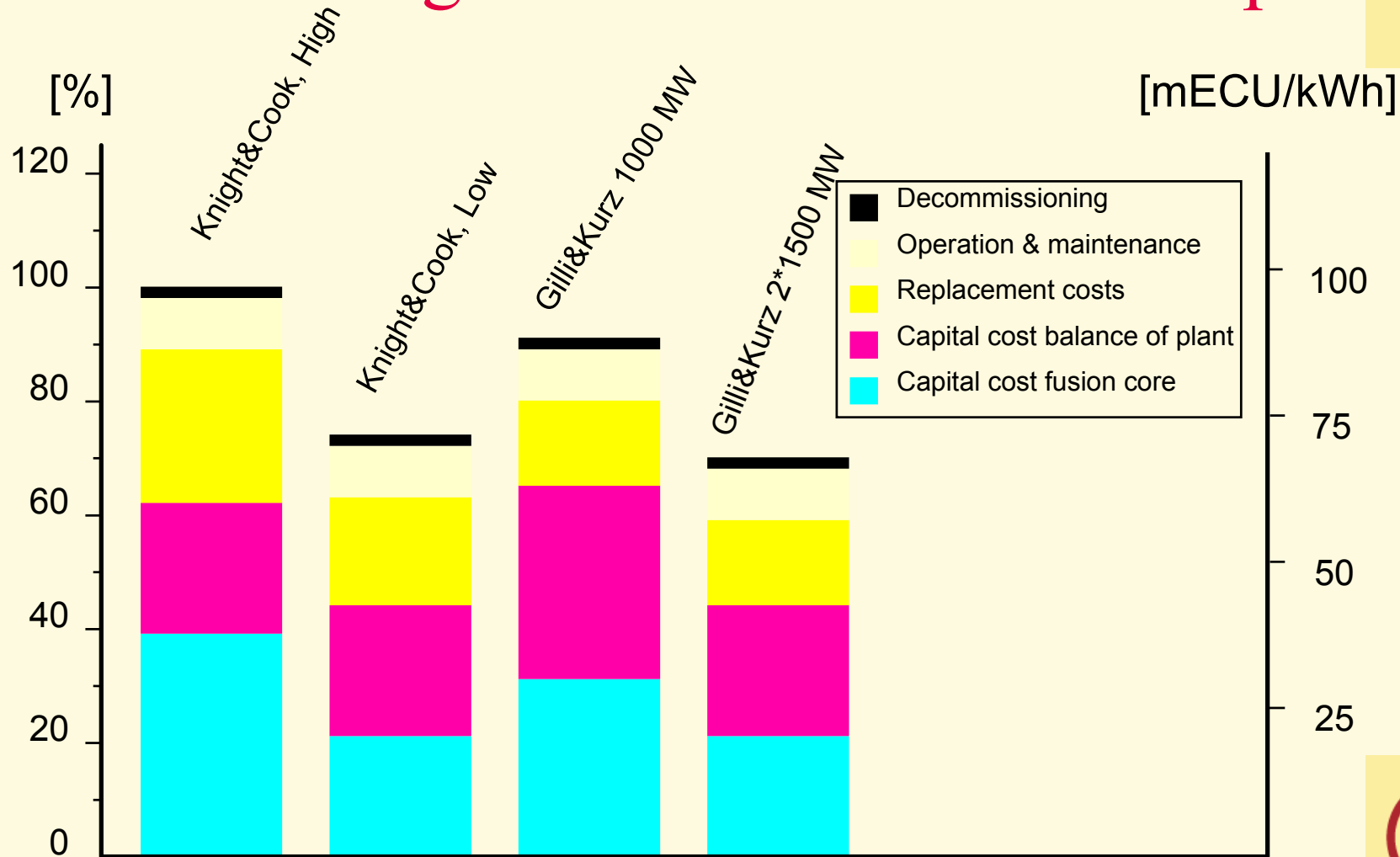


# Investment cost 1000 MW fusion power

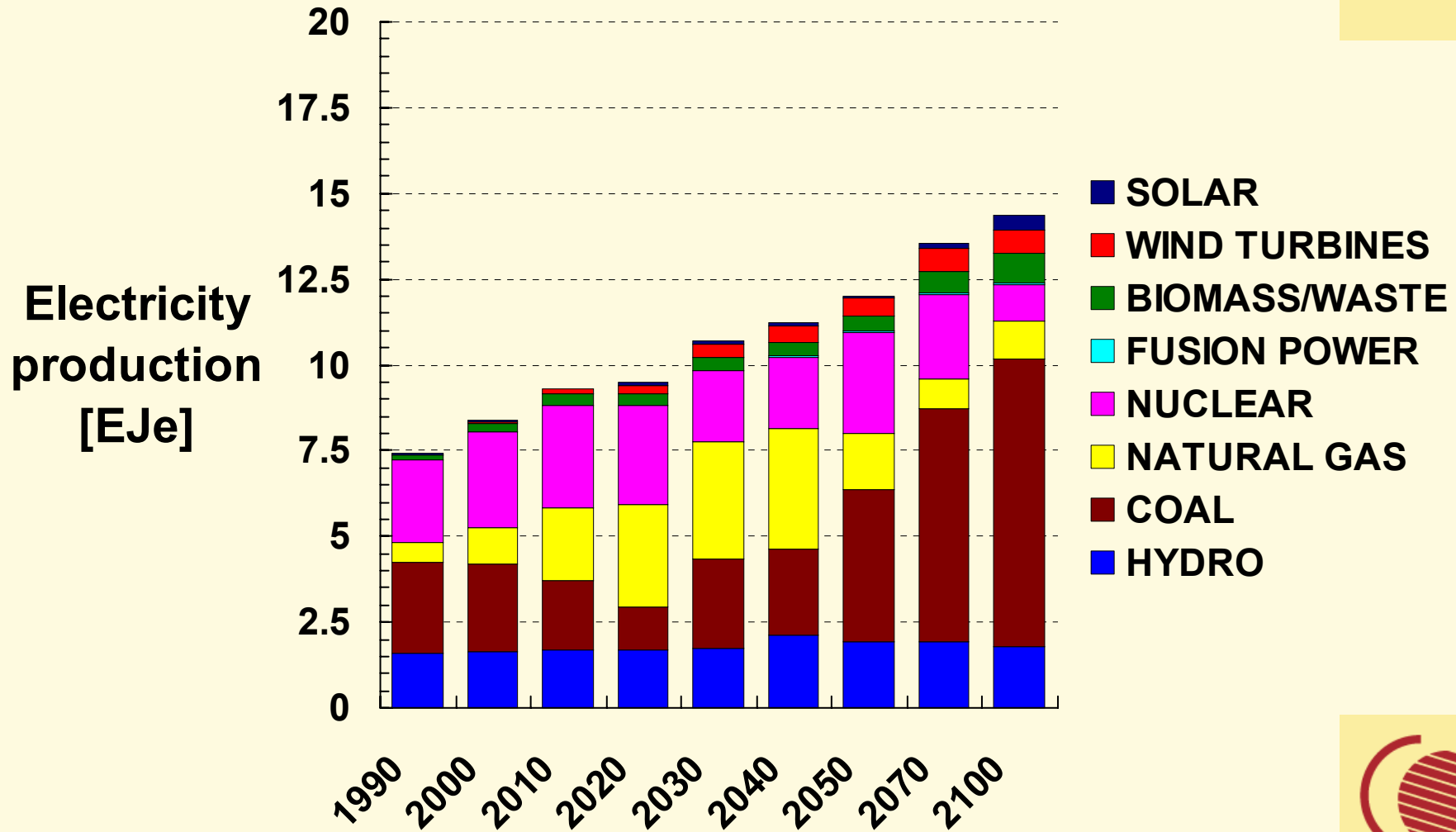
[ECU/kW]



