



Climate Change and Renewable Energy

Jimmie Powell—Covanta—February 11, 2009

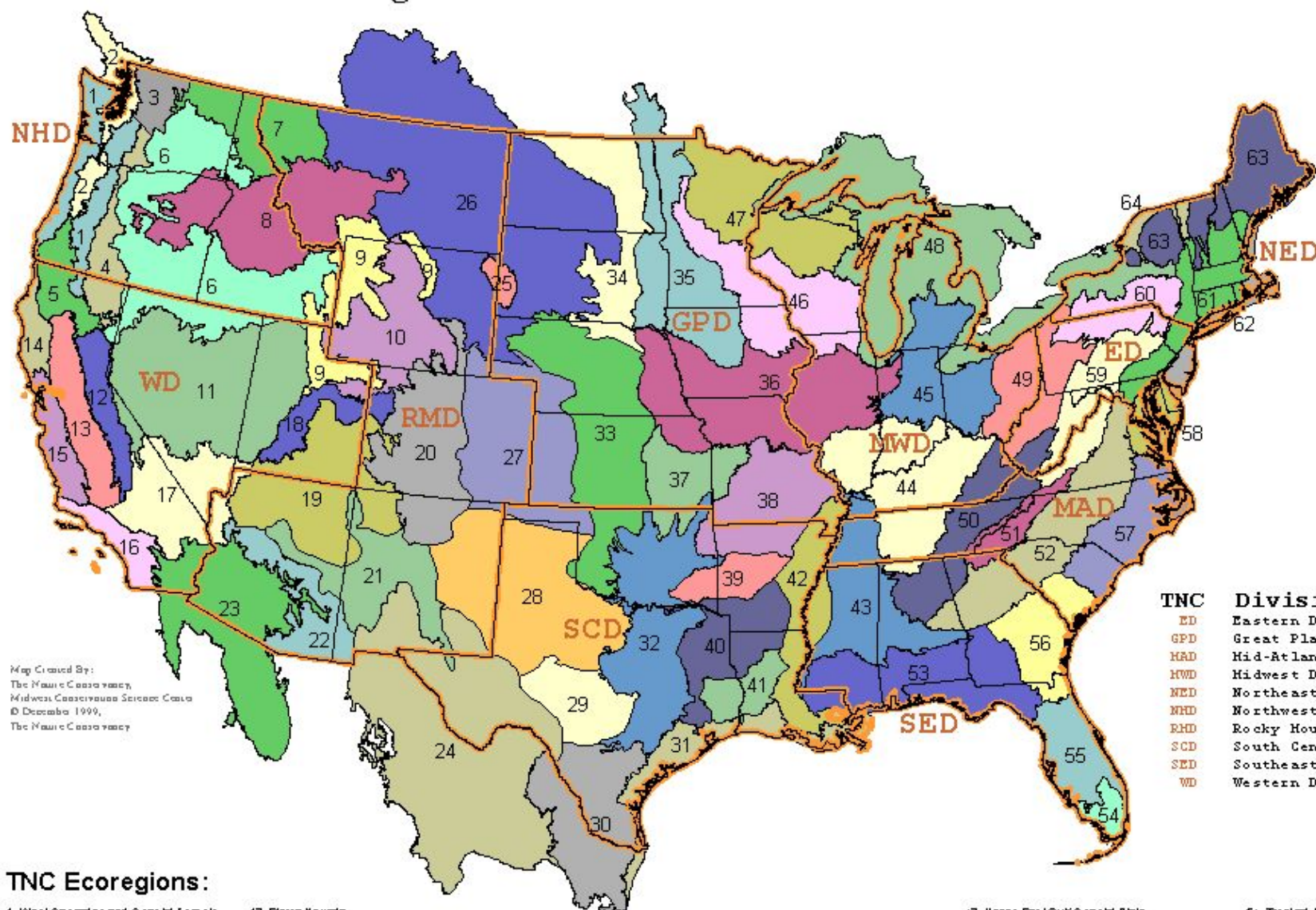
The Nature Conservancy

The mission of The Nature Conservancy is to preserve plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

- Founded in 1953 as a land trust
- All 50 states; 30 countries
- 1400 preserves
- Protected 119 million acres
- Protected 5000 river miles
- 700 scientists
- Natural Heritage programs



TNC Ecoregions and Divisions of the Lower 48 United States



Map Created By:
The Nature Conservancy,
Midwest Conservation Science Center
© December 1999,
The Nature Conservancy

TNC	Divisions:
ED	Eastern Division
GPD	Great Plains Division
MAD	Mid-Atlantic Division
HWD	Midwest Division
NED	Northeast Division
MHD	Northwest & Hawaii Division
RMD	Rocky Mountain Division
SCD	South Central Division
SED	Southeast Division
WD	Western Division

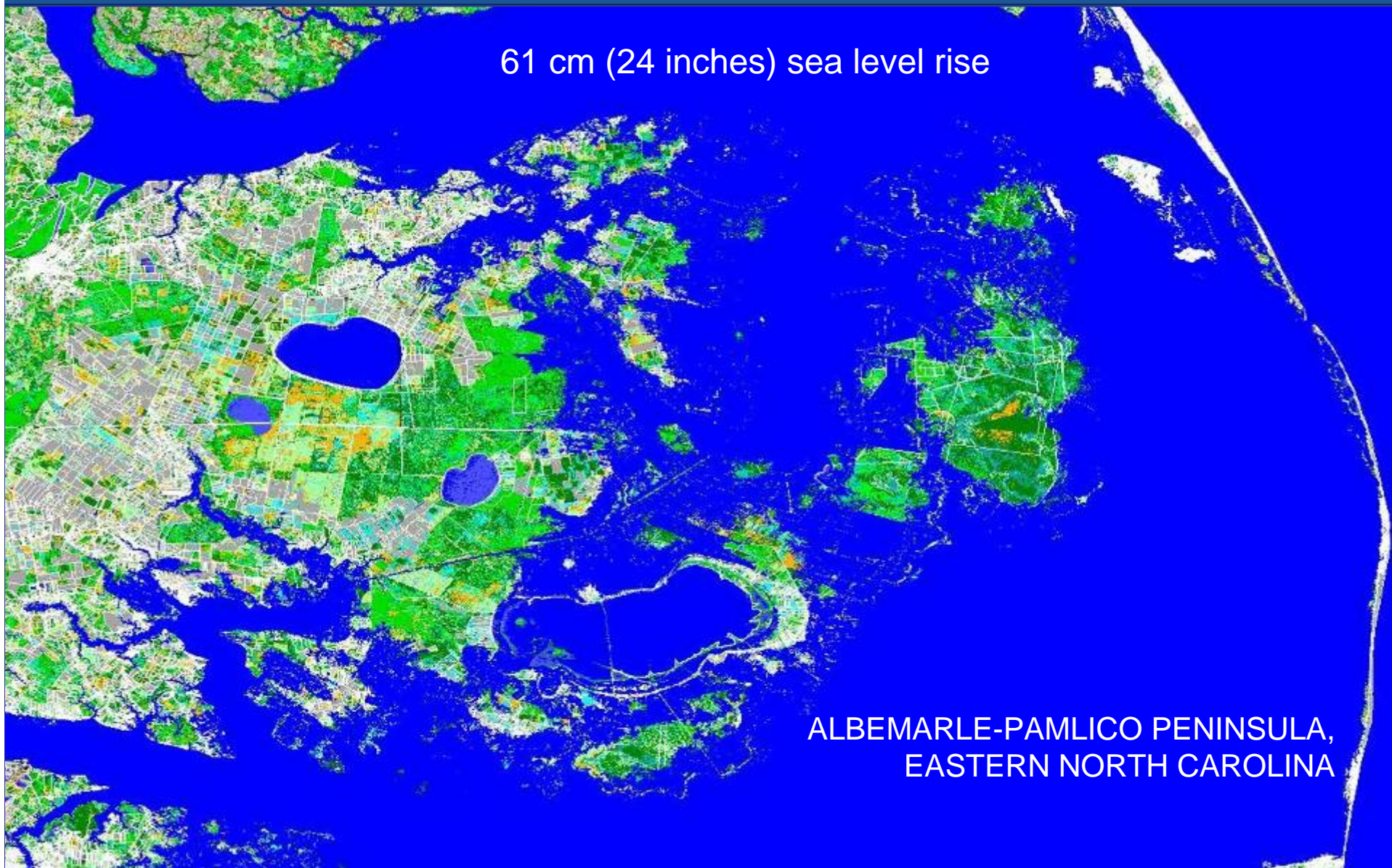
TNC Ecoregions:

- | | | | | | |
|---------------------------------------|---------------------------------|---|-------------------------------------|---|--|
| 1 West Cascades and Coastal Forests | 12 Sierra Nevada | 23 Sonoran Desert | 33 Central Mixed-Grass Prairie | 43 Upper East Gulf Coastal Plain | 54 Tropical Florida |
| 2 Puget Trough and Willamette Valley | 13 Great Central Valley | 24 Chihuahuan Desert | 34 Northern Mixed-Grass Prairie | 44 Interior Low Plateau | 55 Florida Peninsula |
| 3 North Cascades | 14 California North Coast | 25 Black Hills | 35 Northern Tallgrass Prairie | 45 North Central Tillplain | 56 South Atlantic Coastal Plain |
| 4 Modoc Plateau and East Cascades | 15 California Central Coast | 26 Northern Great Plains Steppe | 36 Central Tallgrass Prairie | 46 Prairie-Forest Border | 57 Mid-Atlantic Coastal Plain |
| 5 Klamath Mountains | 16 California South Coast | 27 Central Shortgrass Prairie | 37 Osage Plains/Hill Hills Prairie | 47 Superior Mixed Forest | 58 Chesapeake Bay Lowlands |
| 6 Columbia Plateau | 17 Mojave Desert | 28 Southern Shortgrass Prairie | 38 Ozarks | 48 Great Lakes | 59 Central Appalachian Forest |
| 7 Canadian Rocky Mountains | 18 Utah High Plateaus | 29 Edwards Plateau | 39 Ouachita Mountains | 49 Western Allegheny Plateau | 60 High Allegheny Plateau |
| 8 Middle Rocky Mountain-Blue Mountain | 19 Colorado Plateau | 30 Tamaulipan Thorn Scrub | 40 Upper West Gulf Coastal Plain | 50 Cumberland and Southern Ridge and Valley | 61 Lower New England/Northern Piedmont |
| 9 Utah-Wyoming Rocky Mountains | 20 Colorado Rocky Mountains | 31 Gulf Coast Prairies and Marshes | 41 West Gulf Coastal Plain | 51 Southern Blue Ridge | 62 North Atlantic Coast |
| 10 Wyoming Basins | 21 Arizona-New Mexico Mountains | 32 Cross Timbers and Southern Tallgrass Prairie | 42 Mississippi River Alluvial Plain | 52 Piedmont | 63 Northern Appalachian/Boreal Forest |
| 11 Great Basin | 22 Apache Highlands | | | 53 East Gulf Coastal Plain | 64 St. Lawrence/Champlain Valley |

This map illustrates the Lake Superior region, highlighting the shoreline and the surrounding land. The map is color-coded: green for forested areas, yellow for agricultural or developed land, and blue for water bodies. Numerous locations are labeled, including cities like Duluth, Sault Ste. Marie, and Marquette, as well as various lakes and rivers. The map also shows the international border between the United States and Canada.

