Sustainable Energy Supply:

The Challenge of the Century

State of the Art, Potentials & Perspectives

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Electrical Energy Technology
Sustainable Energy Concepts

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Overview

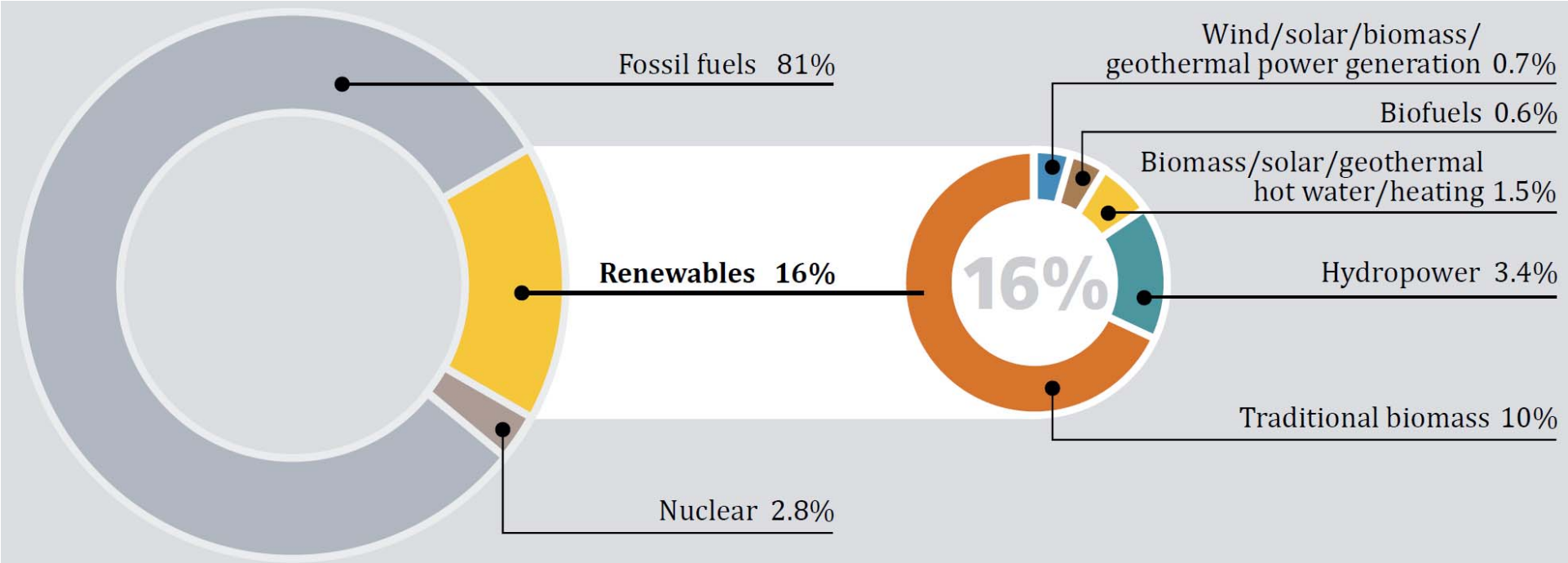
1. Energy Resources & Potentials

   Development of Energy use

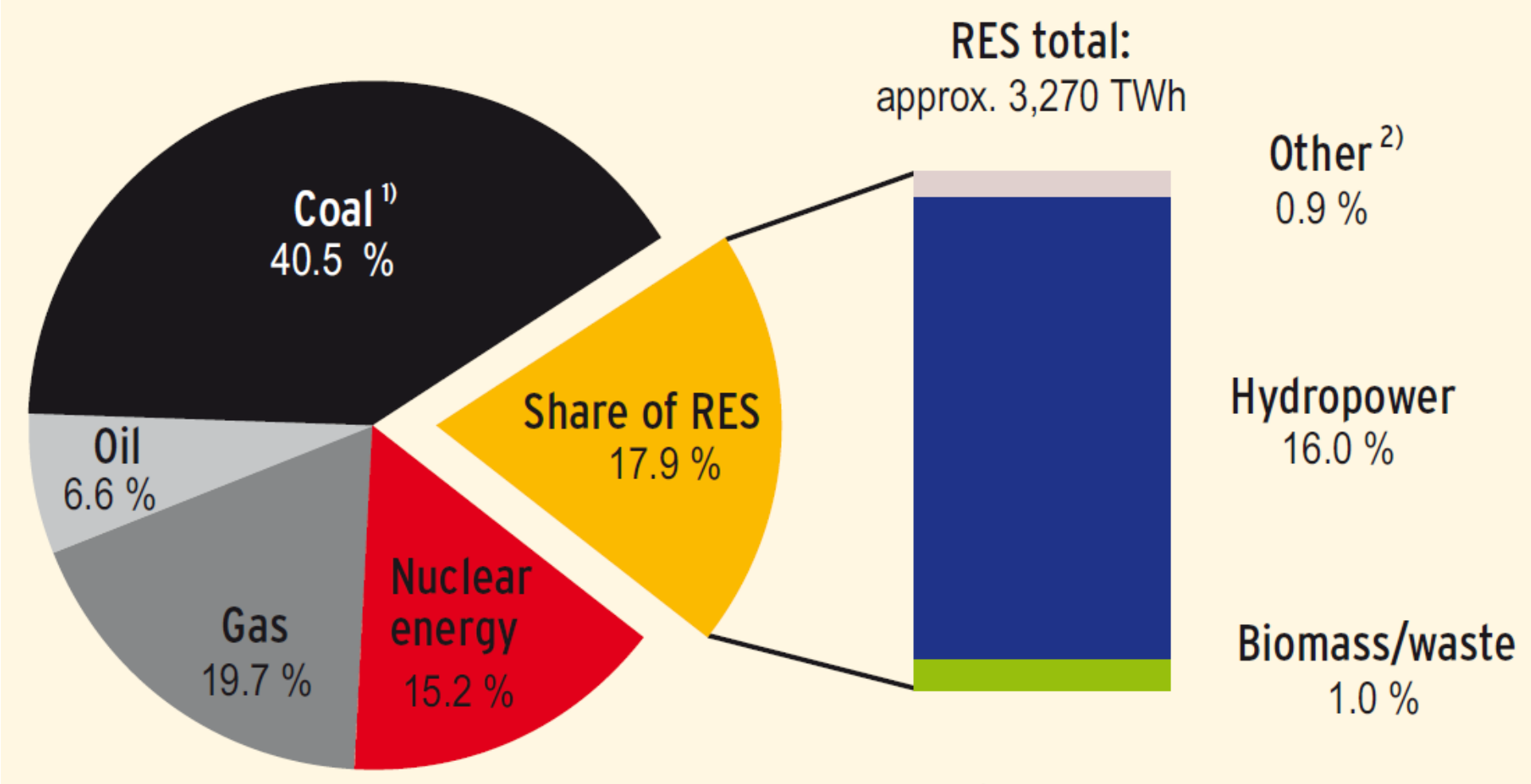
   Present status of Renewables (Worldwide & Germany)

   Challenges for the Energy Structure

Total energy consumption 2010 (electricity, heating, transportation)



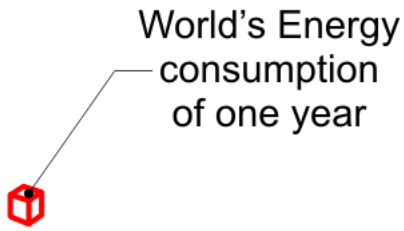
World‘s electricity supply



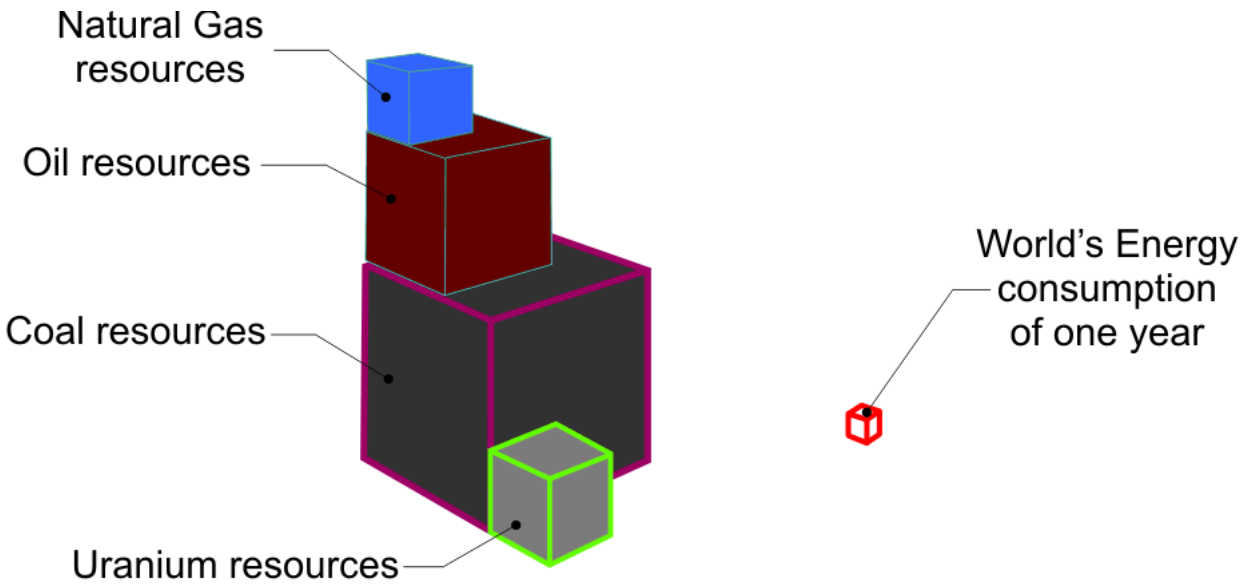
Source: BMU publication „Renewable energy sources in figures - national and international development“, Status: June 2008

1) Includes non-renewable portion of waste (0.2 %)
2) Geothermal energy, solar energy, wind energy, marine energy

