# Engineering in a Coastal Environment

The Kyoto Protocol

Impact on Clean Air Initiatives

# The Questions

Will the Kyoto Protocol have a positive impact on greenhouse gases?

Will Global Warming be significantly impacted by the Kyoto Protocol?

What is the role of Engineering in this issue?

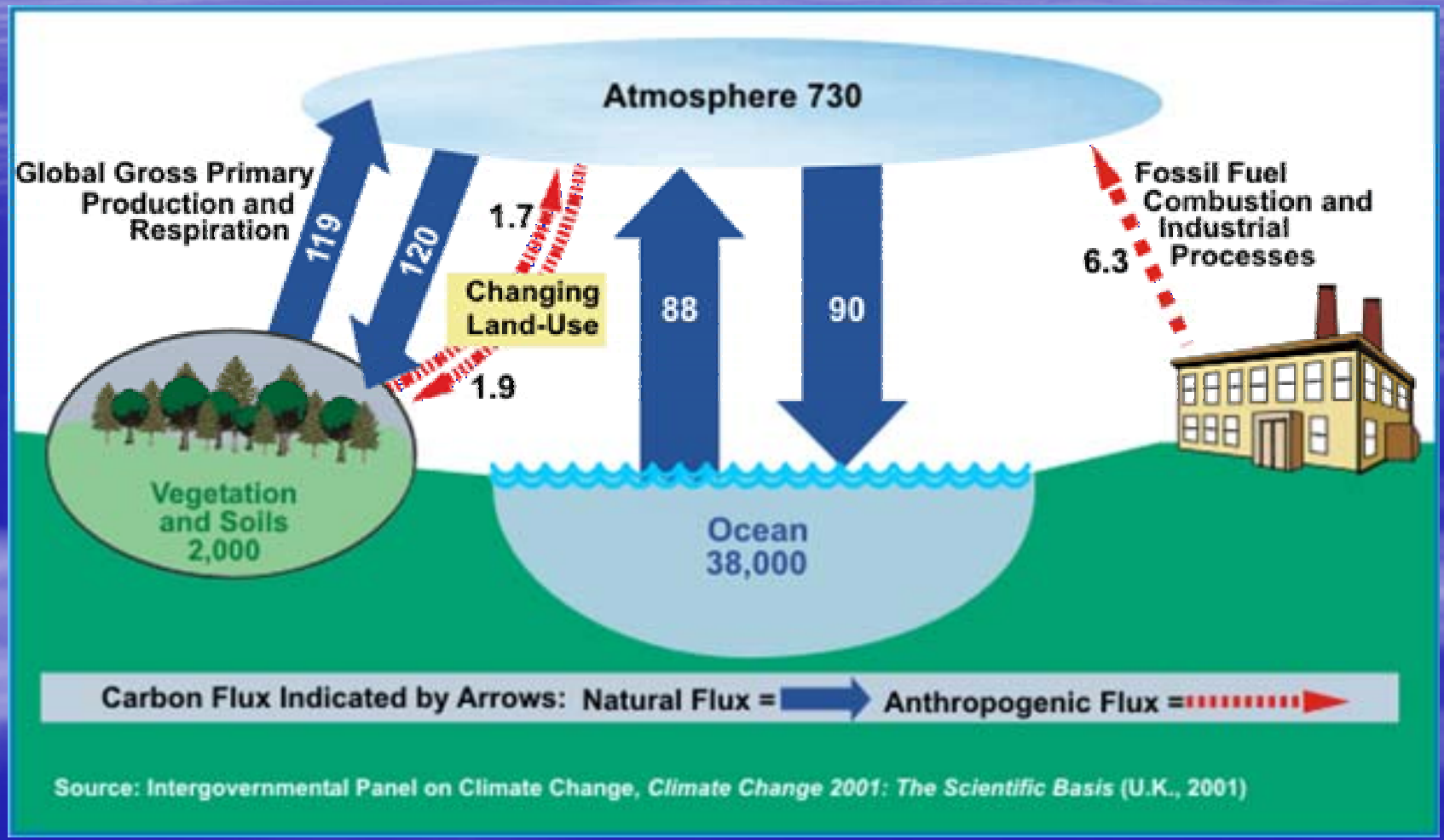
# Regional Issues Related to Clean Air

- Industrial Infrastructure
- Tourism
- Transportation
- Rebuilding Initiatives

# The Issue

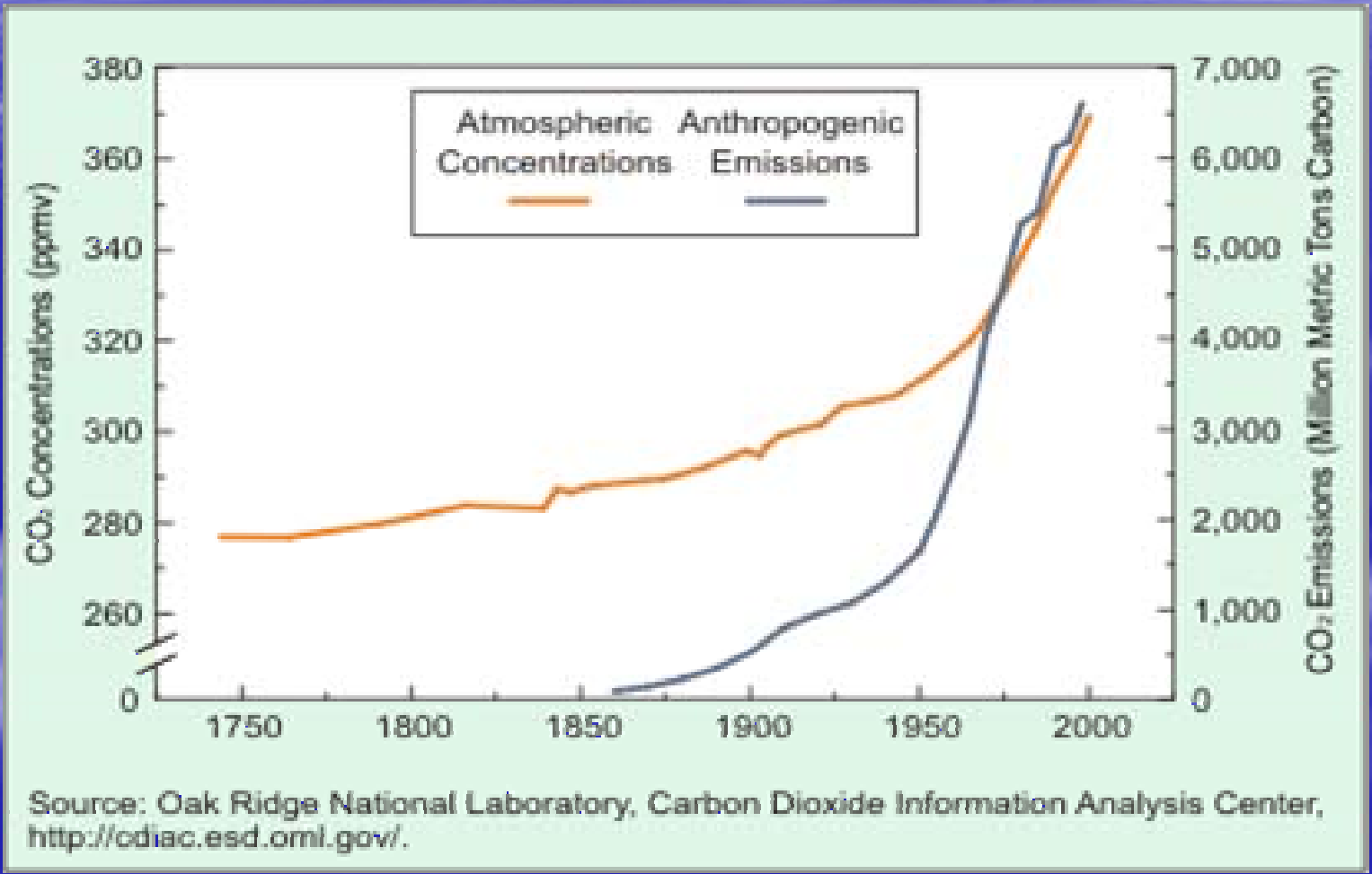
- Global Warming is real and measurable
- The Debate over WHY has become the issue
- Human Impact on the Environment should be the real issue, because it is the issue we can do something about
- The Kyoto Protocol was a call to order for government