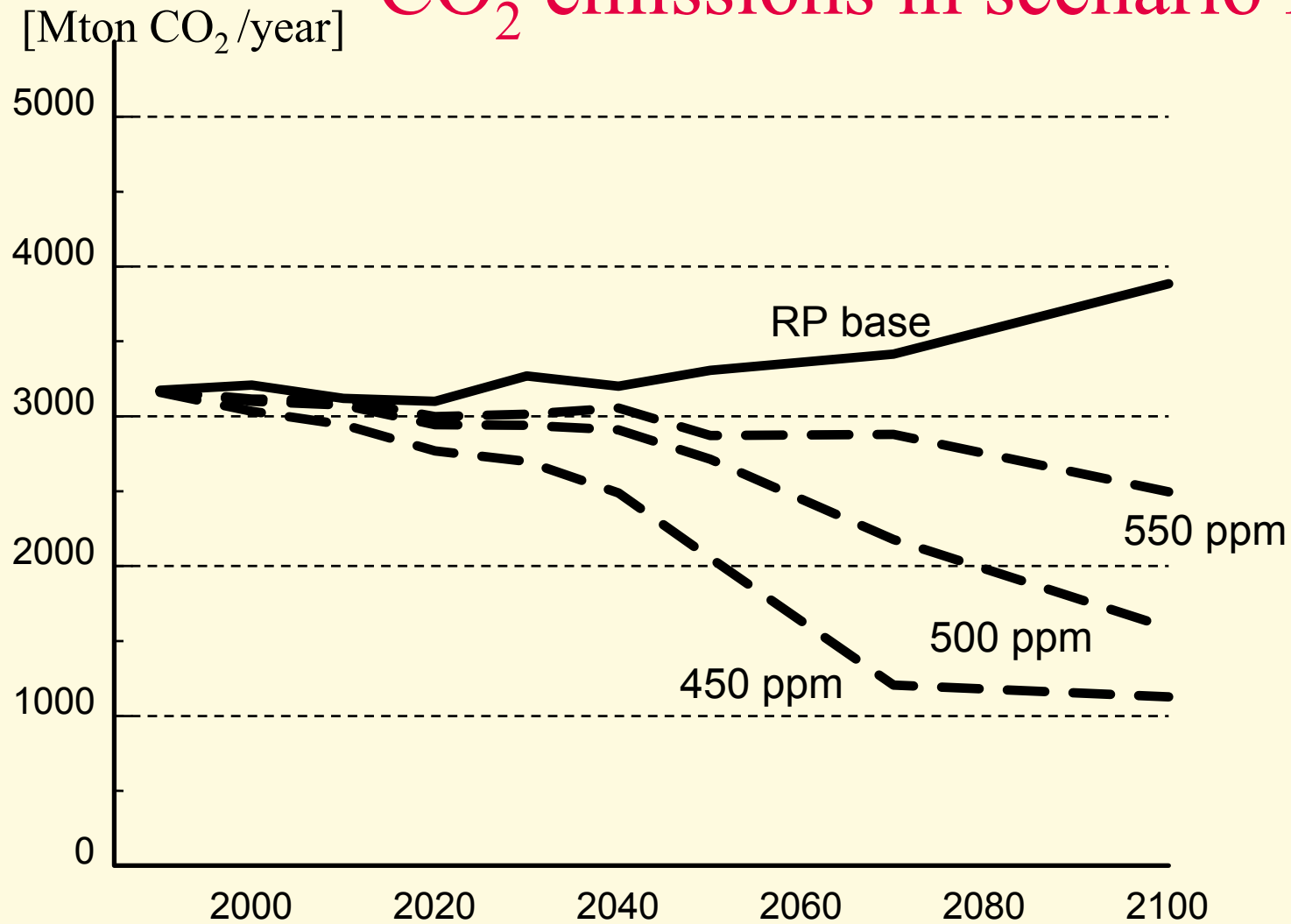
# Power generation cost of fusion power



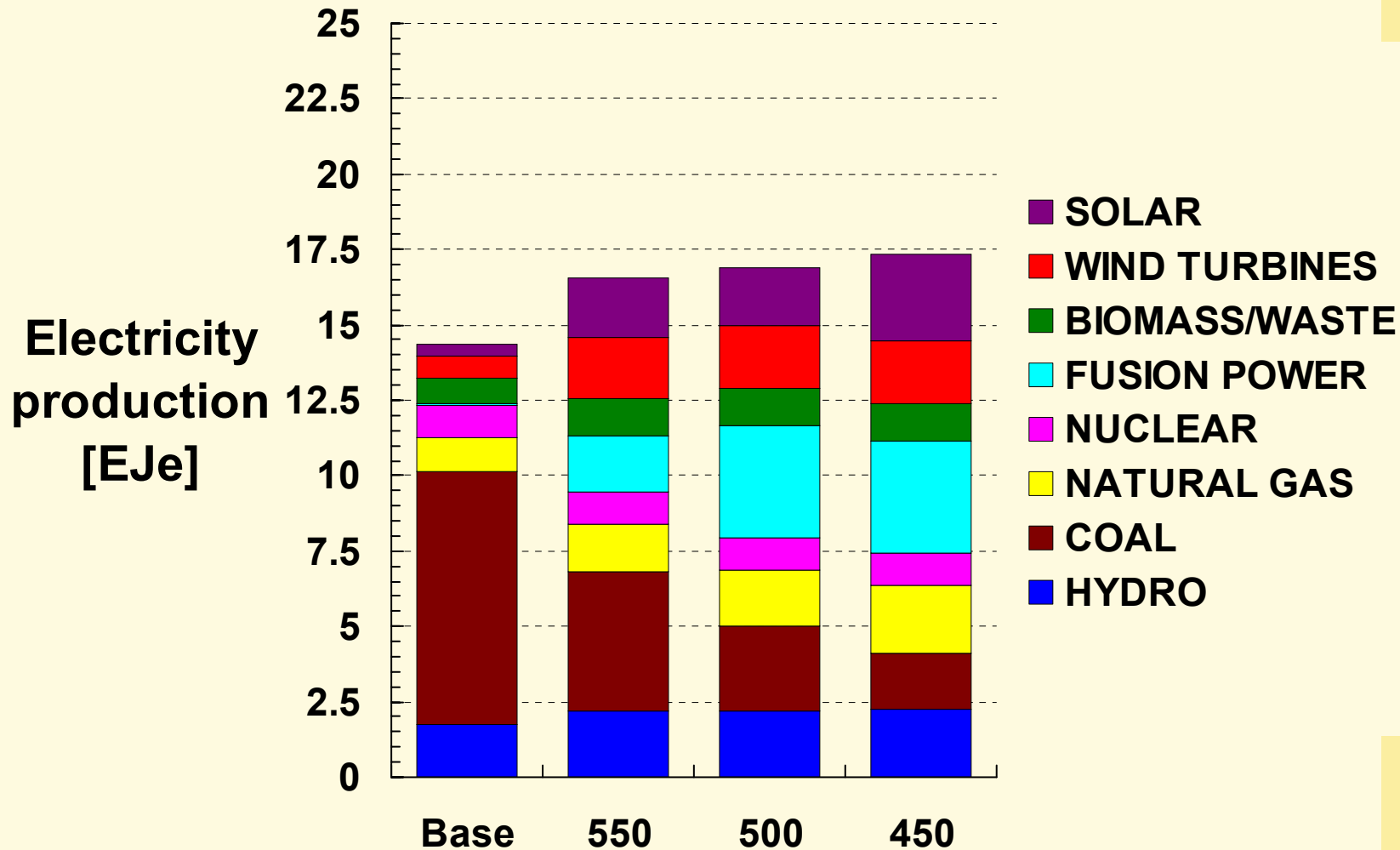
# Scenario RP without stabilisation of CO<sub>2</sub>



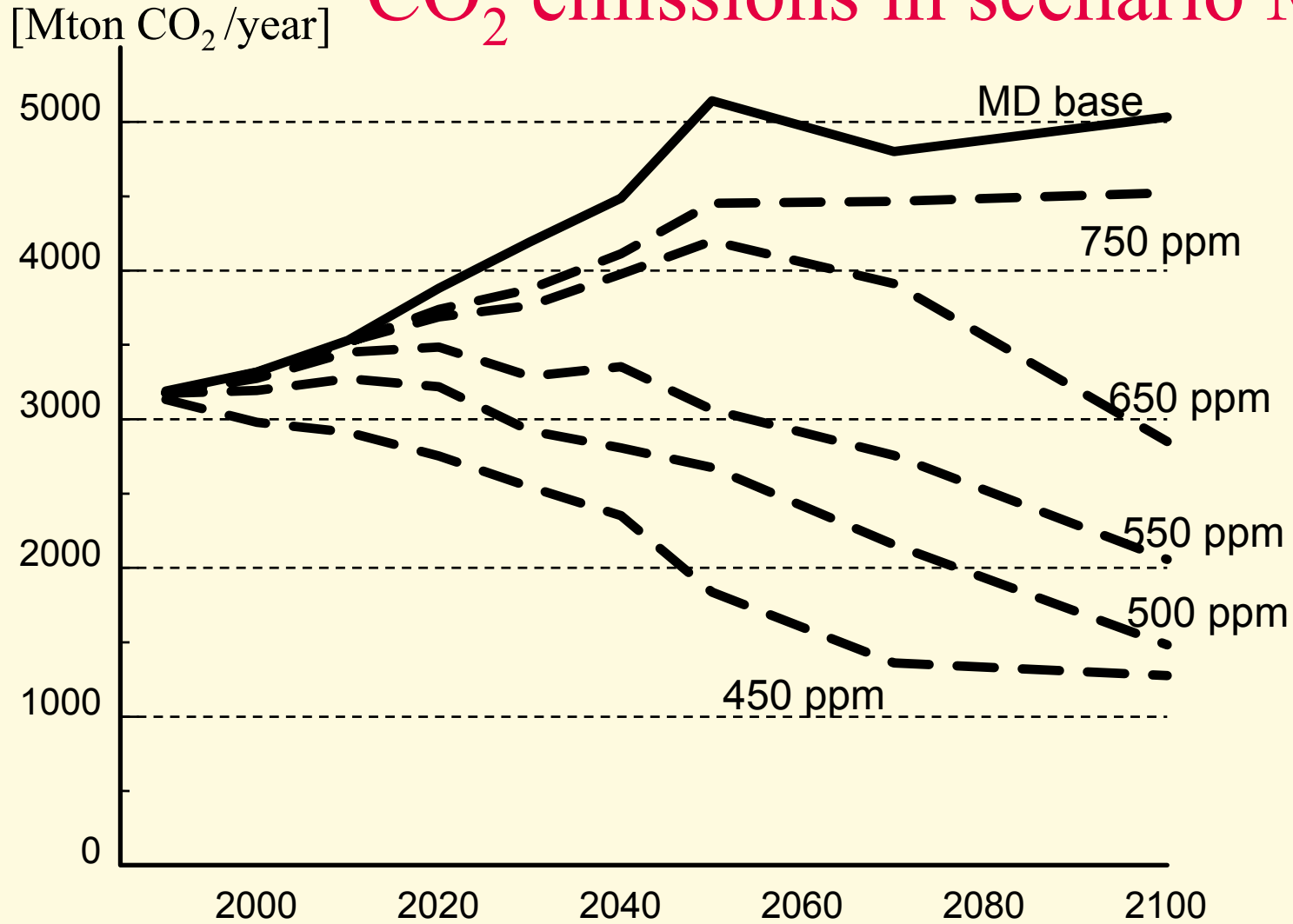
# CO<sub>2</sub> emissions in scenario RP



