Environmental Issues Related to Energy Supply and Demand

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“Responsibility Energy Policy:
Our Future Depends on It”

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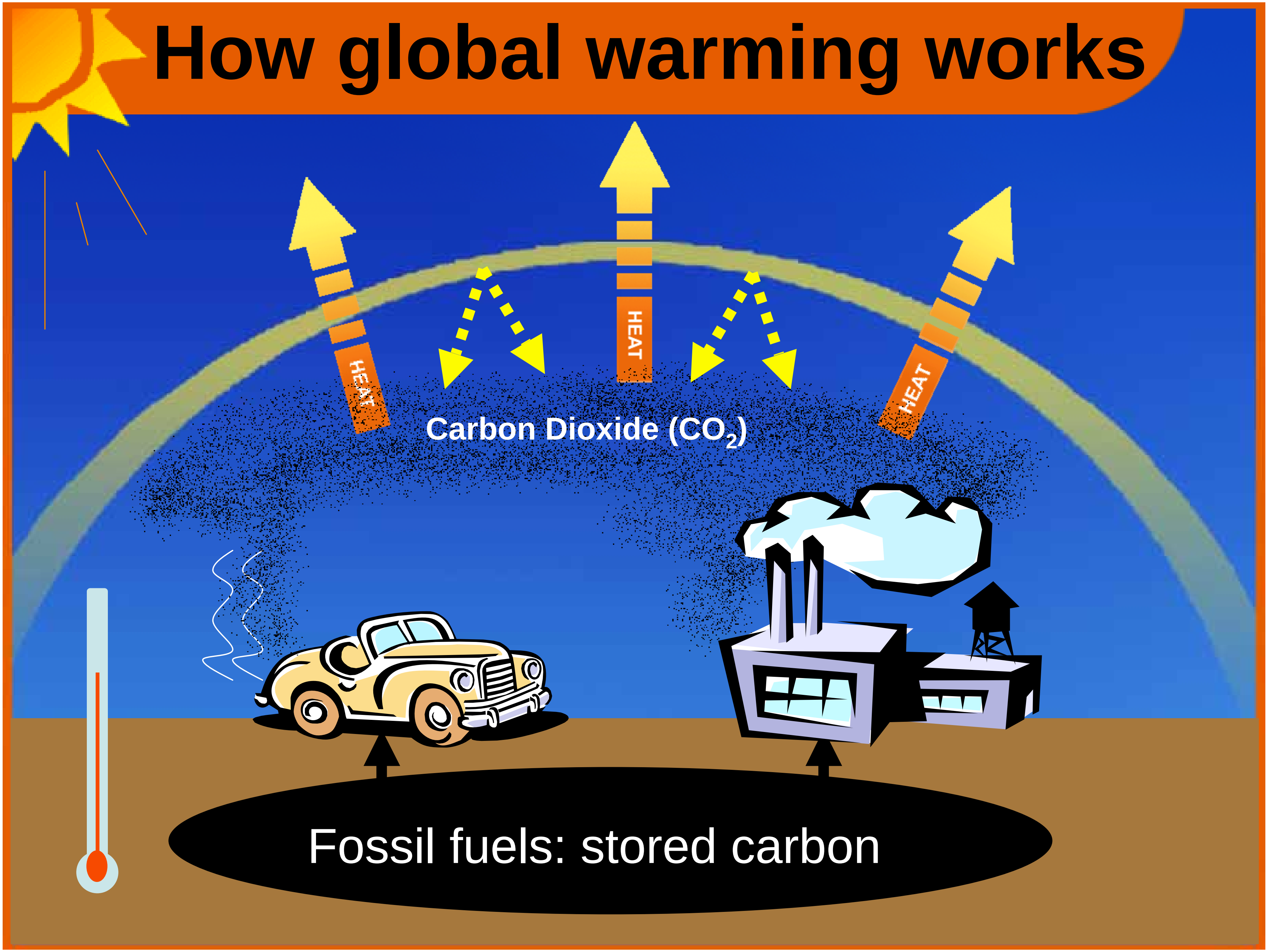
Biggest Problem

CLIMATE CHANGE

Caused by the Use of All Fossil Fuels
(Coal, Oil and Natural Gas)

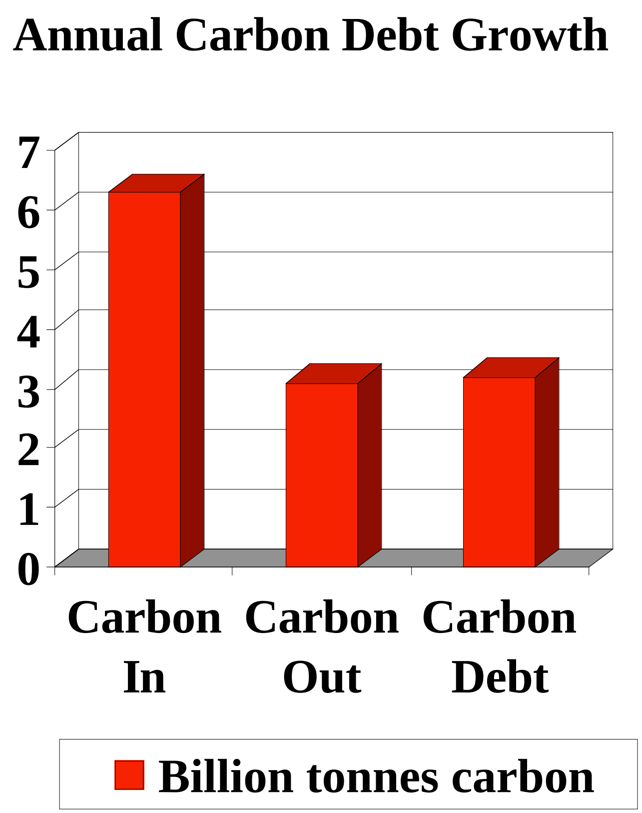
The problem in a nutshell

- The disruption of global climate by human-produced greenhouse gases (GHG) in the atmosphere is beginning to be understood by publics and policy makers alike as the most dangerous and intractable of all the environmental problems caused by human activity.
- It is the most dangerous because climate is the "envelope" within which all other environmental conditions and processes operate. Distortions of this envelope of the magnitude that are in prospect are likely to so badly disrupt these conditions and processes as to impact adversely every dimension of human well-being that is tied to environment – which is most of them.


How global warming works
HEAT
HEAT
HEAT
Carbon Dioxide (CO_2)
Fossil fuels: stored carbon

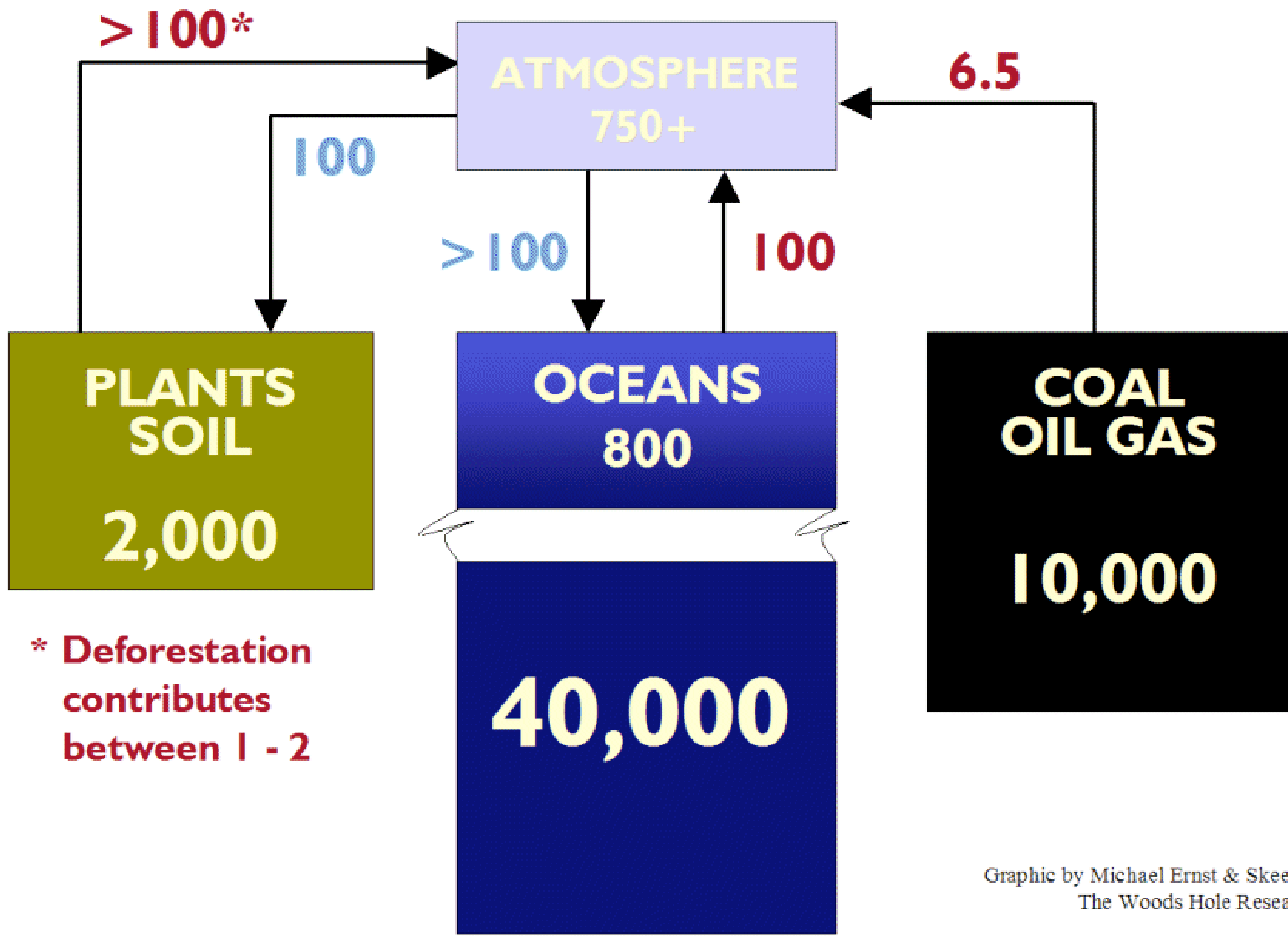
Carbon deficit spending—Do the math

- Energy carbon emissions in year 2000 = 6.3 billion metric tons
- Removal to oceans, soils, trees = 3.1 billion metric tons
- Net buildup in air = 3.2 billion metric tons



Global Flows of Carbon

(Petagrams of Carbon/Year)



