Climate Change and Protection: Sustainable Energy Paths

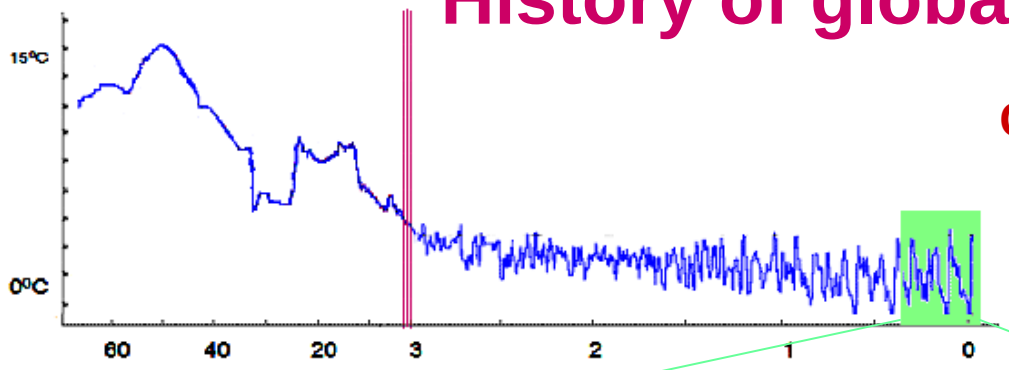
Jürgen Scheffran, University of Illinois

Conference ”Nuclear Abolition, Climate Protection & Our Cities’ Future”

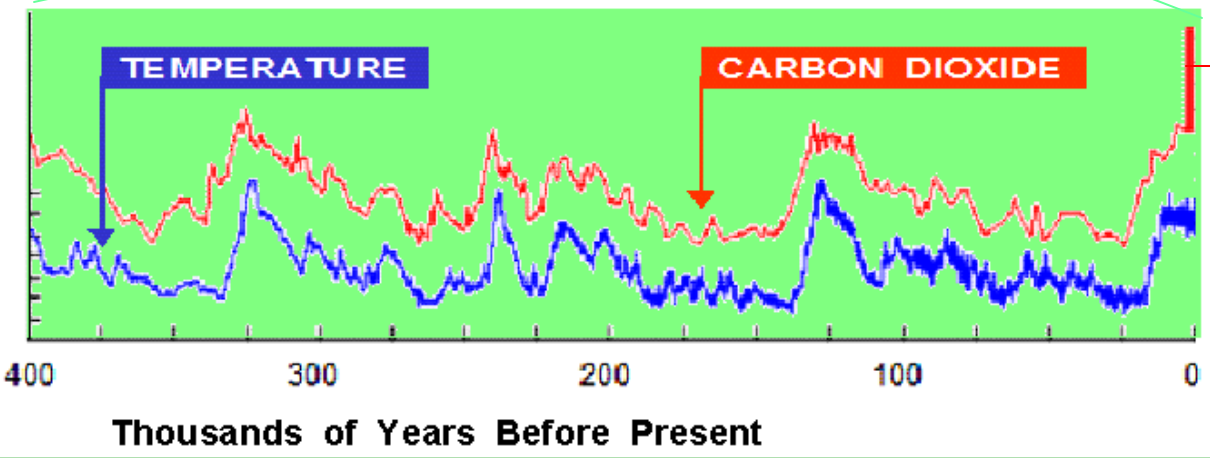
Des Moines, Iowa, October 23, 2008

The Risk of Climate Change

History of global temperature

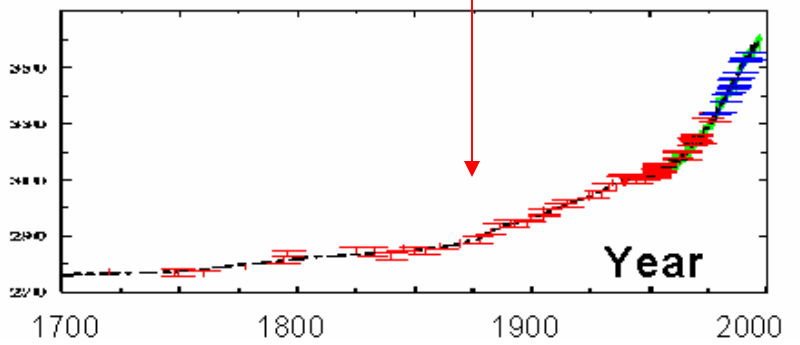


Global Cooling over 60 million years

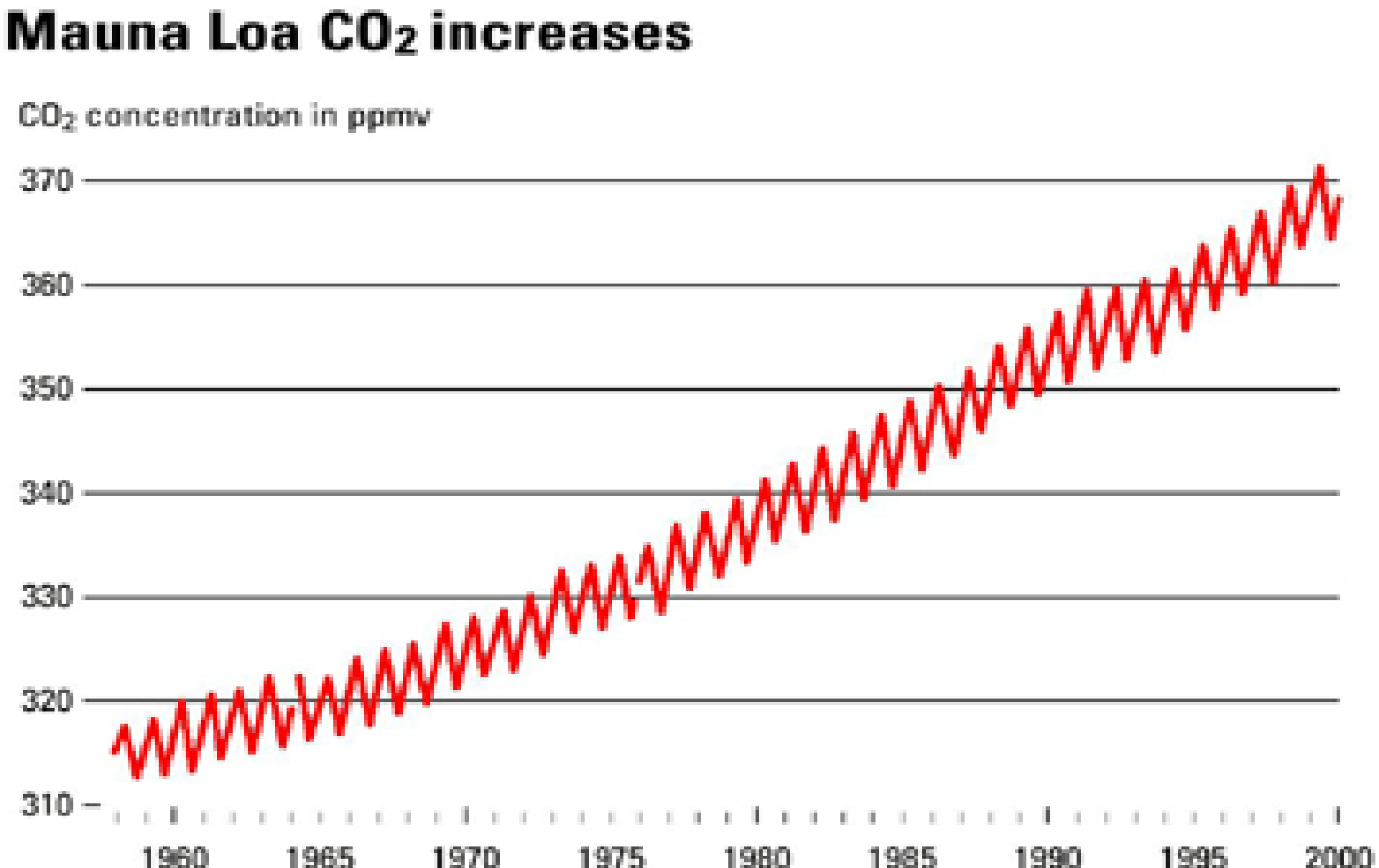


Ice-age cycle of the past 400,000 years

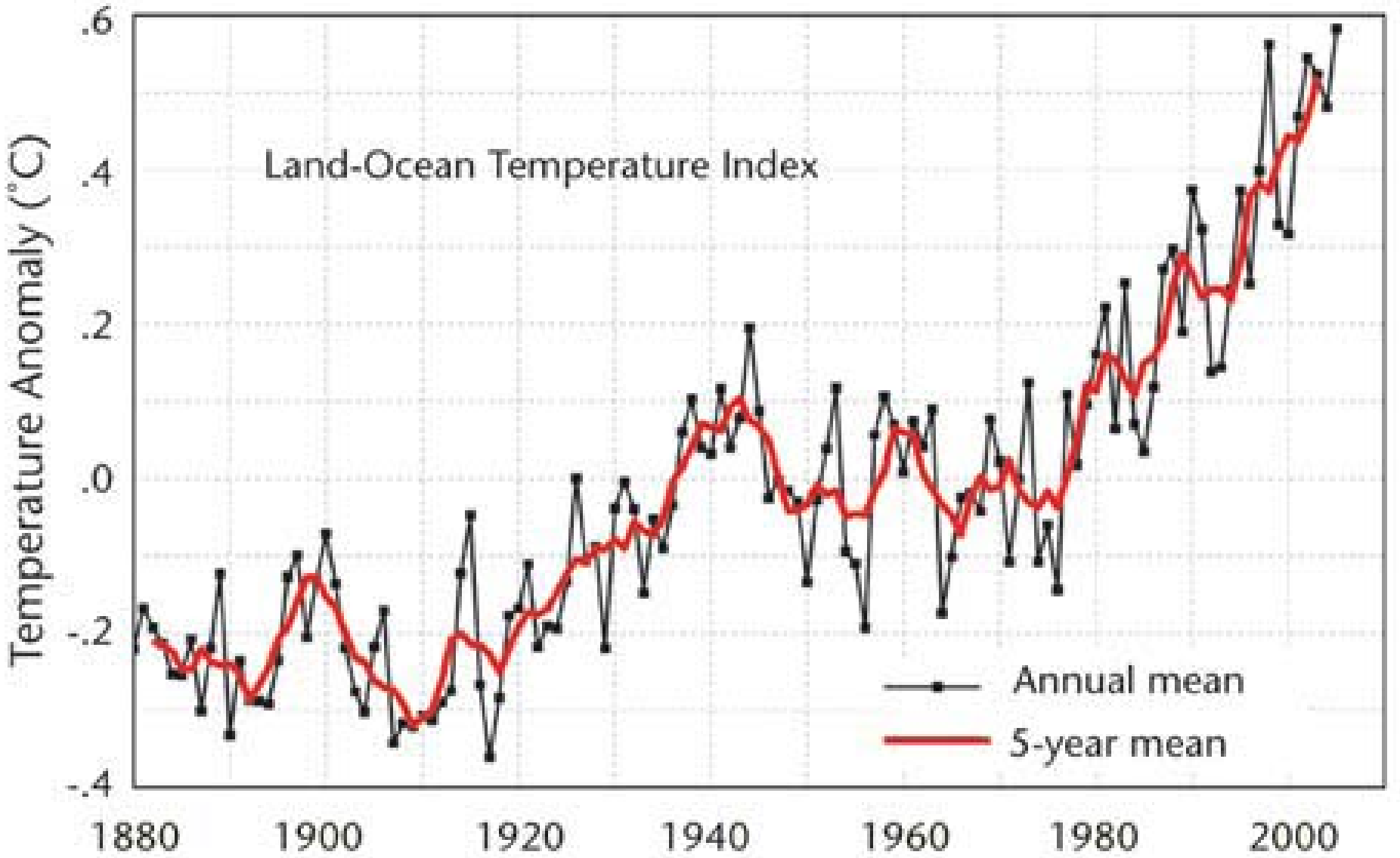
Rise in atmospheric carbon dioxide levels over the past few centuries



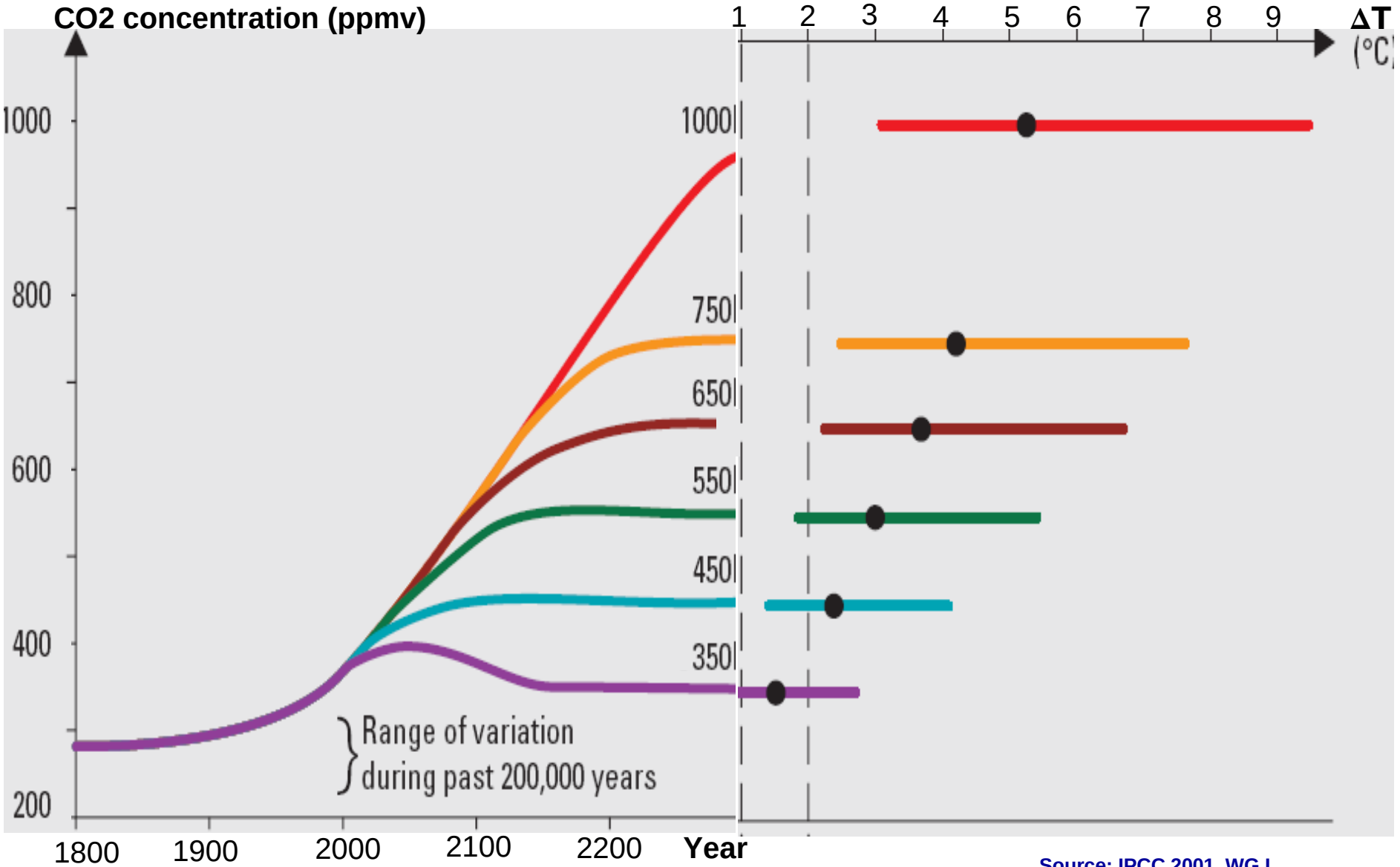
Changes in CO2 composition of greenhouse gases



Global mean surface temperature measurements

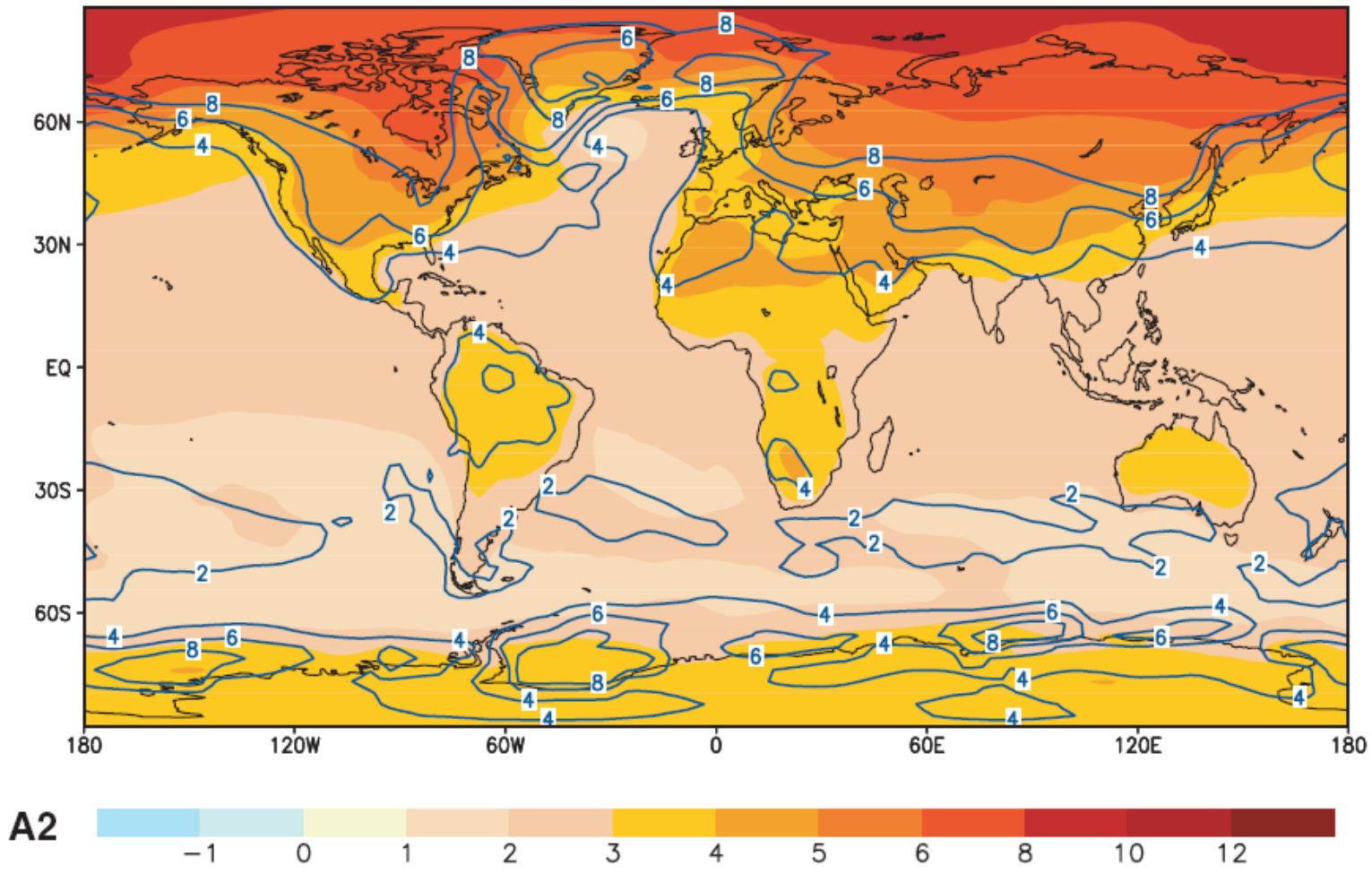


Stabilisation scenarios and temperature increases for different climate sensitivities