# The Carbon Cycle




Source: Intergovernmental Panel on Climate Change, *Climate Change 2001: The Scientific Basis* (U.K., 2001)

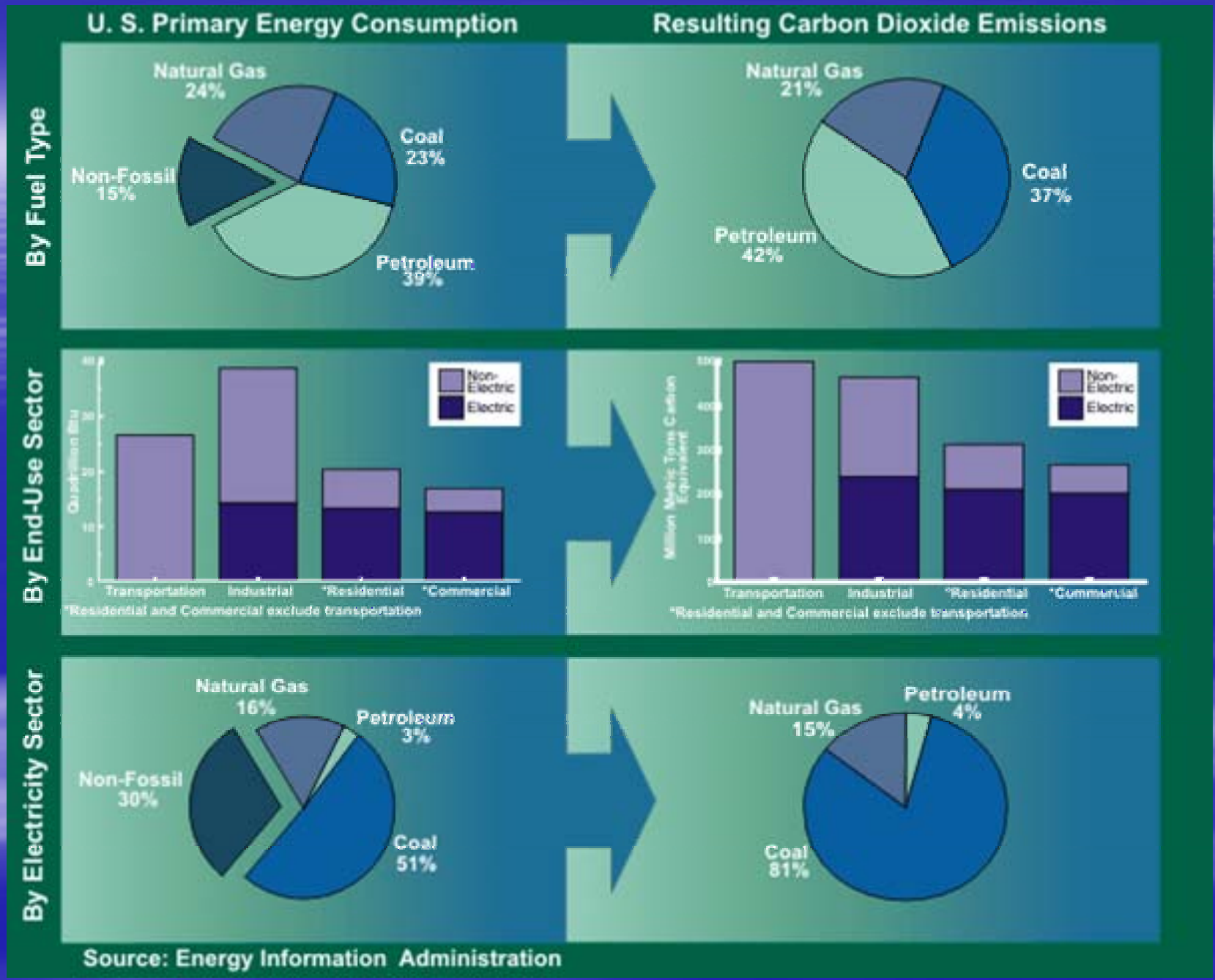
# Human Impact



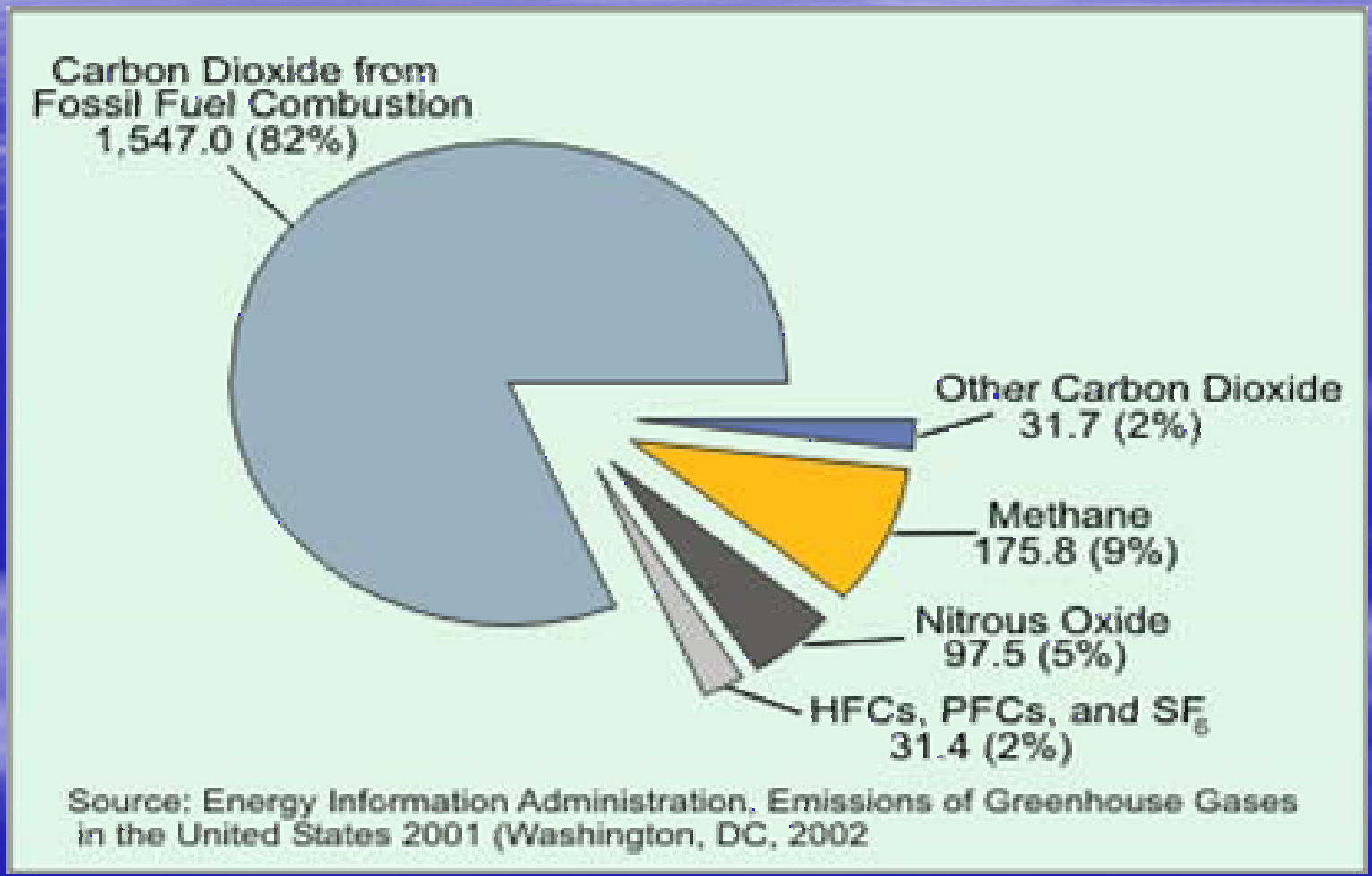

Source: Oak Ridge National Laboratory, Carbon Dioxide Information Analysis Center, http://cdiac.esd.ornl.gov/.

# Other Facts

- $CO_2$ emissions are about 25 billion tons
- Motor vehicles account for about 5 billion tons
- U.S. power generation accounts for about 2.4 billion tons
- U.S. electricity needs will increase by 45% by 2030