Albemarle Peninsula

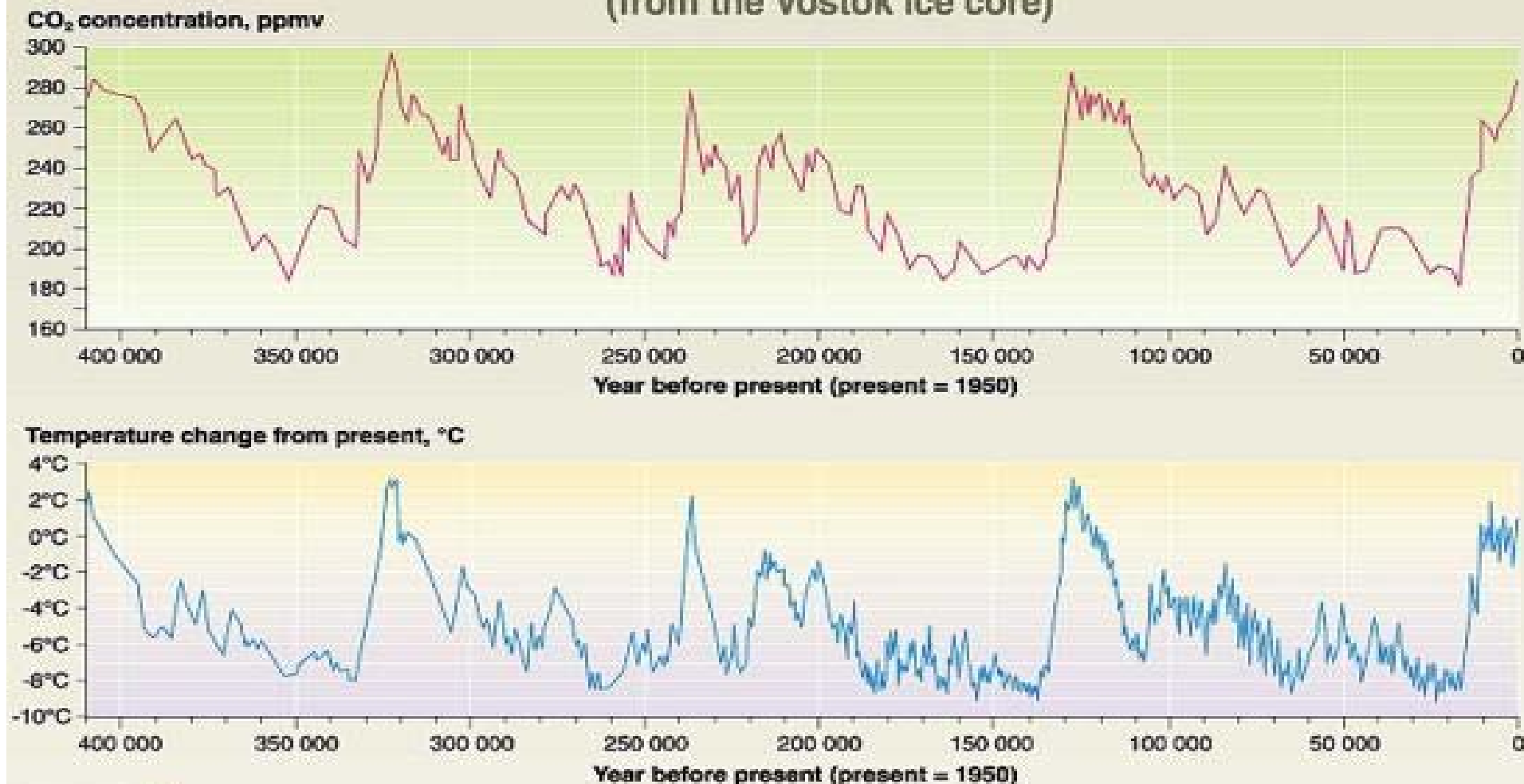
61 cm (24 inches) sea level rise



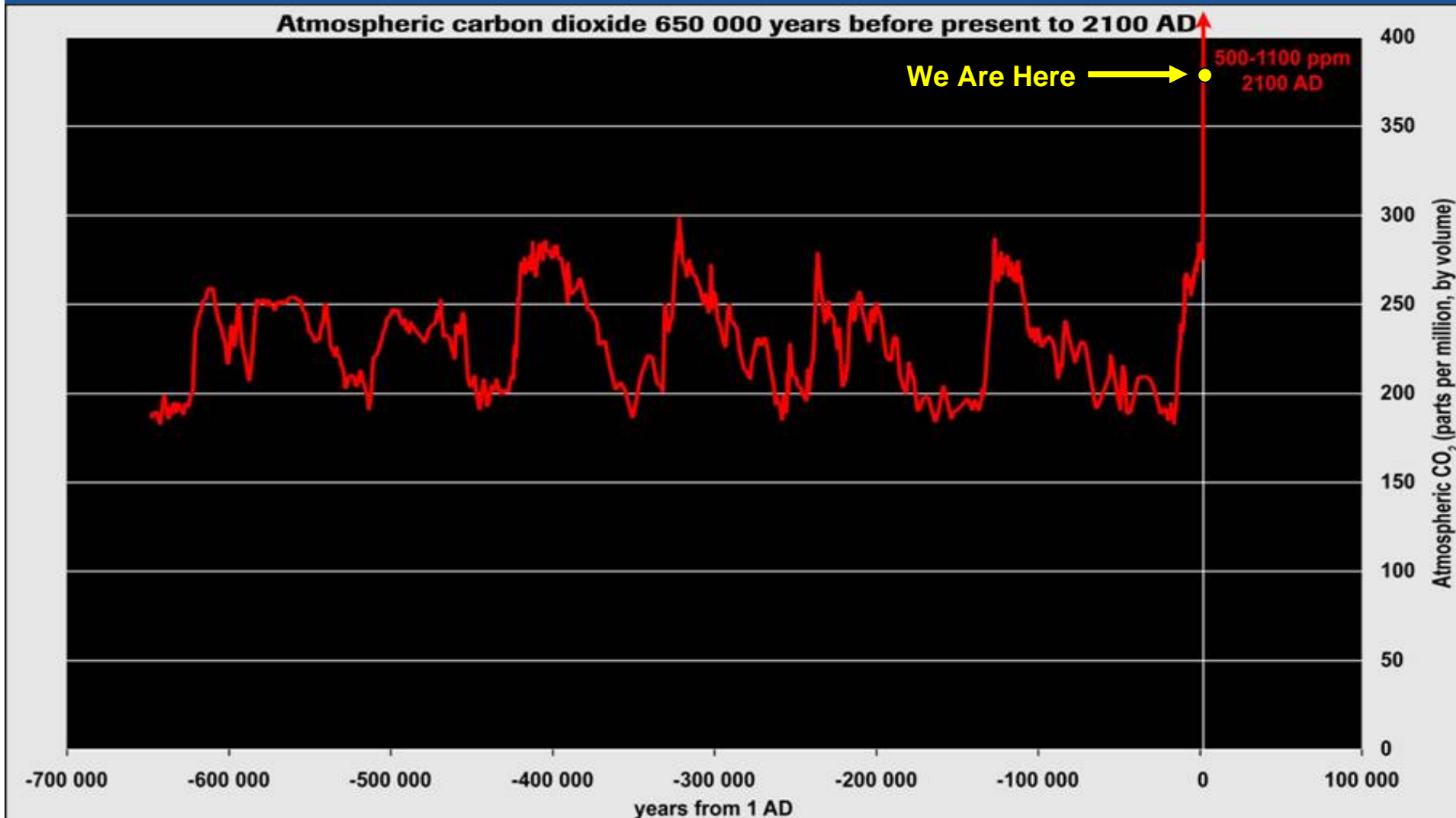
ALBEMARLE-PAMLICO PENINSULA,
EASTERN NORTH CAROLINA

CO₂ and Temperature

Temperature and CO₂ concentration in the atmosphere over the past 400 000 years (from the Vostok ice core)



Atmospheric CO₂ Concentrations



Data: Monnin, E., E.J. Steig, U. Siegenthaler, K. Kawamura, J. Schwander, B. Stauffer, T.F. Stocker, D.L. Morse, J.M. Barnola, B. Bellier, D. Raynaud, and H. Fischer. 2004. *Earth and Planetary Science Letters* 224: 45-54; Petit J.R., J. Jouzel, D. Raynaud, N.I. Barkov, J.M. Barnola, I. Basile, M. Bender, J. Chappellaz, J. Davis, G. Delaygue, M. Delmotte, V.M. Kotlyakov, M. Legrand, V. Lipenkov, C. Lorius, L. Pépin, C. Ritz, E. Saltzman, and M. Stievenard. 1999. *Nature* 399: 429-436; Siegenthaler, U., T.F. Stocker, E. Monnin, D. Lüthi, J. Schwander, B. Stauffer, D. Raynaud, J.M. Barnola, H. Fischer, V. Masson-Delmotte, and J. Jouzel. 2005. *Science* 310: 1313-1317; Graph: P. Gonzalez.