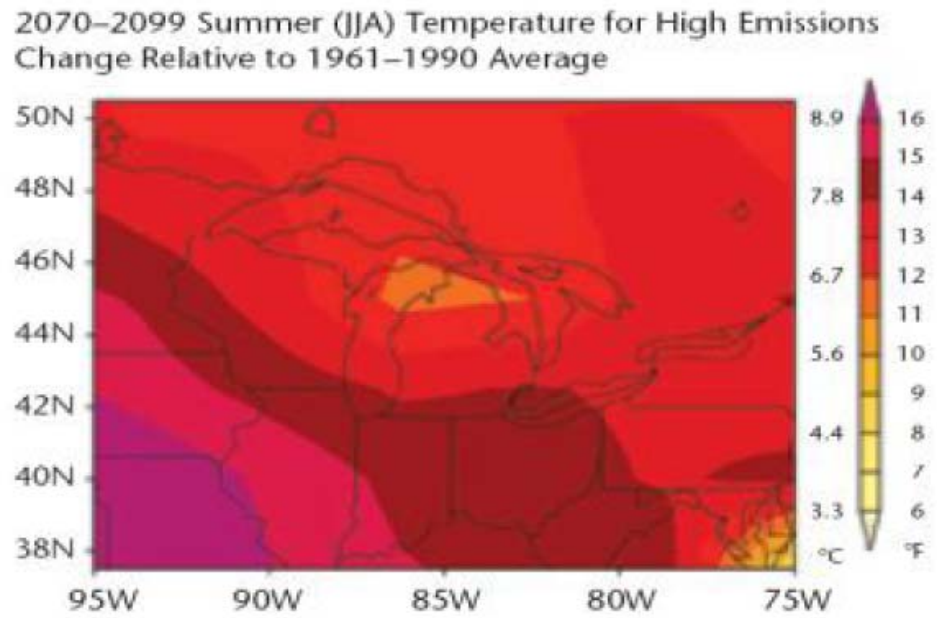
Source: IPCC 2001, WG I

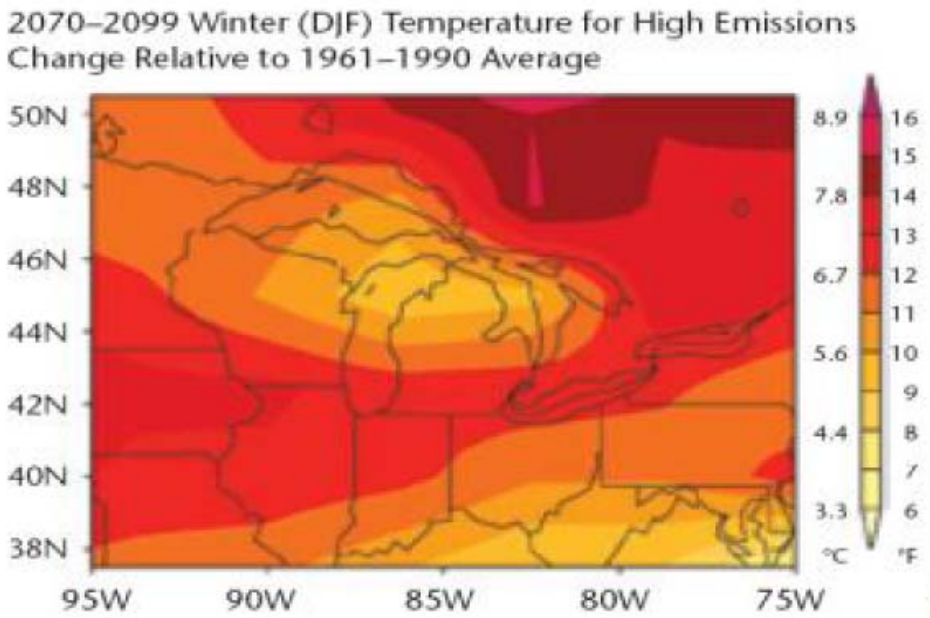
Projected regional temperature change

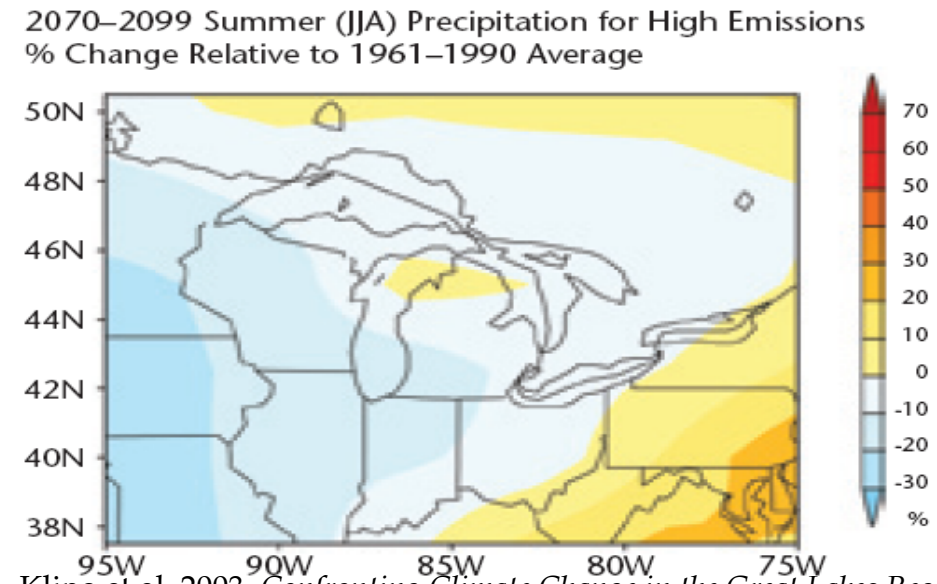


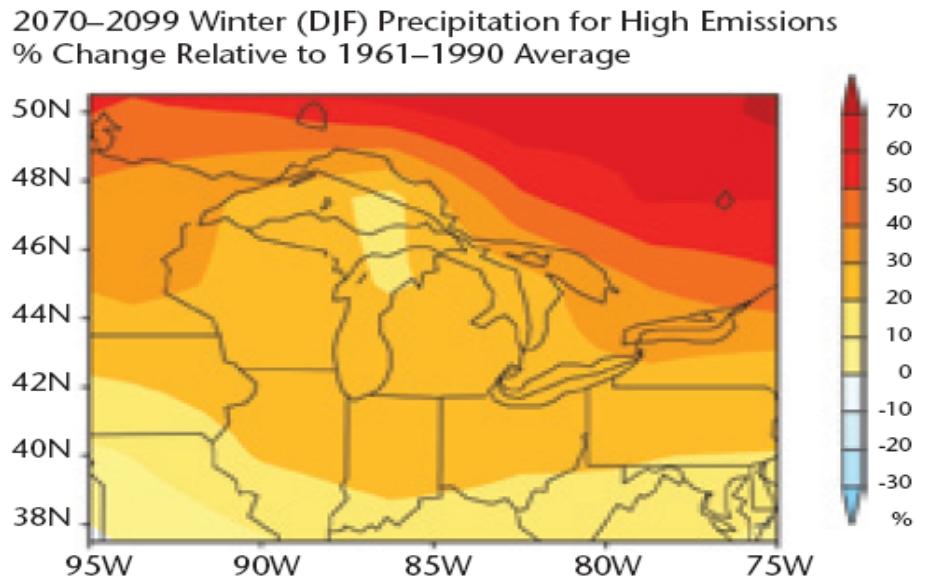
Annual mean change of temperature and its range (unit: °C) for SRES scenario A2 for period 2071 to 2100 relative to the period 1961 to 1990 (IPCC 2001, WG1).

Projected temperature and precipitation change at Great Lakes







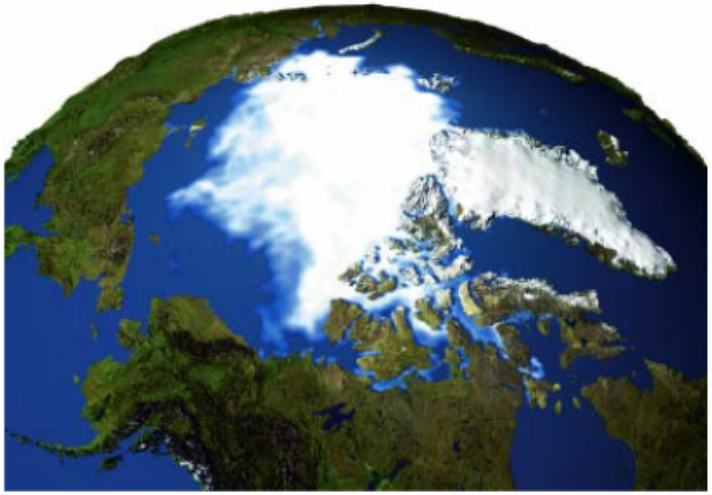


Kling et al, 2003, *Confronting Climate Change in the Great Lakes Region*

Projected sea ice change

Observed Sea Ice September 1979

Observed Sea Ice September 2003

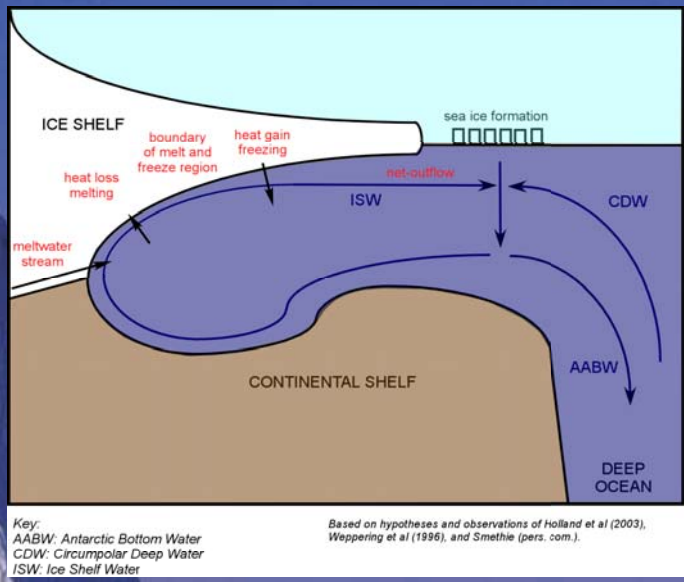


©ACIA, Map ©Clifford Grabhorn

Projected ice extent 2070 to 2090
(5-model average for September) (Source: ACIA 2004)

Disintegration of West Antarctic Ice Sheet (WAIS)

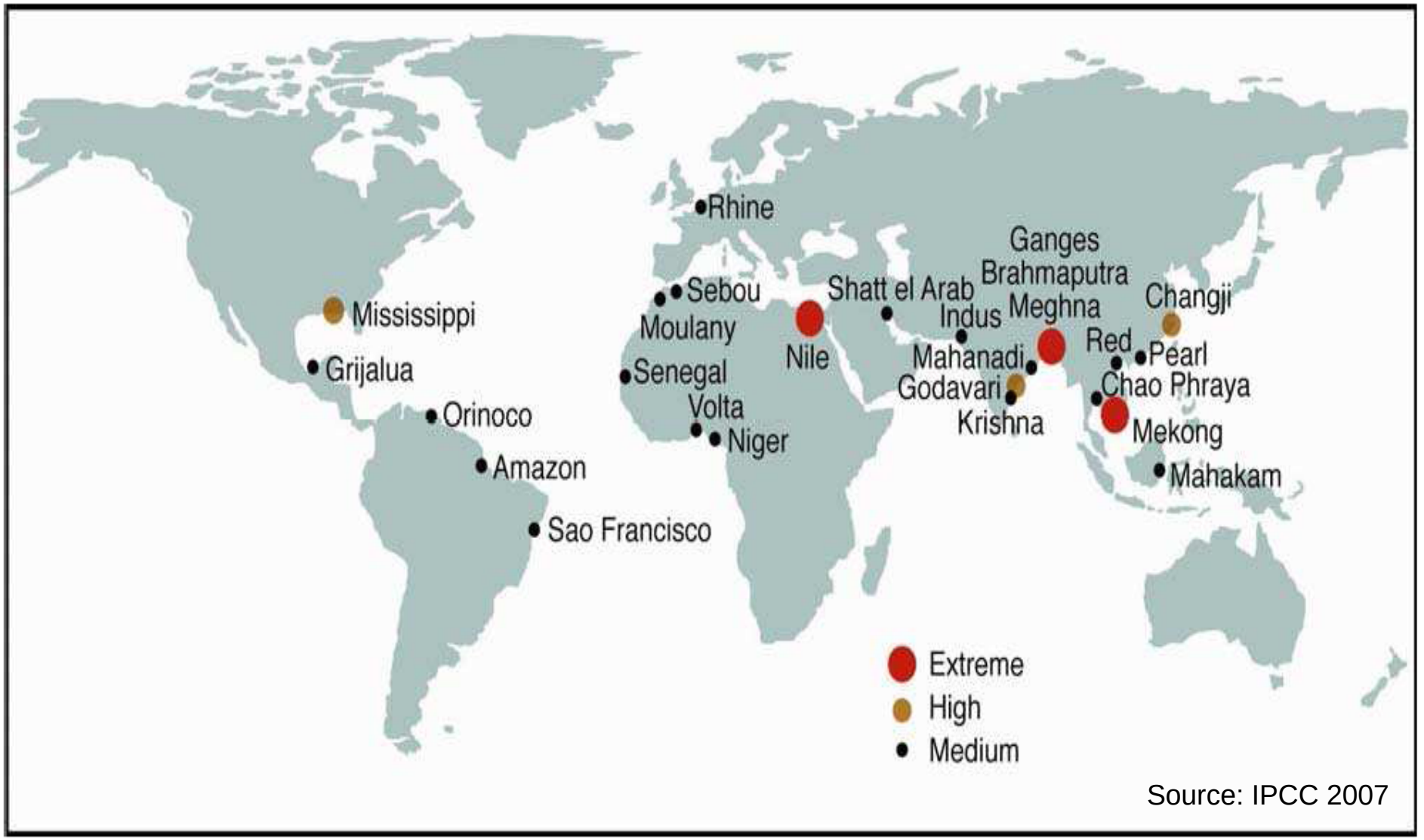
- The WAIS may disintegrate in response to anthropogenic greenhouse gas emissions (Oppenheimer 1998).
- Warming of 2.5 ^{o}C ha as a WAIS climate limit.
- Consequences of WAIS collapse: global sea level rise of around 6 meters, disruption of global oceanic circulation patterns.Keller 2005



Two possible positive feedbacks:

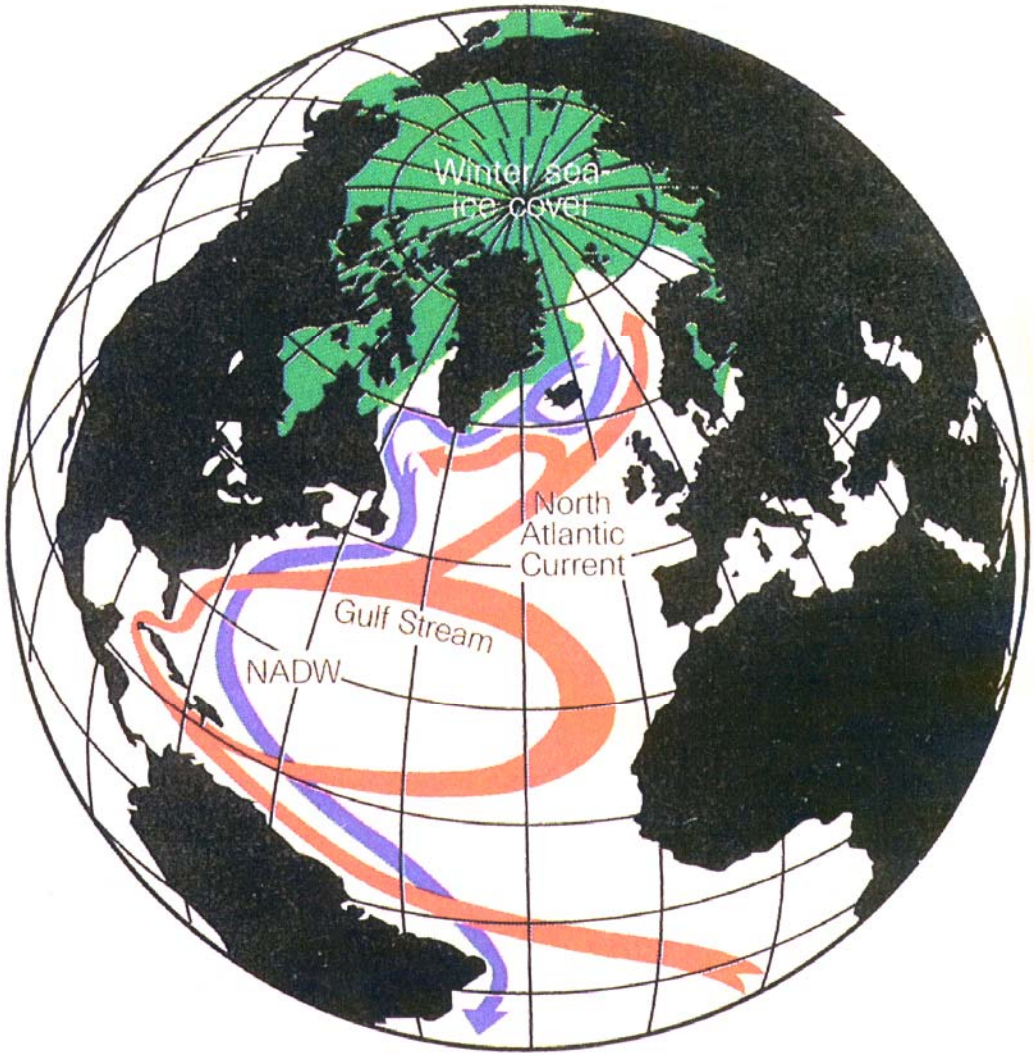
- slip rate ↑ -> bottom temperature ↑ -> slip rate ↑
- temp. ↑ -> melting rate ↑ -> height ↓ -> temp. ↑

