IEA – University of São Paulo
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Energy for Sustainable Development for the 21st Century

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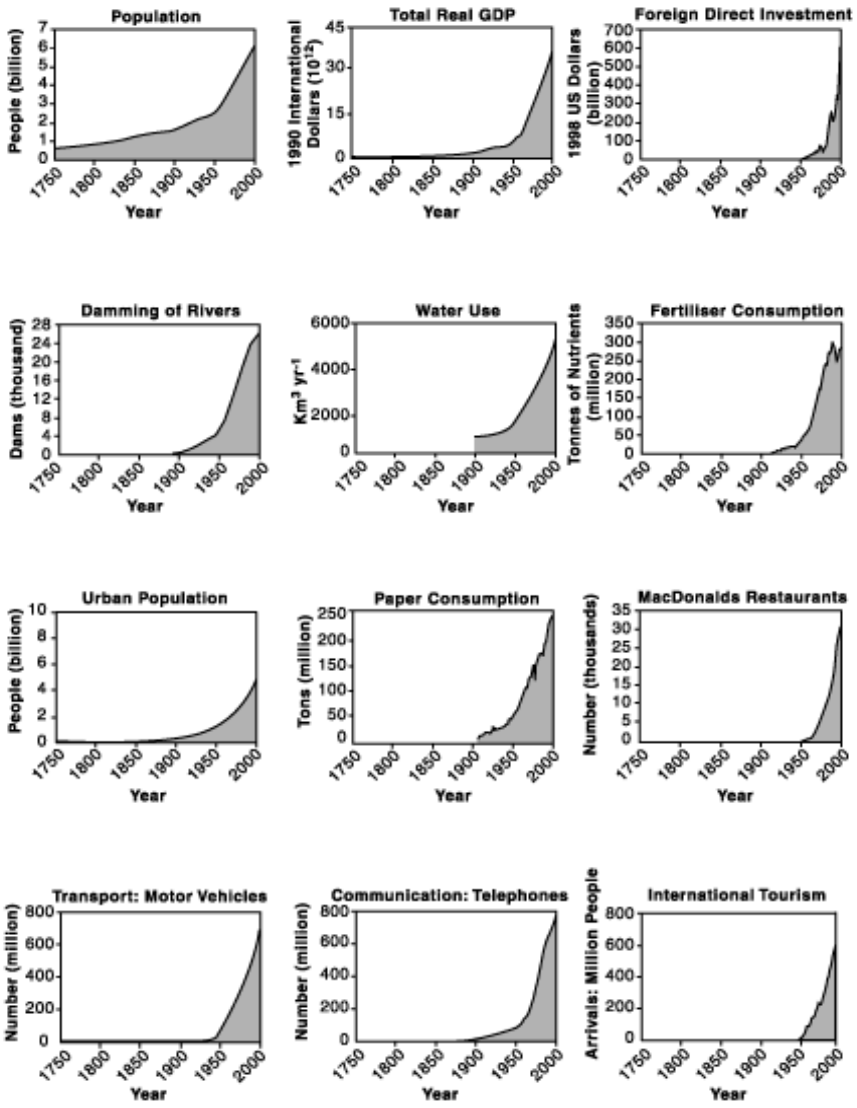
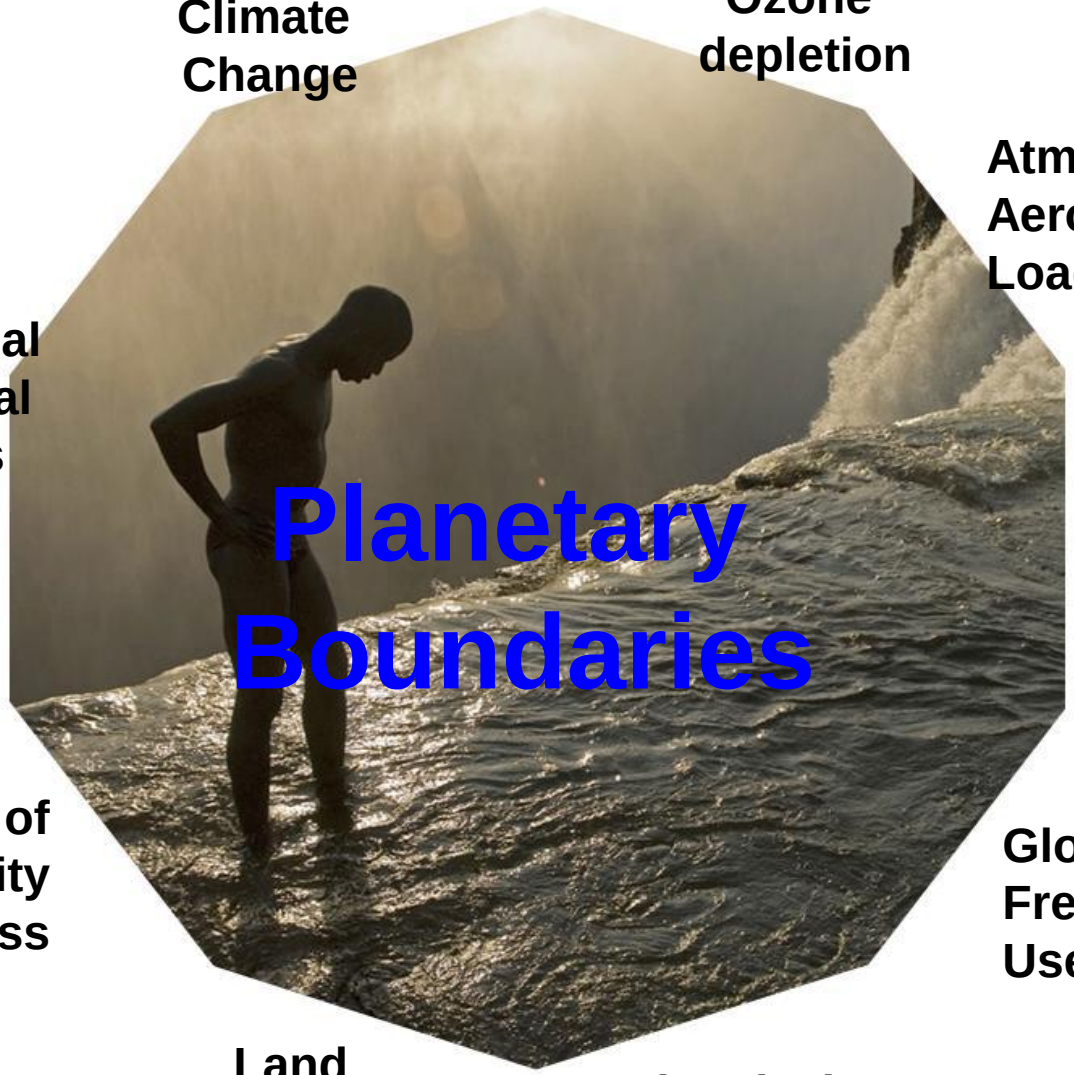


From: Steffen et al. 2004

IGBP


Climate Change
Ozone depletion
Atmospheric Aerosol Loading
Biogeochemical loading: Global N & P Cycles
Planetary Boundaries
Ocean acidification
Rate of Biodiversity Loss
Global Freshwater Use
Land System Change
Chemical Pollution

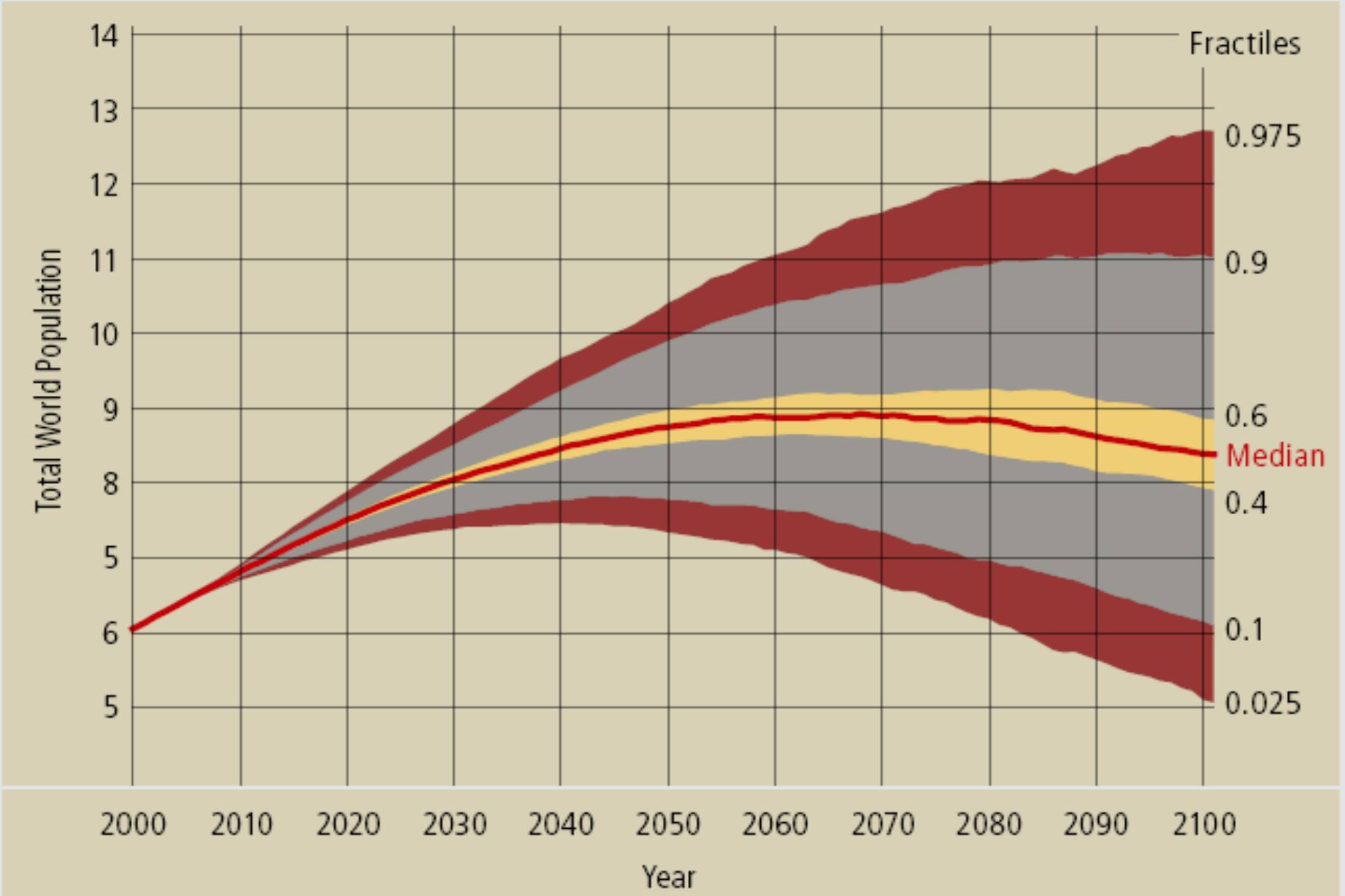
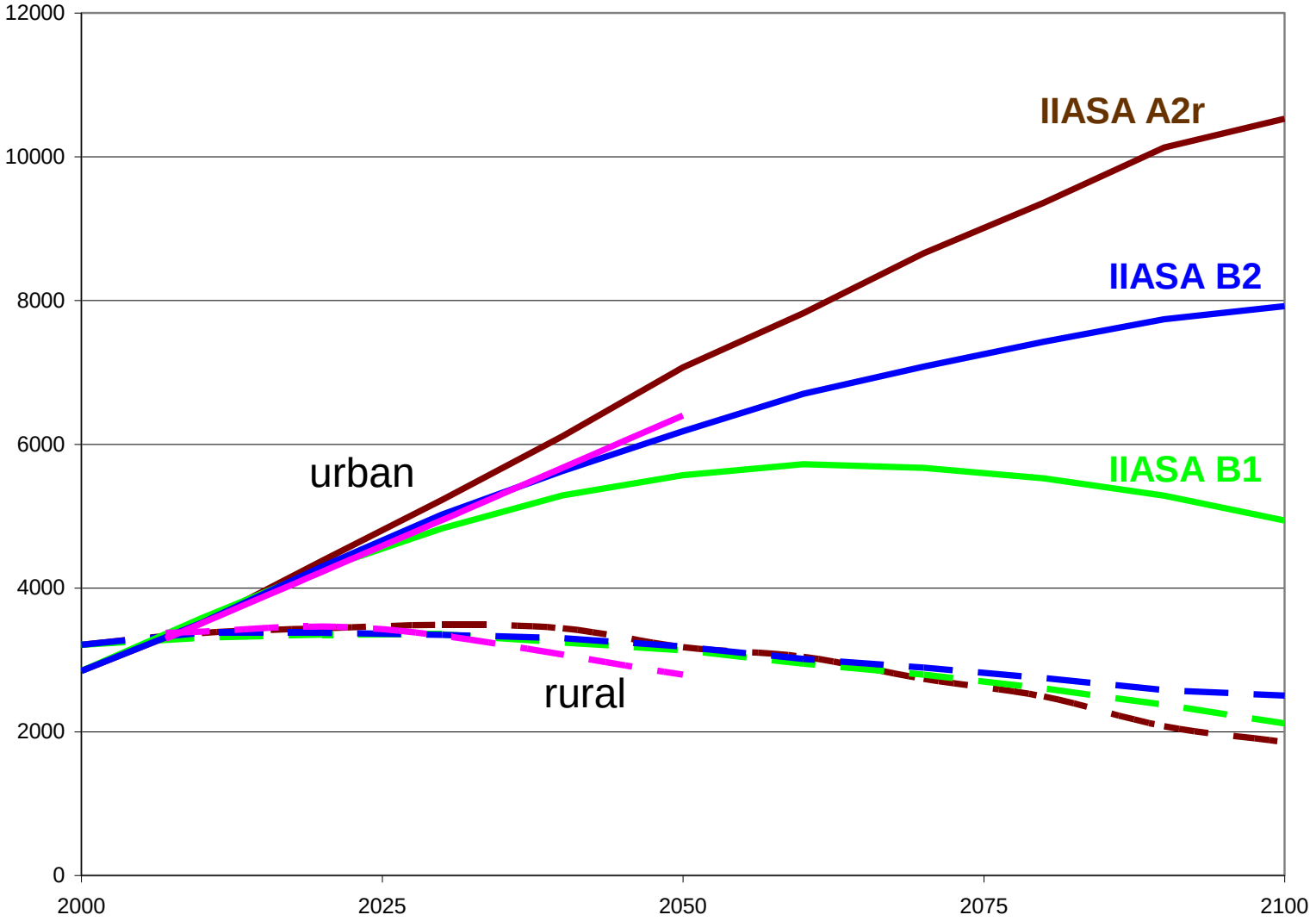