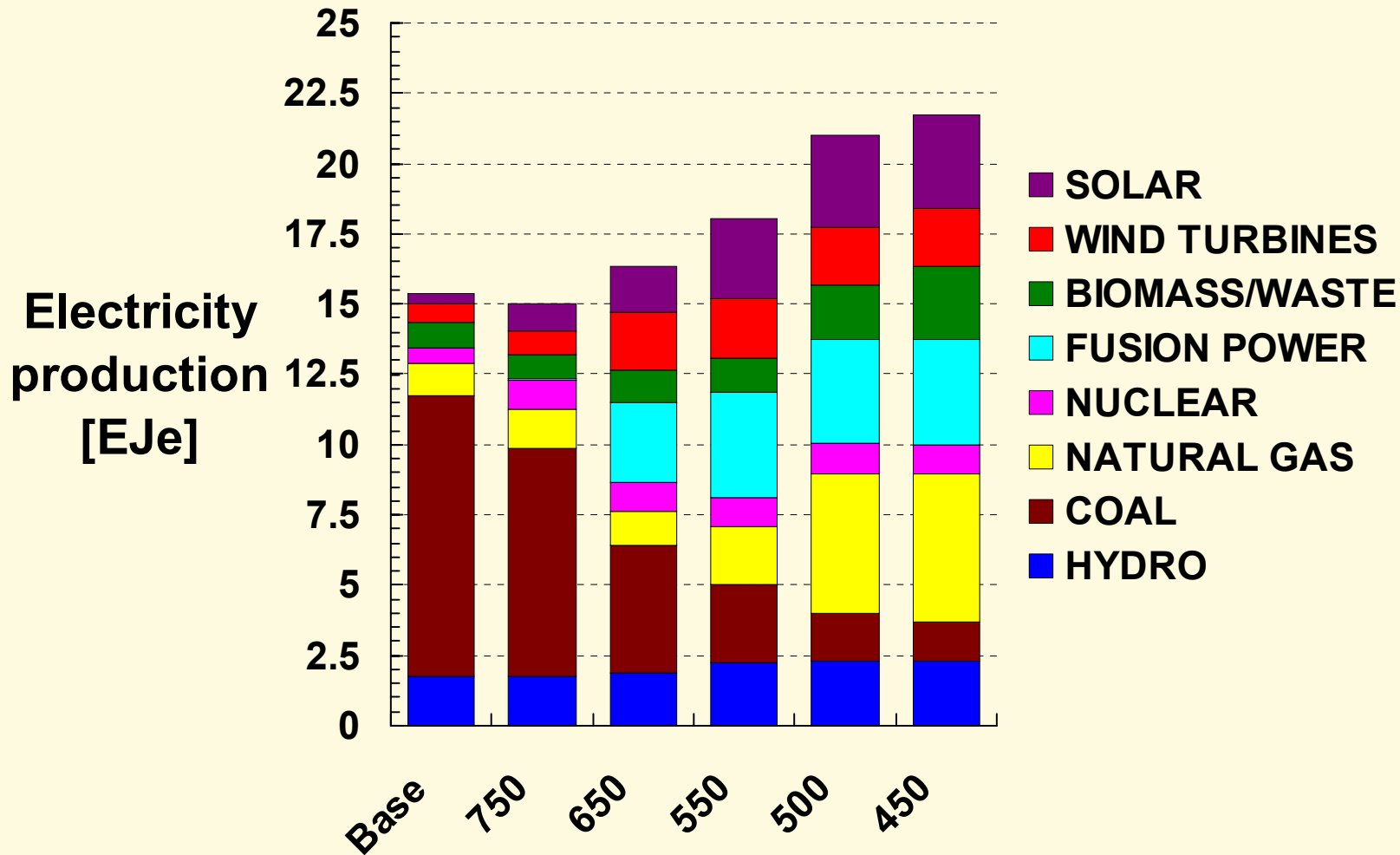
# Scenario variants with various CO<sub>2</sub> limits, RP, 2100



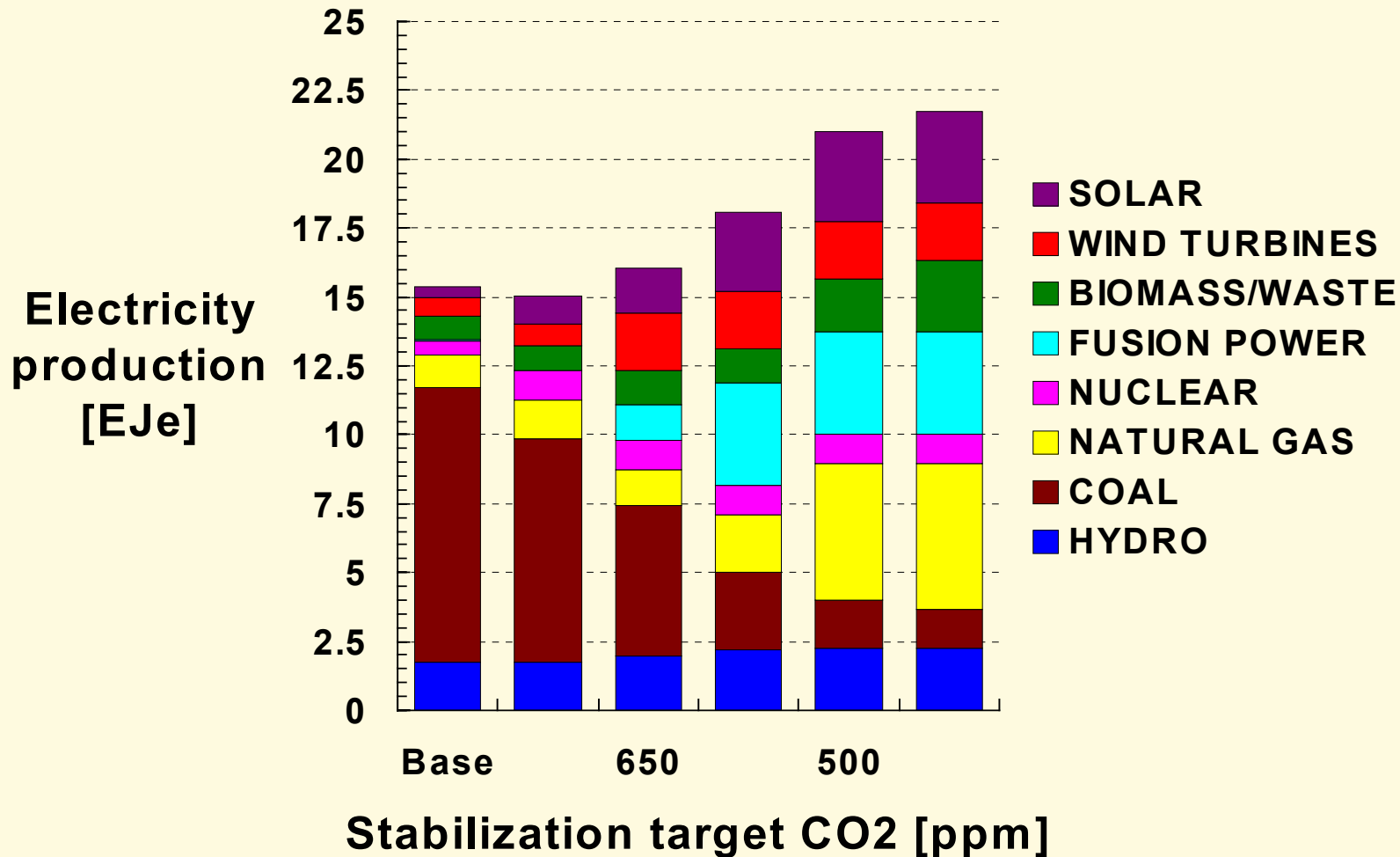
# CO<sub>2</sub> emissions in scenario MD