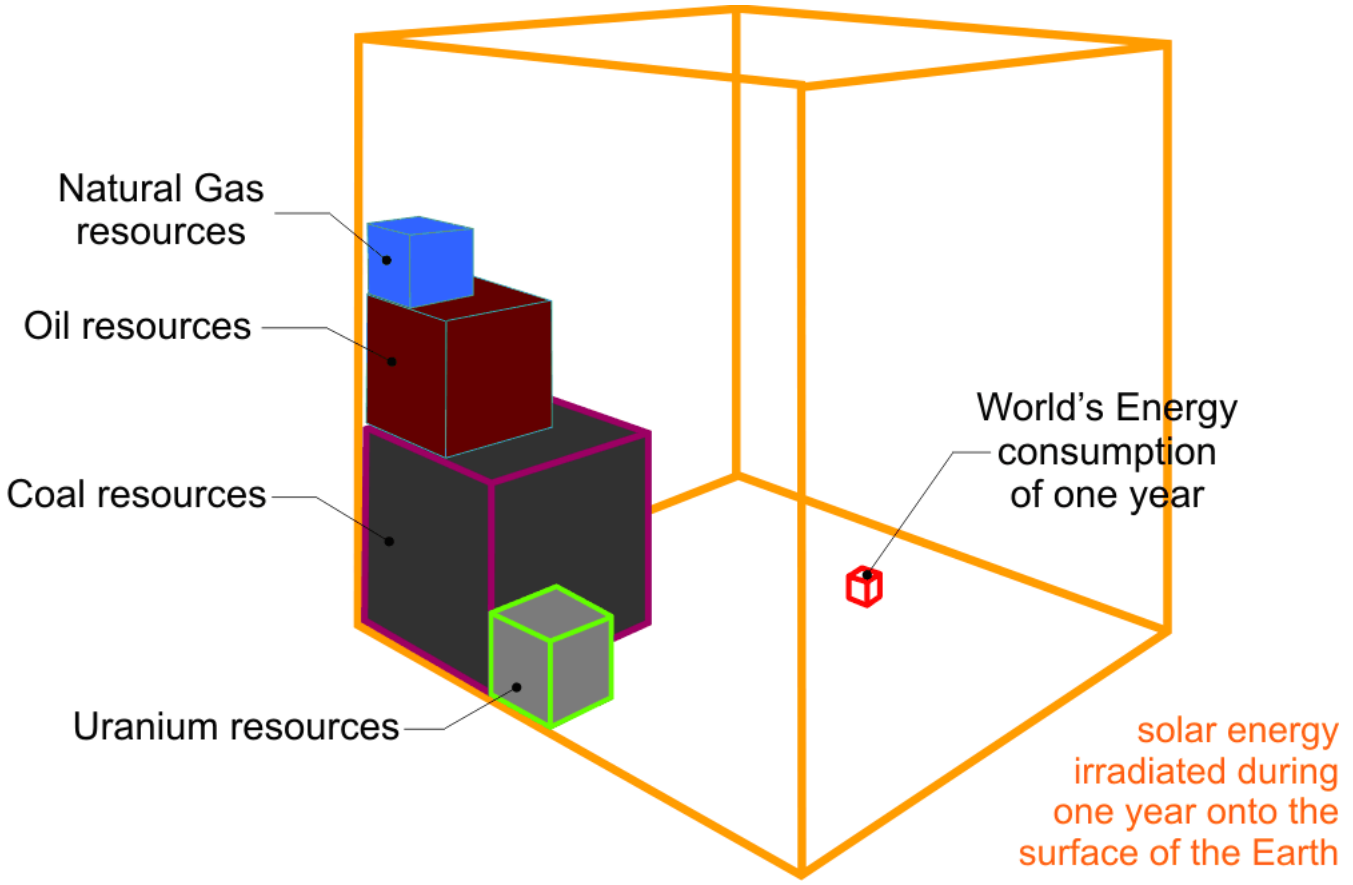
Energy consumption and resources



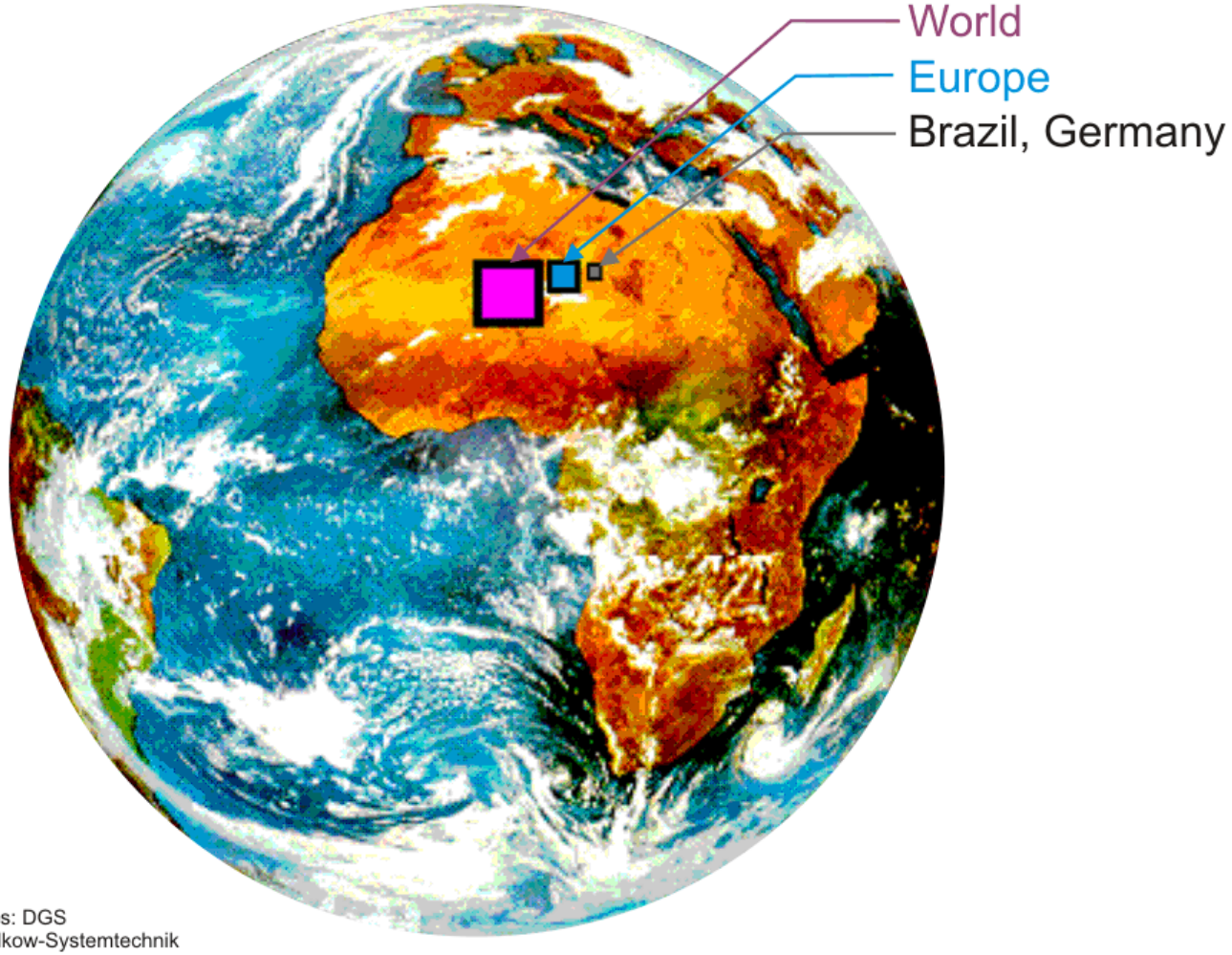
Energy consumption and resources



Energy consumption and resources

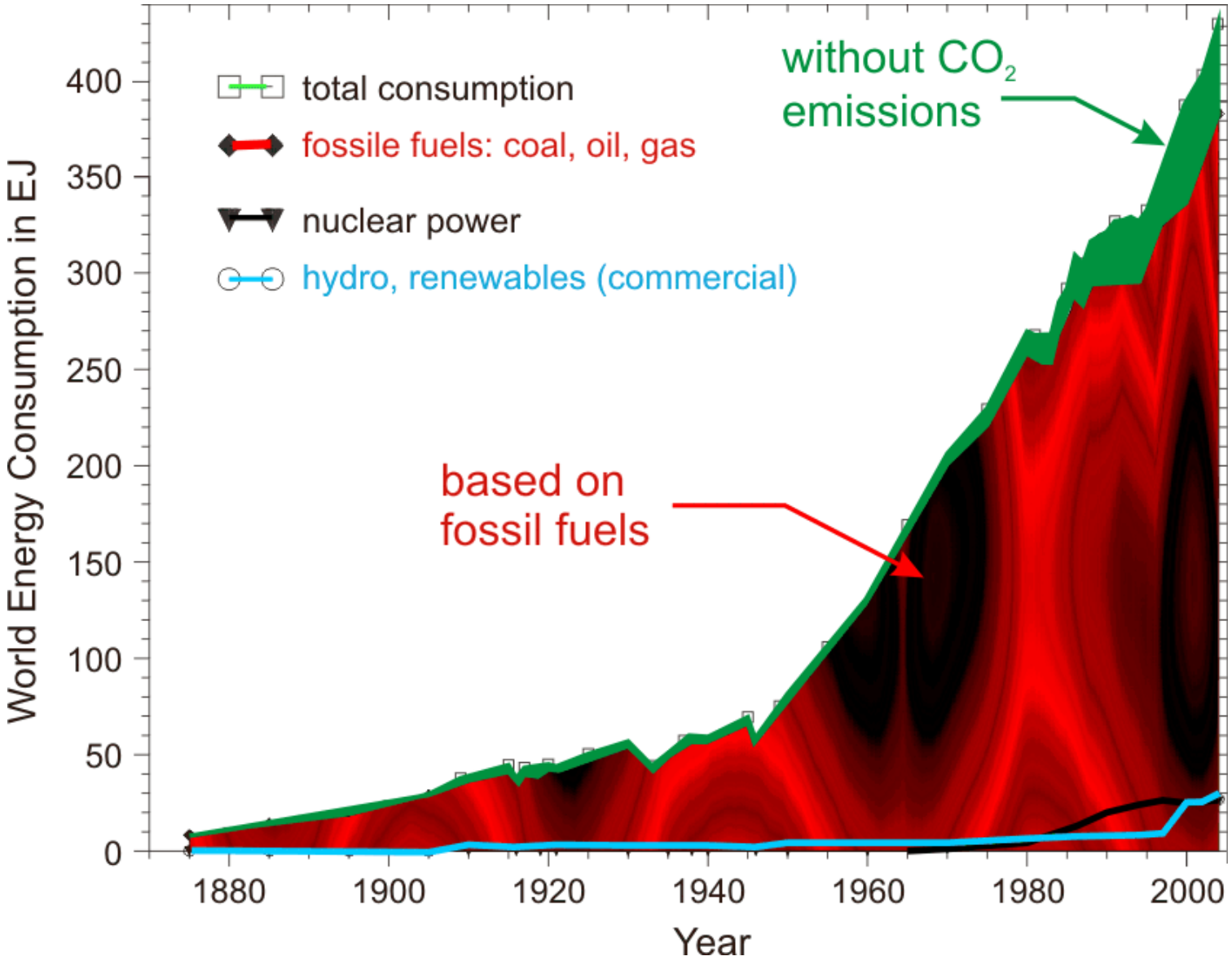


Area necessary for the energy supply via photovoltaics

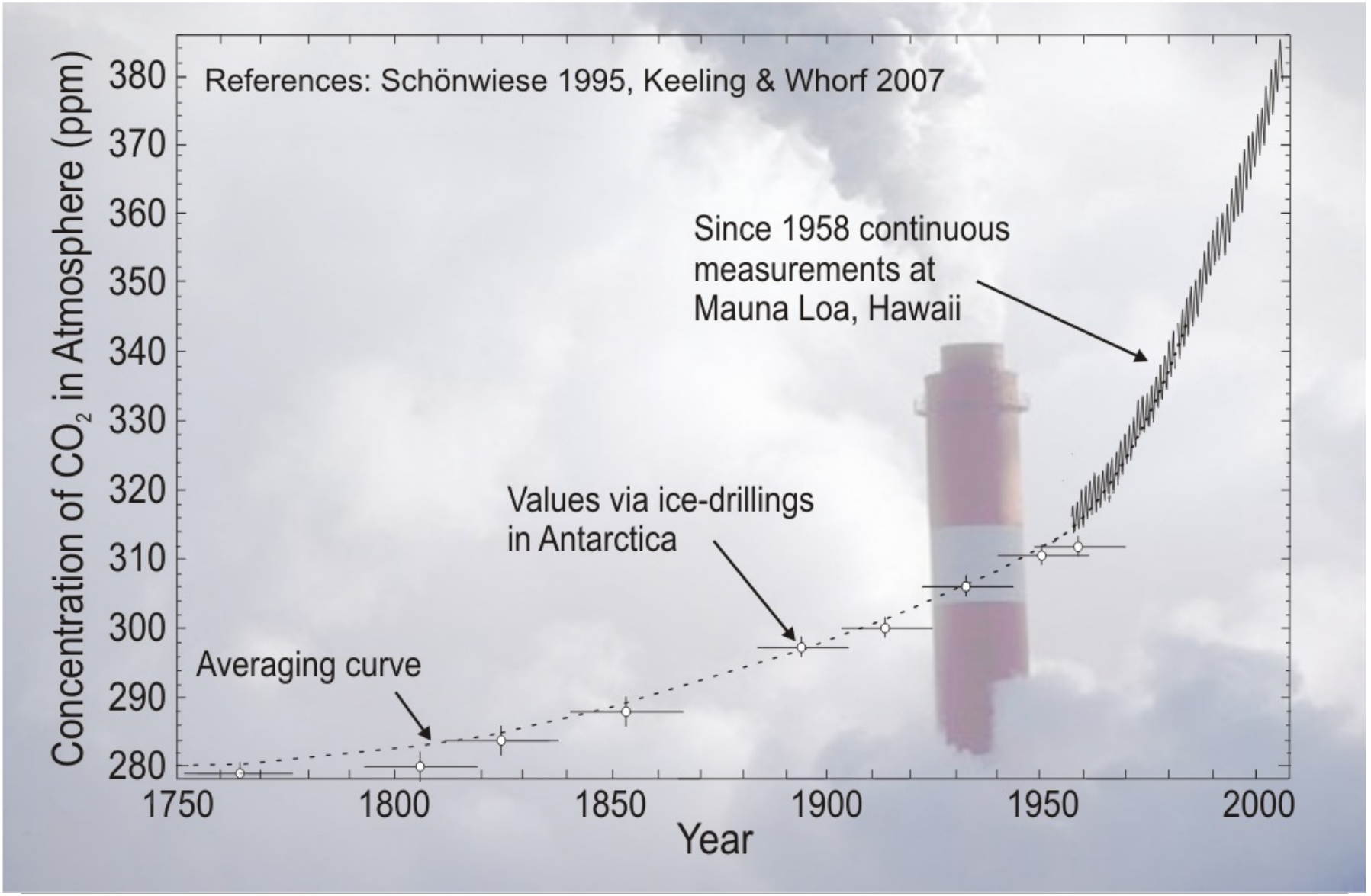