Figure 1. Uncertainty distribution of total world population to 2100, in billions.

Urban and Rural Population Projections (Millions)

(IIASA GGI, 2007 and UN WUP, 2007)



Data source: Riahi et al., 2007; UN, 2007

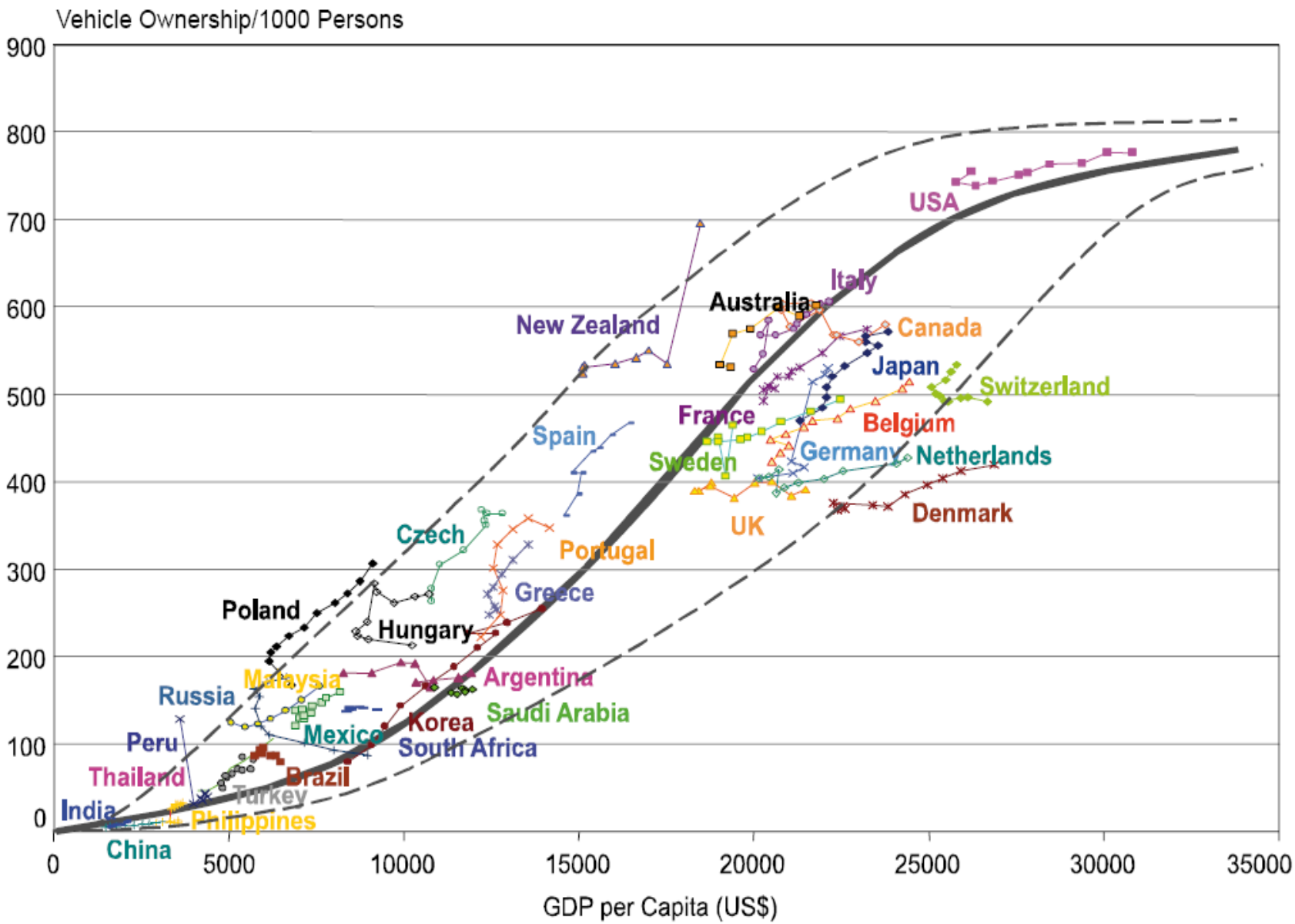
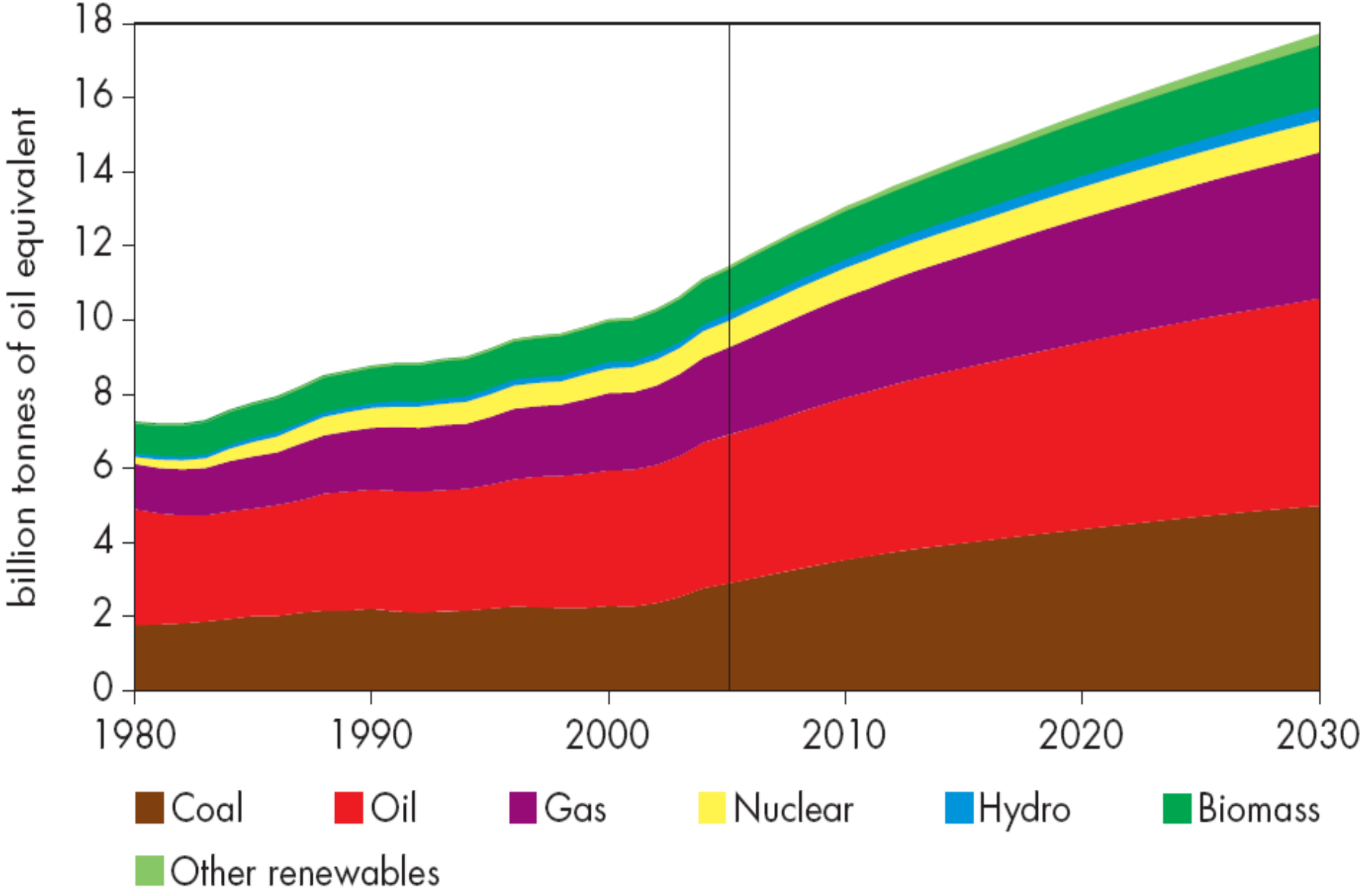


Figure TS.14: *Vehicle ownership and income per capita as a time line per country [Figure 5.2]. Note: data are for 1900–2002, but the years plotted vary by country, depending on data availability.*

Figure 1.1: **World Primary Energy Demand in the Reference Scenario**



Challenges requiring actions on Energy

a. **Energy services for growing populations and economies**
b. **access to modern forms of energy** (the 2 billion w/o access)
c. **affordable** energy services (@$100/bbl??)
d. **secure** supplies, from households to nations
e. **local and regional health and environment challenges**
f. **climate change mitigation**
g. **ancillary risks**

=> Major Energy System Changes Needed!

