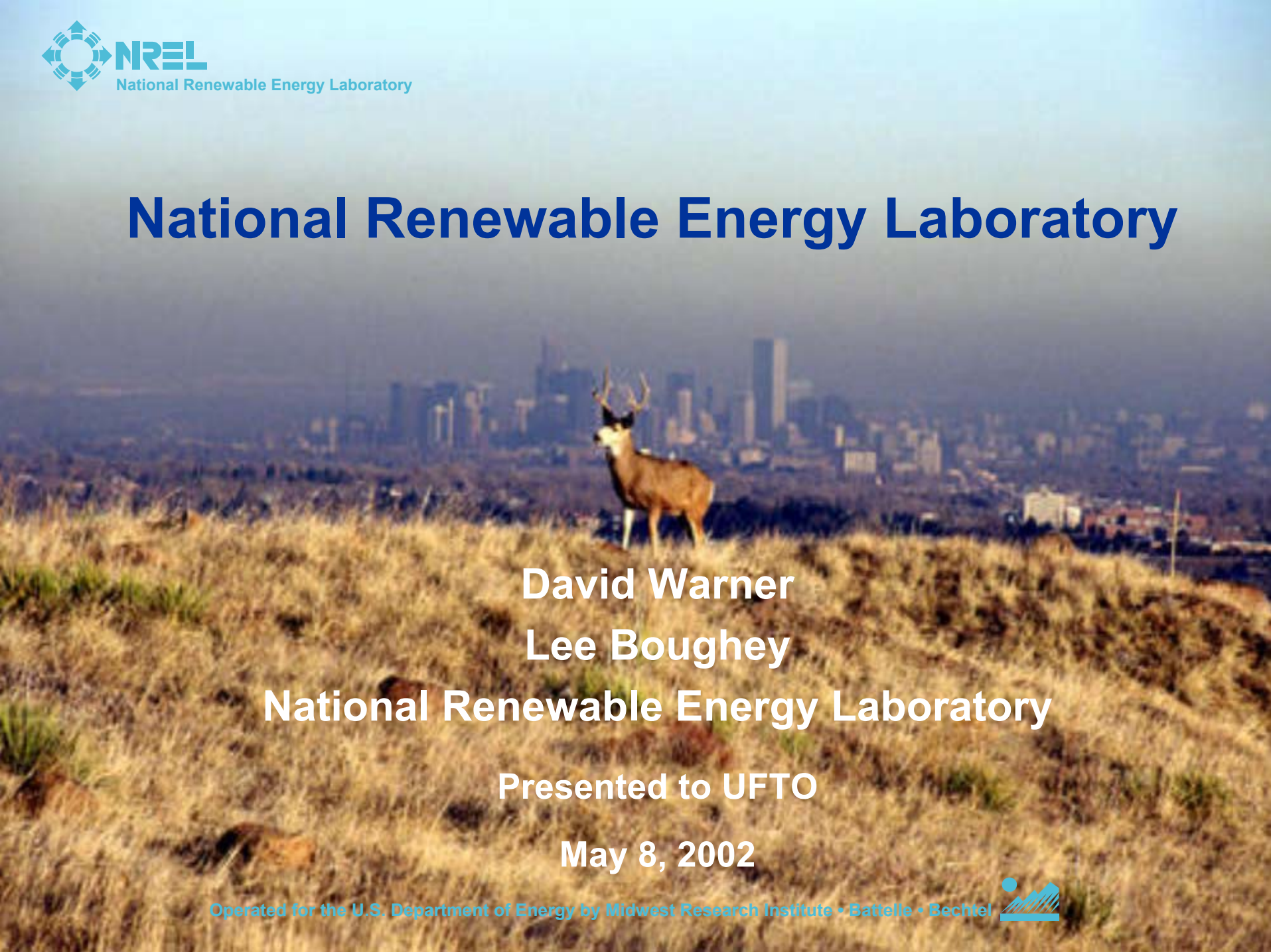
NREL
National Renewable Energy Laboratory