Graphic by Michael Ernst & Skee Houghton
The Woods Hole Research Center

CO_2 Concentrations

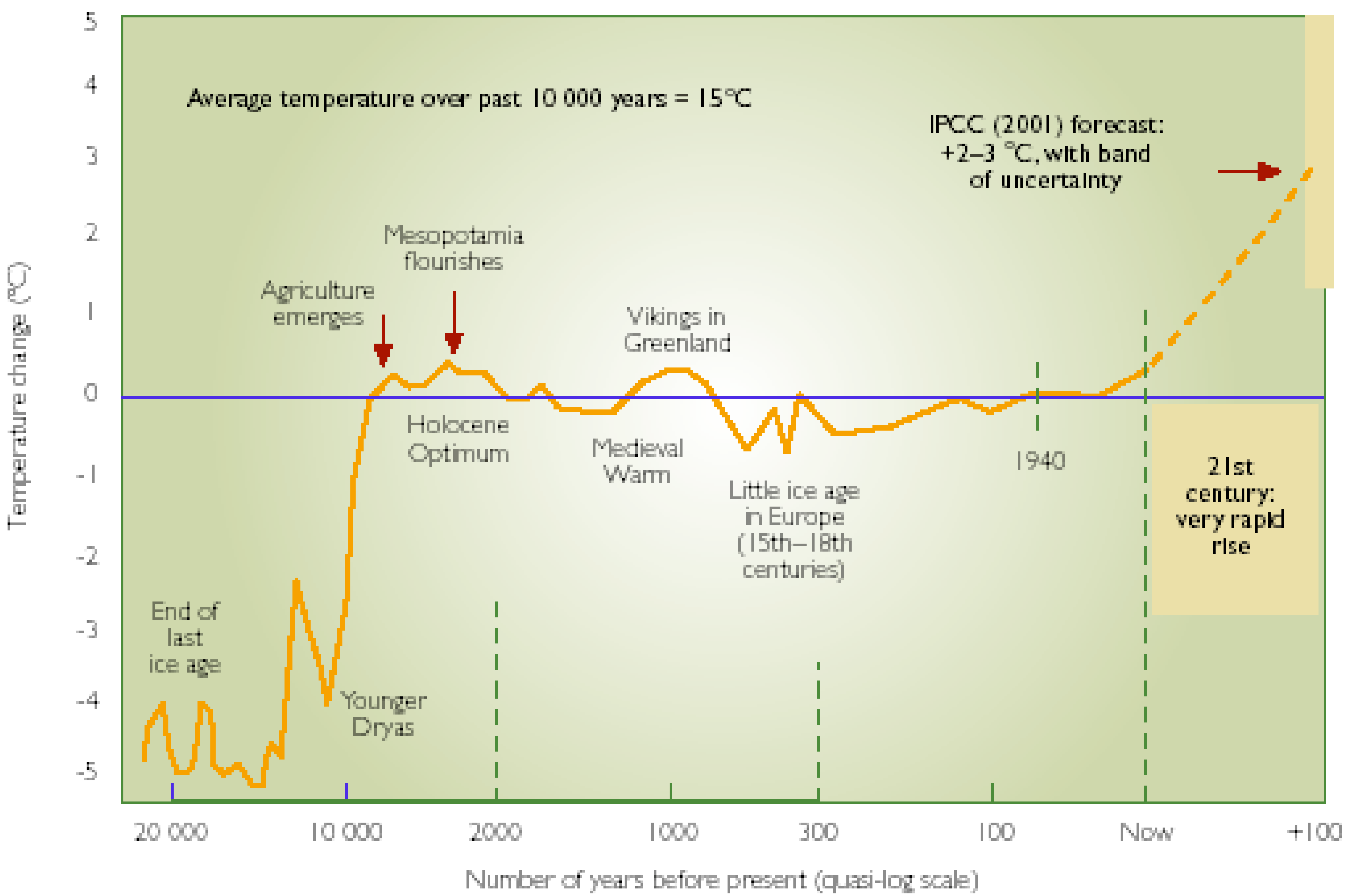
- Each 2.12 billion metric tons of net carbon (GtC) retained in the atmosphere adds 1 parts per million (ppm) by volume to the concentration of CO_2 in the atmosphere.

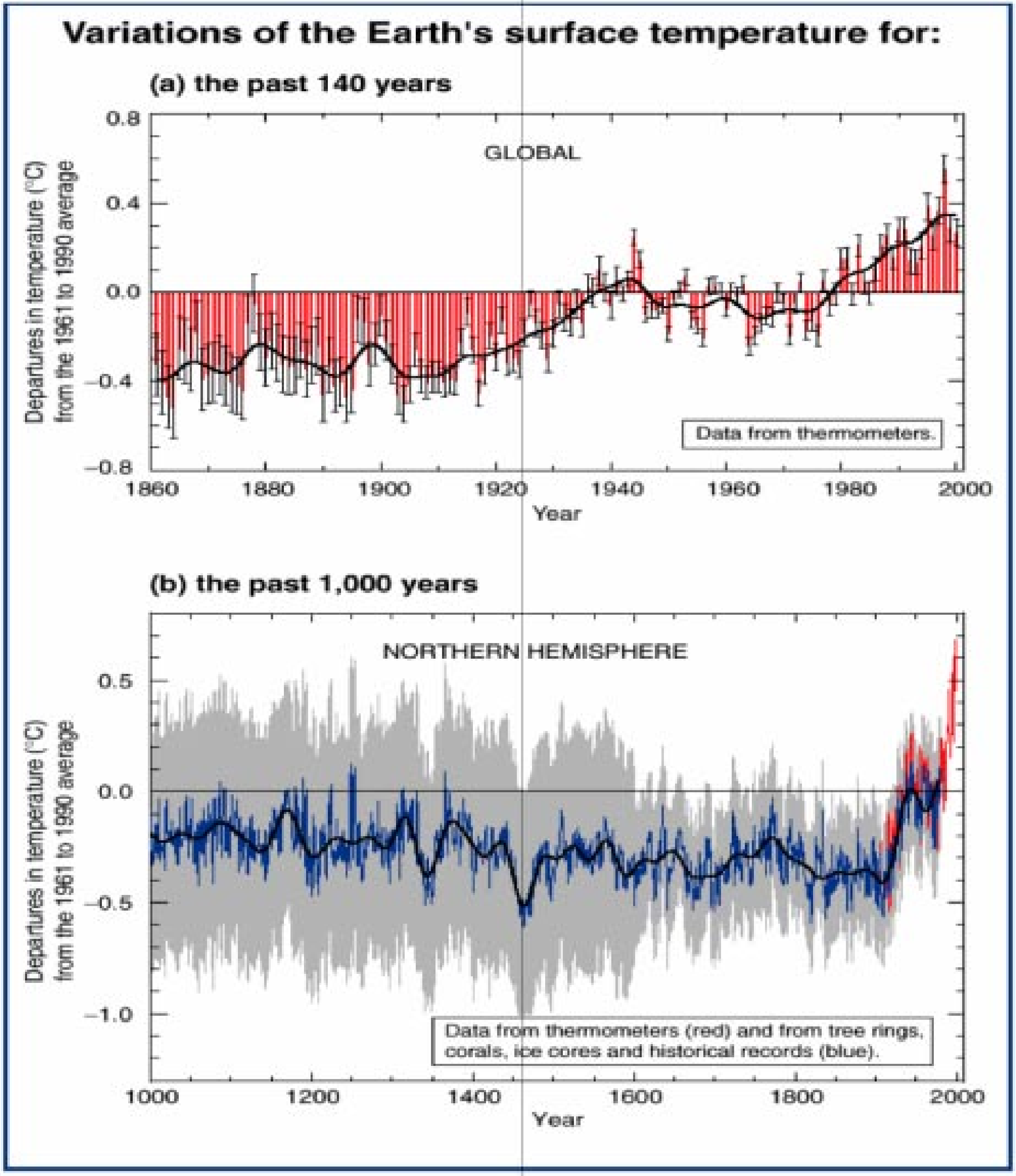
- The pre-industrial level of CO_2 in the atmosphere was 280 ppm.

- Today the concentration is about 380 ppm.

- The concentration of CO_2 in the atmosphere today has not been exceeded for at least the last 420,000 years and probably not for the last 20 million years.

Figure 1.1. Variations in Earth's average surface temperature, over the past 20,000 years



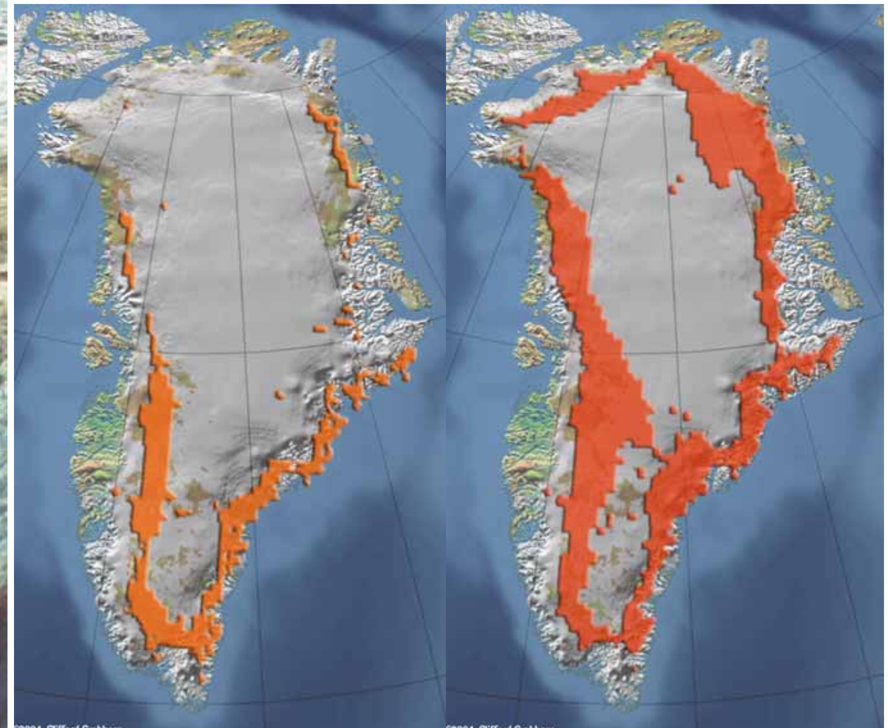

Variations of the Earth's surface temperature for:
(a) the past 140 years
GLOBAL
Departures in temperature (°C) from the 1961 to 1990 average
0.8
0.4
0.0
−0.4
−0.8
Data from thermometers.
1860
1880
1900
1920
1940
1960
1980
2000
Year
(b) the past 1,000 years
NORTHERN HEMISPHERE
Departures in temperature (°C) from the 1961 to 1990 average
0.5
0.0
−0.5
−1.0
Data from thermometers (red) and from tree rings, corals, ice cores and historical records (blue).
1000
1200
1400
1600
1800
2000
Year