These **challenges** must be addressed

adequately

timely

simultaneously

Assessement

Process leading to a Report and much more

25 Knowledge Modules, ~200 authors, geographically and gender diversified

Stakeholder consultations

External peer review

Extensive dissemination

Informing Rio +20 and other international, regional, naitonal and corporate on energy and/or linked to energy issues

Supporting the GEA:

International Organizations
UNDESA
UNDP
UNEP
UNIDO
World Bank
IIASA

Country Governments/Agencies
Austria
Brazil
European Union
Germany
Italy
Sweden
USA

Corporations
Petrobras
TEPCO
First Solar

Industry groups
WEC
WBCSD

Foundations
UN Foundation
Climate Works

Four Clusters of Knowledge modules:

1. **The Challenges, nature and magnitude of change required**

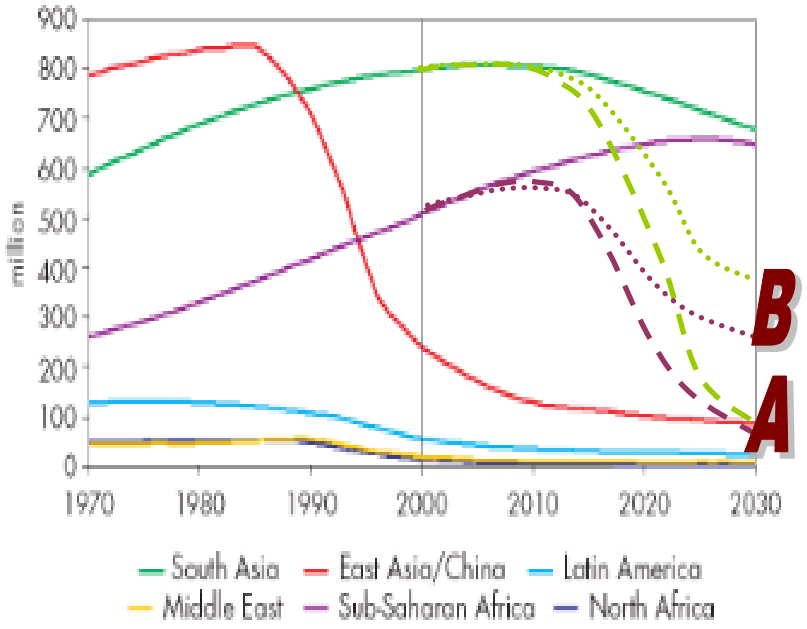
2. **Resources and technology options**

3. **Pathways to sustainability, urbanisation, rural energy, and land use**

4. **Policies, energy end use and supply sectors, access, innovation, capacity developoment**

Electricity

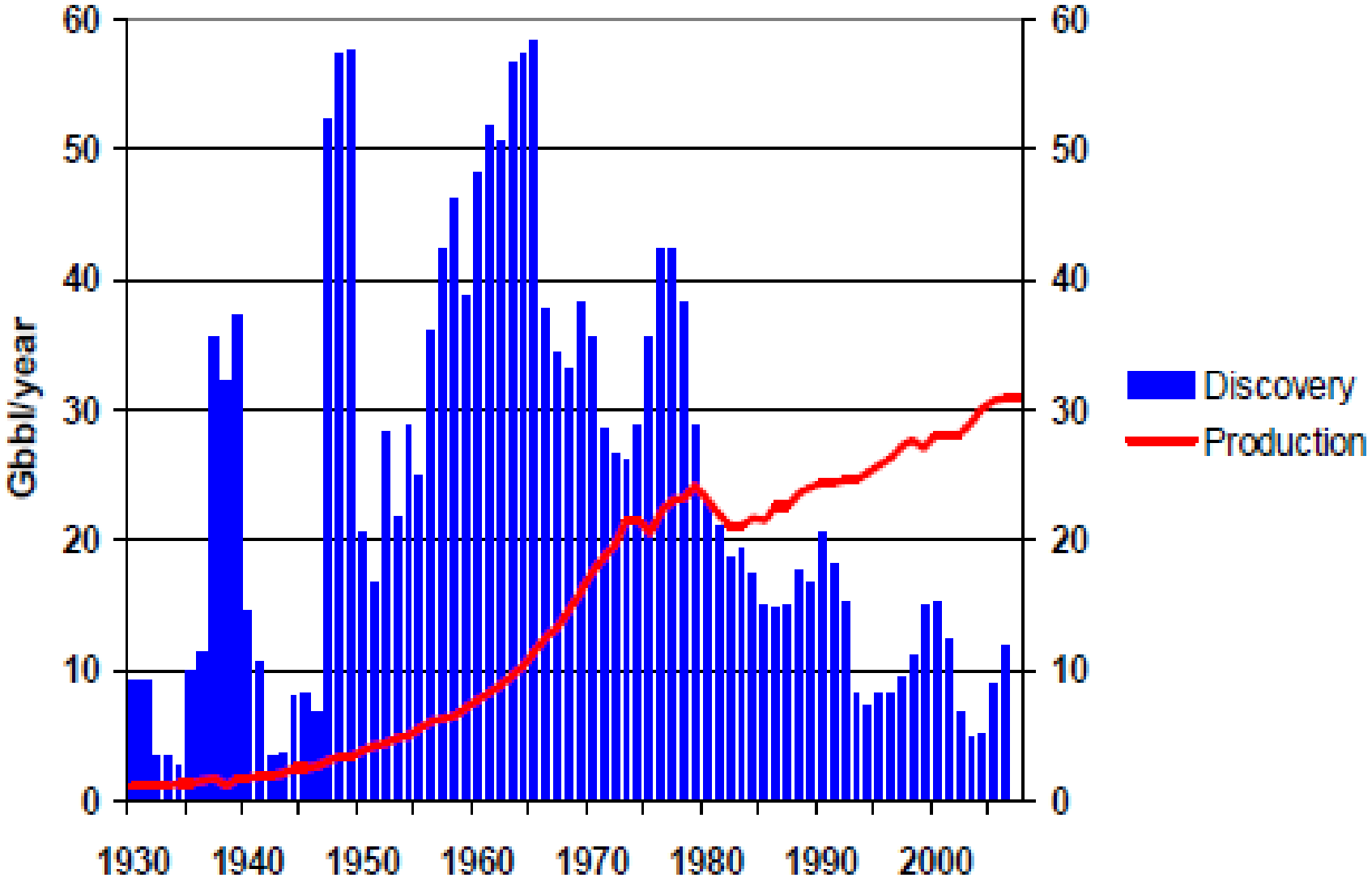
- Electricity for All in the Medium Term (may be achievable)
  - Use of both grid-extension and decentralized systems + conventional and renewable energy technologies
  - Strong national (and local) + public (and private) delivery models
  - Smart use of subsidies and other innovative financing mechanisms (global effort would be required)



Clean Cooking Fuels

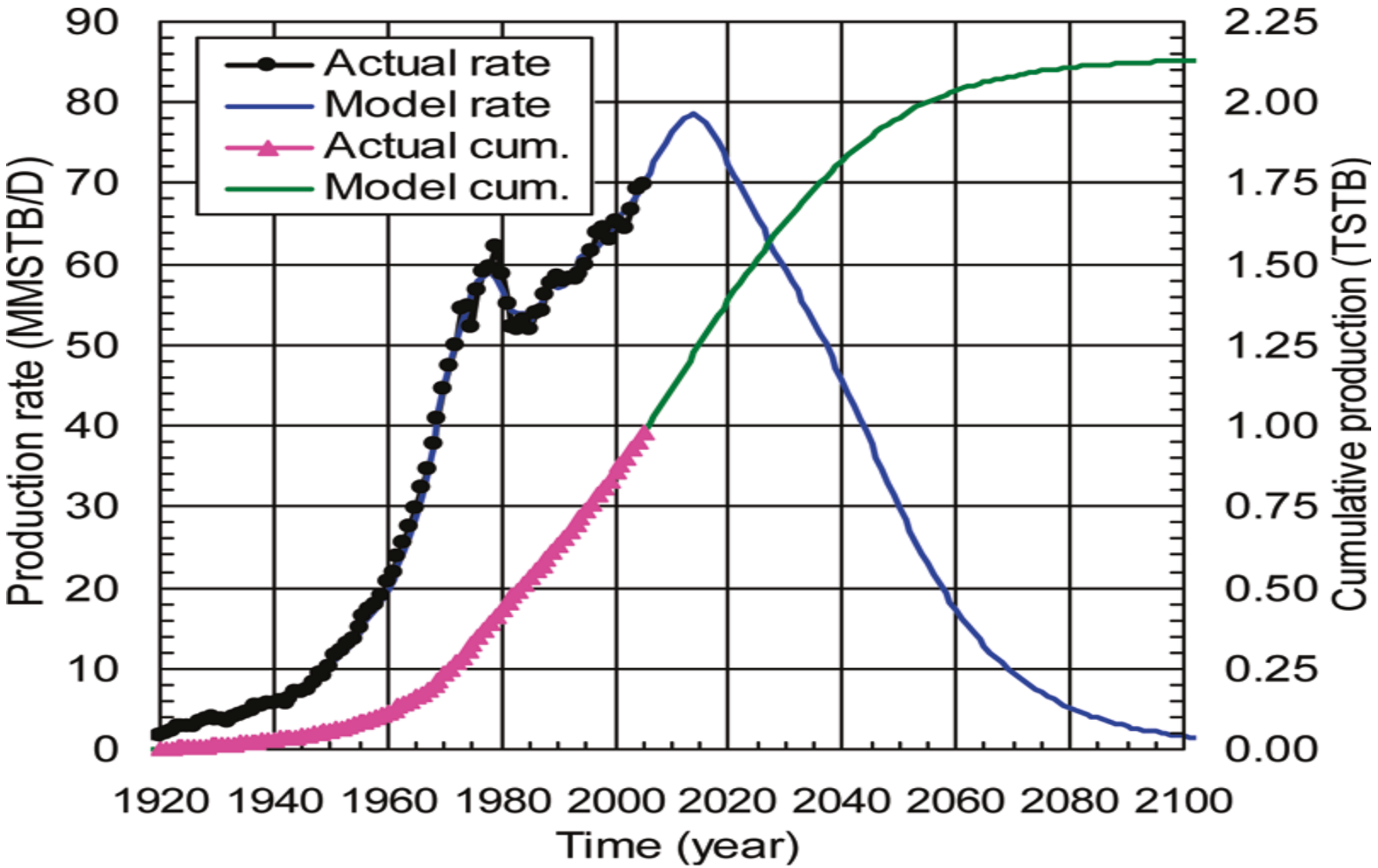
- Biogas, LPG, alcohols, kerosene, electricity

- Benefits
  - Health
  - Time spent
  - Reduced emissions of
    - Products of incomplete combustion
    - Black carbon

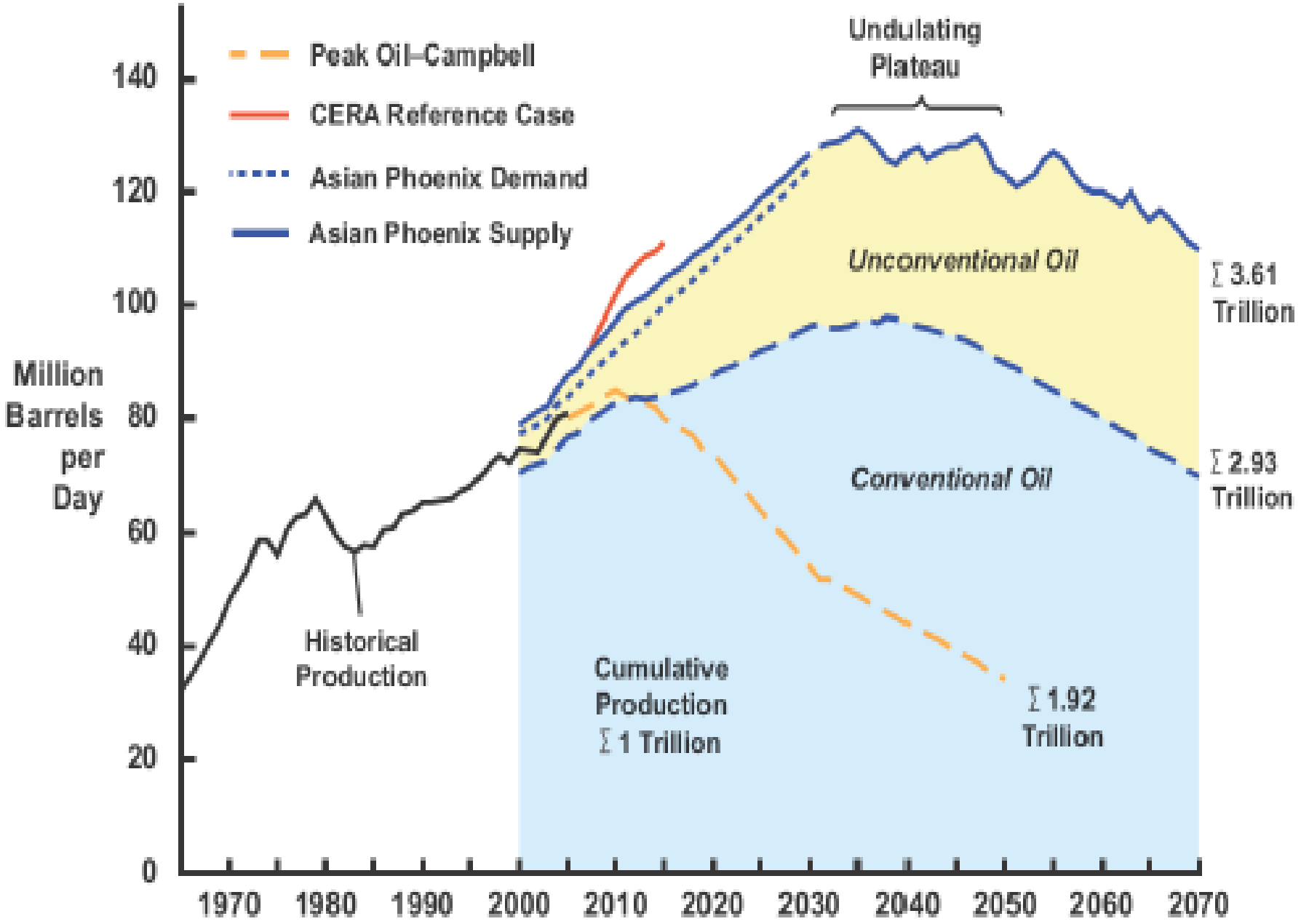


(Source: Earth Policy Institute, 2007)