References: DGS
Lutwig-Bölkow-Systemtechnik

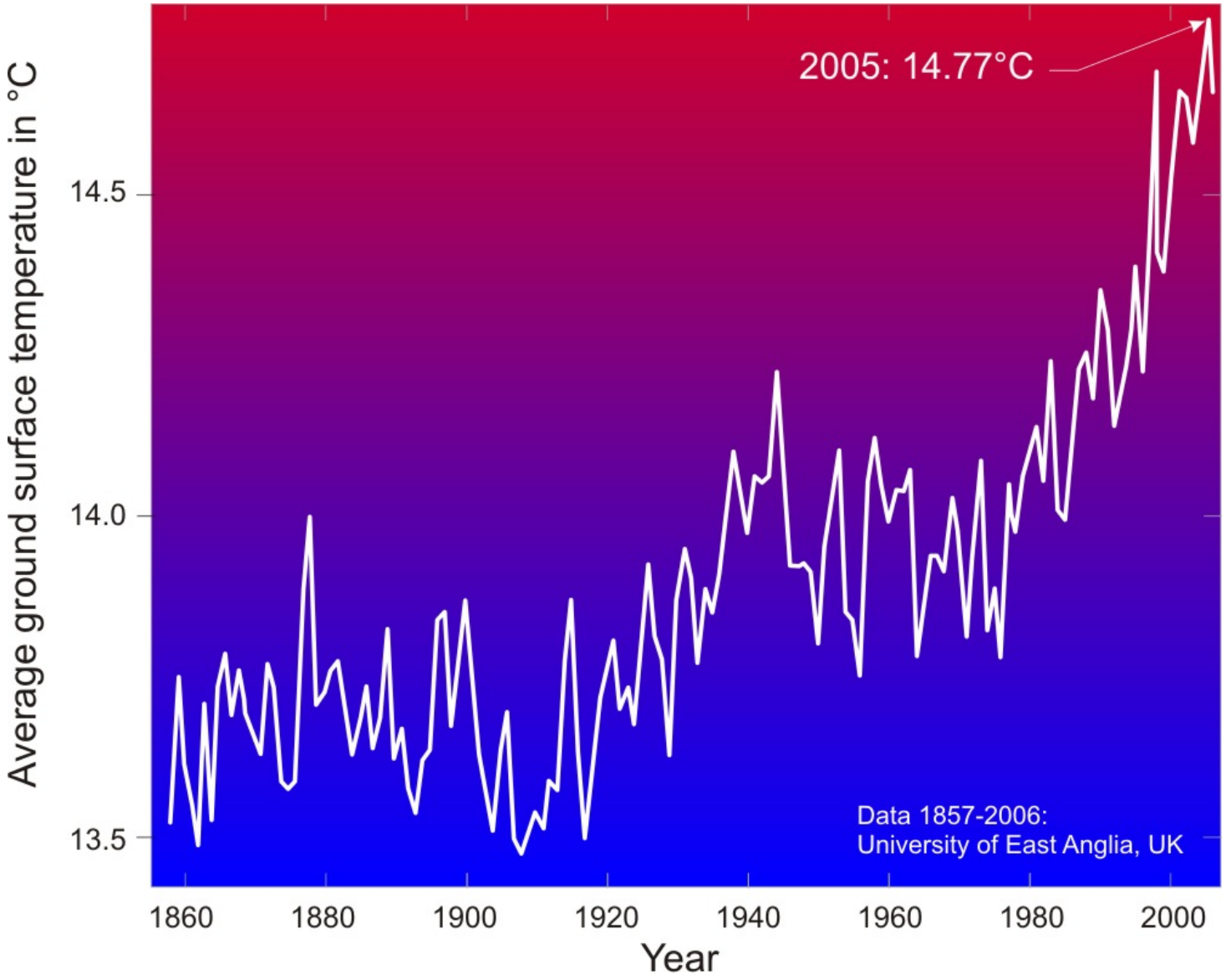
Development of World‘s Energy Supply



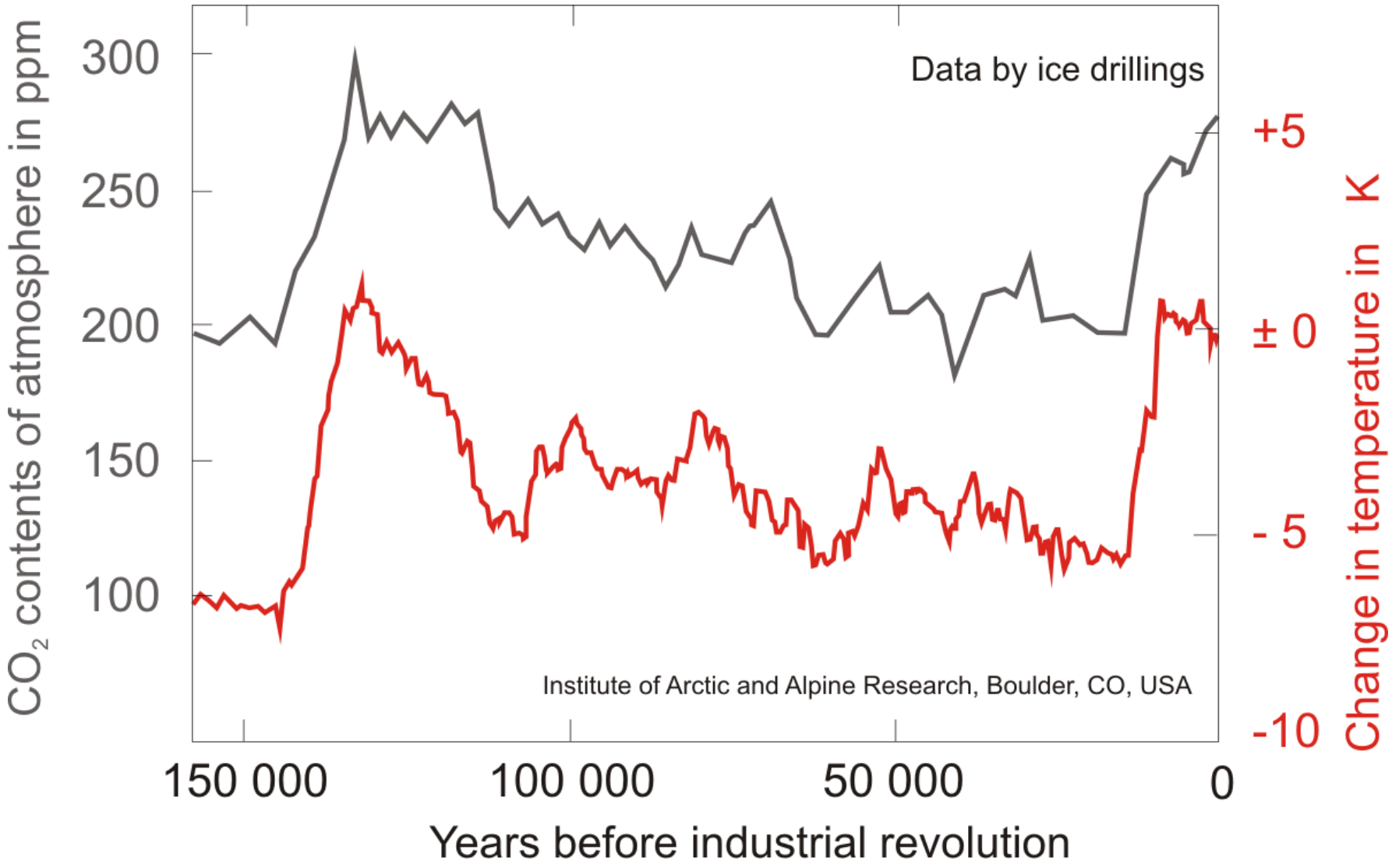
Development of Earth‘s atmosphere CO_2-contents



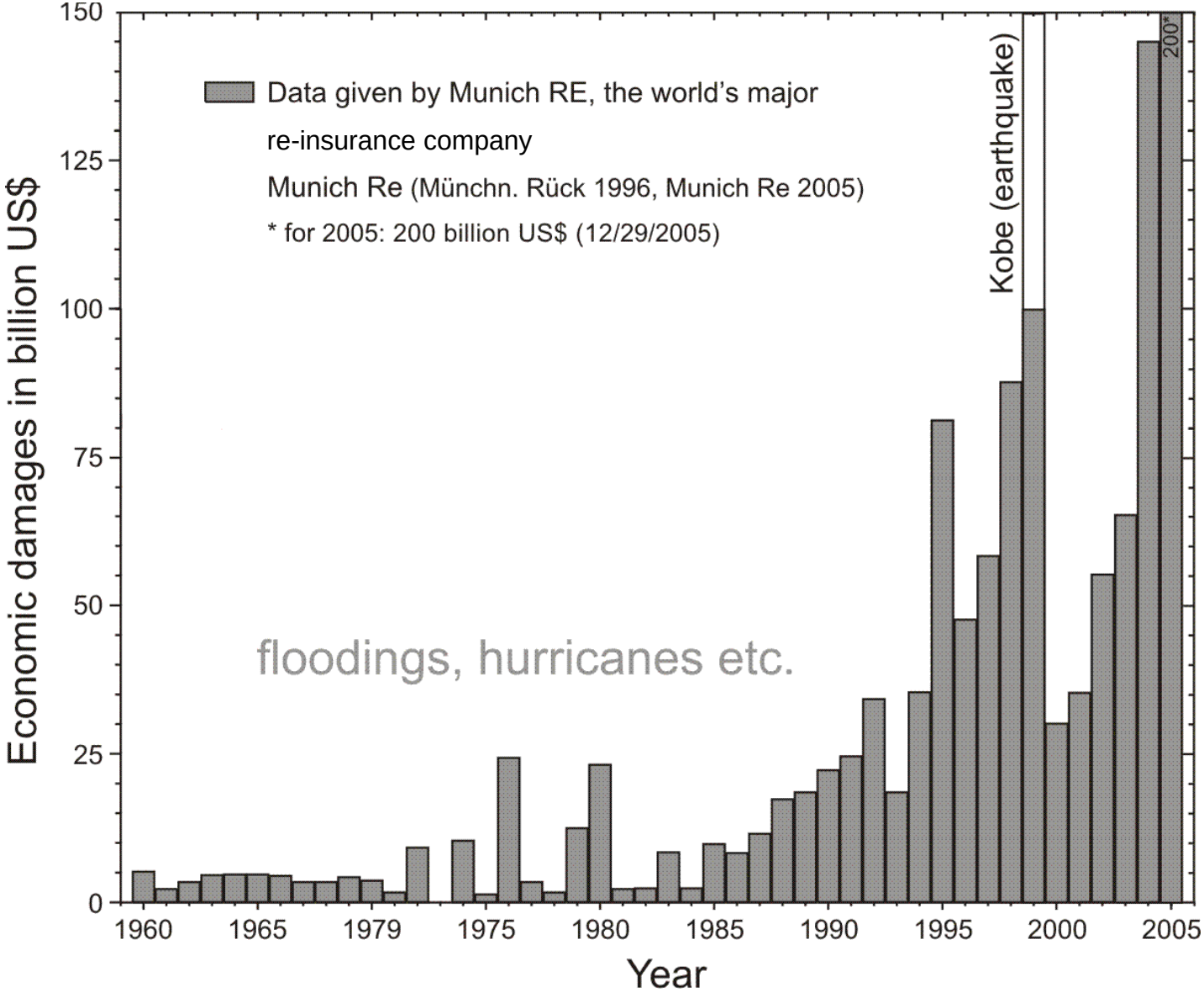
Development of global ground surface temperature



