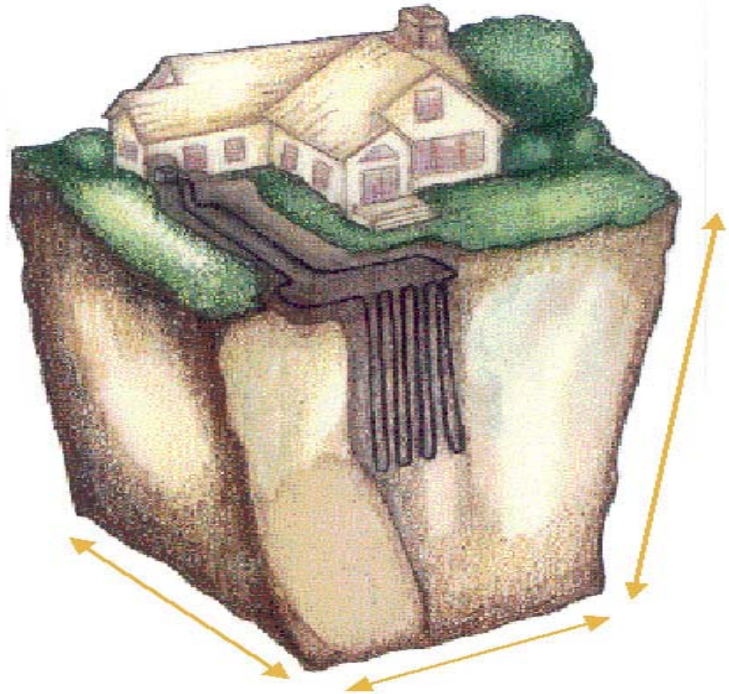
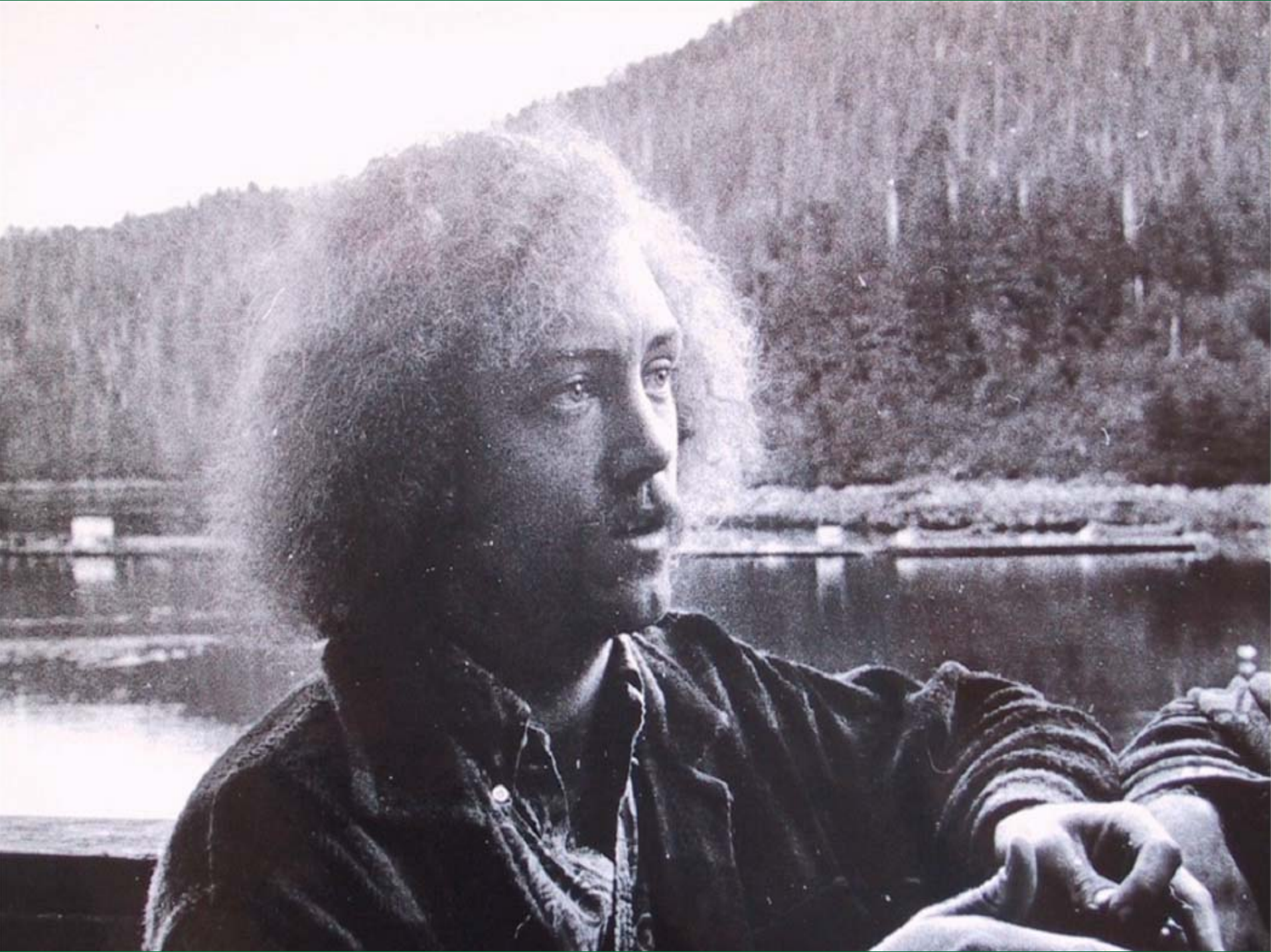
Searching for a Sustainable Energy Future

Canadian Nuclear Association
Ottawa, Ontario – February 23, 2006

Patrick Moore, Ph.D.

Greenspirit Strategies Ltd.



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RAINBOW WARRIOR


RAINBOW WARRIOR


ДАЛЬНИЙ ВОСТОК
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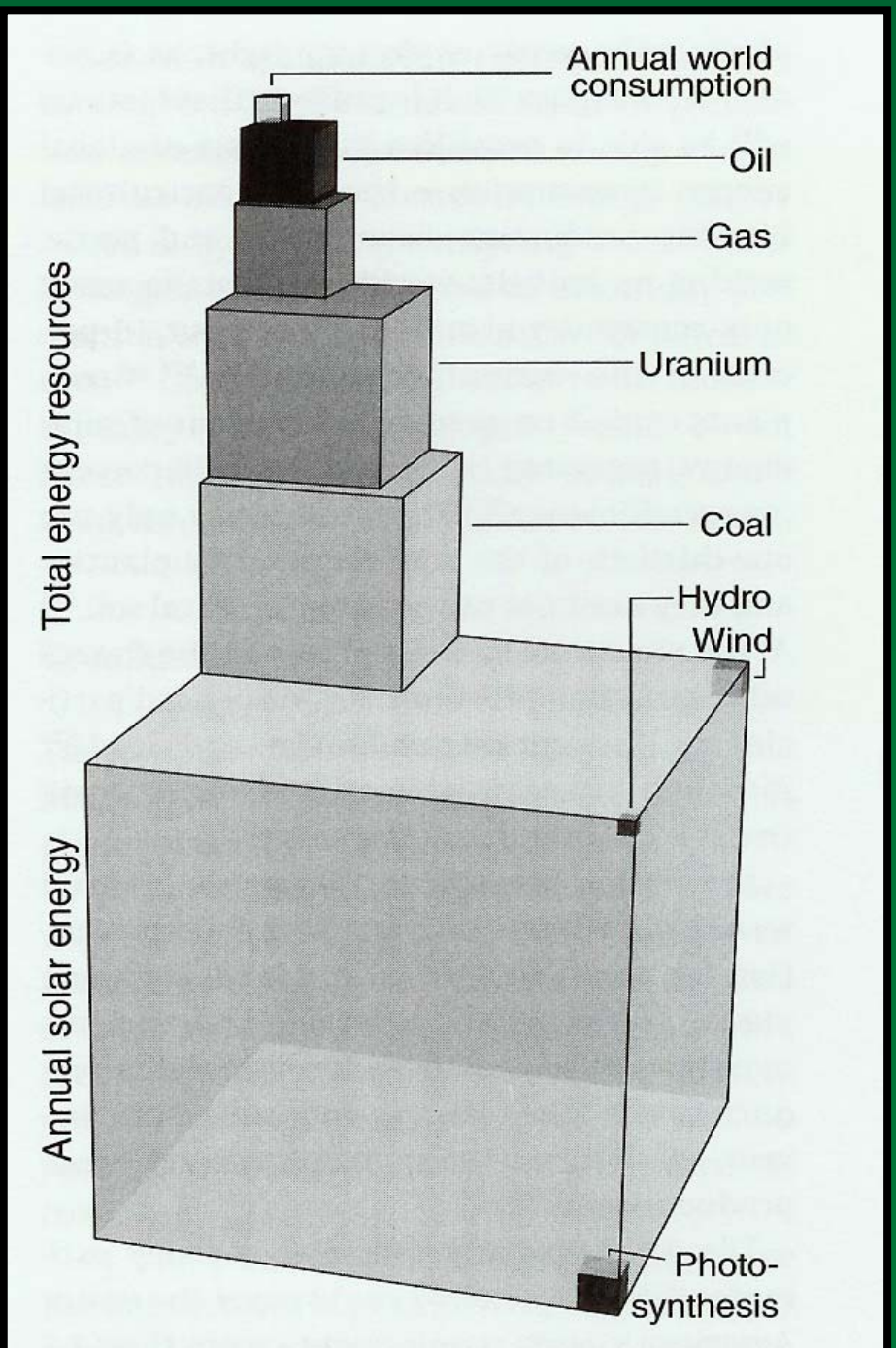
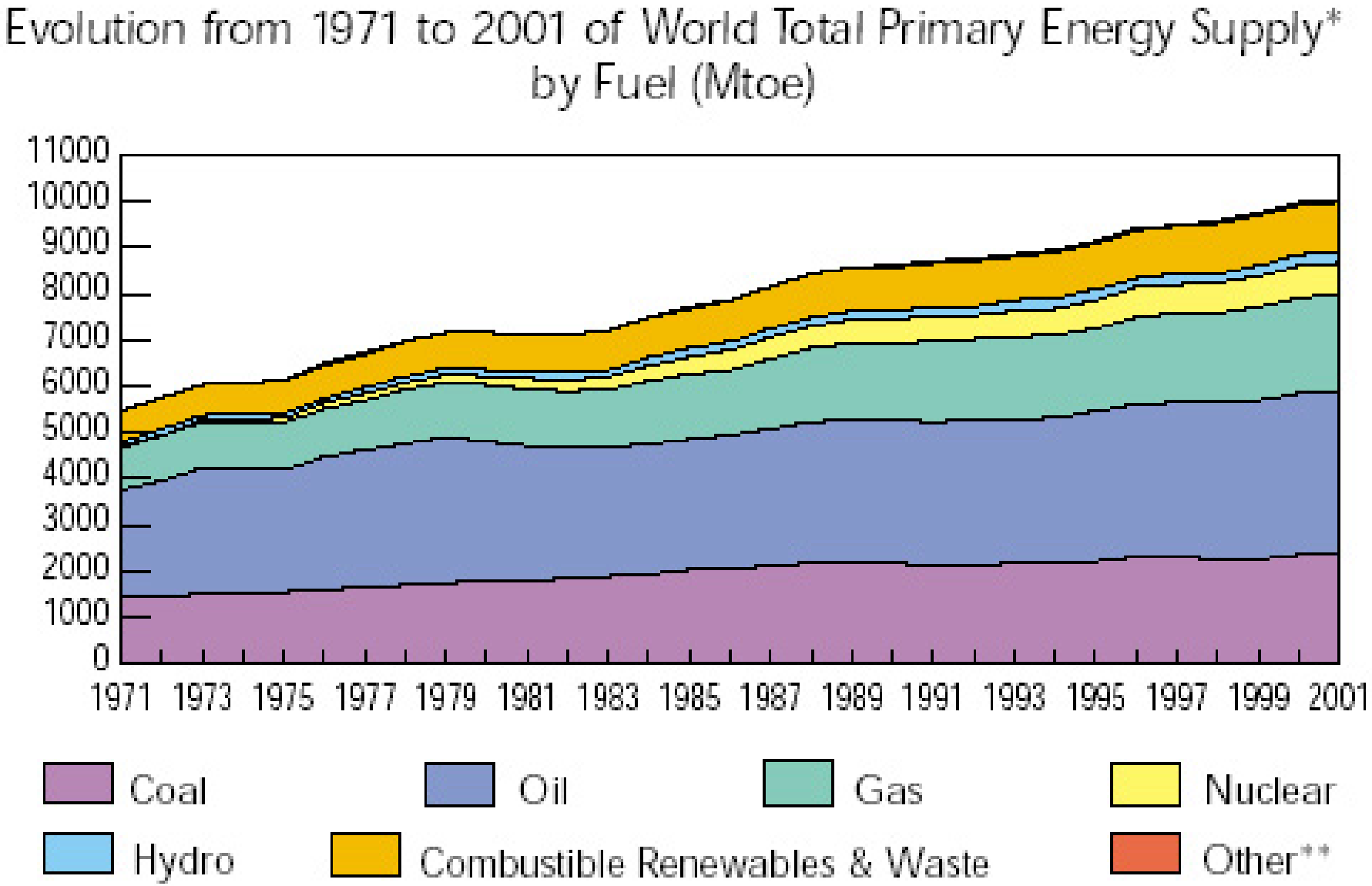


Figure 73 Energy contents in the *annual* solar radiation (2,895,000EJ), compared to the *total* resources of non-renewables (oil 8,690EJ; gas 17,280EJ; uranium 114,000EJ and coal 185,330EJ), and the global, annual energy consumption (400EJ). The potential of the other big renewables are indicated; hydro power can maximally provide 90EJ and wind power 630EJ. For comparison, plant photosynthesis takes up about 1260EJ. All resources and potentials are best guesses and only to be taken as order of magnitude.[972] Source: Craig *et al.* 1996:159, 163, 181, 193, Cunningham and Saigo 1997:505.

