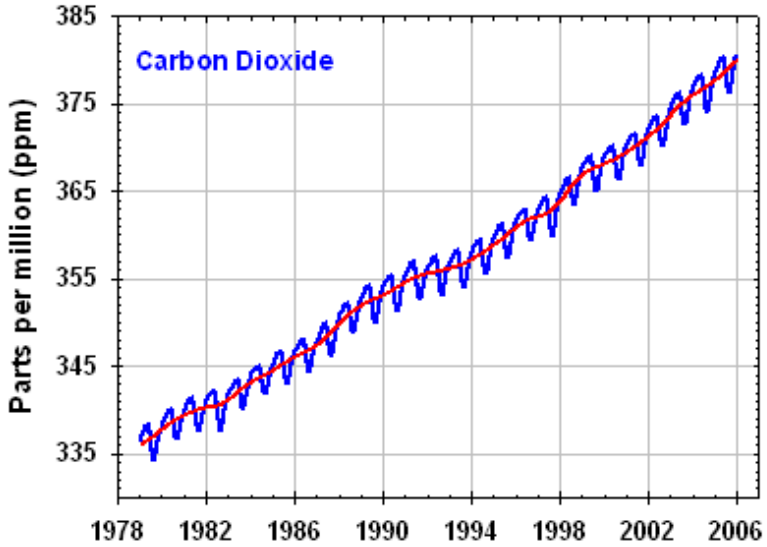
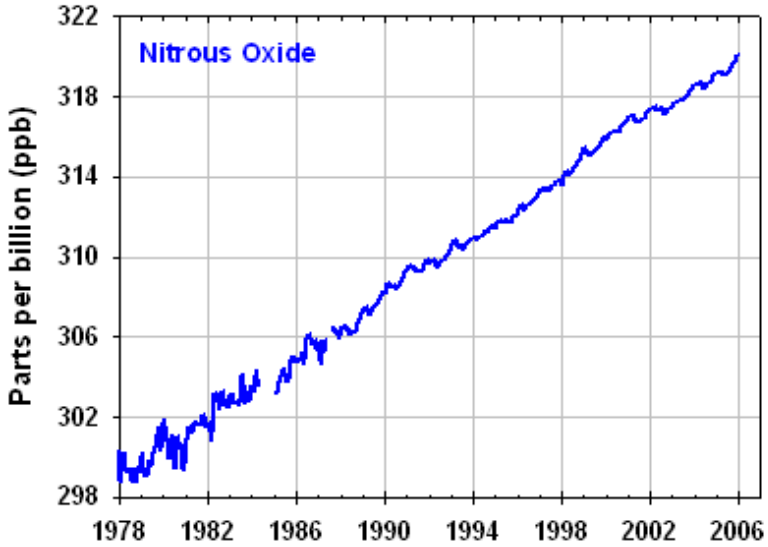
"Challenges of Eco-Efficiency"
5 December 2006

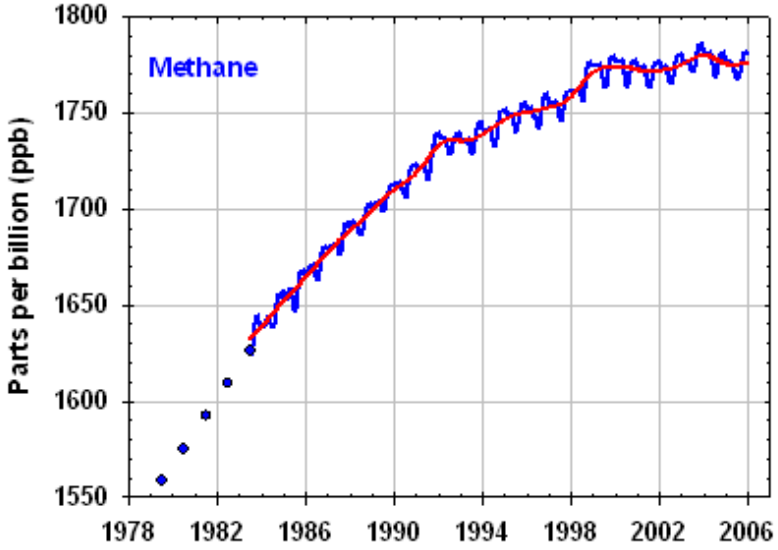
Climate Change Mitigation and Eco-efficiency

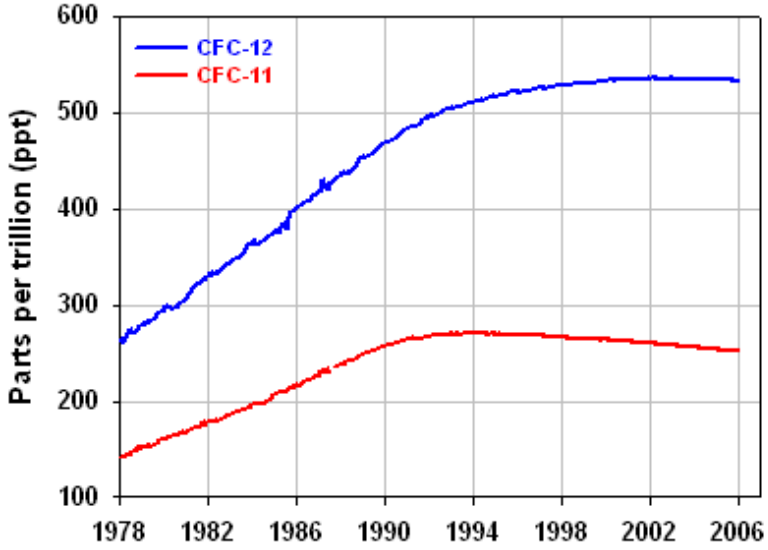
Ilkka Savolainen
Research Professor
Technical Research Centre of Finland VTT
ilkka.savolainen@vtt.fi