Vulnerability of coastal delta populations



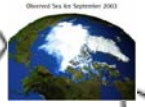
Source: IPCC 2007

Changing ocean circulation in the North Atlantic could lead to cooling in Europe



Rahmstorf 1997

World map of climate risks



Loss of Artic sea ice

Glacier retreat

Species loss

Species loss

Methane outburst

Shutdown of thermohaline circulation

Harvest loss

Storms

Sea-level rise

Sea-level rise

Floods

Droughts

Water scarcity

Change in hydrological cycle

Droughts

Tropical Monsoon suppression

Monsoon suppression

Sea-level rise

Diseases

Collapse Amazon forest

Species loss

Sea-level rise

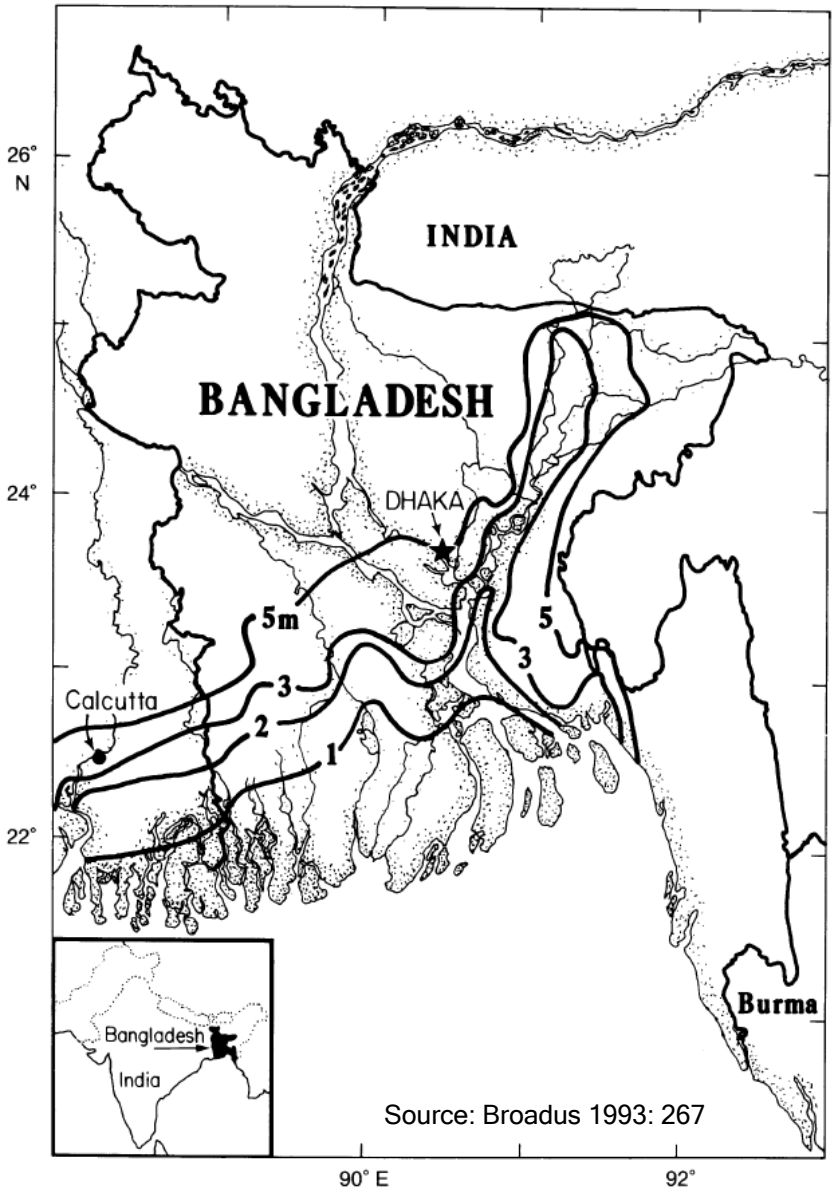
Loss of coral reefs

Loss of species & ecosystems

Collapse West Antarctic Ice Sheet

PROBLEMS AND CONFLICTS OF FOSSIL- NUCLEAR ENERGY

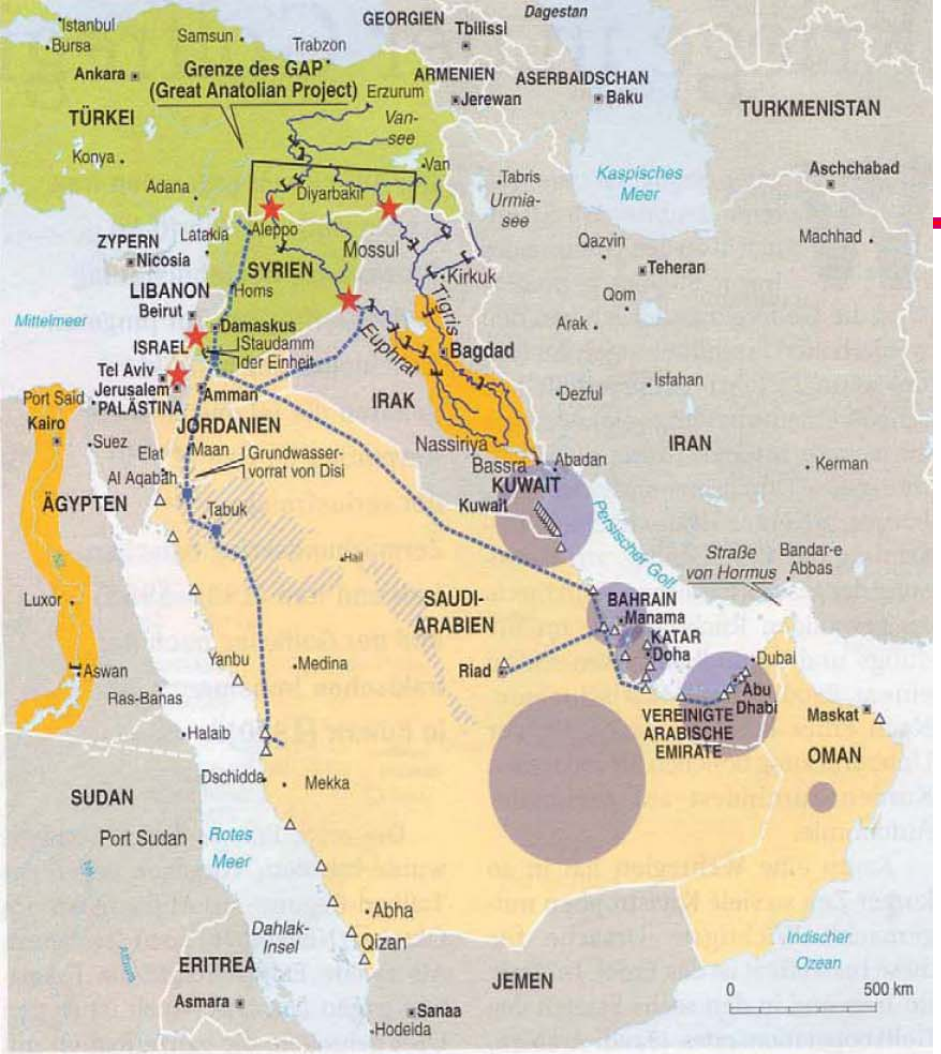
Sea level transgression scenarios for Bangladesh



Since 1960, about 600,000 persons died due to cyclones, storm surges and floods. November 2007 cyclone SIDR raked Bangladesh's southwest coast with maximum sustained winds of 241 km/h (150 mph), leaving thousands dead and hundreds of thousands homeless.

Climate change would significantly aggravate human insecurity in Bangladesh, one of the poorest and most densely populated countries of the world. During the monsoon about one quarter of Bangladesh is flooded

Water crisis in the Middle East



Quellen: Masahiro Musakami, Managing Water for Peace in the Middle East: Alternative Strategies, New York (United Nations University Press / UNUP) 1995.

Water strategic issue and conflict factor in the Middle East

- Arid climate
- Imbalance between water demand and supply
- Confrontation between key political actors
- Transboundary water resources
- Water disputes coincede with land disputes.

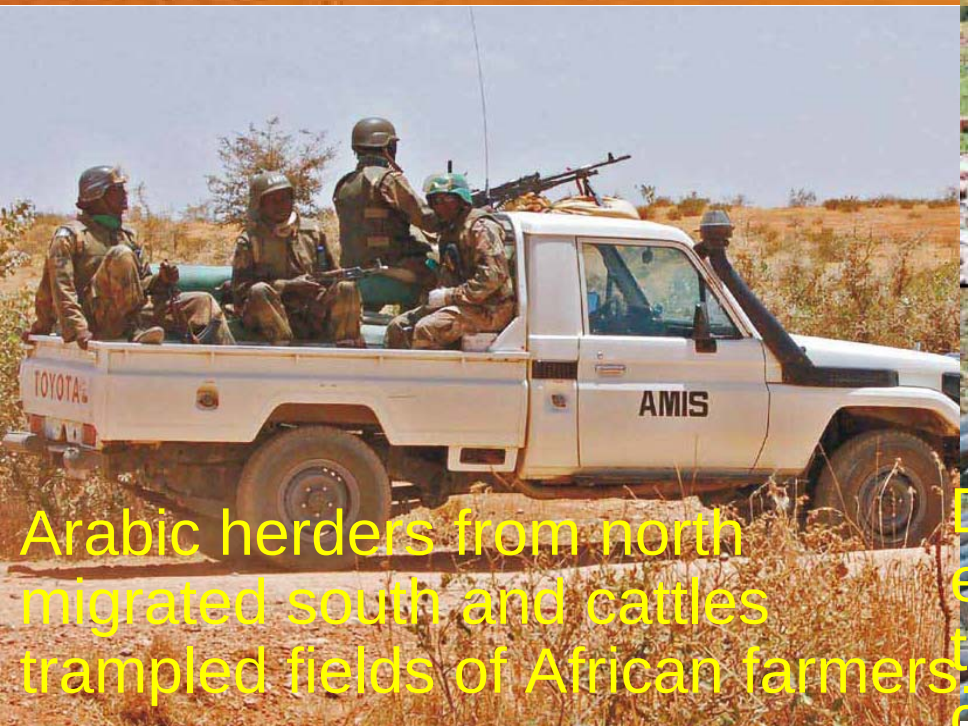
Competition over shared water resources

- Nile
- Euphrate
- Jordan

→ Water wars or water cooperation?

Darfur Sudan

Boundary semi-desert to desert moved southward by 50 to 200 km since 1930s. Significant drop in food production (20%)

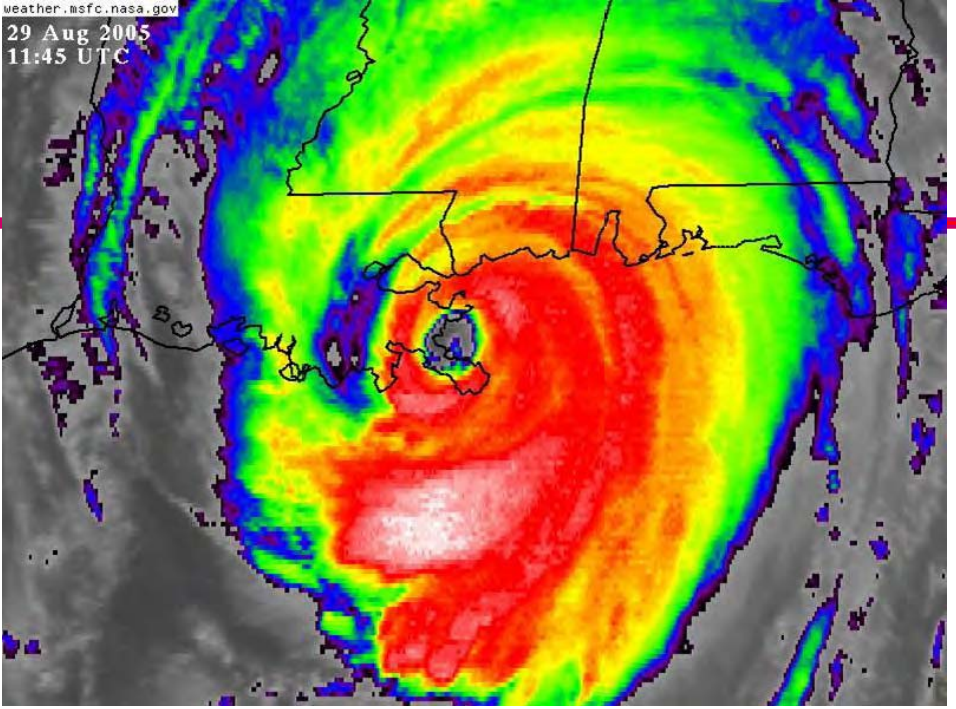


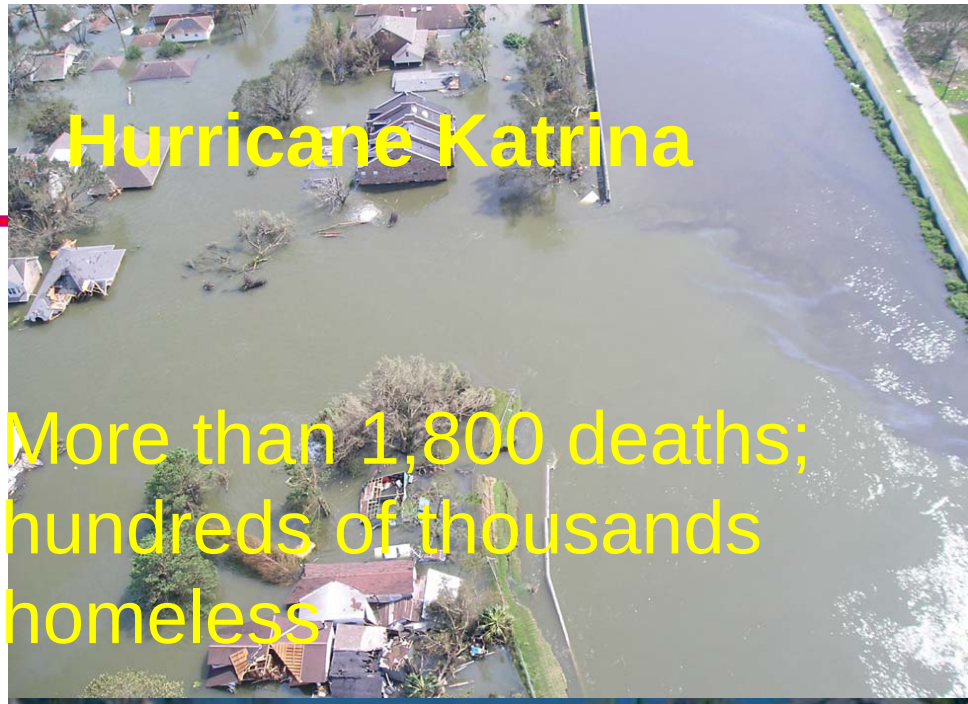
Arabic herders from north migrated south and cattles trampled fields of African farmers.

Drought & desertification in Sahara increased migration of nomadic groups into more fertile areas of Darfur.

Darfur is considered a "tragic example of the social breakdown that can result from ecological collapse" (UNEP 2007)

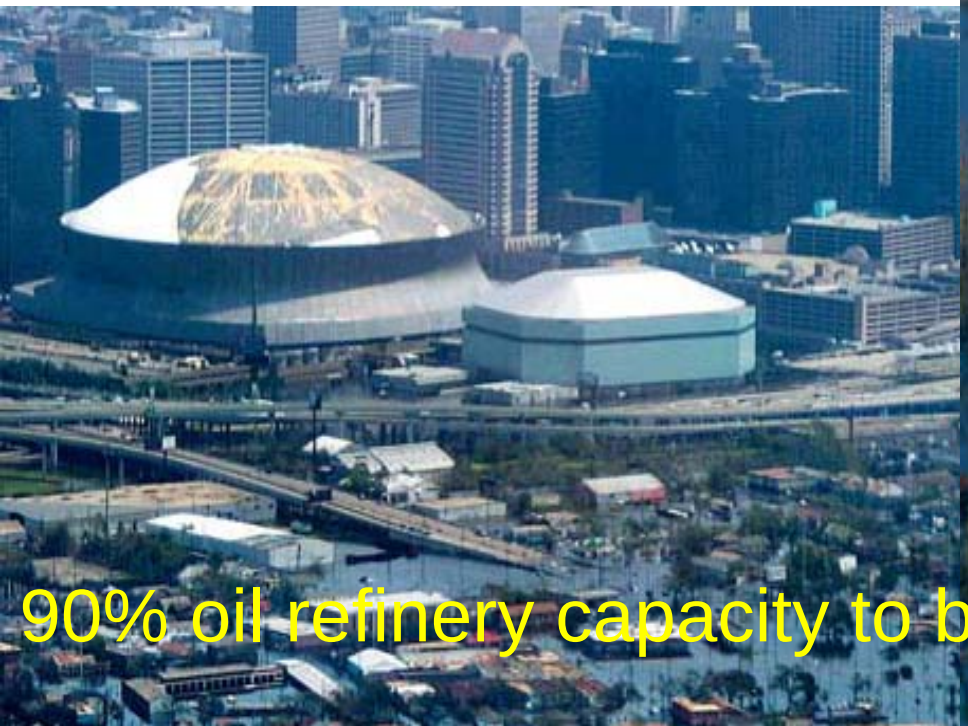

2003 heatwave in Europe: 35,000 people died and agricultural losses reached $15 billion.
A juvenile playing with matches started a Southern California wildfire that scorched more than 38,000 acres and destroyed 63 structures.





Hurricane Katrina

More than 1,800 deaths; hundreds of thousands homeless



90% oil refinery capacity to be shut down.