National Renewable Energy Laboratory



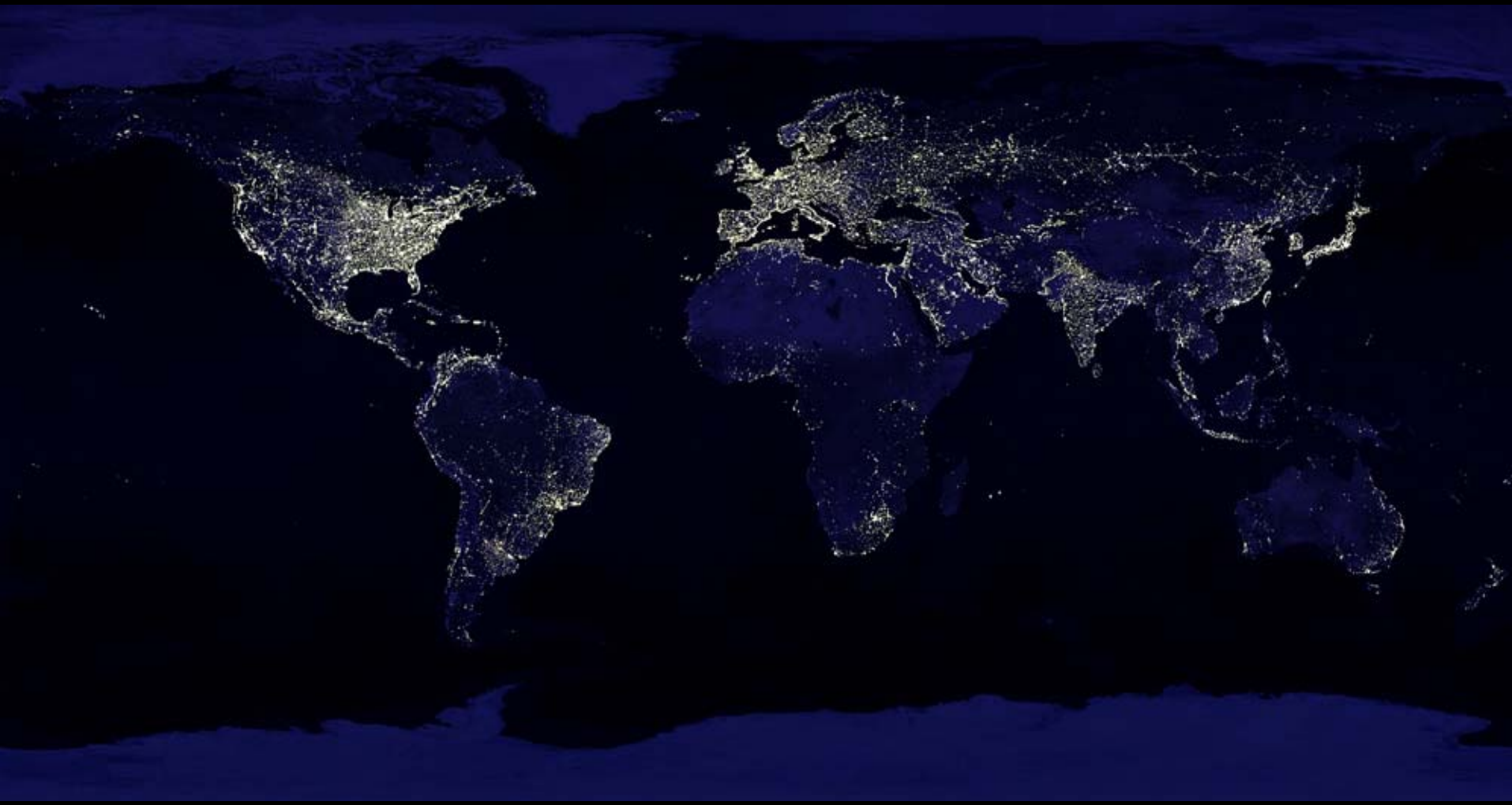
David Warner
Lee Boughey
National Renewable Energy Laboratory