The ice caps are melting

NRDC
THE EARTH'S BEST DEFENSE

Greenland glaciers are slipping

Melt Area



1992 2002

NRDC
THE EARTH'S BEST DEFENSE

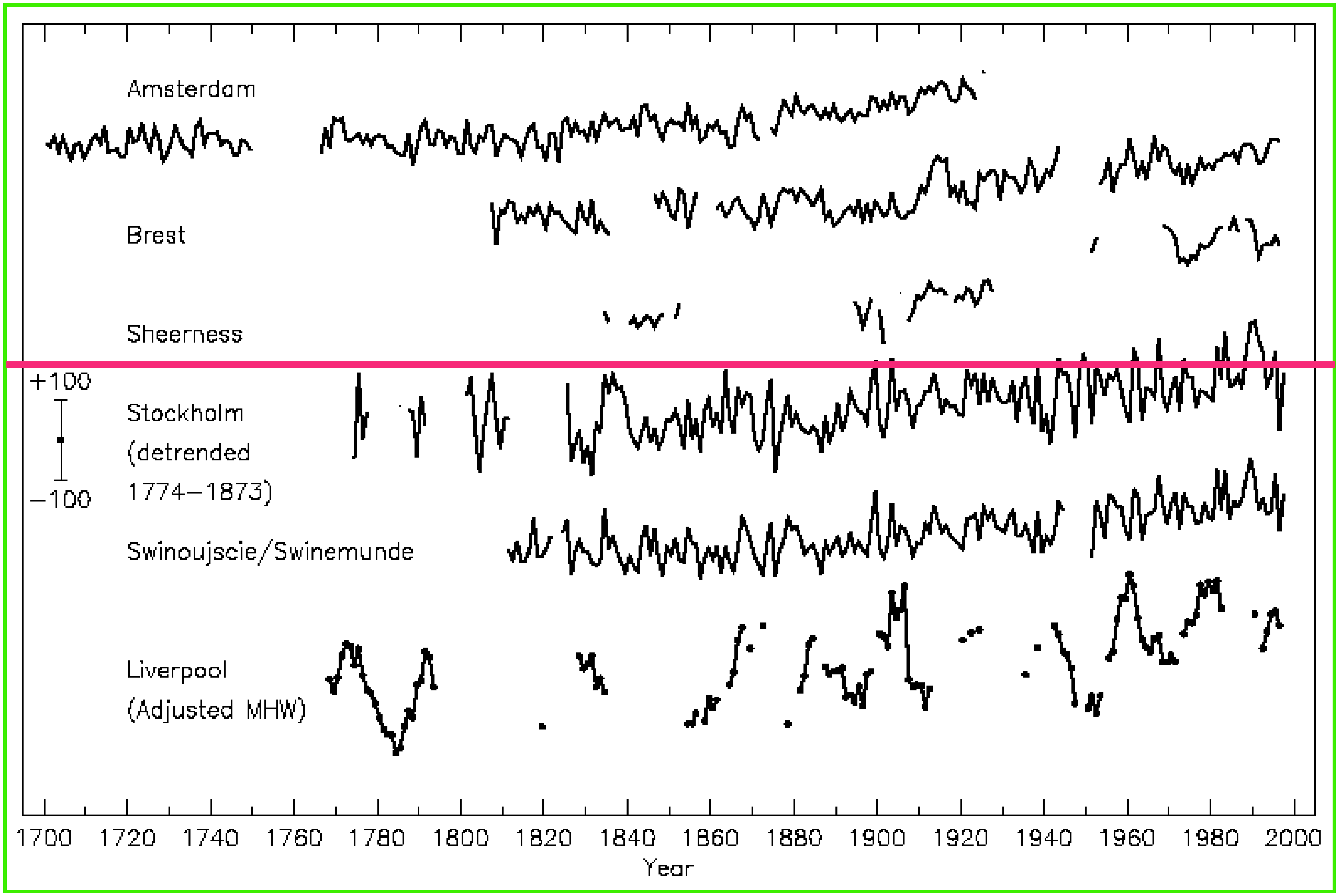
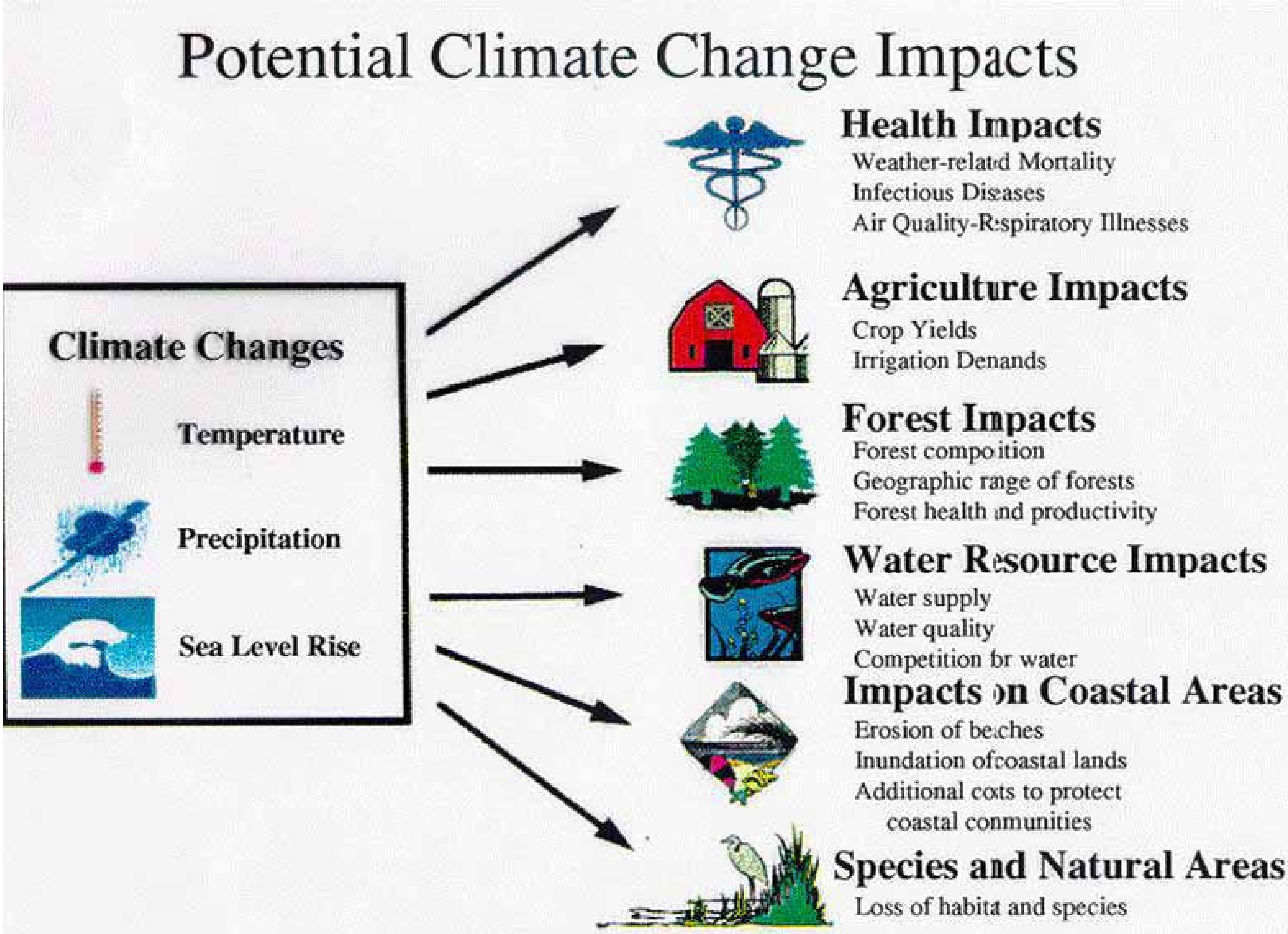


Figure 6: Time-series of relative sea level for the past 300 years from Northern Europe: Amsterdam, Netherlands; Brest, France; Sheerness, UK; Stockholm, Sweden (detrended over the period 1774 to 1873 to remove to first order the contribution of post-glacial rebound); Swinoujscie, Poland (formerly Swinemunde, Germany); and Liverpool, UK. Data for the latter are of "Adjusted Mean High Water" rather than Mean Sea Level and include a nodal (18.6 year) term. The scale bar indicates ±100 mm. [Based on Figure 11.7]

The gradual rise of sea level is evident in these data, with the red line shown as a horizontal reference. (IPCC)


Potential Climate Change Impacts
Climate Changes
Temperature
Precipitation
Sea Level Rise
Health Impacts
Weather-relatd Mortality
Infectious Diseases
Air Quality-Respiratory Illnesses
Agriculture Impacts
Crop Yields
Irrigation Denands
Forest Impacts
Forest compoition
Geographic rage of forests
Forest health and productivity
Water Resource Impacts
Water supply
Water quality
Competition br water
Impacts on Coastal Areas
Erosion of beaches
Inundation ofcoastal lands
Additional costs to protect coastal communities
Species and Natural Areas
Loss of habita and species

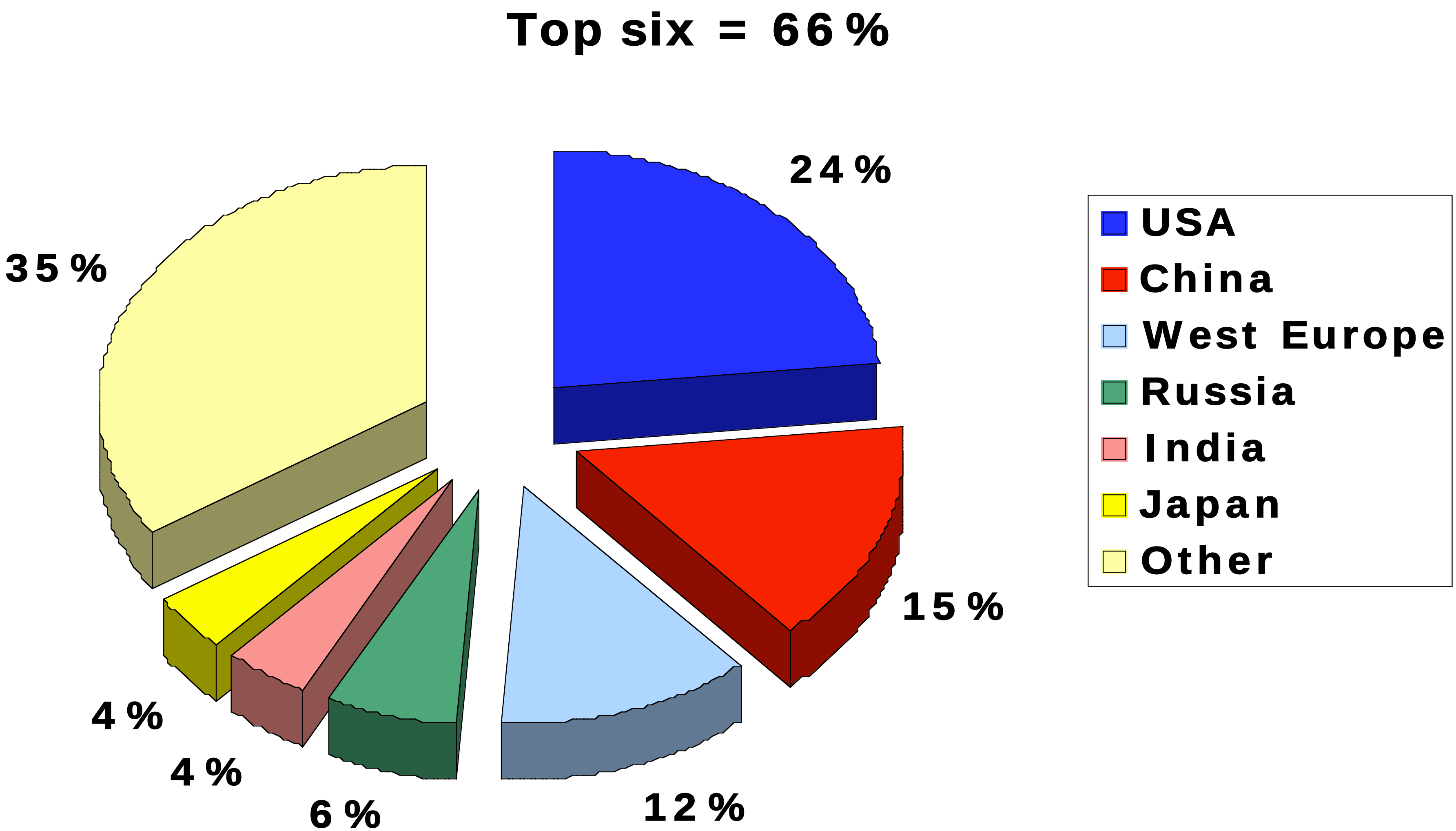
Diseases are spreading

Disease	*Vector*	*Population at risk (millions)*	*Present distribution*	*Likelihood of altered distribution with warming*
Malaria	mosquito	2,100	(sub)tropics	✓✓
Schistosomiasis	water snail	600	(sub)tropics	✓✓
Filariasis	mosquito	900	(sub)tropics	✓
Onchocerciasis (river blindness)	black fly	90	Africa/Latin America	✓
African trypanosomiasis (sleeping sickness)	tsetse fly	50	tropical Africa	✓
Dengue	mosquito	unavailable	tropics	✓✓
Yellow fever	mosquito	unavailable	tropical South America & Africa	✓