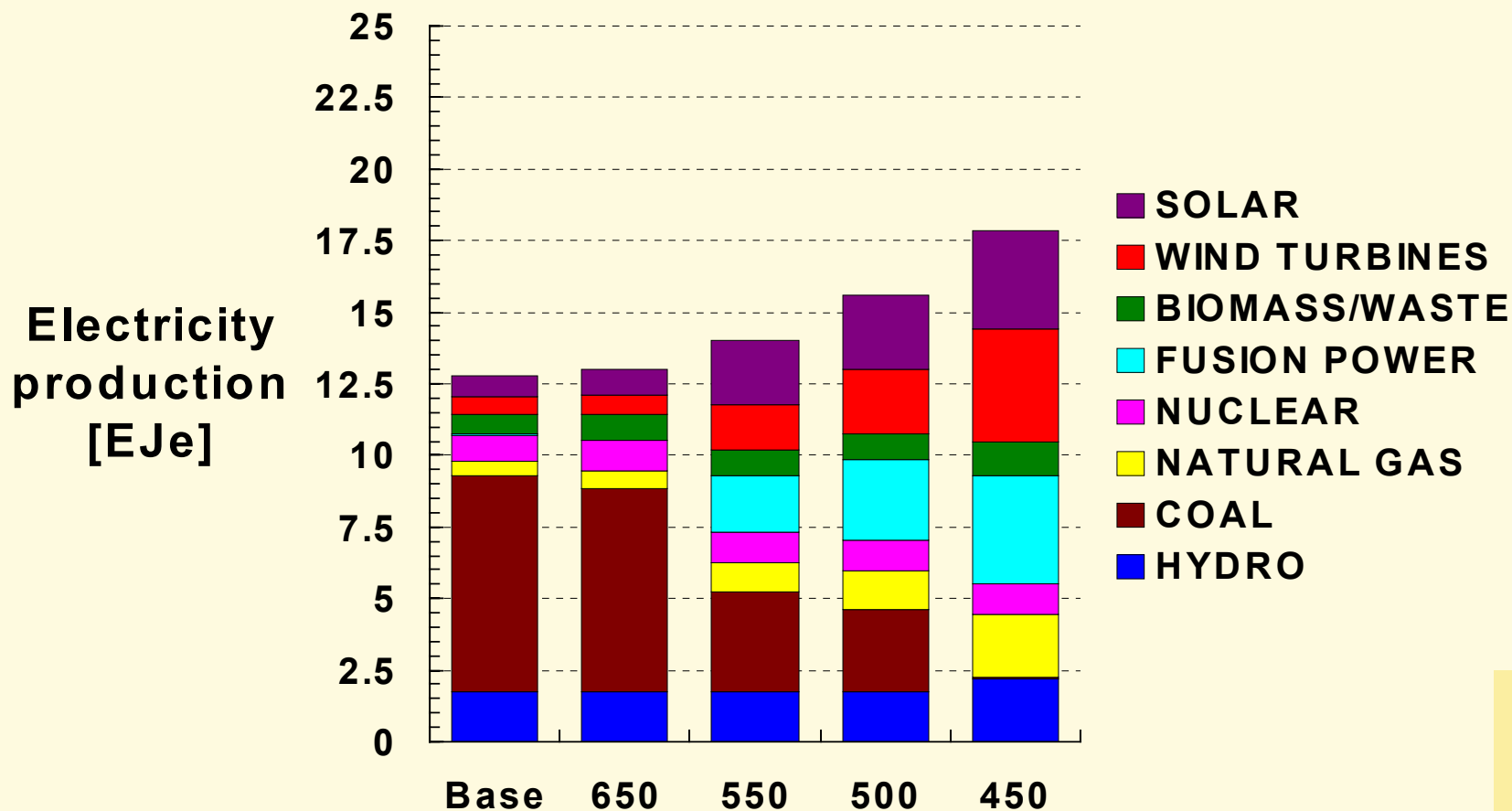
# Scenario variants with various CO<sub>2</sub> limits, MD, 2100



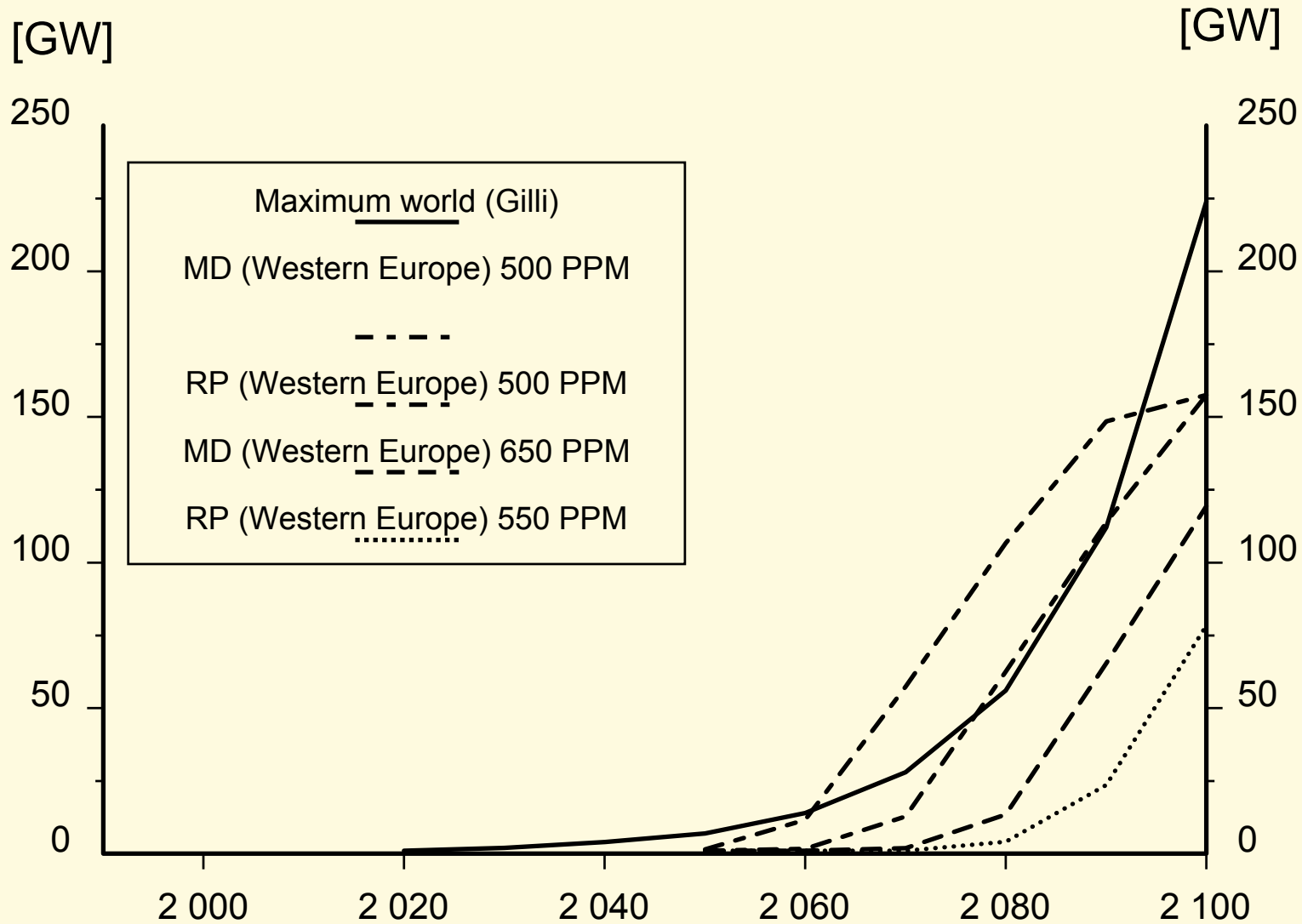
# Scenario variants with various CO<sub>2</sub> limits, scenario MD, high cost of fusion power, 2100



# Scenario variants with various CO<sub>2</sub> limits, scenario MD, high potential of renewables, 2100



# Optimum/maximum potential fusion power



# Short comments

- Kyoto protocol ratified by 127 countries
- Oil remains world's most precarious fossil fuel
- Natural gas has higher Reserves/Production ratio, but still may experience global peak around 2050
- Coal plentiful, should get rid of CO<sub>2</sub> (sequestration)
- Renewables: photovoltaic power at least as costly
- Bounds: potential (onshore wind), intermittency