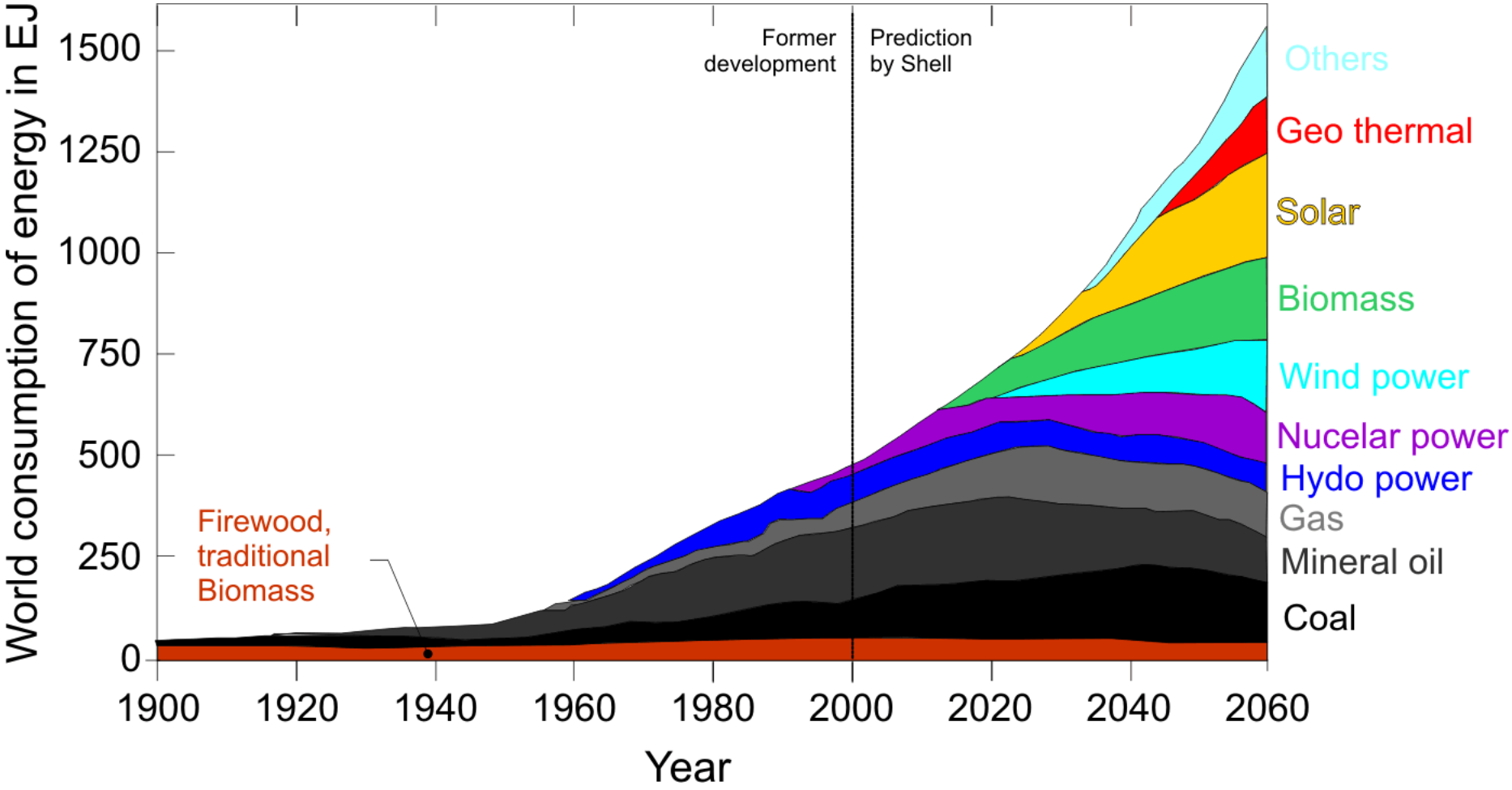
CO_2 contents in Earth's atmosphere and global temperature



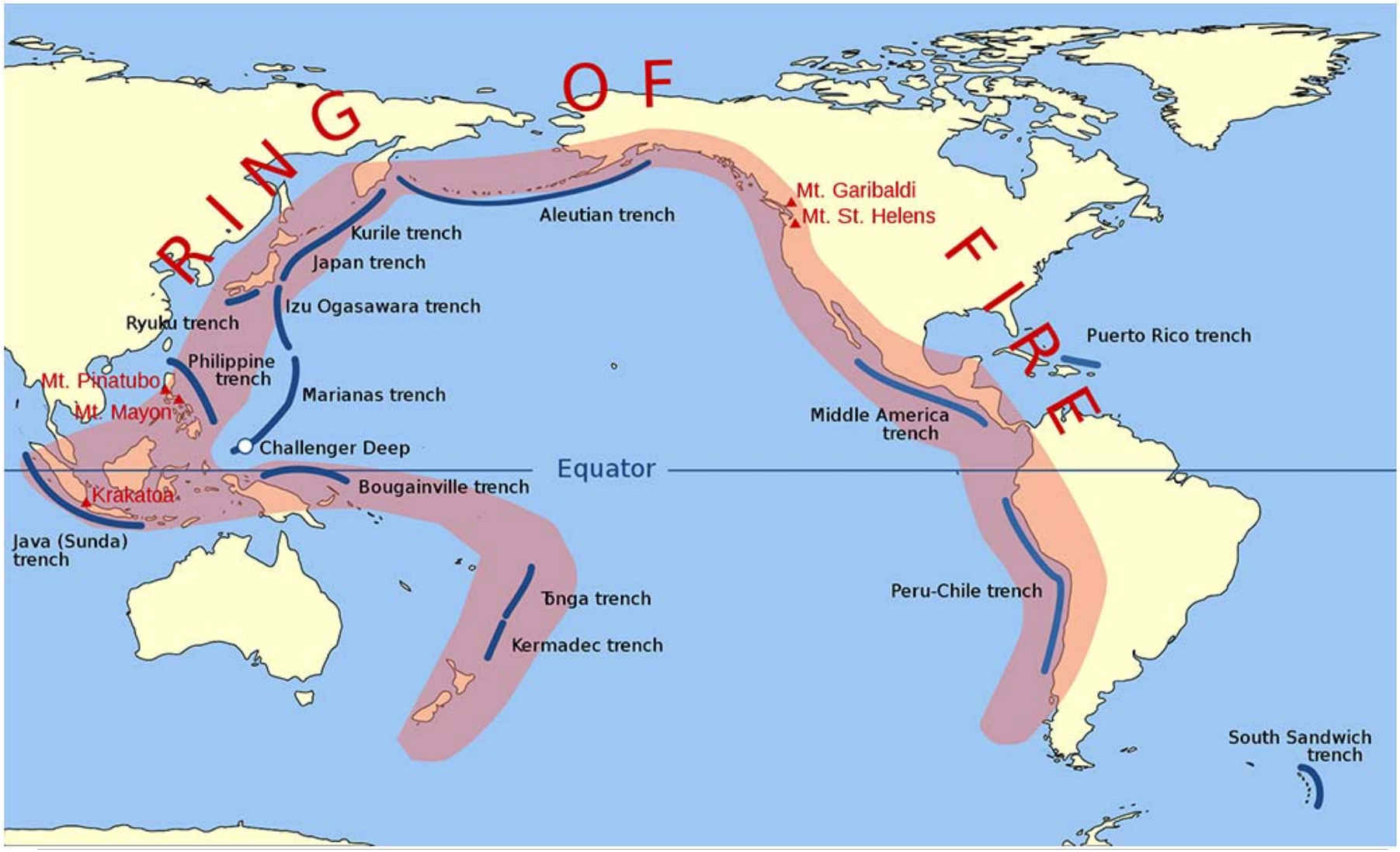
Economic damages caused by natural catastrophes



Development of energy consumption: past & future



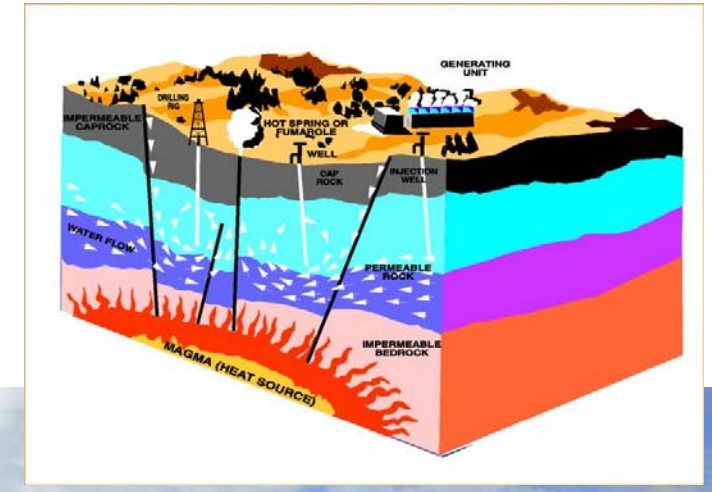
Potentials for Geothermal Energy



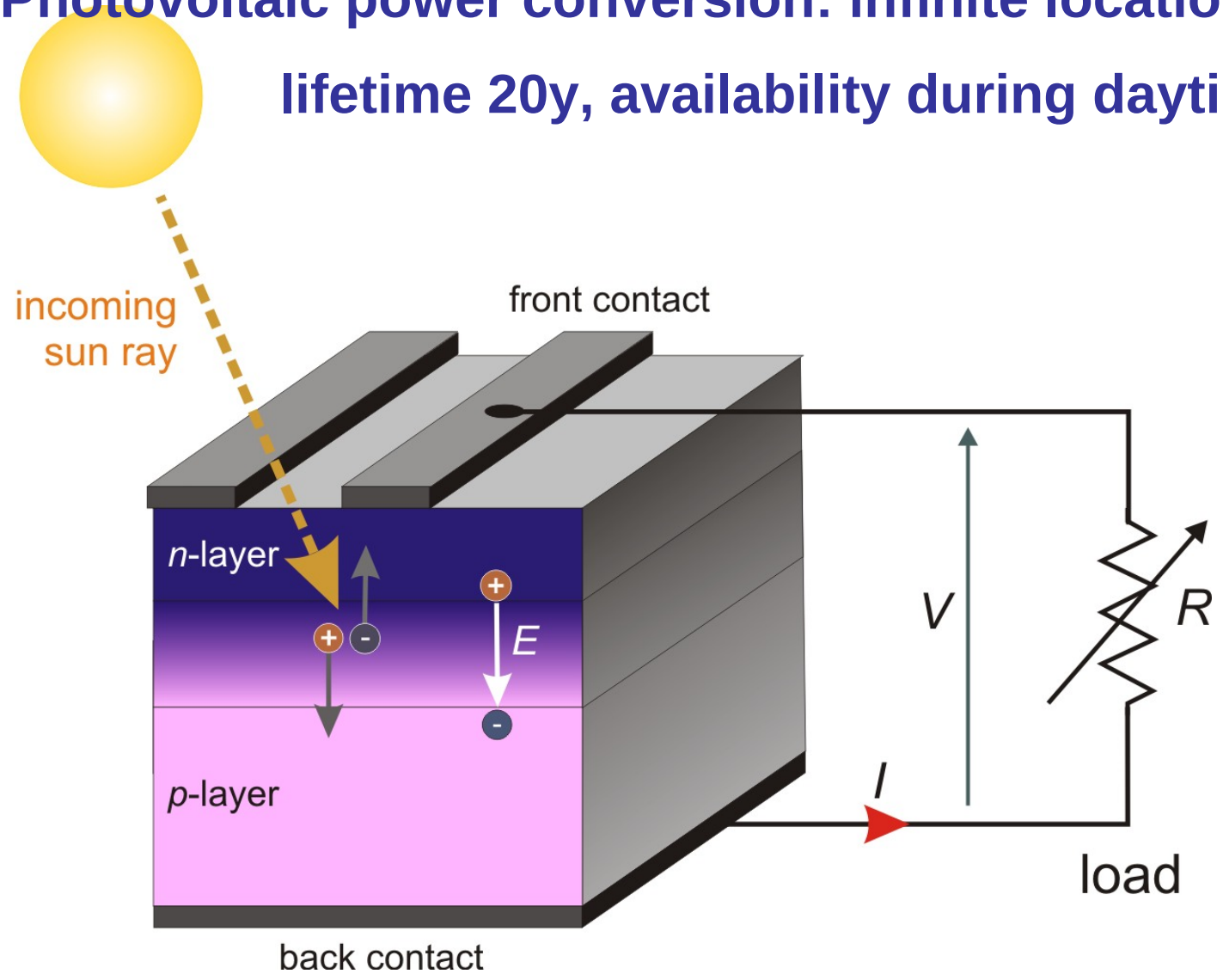
Geothermal Energy Conversion:

constant power output,

few adequate locations



Photovoltaic power conversion: infinite locations, lifetime 20y, availability during daytime