World crude oil production model

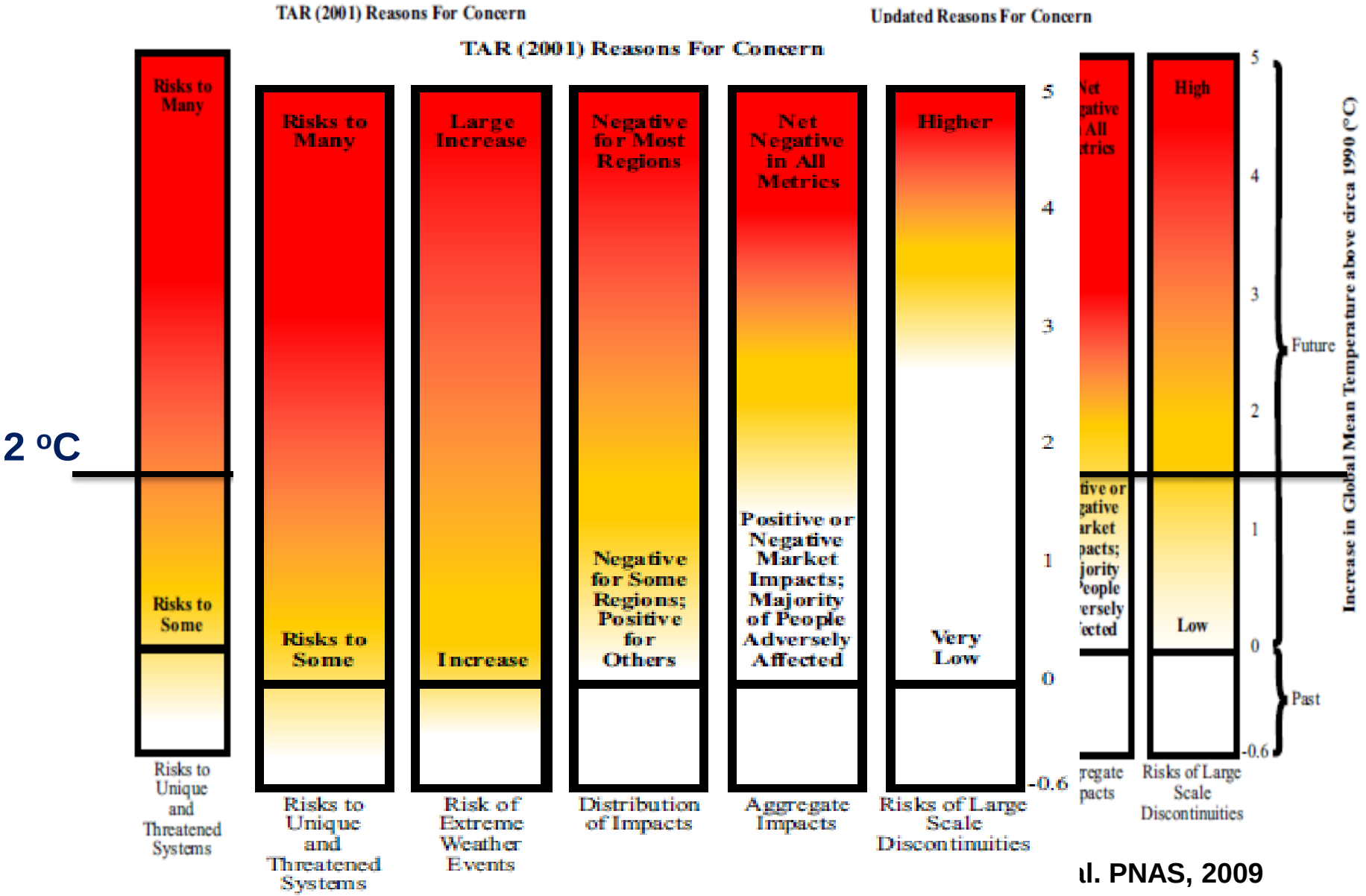


Nashawi et al., Energy Fuels 2010, 24, 1788–1800



(Source: CERA, 2008)

Reasons for Concern – "The Red Embers"



al. PNAS, 2009

Global emission pathways in compliance with a 2 ºC guardrail

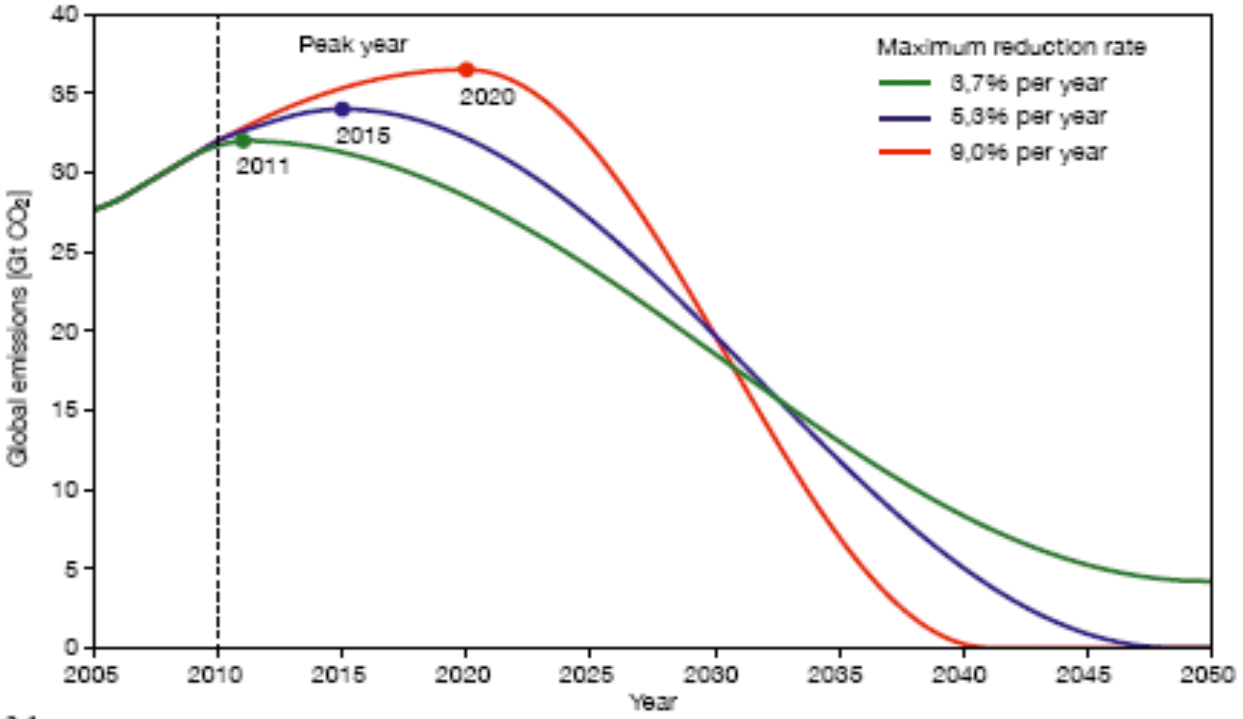


Figure 3.2-1
Examples of global emission pathways for the period 2010–2050 with global CO_2 emissions capped at 750 Gt during this period. At this level, there is a 67 % probability of achieving compliance with the 2°C guard rail (Chapter 5). The figure shows variants of a global emissions trend with different peak years: 2011 (green), 2015 (blue) and 2020 (red). In order to achieve compliance with these curves, annual reduction rates of 3.7 % (green), 5.3 % (blue) or 9.0 % (red) would be required in the early 2030s (relative to 2008).
Source: WBGU

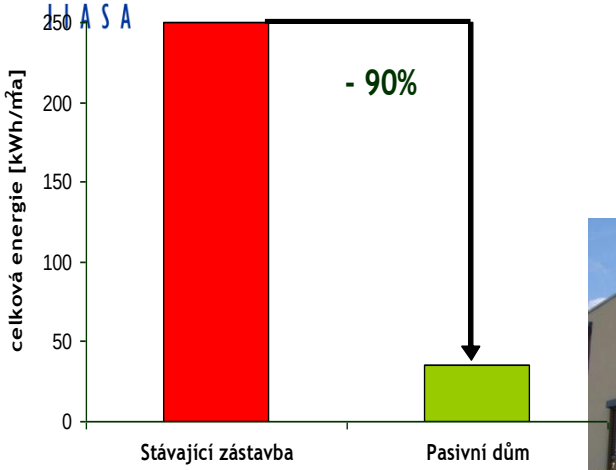
this translates into a need for a major energy systems transformation

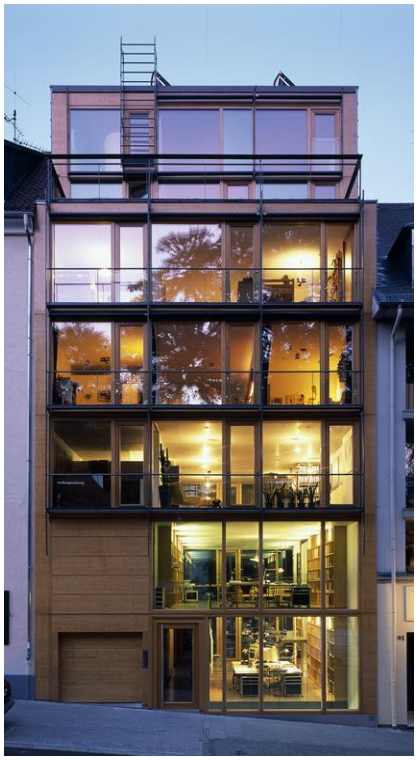
Main elements:

- Energy end-use efficiency
- Renewable energies
- Carbon Capture and Storage (for CC only)

- **Efficiency** and **Renewables** are **INSTRUMENTS** for addressing all the challenges at the same time!