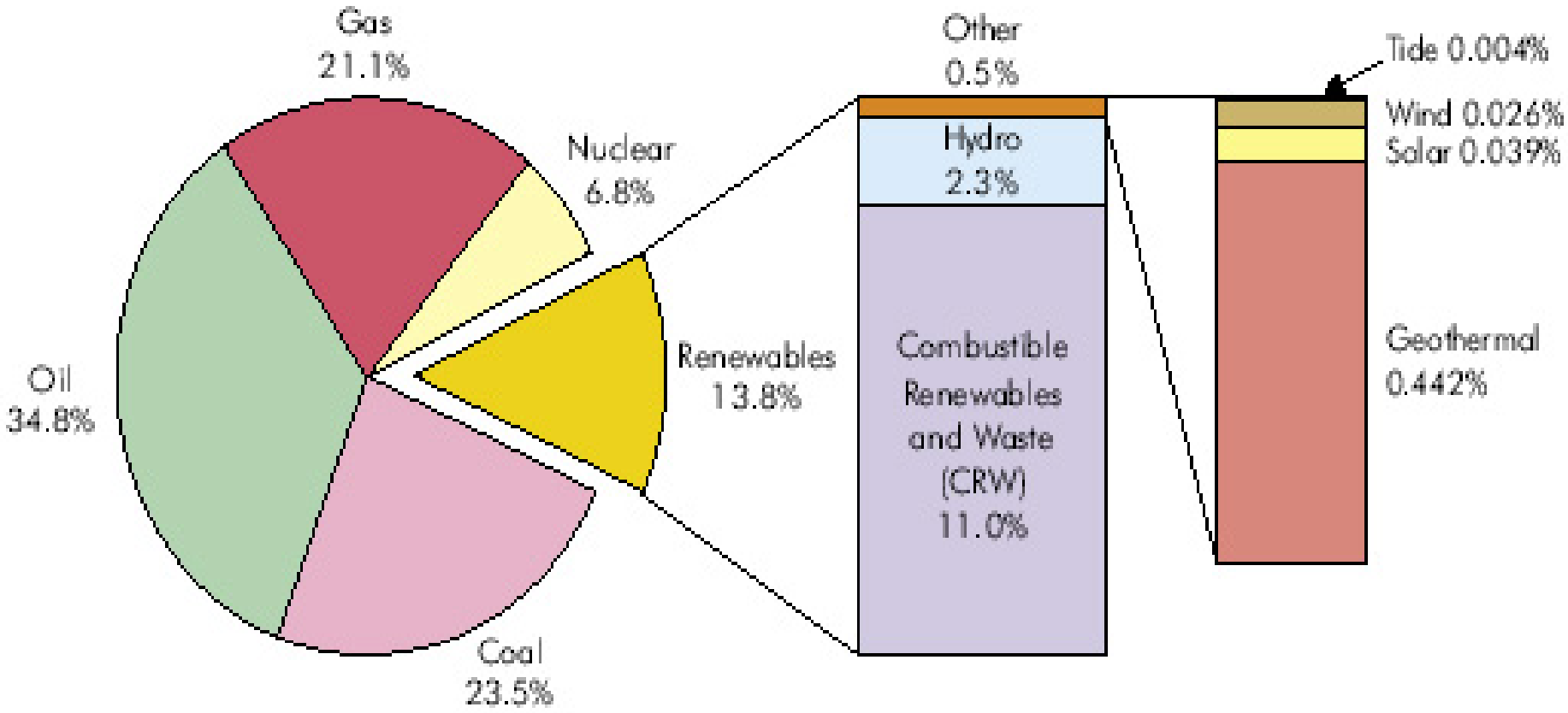
Source: Bjorn Lomborg – The Skeptical Environmentalist



Global Energy Consumption for Major Fuels and Sources

(million tonnes oil equivalent)

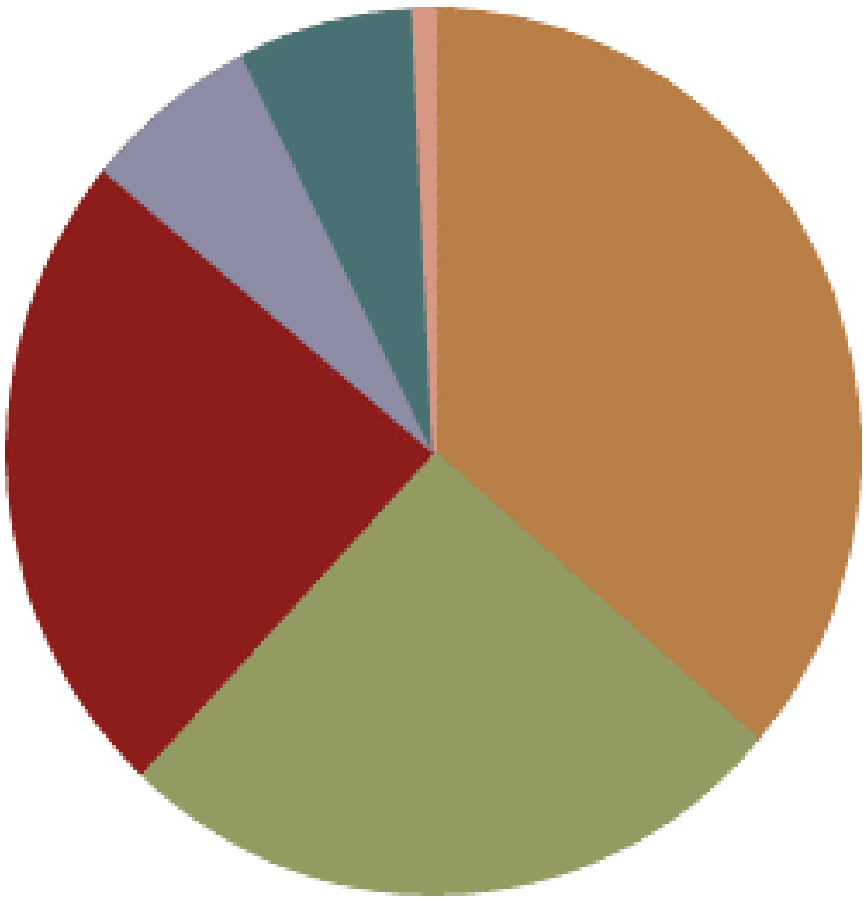
2000 Fuel Shares of World Total Primary Energy Supply*



Break-out of Renewable Energy vs. Non-renewable Energy

(source: International Energy Agency)

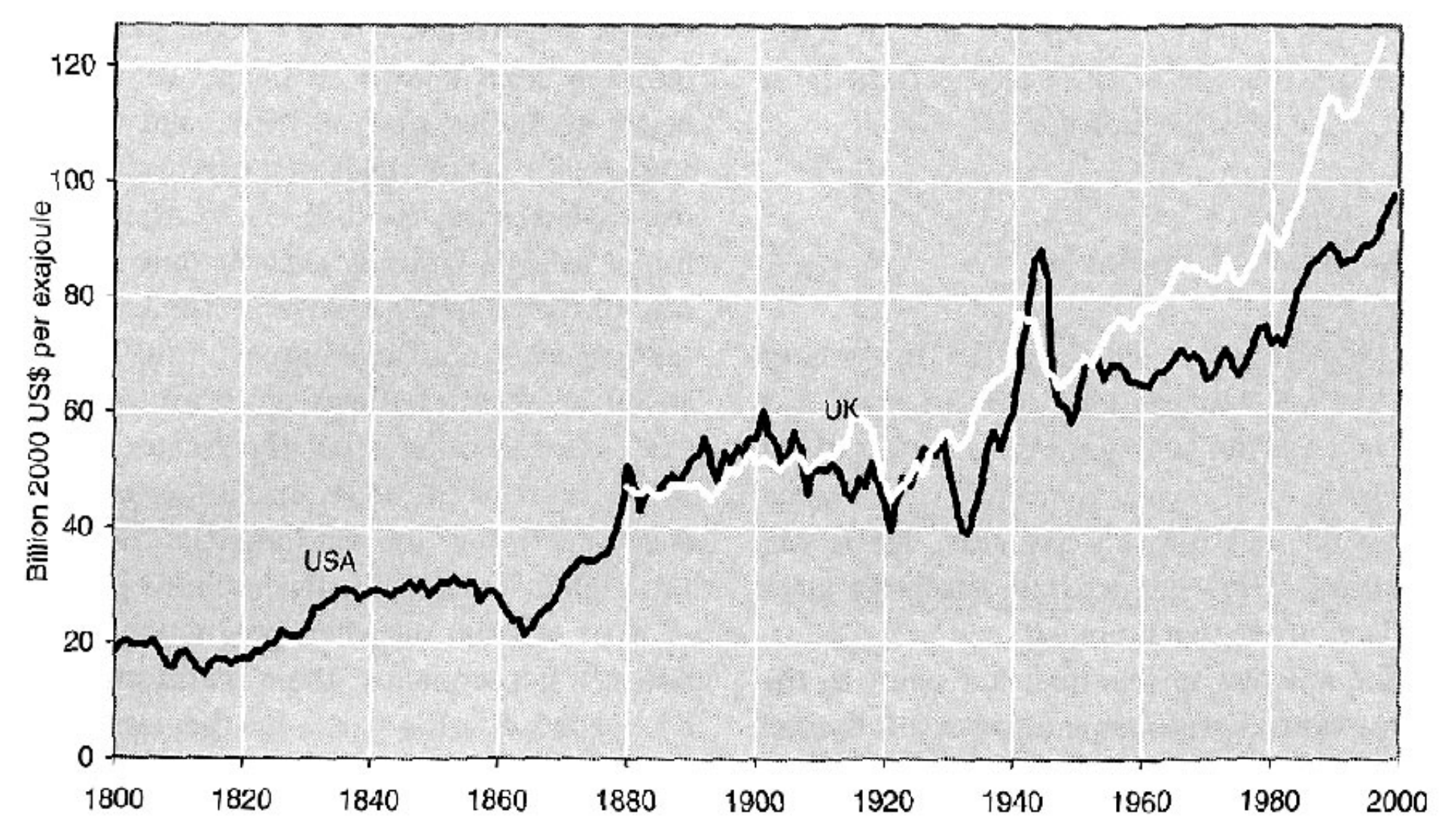
86% of World Energy Produced by Fossil Fuels



- **36.3%** Petroleum
- **25.8%** Natural Gas
- **23.9%** Coal
- **6.7%** Hydroelectric
- **6.6%** Nuclear
- **0.8%** Other*

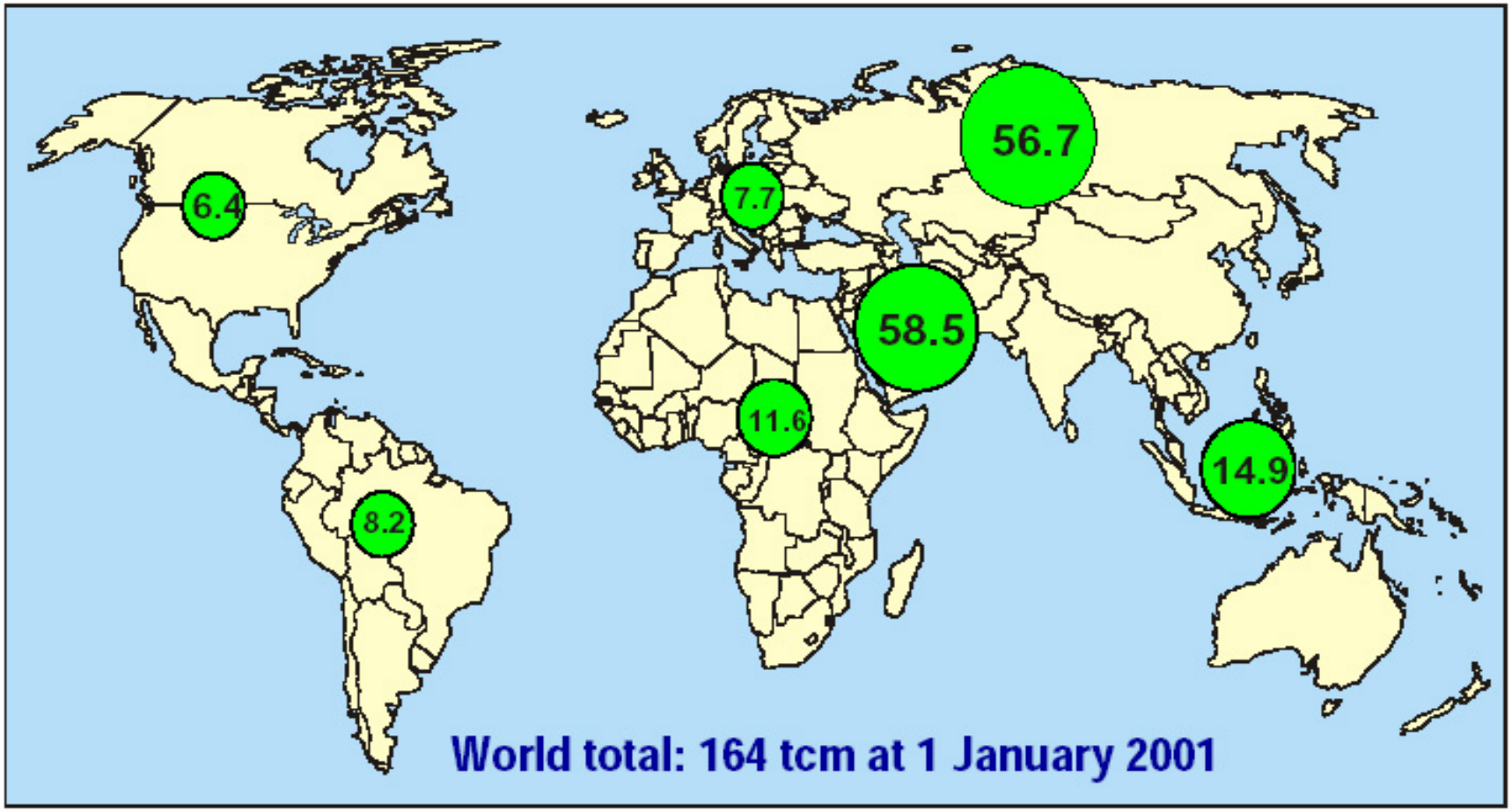
World Energy Production by Source
(not including wood or biomass)

* Includes geothermal, solar, and wind power.
Source: Energy Information Administration, 2001 data.