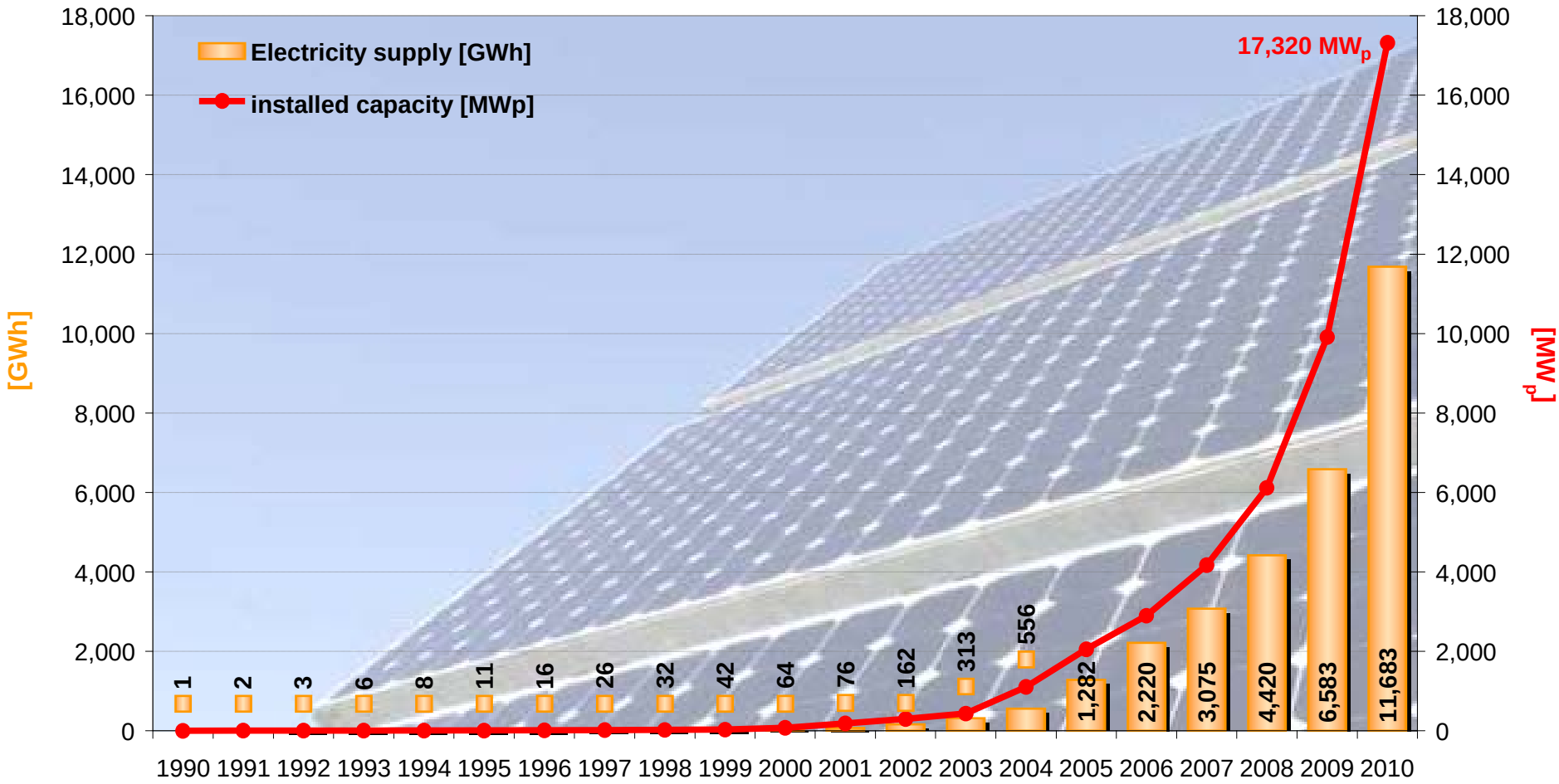
Off-grid middle class 400 W_p PV-system in Brazil

PV Roof in Freiburg, Germany

2 MW_p PV generator integrated into the airport of Munich 2000

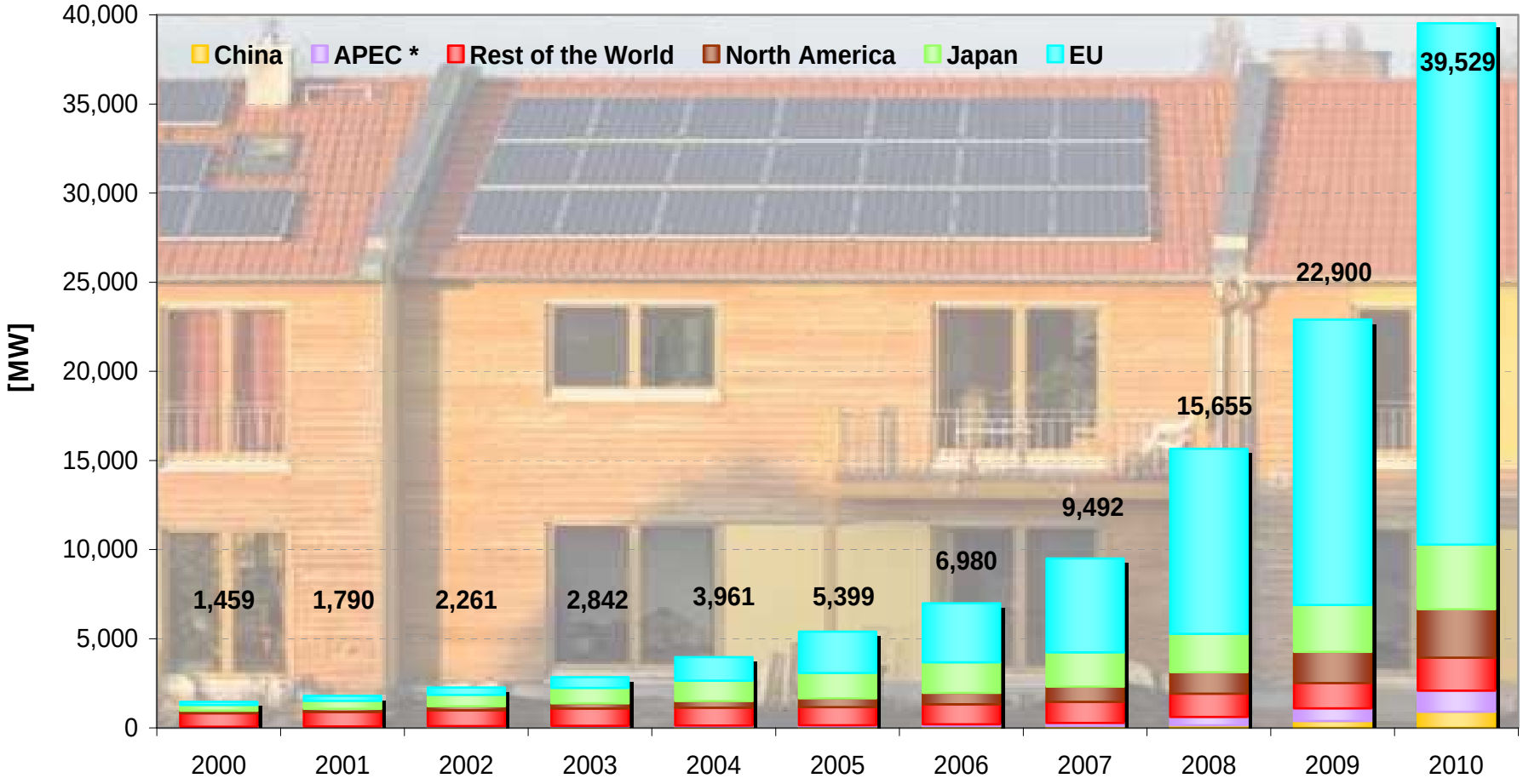
11 MW_p PV power plant in Sherpa, Portugal

Installed capacity and energy supply from photovoltaic installations in Germany



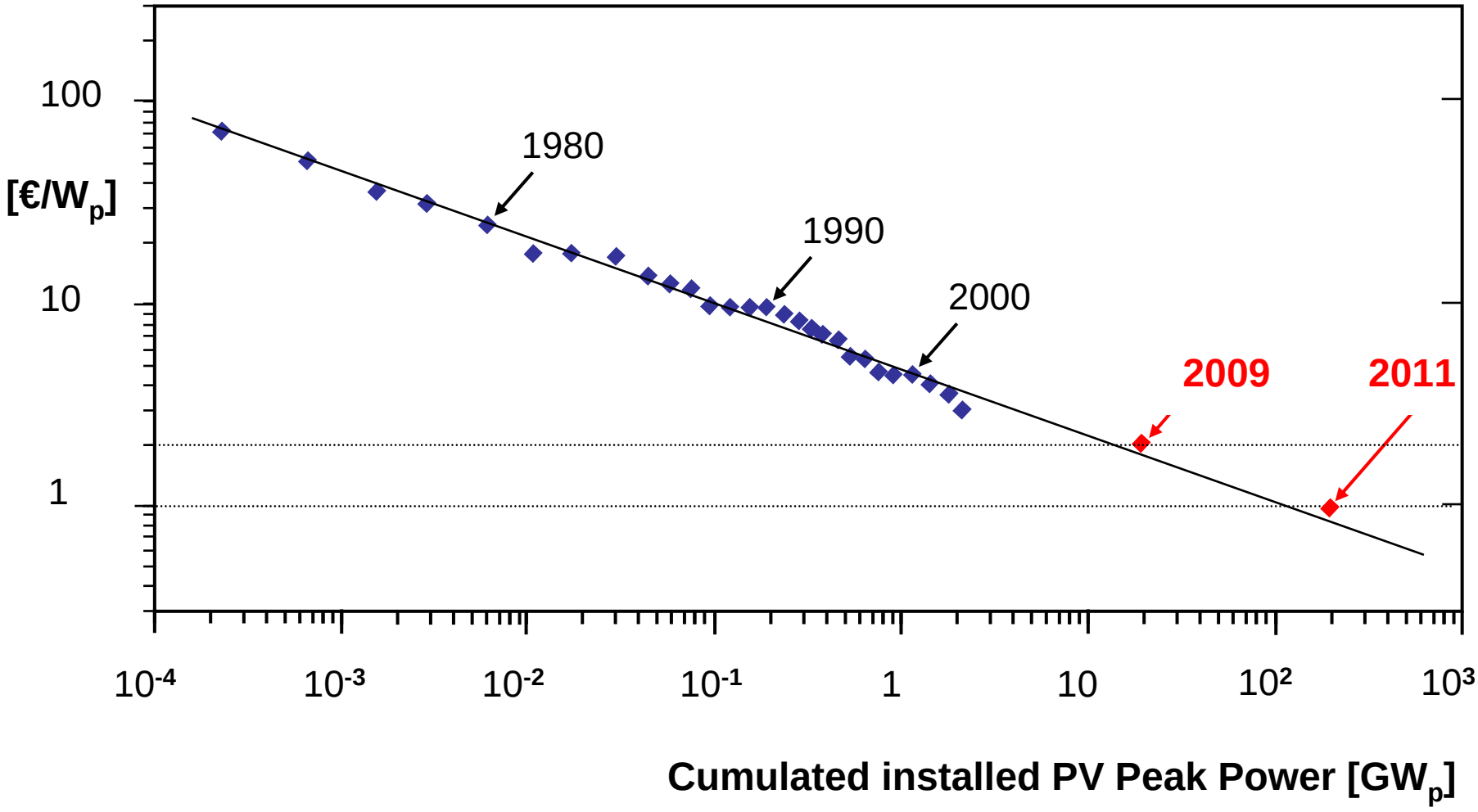
Source: BMU-KI III 1 according to Working Group on Renewable Energy-Statistics (AGEE-Stat);
1 GWh = 1 Mill. kWh; 1 MW = 1 Mill. Watt; image: BMU / Bernd Müller; as at: July 2011; all figures preliminary