Development of greenhouse gas concentrations

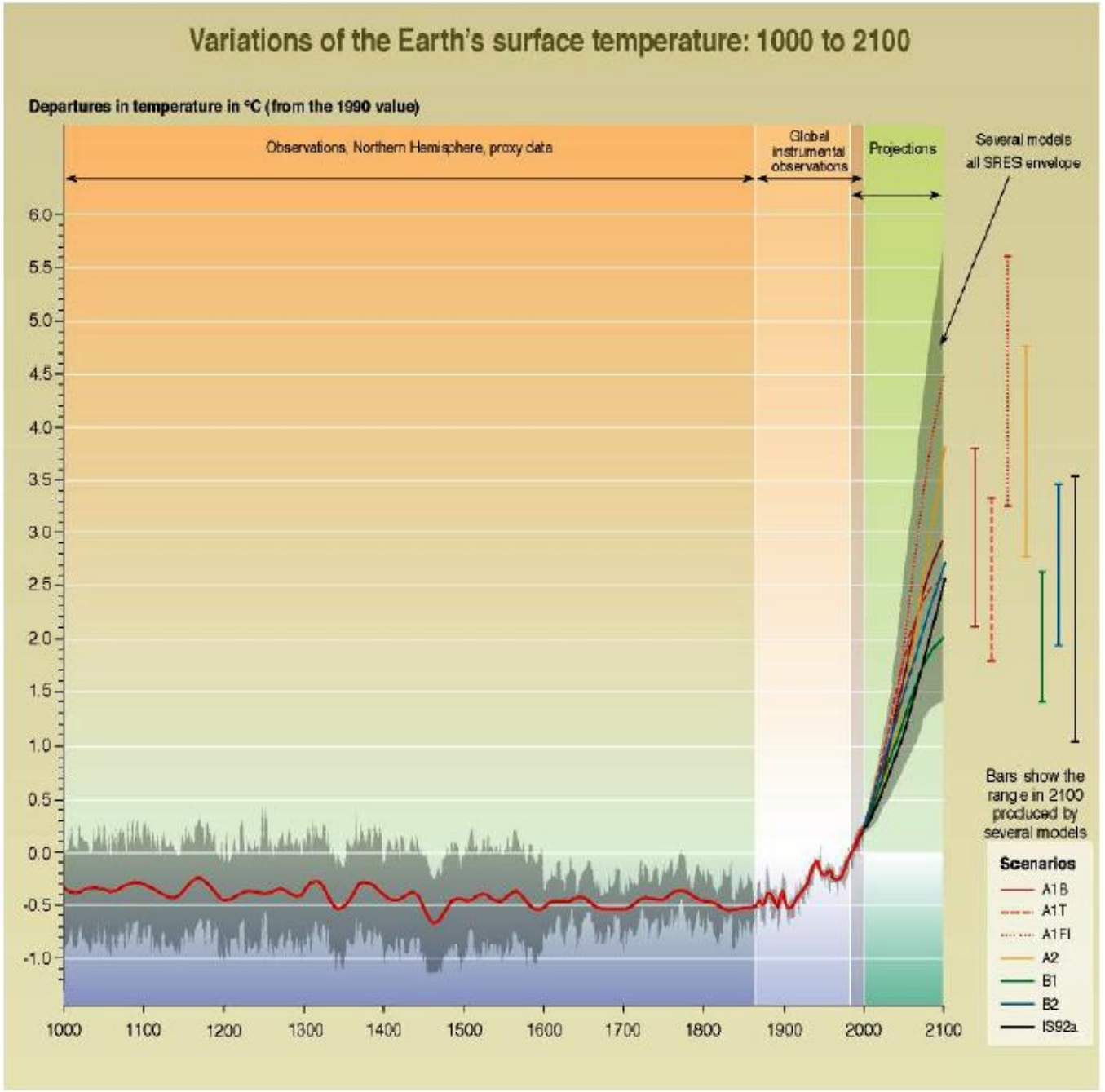




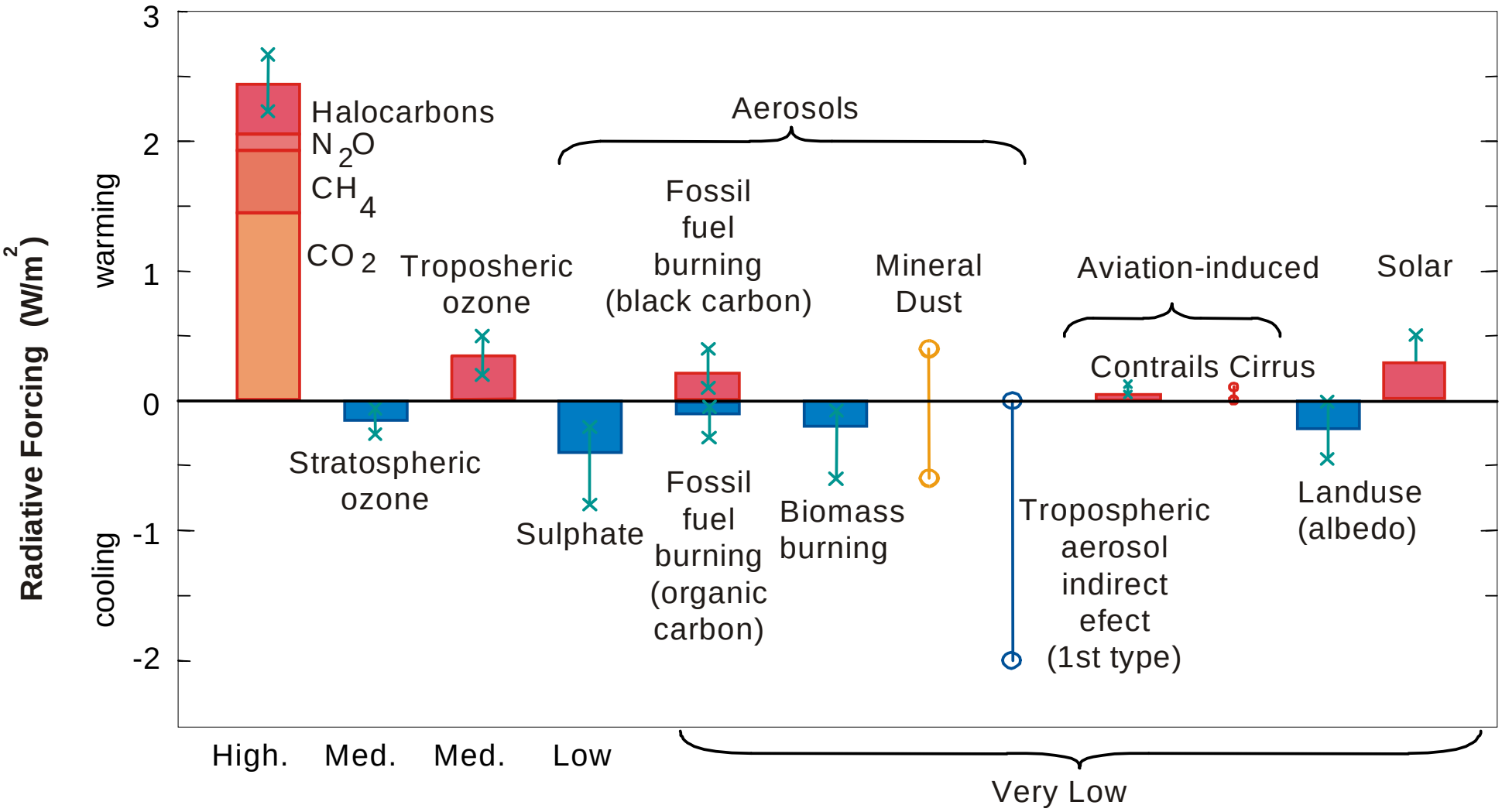


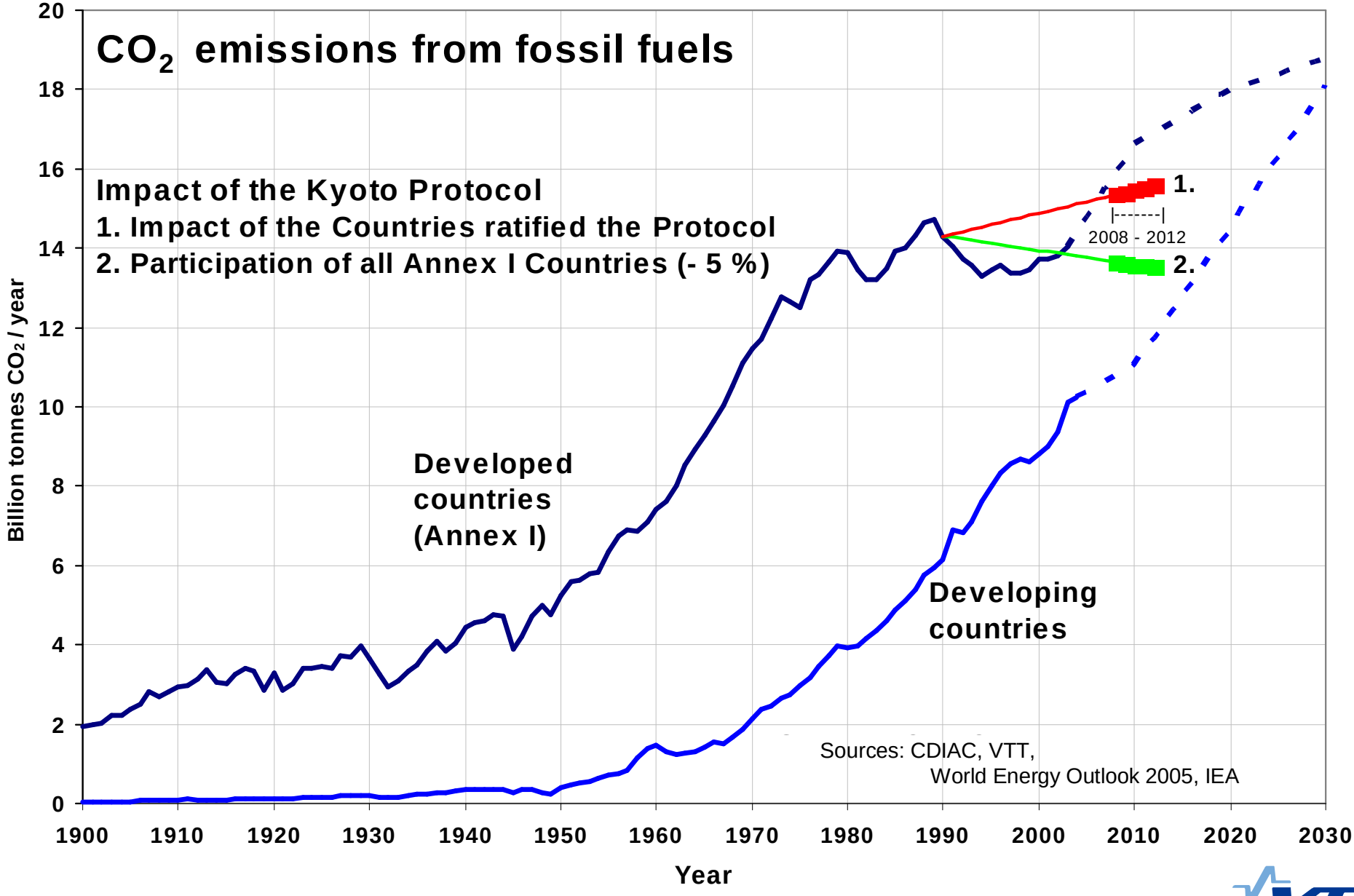


Lähde: NOAA, 2006.


Variations of the Earth's surface temperature: 1000 to 2100
Departures in temperature in °C (from the 1990 value)
Observations, Northern Hemisphere, proxy data
Global instrumental observations
Projections
Several models all SRES envelope
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
Bars show the range in 2100 produced by several models
Scenarios
A1B
A1T
A1FI
A2
B1
B2
IS92a

Global average radiative forcing in early 1990's (IPCC 2001)




CO_2 emissions from fossil fuels
Impact of the Kyoto Protocol
1. Impact of the Countries ratified the Protocol
2. Participation of all Annex I Countries (- 5 %)
1.
2008 - 2012
2.
Developed countries (Annex I)
Developing countries
Sources: CDIAC, VTT, World Energy Outlook 2005, IEA
Billion tonnes CO_2 / year
Year
0
2
4
6
8
10
12
14
16
18
20
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030