Likely ✓
Very likely ✓✓

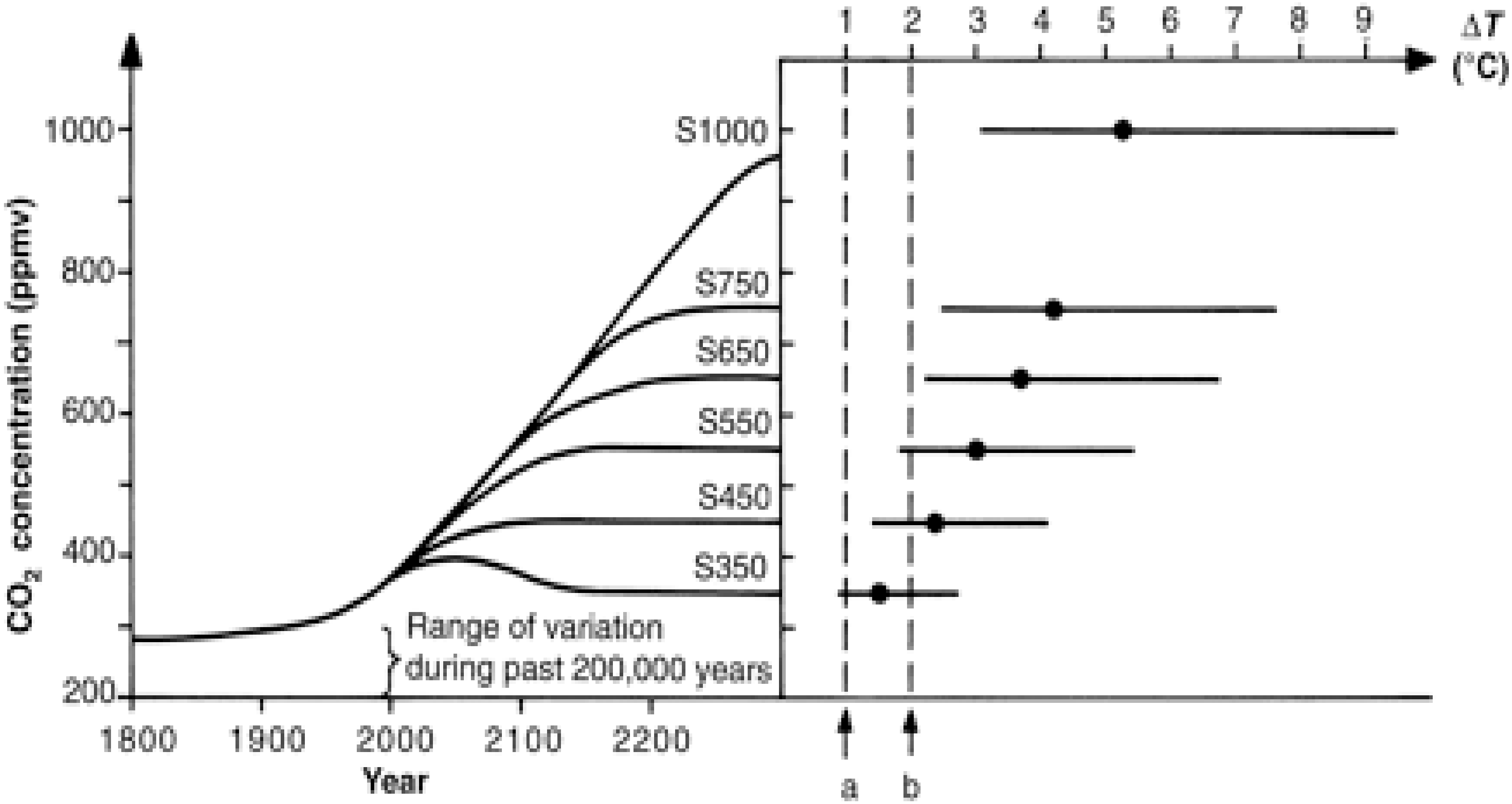
Source: Modified WHO, as cited in Stone (1995).

Biggest Emitters 2000-2025



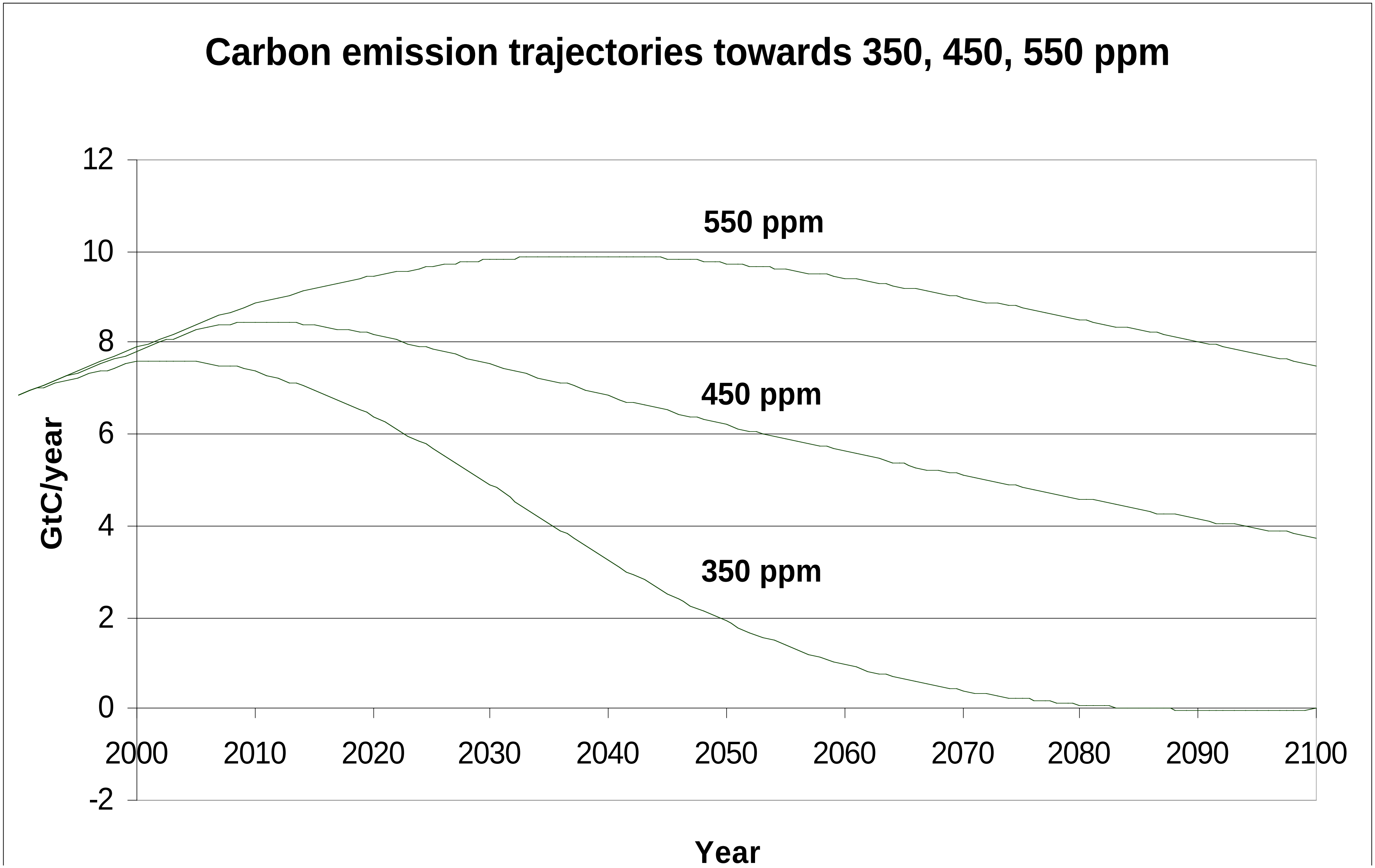
Cumulative CO2 Emissions 2000-2025, EIA, *IEA 2002*

To prevent the mean global temperature from rising more than 2 ^{o}C above pre-industrial level the atmospheric concentration of CO_2 will have to be stabilized below ~425 ppm.



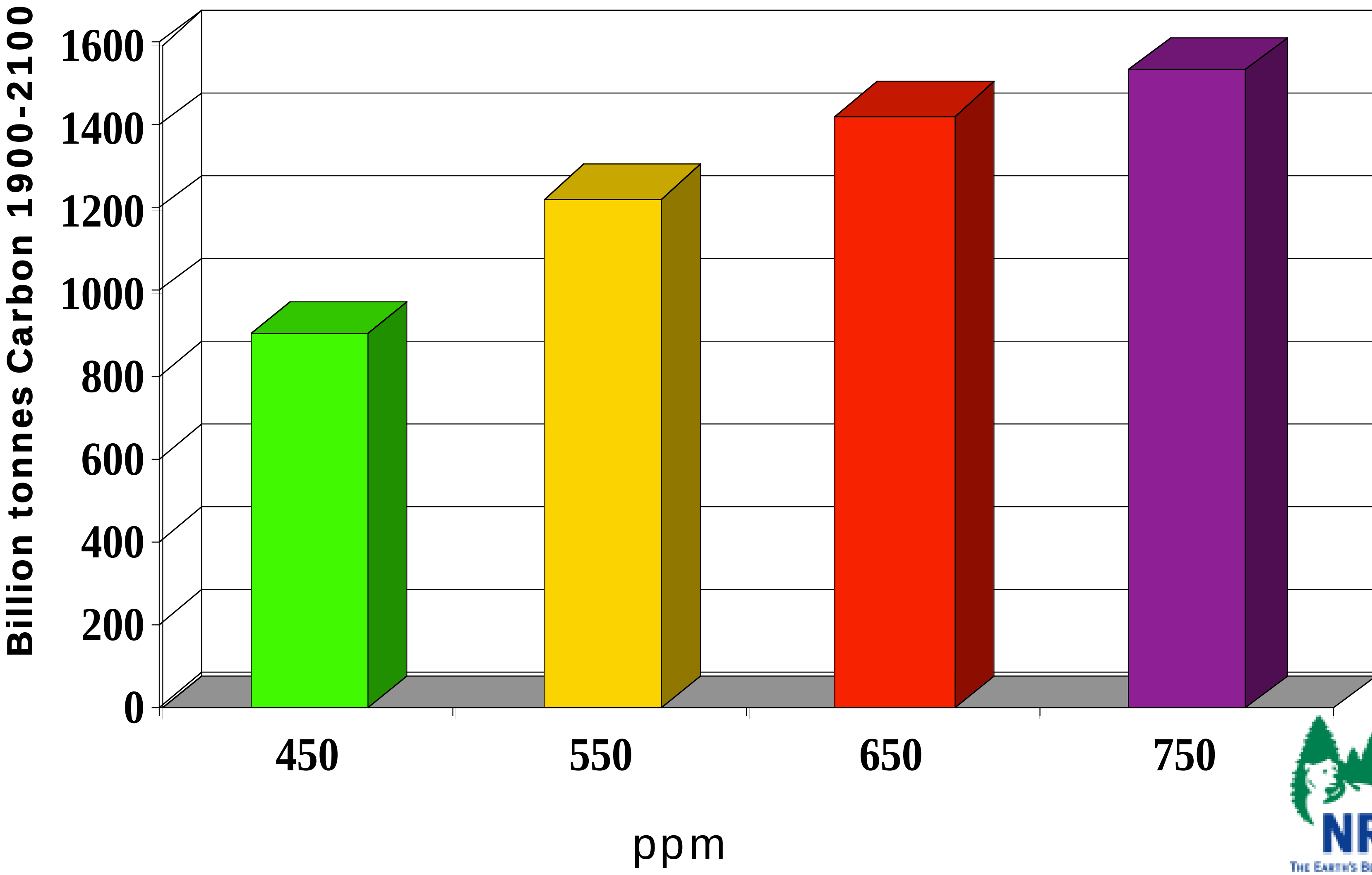
Global average surface equilibrium temperature change for various stabilization targets. Dashed line *a)* refers to an estimate of the maximum natural variability of the global temperature over the past millennium, and dashed line *b*) shows the 2°C temperature target.