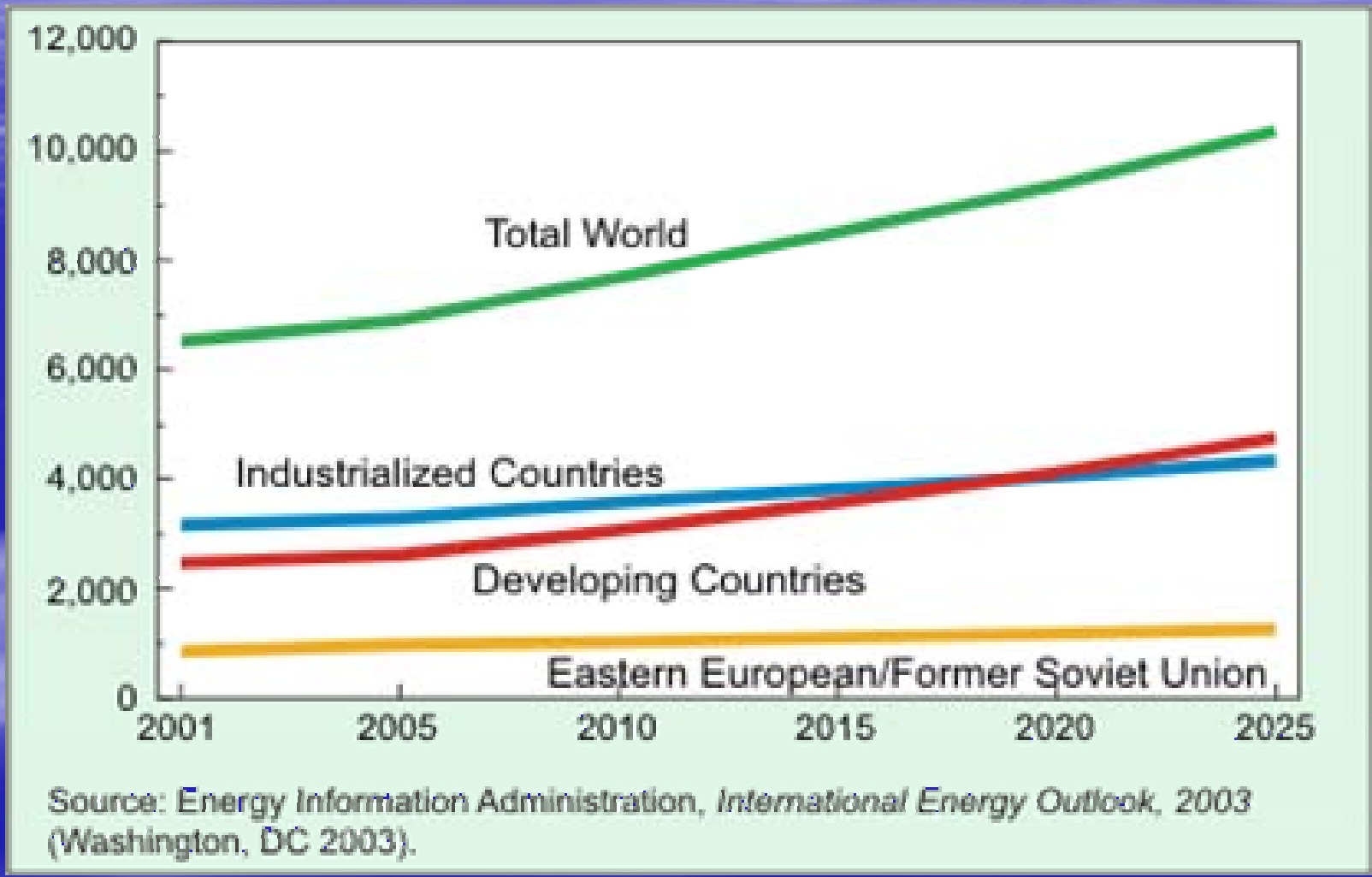

U. S. Primary Energy Consumption
Resulting Carbon Dioxide Emissions
By Fuel Type
Natural Gas 24%
Coal 23%
Non-Fossil 15%
Petroleum 39%
Natural Gas 21%
Coal 37%
Petroleum 42%
By End-Use Sector
Non-Electric
Electric
Transportation
Industrial
*Residential
*Commercial
*Residential and Commercial exclude transportation
Million Metric Tons Carbon Equivalent
By Electricity Sector
Natural Gas 16%
Petroleum 3%
Non-Fossil 30%
Coal 51%
Natural Gas 15%
Petroleum 4%
Coal 81%
Source: Energy Information Administration