World market Photovoltaics 2000–2010
cumulated installed capacity

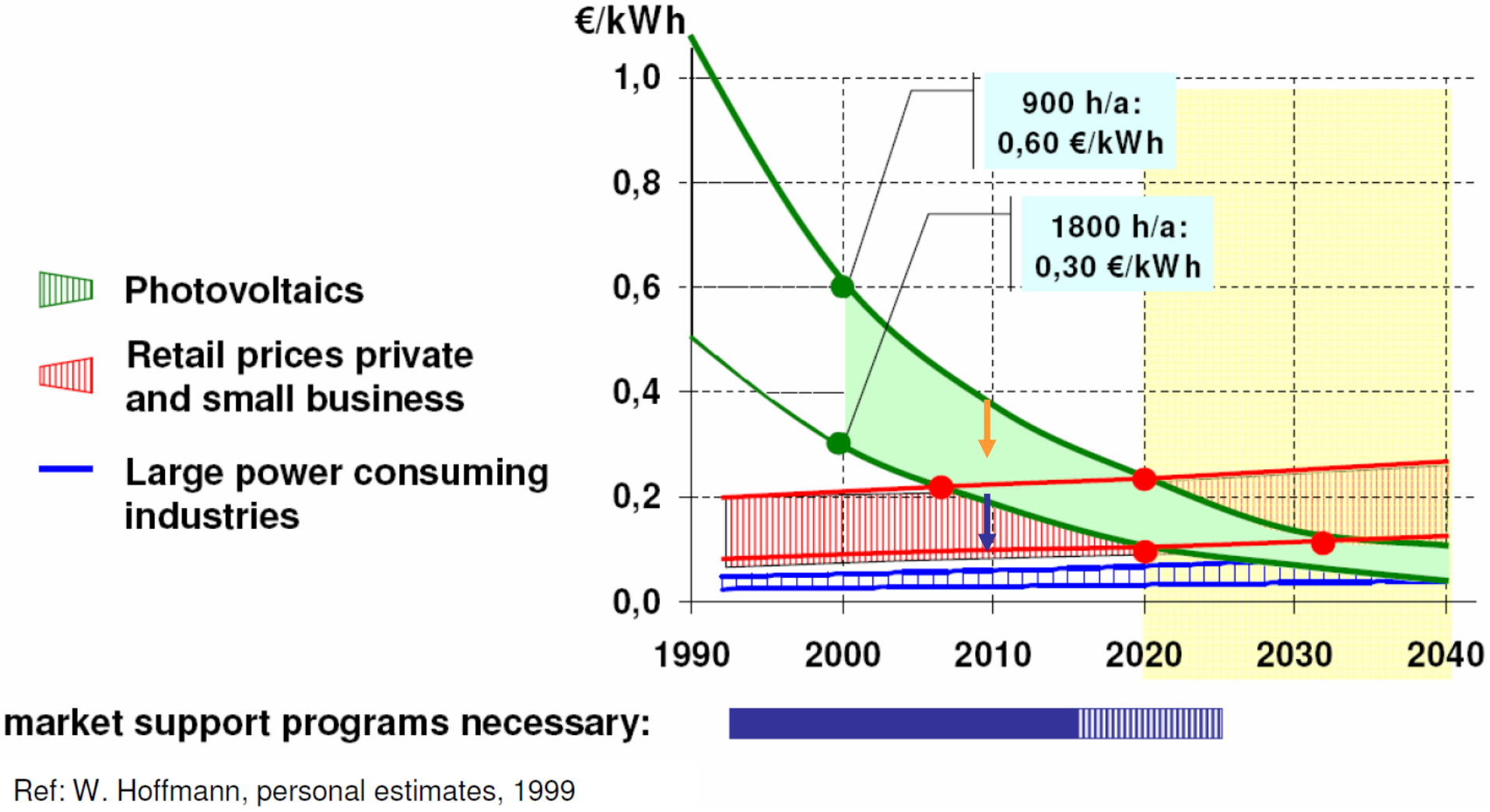


Members of Asia-Pacific Economic Cooperation (APEC) are: Australia, Brunei, Canada, Indonesia, South Korea, Malaysia, New Zealand, The Philippines, Singapore, Thailand, USA, Panama, Taiwan, Hongkong, Mexico, Papua New Guinea, Chile, Peru, Russia, Vietnam plus China and Japan, visualised separatly.
Source: European Photovoltaik Industry Association (EPIA): "Global Market Outlook for Photovoltaics until 2015"; Image: BMU / Brigitte Hiss; as at: May 2011; all figures provisional

„Learning curve“ of PV
(for crystalline Si-wafer based PV)

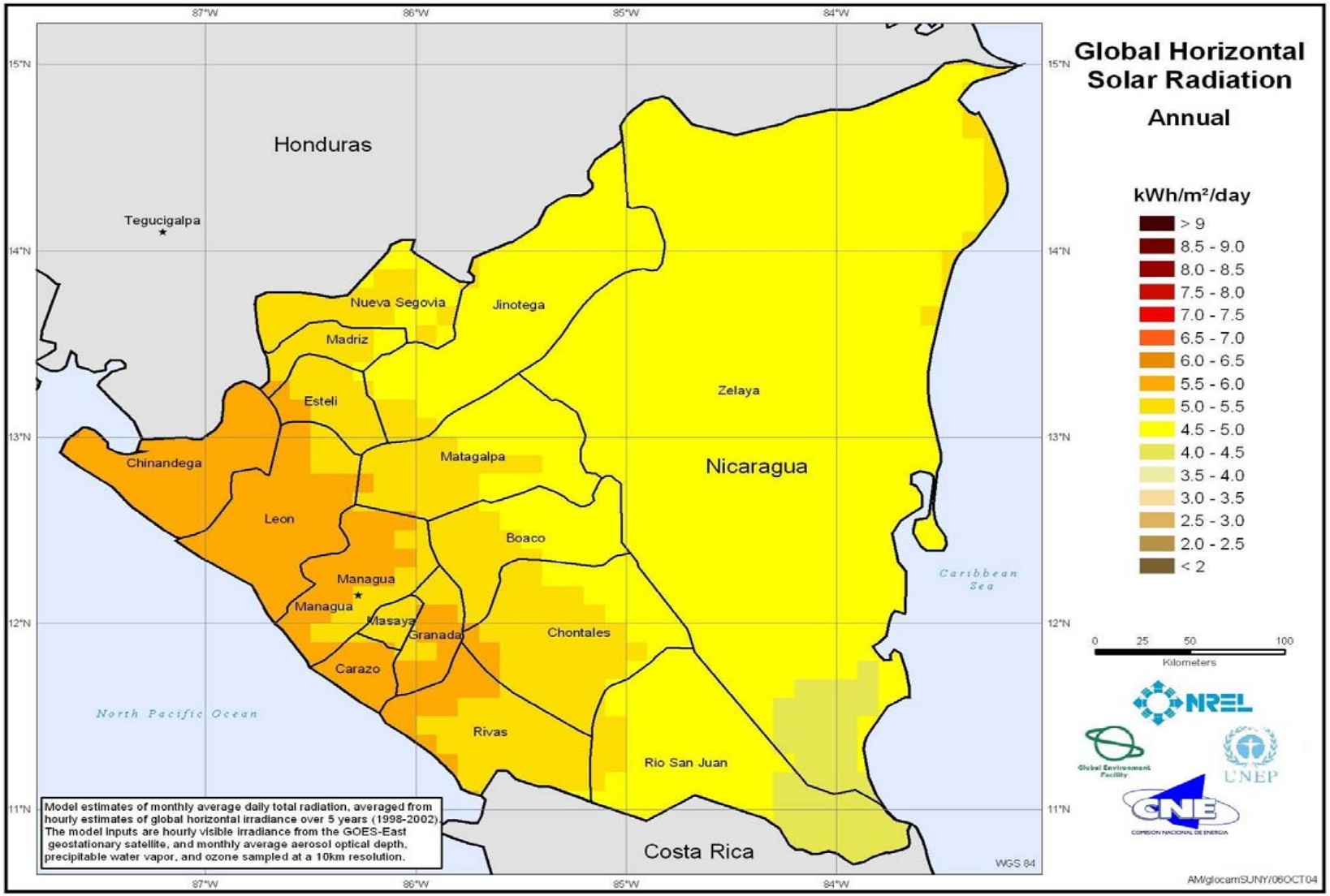


Roadmap to „grid parity“ of PV

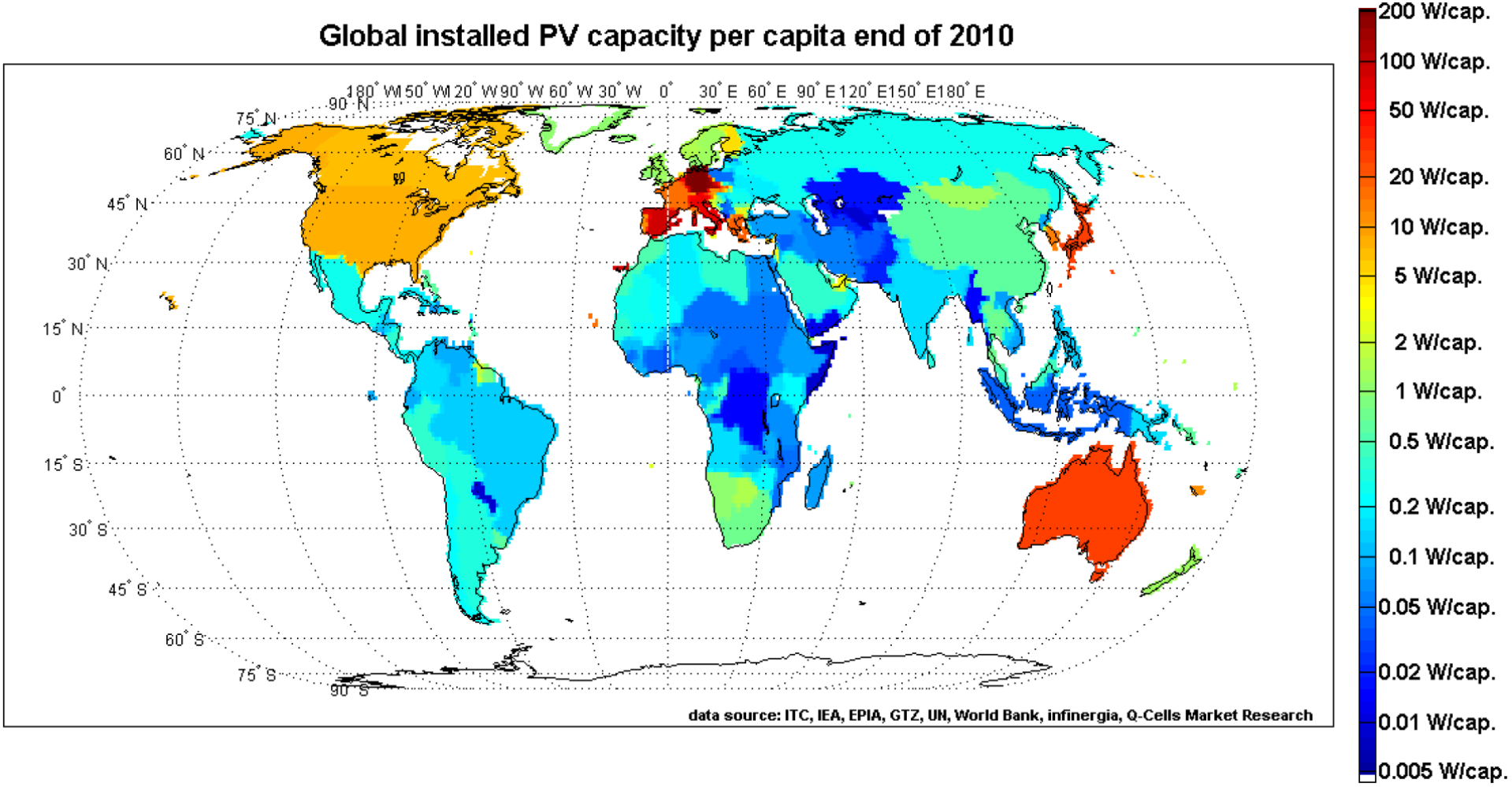


Ref: W. Hoffmann, personal estimates, 1999

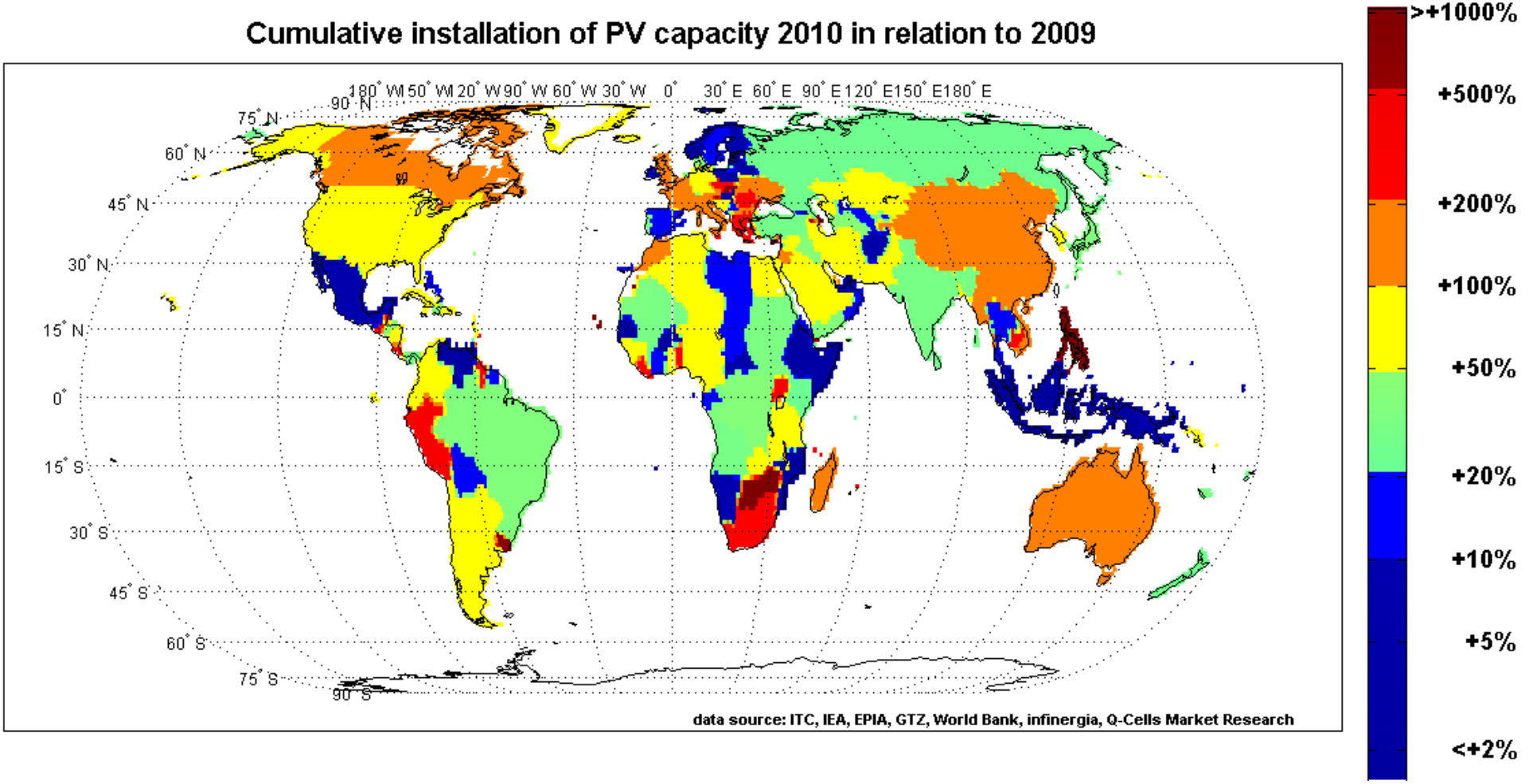
Solar Irradiance in Nicaragua: 2000 kWh/(m²a)