Source: Azar, C., & Rodhe, H., 1997. Targets for Stabilization of Atmospheric CO2. *Science* **276**, 1818-1819.

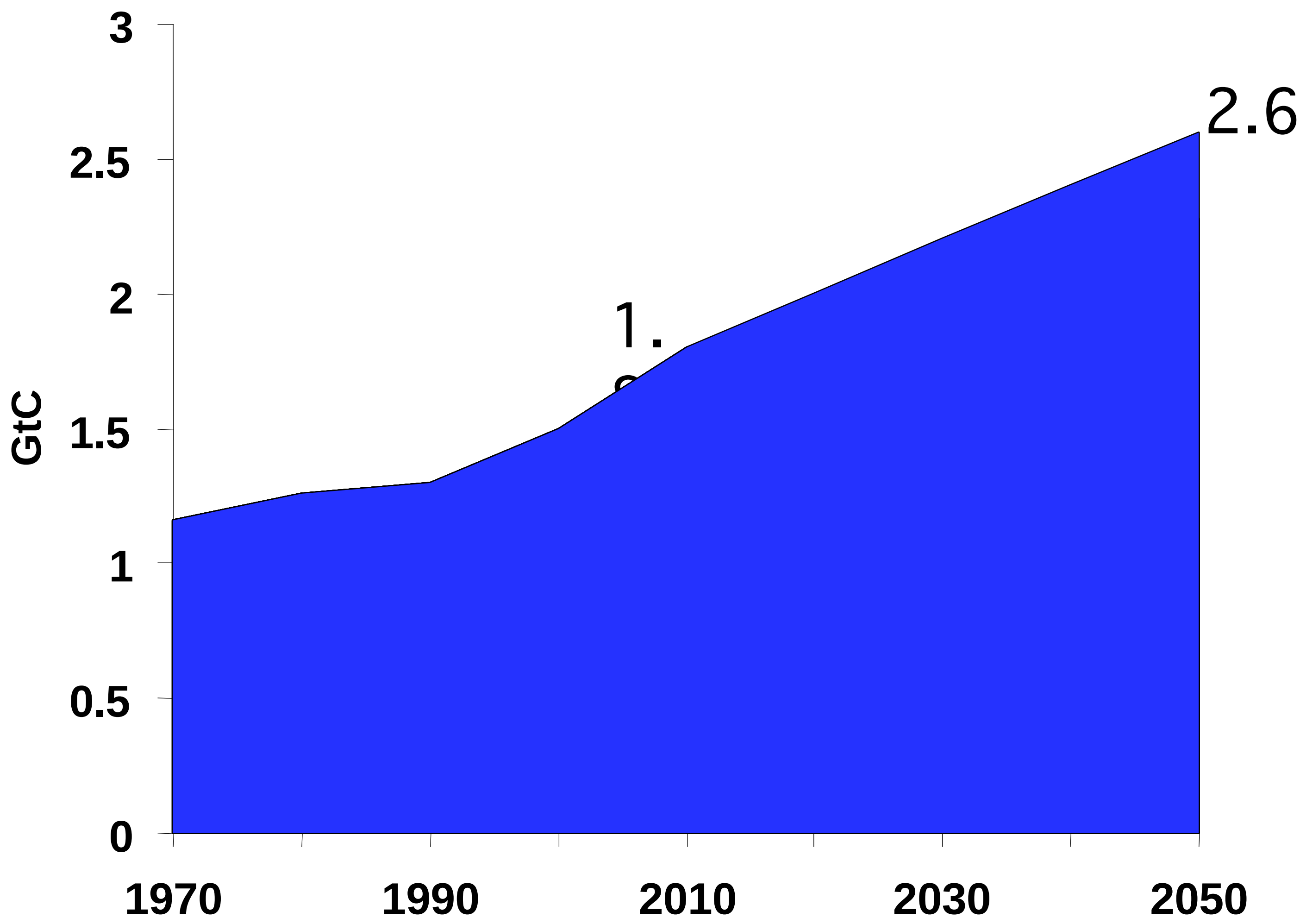


Carbon emission trajectories towards 350, 450, 550 ppm
550 ppm
450 ppm
350 ppm
GtC/year
12
10
8
6
4
2
0
-2
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year