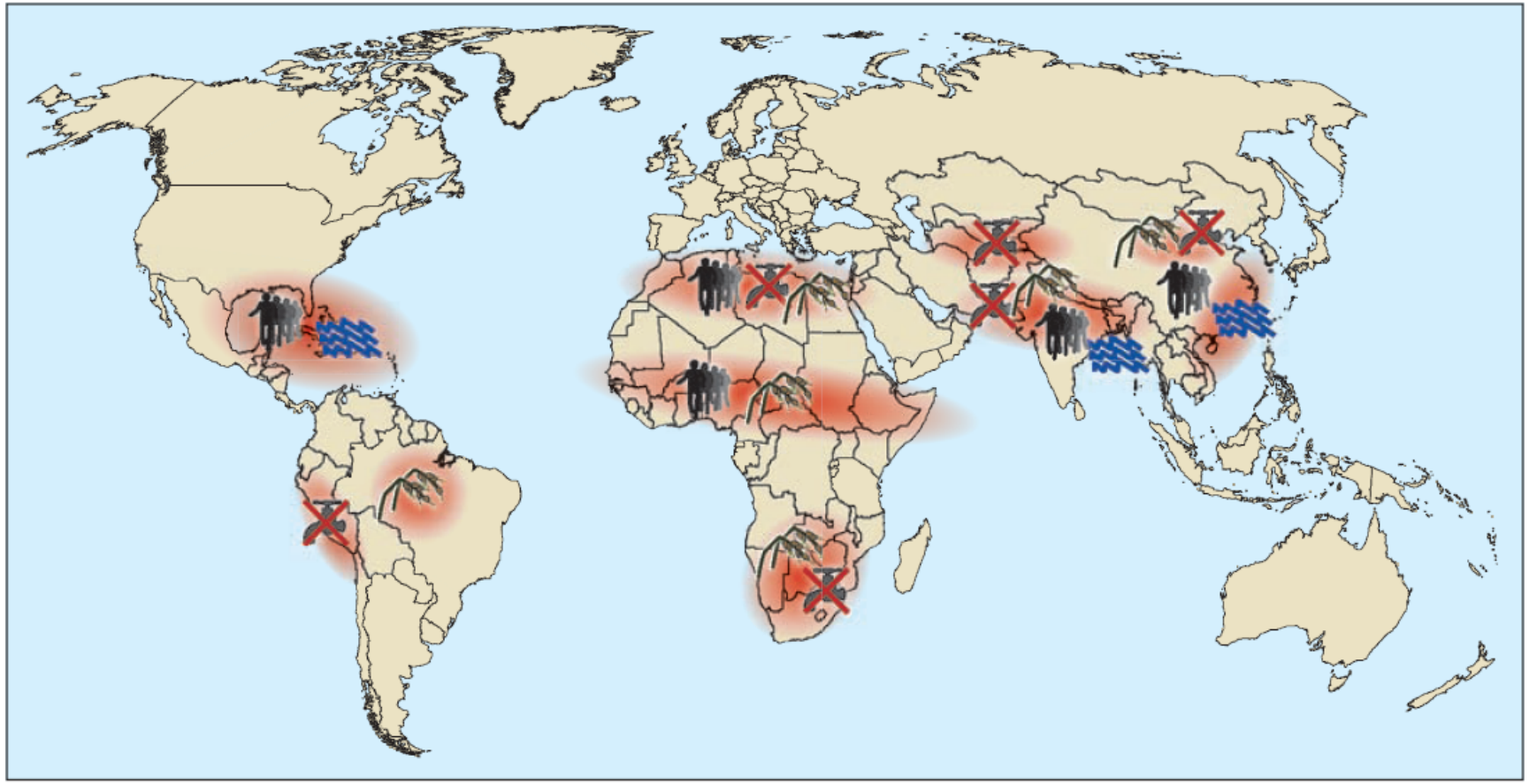
Climate refugees?

8.4 million registered refugees and 23.7 million of Internally Displaced Persons (2006).

At least 25 million environmental migrants mid-1990s and expected 50 million by 2010 and up to 150 million by 2050

Number of environmental migrants likely substantially rise in the future due to the impacts of climate change,.

Security risks associated with climate change: Selected hotspots



Conflict constellations in selected hotspots

Climate-induced degradation of freshwater resources

Climate-induced decline in food production

Hotspot

Climate-induced increase in storm and flood disasters

Environmentally-induced migration

Source: WBGU 2007

Security risks of climate change

"Climate-related shocks have **sparked violent conflict** in the past, and conflict is a serious risk in areas such as West Africa, the Nile Basin and Central Asia." (Stern Review 2006)

The effects of global warming could lead to large-scale migrations, increased border tensions, the spread of disease and conflicts over food and water, all of which could directly involve the US military. Climate change is characterized as a **"threat multiplier"** in already fragile regions of the world, exacerbating conditions that lead to failed states — the breeding grounds for **extremism and terrorism**. (National Security and the Threat of Climate Change, April 2007)

The effects of climate change have "long-term security implications for all countries which are far more serious, lasting and **destructive than those of international terrorism**."(ORG 2006)

UN Secretary General Ban Ki-Moon warned that climate change may pose as much of a **danger to the world as war**.

Abrupt climate change and nuclear power: a security risk?

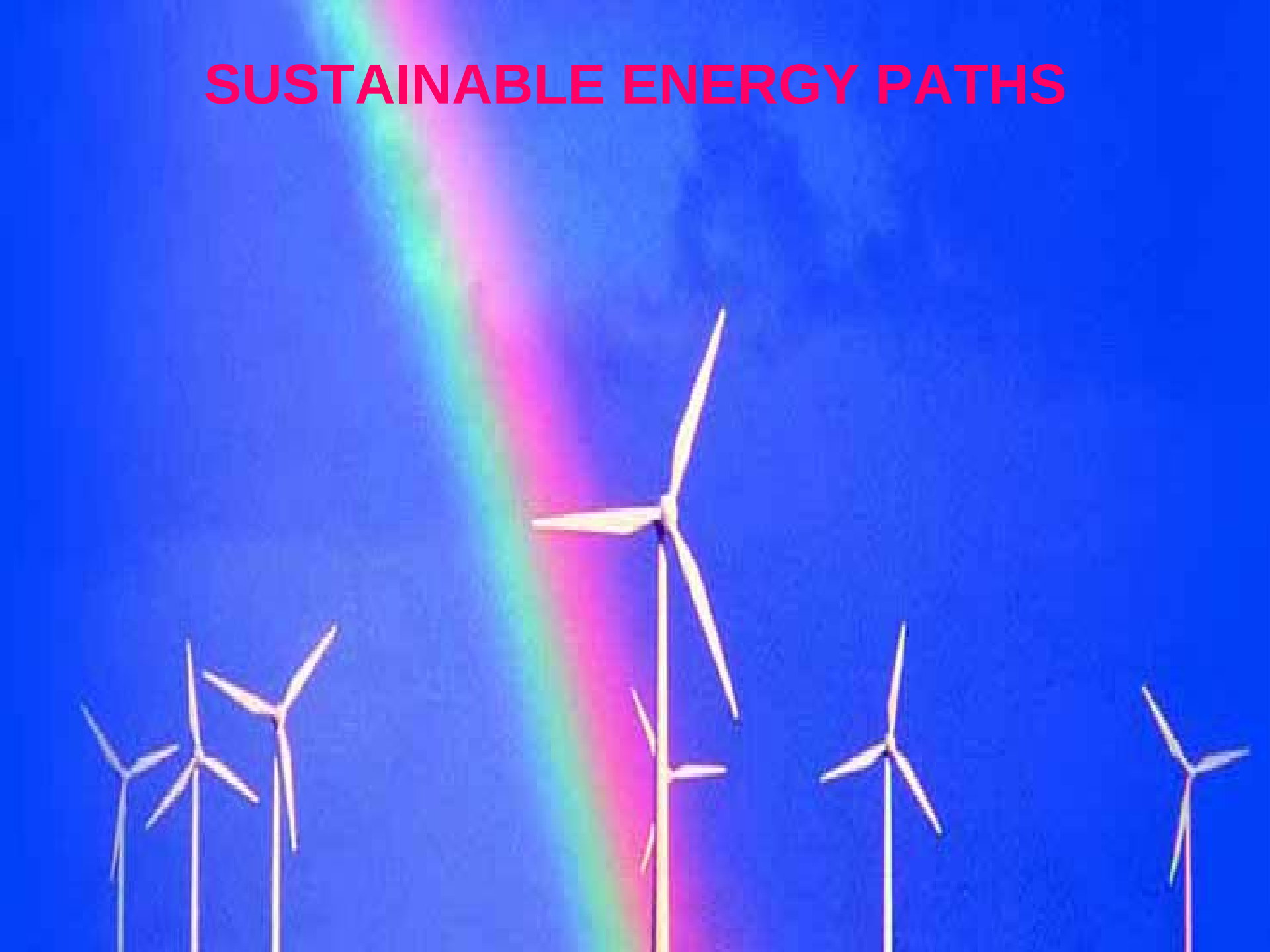
„With a scarcity of energy supply – and a growing need for access -- nuclear energy will become a critical source of power, and this will accelerate nuclear proliferation as countries develop enrichment and reprocessing capabilities to ensure their national security. China, India, Pakistan, Japan, South Korea, Great Britain, France, and Germany will all have nuclear weapons capability, as will Israel, Iran, Egypt, and North Korea.“ (Schwartz/Randall 2003)

Nuclear Winter and Global Warming

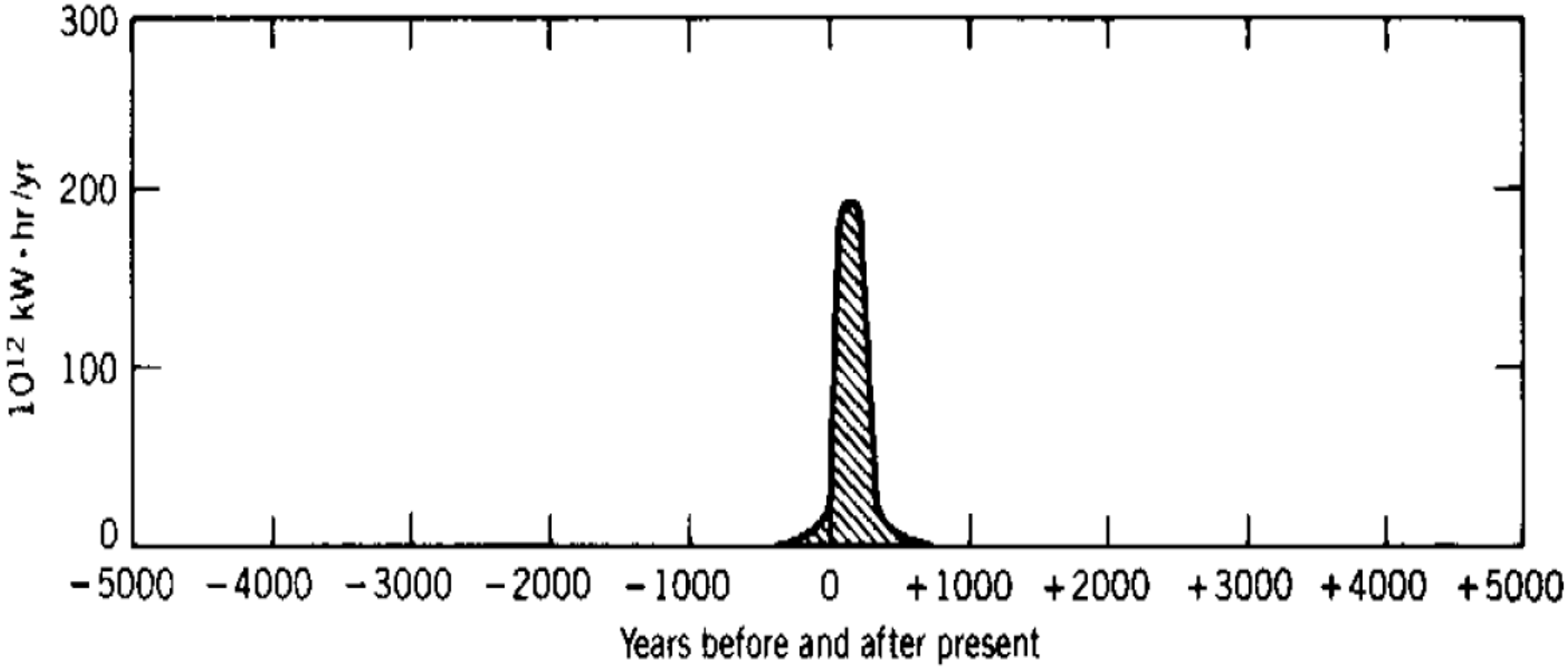
The two perils have a great deal in common. Both are fruit of swollen human power—in the one case, the destructive power of war; in the other, the productive of fossil-fuel energy. Both put stakes on the table of a magnitude never present before in human decision m Both threaten life on a planetary scale. Both require a global response. Anyone concerned by the one shoul concerned with the other. It would be a shame to save Earth from slowly warming only to burn it up in an ins a nuclear war." Jonathan Schell, The Seventh Decade


Global warming may “induce large-scale migration and lead to greater competition for the earth's resources” and result in “increased danger of violent conflicts and wars, within and between states”
Nobel Peace Prize Committee 2007
AP PHOTO