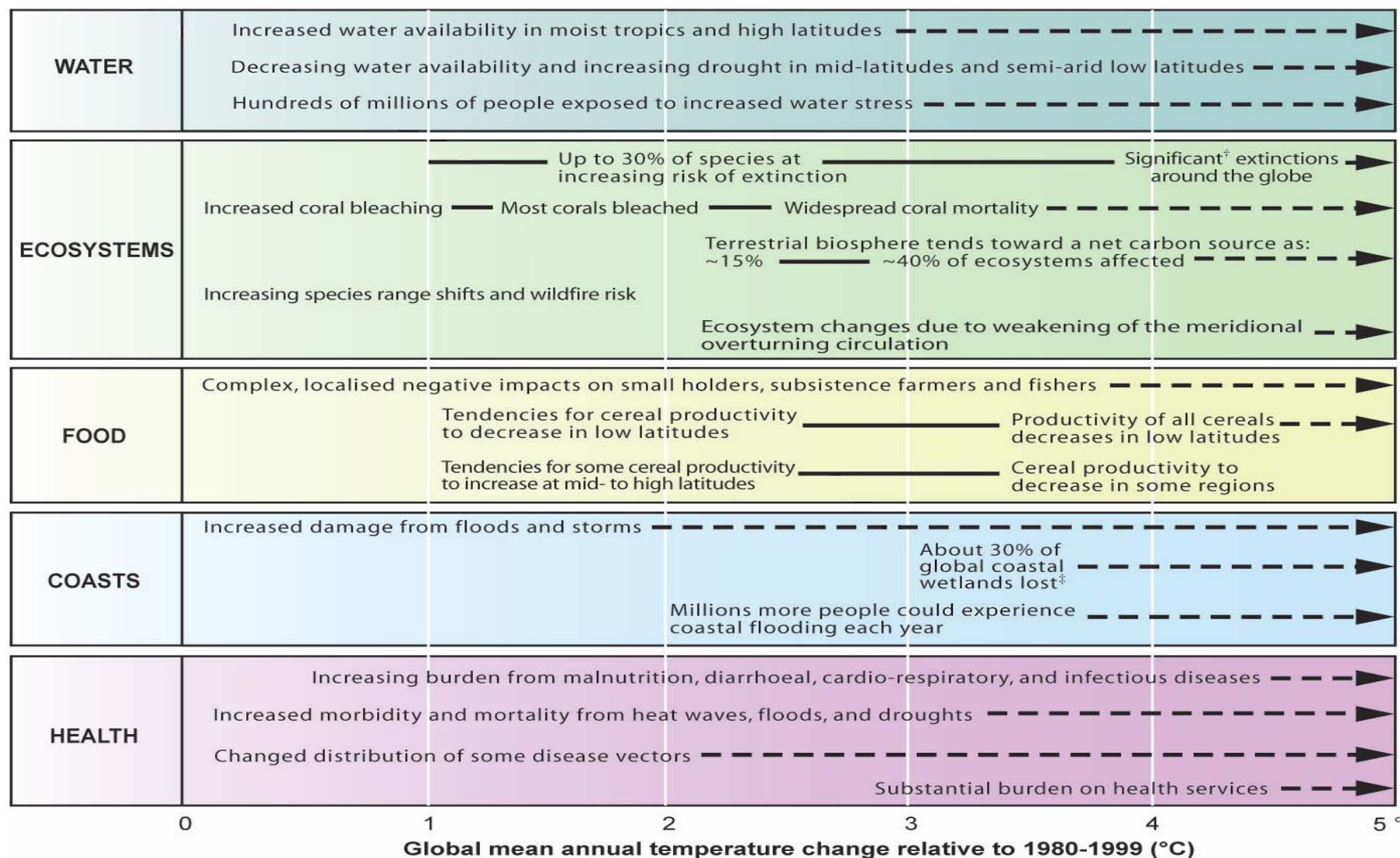
UNFCCC Goal

- United Nations Framework Convention on Climate Change signed in Rio in 1992:

to achieve “**stabilization** of greenhouse gas concentrations in the atmosphere at a level that would prevent **dangerous anthropogenic interference** with the climate system”