Emission budgets are needed

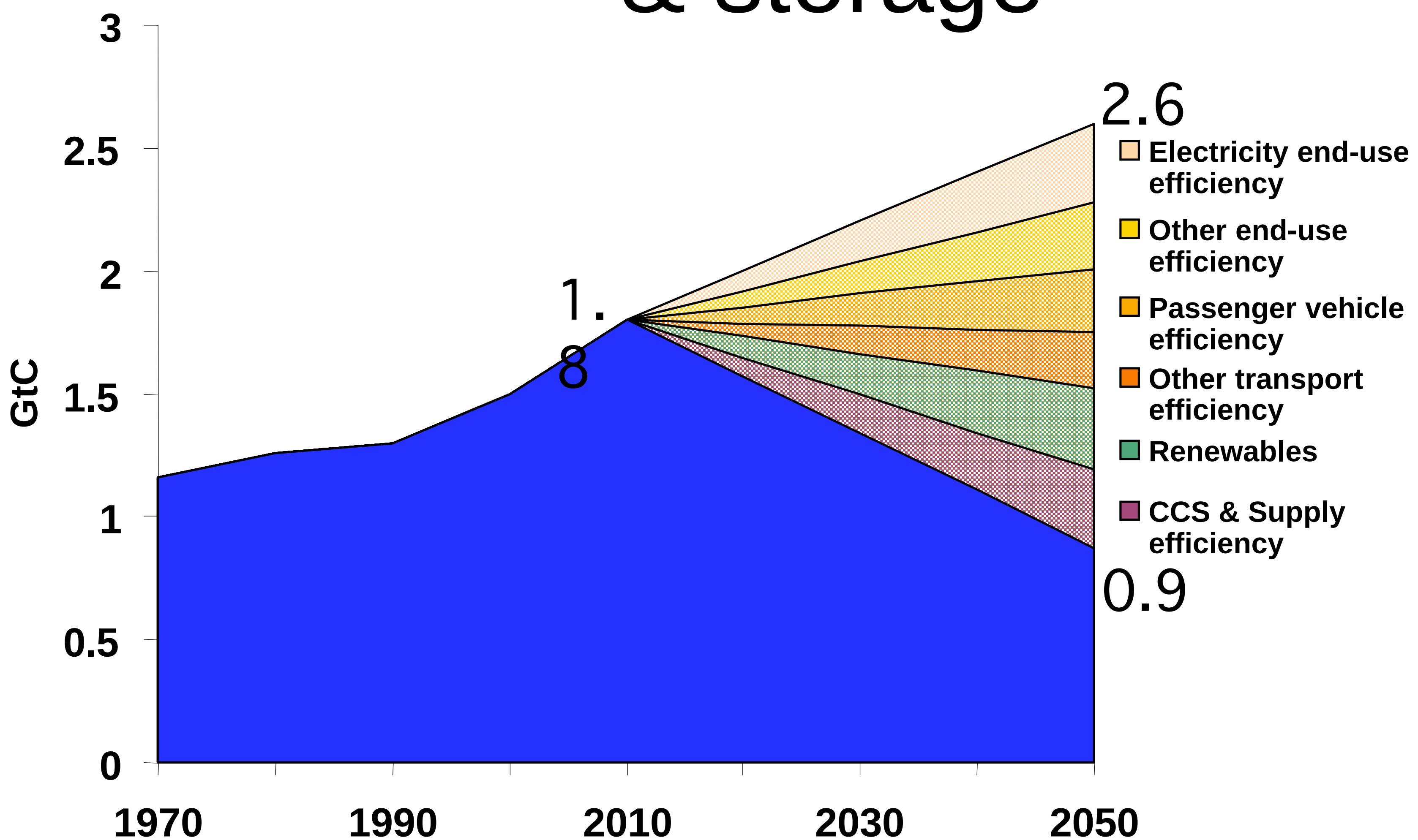


U.S. Emissions: Business as Usual



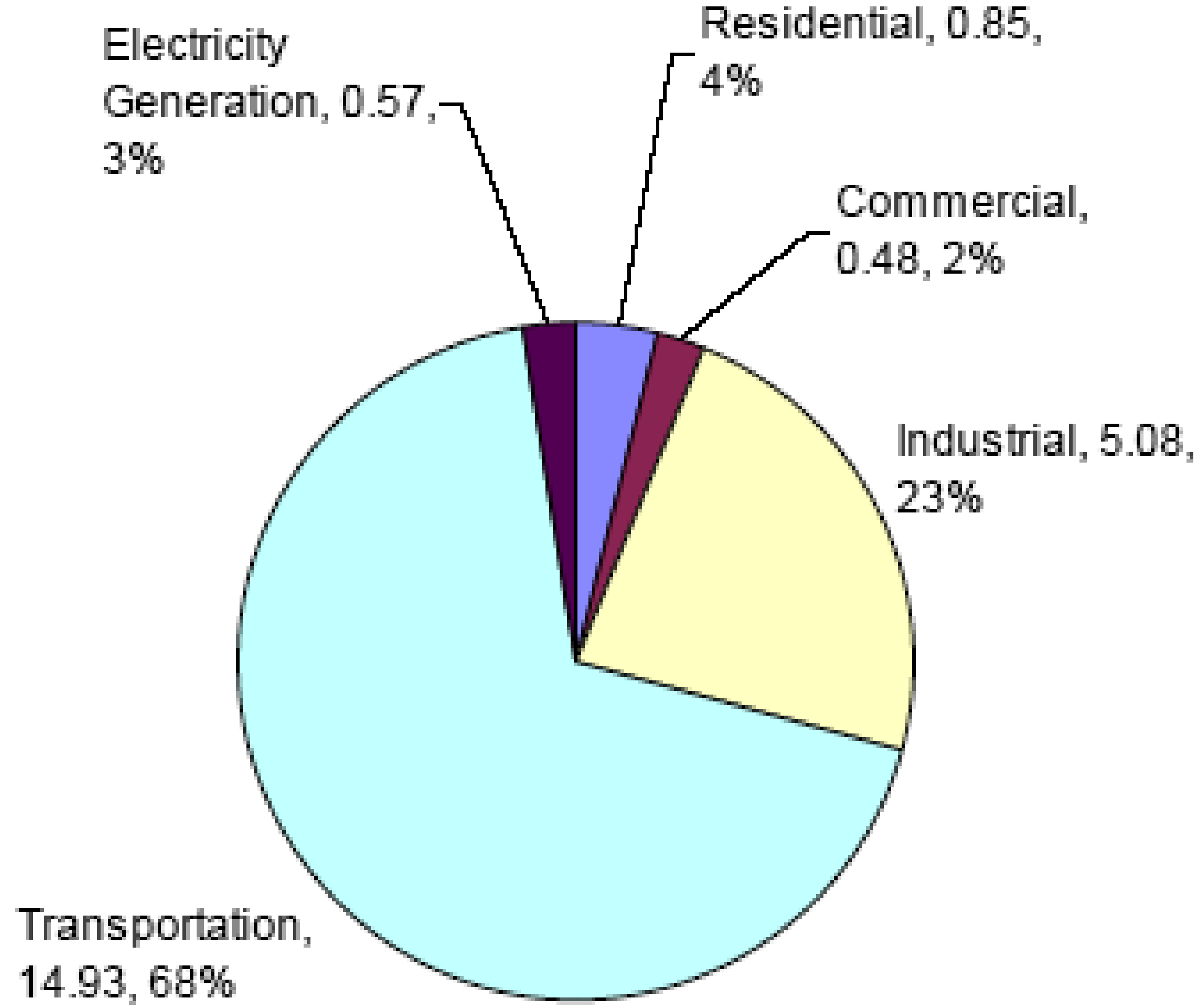
After Pacala and Socolow, 2004; ARI CarBen3

U.S. Emissions: Carbon capture & storage

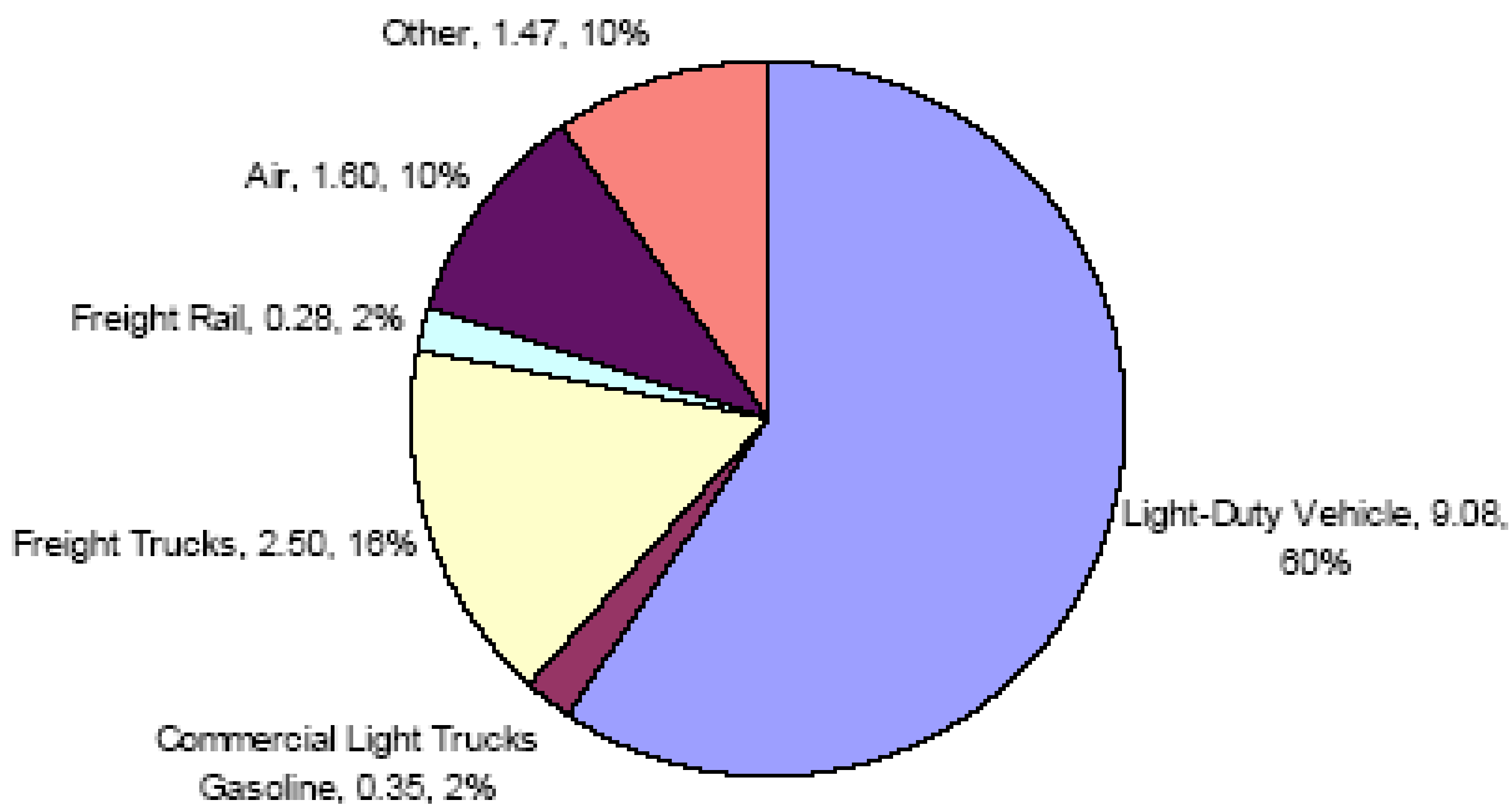


After Pacala and Socolow, 2004; ARI CarBen3

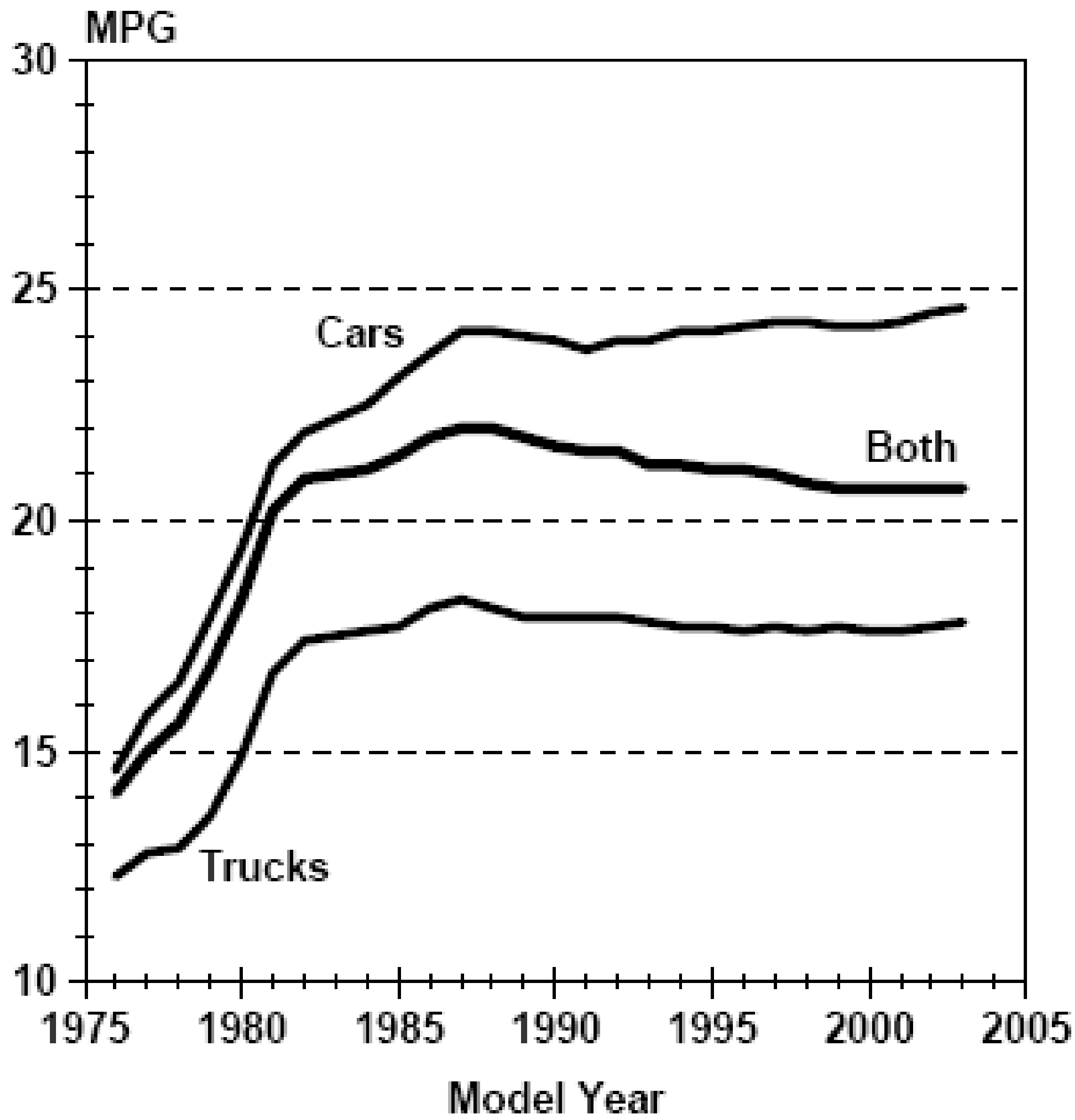
Petroleum Consumption by Sector (mbd, % of total), 2003