“PassivHaus”





Source: Jan Barta, Center for Passive Buildings, www.pasivnidomy.cz

Example of savings by reconstruction

Before reconstruction

Reconstruction according to the passive house principle

-90%

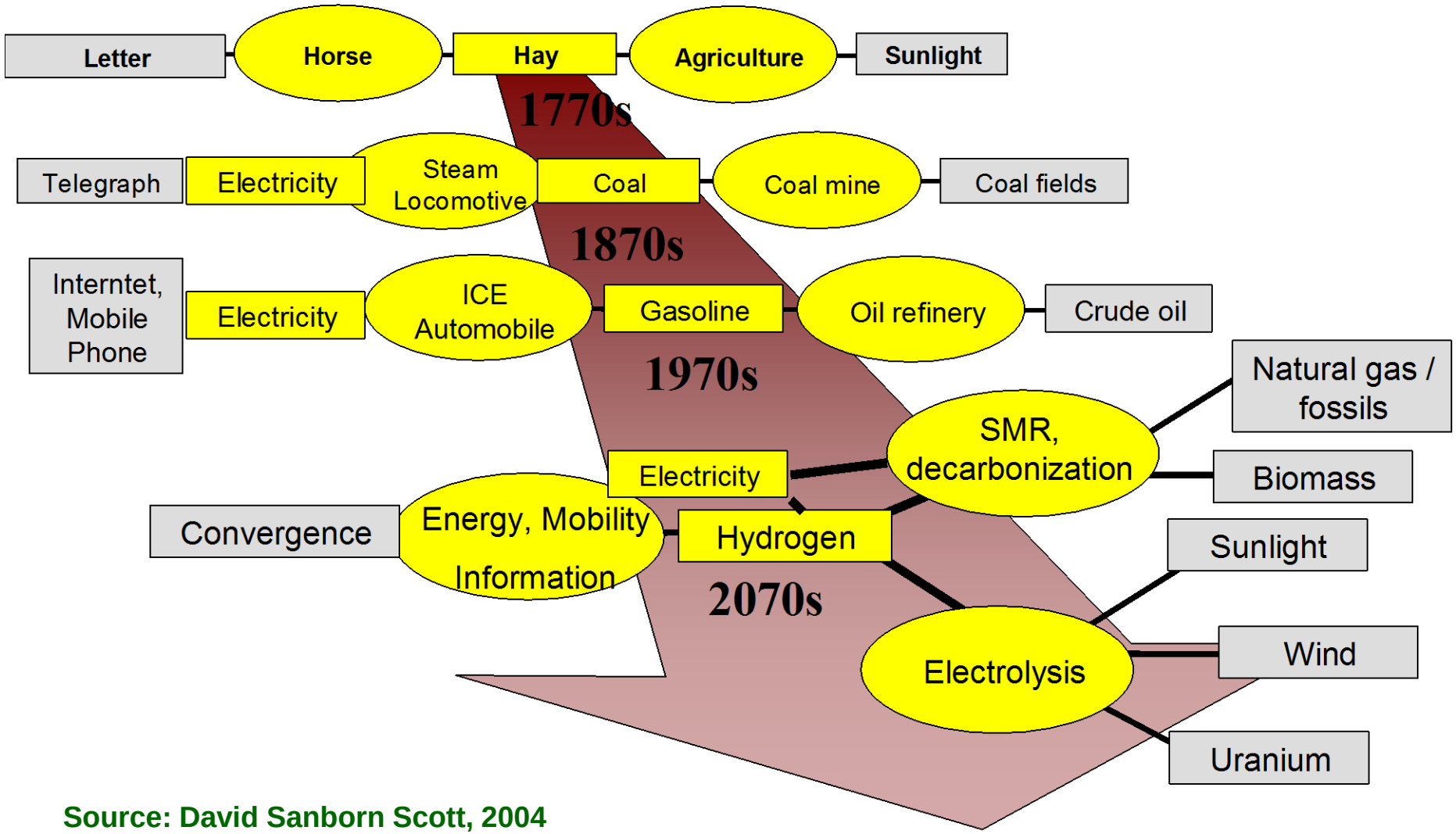
over 150 kWh/(m²a)

15 kWh/(m²a)

Source: Jan Barta, Center for Passive Buildings, www.pasivnidomy.cz, EEBW2006

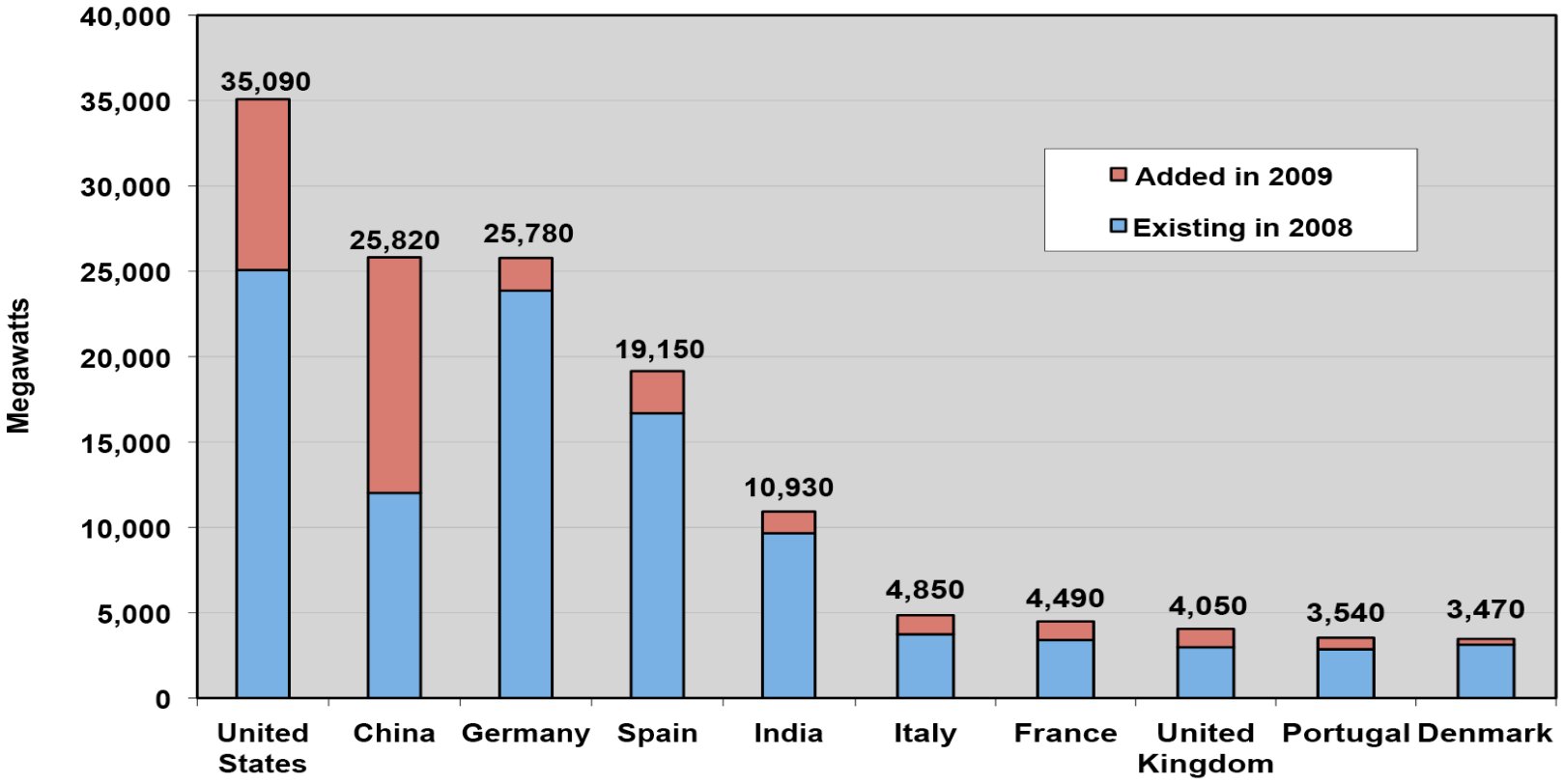
How far can buildings take us?