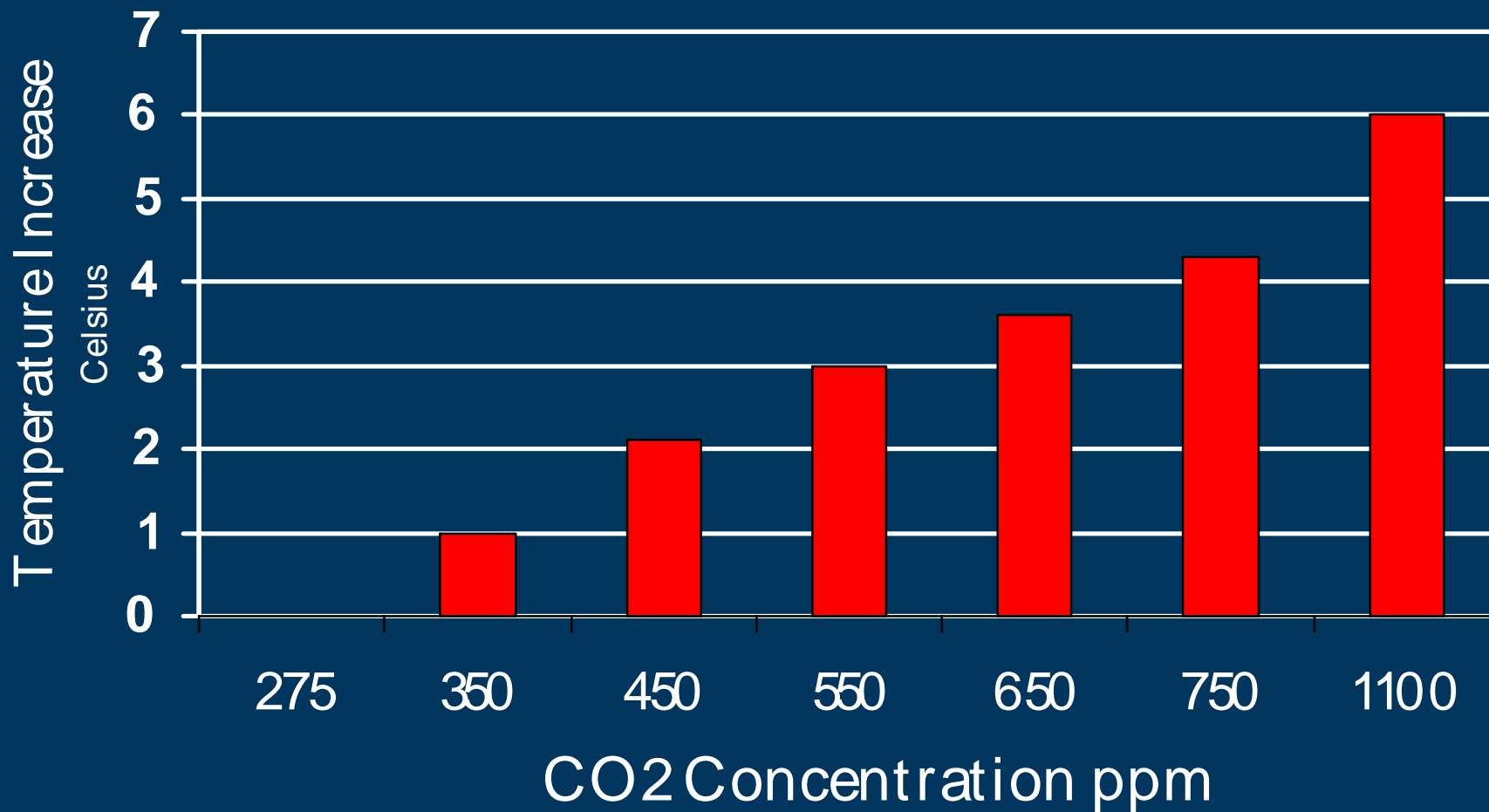
Climate Change Impacts

Source: IPCC 2007



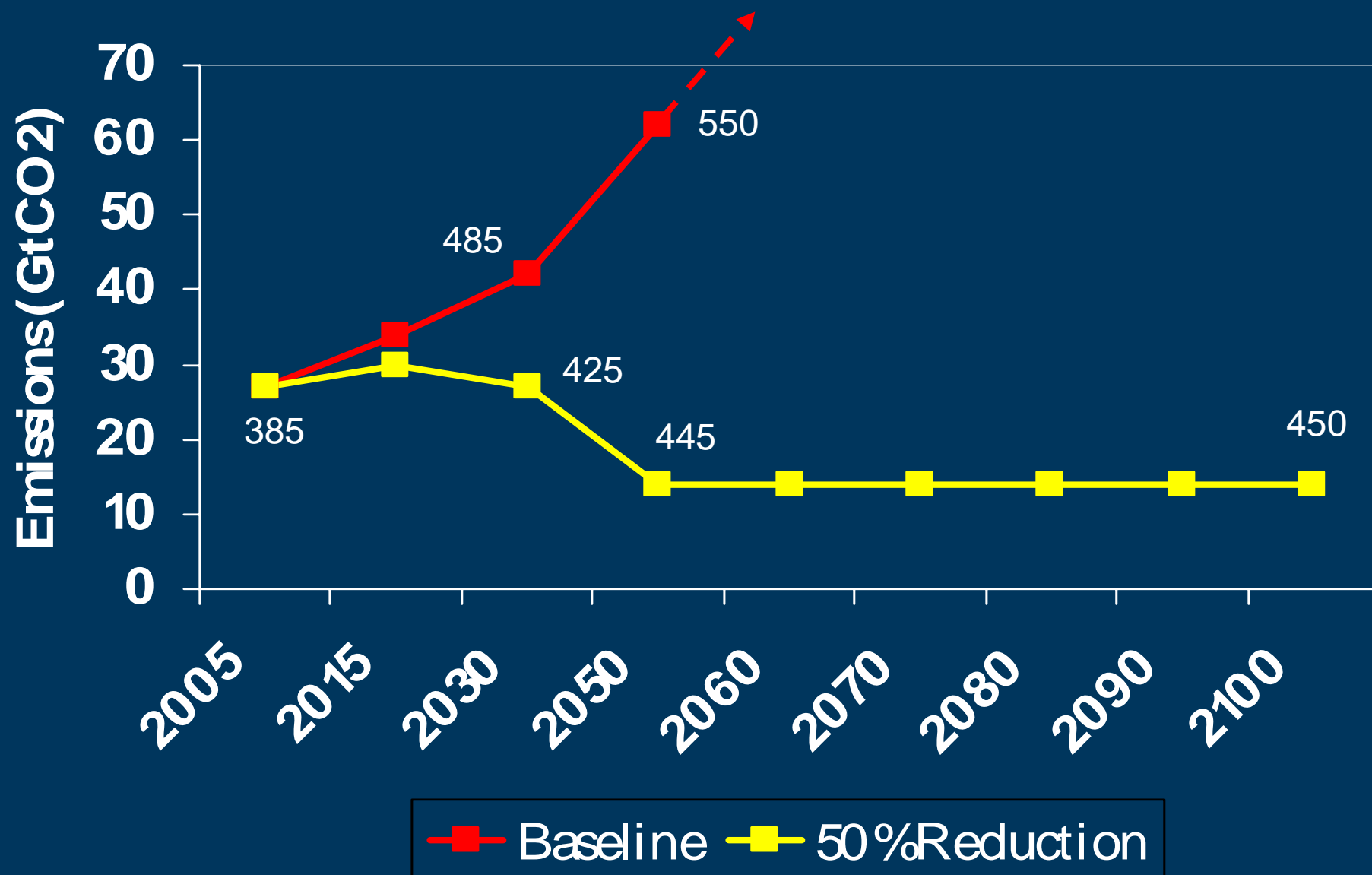
CO2 and Temperature

Source: IPCC 2007



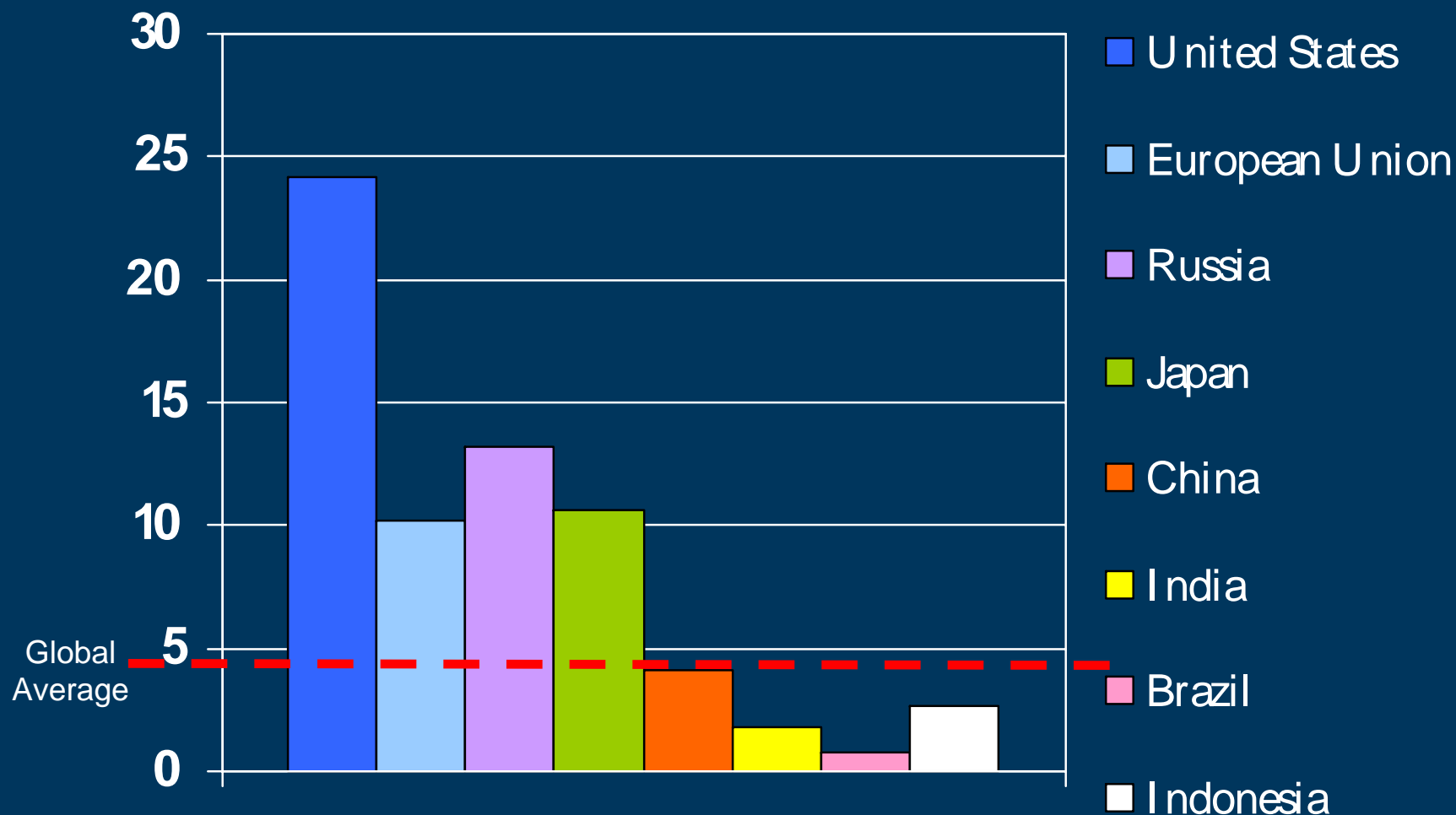
G8: Stabilizing at 450 ppm CO₂

Global; International Energy Agency 2008

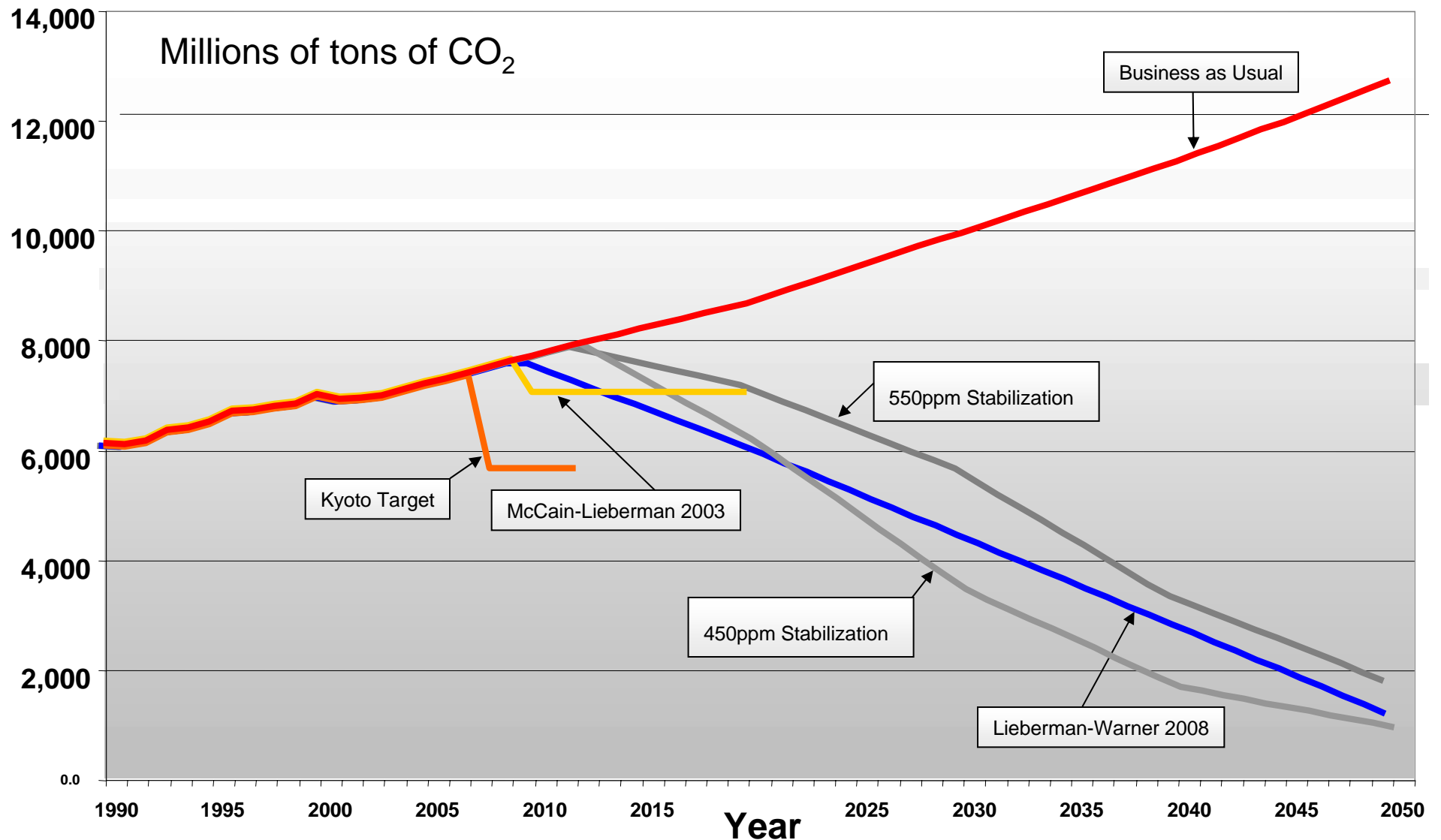


Emissions Per Capita by Country

2000—Tons of CO₂/person; Without Land Use Change



U.S. GHG Emissions Reductions



US Climate Action Partnership



JOHN DEERE



PEW CENTER
ON
Global CLIMATE
CHANGE



Boston
Scientific



Exelon



ALCOA
e

ConocoPhillips

XEROX



WORLD
RESOURCES
INSTITUTE

The Nature
Conservancy



Protecting nature. Preserving life.™

ENVIRONMENTAL DEFENSE
finding the ways that work



NRG

FPL
GROUP

AIG

Johnson & Johnson



Duke
Energy



PEPSICO