# Fossil Fuels Combustion




Source: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2001* (Washington, DC, 2002

# Million Tons Carbon Equivalent

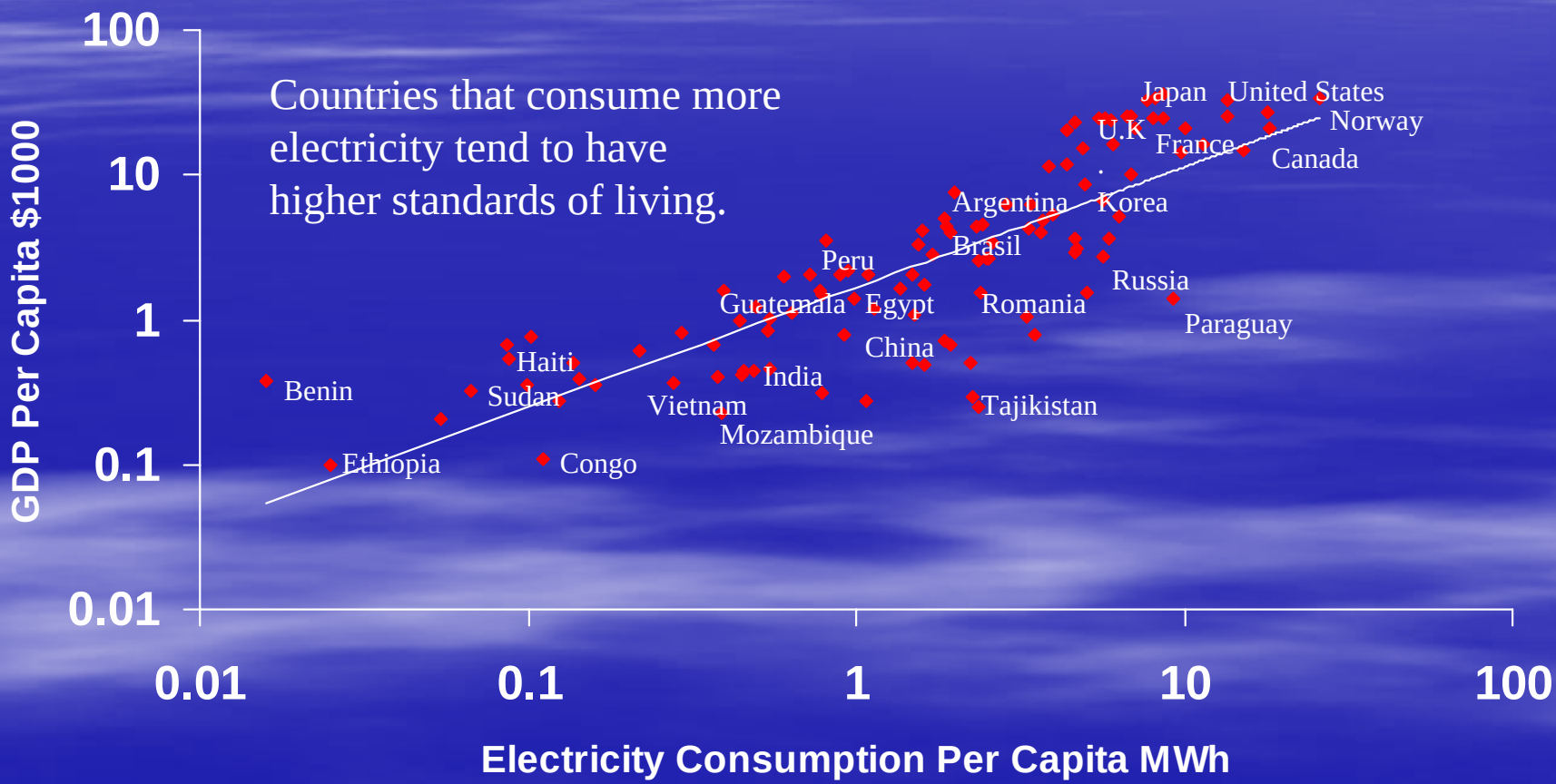



Source: Energy Information Administration, *International Energy Outlook, 2003* (Washington, DC 2003).

# Simple Rules

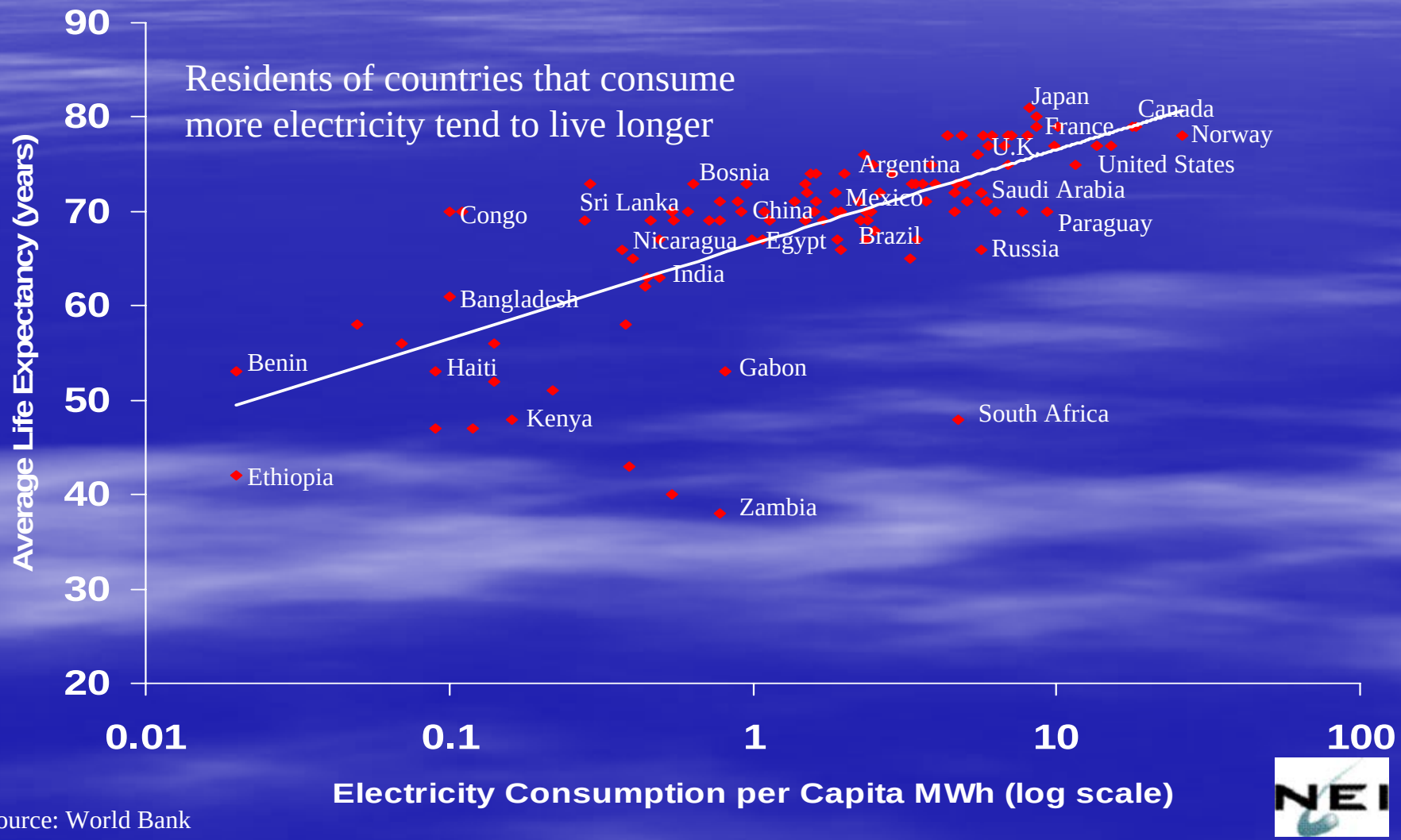
- Energy availability drives economic growth
- Energy utilization can adversely impact environmental conditions
- Environmental conditions affect quality of life