SUSTAINABLE ENERGY PATHS

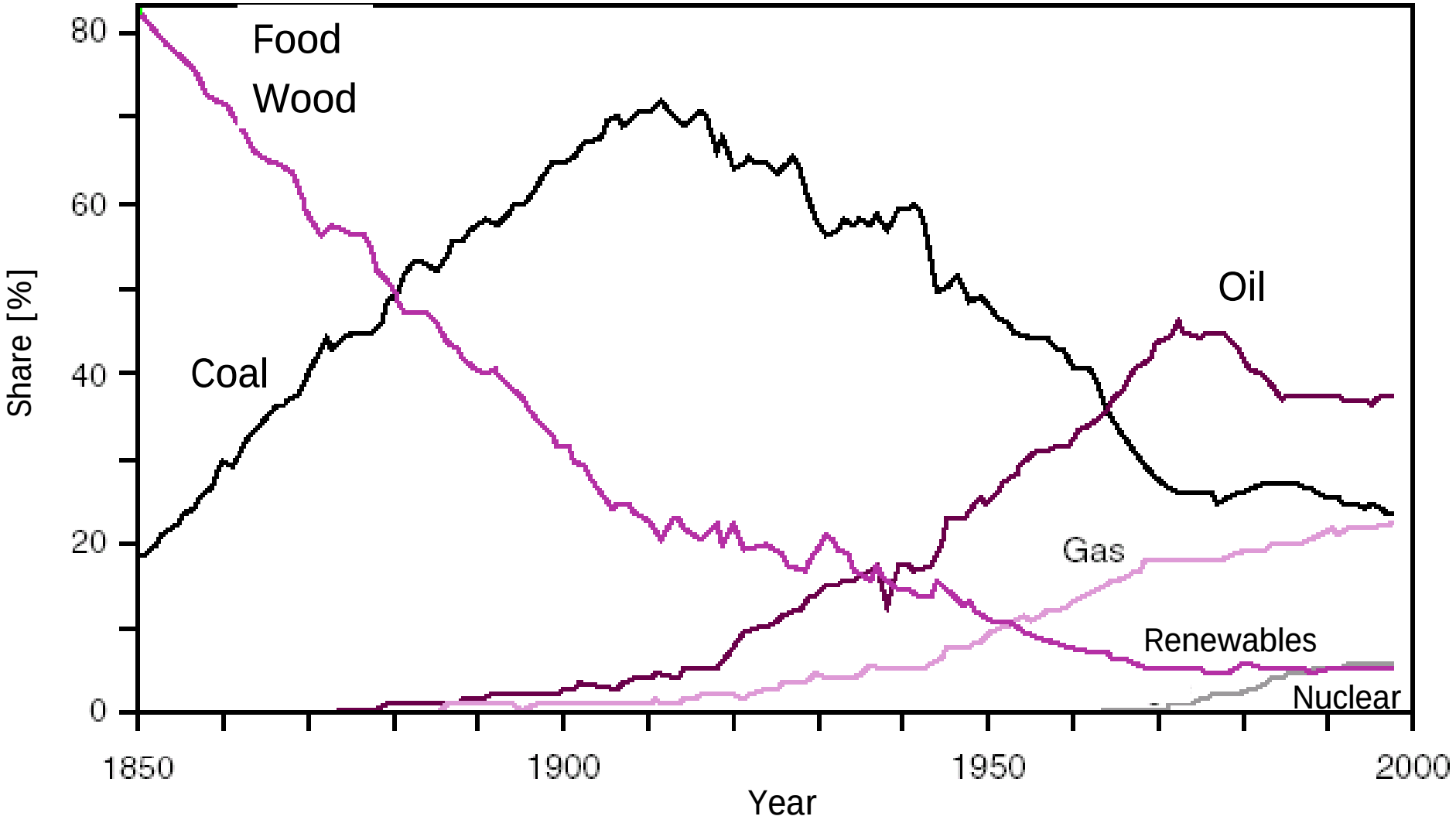


Exploitation of fossil fuels in historic context



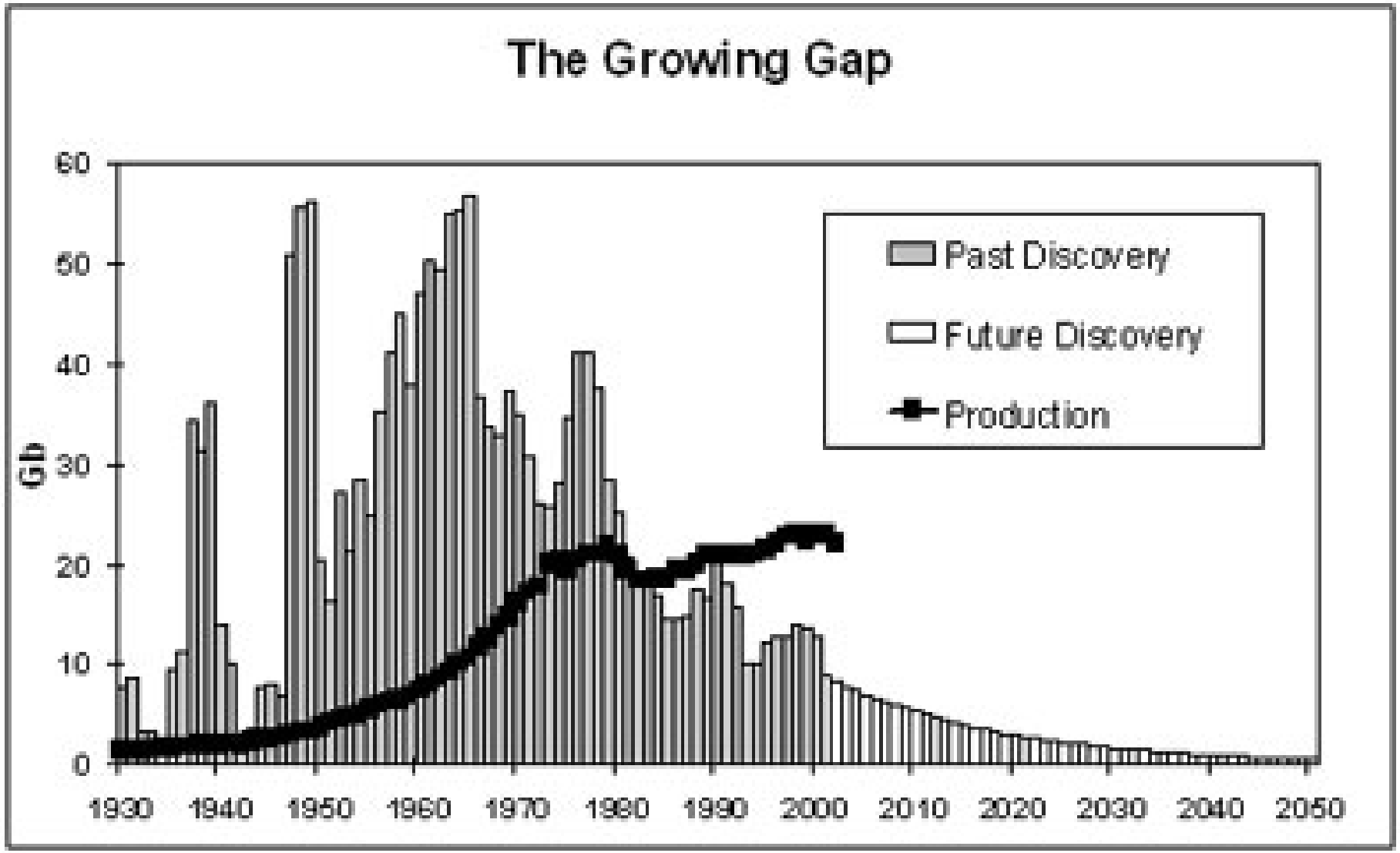
Source: Hubbert 1969

Share of energy sources in global primary energy use

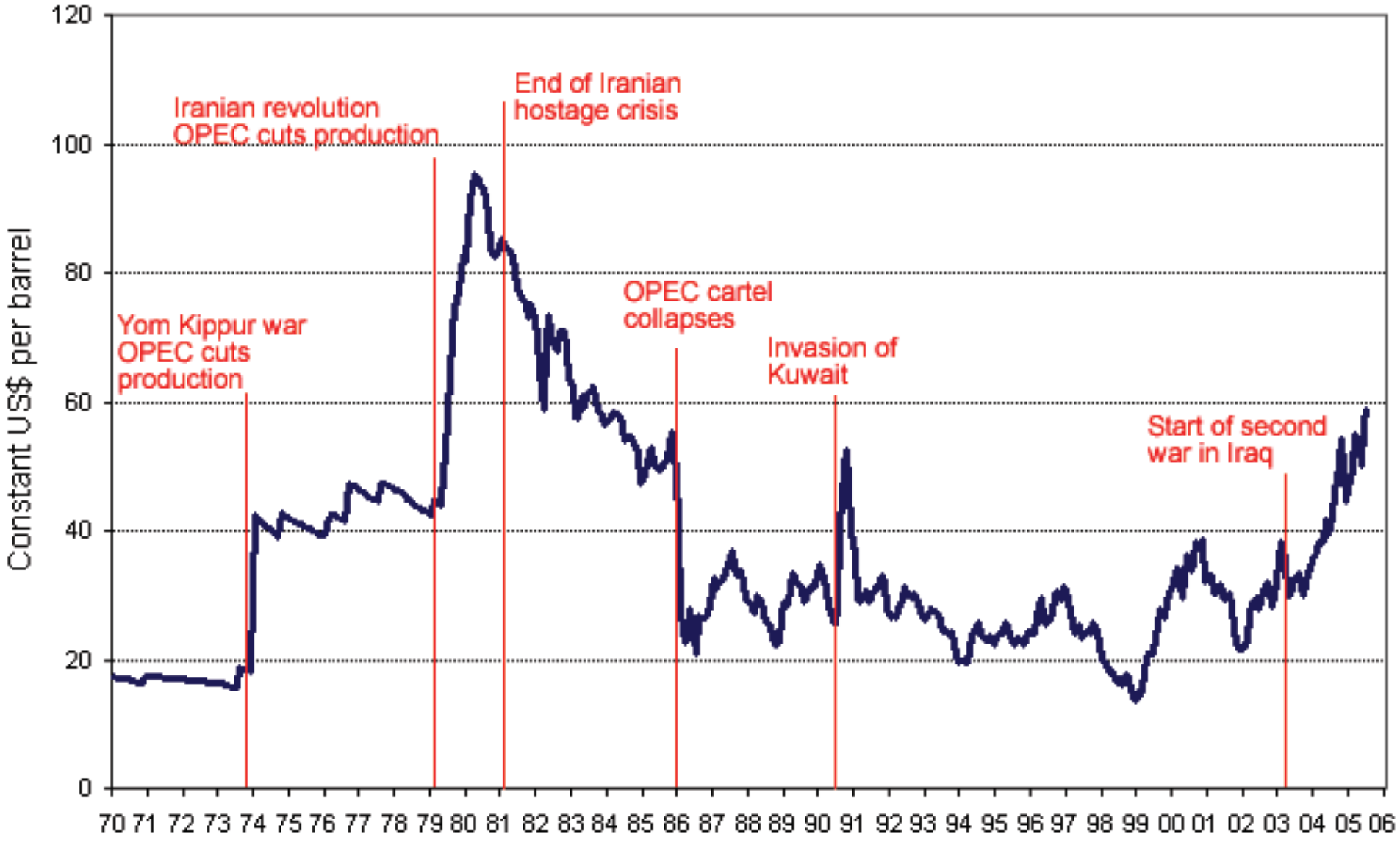


Source: Nakicenovic et al., 1998

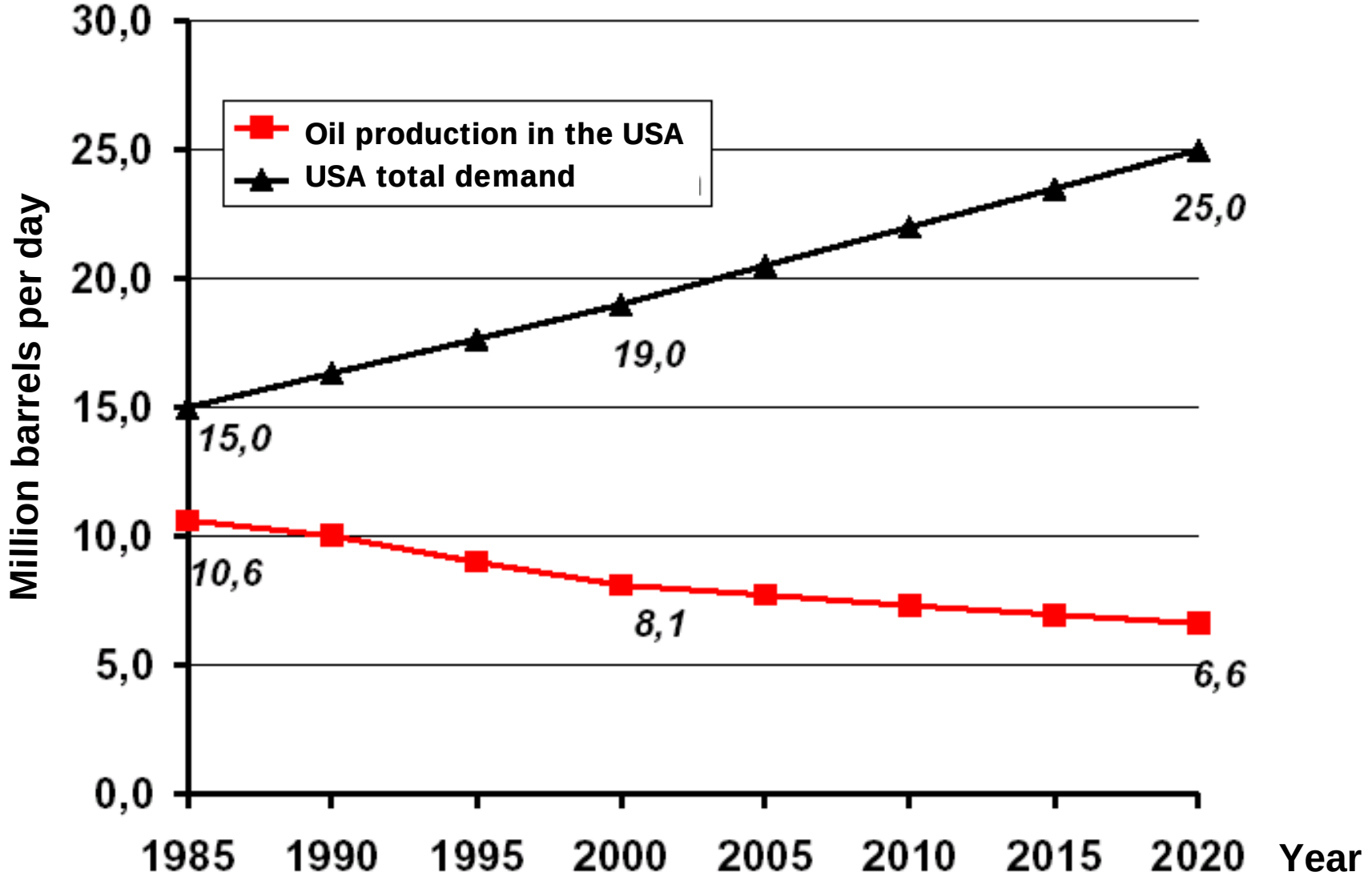
Oil exploration vs. production



Oil price and conflict



Growing US foreign oil dependence



Source: EIA, DOE prognosis

UN Framework Convention on Climate Change

UNFCCC Article 2 ultimate objective (Rio 1992):

"stabilization **of greenhouse gas concentrations in the atmosphere at a level that would** prevent dangerous **anthropogenic interference with the climate system.**

Such a level should be achieved within a time-frame **sufficient**

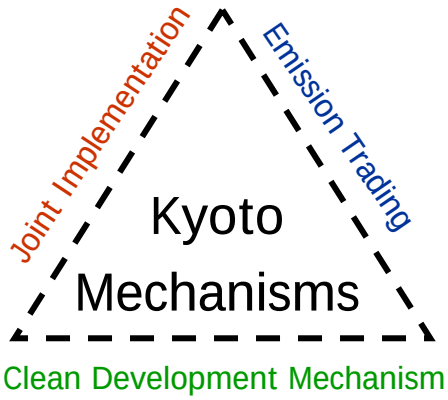
to allow ecosystems to adapt naturally to climate change,

to ensure that food production is not threatened and

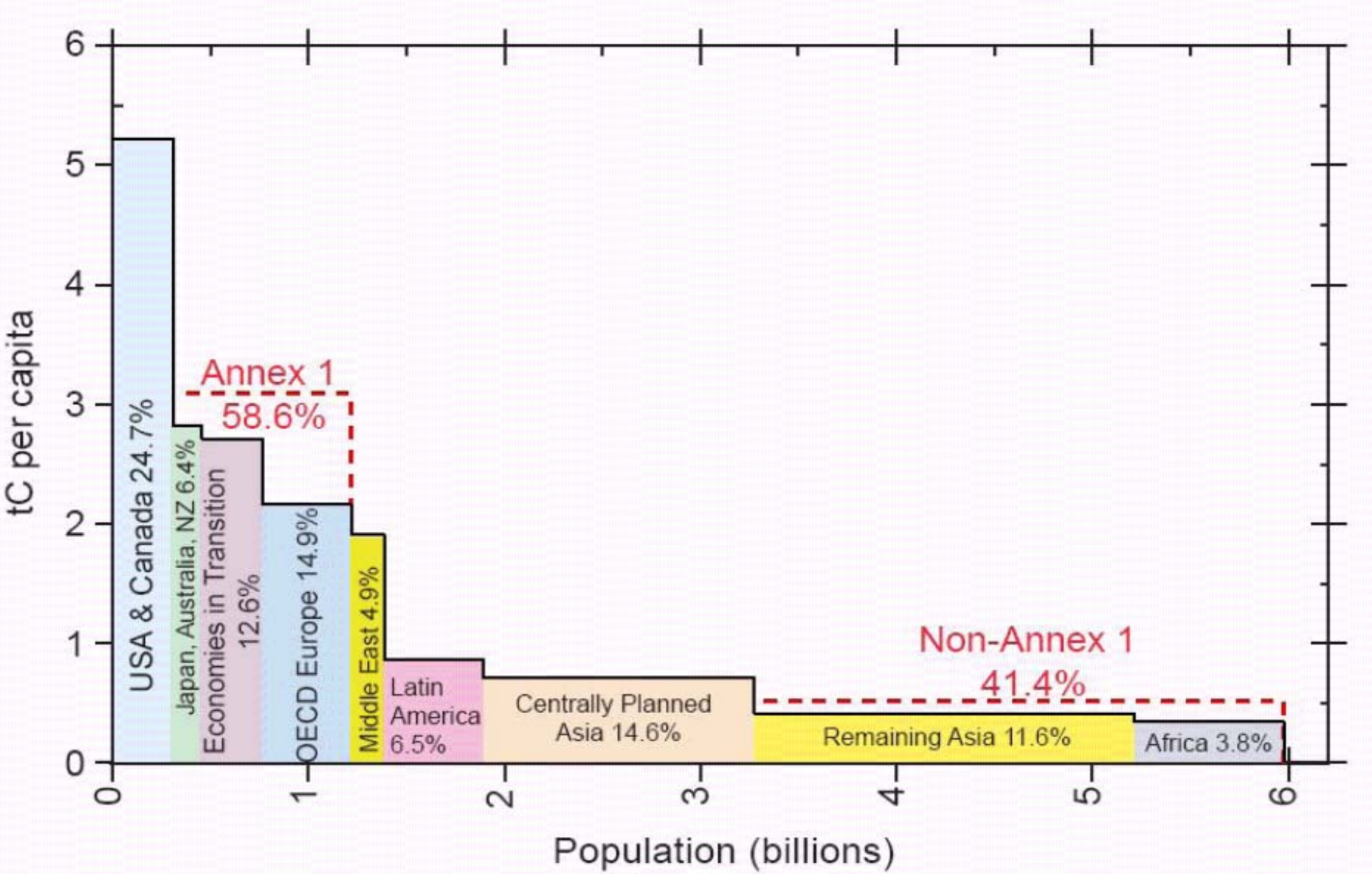
to enable economic development to proceed in a sustainable manner."

1997 Kyoto Protocol to the UNFCCC:

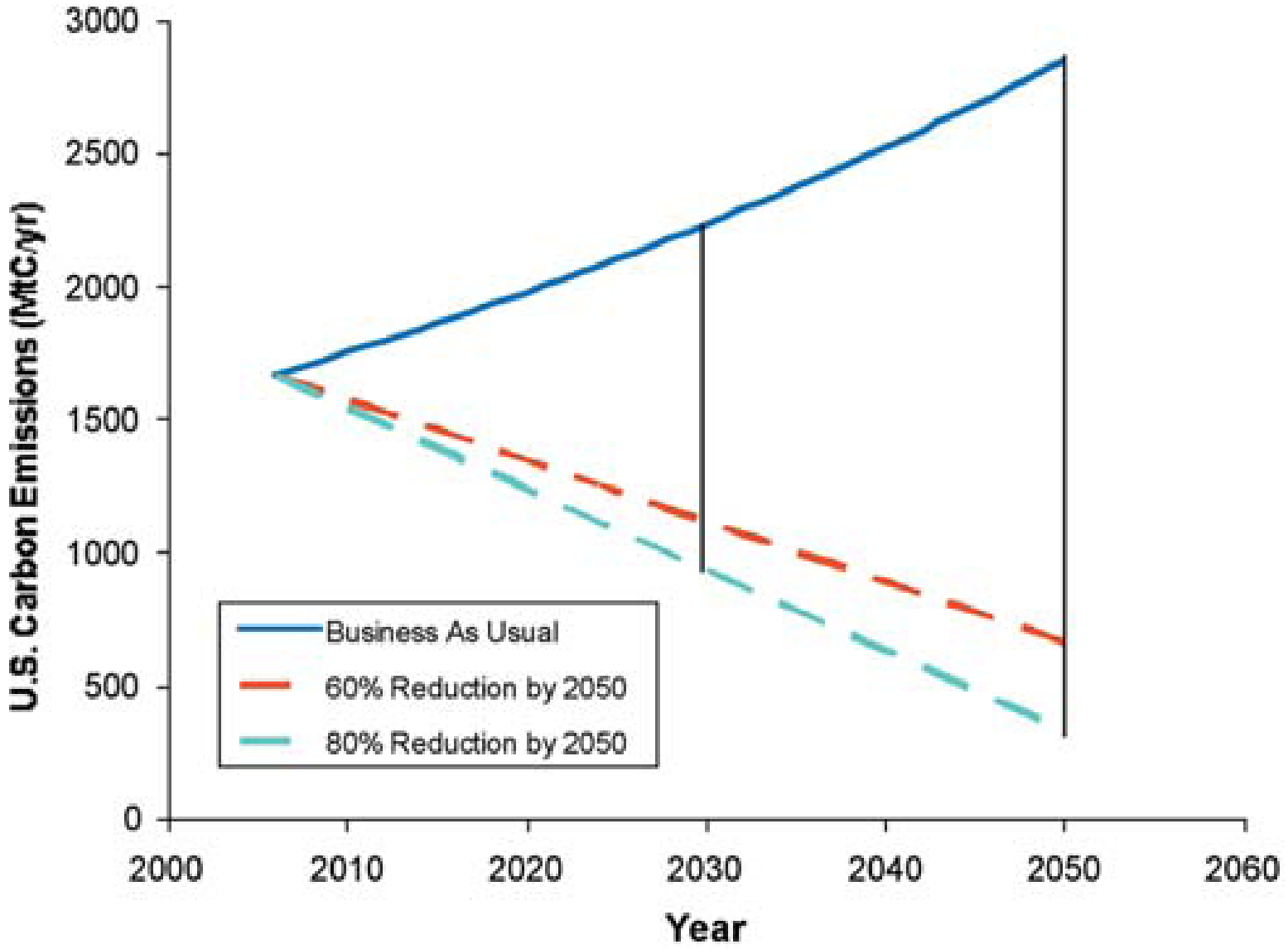
- GHG emission reductions average -5.2% of 1990 level until 2008-2012
- Enters into force February 16, 2005