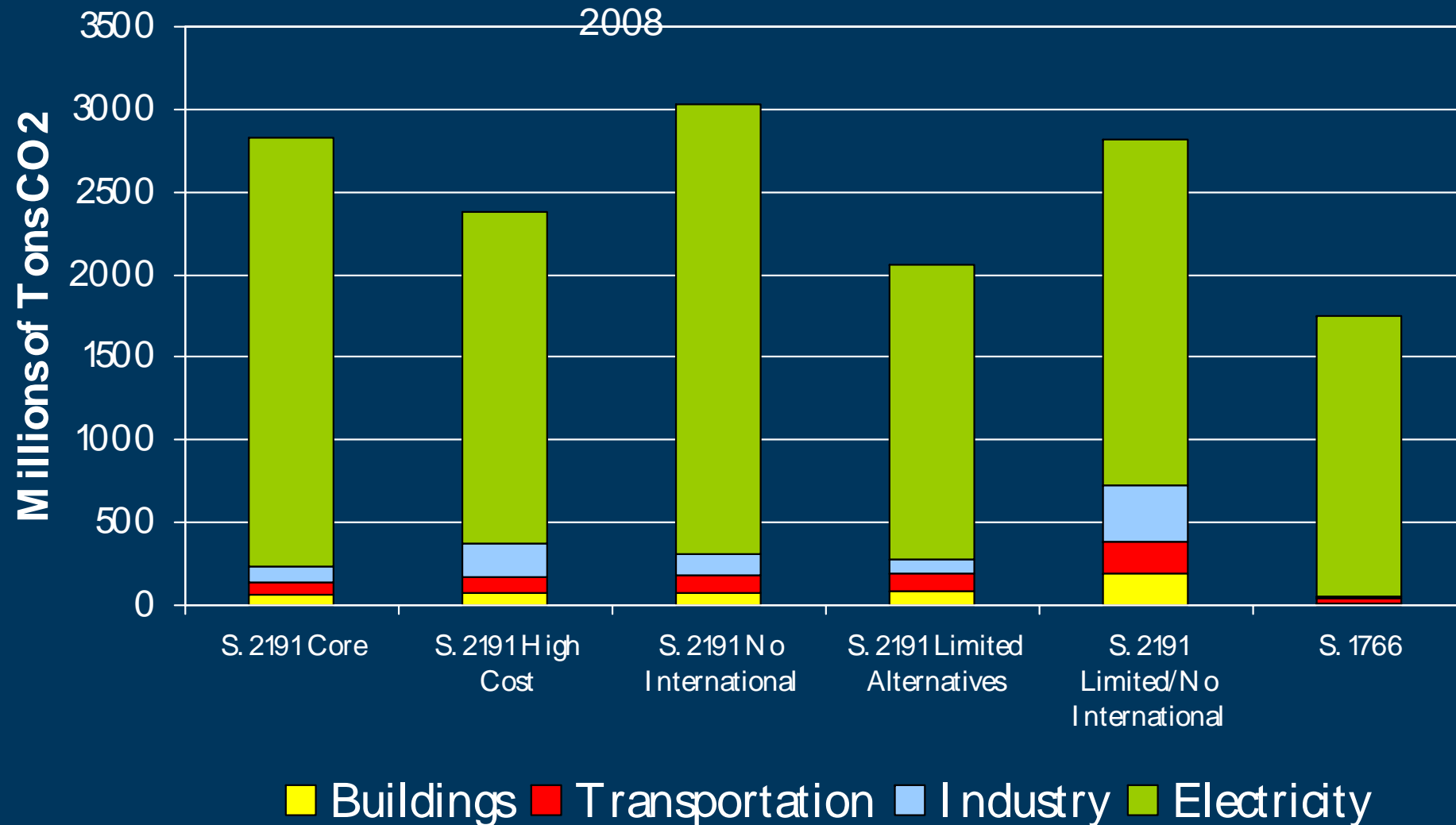
CHRYSLER

Major Issues for Legislation

- Allocation or auction of allowances?
- 2020 cap (size of reduction)
- Role of offsets (3 billion tons/yr ?)
- Complimentary measures (RES; LCFS; efficiency)
- Cost containment (safety valve mechanism)
- Disposition of auction revenues
- State preemption (CA tailpipe standards; RGGI)
- Sanctions on non-participating nations

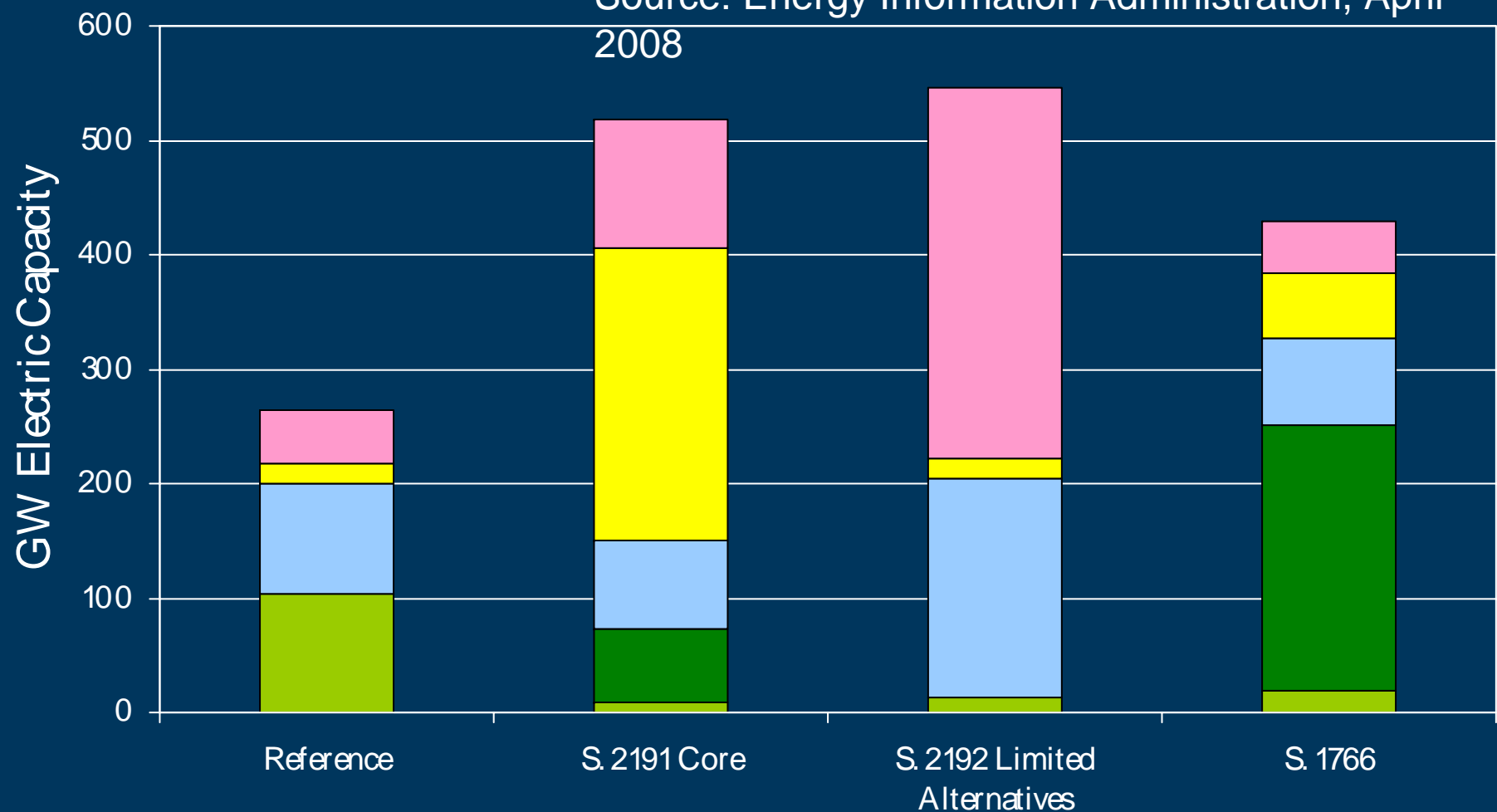
Emissions Reductions from a Cap Projections for 2030

Source: Energy Information Administration, April 2008



Additions to Generating Capacity Projections for 2030

Source: Energy Information Administration, April 2008

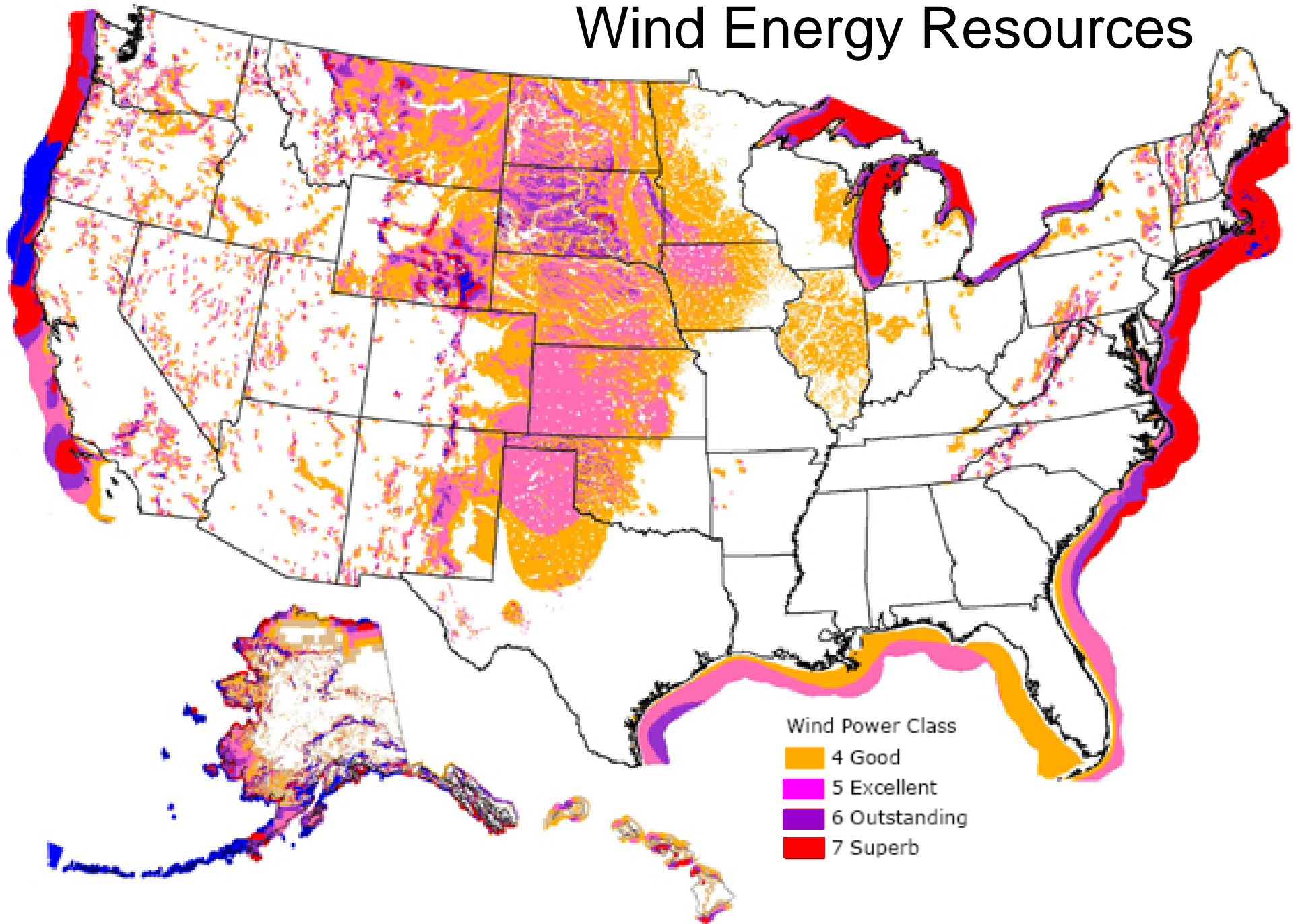


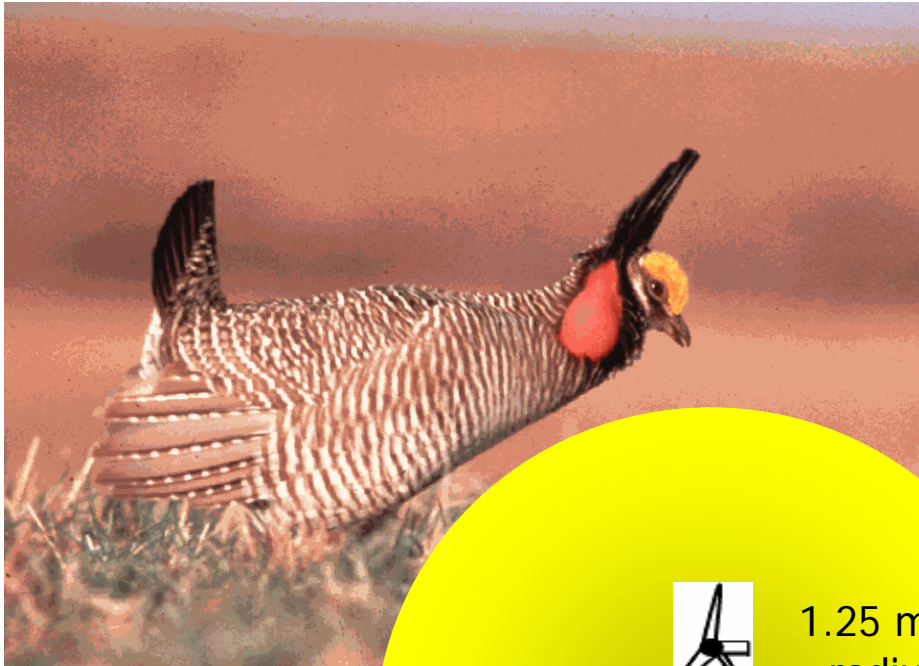
■ Coal no CCS ■ Coal with CCS ■ Natural Gas ■ Nuclear ■ Renewables