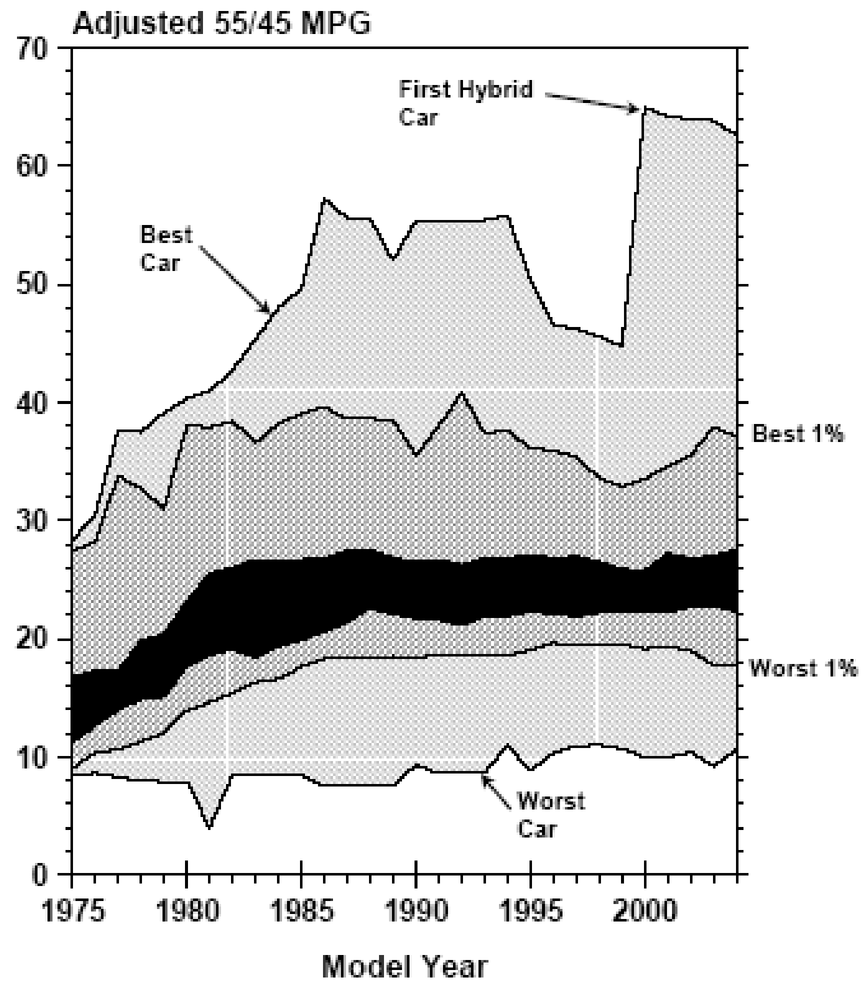
Transportation Sector Petroleum Consumption (mbd, % of total), 2003



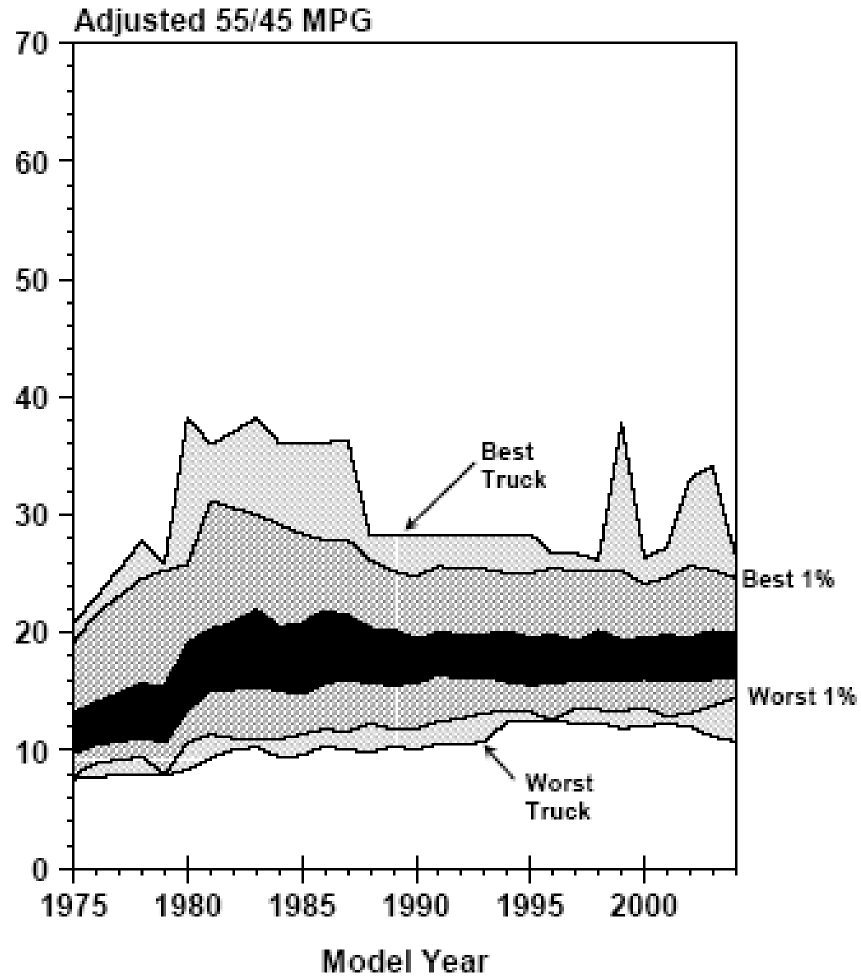
Adjusted Fuel Economy by Model Year
(Three-Year Moving Average)



Sales Weighted Car Fuel Economy Distribution



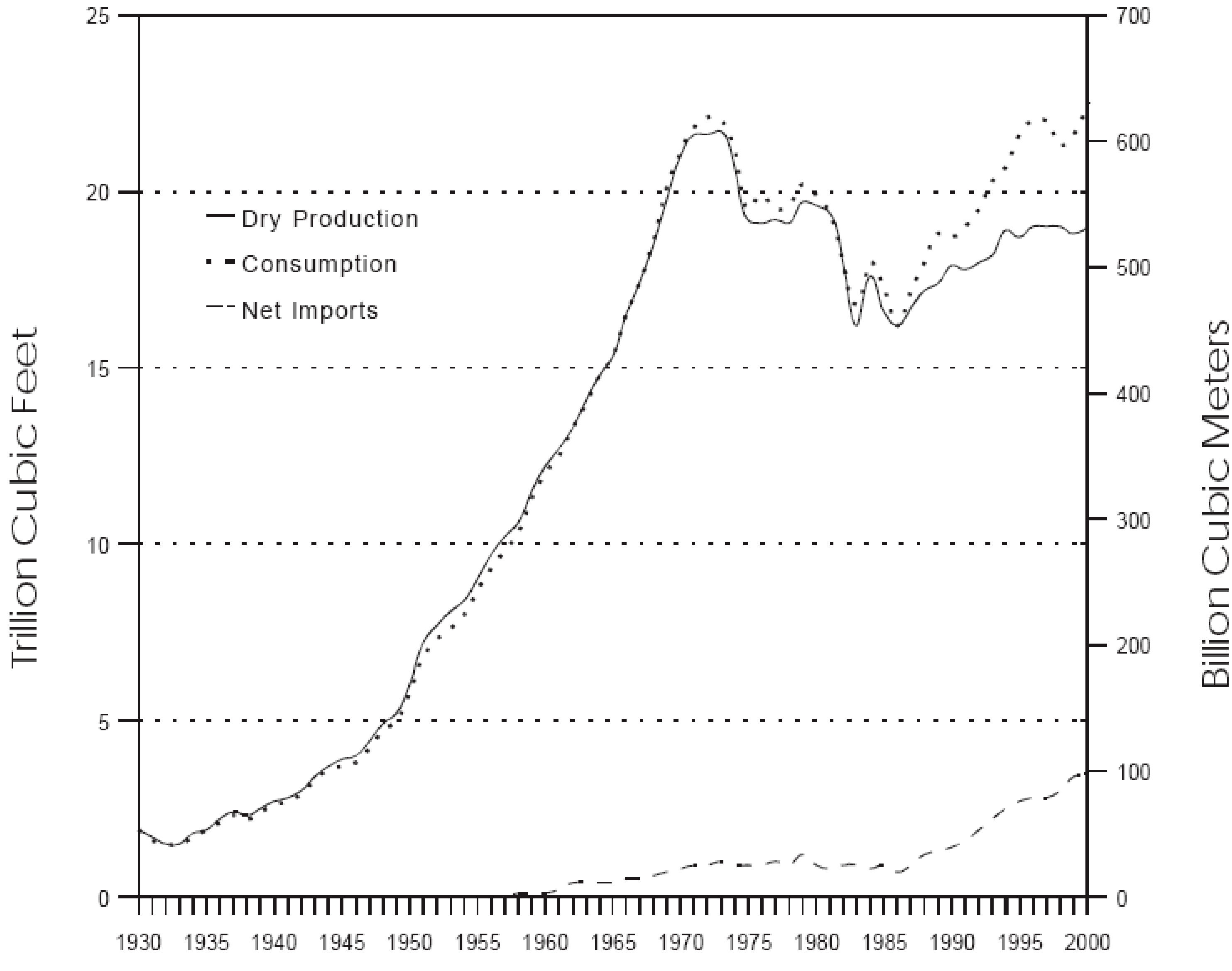
Sales Weighted Truck Fuel Economy Distribution



Technologically Achievable Oil Savings (million barrels per day)

Oil Savings Measures	2015	2025
Raise fuel efficiency in new passenger vehicles through tax credits and standards	1.6	4.9
Accelerate oil savings in motor vehicles through		
fuel efficient replacement tires and motor oil	0.5	0.6
efficiency improvements in heavy-duty trucks	0.5	1.1
Accelerate oil savings in industrial, aviation, and residential sectors	0.3	0.7
Encourage growth of biofuels industry through demonstration and standards	0.3	3.9
Total Oil Saved	**3.2**	**11.2**

Natural Gas



Trillion Cubic Feet
Billion Cubic Meters
Dry Production
Consumption
Net Imports
25
20
15
10
5
0
700
600
500
400
300
200
100
0
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000

NATURAL GAS

- Issue new standards for energy-efficient heating and cooling equipment.
- Do not drill in sensitive offshore areas, including moratorium areas, Alaska, and the eastern Gulf of Mexico; rather maintain existing protections for sensitive onshore public lands and extend protection to other special places.
- Construct an Alaska gas pipeline to deliver Prudhoe Bay gas to the lower 48 states that follows the Trans-Alaska Pipeline System and the Alaska-Canadian Highway.

COAL

- Mining
  - Black lung and other respiratory disease
  - Mine accidents
  - Mountaintop removal—stream pollution
- Power Plant Emissions
  - CO_2—climate change
  - SO_2—acid rain, fine particulates and ozone
  - NO_x—fine particulates and ozone
  - mercury—neurotoxin

Nuclear Economics

- Existing nuclear plants can compete favorably with fossil-fueled plant today because of their low operation and maintenance (O&M) and fuel costs.

- New nuclear power plants are uneconomical today because of their high construction costs.

- There have been no successful nuclear plant orders in the U.S. since 1973.