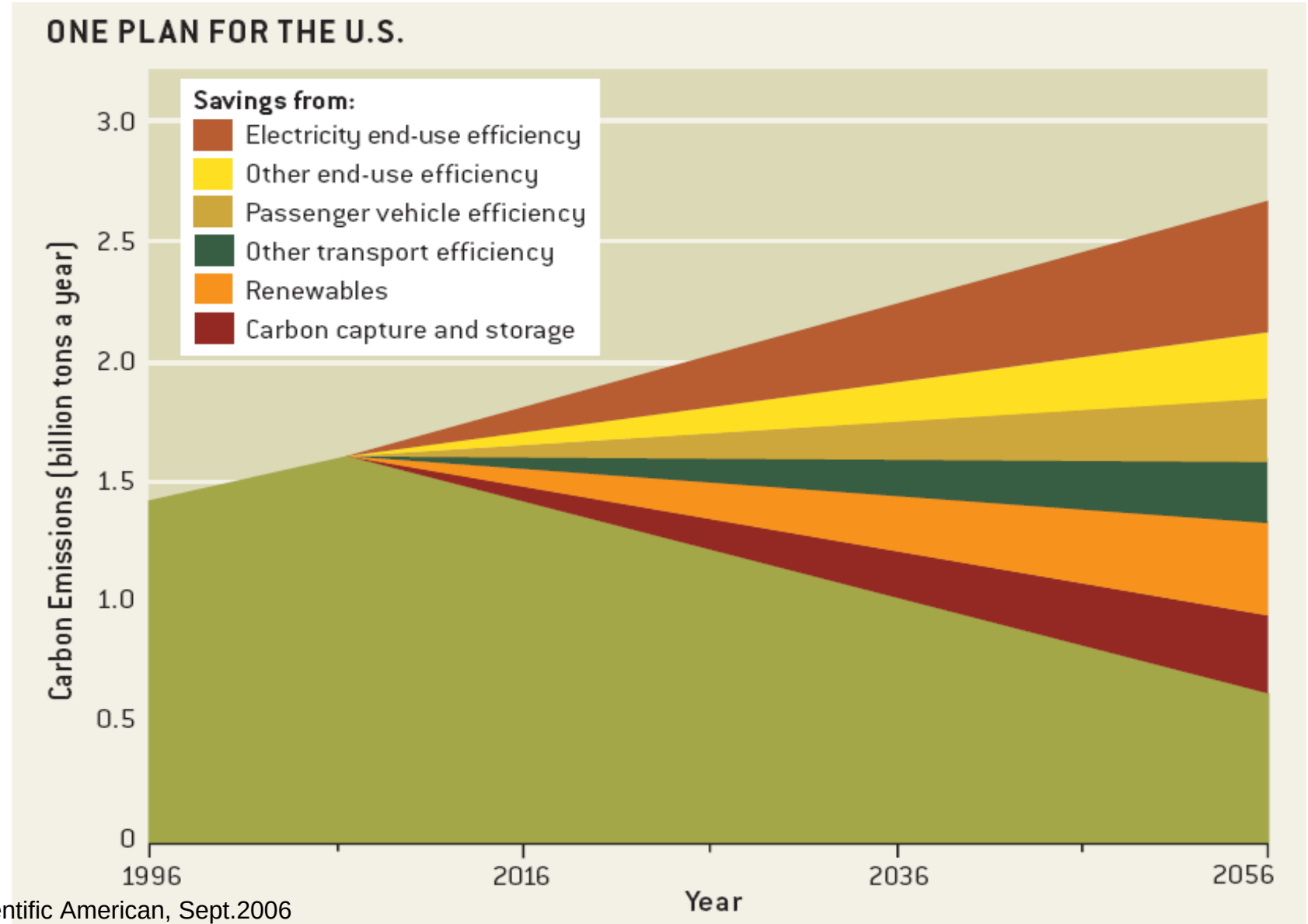
Emission per capita in different world regions



Growing gap between projected U.S. fossil fuel carbon emissions the required 60% to 80% reduction by 2050

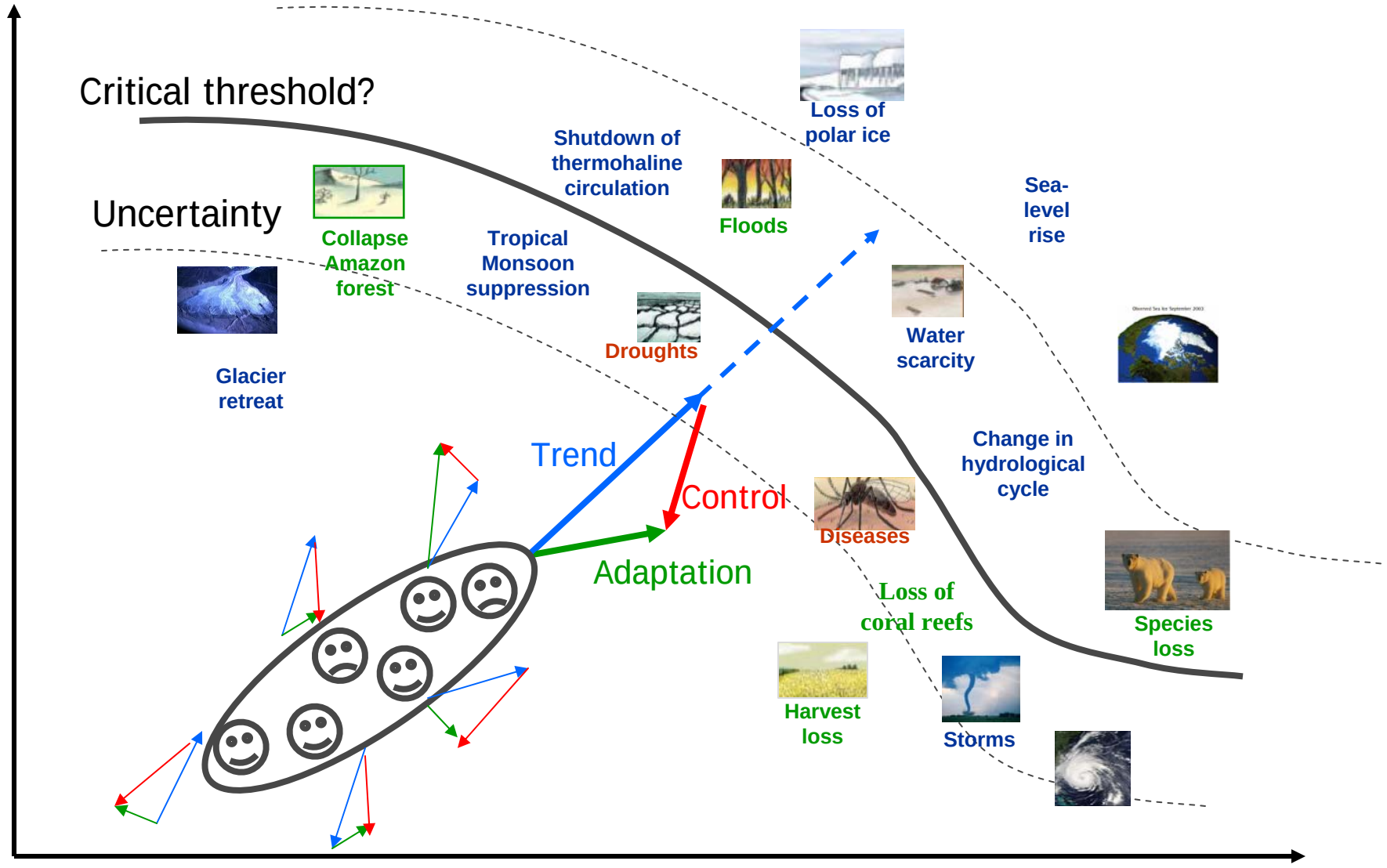


Integrated strategies for US emission reductions



Scientific American, Sept.2006

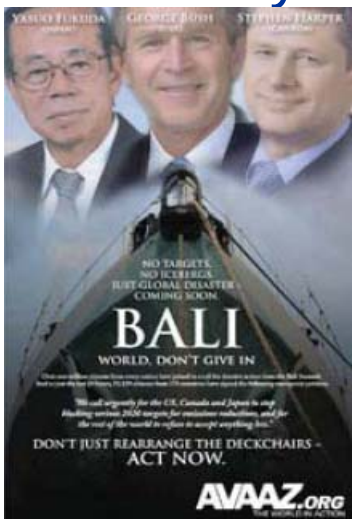
World in a boat: Where to go and how fast?



Climate COP in Bali: Drama of the Commons

Fuelling Change in the USA

- Over 700 U.S. cities signed to meet Kyoto Protocol
- California mandated 25% reduction in greenhouse gases by 2020
- Shadow U.S. delegation in Bali including Al Gore, John Kerry, Michael Bloomberg, officials from California
- Al Gore: "My own country, the United States, is principally responsible for obstructing progress here. … We all know that. … We are going to change in the U.S.“
- European Union officials threatened to boycott U.S.-sponsored climate talks in Washington



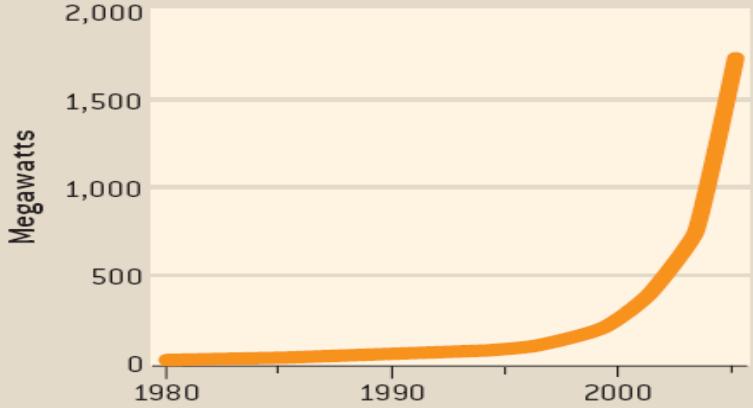

“The time is over. The scienc
in. The time to act is now. Gl
warming is a serious issue fa
the world and California has
an historic step…”
California Governor Schwarzene
launching his global warming ini
to cut emissions by 80% by 205
June 2005.

Renewable Portfolio Standard

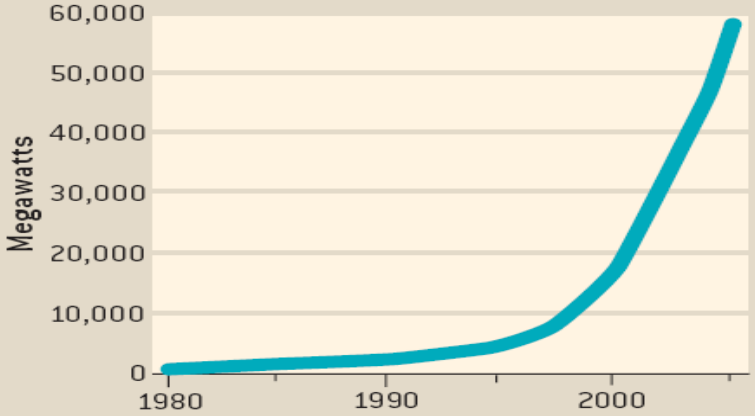
RPS is state policy that requires electricity providers to obtain a minimum percentage of their power from renewable energy resources by a certain date. Four other states, Illinois, Missouri, Virginia, and Vermont, have nonbinding goals for adoption of renewable energy instead of an RPS.

State	Amount	Year
Arizona	15%	2025
California	20%	2010
Colorado	20%	2020
Connecticut	23%	2020
District of Columbia	11%	2022
Delaware	20%	2019
Hawaii	20%	2020
Iowa	105 MW	
Illinois	25%	2025
Massachusetts	4%	2009
Maryland	9.5%	2022
Maine	10%	2017
Minnesota	25%	2025
Missouri*	11%	2020
Montana	15%	2015
New Hampshire	16%	2025
New Jersey	22.5%	2021
New Mexico	20%	2020
Nevada	20%	2015
New York	24%	2013
North Carolina	12.5%	2021
Oregon	25%	2025
Pennsylvania	18%	2020
Rhode Island	15%	2020
Texas	5,880 MW	2015
Vermont*	10%	2013
Virginia*	12%	2022
Washington	15%	2020
Wisconsin	10%	2015

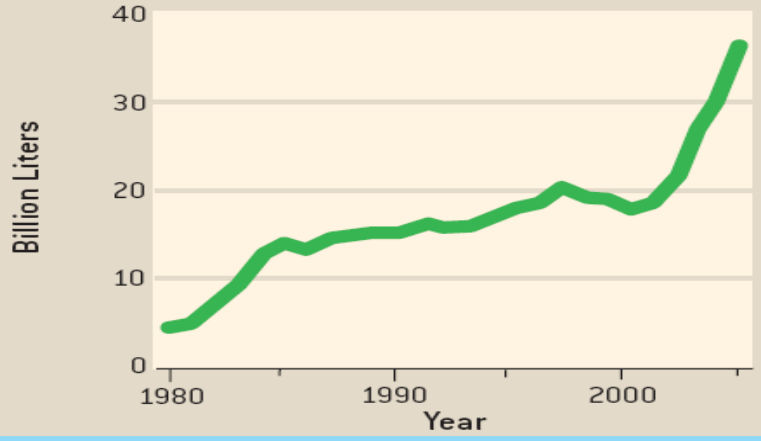
Photovoltaic Production



Wind Energy Generating Capacity



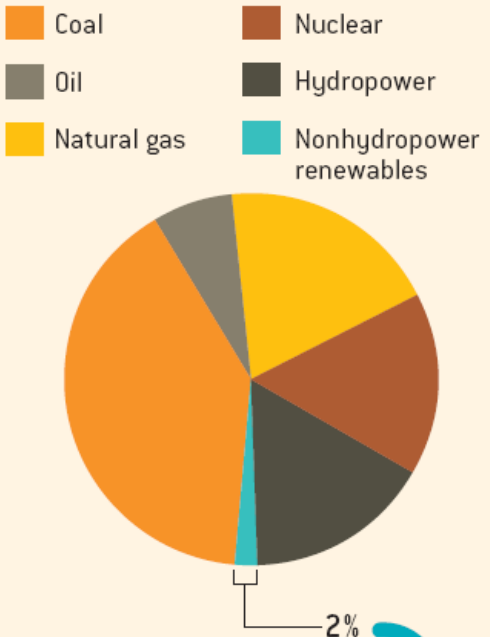
Ethanol Production



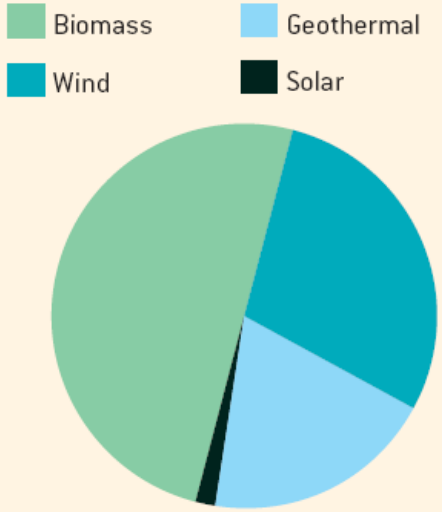
Scientific American, Sept.2006

COMPETING ENERGY SOURCES

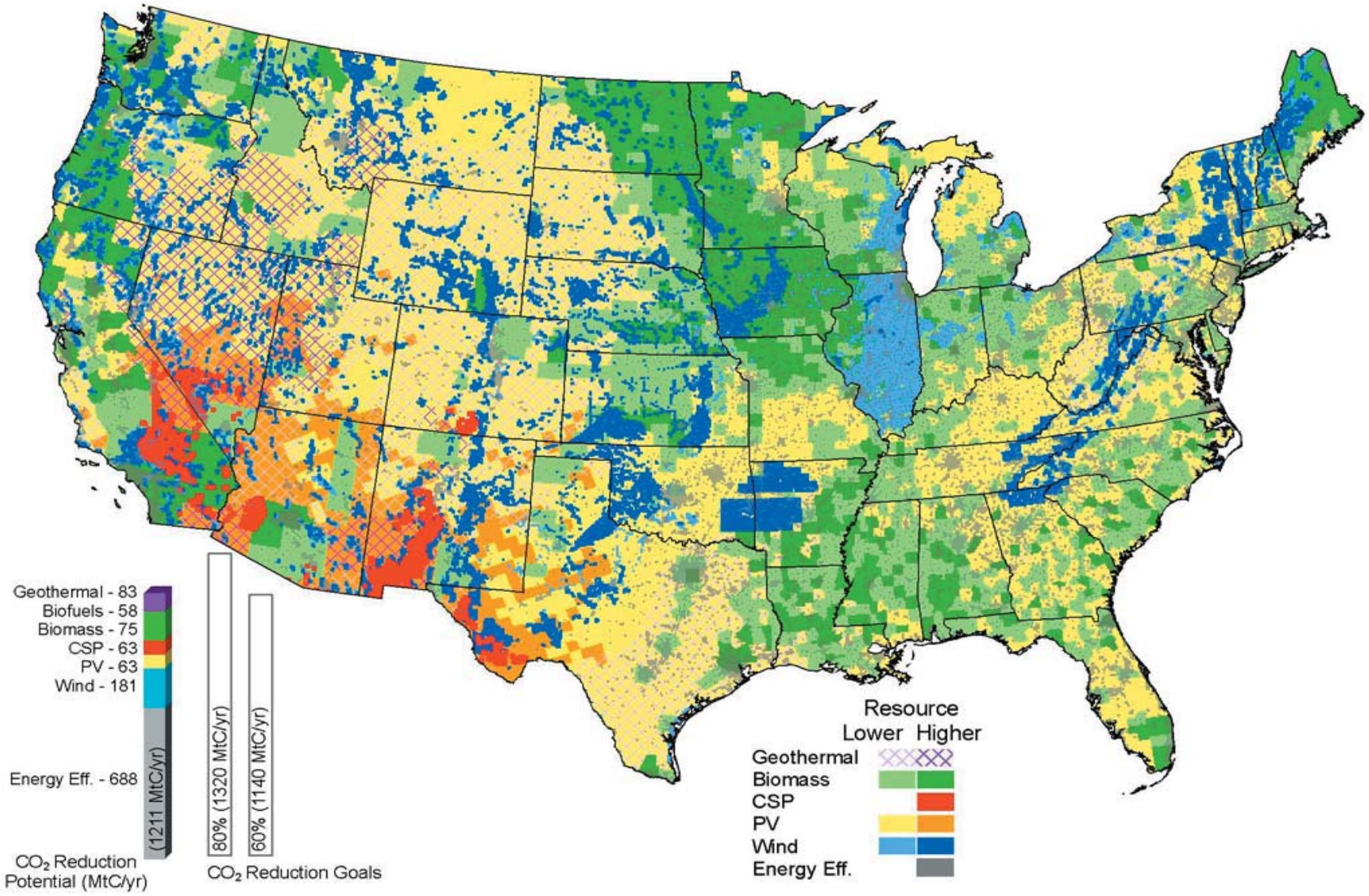
Fraction of global electricity generation