Countermeasures

- **Mitigation of climate change**
- **Adaptation to climate change**

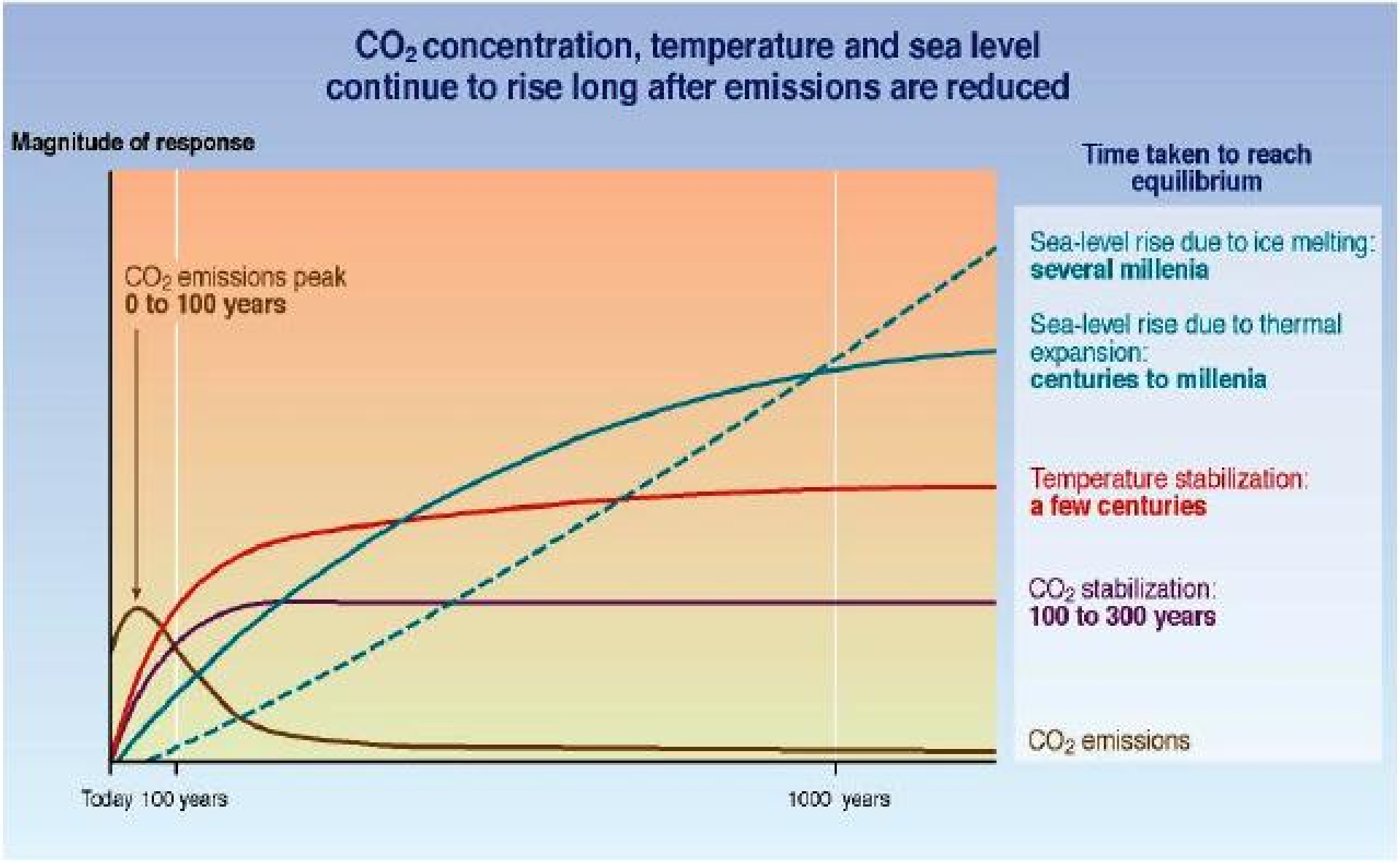
- **UN Framework Convention of Climate Change (UNFCCC) (ilmastosopimus)**

  Conference of Parties (COP) (osapuolten kokoukset)

  Kyoto Protocol (Kioton pöytäkirja)

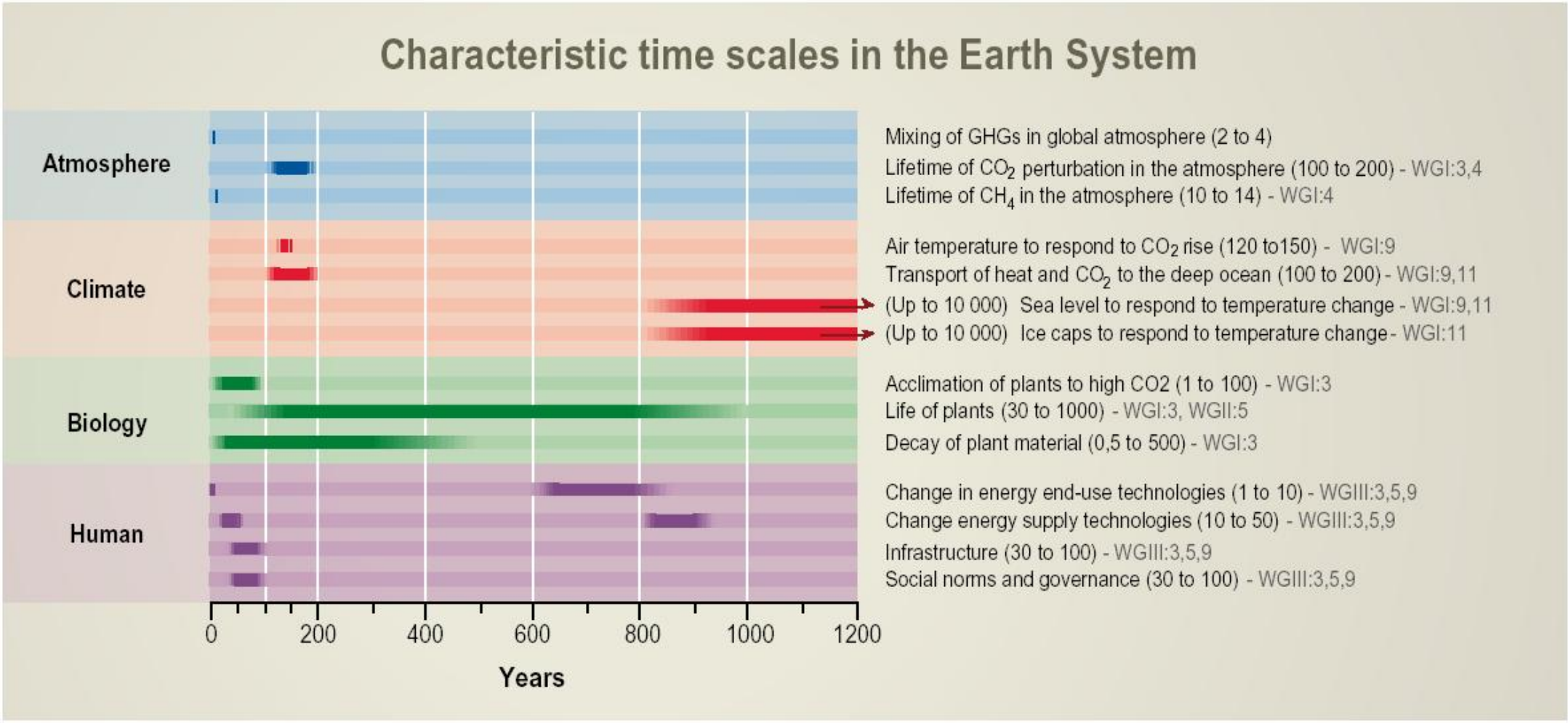
  Requirements for the new protocol:

  - Greater number of countries to achieve deeper total emission reductions
  - The protocol should steer technologies and economy towards lower emissions


CO_2 concentration, temperature and sea level continue to rise long after emissions are reduced
Magnitude of response
CO_2 emissions peak
0 to 100 years
Today 100 years
1000 years
Time taken to reach equilibrium
Sea-level rise due to ice melting:
several millenia
Sea-level rise due to thermal expansion:
centuries to millenia
Temperature stabilization:
a few centuries
CO_2 stabilization:
100 to 300 years
CO_2 emissions

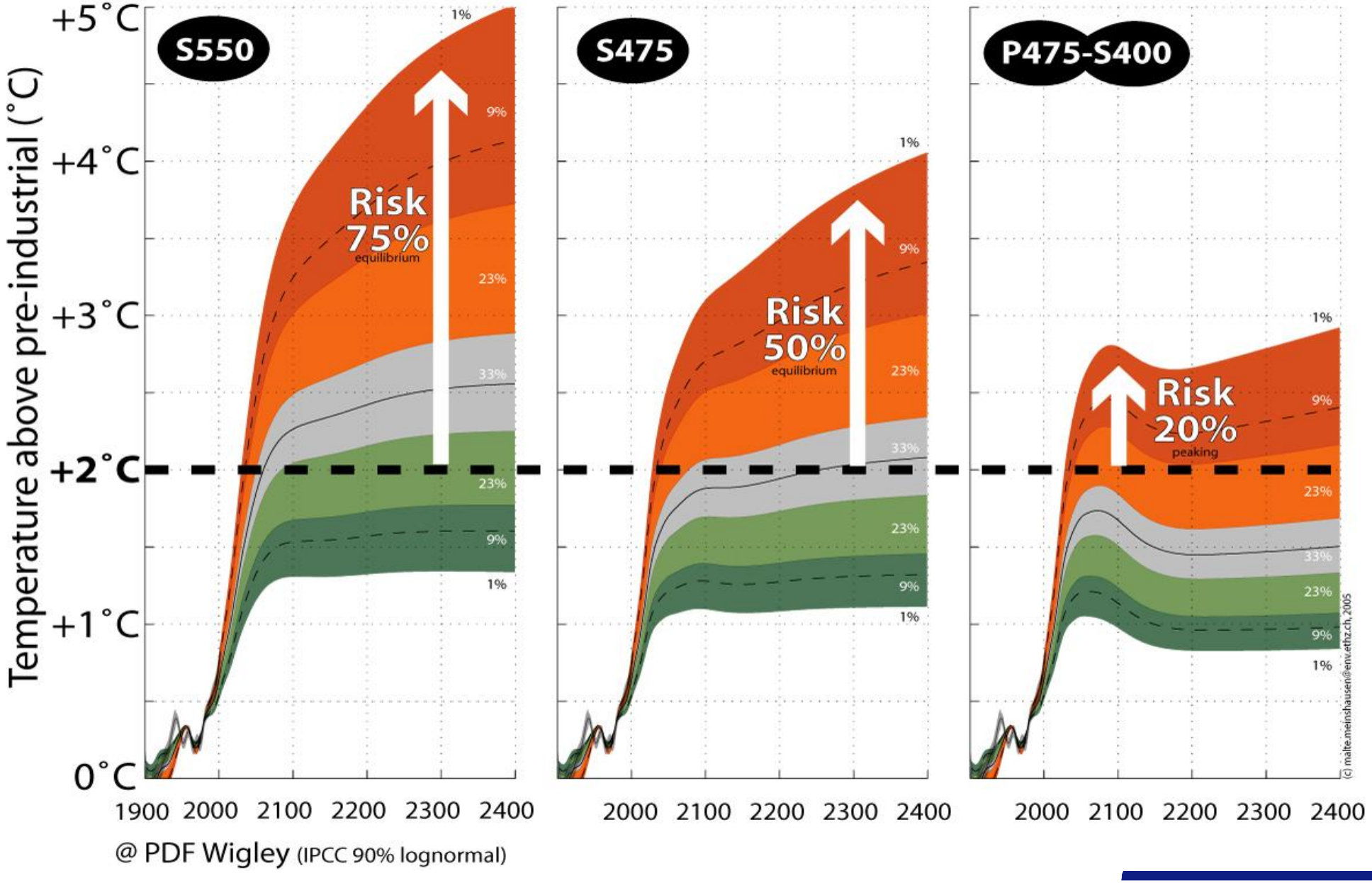
(IPCC 2001)