# Oil (1)

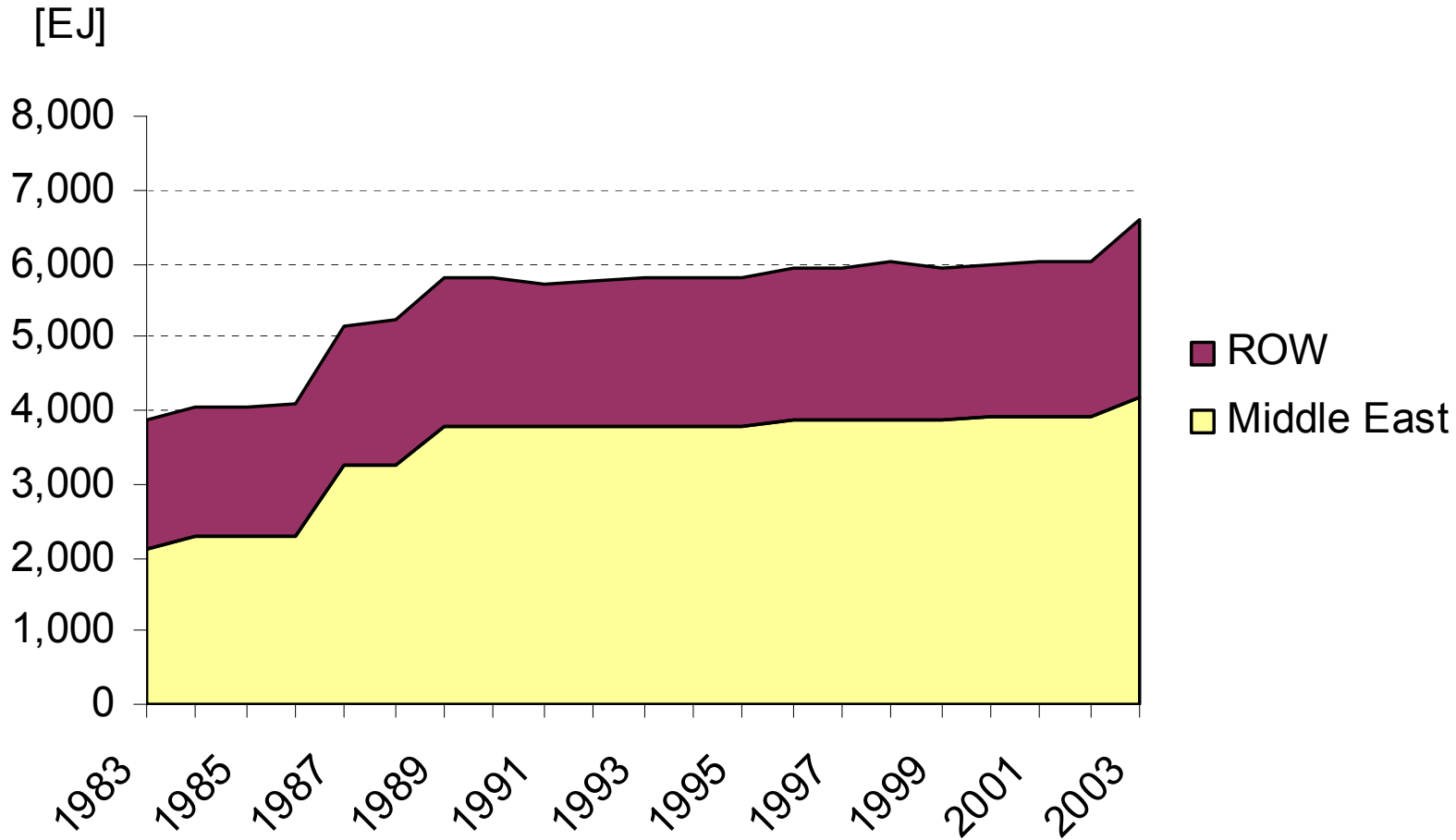


Figure 1 *Proved oil reserves cf. 'BP Statistical Review of World Energy'*

# Oil (2)

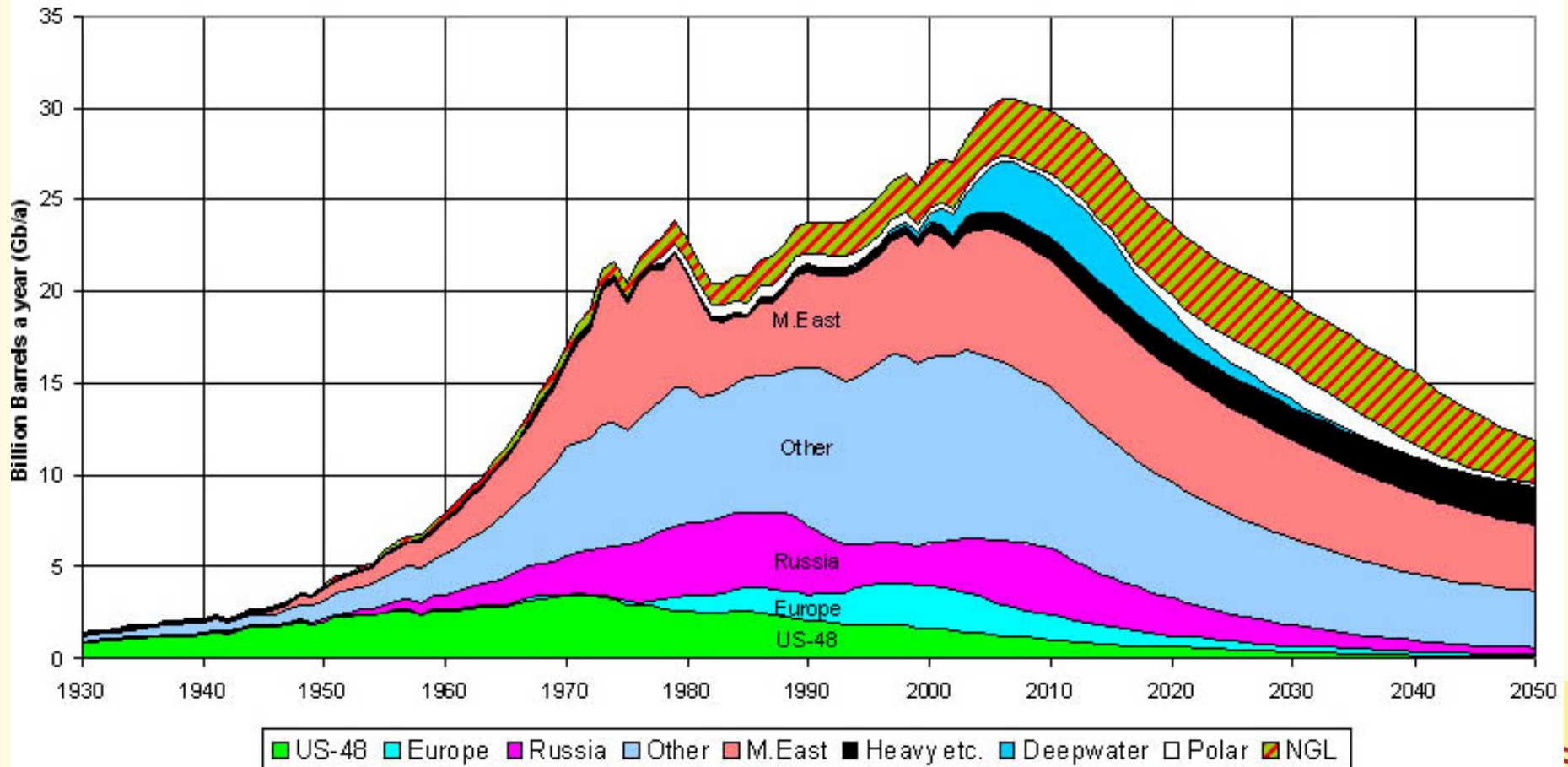


Figure 2 Oil production 1930-2050 by world region cf. Campbell's '2004 scenario'