Five-fold Increase in Energy Efficiency in 200 years

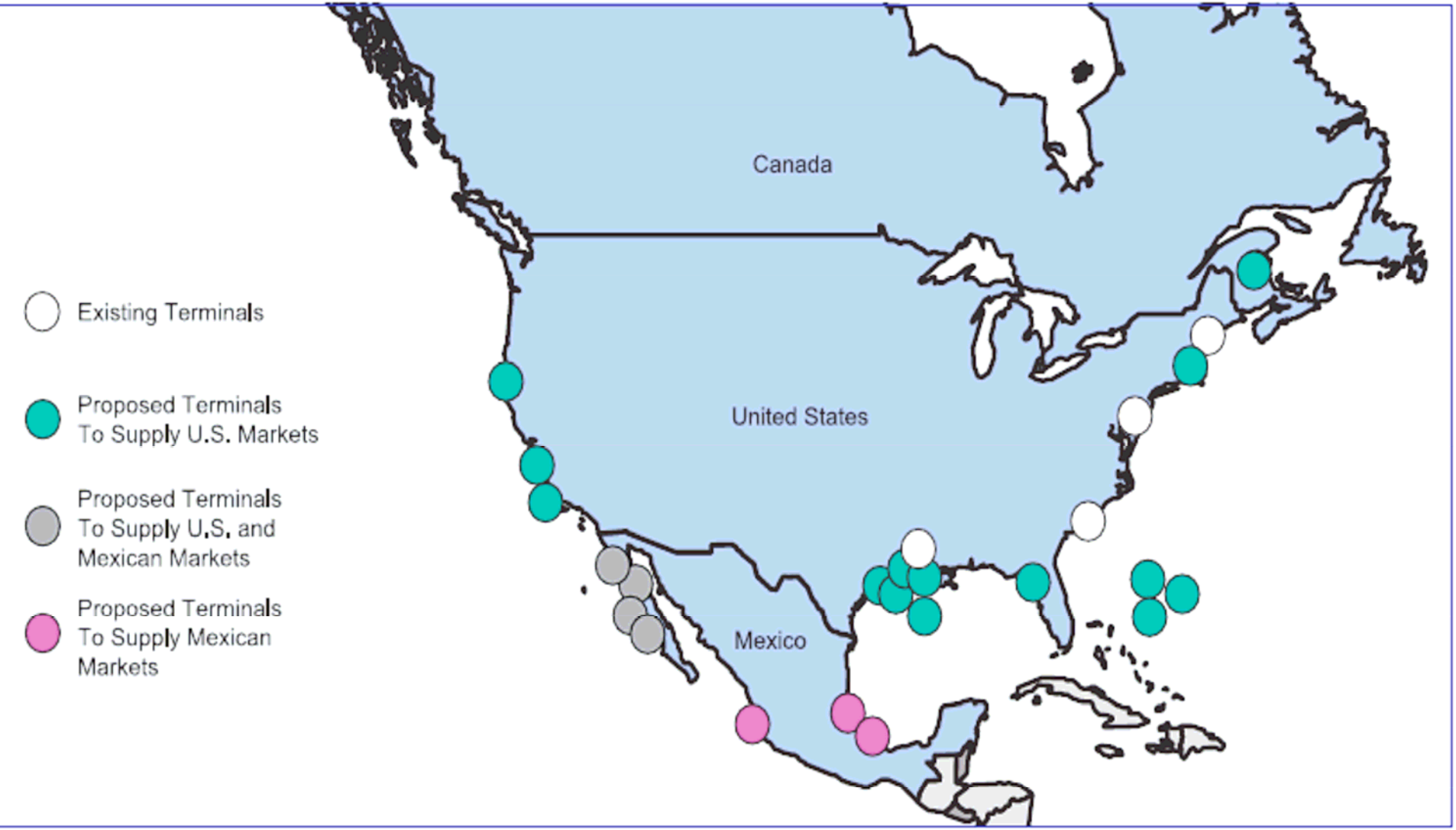
(source: Bjorn Lomborg)



Ultimate remaining resources (including proven reserves) are an estimated 453 - 527 tcm

World Natural Gas Reserves by Region

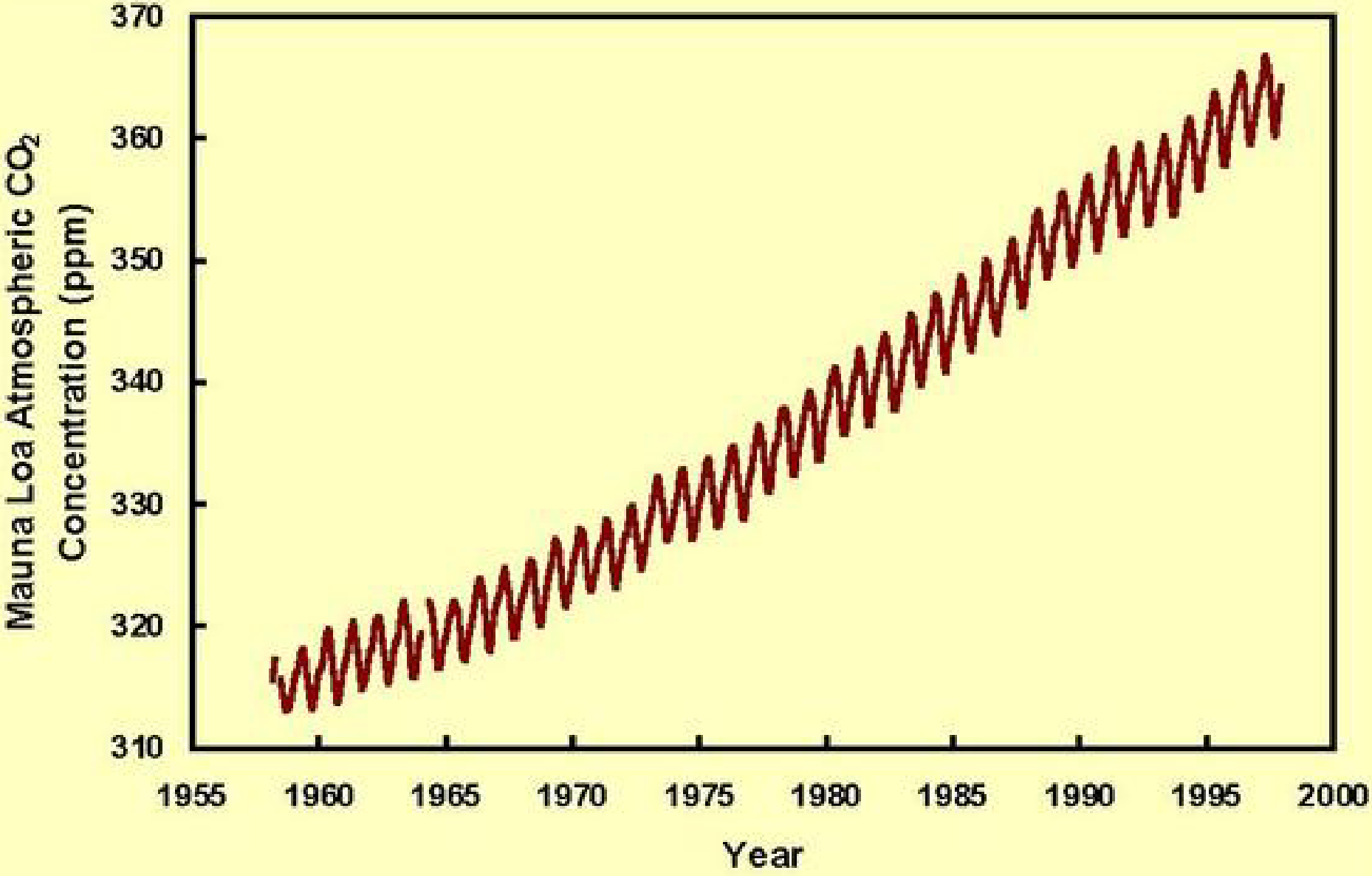
Figure 42. Existing U.S. LNG Terminals and New Terminals Planned in North America



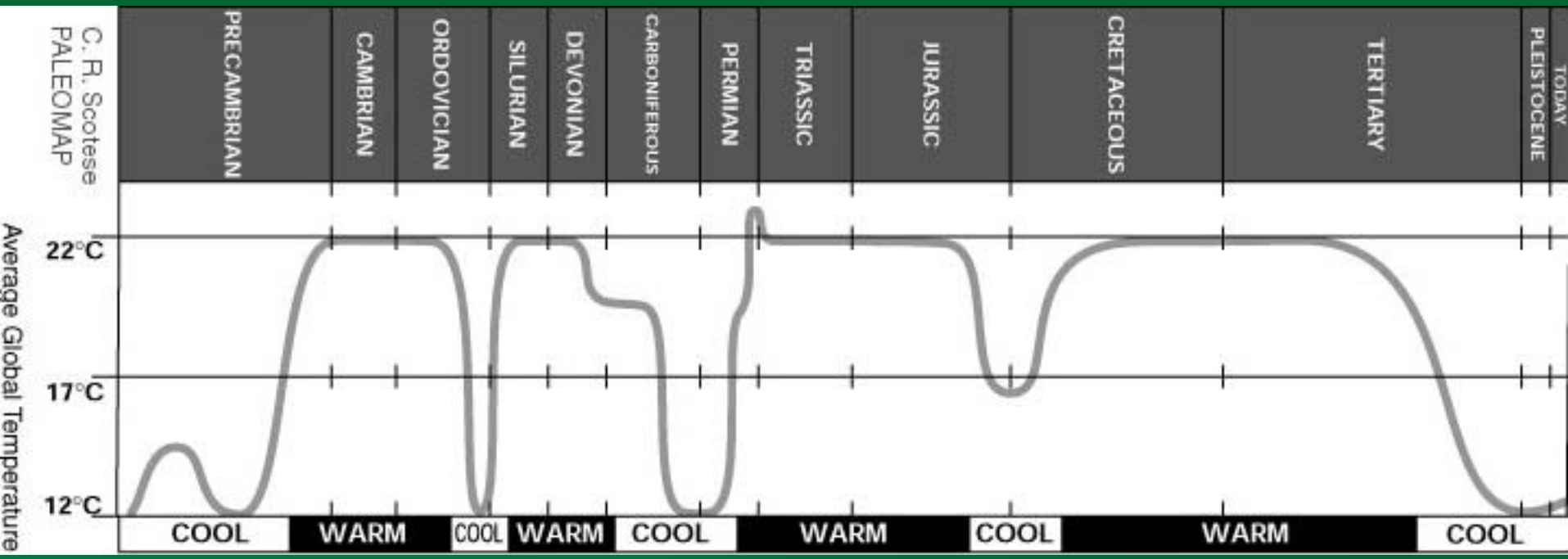
Source: Energy Information Administration.