Renewable Energy Issues

- Intermittent production (low capacity factor)
 - Wind = 30-35 percent capacity factor
 - Solar = 20-25 percent capacity factor
- Located in sparsely populated areas
- High land requirements (low power density)
- Not cost competitive without taxpayers subsidies

Wind Energy Resources





1.25 mile
radius

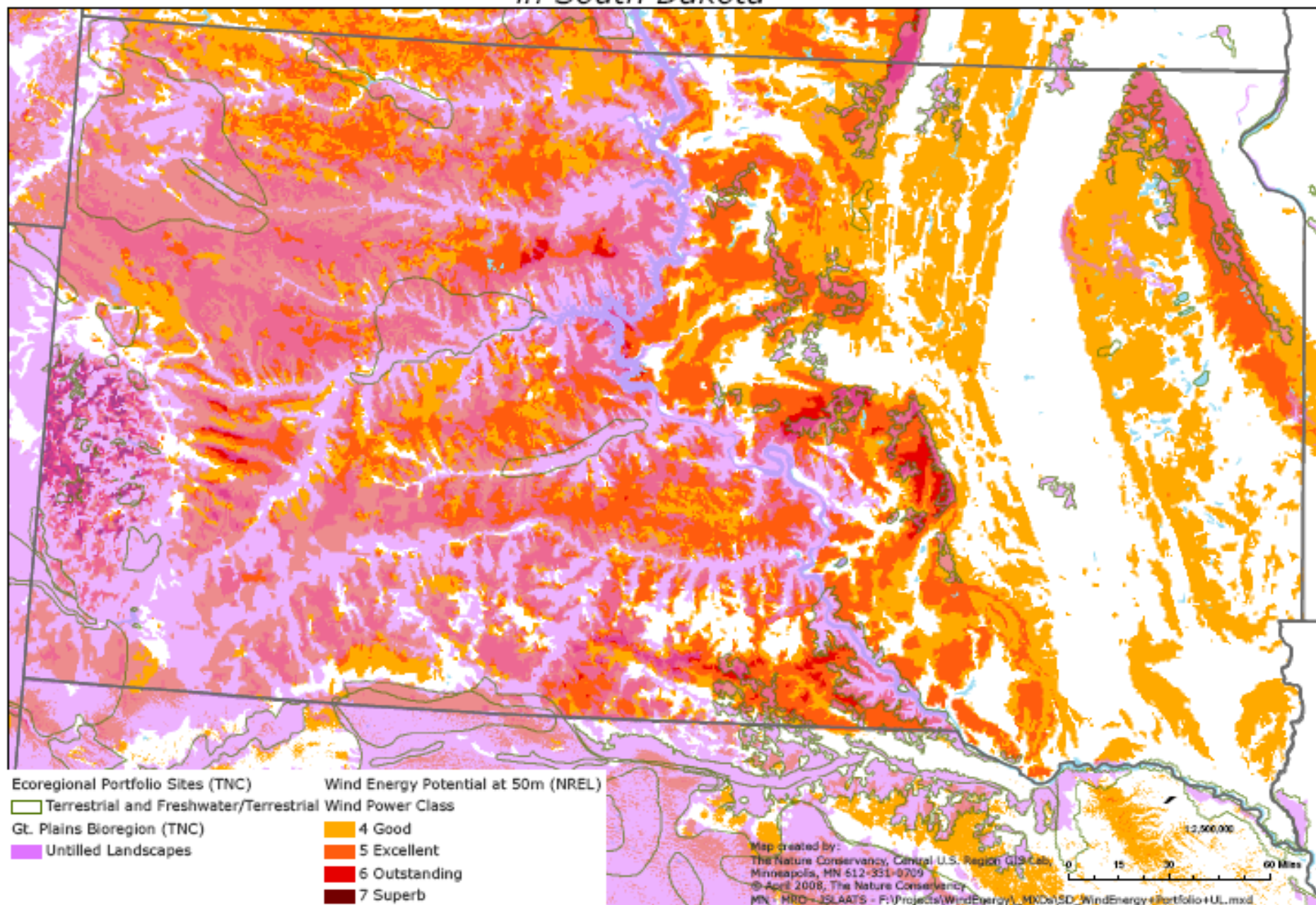
← →
= >2000 ac.

1.5 MW turbine

Area that may be abandoned
by prairie chickens
(nesting & brood rearing activities)



Wind Energy Potential, ERA Portfolio Sites and Untilled Landscapes in South Dakota





Mojave Solar Thermal Energy



Energy Sprawl

Generation equivalent to 1000 MW nuclear plant:

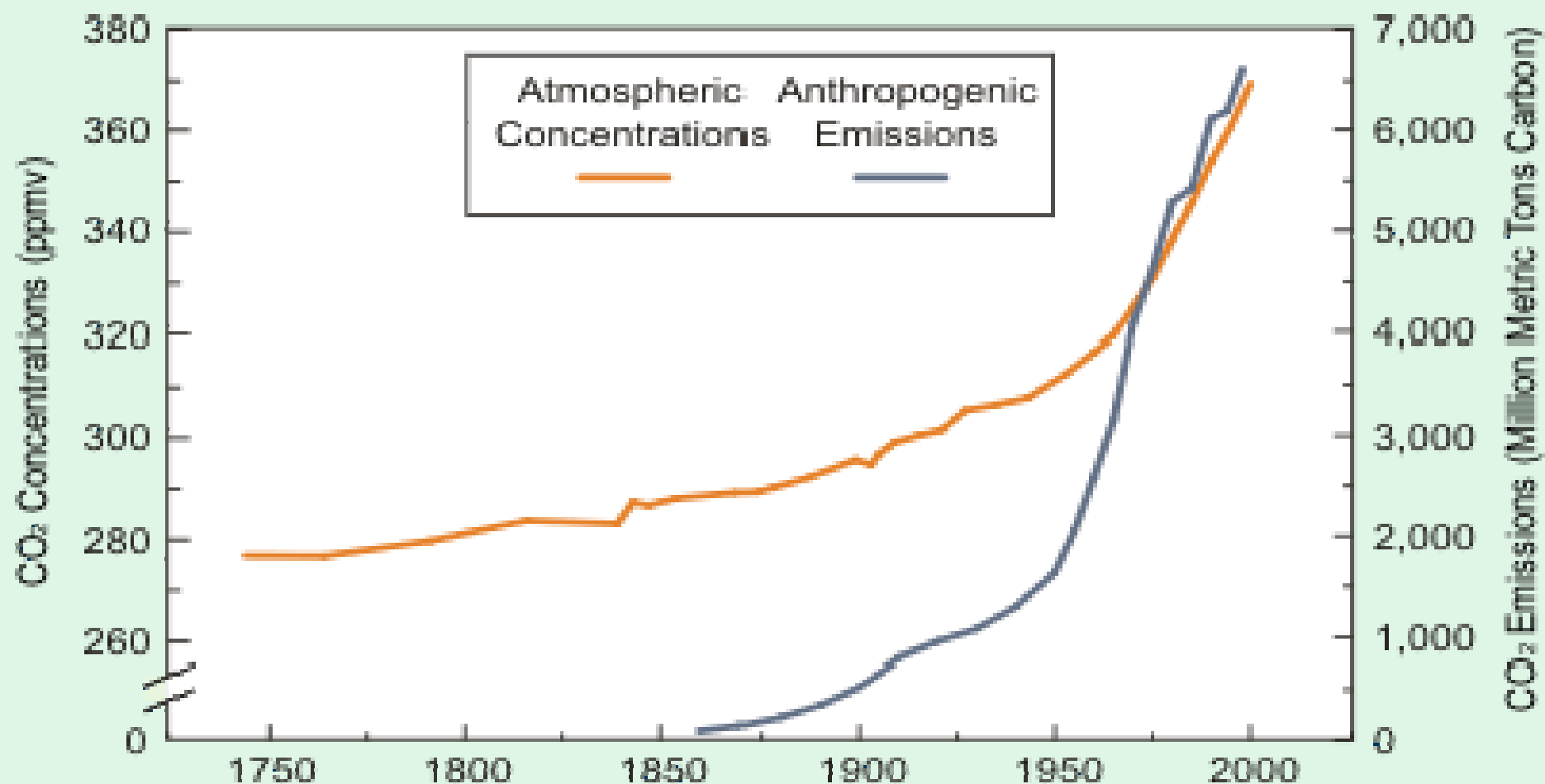
- Nuclear = 250 to 1000 acres
- Fossil fuel = 350 to 2500 acres
- Solar PV = 30 to 90 sq miles (53,000 acres)
- Wind = 100 to 300 sq miles (200,000 acres)
- Dedicated energy crops = 1500 to 2600 sq miles (1,700,000 acres)

Energy-from-Waste

- Renewable source of energy
- Cost competitive today
- Located at electrical load centers
- Baseload capacity
- Reduces land use requirements for waste disposal



CO₂ Emissions and Concentrations



Source: Oak Ridge National Laboratory, Carbon Dioxide Information Analysis Center, <http://cdiac.esd.ornl.gov/>.