# Oil (3)

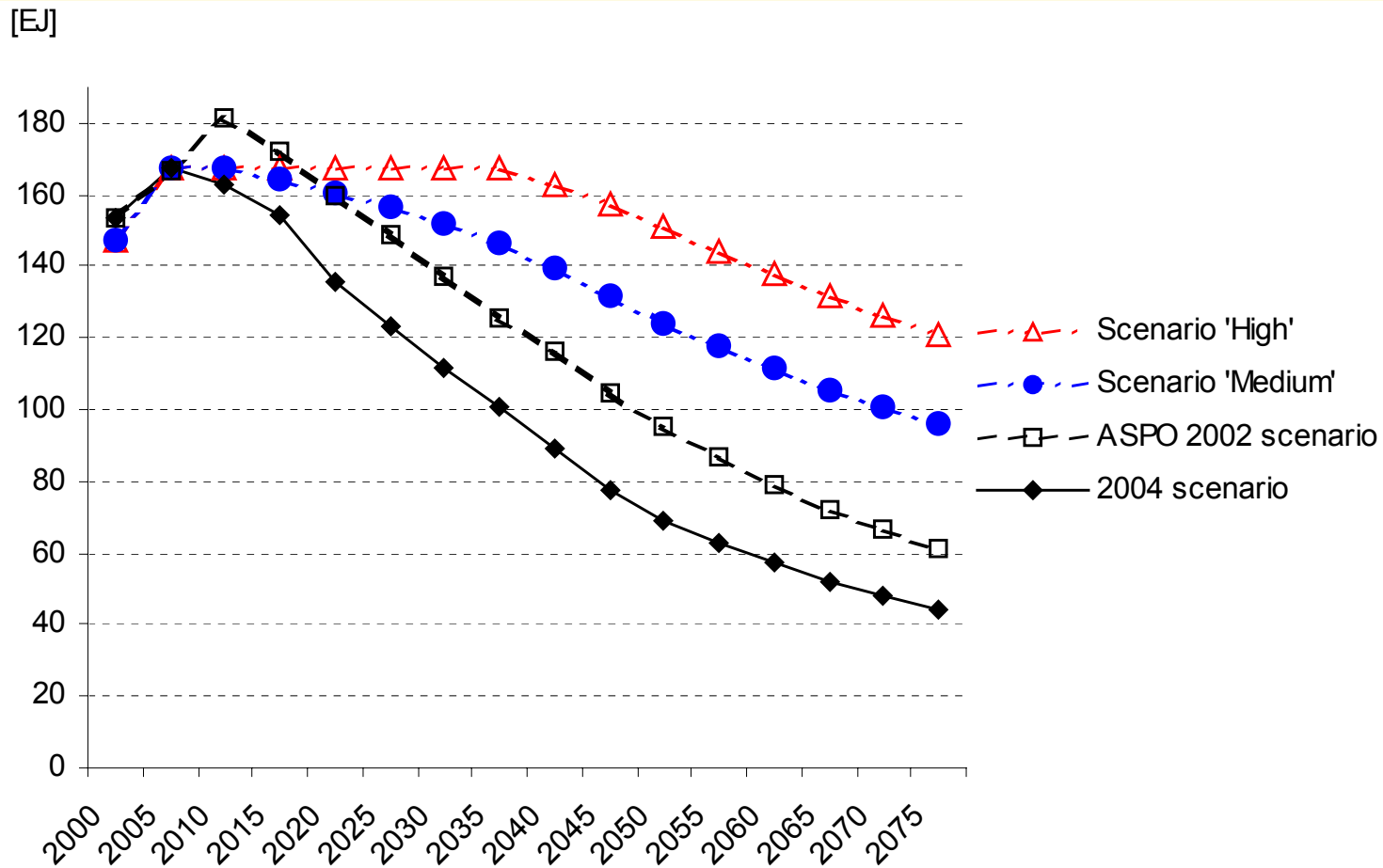


Figure 3 Oil production scenarios dependent on estimate of oil resource base

# Gas

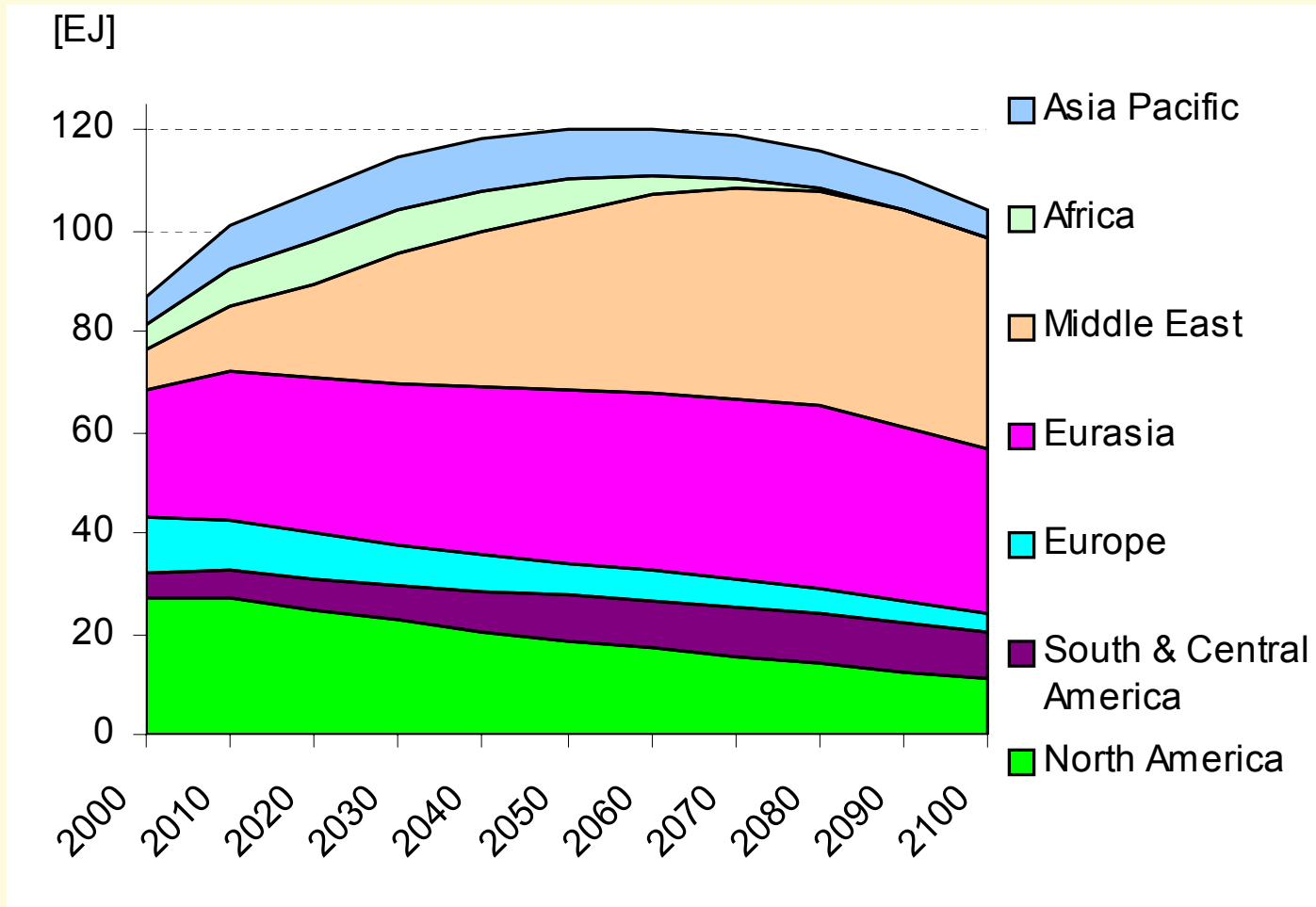


Figure 4 Conventional gas production 2000-2100 by world region cf. scenario 'High'