Mobility and Communication Through Time



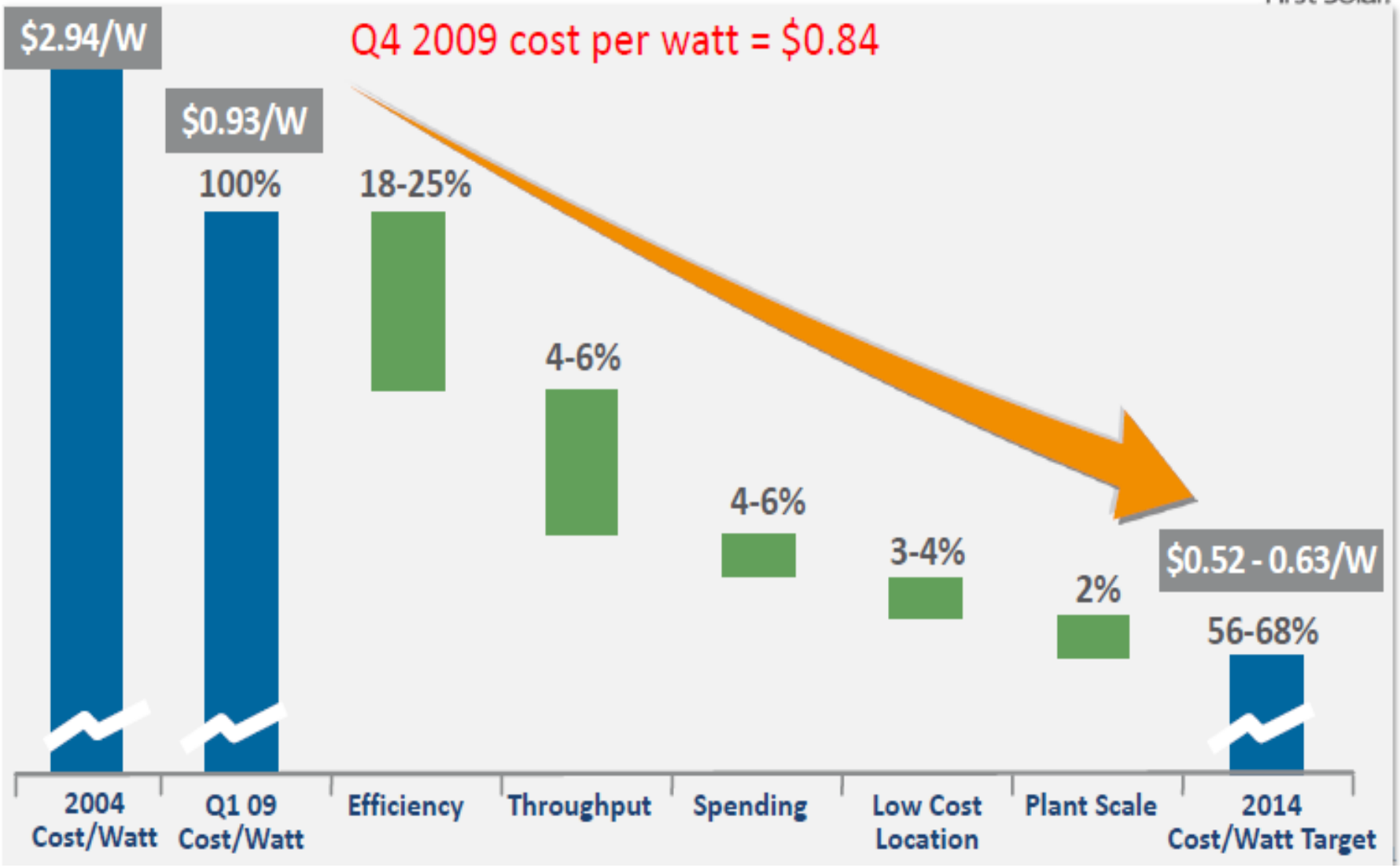
Source: David Sanborn Scott, 2004

Figure 6. Wind Power Capacity, Top 10 Countries, 2009



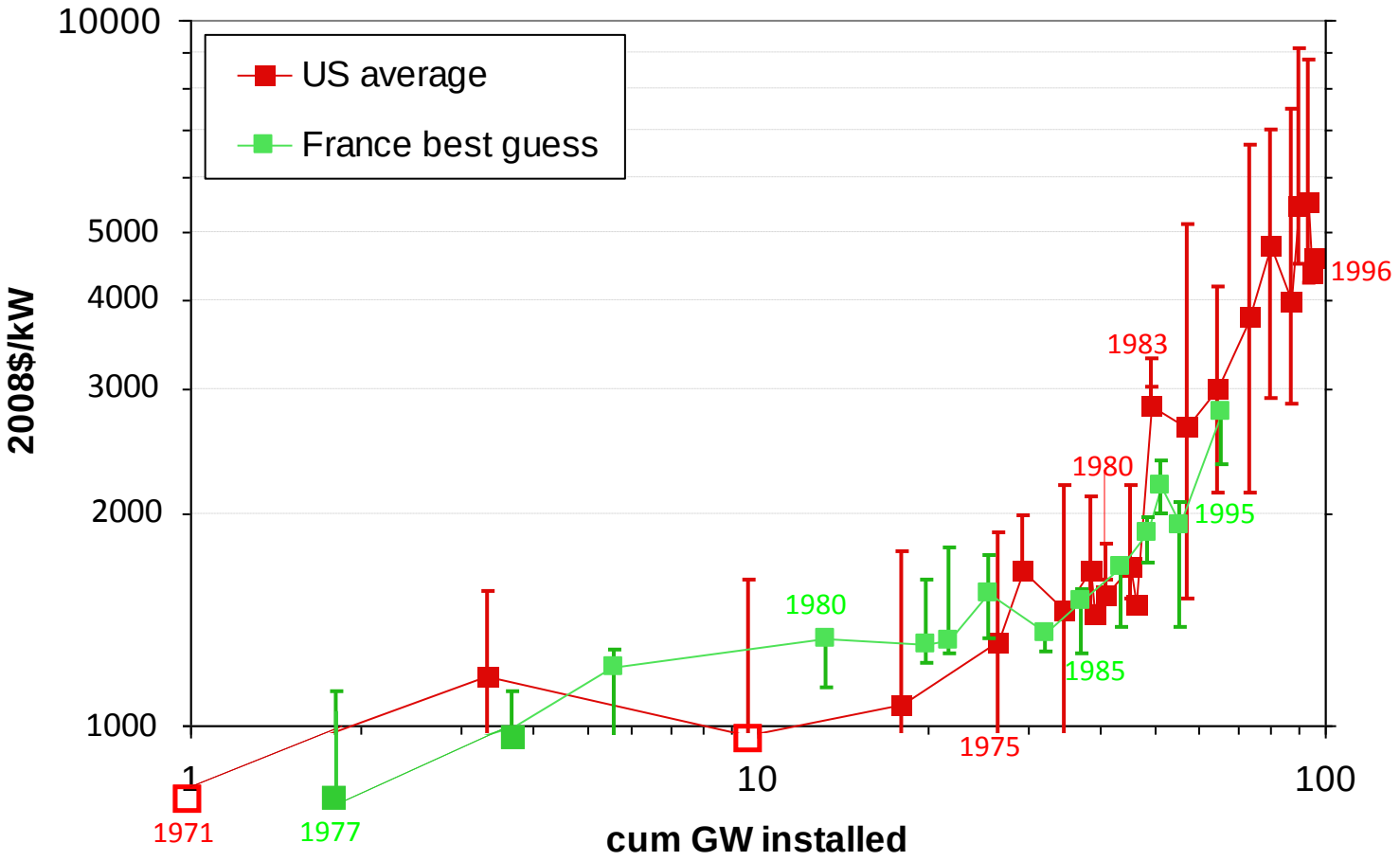
Source: REN21

Module Cost Reduction Roadmap



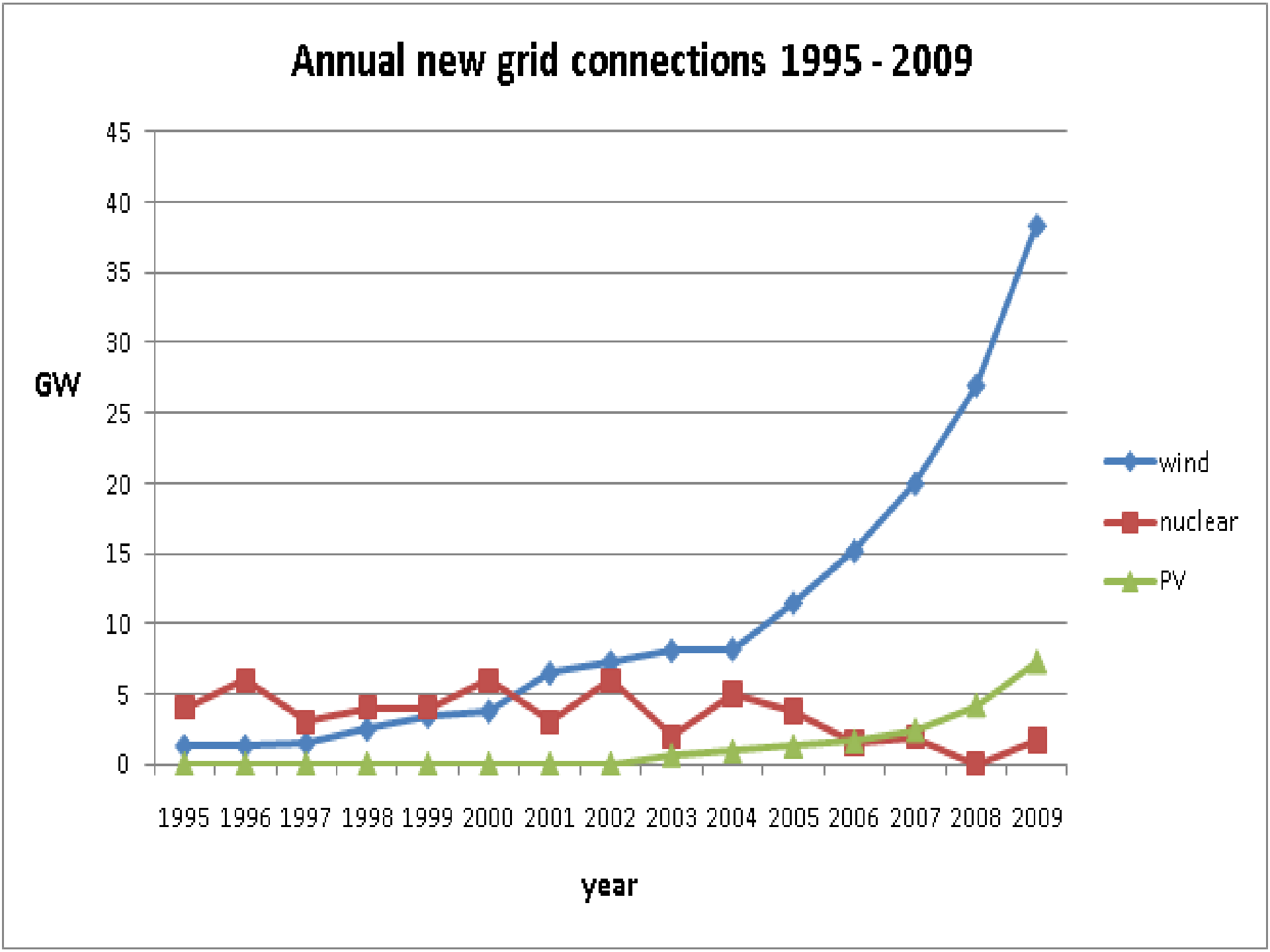
Nuclear PWR Investment Costs

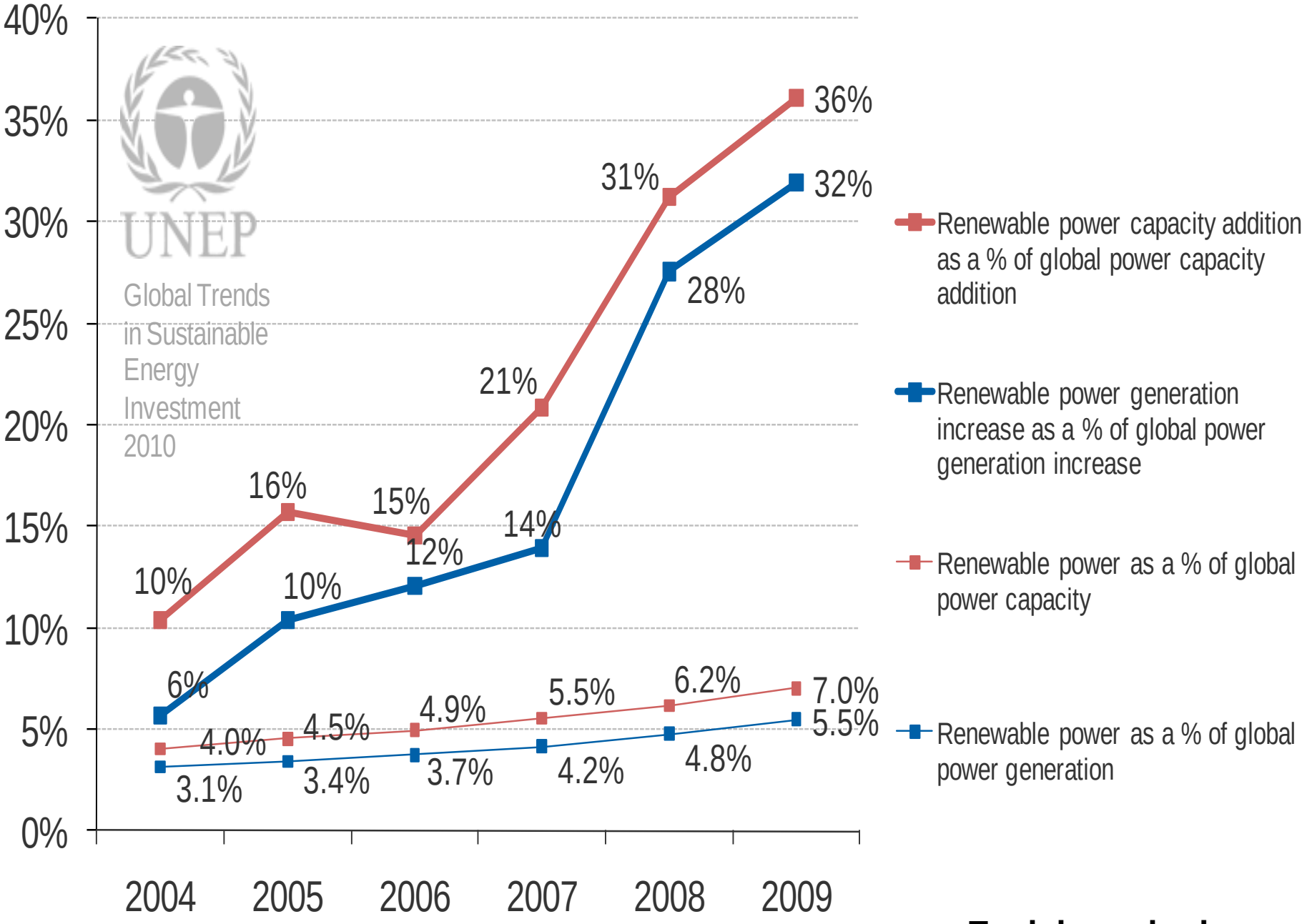
US overnight excl. interest, France partly incl. interests
mean/best guess and min/max of costs



US: Koomey&Hultman, 2007, France: Grubler, 2009

Source: GEA KM24 forthcoming


Annual new grid connections 1995 - 2009
45
40
35
30
25
20
15
10
5
0
GW
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
year
wind
nuclear
PV