Time scales



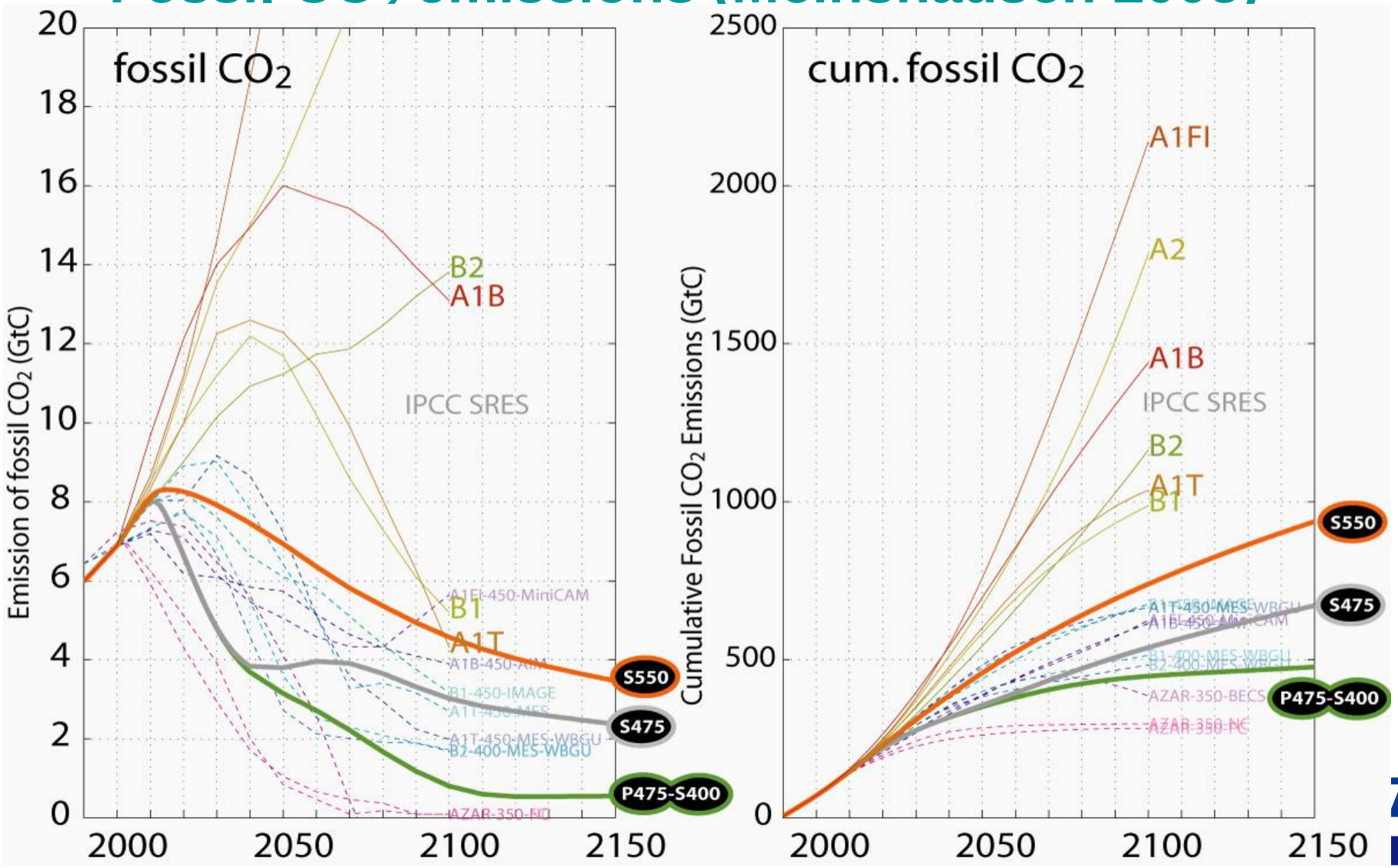
(IPCC 2001)

(Meinshausen 2005)



- **475 peaking within range, but at lower end of existing mitigation scenarios**
- **Fossil carbon budget 400 GtC for stabilization at 400 ppm CO_2eq.**

Fossil CO_2 emissions (Meinshausen 2005)



Pressures

OECD/IEA World Energy Outlook 2004 and 2005:

World population will grow

from 6,2 billion in the year 2002 to over 8 billion in 2030

World economy will grow

by a factor of 2,5 to the year 2030

Energy consumption will be

by a factor of 1,5 greater in 2030

the share of fossil fuels will remain over 80 per cent

In 2002 there was 1,6 billion people without electricity, this is a serious constraint for development and well-being

In 2002 about 2,4 billion peaople use traditional biomass for cooking and heating