# Coal

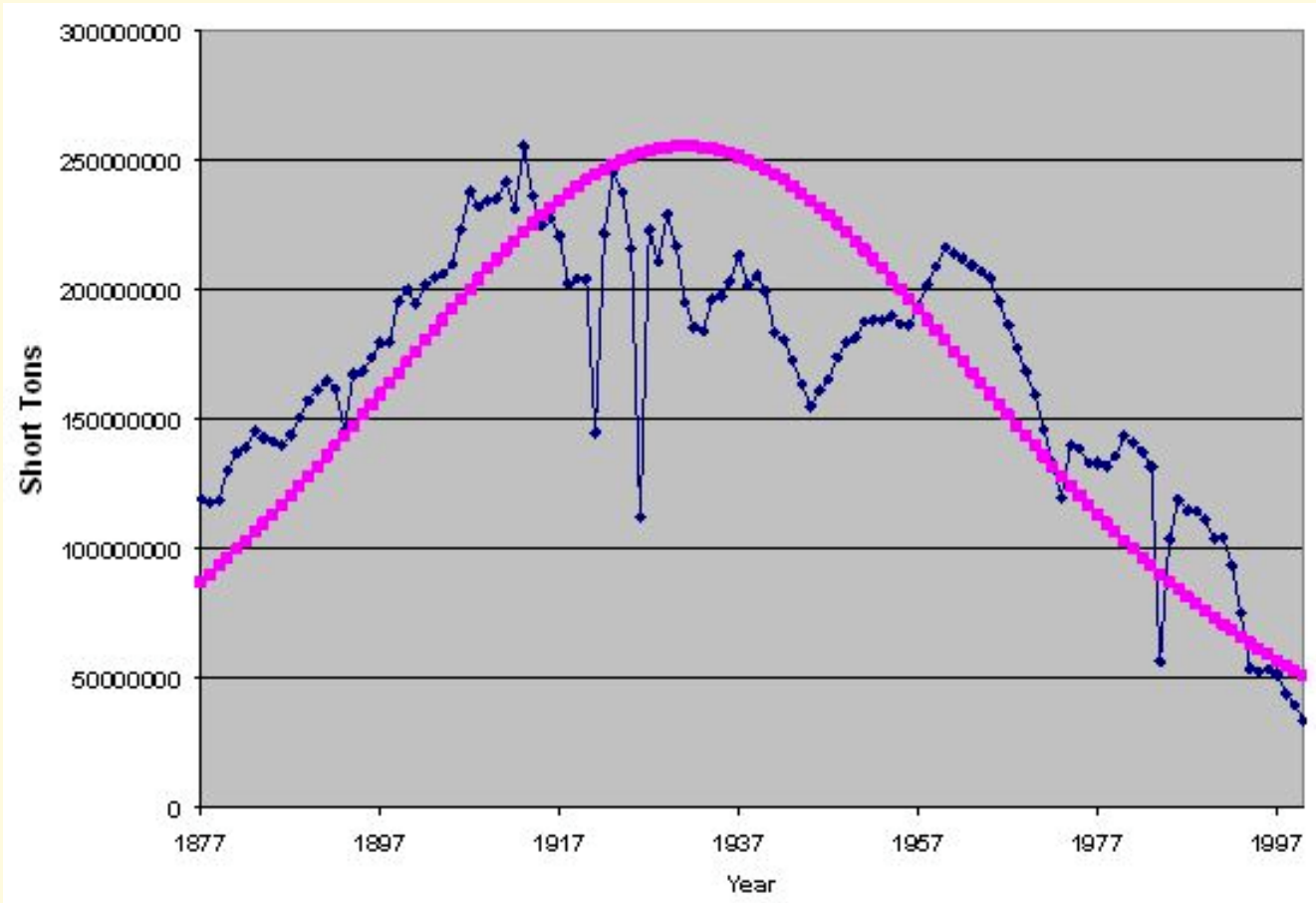


Figure 5 *Coal production UK 1877-2000*

# Uranium & thorium (1)

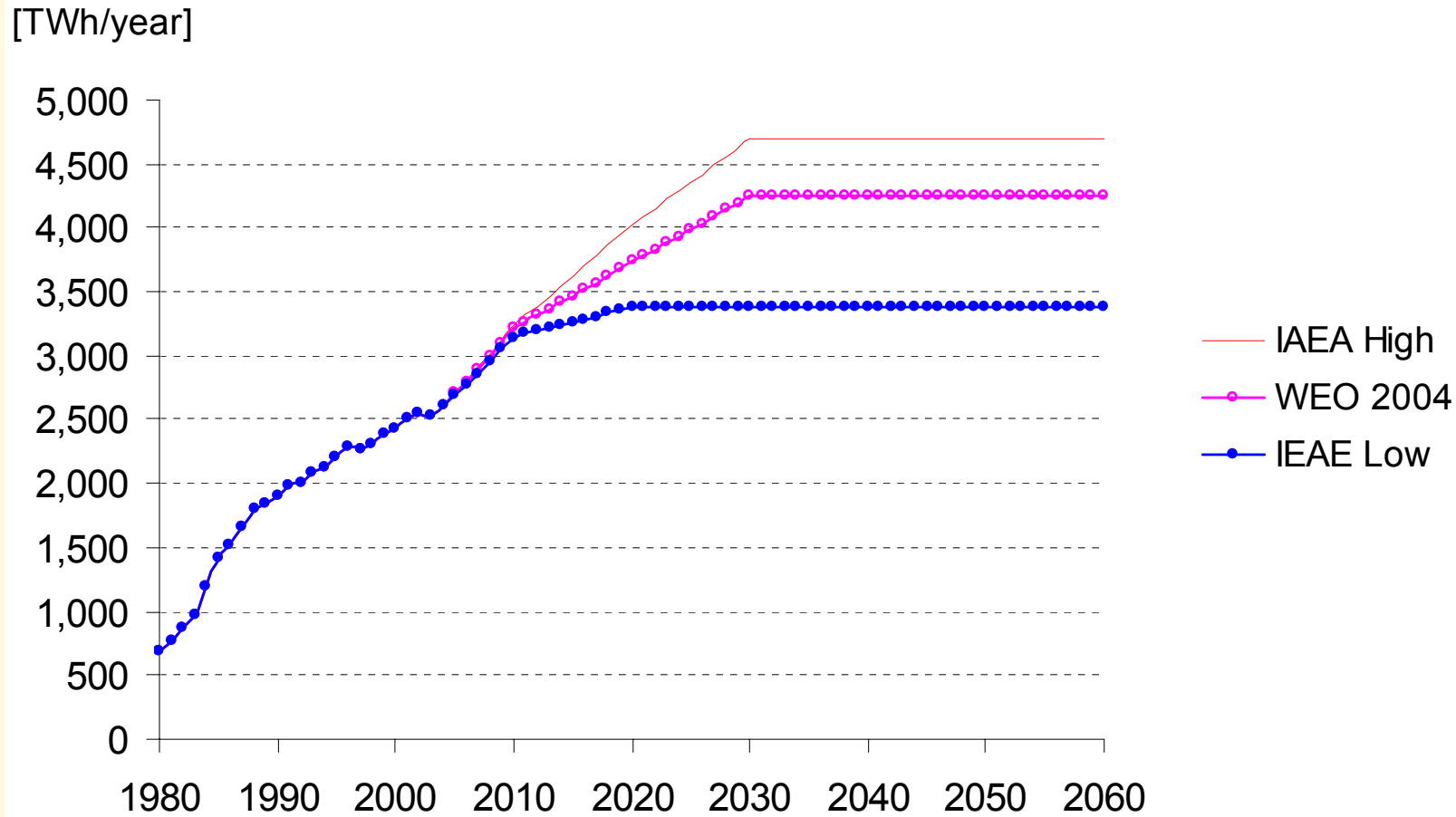


Figure 6 *Global electricity generation based on nuclear power, 1980-2060*

# Uranium & thorium (2)

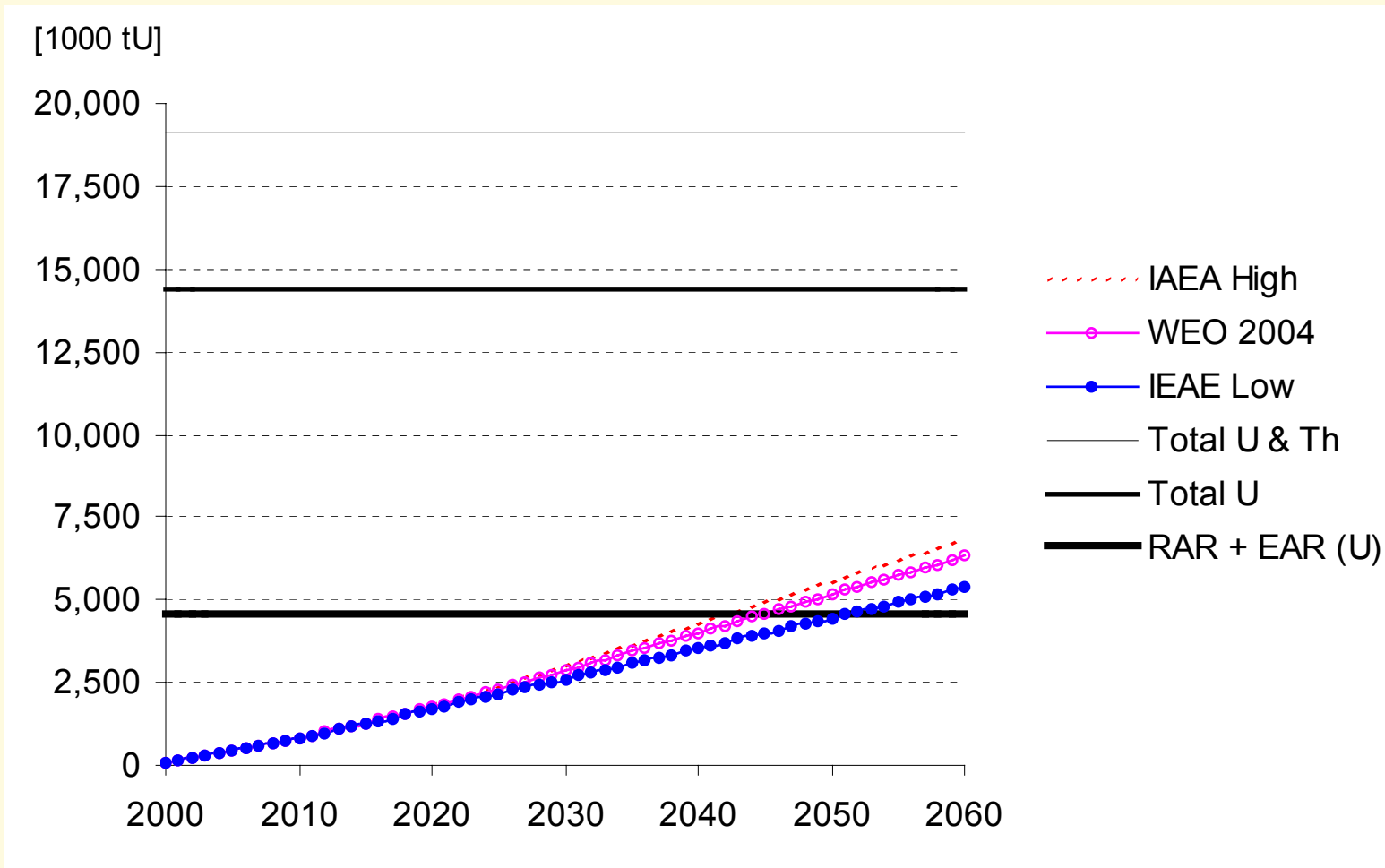


Figure 7 *Cumulative global uranium requirements for three scenarios to 2030*