Increasing Rate of Change

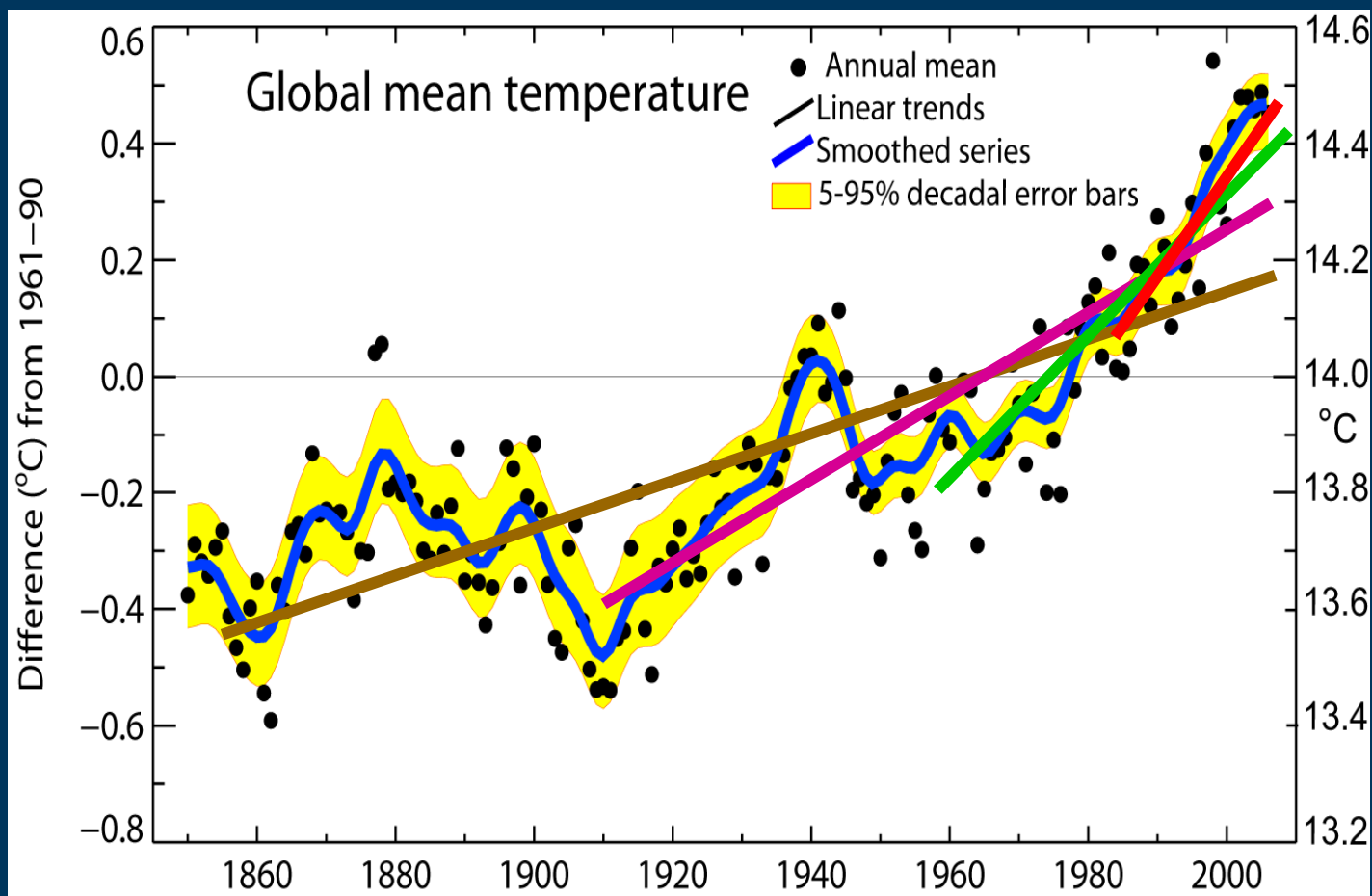
Period Rate
Years °C/decade

25 **0.18 ± 0.05**

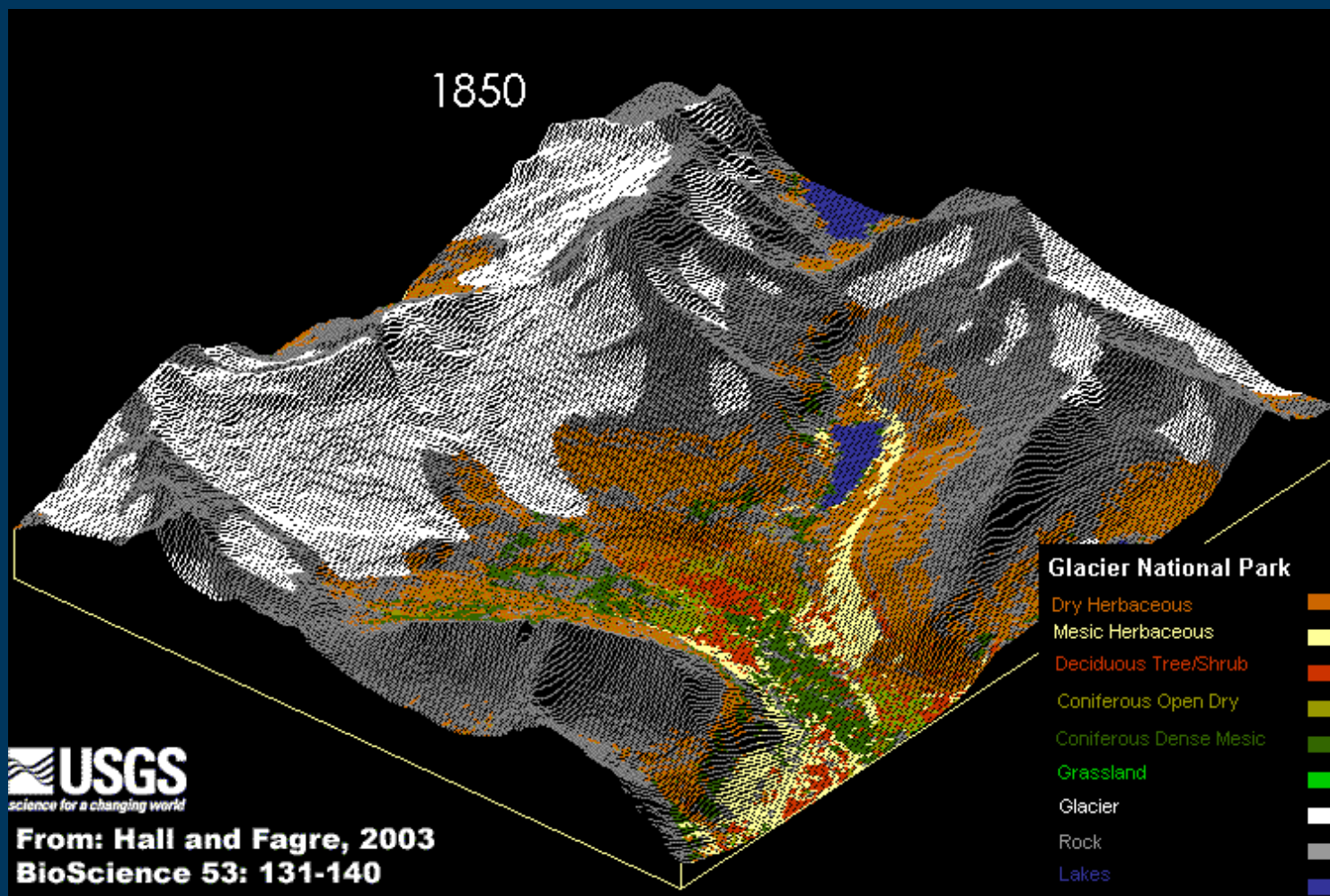
50 **0.13 ± 0.03**

100 **0.07 ± 0.02**

150 **0.05 ± 0.01**

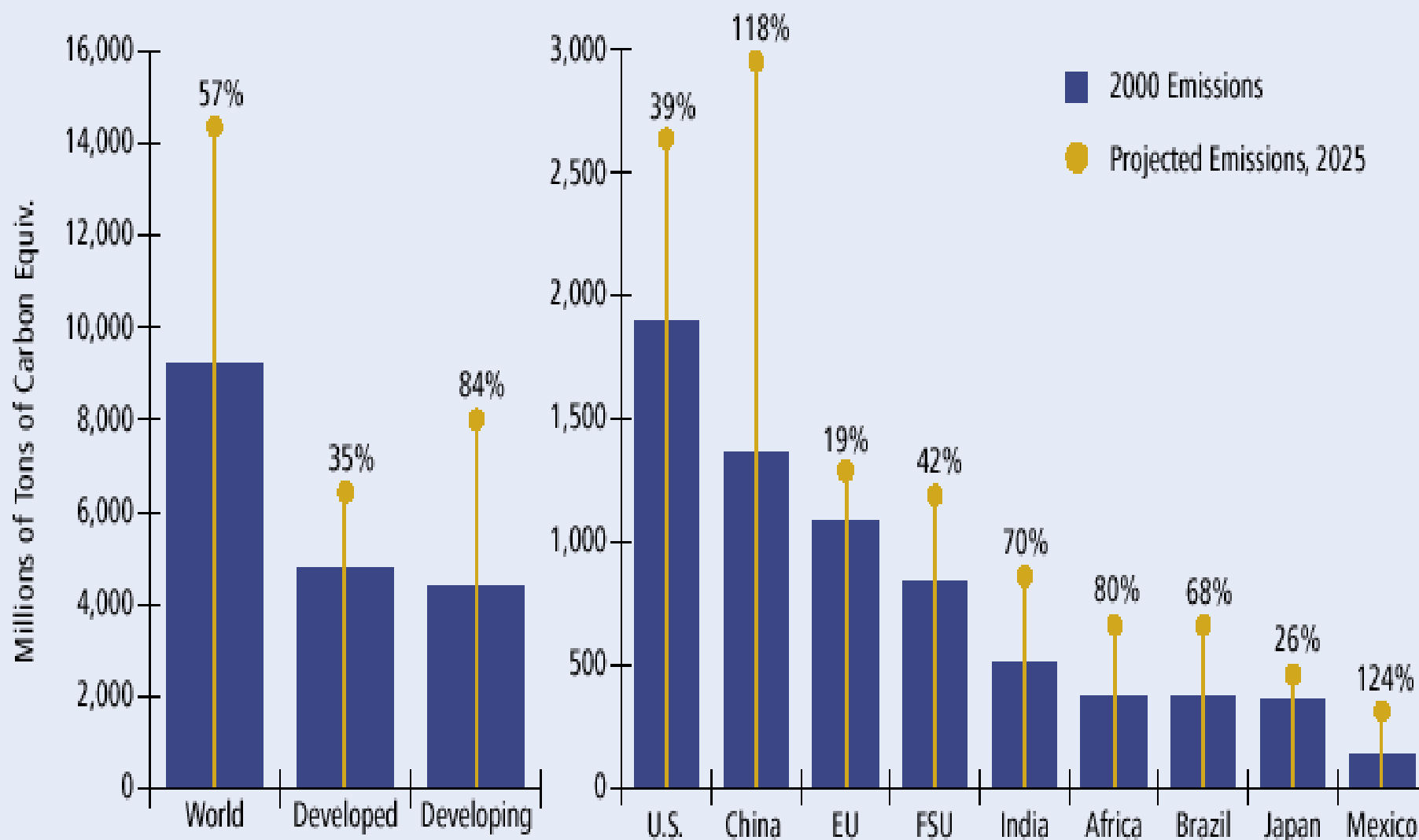


Habitat on the Move

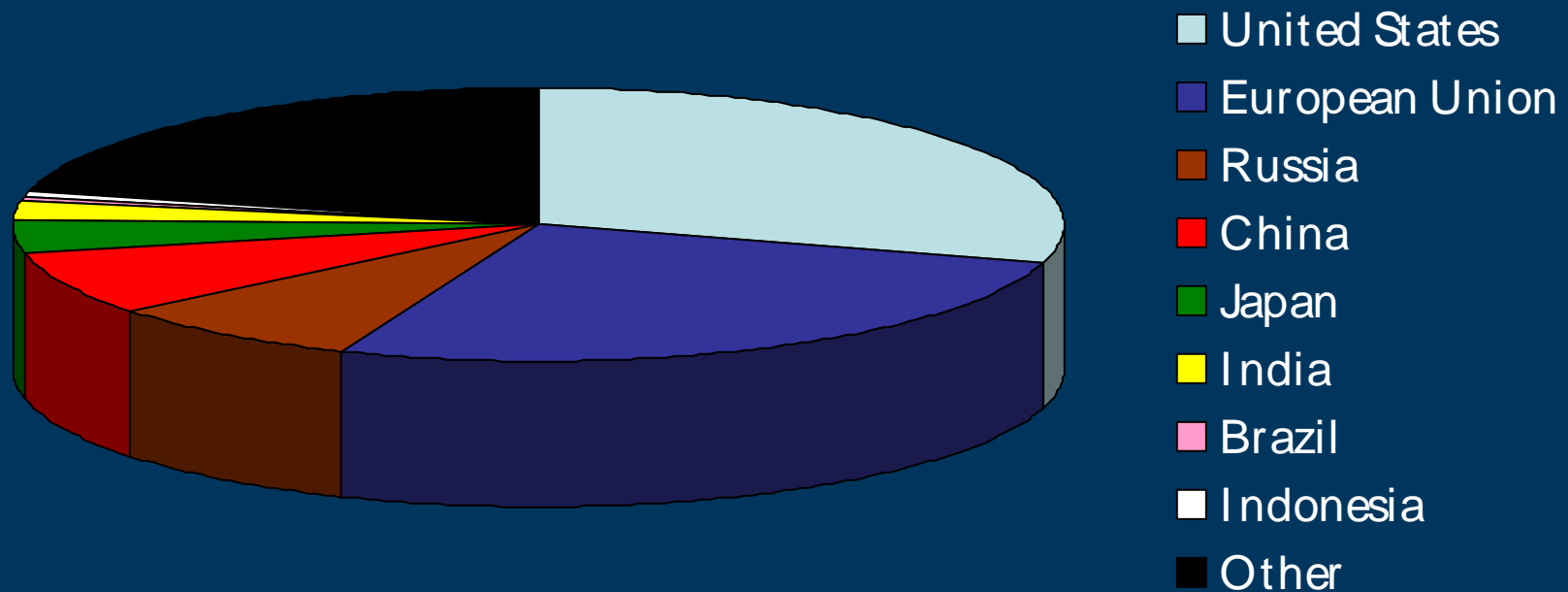


Annual GHG Emissions by Country

Figure 3.1. Projected Emissions of GHGs in 2025



Cumulative Emissions by Country 1850-2000--Percent of World



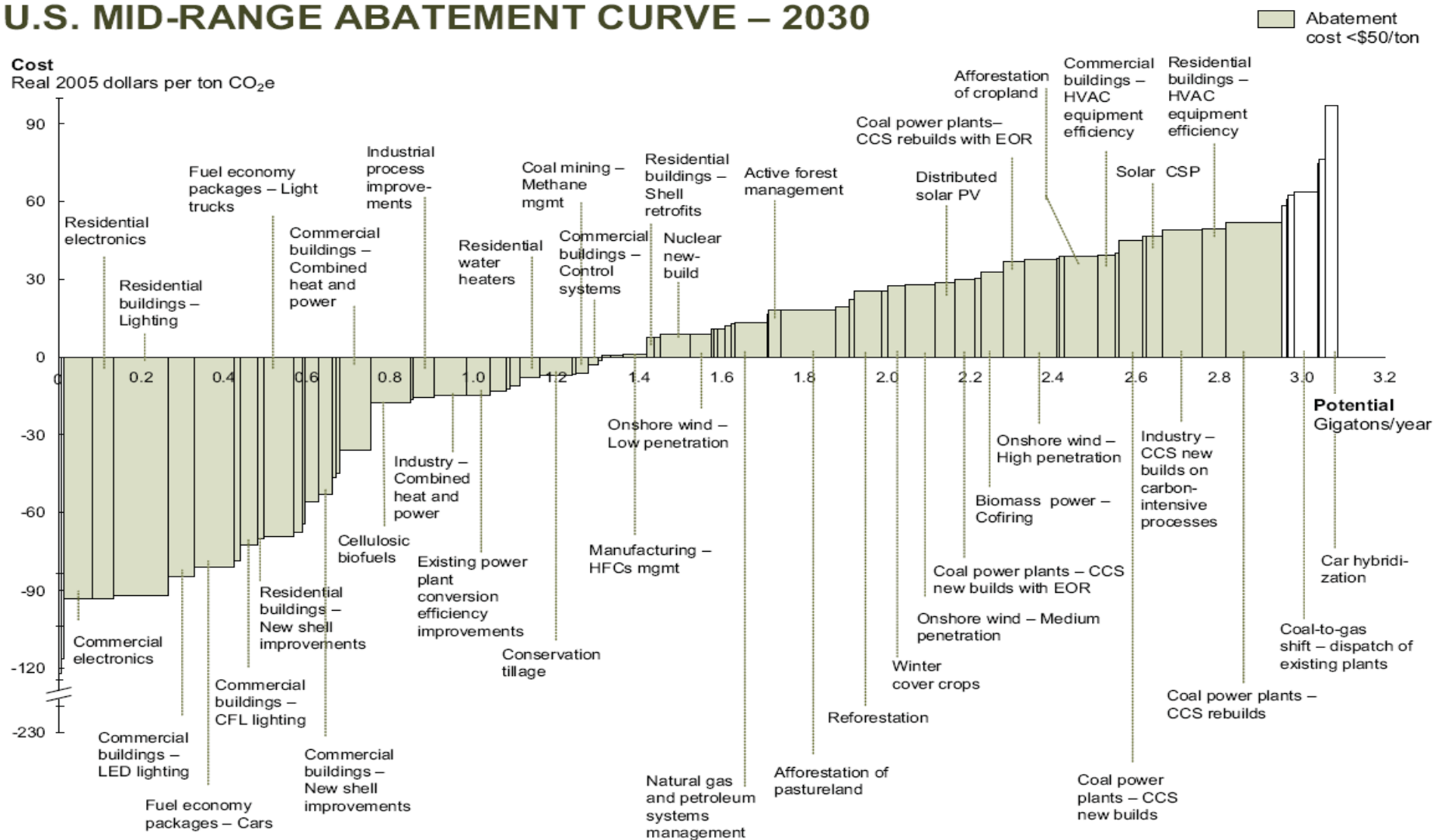
One Family's Carbon Footprint

18 tons allowed; 65 tons total; U.S. average 110 tons

- Single-family detached 3-bedroom home in Virginia
29 tons for household energy use
- One mid-size car going 10,000 miles/year
7.5 tons
- 8 plane trips (4 short, 4 long)
10.4 tons
- Food (very little organic)
16 tons
- Waste (recycle and compost everything)
2.1 tons
- Recreation (cross-country skiing)
Priceless

Emissions Reductions Cost Curve