# Country by Country Economic Output and Electricity Production (log scale)



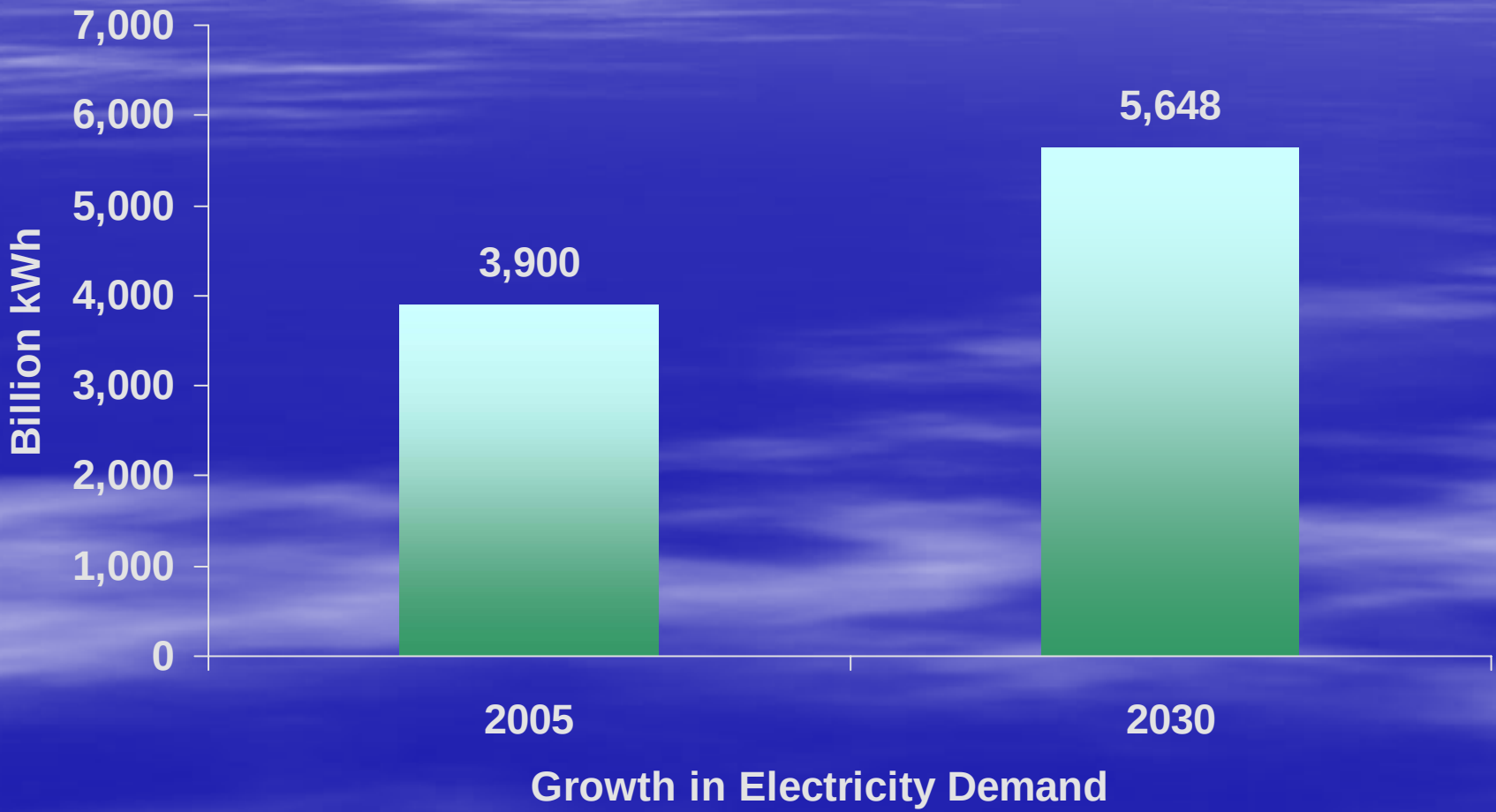

Source World Bank 1999

# Cross Country Comparisons of Life Expectancy and Electricity Consumption




Source: World Bank

# U.S. Needs 45 Percent More Electricity by 2030

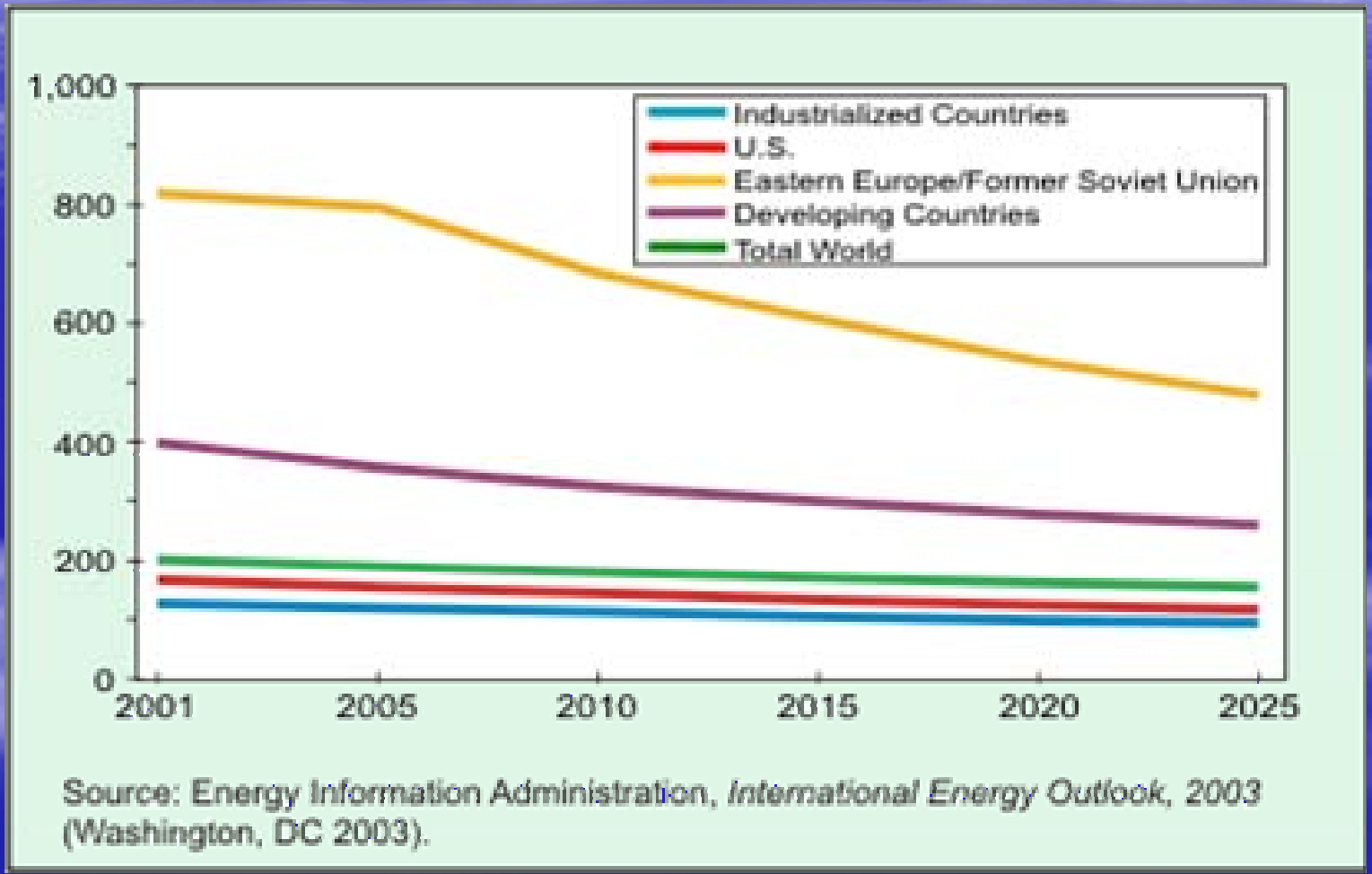



*Source: Energy Information Administration*

# The Prognosis

- World production of greenhouse gases could follow the historical model unless there is a significant change in technology
- Carbon intensive technology will be utilized by developing nations without intervention
- Technology Advancements are forecast to be effective in reducing carbon emissions

# Carbon Intensity Reductions (Million tons per $ units)




Source: Energy Information Administration, *International Energy Outlook, 2003* (Washington, DC 2003).

# Where Does Engineering Fit In?

- Science alone is often not enough to drive public opinion and change
- Economic factors must be compelling to create significant change in behaviors
- Engineering can create good technical and economic outcomes
- Global Warming is a prime candidate for engineered solutions

# Pre-Kyoto?

- Greenhouse Effects were identified about a 100 years ago
- In the 1950's, atmospheric CO2 concentrations were measured as increasing
- In 1979, a World Climate Conference was held in Geneva to discuss the role of human sources of CO2
- In 1988, the UN Intergovernmental Panel on Climate Change was formed with three working groups
- IPCC issued its first report in 1990
- The UN General Assembly created the Framework Convention on Climate Change in 1992.

# Kyoto Protocol History

- By the mid-90's, it was seen that industrialized nations were not likely to meet the "Framework" goals from 1992.
- The Council of Parties (COP) drafted binding commitment language instead of voluntary, and started negotiations in 1995.