55 LNG Tankers are Now Under Construction – 133 are Already Operating

About 10% of Global CO_2 Emissions are from Coal-Fired Power Plants in the US and Canada

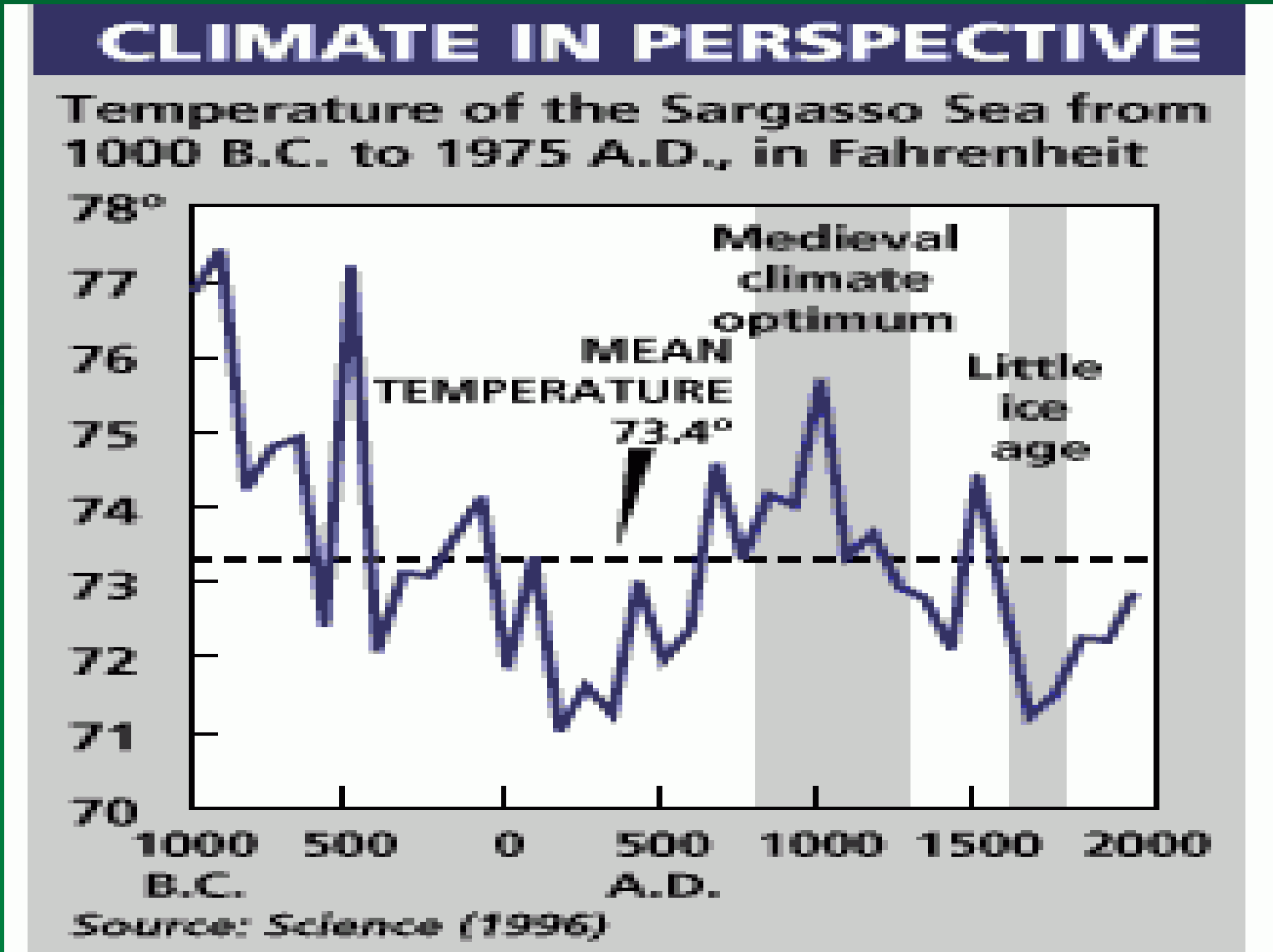


CO_2 Levels in the Global Atmosphere

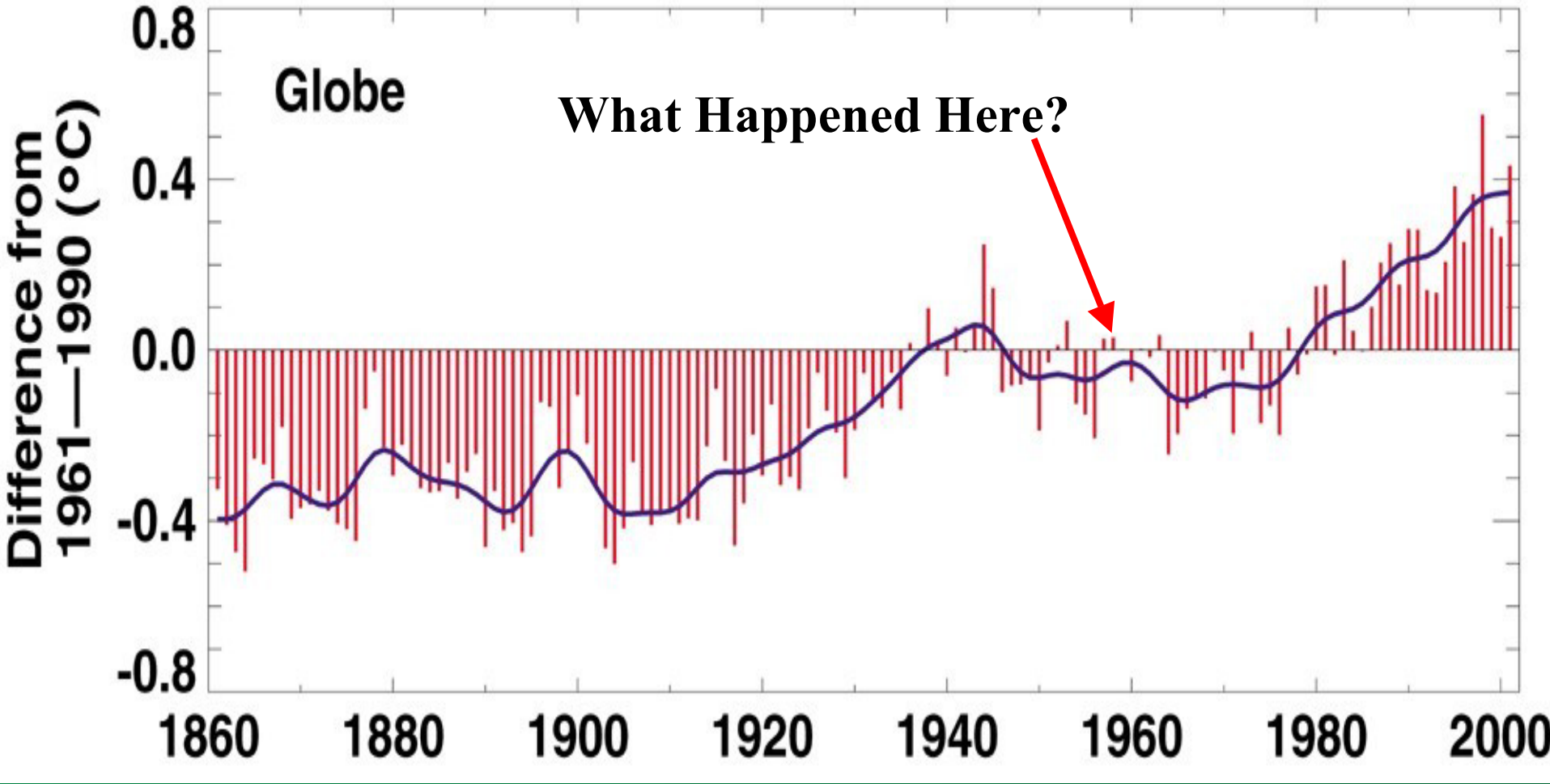


A Billion Years of Global Climate Change

Warmer = Better?



Graph 1 Combined annual land-surface air and sea-surface temperatures from 1860-2001, relative to 1961-1990 for the globe; the solid curves have had sub-decadal time-scale variations smoothed with a binomial filter
(Sources: Climatic Research Unit, University of East Anglia and Hadley Centre, The Met Office)



“There are no experimental data to support the hypothesis that increases in carbon dioxide and other greenhouse gases are causing or can be expected to cause catastrophic changes in global temperatures or weather.”

The Oregon Petition – Opposed to Kyoto – Signed by 19,000 Scientists and Professionals.

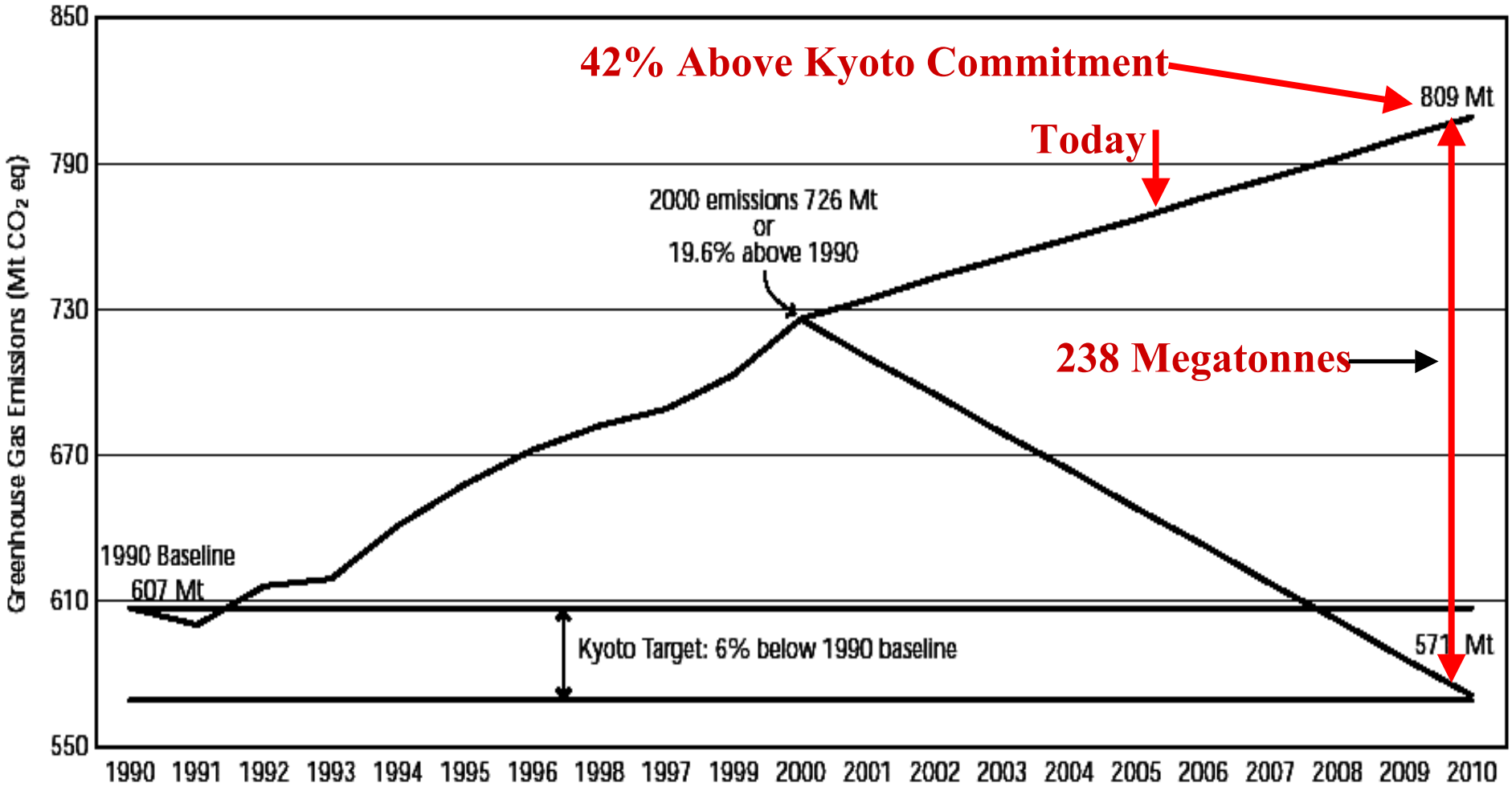
“There is new and stronger evidence that most of the observed warming over the last 50 years is attributable to human activities.“

International Panel on Climate Change – 3rd Assessment Report.

“I am certain that there is too much certainty in the world”

Michael Crichton, “State of Fear”, 2004

Canada's 238-Megatonne Credibility Gap



Sources: Actual Emission Estimates, Baseline (estimates presented in this report); Forecast: McIlveen, N. (2002), personal communication, Analysis and Modelling Group, Natural Resources Canada.