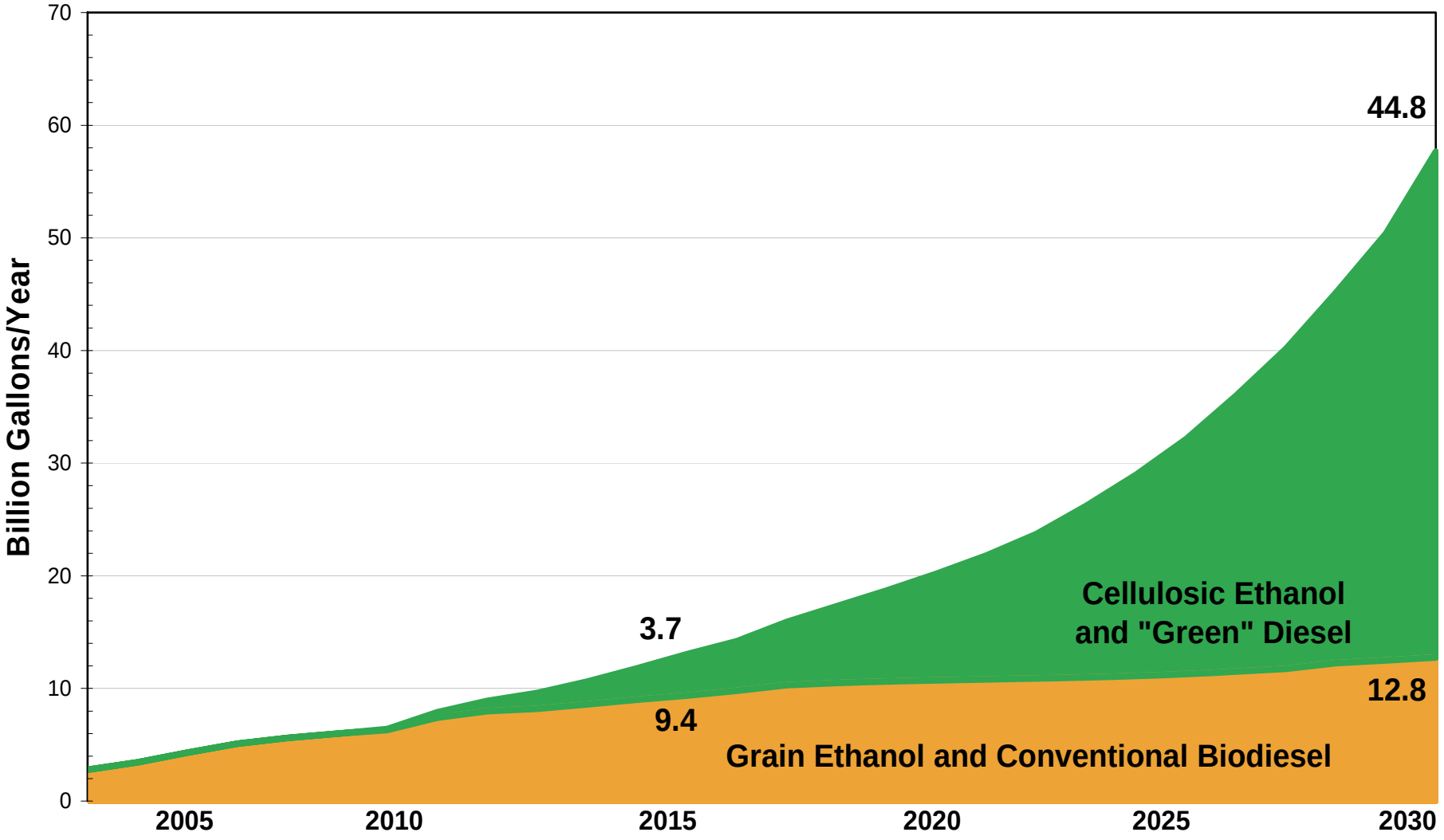
Breakdown of nonhydropower renewables



U.S. map with potential contributions from energy efficiency and renewable energy by 2030

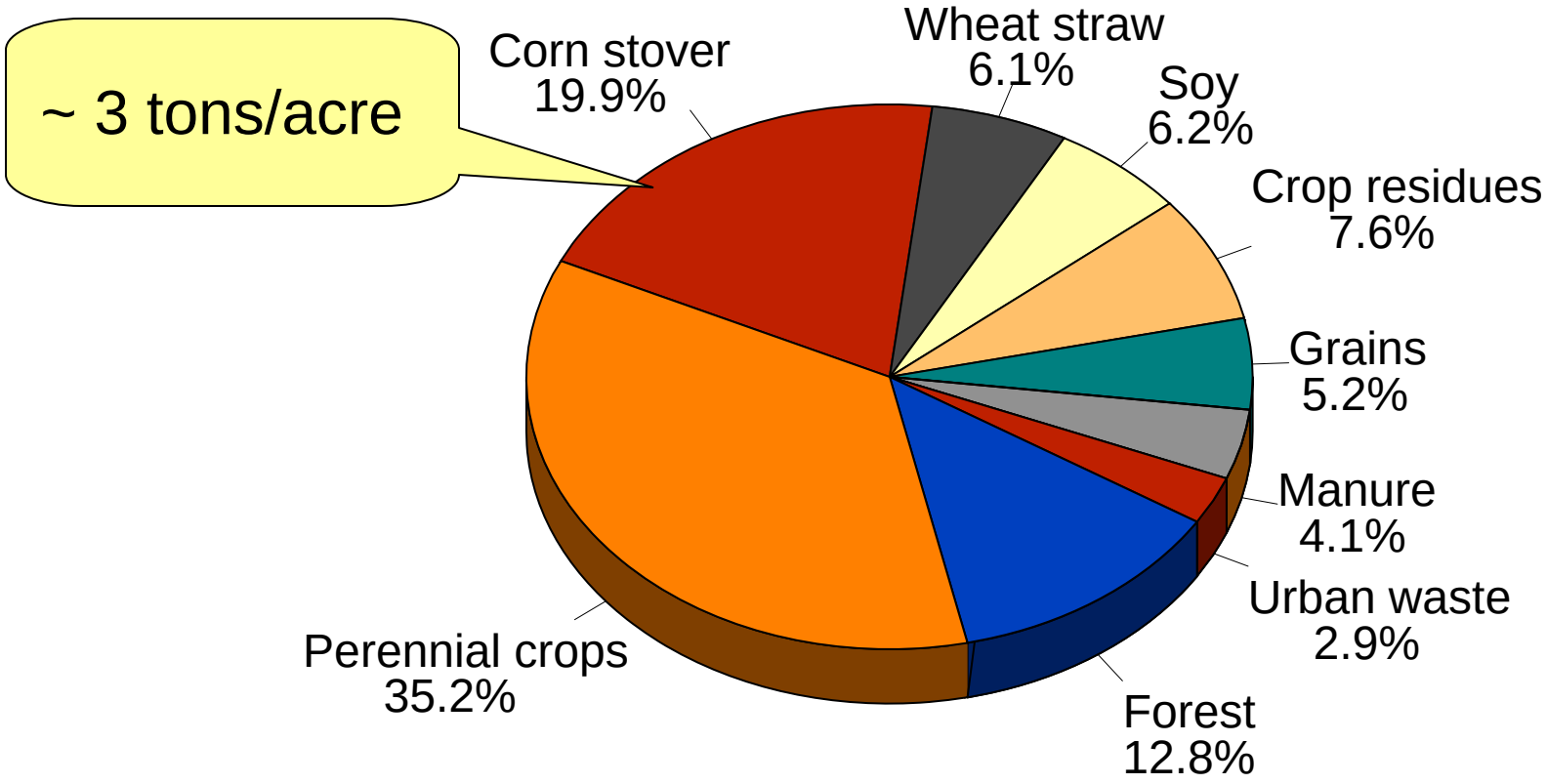


Required growth of cellulosic Ethanol to supply 30% of U.S. Gasoline demand by 2030



Source: Stanley R. Bull, NREL

US Biomass inventory = 1.3 billion tons

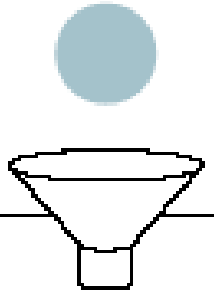
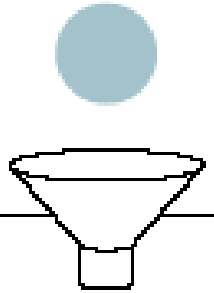


From: Billion ton Vision, DOE & USDA 2005

Critical issues of biofuels

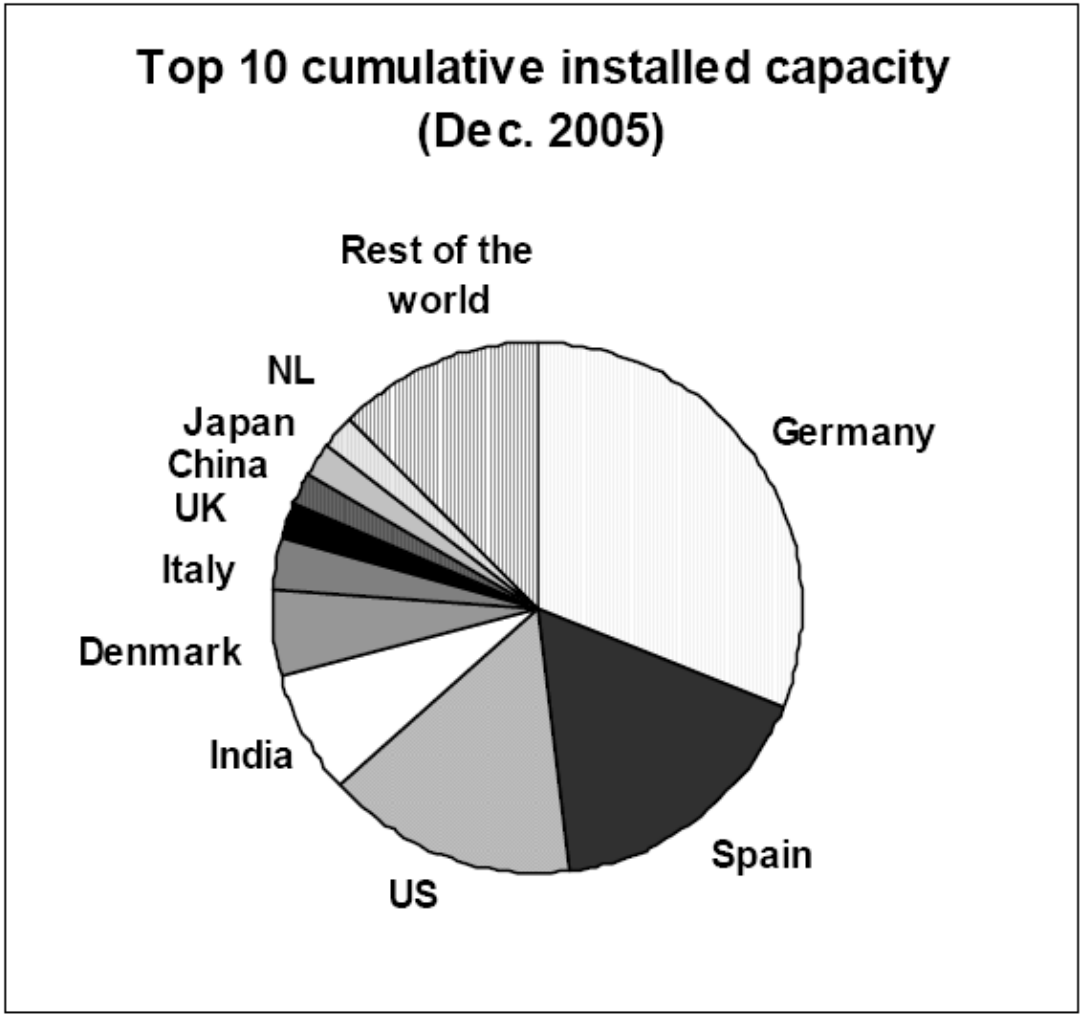
- Energy balance
- Carbon balance
- Land use
- Competition with food
- Water needs
- Fertilizer and chemical inputs
- Biodiversity, monoculture, invasive species
- Safety and security
- Cost of harvest and distribution
- Jobs
- Legal issues

Energy ratio and carbon emissions of ethanol

Ethanol from:	Corn	Cellulose
Fossil energy used in production		
Energy produced	1.3 times 	10 times 
Greenhouse-gas reduction**	12% to 26%	82% to 85%

Technology Review, Jan. 2008

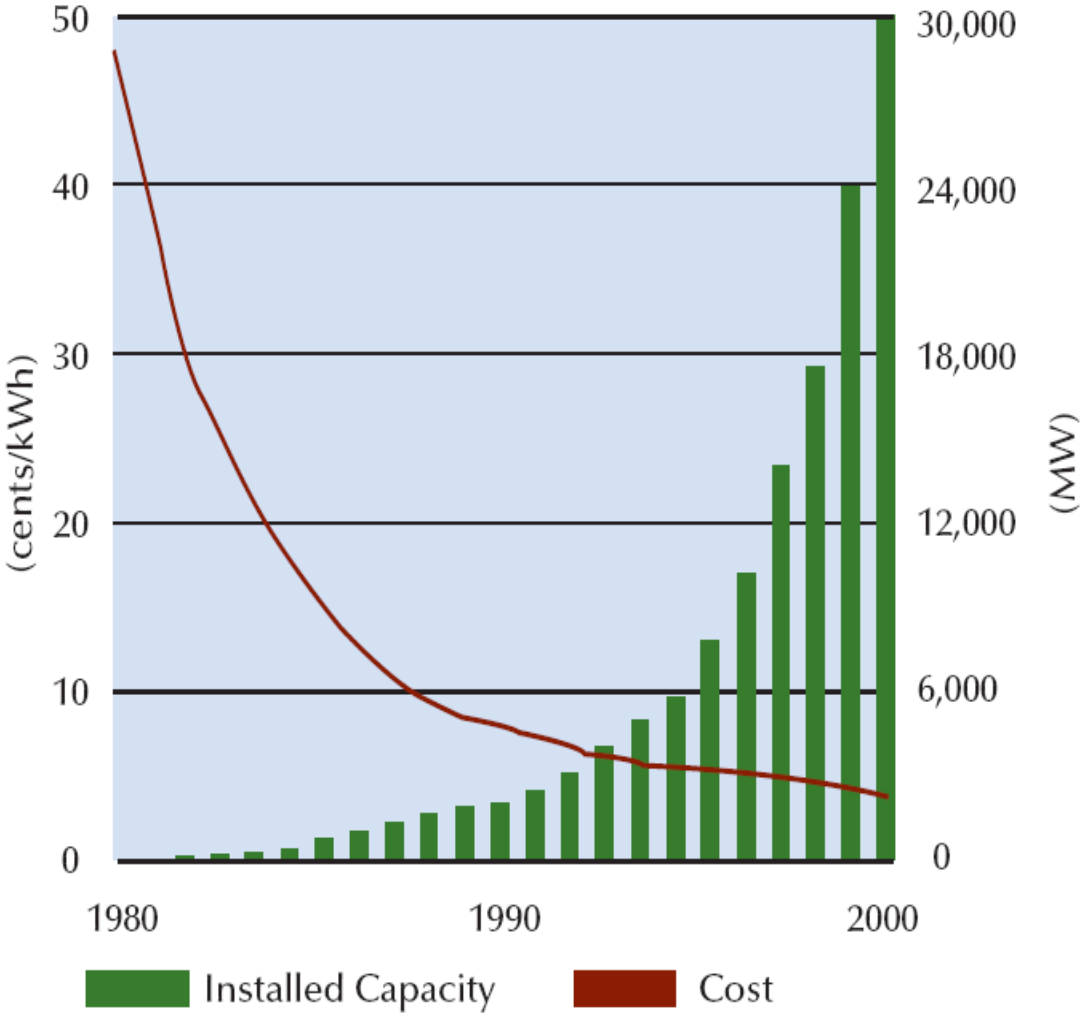
Cumulative wind power capacity



Total capacity	MW	%
Germany	18,428	31.0
Spain	10,027	16.9
US	9,149	15.4
India	4,430	7.5
Denmark	3,122	5.3
Italy	1,717	2.9
UK	1,353	2.3
China	1,260	2.1
Japan	1,231	2.1
NL	1,219	2.1
Top 10 – Total	**51,936**	**87.5**
Rest of the world	**7,368**	**12.5**
World total	**59,322**	**100**

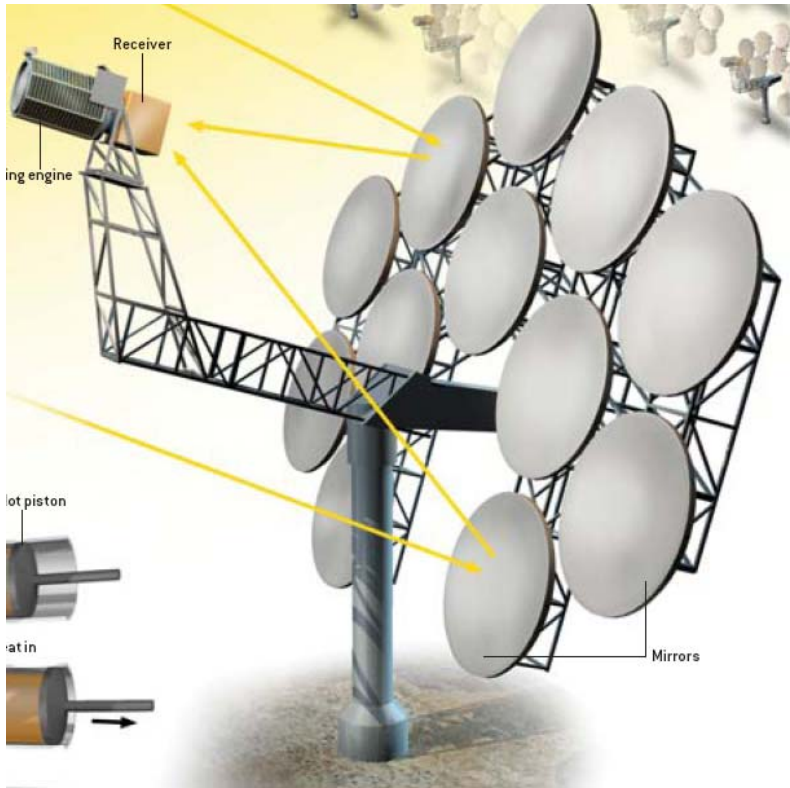
http://www.gwec.net/uploads/media/Statistics2005_170206.pdf