Excl. large hydro

HVDC Light cable development

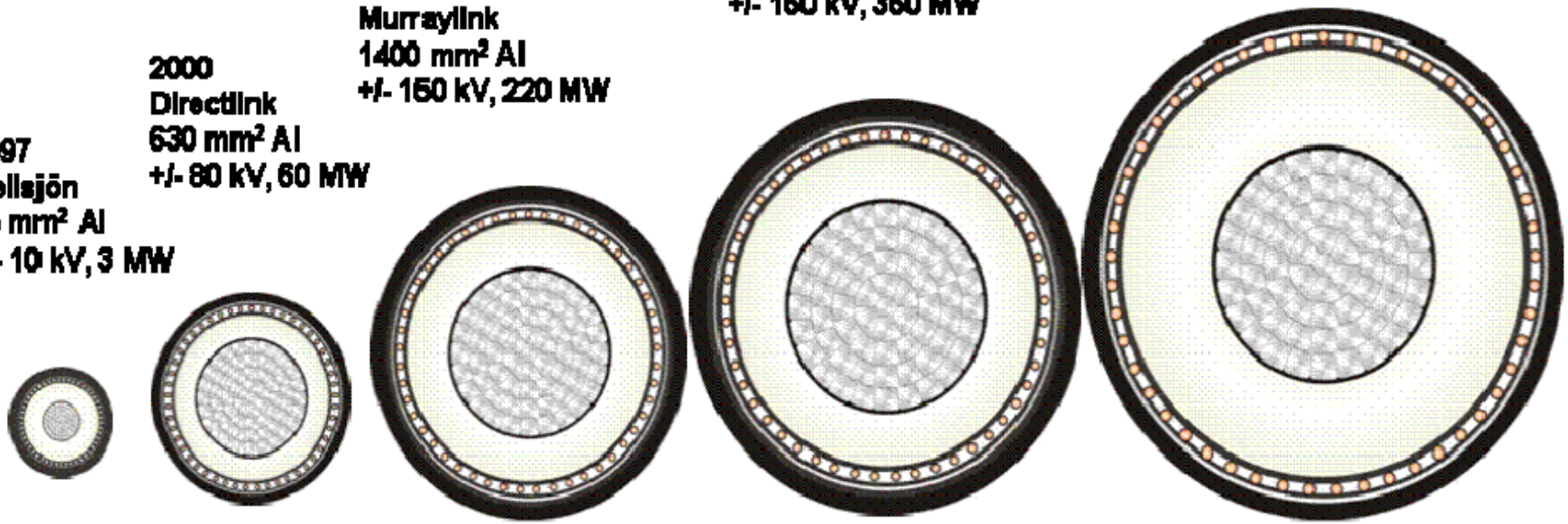
1997
Hellsjön
95 mm² Al
+/- 10 kV, 3 MW

2000
Directlink
630 mm² Al
+/- 80 kV, 60 MW

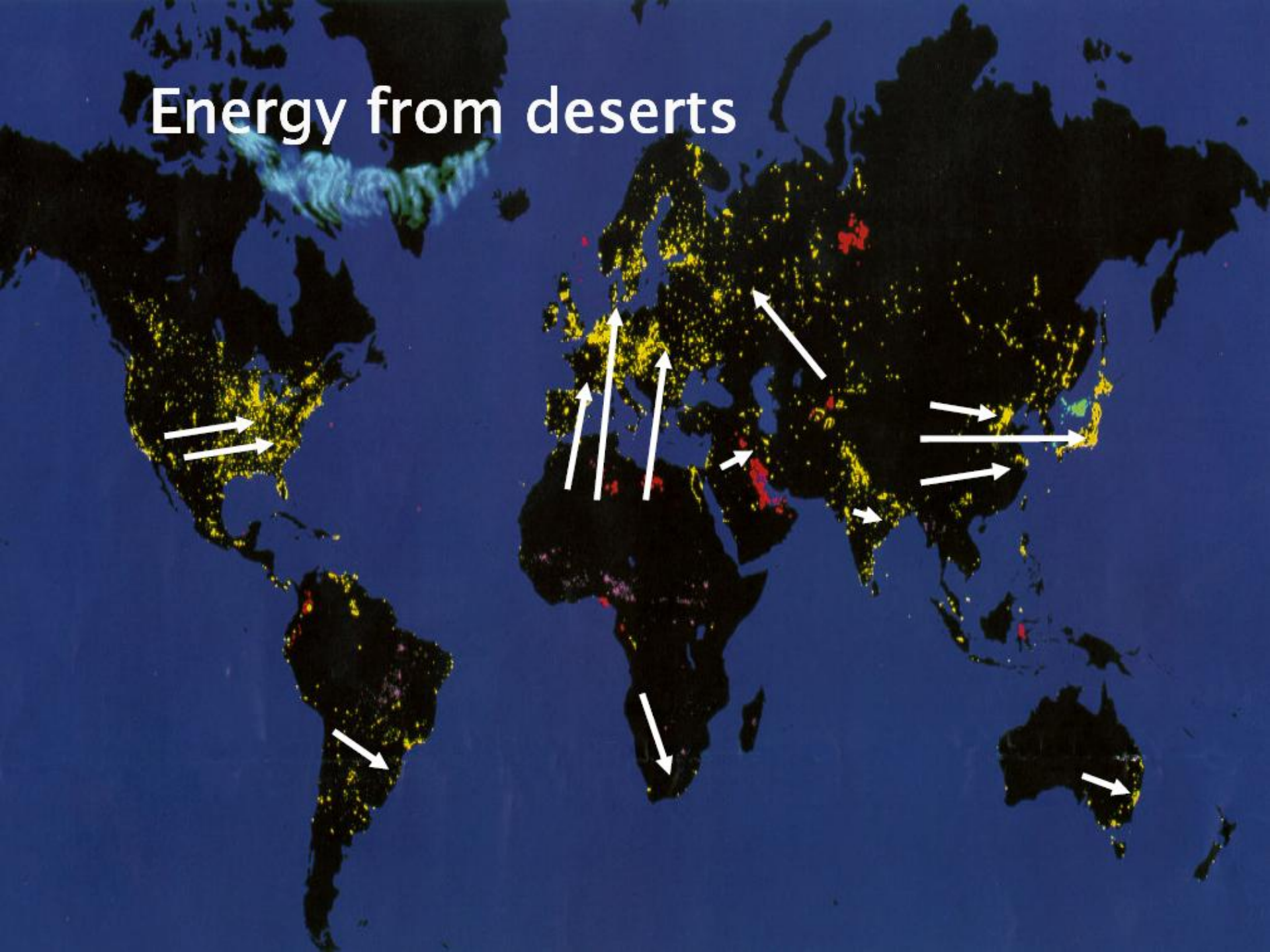
2001
Murraylink
1400 mm² Al
+/- 150 kV, 220 MW

2004
Estlink
2000 mm² Al
+/- 150 kV, 350 MW

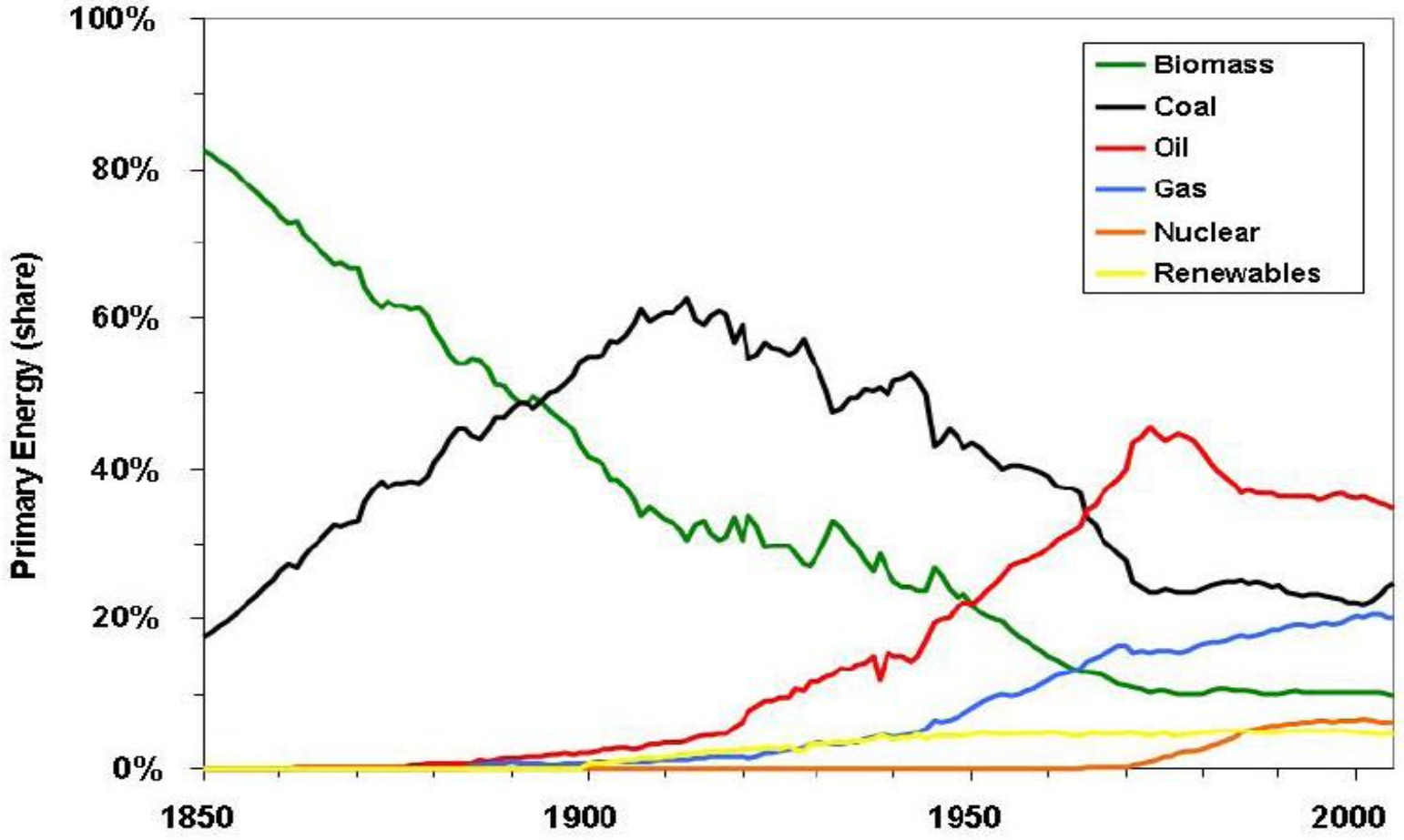
2006 - 2007
1600 mm² Al (Cu)
+/- 300 kV, 700 MW (1100 MW)