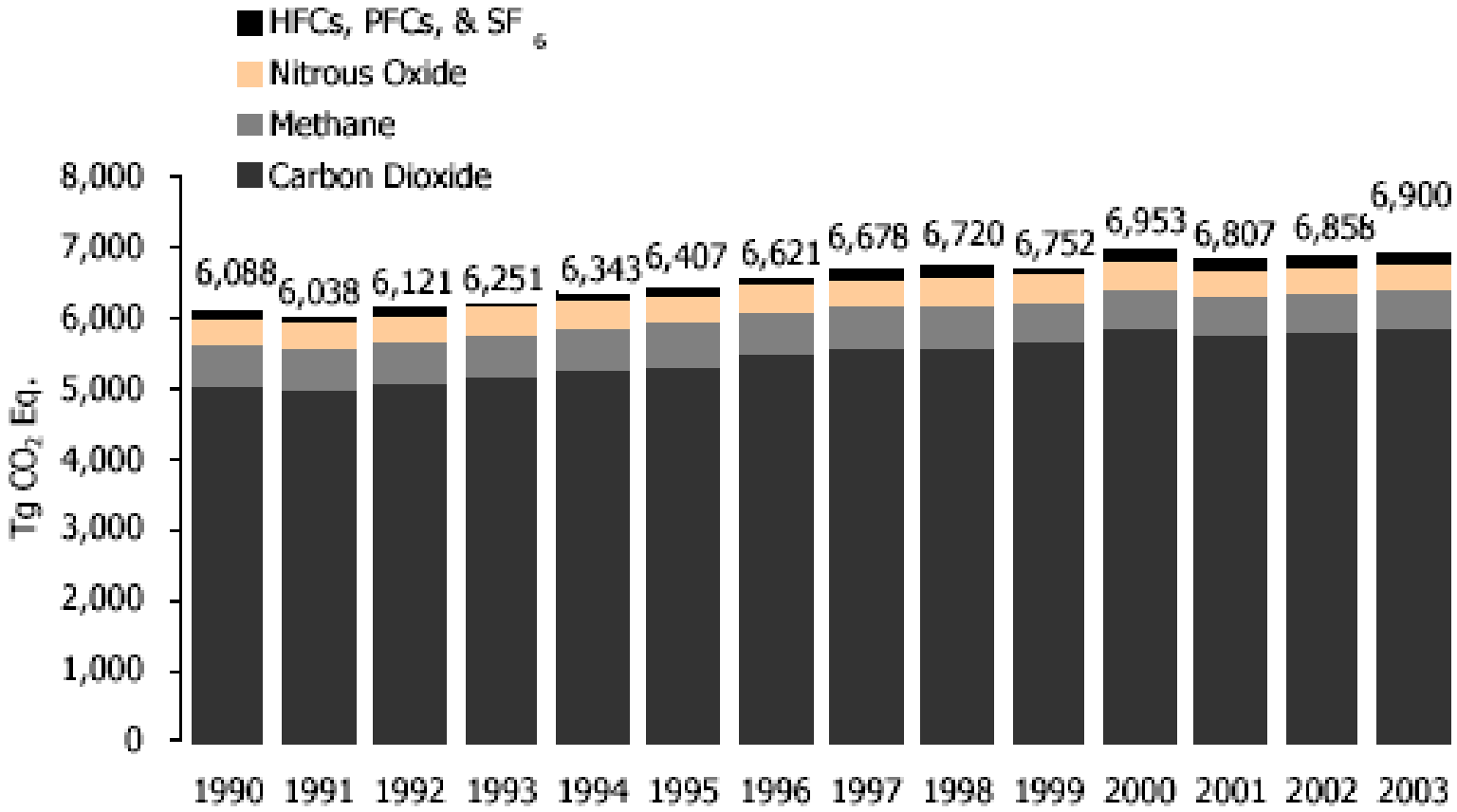


Figure ES-1: U.S. GHG Emissions by Gas

US Greenhouse Gas Emissions - 14% Increase Since 1990

Wood is the Most Abundant Renewable Source of Material and Energy

About 50%, 2 billion tonnes, of the wood harvested annually is used for cooking and heating, mainly in the tropical developing countries. Wood and hydro are the most abundant forms of renewable energy used today.

Clever Wood-Stove For Cooking Chicken

Food +
Timber

+
Biofuels?

Biofuels – How Much Land is Available?

Biomass Will Make a Difference

Turning South Dakota into…

	Today	Tomorrow
Farm acres	44 Million	44 Million
Tons/acre	5	15
Gallons/ton	60	80
Thousand barrels/day	857	**3,429**

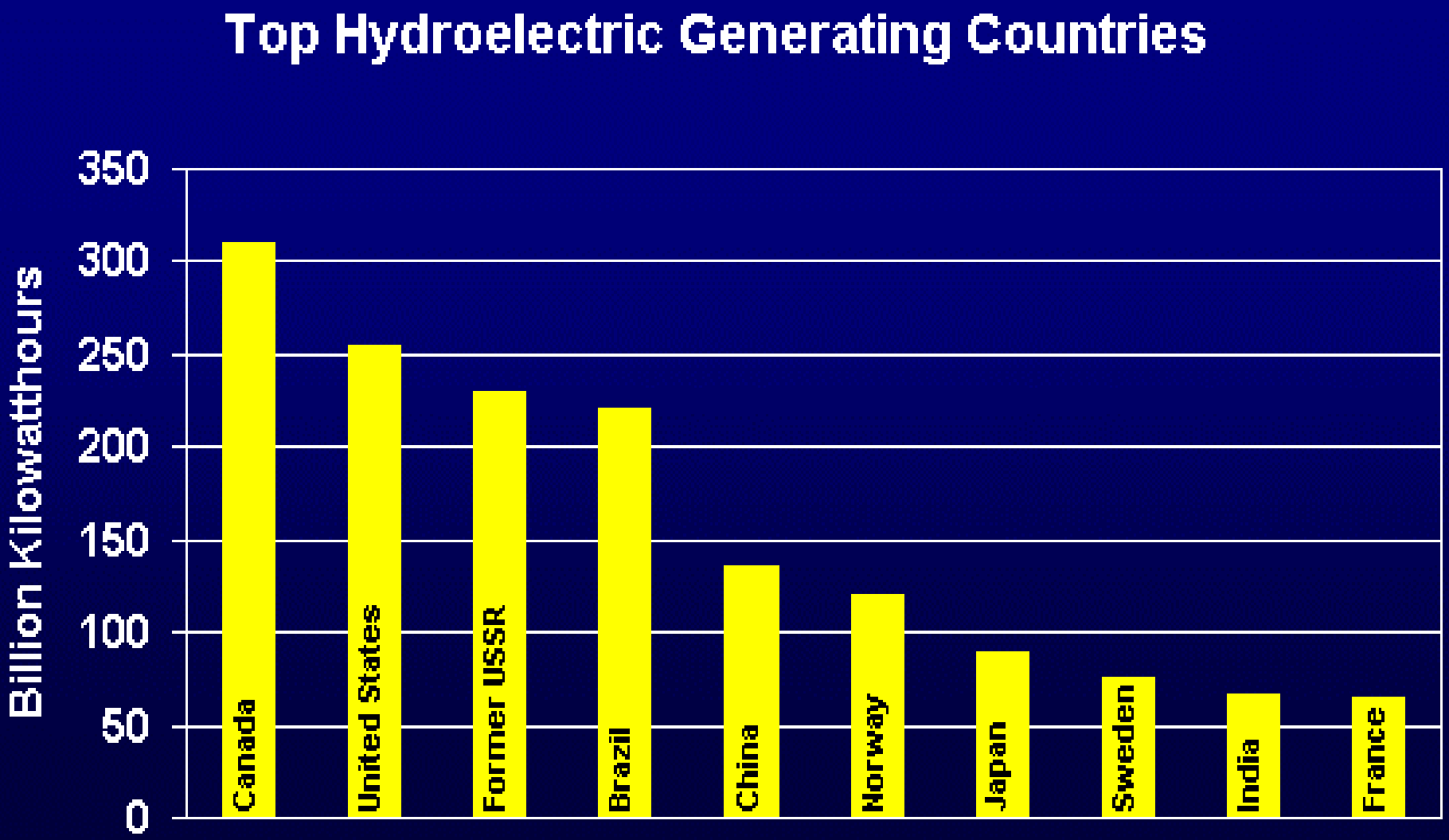
…a member of OPEC?!

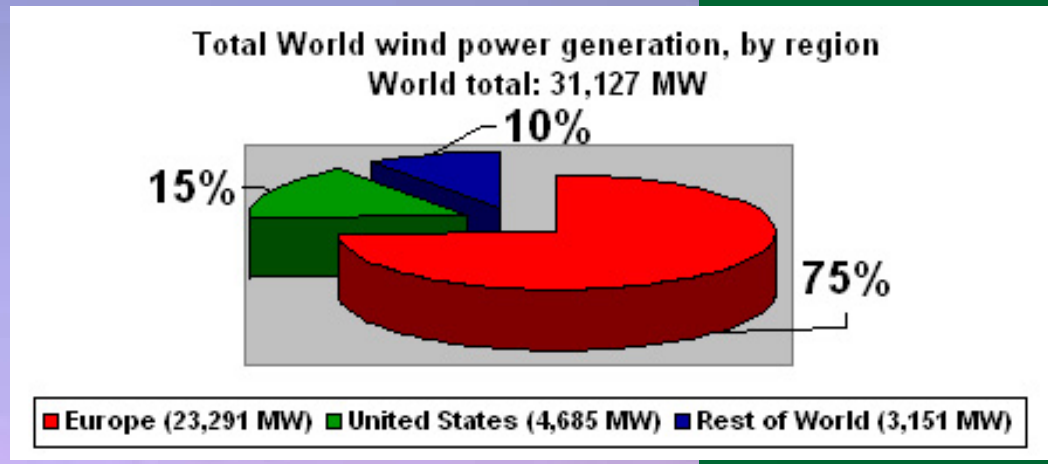
	Thousand barrels/day
Saudi	9,101
South Dakota	*3,429*
Nigeria	2,509
UAE	2,478
Kuwait	2,376
Iraq	2,011
Libya	1,515
Qatar	818

…or ~30% of U.S. transportation fuel supply!!

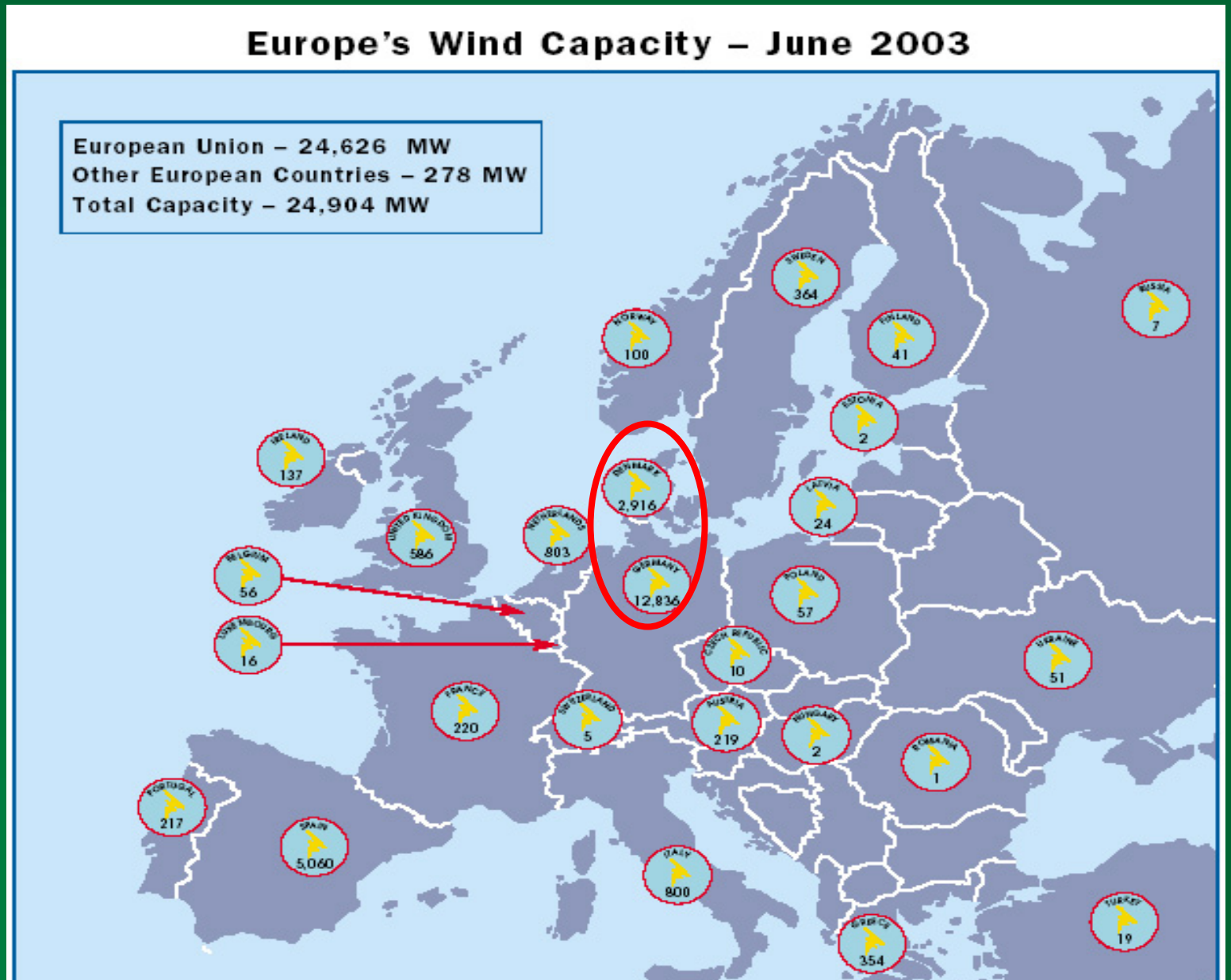
Hydro Supplies 20% of Global Electricity Production

Canada and US Lead in Hydroelectric Generation




Total World wind power generation, by region
World total: 31,127 MW
10%
15%
75%
Europe (23,291 MW)
United States (4,685 MW)
Rest of World (3,151 MW)

Germany and Denmark Generate 50% of Global Wind Energy



Transportation is the Greatest Challenge for CO_2 Emissions Reduction

Toyota Highlander Hybrid
Energy-efficient Gas-Electric Hybrid

GRAB LIFE BY THE HORNS

DODGE

THE CHARGER HYBRID– IT BURNS GAS AND RUBBER.