Energy security is at risk in many countries

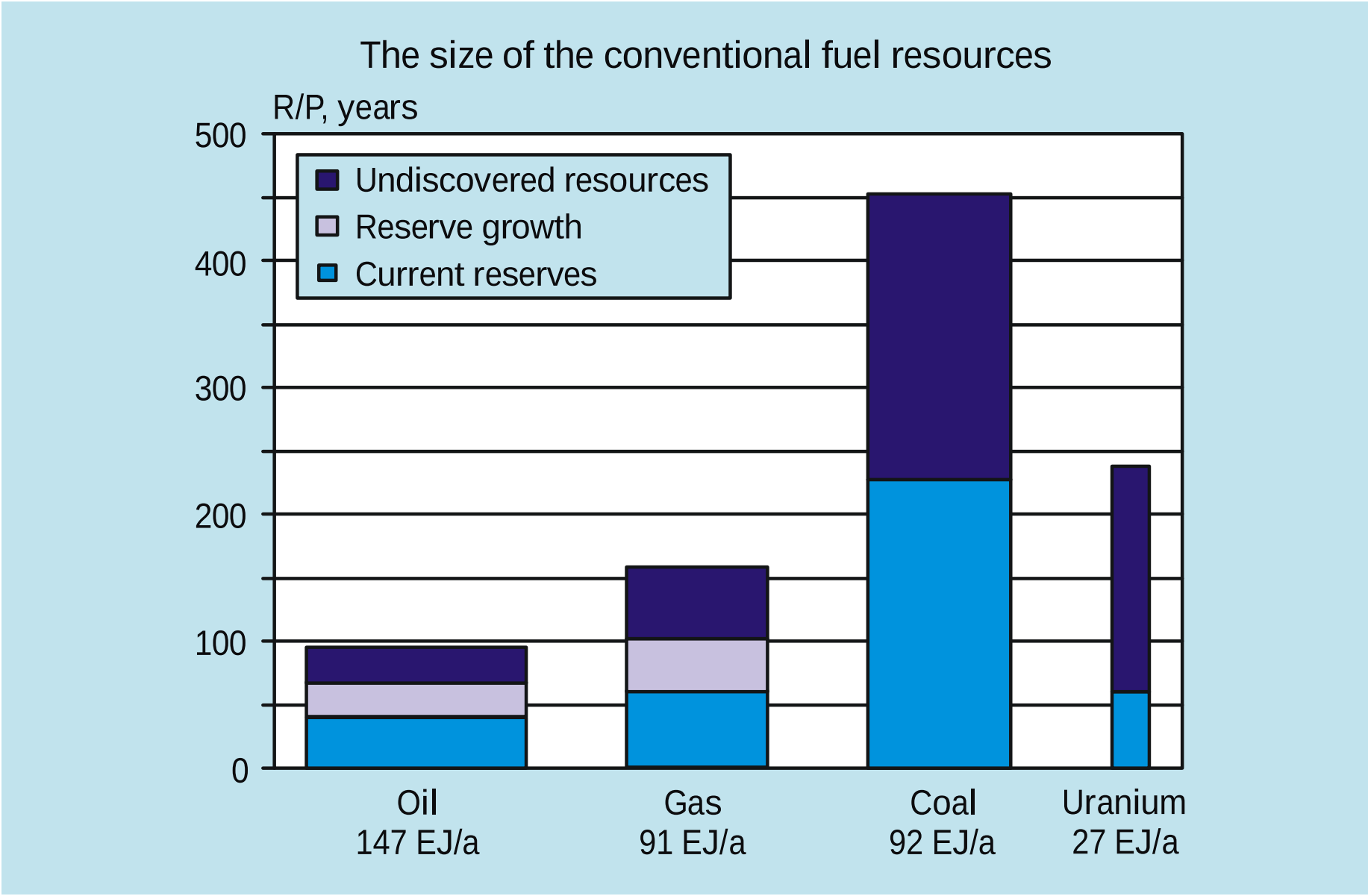
Reduction of Emissions

Ordinary emission reduction measures

- Efficient low-emissions technology
- Change of consumption

Steering instruments

- Agreements, standards, norms
- Economic instruments: taxes, subsidies, emission trading etc.
- Information, voluntary measures


The size of the conventional fuel resources
R/P, years
500
400
300
200
100
0
Undiscovered resources
Reserve growth
Current reserves
Oil
147 EJ/a
Gas
91 EJ/a
Coal
92 EJ/a
Uranium
27 EJ/a

Kaya identity

$$C = \left(\frac{C}{E}\right) \times \left(\frac{E}{GDP}\right) \times \left(\frac{GDP}{POP}\right) \times POP$$

C = CO_2 emission

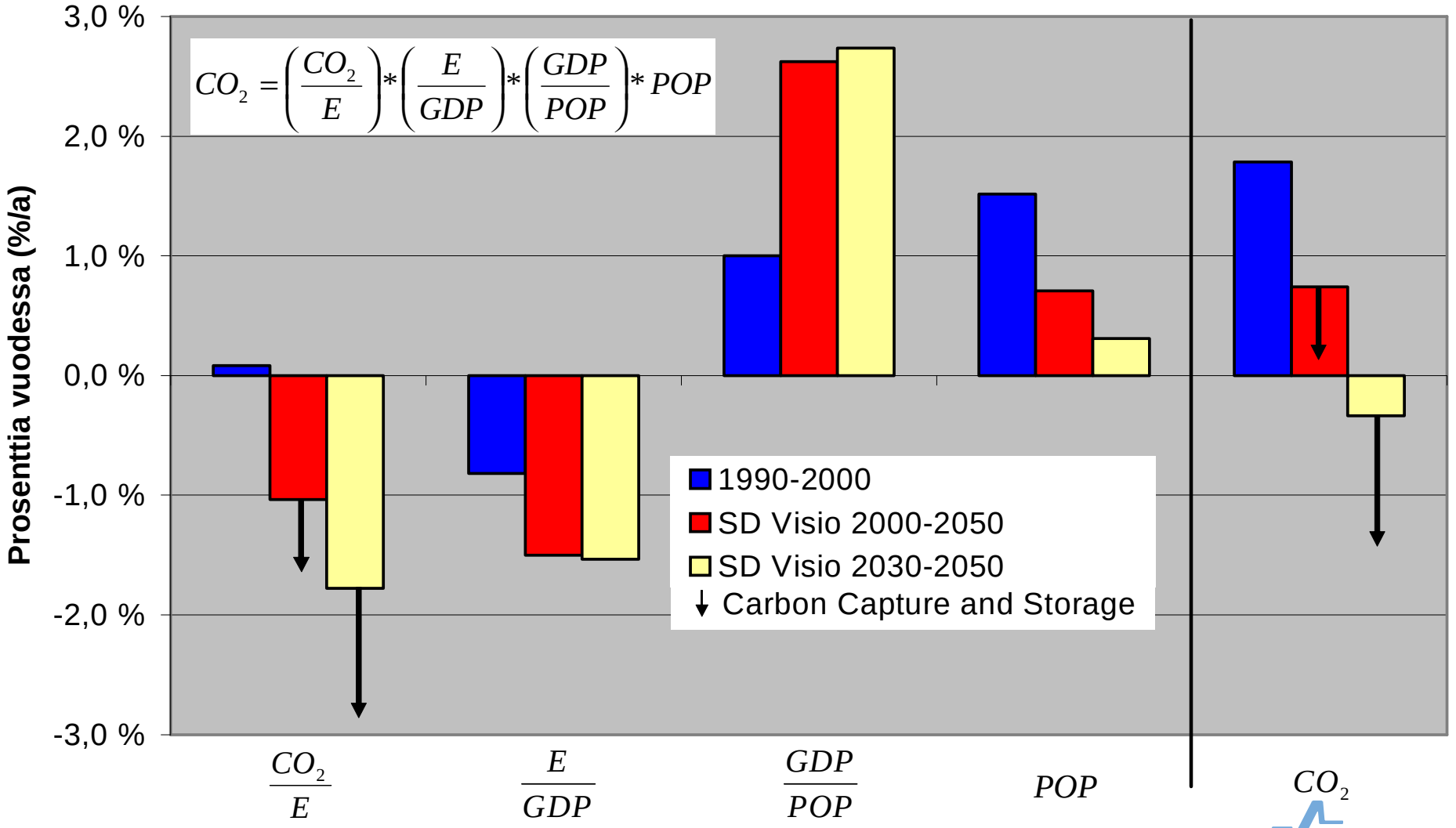
E = Energy use

GDP = Gross domestic Product

POP = Population

- *POP* is increasing in developing countries, almost stable in developed countries (except in USA)
- Factor *(GDP / POP)* can be increased only.
- Factor *(E / GDP)* can be controlled by structural changes and efficiency improvements (practices, technology).
- Factor *(C / E)* can be controlled by technology and by choice of energy source (most easy to accept).