- Agreement by 180 countries at Kyoto in 1997
- Targeted reductions in Greenhouse gases
  - Europe targeted at an 8% reduction from 1990 levels
  - Canada is 6%
  - Japan is 7%
- Note that current levels are much higher than in 1990
  - For Canada the target is 18% lower than for 1990
- U.S. would have been targeted at a 7% reduction
- Overall Goal: 5.2% reduction from 1990 levels by 2012

# History (continued)

- Developing countries were given exemptions
- Targeted countries to achieve a 5% reduction by 2012
- Activities targeted include agriculture, manufacturing, transportation, mining, and chemical processes
- Specific reference is made to new and renewable energy sources, carbon sequestration, and conservation.

# The Debate over the Science

- The Kyoto Protocol referenced studies from the mid-90's
- The United Nations Intergovernmental Panel on Climate Change in 1990 commissioned the development of models for climate change predictions
- Some subsequent studies show temperature rises less than predicted
- This DPO has fueled both opposition and apathy
- International positions vary widely

# Alternative Opinions?

- Forests churn out Methane, which is more influential on warming than CO2. New theories about aerobic processes have overturned what many thought were the primary sources of methane
- New study states that Solar Activity is the primary force behind climate change

# Kyoto Response

- Fear of future economic damage was the US response to Kyoto
- US is promoting a six nation voluntary initiative to reduce emissions via the Asia Pacific Partnership on Clean Development and Climate
- Change Drivers
  - Developing countries and their adoption of technology
  - Rising consumer costs for fossil fuels
  - Current deterioration of industrial infrastructure
  - New and “better” data
  - New environmental movement?