CHARGER UNLEASHED › 340 horses of HEMI® power › 390 lb-ft of torque › All-speed traction control › Electronic Stability Program › 5-speed AutoStick® transmission › Visit dodge.com or call 800-4ADODGE

Hybrid Locomotive

15% less fuel, 15% fewer emissions

Who would have dreamed that a 415,000 lb. diesel locomotive could have an environmental conscience? The Evolution™ Series locomotive is designed to be more fuel efficient and more powerful while it exceeds stringent EPA emissions standards, making the air cleaner and clearer for all. This is the "little" engine that could. And will.

Hydrogen – Reality or Pipe Dream?

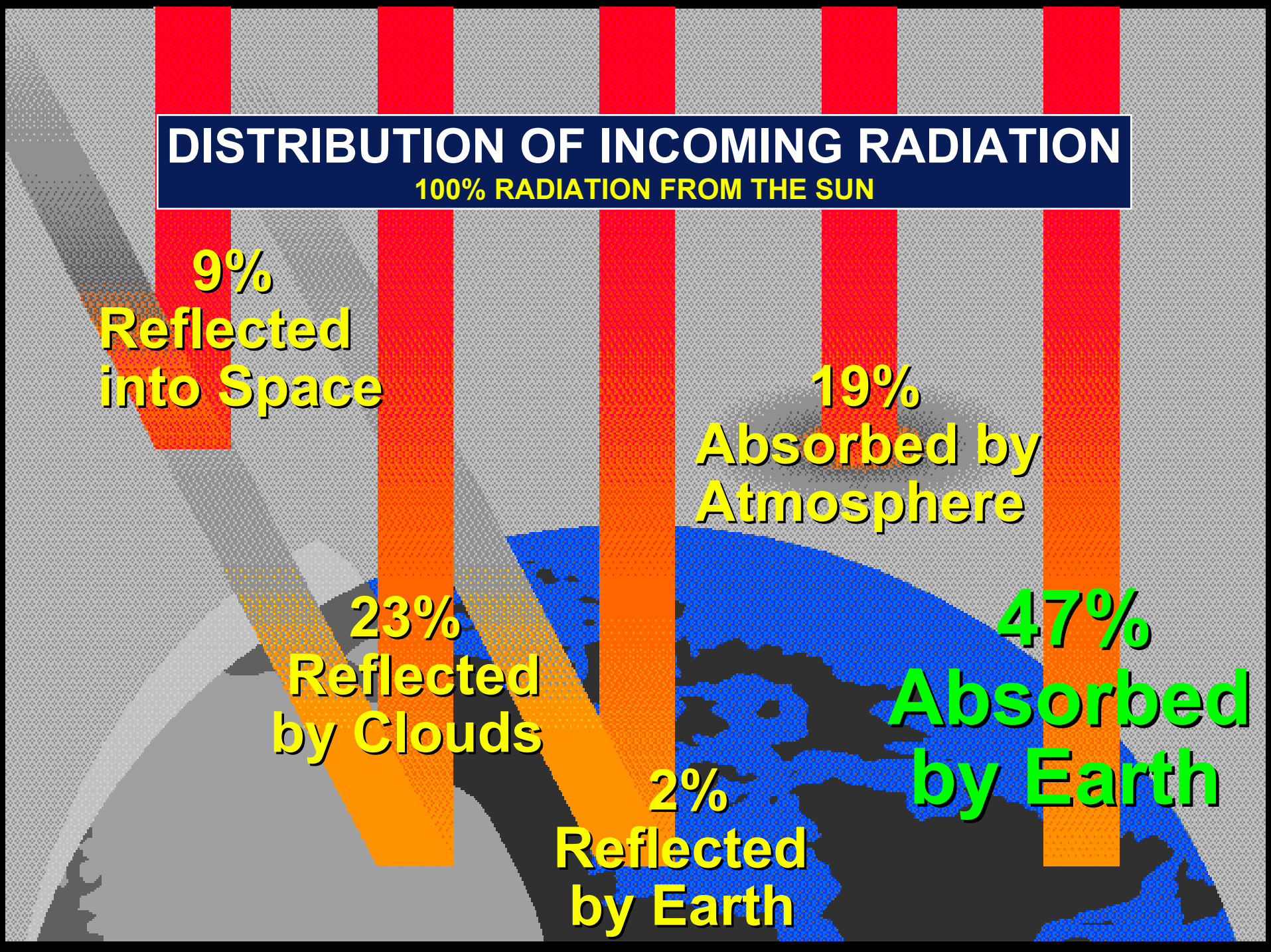
DaimlerChrysler Fuel Cell Vehicle

Geothermal Energy

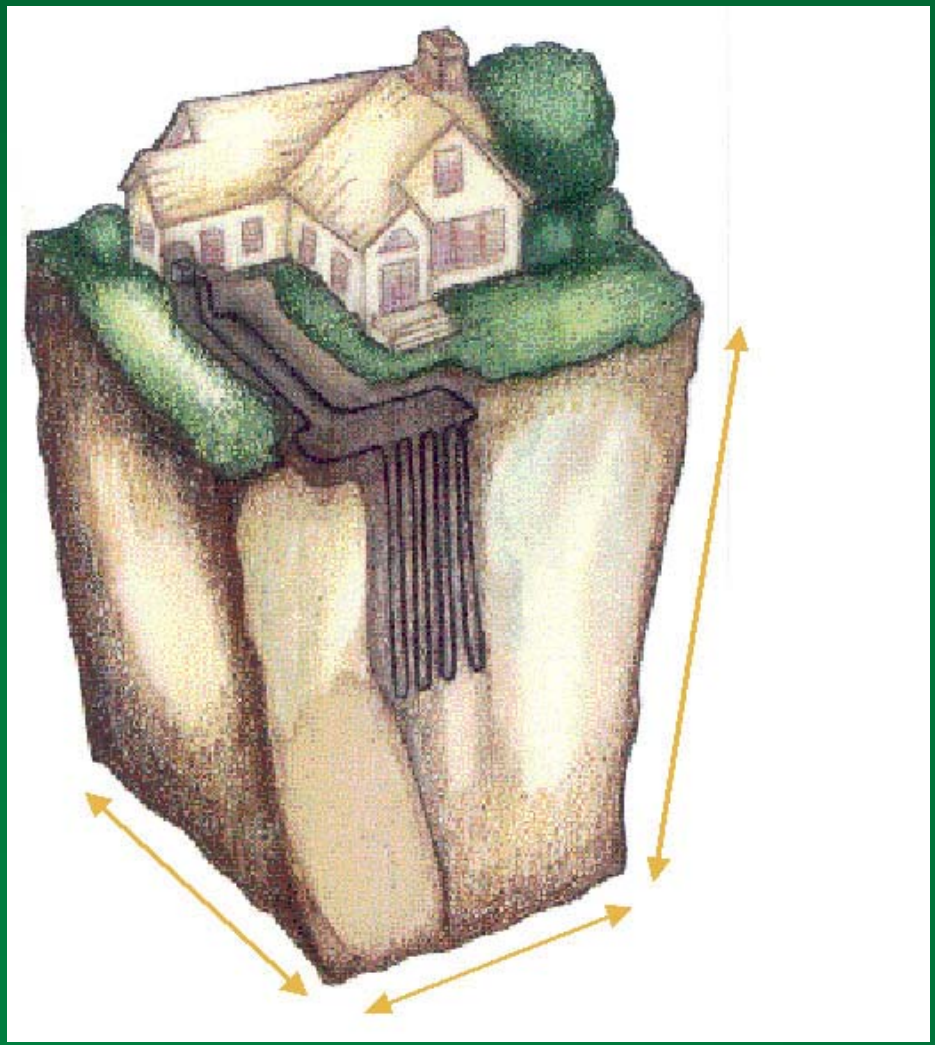
(Ground Source Heat Pumps)

Affordable – Renewable - Clean

- Geothermal is cost-competitive with all other technologies for heating, cooling and domestic hot water production. Over the long term it is economically superior to all other systems.
- Geothermal is renewable – it is basically stored solar energy, available on demand from the ground beneath any building.
- Geothermal energy produces no emissions. This technology is one of our most powerful tools for reducing CO_2 emissions and reducing greenhouse gas emissions.


DISTRIBUTION OF INCOMING RADIATION
100% RADIATION FROM THE SUN
9%
Reflected
into Space
19%
Absorbed by
Atmosphere
23%
Reflected
by Clouds
47%
Absorbed
by Earth
2%
Reflected
by Earth

Geothermal:



More Energy Than a Home Can Use.