Installed PV per capita worldwide

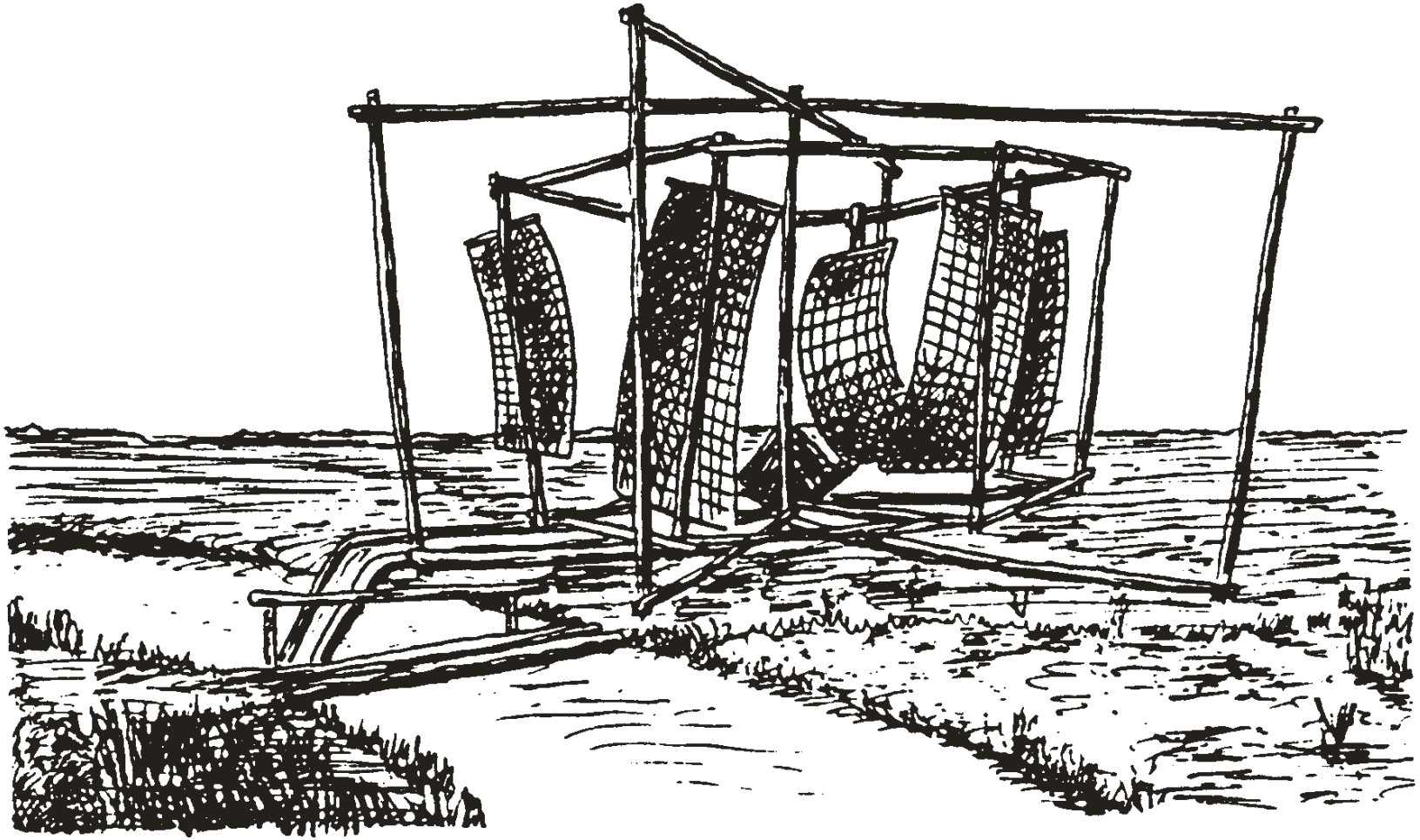


Increase of PV installations

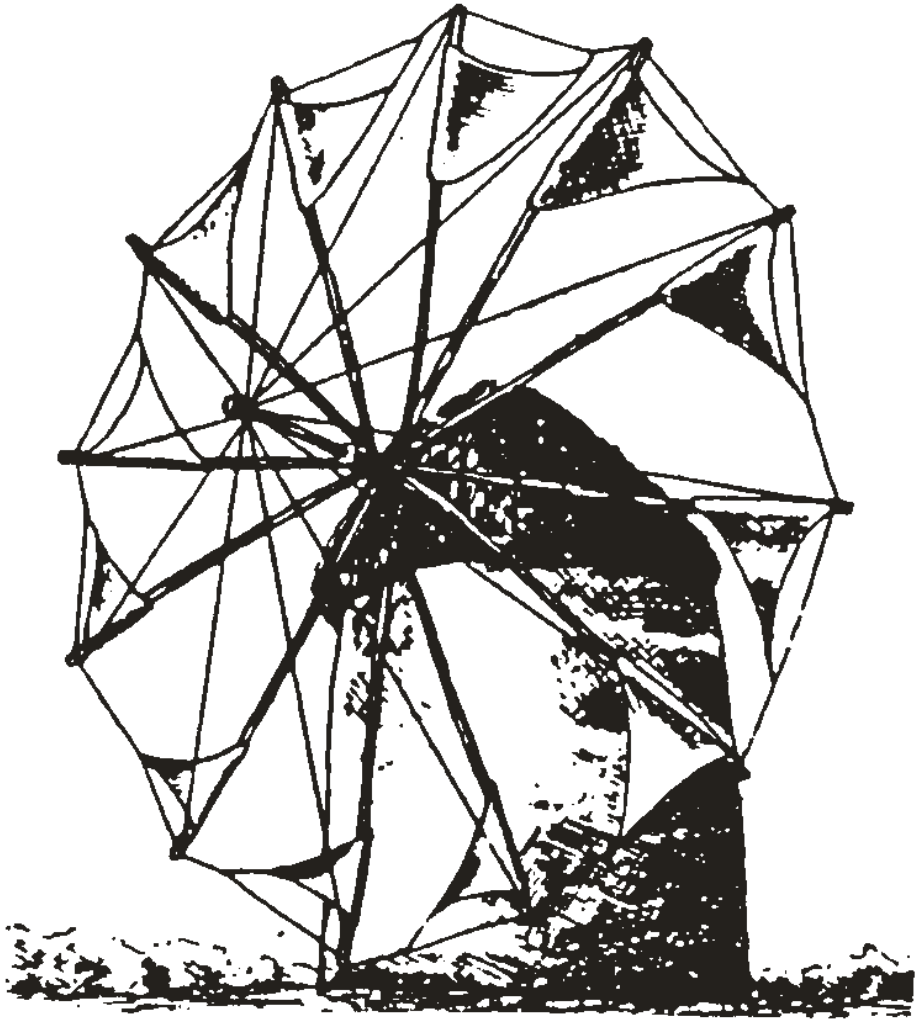


Wind power conversion:

Wind pump 1000 A.D. (China)



Wind power converter 1400 A.D. (Spain)



Wind power converter 1700 A.D. (Holland)