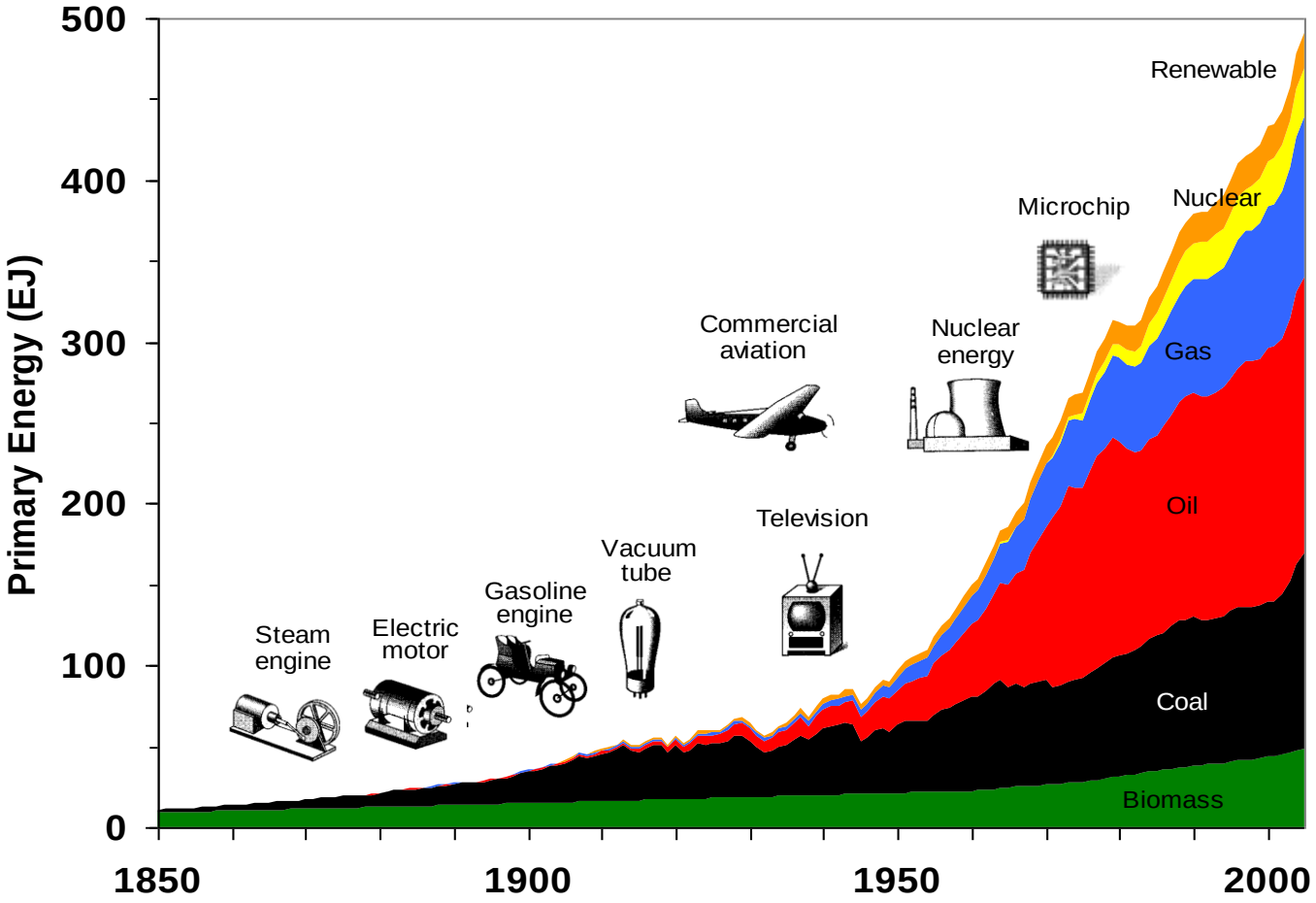
Energy from deserts



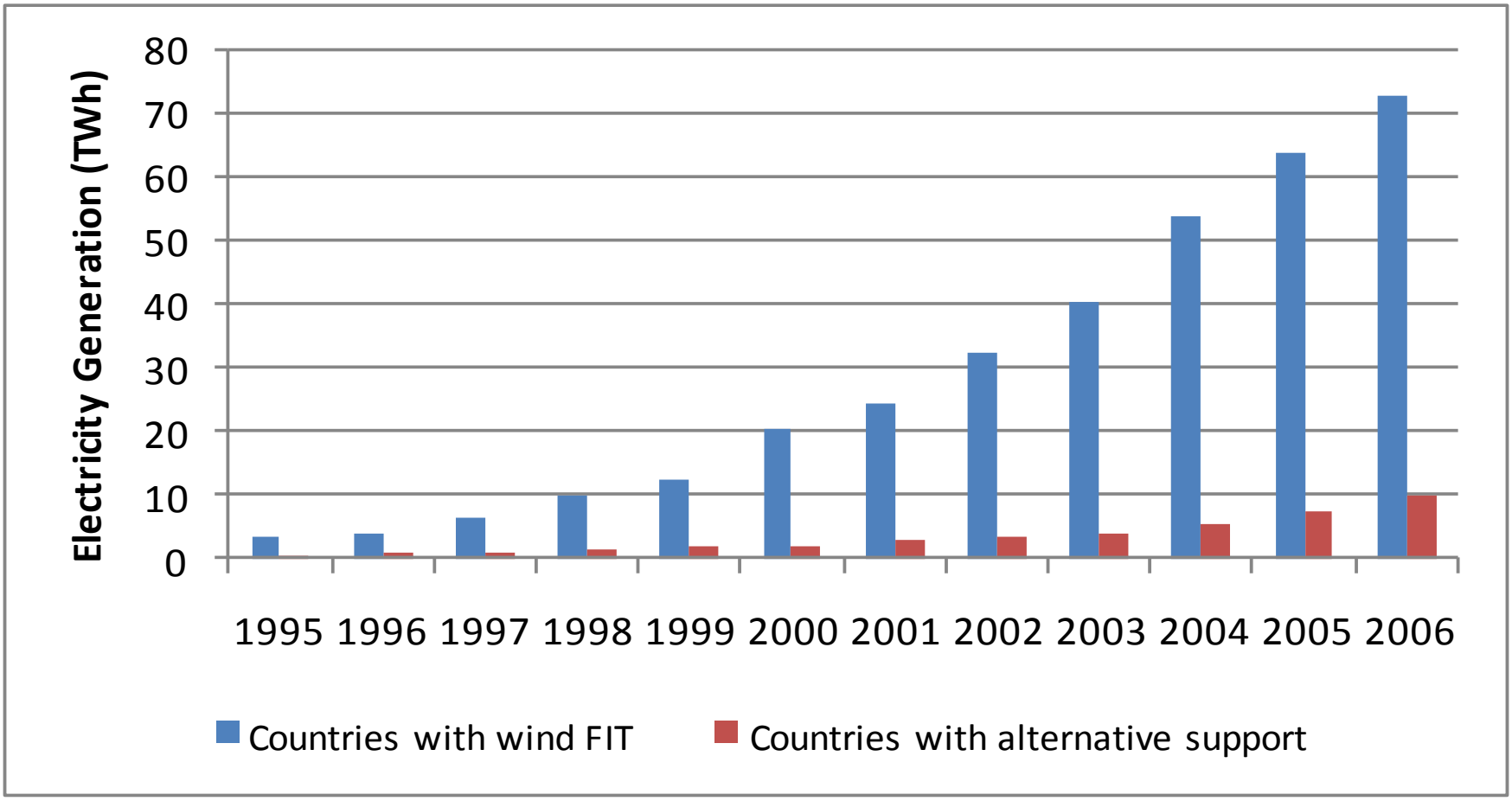
Global energy transitions



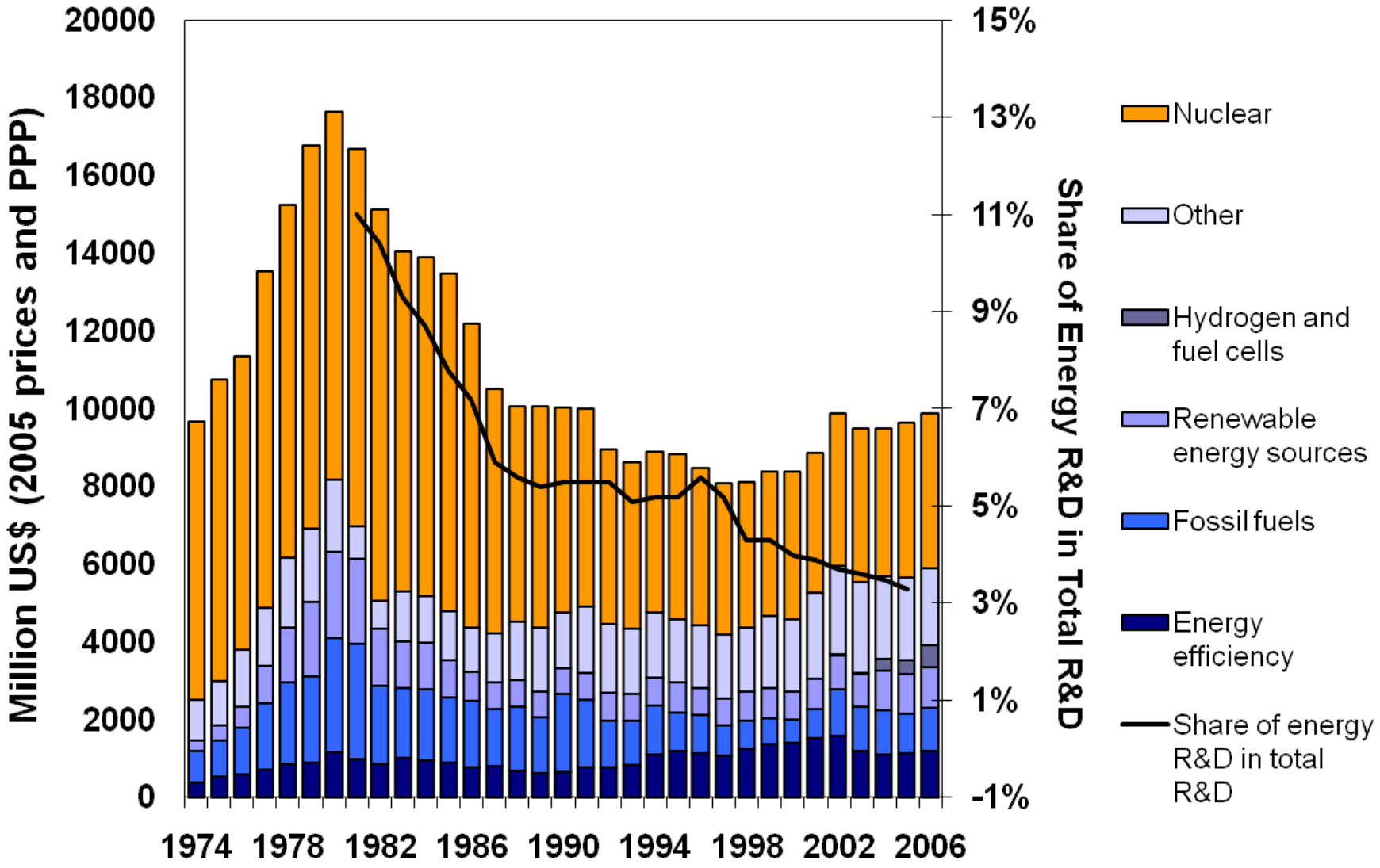
World Primary Energy



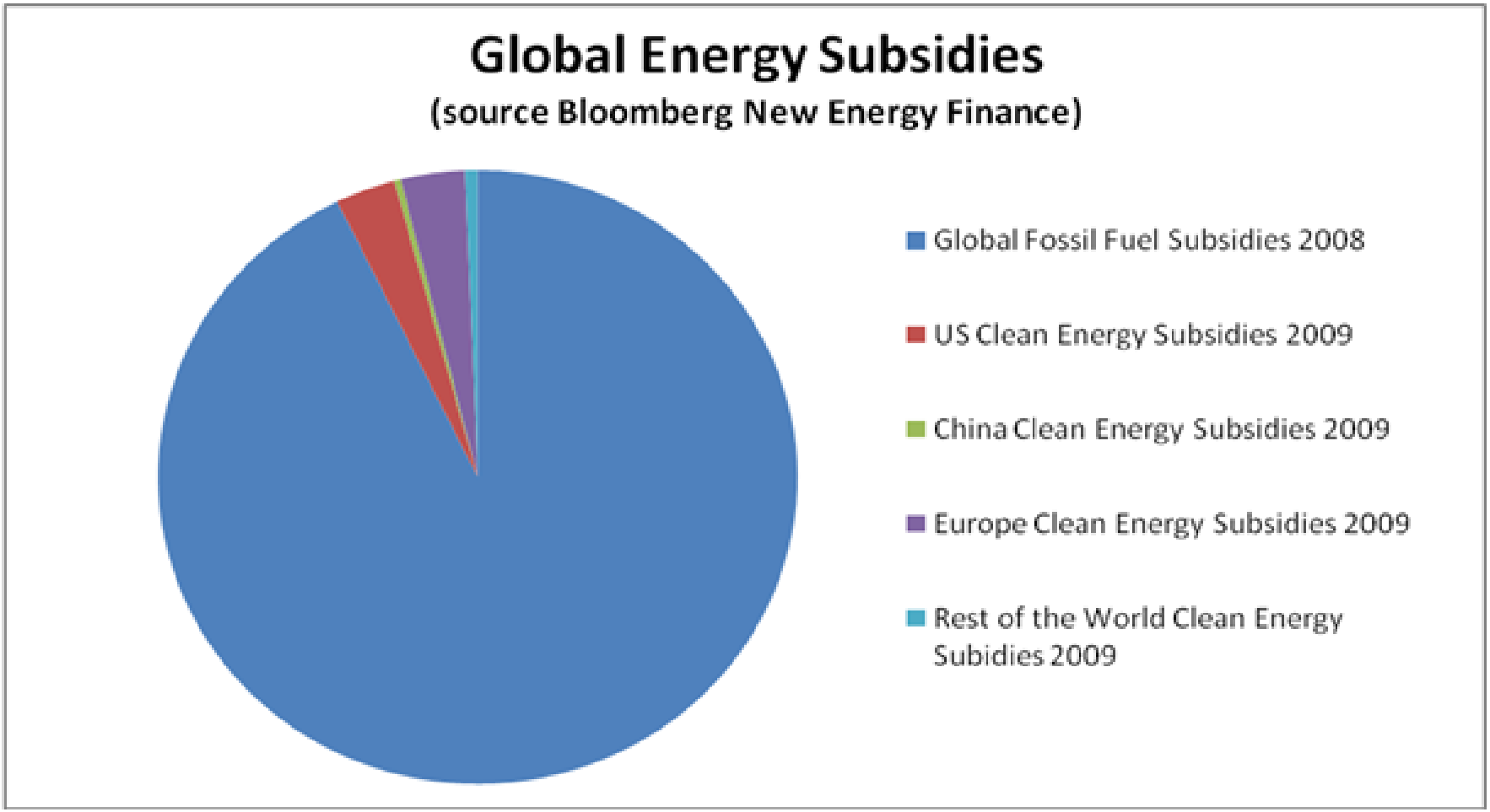
Wind Power in EU-27 and FITs



Public Energy R&D in OECD



Source: IEA, 2008


Global Energy Subsidies
(source Bloomberg New Energy Finance)
Global Fossil Fuel Subsidies 2008
US Clean Energy Subsidies 2009
China Clean Energy Subsidies 2009
Europe Clean Energy Subsidies 2009
Rest of the World Clean Energy Subidies 2009

not just energy technology

- Urban planning
- Transportation systems
- Material use
- Land use
- Consumption patterns
- …..

Economic development and poverty alleviation while mitigating climate change

- Multiple benefits concept
- Value **all** benefits (jobs, growth, security, health, local environment, ...)
- Costs in terms of € per tC misleading

- Energy efficiency
- Renewable energies

Major findings and conclusions

- Rapidly changing world
- Transformative changes needed on energy
- Window of opportunity exists
- Resources and technologies exist
- Rapidly growing role for renewable energies
- Electricity growing importance
- Policies and institutions critical
- Energy subsidies and R&D misallocated
- Capacity developoment worldwide

Thank you!

www.globalenergyassessment.org