Energy Available:
120 kW on Demand

Energy Required:
5 kW Average Home

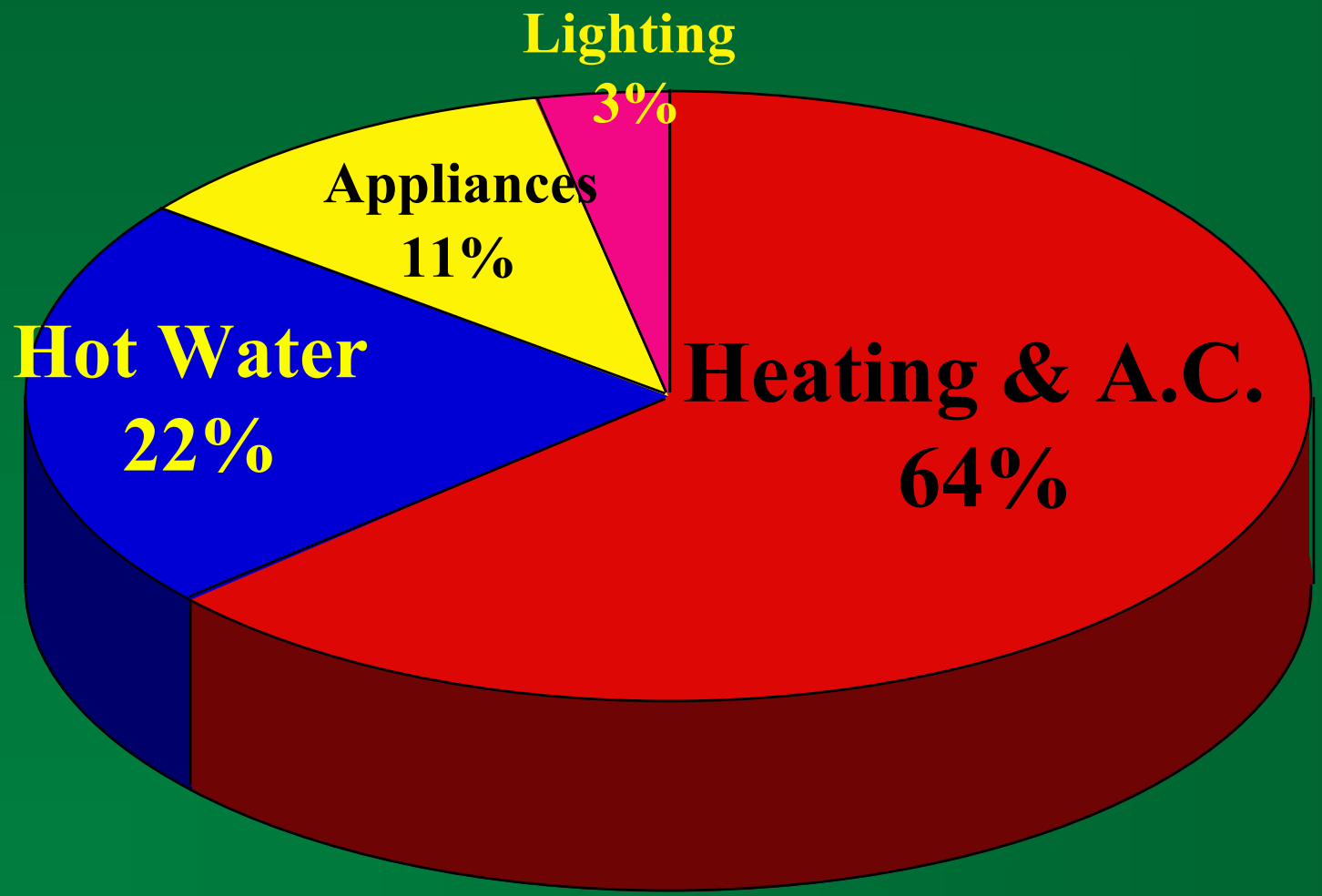
Geothermal Renewable Energy Concept

1 kW Electrical Energy from the Grid

3-4 kW of Renewable Energy delivered on demand from the Earth

4-5 kW Heat Delivered

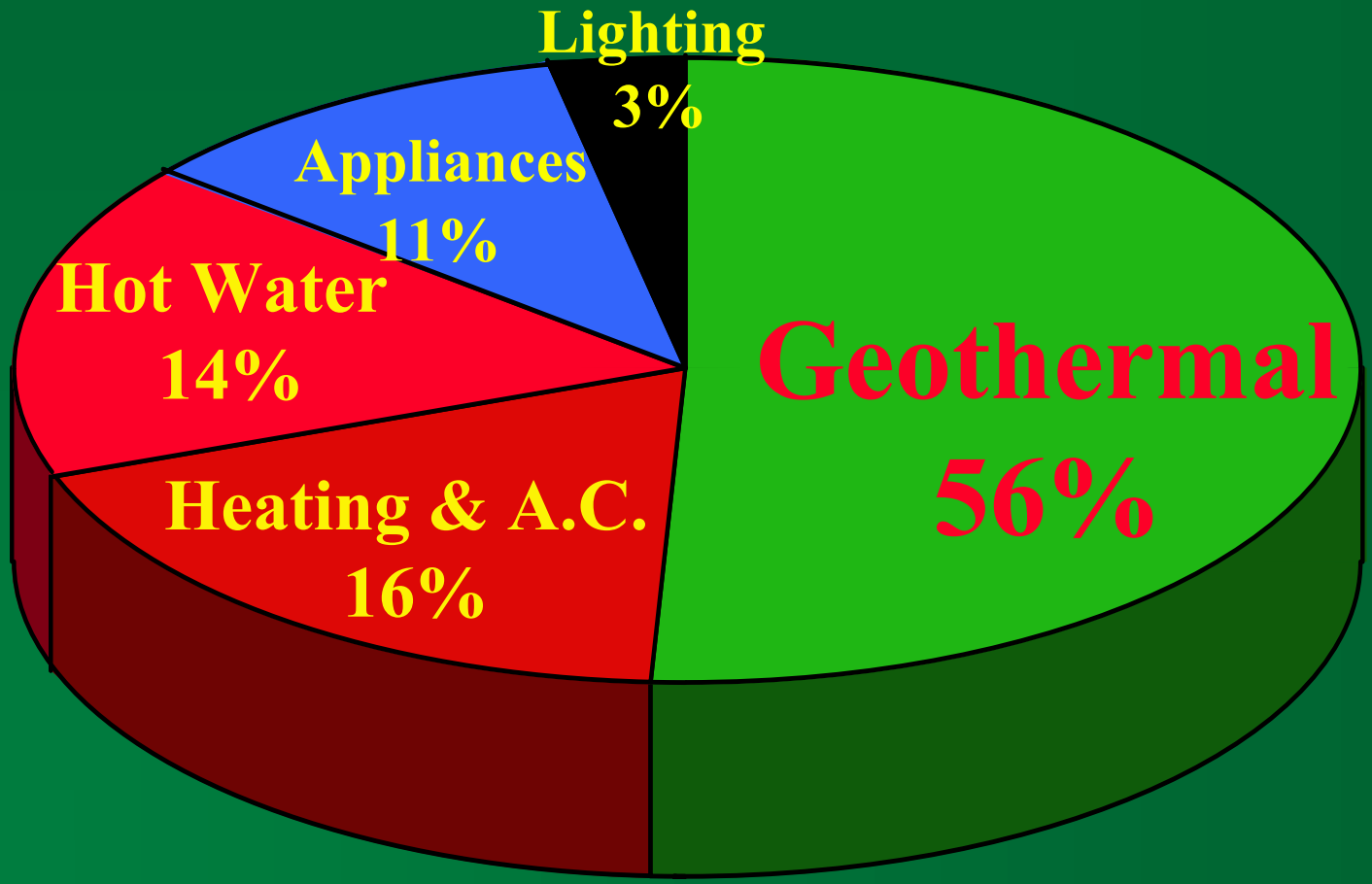
Residential Energy Use
(86% for Heating and Cooling)



Conventional System

Residential Energy Use

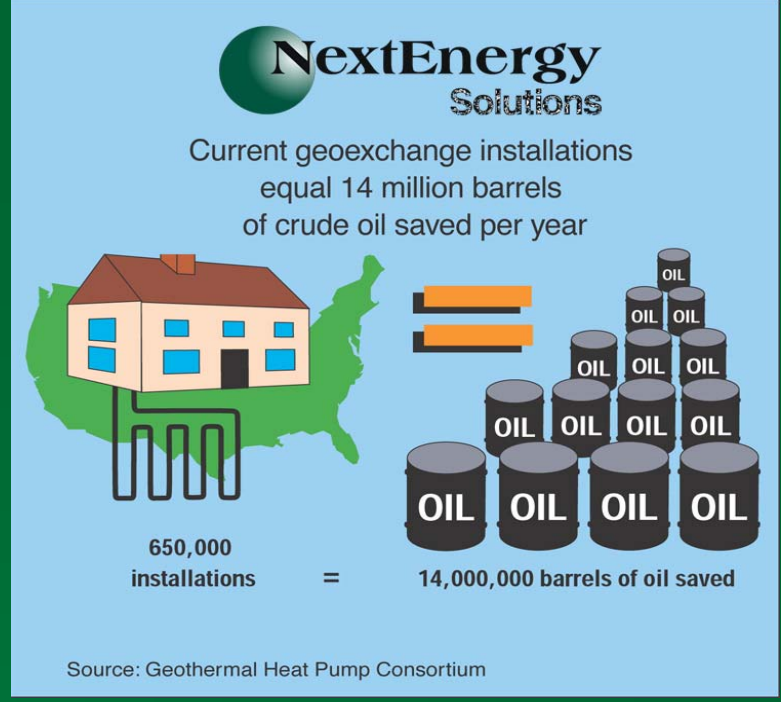
(If Electricity Supply is Renewable the Building is 100% Renewable Energy and Zero CO_2 Emissions)

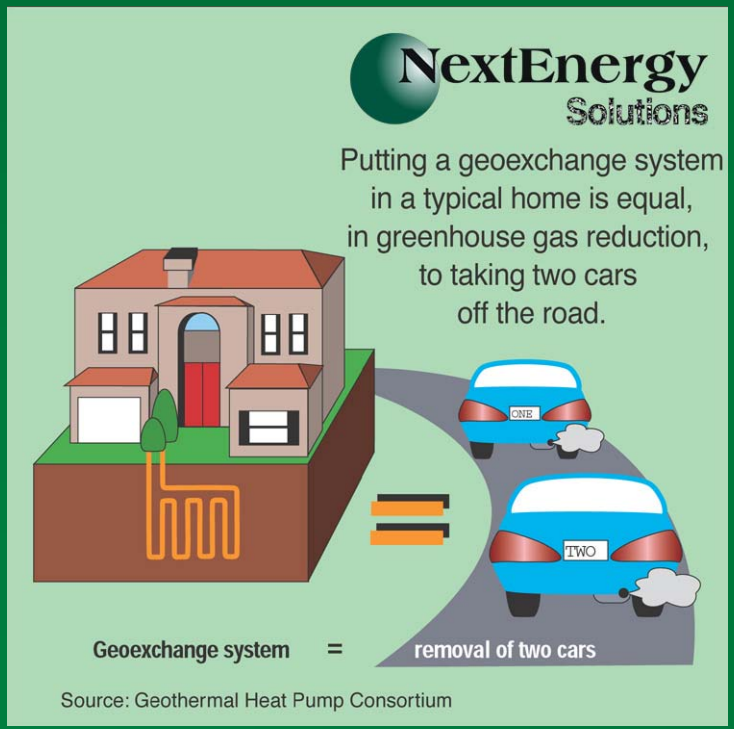


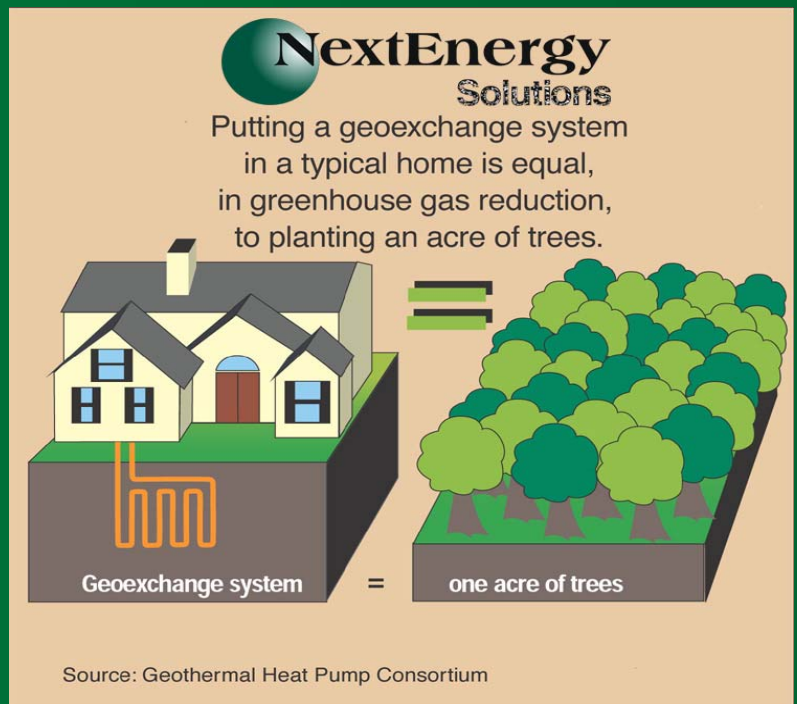
Geothermal Technology

CO2 Emission Reductions

Source:
Geothermal Heat Pump Consortium, Washington D.C.



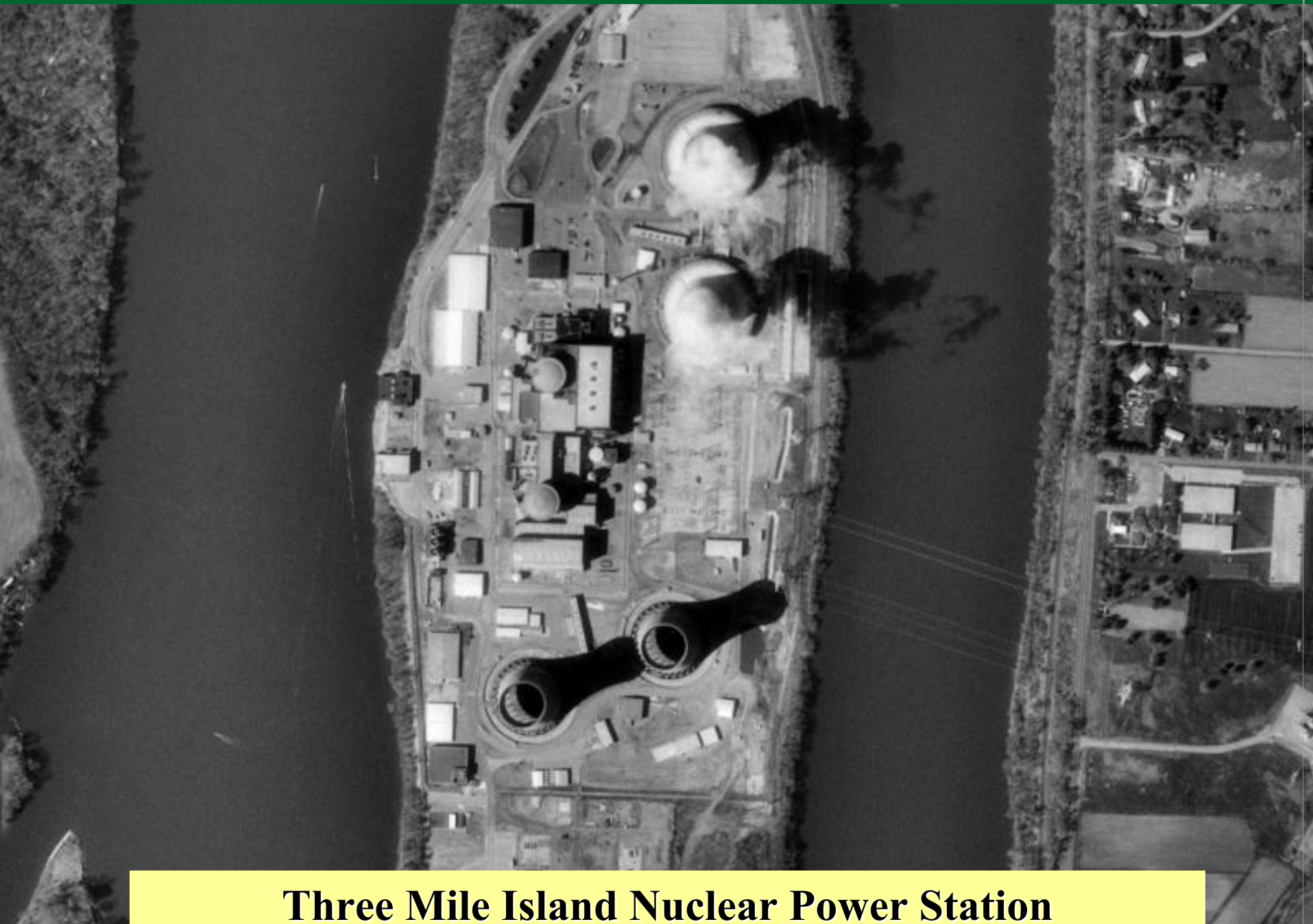




Geothermal Compared to Solar Panels*

- **$20,000 invested in solar panels produces about 1500 KWhrs/year or about $100 worth of energy.**
- **$20,000 invested in geothermal produces the equivalent of 20,000 KWhrs/year or about $1300 worth of energy.**
- **Both technologies are renewable and can help reduce greenhouse gas emissions. Geothermal produces about 13 times the energy and CO2 emissions reduction for the same investment. Which would you choose? Which would you promote?**

* Approximate for southern Ontario



Three Mile Island Nuclear Power Station

Chernobyl:

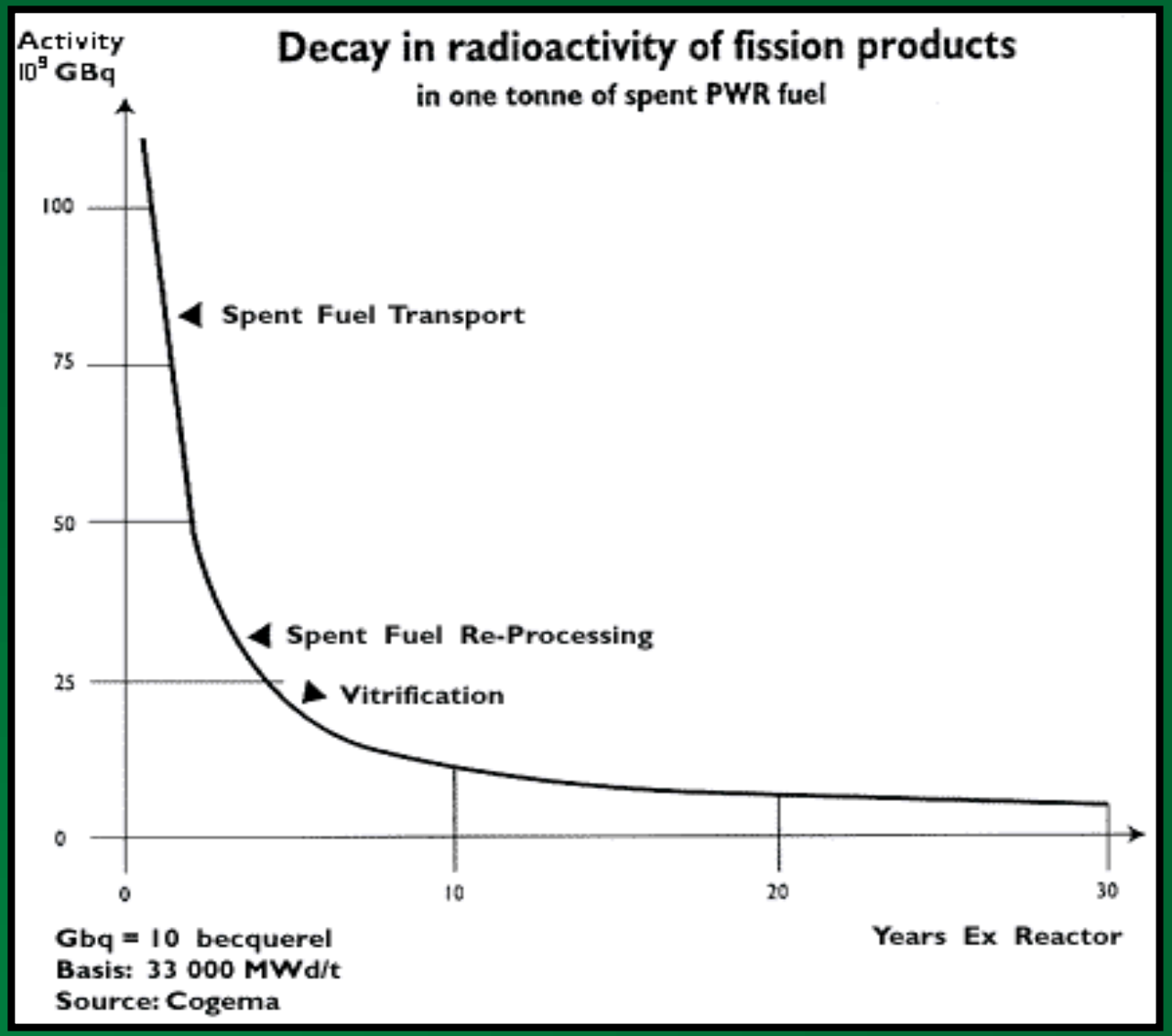
An accident waiting to happen. No containment vessel, bad design, worse operating procedure. Fewer than 50 deaths directly attributable to the accident

Safety

- 103 nuclear reactors are operating every day in the US, 442 world-wide. No serious accident since 1986
- No one has died as a result of a radiation-related accident in the history of the US or Canadian civilian nuclear program
- 45,000 people die in automobile accidents every year in North America

Used Fuel

- Used fuel is not waste; 95% of the usable energy remains
- We are capable of long-term secure storage of used fuel
- Most of the radioactive elements in used fuel decay rapidly



Forty years after removal from the reactor, less than one thousandth of the radioactivity remains

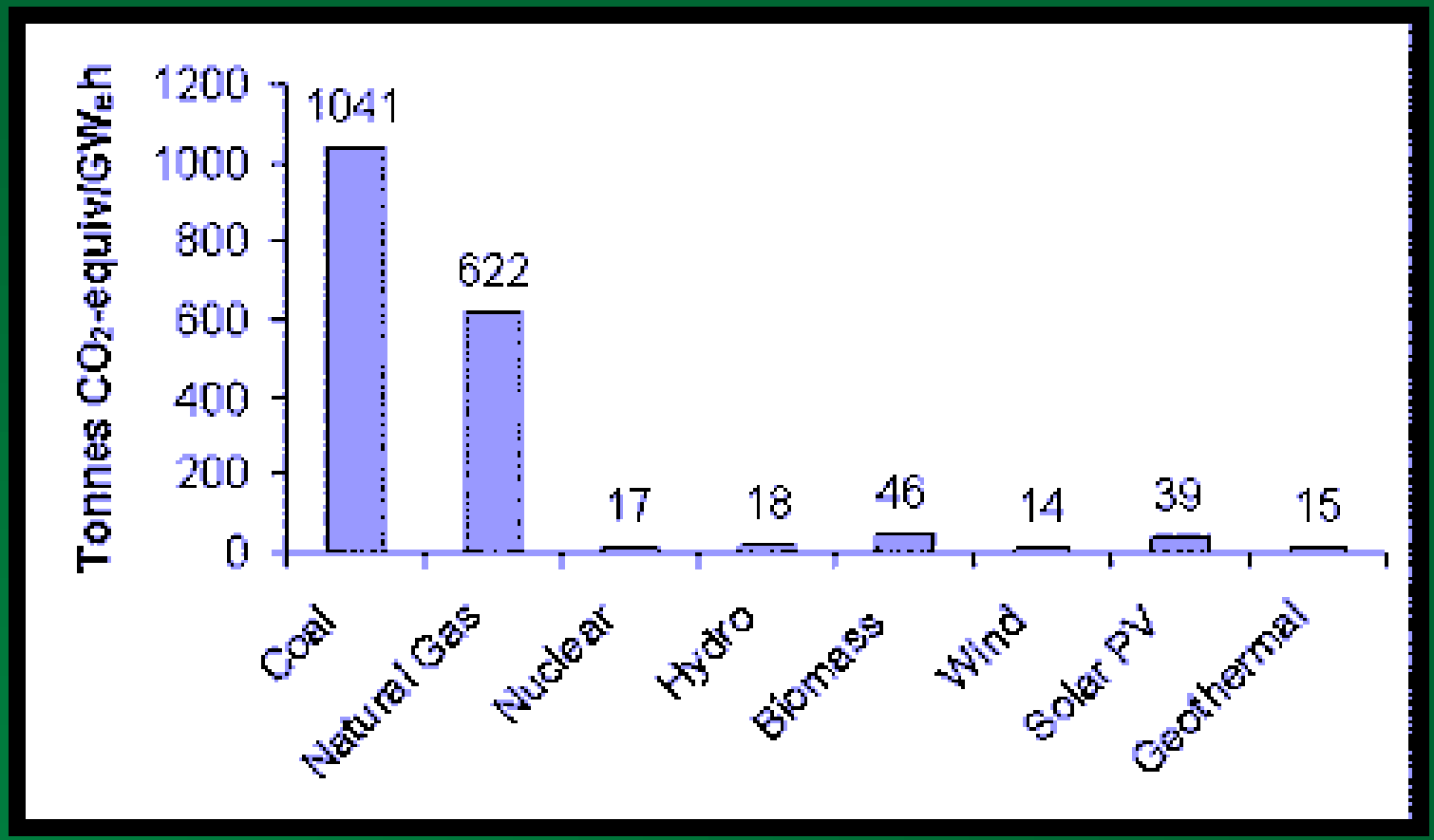
Proliferation

- Many technologies can be used for good or evil; guns, machetes, car-bombs, fire. This doesn't mean you should ban the technologies
- Higher priority must be placed on international efforts to prevent further proliferation of weapons of mass destruction

Nuclear energy is the only non-greenhouse gas-emitting energy source that can effectively replace fossil fuels and satisfy global demand.

- ✓ Electricity
- ✓ Hydrogen
- ✓ Desalinization
- ✓ Heating

Comparison of Life-Cycle Emissions



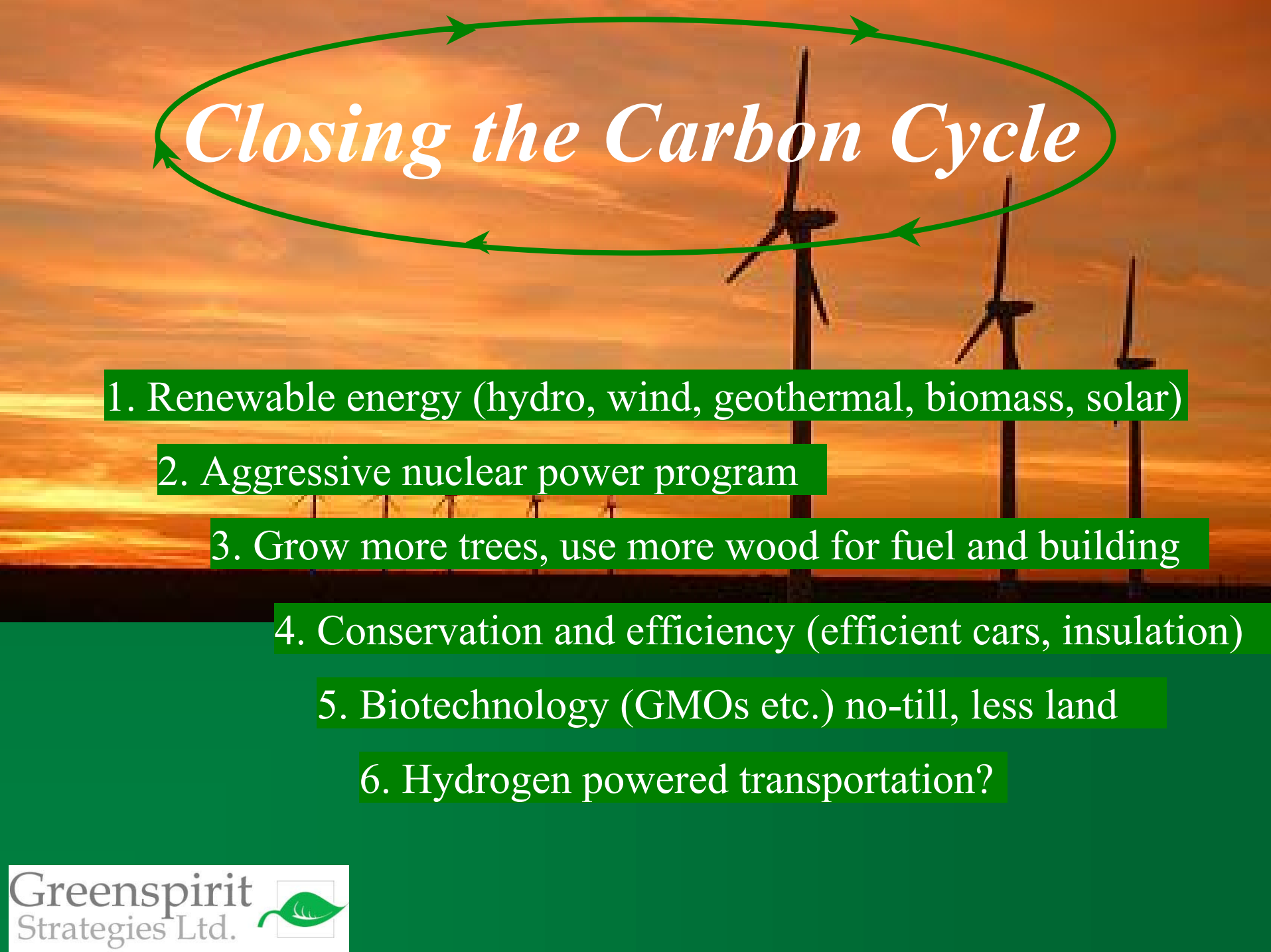
Source: "Life-Cycle Assessment of Electricity Generation Systems and Applications for Climate Change Policy Analysis," Paul J. Meier, University of Wisconsin-Madison, August, 2002.

Isn't it Ironic?

The "Environmental Movement" is a Major Obstacle to the Realistic Achievement of CO2 Emissions Reductions Around the World.

Activists Oppose Nuclear Energy, Hydroelectric Projects, Many Wind Farms, Intensive Forestry, Genetic Enhancement and do Little to Promote Geothermal Energy.

Activist Support for Solar Drains $$ From More Effective Technologies.


Closing the Carbon Cycle
1. Renewable energy (hydro, wind, geothermal, biomass, solar)
2. Aggressive nuclear power program
3. Grow more trees, use more wood for fuel and building
4. Conservation and efficiency (efficient cars, insulation)
5. Biotechnology (GMOs etc.) no-till, less land
6. Hydrogen powered transportation?
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Searching for a Sustainable Energy Future (Thank-You)

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