# Onshore wind

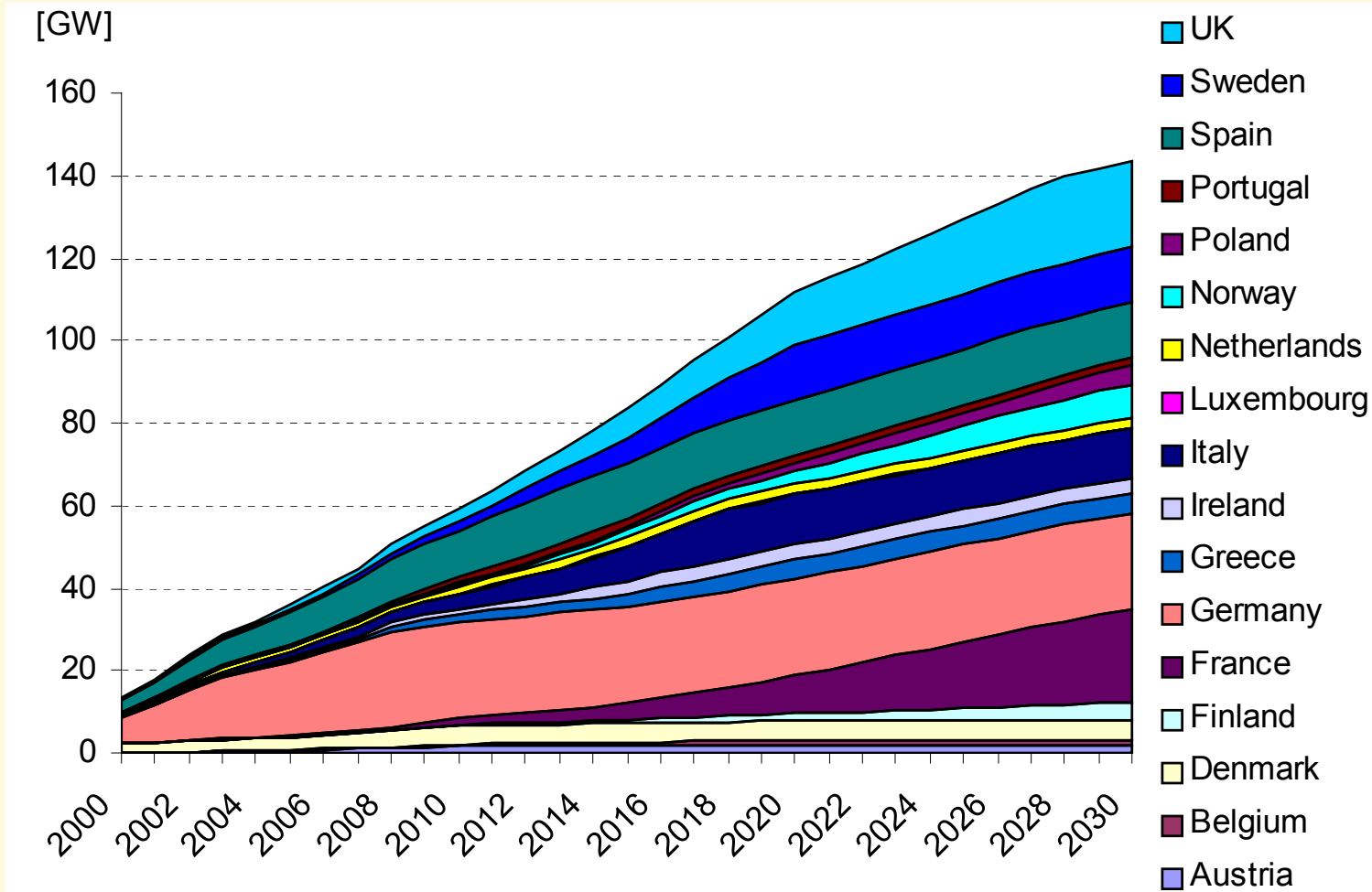


Figure 8 *Realisable onshore wind capacity EU-15, Norway and Poland*

# Offshore wind

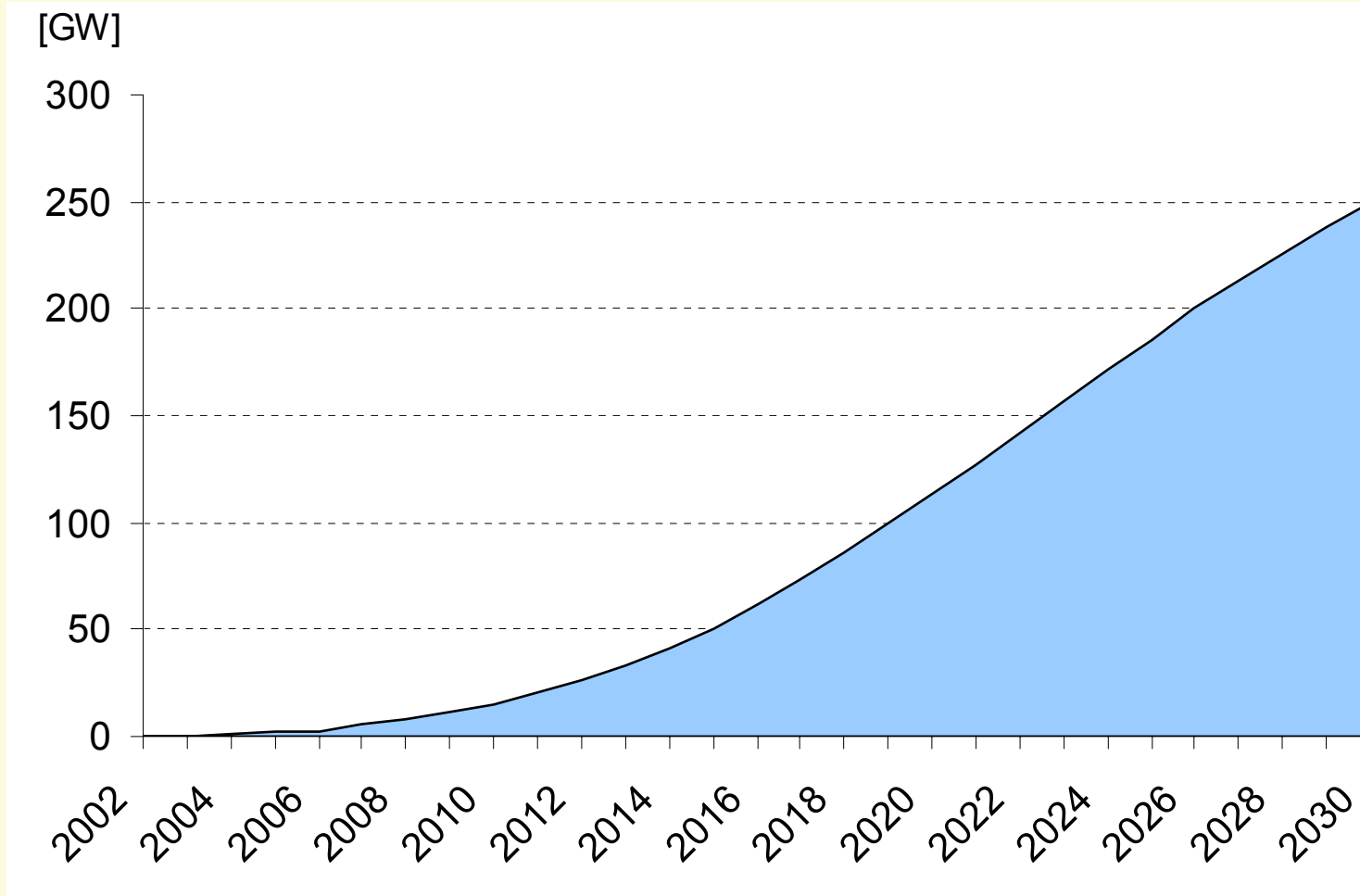


Figure 9 Possible development of offshore wind capacity in Europe, 2003-2030

# Photovoltaic power

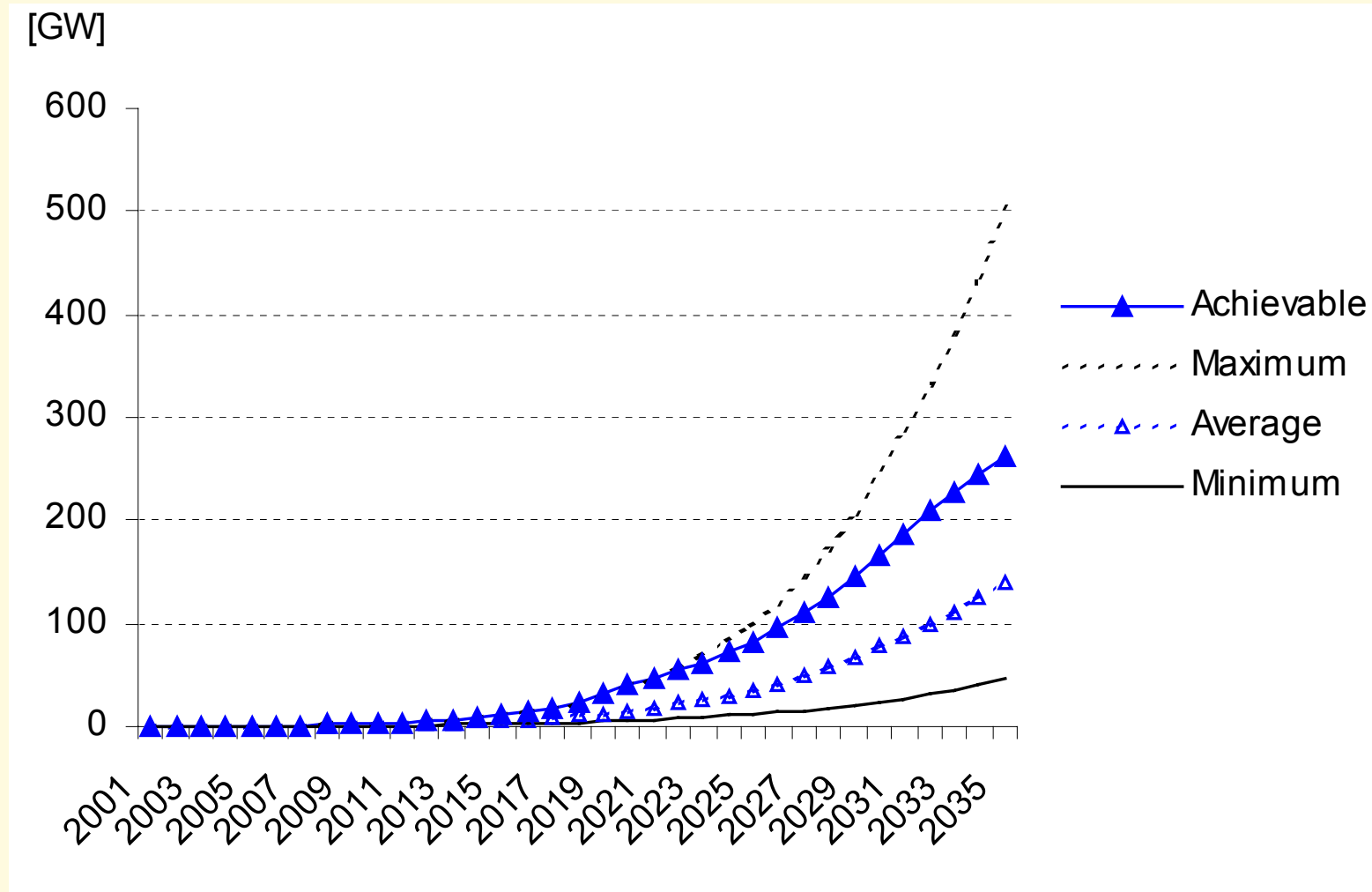


Figure 10 *Installed capacity of solar PV in Europe for four deployment scenarios*