Presented to UFTO

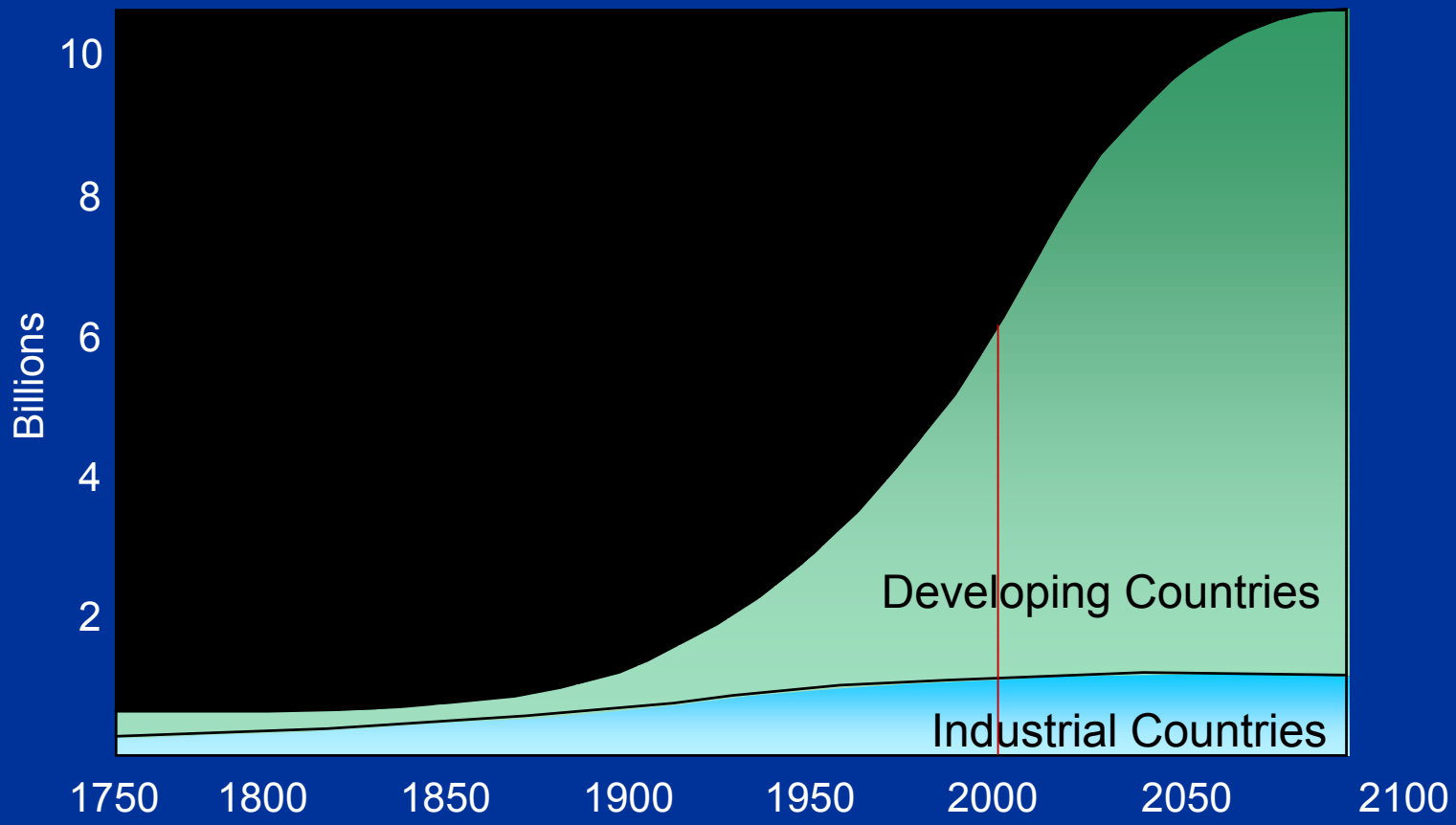
May 8, 2002

Operated for the U.S. Department of Energy by Midwest Research Institute • Battelle • Bechtel

Earth Lights!