Table 5.1 Costs of Electric Generation Alternatives
Real Levelized Cents/kWe-hr (85% capacity factor)

Base Case	25-YEAR	40-YEAR
Nuclear	7.0	6.7
Coal	4.4	4.2
Gas (low)	3.8	3.8
Gas (moderate)	4.1	4.1
Gas (high)	5.3	5.6
Gas (high) Advanced	4.9	5.1
Reduce Nuclear Costs Cases		
Reduce construction costs (25%).	5.8	5.5
Reduce construction time by 12 months	5.6	5.3
Reduce cost of capital to be equivalent to coal and gas	4.7	4.4

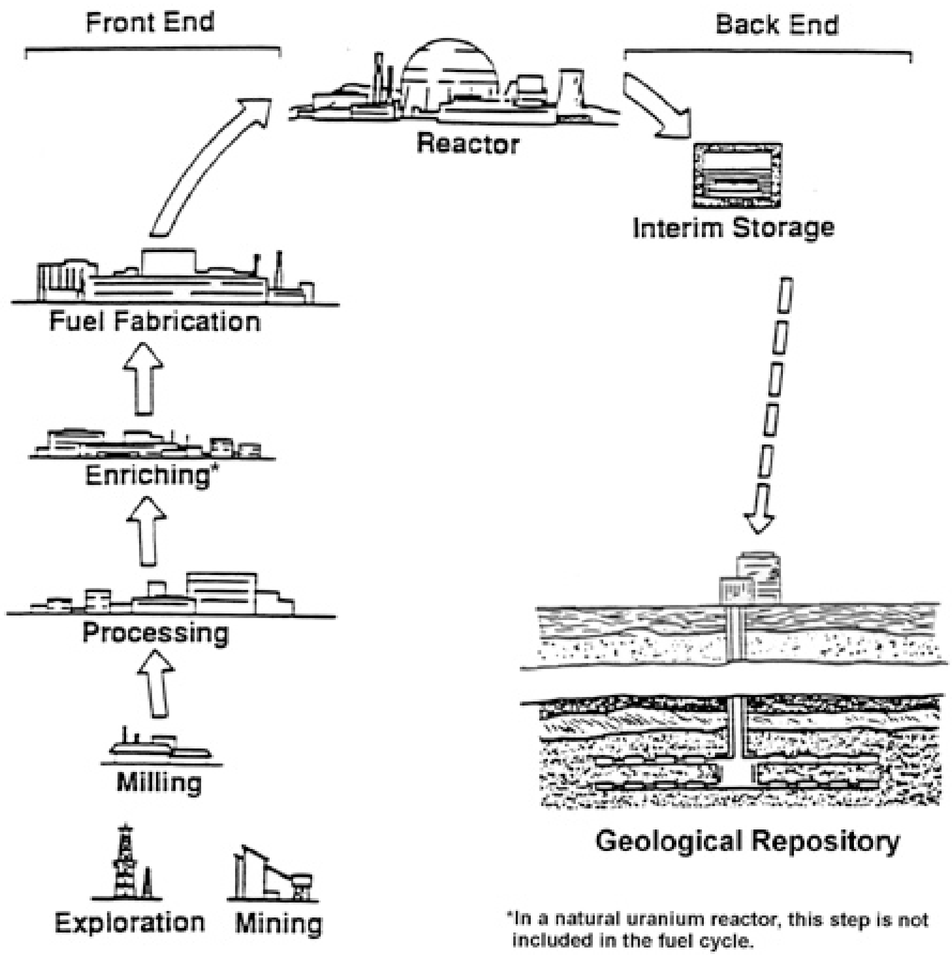
Carbon Tax Cases (25/40 year)

	$50/tC	$100/tC	$200/tC
Coal	5.6/5.4	6.8/6.6	9.2/9.0
Gas (low)	4.3/4.3	4.9/4.8	5.9/5.9
Gas (moderate)	4.6/4.7	5.1/5.2	6.2/6.2
Gas (high)	5.8/6.1	6.4/6.7	7.4/7.7
Gas (high) advanced	5.3/5.6	5.8/6.0	6.7/7.0

Source: MIT Study, “The Future of Nuclear Power,” 2003, p. 42.

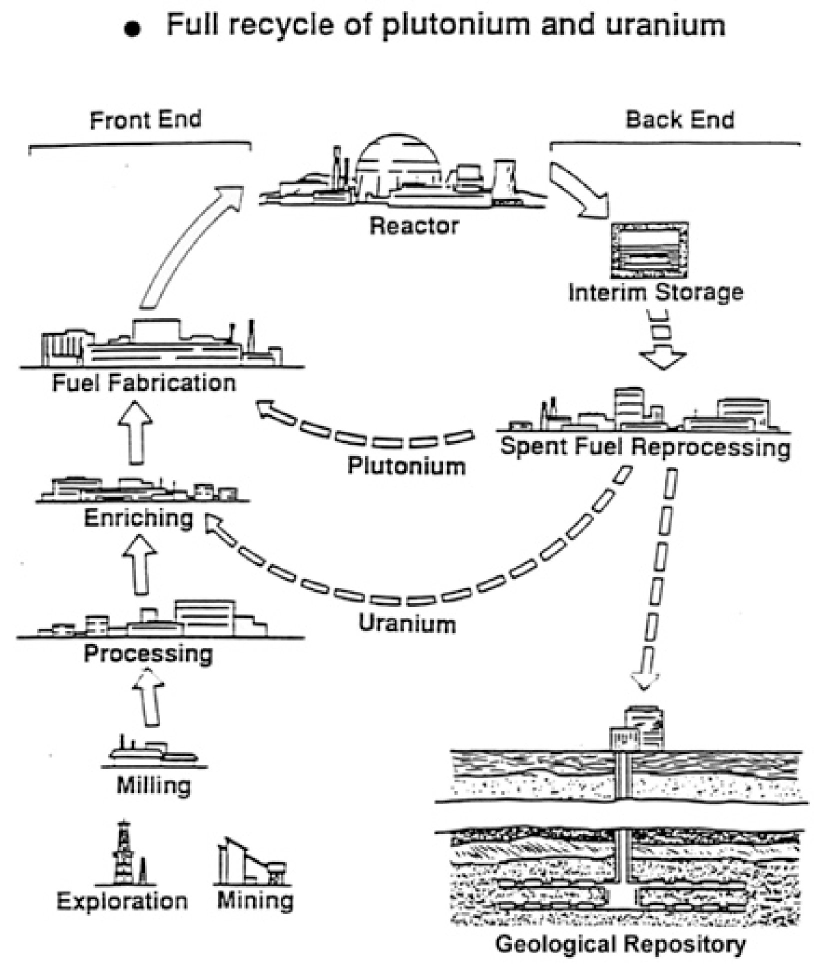
Once-Through, or "Open" Fuel Cycle

- Disposal of spent fuel
- Current policy in U.S.



*In a natural uranium reactor, this step is not included in the fuel cycle.

Closed Fuel Cycle



Proliferation

- Nuclear Power is the only existing energy technology that requires an international safeguards regime.
- As evidenced by Iran and the two Koreas, current IAEA safeguards have major vulnerabilities.
  - The “timely warning criteria” cannot be met if enrichment and reprocessing technologies are operated in non-weapon states.

Nuclear Safety Priorities

- In March 2002, a football-size cavity (created by boric acid corrosion) was discovered in the Davis-Besse reactor vessel head.

- “The fact that (the licensee) sought and the [NRC] staff allowed Davis-Besse to operate past December 31, 2001, without performing these inspections was driven in large part by the desire to lesson the financial impact on (the licensee) that would result in an early shutdown.”

  NRC Inspector General, NRC’s Regulation of Davis Besse Regarding Damage to the Reactor Vessel Head,” Dec. 30, 2002, p. 23.

Yucca Mountain

Yucca's Geologic Media Leaks

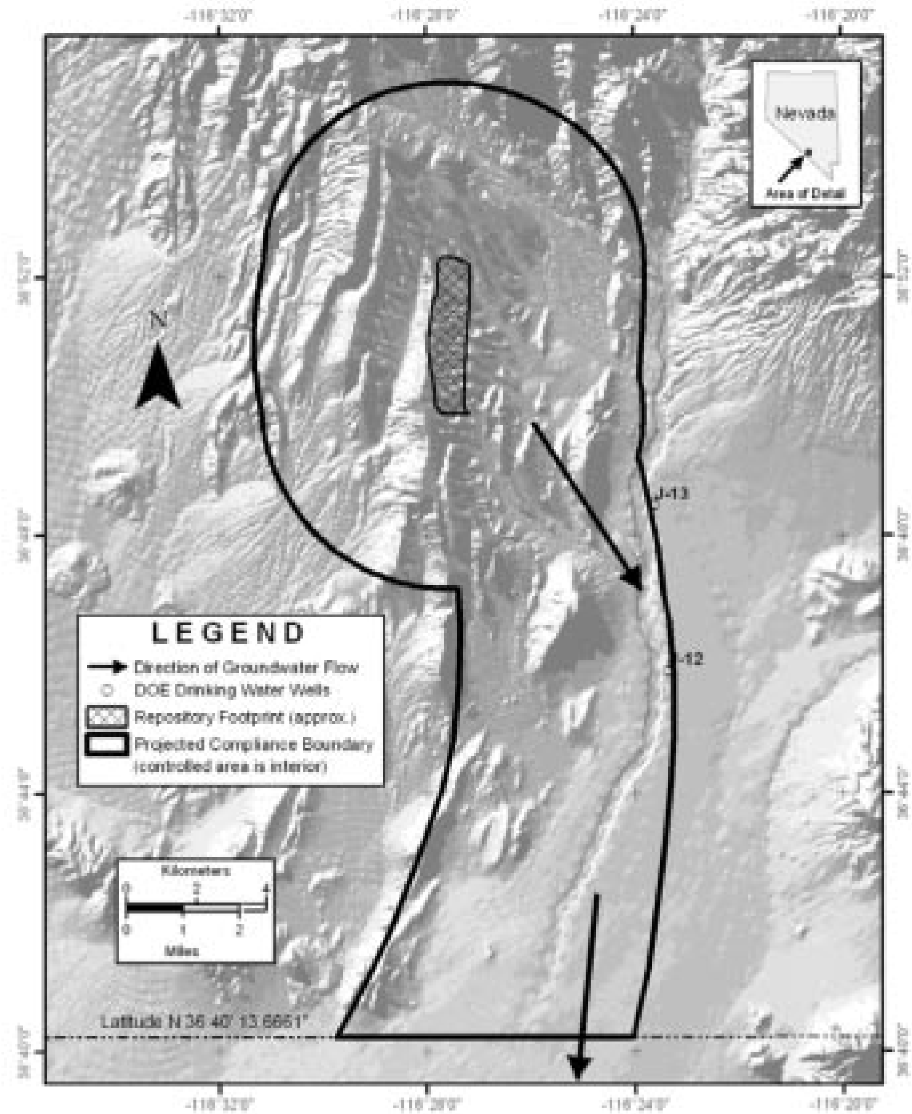
Containment of Radionuclides Relies Primarily on the Engineered Containers

The Government's Solution to a Leaky Repository

- Adjust the EPA licensing criteria to ensure the project can be licensed by:
  - Gerrymandering the control boundary so that dose limits do not have to be met in the radioactive septic field flowing 18 km downstream from the repository; and by
  - Limiting dose calculations to 10,000 years, rather than requiring the geologic site isolate the waste for the length of time it is dangerous.

Projected Groundwater Standards Compliance Boundary for Spread of Radioactive Contamination at the Yucca Mountain Project

Measurement of Radioactive Contamination Takes Place Outside of Controlled Area



NRDC produced this visual representation from the following information:
"The controlled area may extend no more than 5 km in any direction from the repository footprint, except in the direction of groundwater flow. In the direction of groundwater flow, the controlled area may extend no farther south than latitude 36 40' 13.6661" North ... [T]he size of the controlled area may not exceed 300 square km." 66 Fed Reg. at 32117 (June 13, 2001). The direction of groundwater flow is from FEIS (February 2002) at 5-21, Figure 5-3. The repository footprint is from the Yucca Mountain Science and Engineering Report, DOE/RW-0539, at 1-17, Figure 1-3, and the area is approximately 4.27 square km. The area within the projected compliance boundary, as shown in this map, is about 230 square km. The relief image was created from a 1 arc-second Digital Elevation Model from the USGS National Elevation Dataset, April 2002. This map is based on a Nevada State Plane Central projection, North American Datum 1927.