Declining costs of wind power

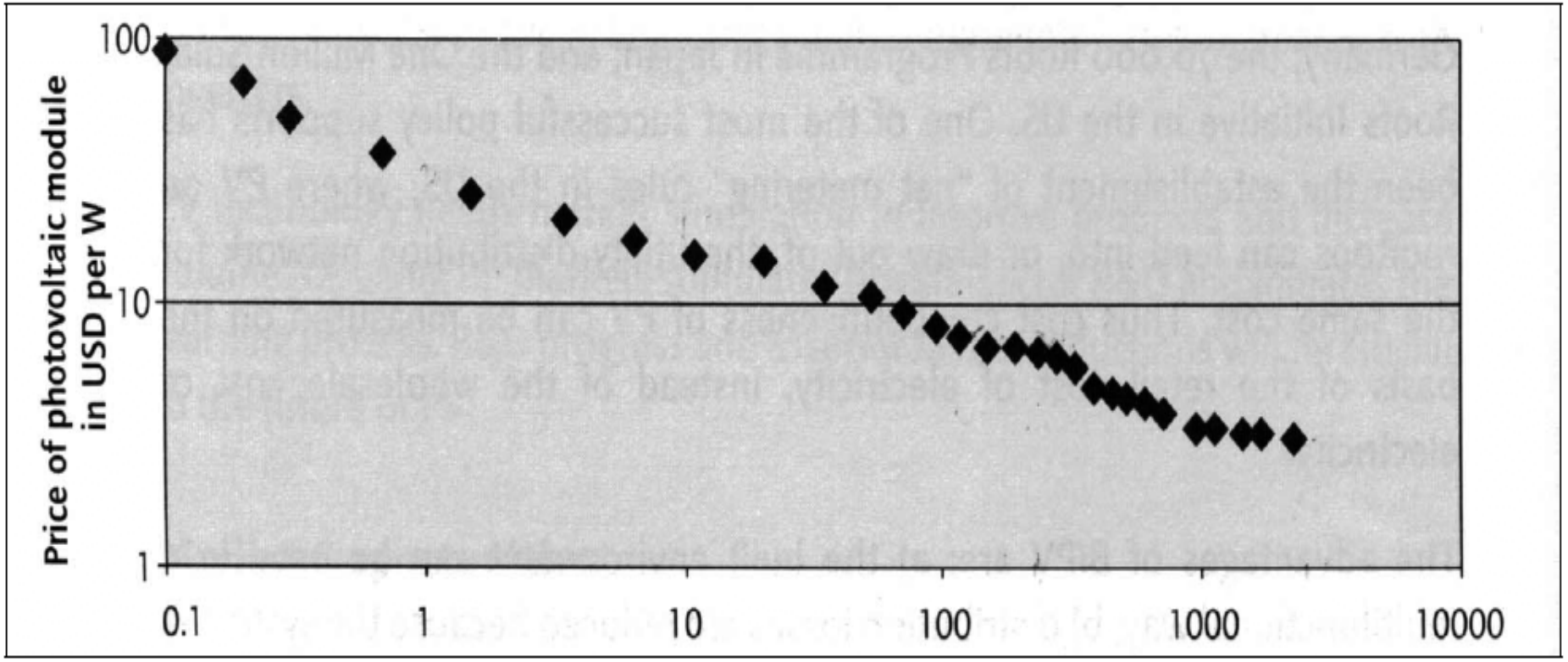


The Energy Foundation, 2004

Solar power

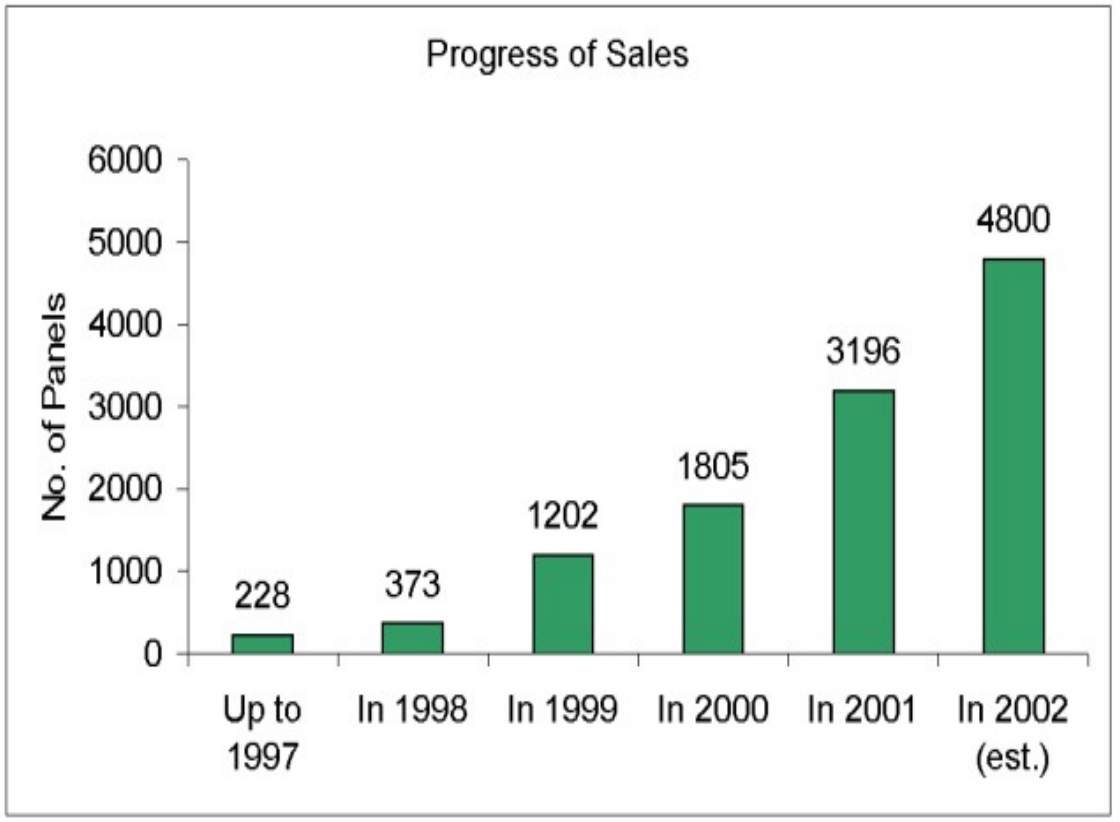


Solar learning:
Declining price of photovoltaics with usage



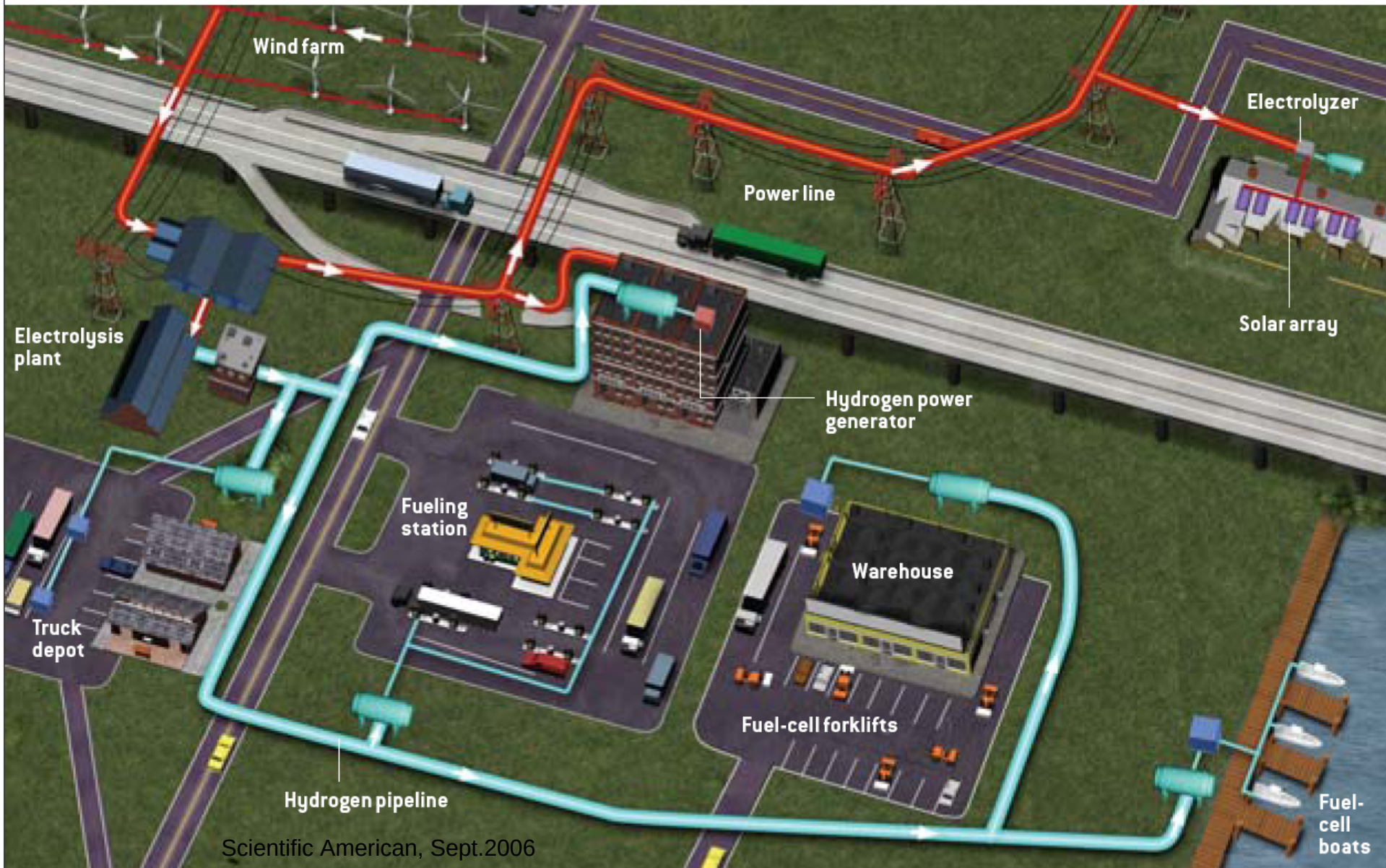
Source: DPG 2005

Microenergy and rural development: Solar Home Systems in Bangladesh



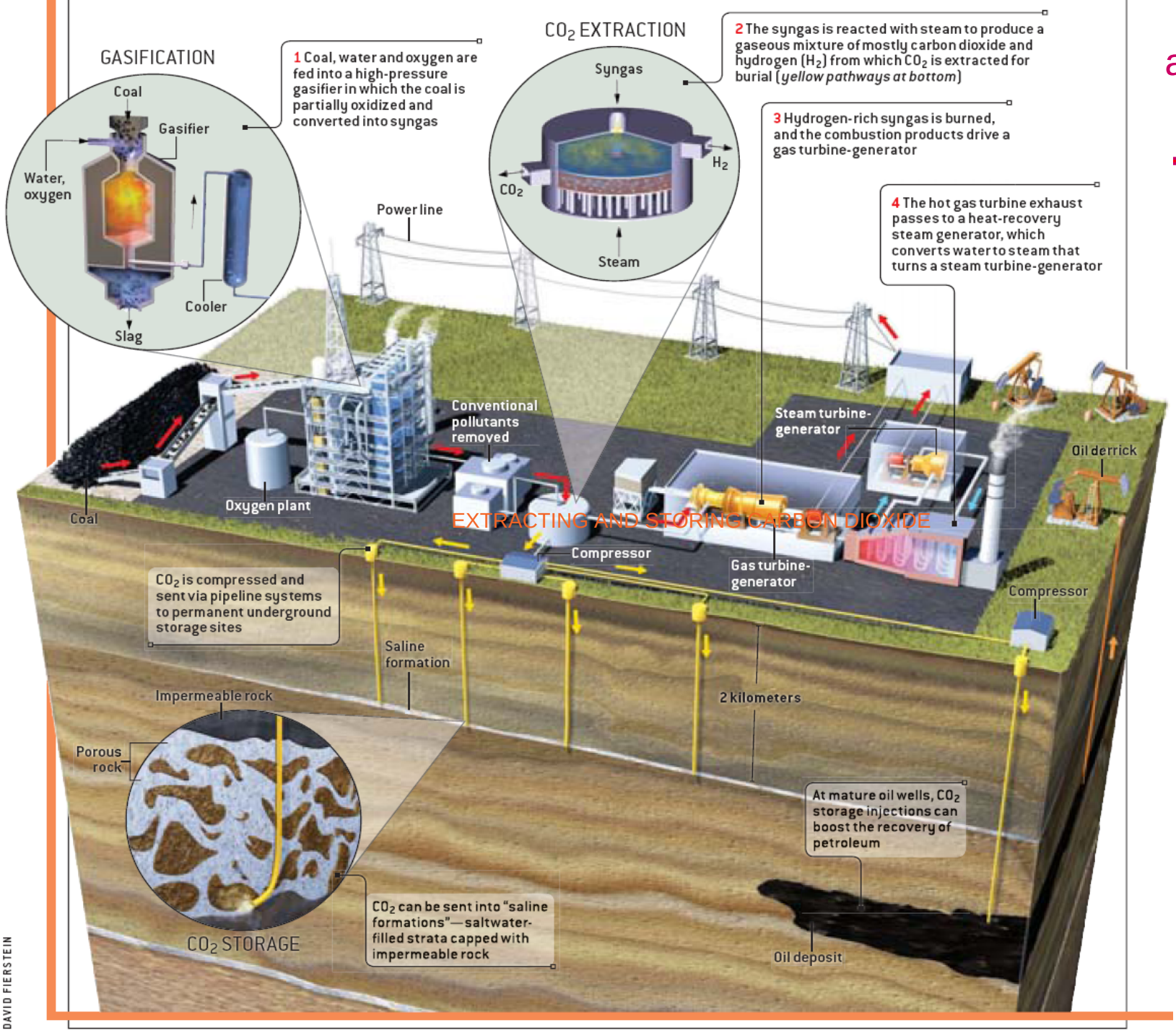
Sales of solar panels by Grameen Energy in Bangladesh (Source: www.tu-berlin.de/zek/microenergy-project)

The many uses of hydrogen



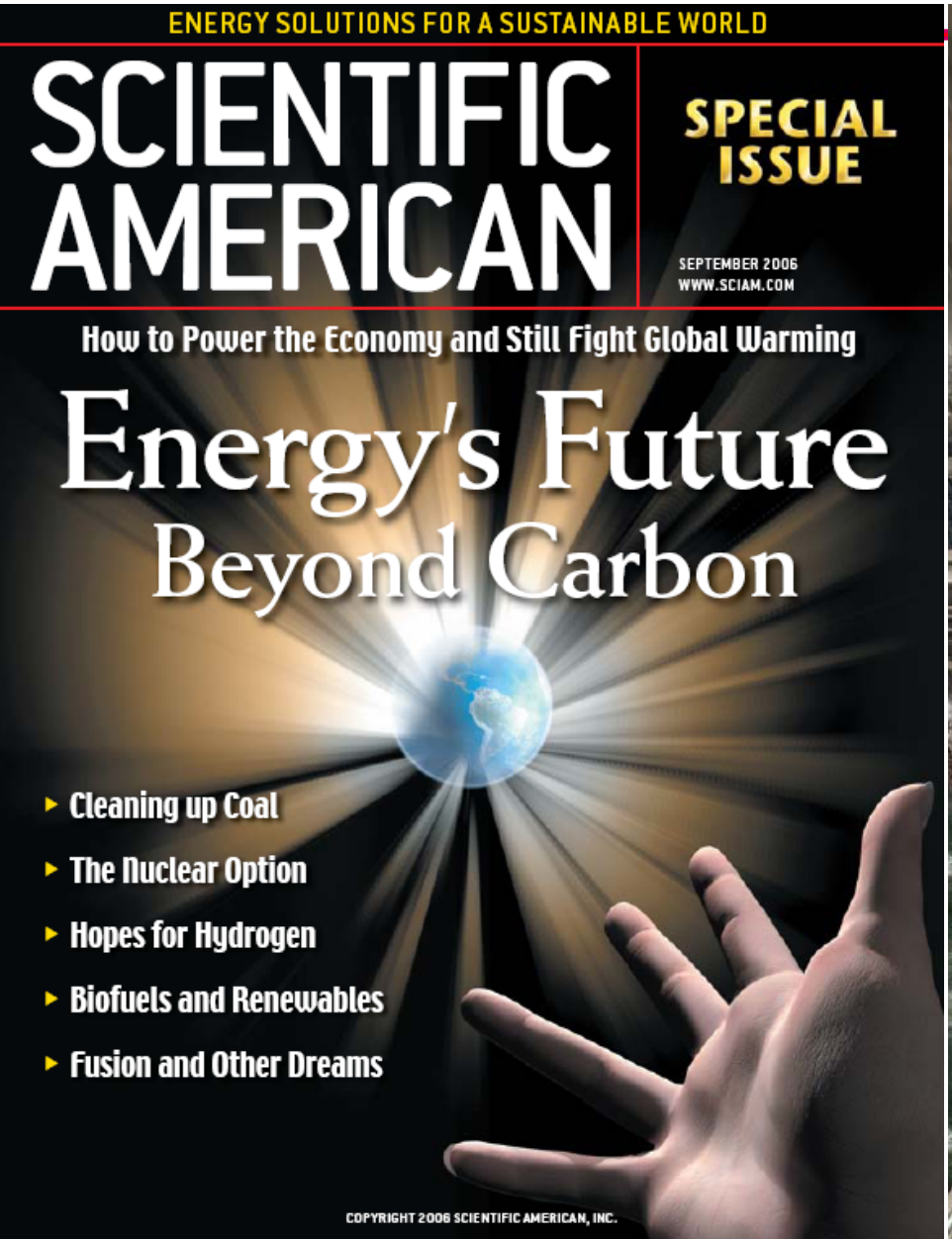
Scientific American, Sept.2006

Extracting and storing Carbon Dioxide



DAVID FIERSTEIN

The challenge:
Decarbonizing energy and the economy



Towards a peaceful and sustainable energy future