# Opinion

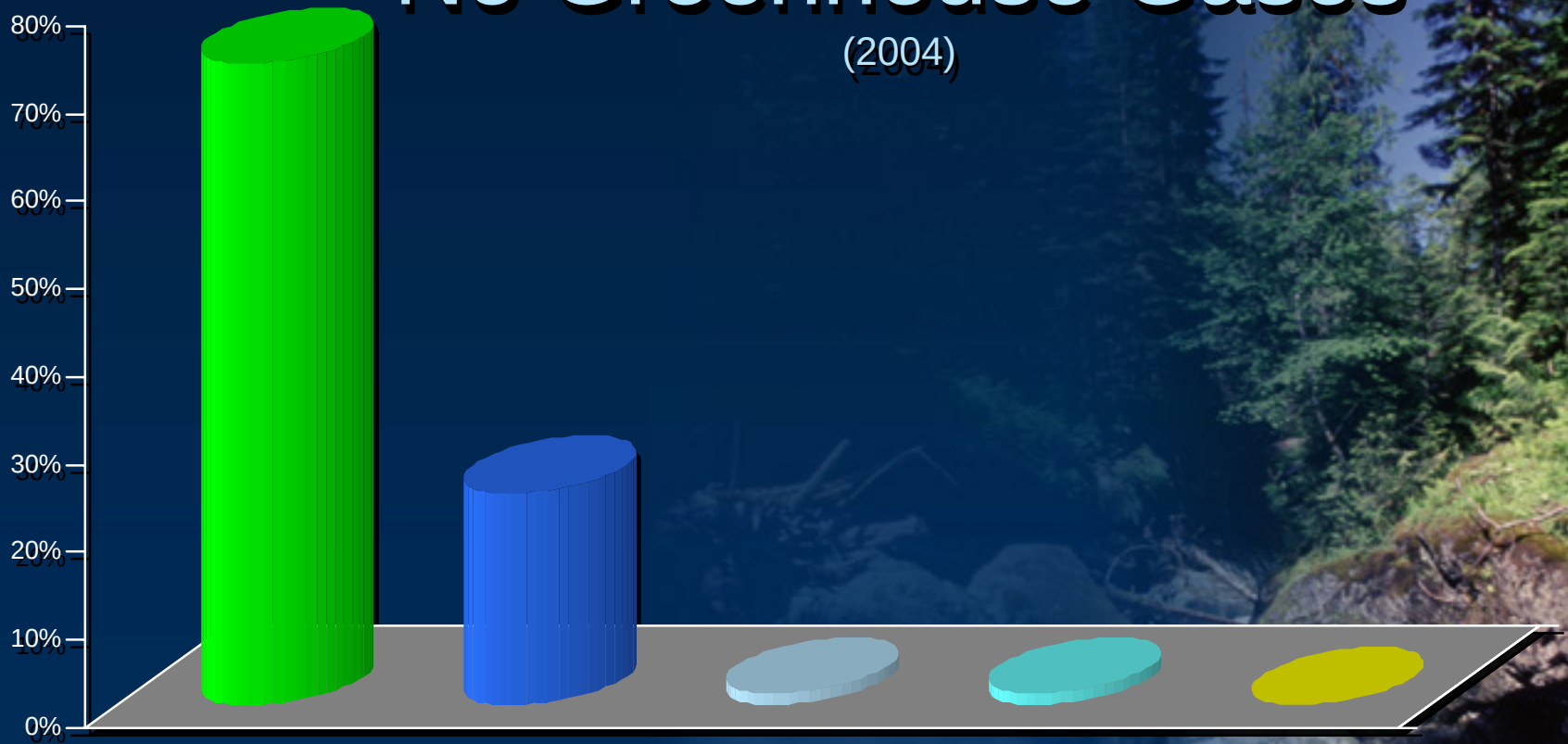
- Consumer activism and politics will drive more change than science in the near term
- Private sector investment will occur once the economics are clear
- New technology will be adopted in the transportation and energy sectors
- States may drive more change than the federal government ( Think global, act local)
- Kyoto Protocol provided a needed platform for debate

# Potential Solutions

- Opportunities
  - Hybrid vehicles and mass transit
    - Smaller aircraft and emergence of regional buses
  - Power Generation and secondary industries
    - Clean Coal, New Nuclear and LNG usage
  - Re-engineering the Infrastructure
    - Replacement of petrochemical technology
    - The power of “green” economics to justify new price structures

# Electricity Sources Emitting No Greenhouse Gases

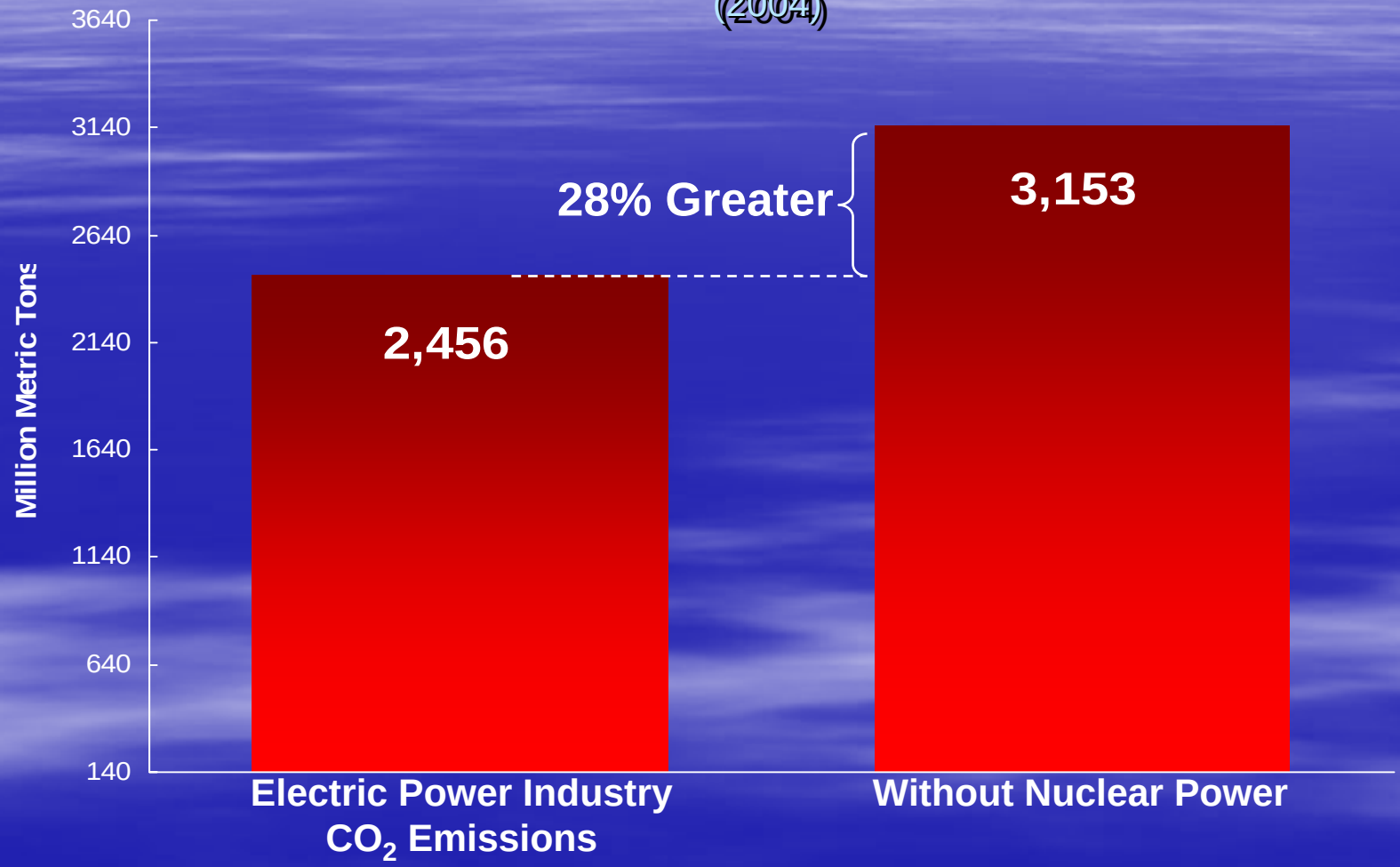
(2004)