Windpower 2011 in Nicaragua

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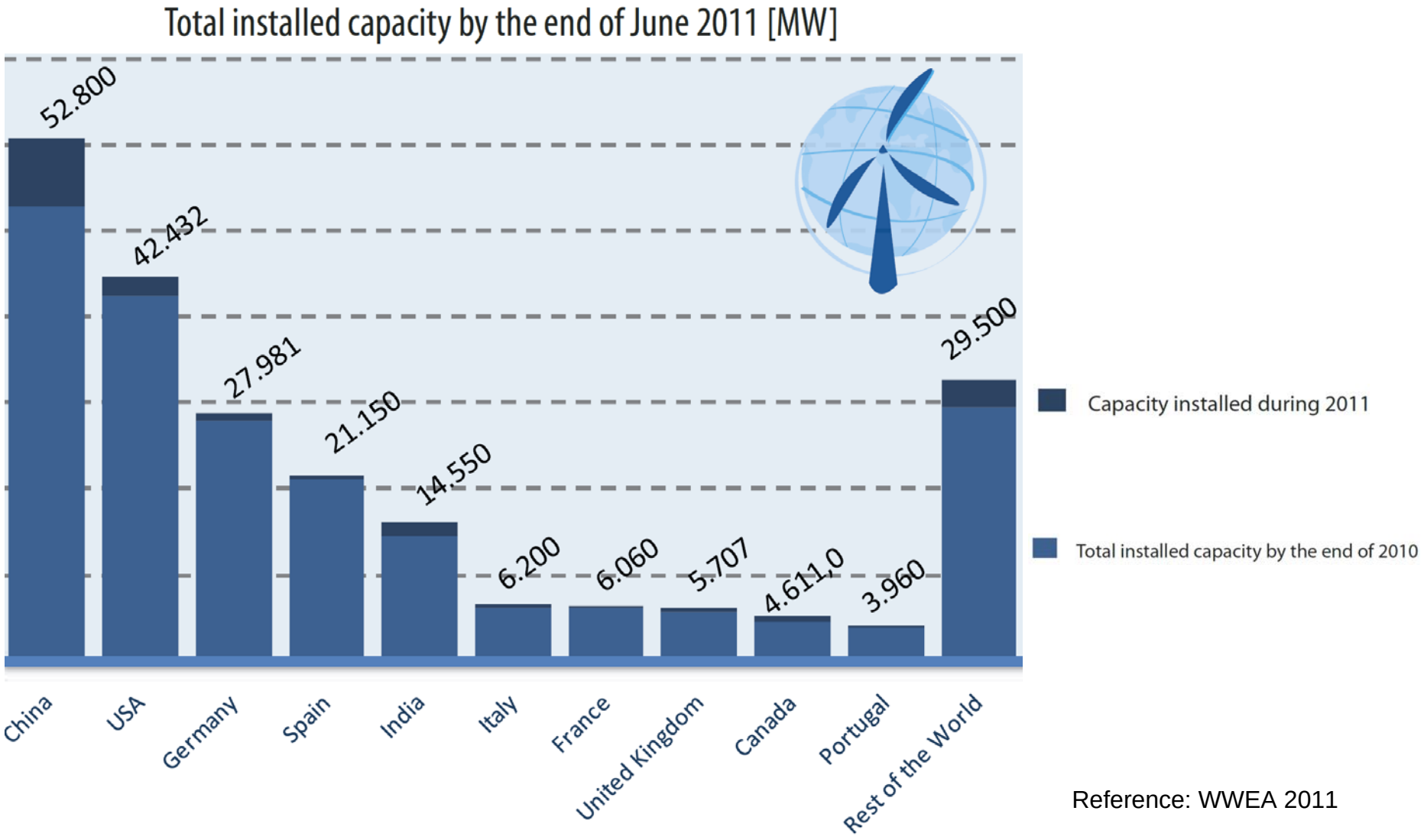
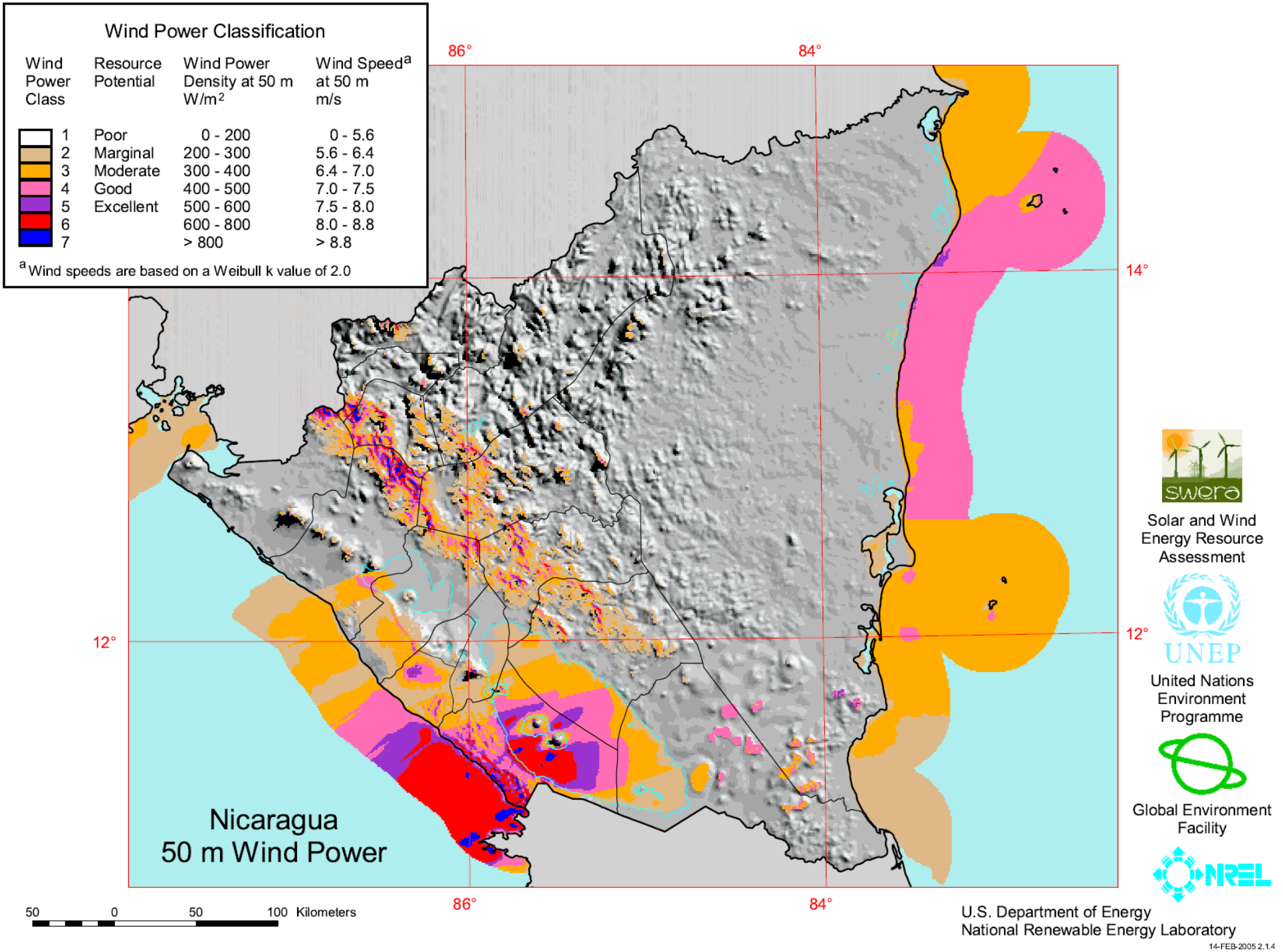
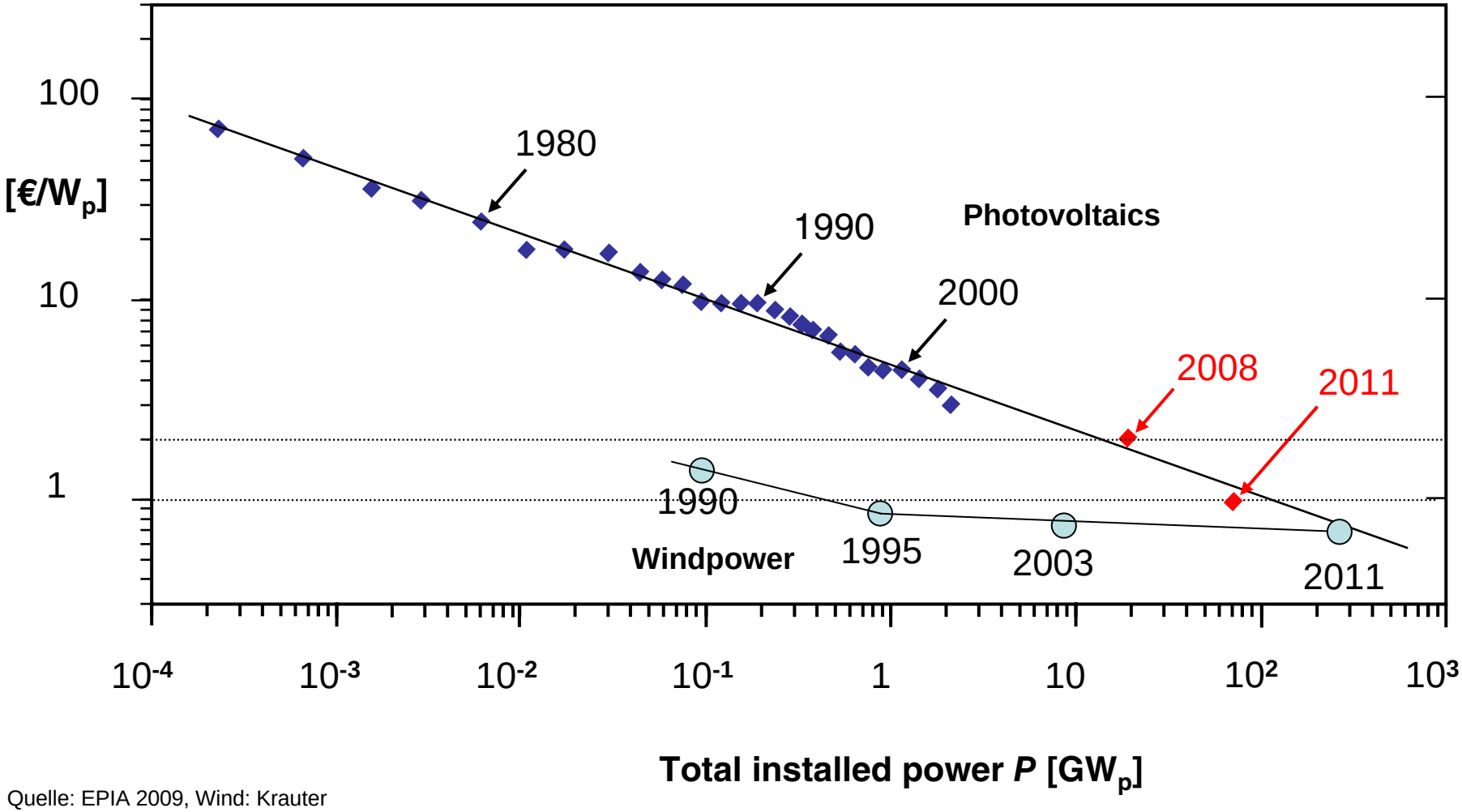
Installed windpower worldwide (215 GW June 2011)



Reference: WWEA 2011


Wind Power Classification
Wind Power Class
Resource Potential
Wind Power Density at 50 m W/m²
Wind Speed[a] at 50 m m/s
1 Poor 0 - 200 0 - 5.6
2 Marginal 200 - 300 5.6 - 6.4
3 Moderate 300 - 400 6.4 - 7.0
4 Good 400 - 500 7.0 - 7.5
5 Excellent 500 - 600 7.5 - 8.0
6 600 - 800 8.0 - 8.8
7 > 800 > 8.8
[a] Wind speeds are based on a Weibull k value of 2.0
86°
84°
14°
12°
Nicaragua
50 m Wind Power
50 0 50 100 Kilometers
Solar and Wind Energy Resource Assessment
United Nations Environment Programme
Global Environment Facility
U.S. Department of Energy
National Renewable Energy Laboratory
14-FEB-2005 2.1.4

PV: 50% cost reduction every 10 years (even more last years)
Wind power: 50% cost reduction after 13 years (now increasing)



Quelle: EPIA 2009, Wind: Krauter

Fluctuating energies require

Change in energy systems

Example: Pumped-storage hydroelectricity

La Muela I&II at *Río Jucar* (Spain) designed for 850 MW wirh four 213 MW pump-turbines.

This storage was built mainly to balance electricity demand and secure supply even with a growing share of wind power in Spain.

Challenge to adapt load

Technical solutions:

- Use of modern, controllable and energy-efficient loads
- Intelligent combination of different energy sources and storage

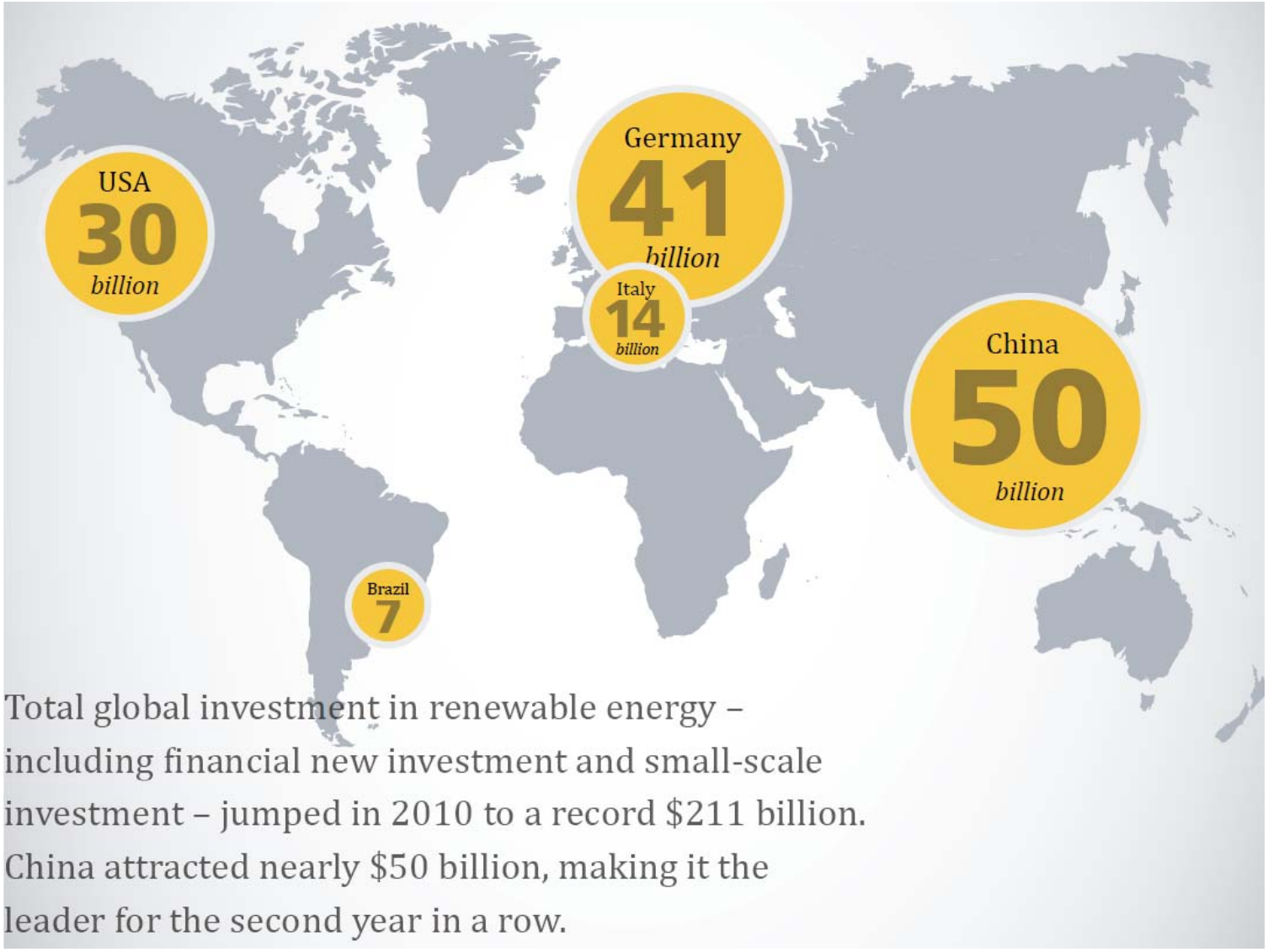
User awareness:

- Decision-making: which loads should be controlled by the user, which loads can be controlled the grid

Grid access & Trading:

- Creation of a fair market for real-time trading of energy, even in small amounts

Investment flows in Renewable Energies in 2010



Total global investment in renewable energy – including financial new investment and small-scale investment – jumped in 2010 to a record $211 billion. China attracted nearly $50 billion, making it the leader for the second year in a row.

Let’s improve conditions for investments here !

The organization team wishes you a fruitful RIO 12 - Event !