IEA SD Vision Scenario, World
Kaya Identity factors



General possibilities to control climate change

Factors reducing greenhouse gas emissions

- change of economic structure so that proportion of relatively less energy using sectors will grow

- more efficient and economical use of energy (changes connected to energy use technologies and consumption habits)

- more efficient energy production, and growth of proportion of low and non-emission energy sources

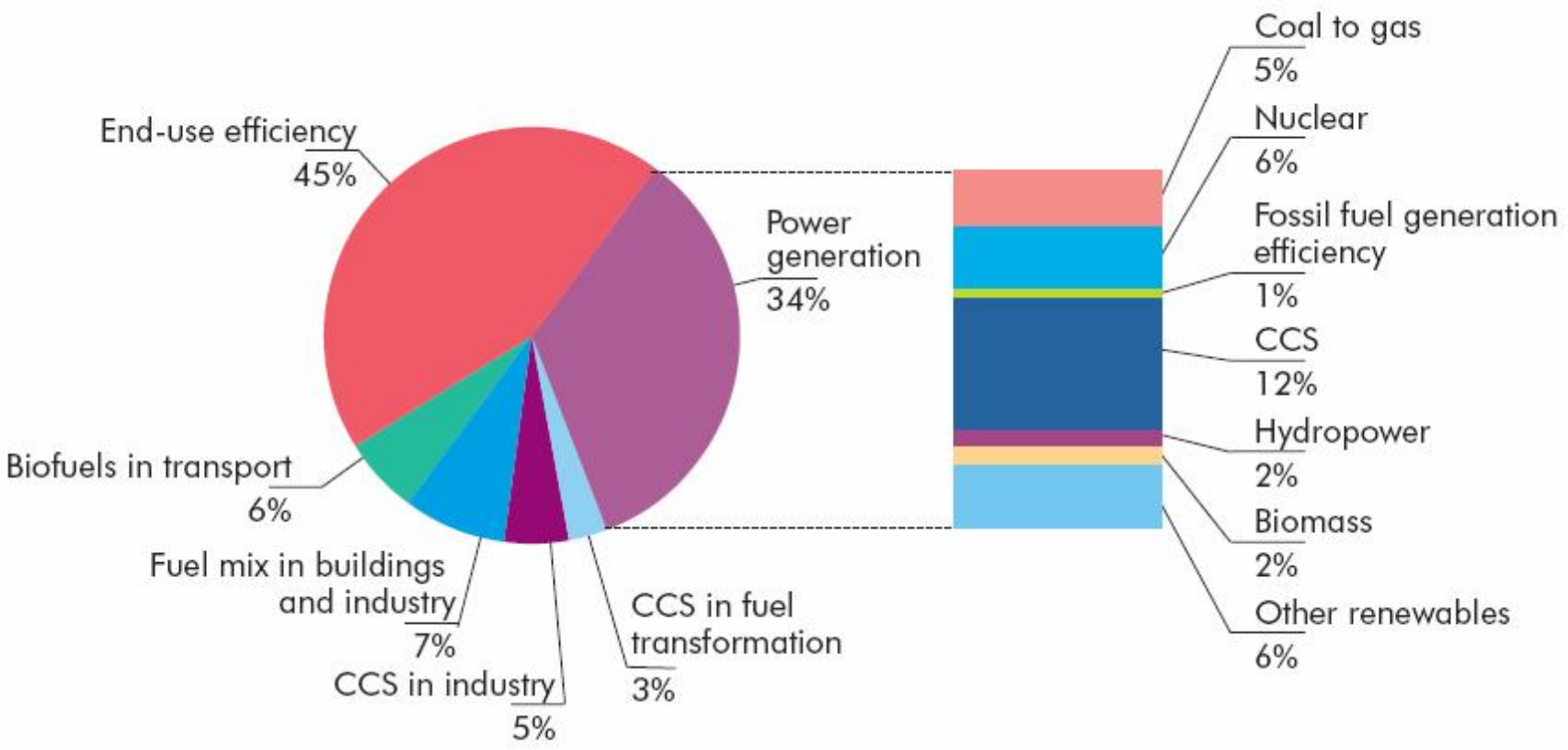
- decrease of industrial process emissions as well as emissions of other sectors (e.g. agriculture, waste management, refrigeration appliances)

- In addition, the atmospheric CO2 concentration can be lowered by storing atmospheric carbon to carbon sink

Technological alternatives

- **Improvements of energy use efficiency**
- **Raising the efficiency of fuel use in energy production (e.g. CHP, combined cycle processes)**
- **Renewable energy sources (biomass, industrial and municipal wastes, wind, hydro etc.)**
- **Nuclear power**
- **CO2 capture and storage (e.g. old oil and gas fields)**
- **Reduction of emissions from waste management and agriculture**
- **Reduction of emissions of fluorinated gases**

IEA: Reduction of the CO2 emissions by 16% by 2050



Key point

Improved efficiency of end-use technologies contributes 45% of the reduction in CO_2 emissions.

IEA, 2006. Energy technology perspectives 2050.

Summary

- **Deep emission reductions required to mitigate climate change**
  - Broad spectrum of technologies needed (in esp. energy production and use)
  - Product substitutions
  - Structural changes in consumption needed
  - Carbon sequestration (biological, geological)
  - Control of other GHG emissions (e.g. CH4, N2O, Fluorinated gases)

Summary (2)

- **Climate change seems to be unavoidable >> mitigation and adaptation possible**
- **Very great inertia (natural and socioeconomic)**
- **Wide spectrum of emission reduction measures needed**
- **Costs of emission reduction vary by sectors and areas**
- **85% of global energy production is based on fossil fuels, growth of world population and consumption increase energy demand**

- Great demand for new low-emission technologies
- Great demand for efficiency improvements