*Source: U.S. Energy Information Administration*

# Nuclear Energy Limits Carbon Dioxide Emissions in Power Sector

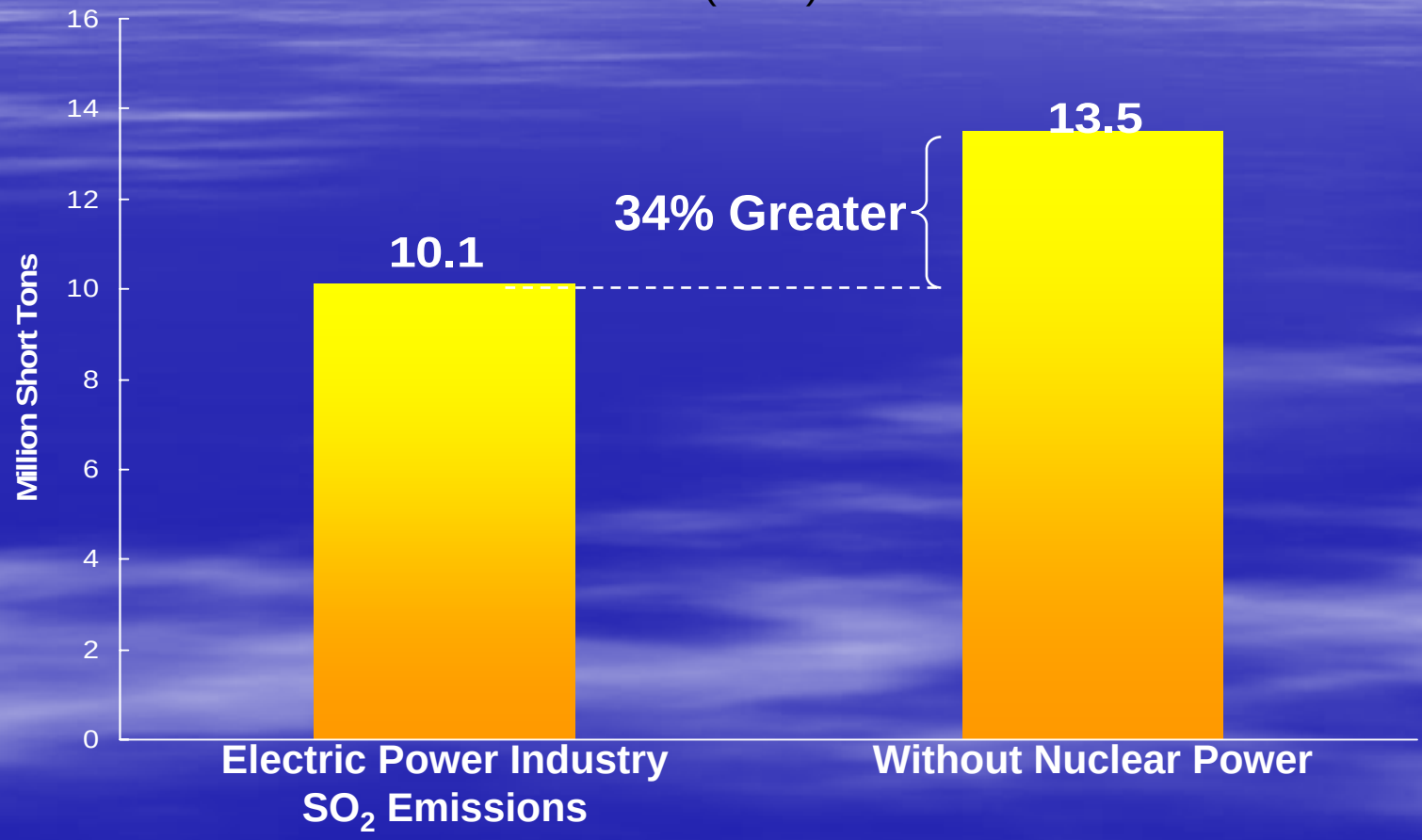
(2004)




*Emissions avoided by nuclear power are calculated using regional fossil fuel emissions rates (from the Environmental Protection Agency's Continuous Emission Monitoring System) and individual plant generation data from NRC. Total emissions are calculated from EPA CEMS data.*

# Nuclear Energy Limits Sulfur Dioxide Emissions in Power Sector

(2004)

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# International Responses

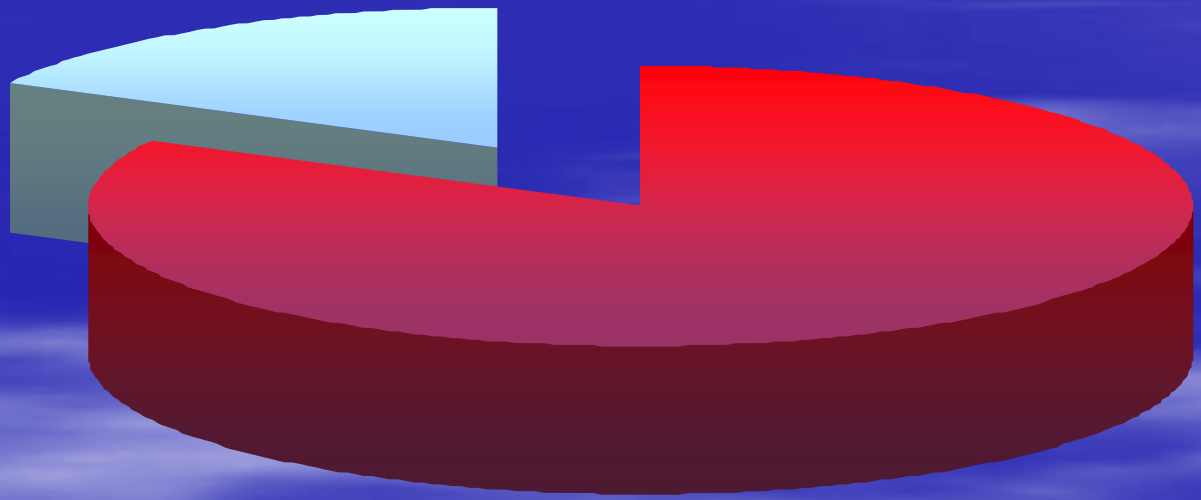
- European decisions on nuclear reactors for Finland and France
- EU “Cap-and-trade” program began in 2005
- Canada considering program for greenhouse gases
- China adding reactors near cities to meet energy demand and enhance air quality

# President Bush's Climate Change Initiative

- Reduce greenhouse gas emissions by 18% by 2012.
- But…nuclear energy expansion will satisfy only 20% of emissions reduction goals.

# Nuclear Energy Will Meet 20% of Carbon Reduction Targets in 2012

**Nuclear energy sector commitment:**
**22 million metric tons of carbon**



**Bush administration's target:**
**106 million metric tons of carbon**

# MIT-Harvard Study:

- Nuclear energy “is an important carbon-free source of power.”
- Tripling world nuclear capacity by 2050 would avoid 25% of added carbon emissions from coal plants.
- The U.S. Energy Policy Act of 2005 provides a production tax credit for 6,000 MW of new nuclear equal to the current credit for wind power.

# Columbia Univ. Earth Institute:

State of the Planet 2004 conference recommends “some combination of renewable and nuclear energy, energy conservation and industrial carbon sequestration” for the future.

# The Answers

- The qualitative impact of Kyoto on future greenhouse gas emissions has been positive. It created the dialogue.
- The impact on global warming rate is still in debate.
- The role of Engineering is to seize opportunity when it occurs, and apply innovative and economically feasible solutions in the near term.