U.S. MID-RANGE ABATEMENT CURVE – 2030

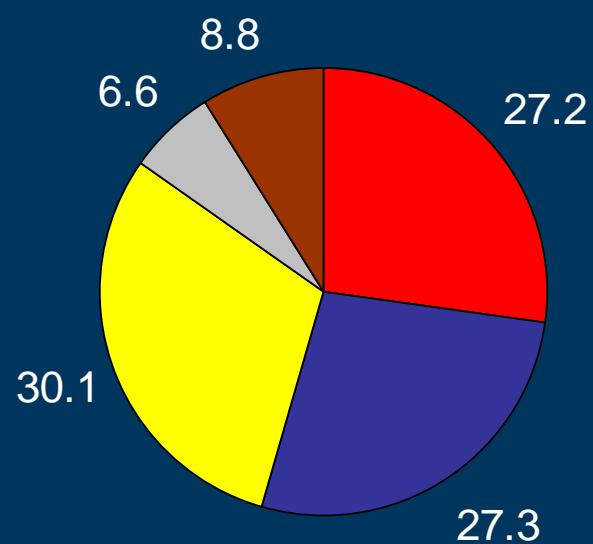


Source: McKinsey analysis

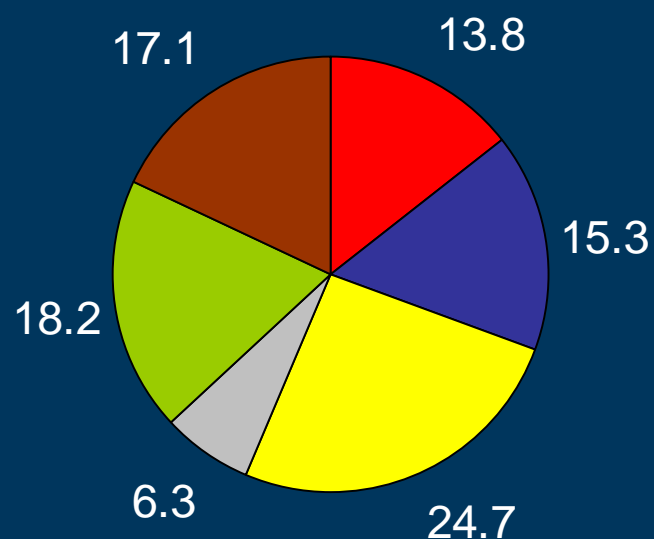
CAA v Cap v Tax

- CAA source-by-source technology regulations
- Cap and trade with allocation
 - Certain emissions limit
 - International integration
 - Uncertain price for allowance trades
 - Polluter windfall
 - Central planning inefficiencies
- Cap with auction
 - Certain emissions limit
 - International integration
 - Uncertain price for allowances in auction
 - Inefficient revenue recycling
- Carbon tax
 - Certain long-term cost impact on emitters
 - Uncertain total emissions
 - No international integration
 - Inefficient revenue recycling

Avoided Deforestation



United States



World

- Transportation
- Buildings
- Industry
- Extraction
- Land Use Change
- Agriculture and Waste

A Strategic Option for Electric Power

Sources: EIA; Mckinsey Group 2008