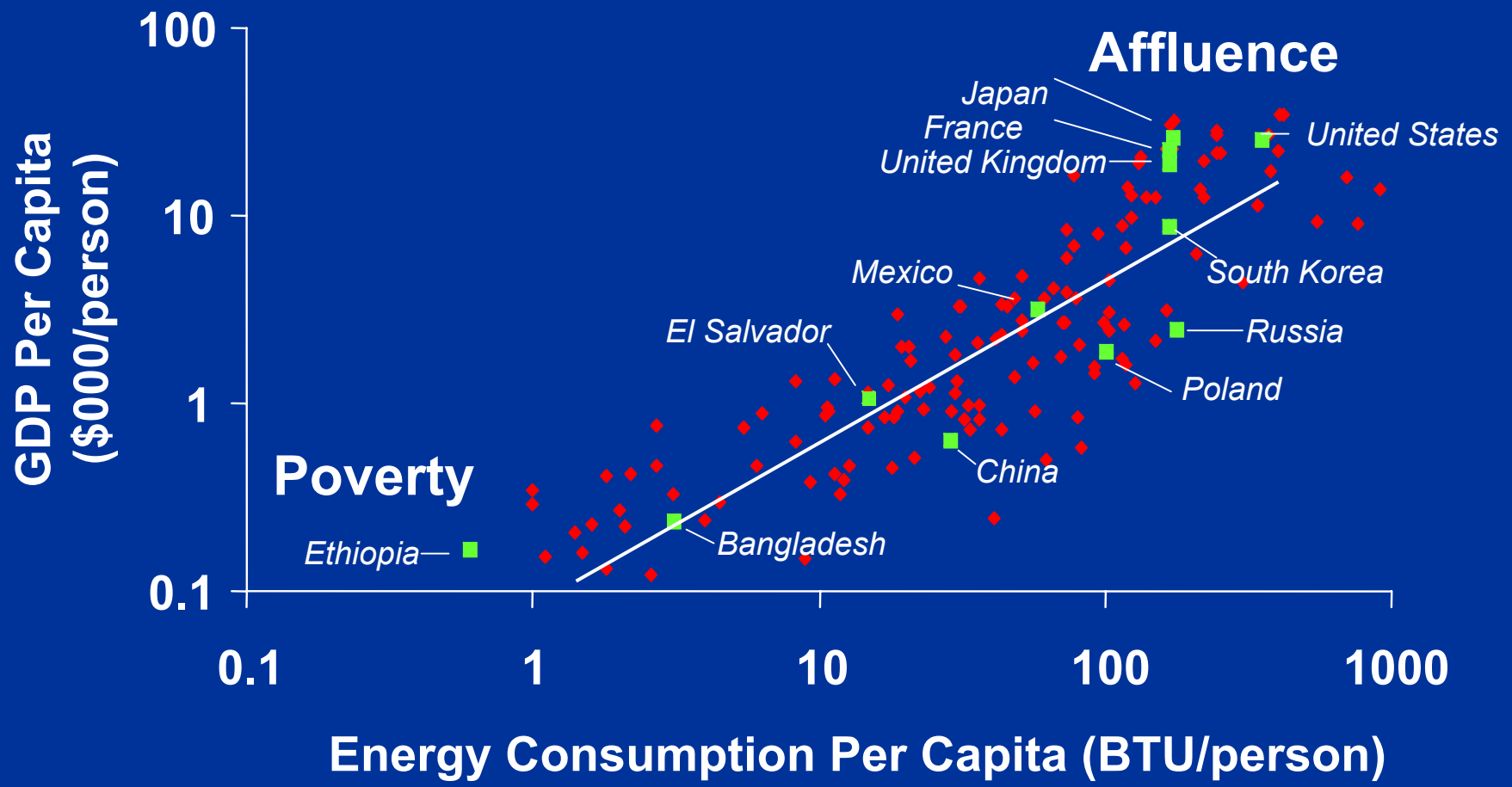


World Population Growth
1750-2100



Source: Population Reference Bureau

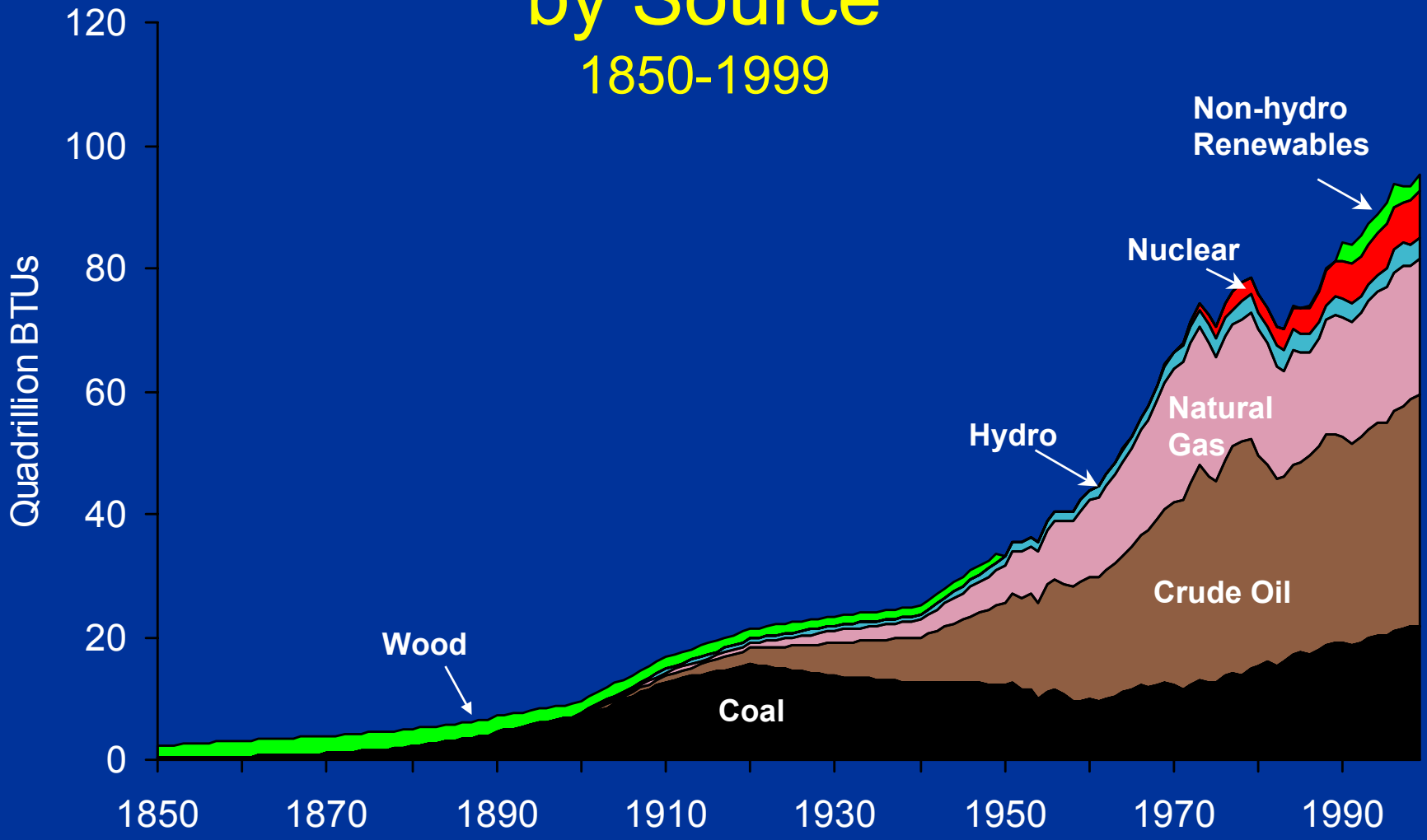
Energy and Economic Development



Source: Energy Information Administration, International Energy Annual 1998 Tables E1, B1, B2; Mike Grillot, 5/17/00
Gross Domestic Product per capita is for 1997 in 1990 dollars. Energy Consumption per capita is 1997.

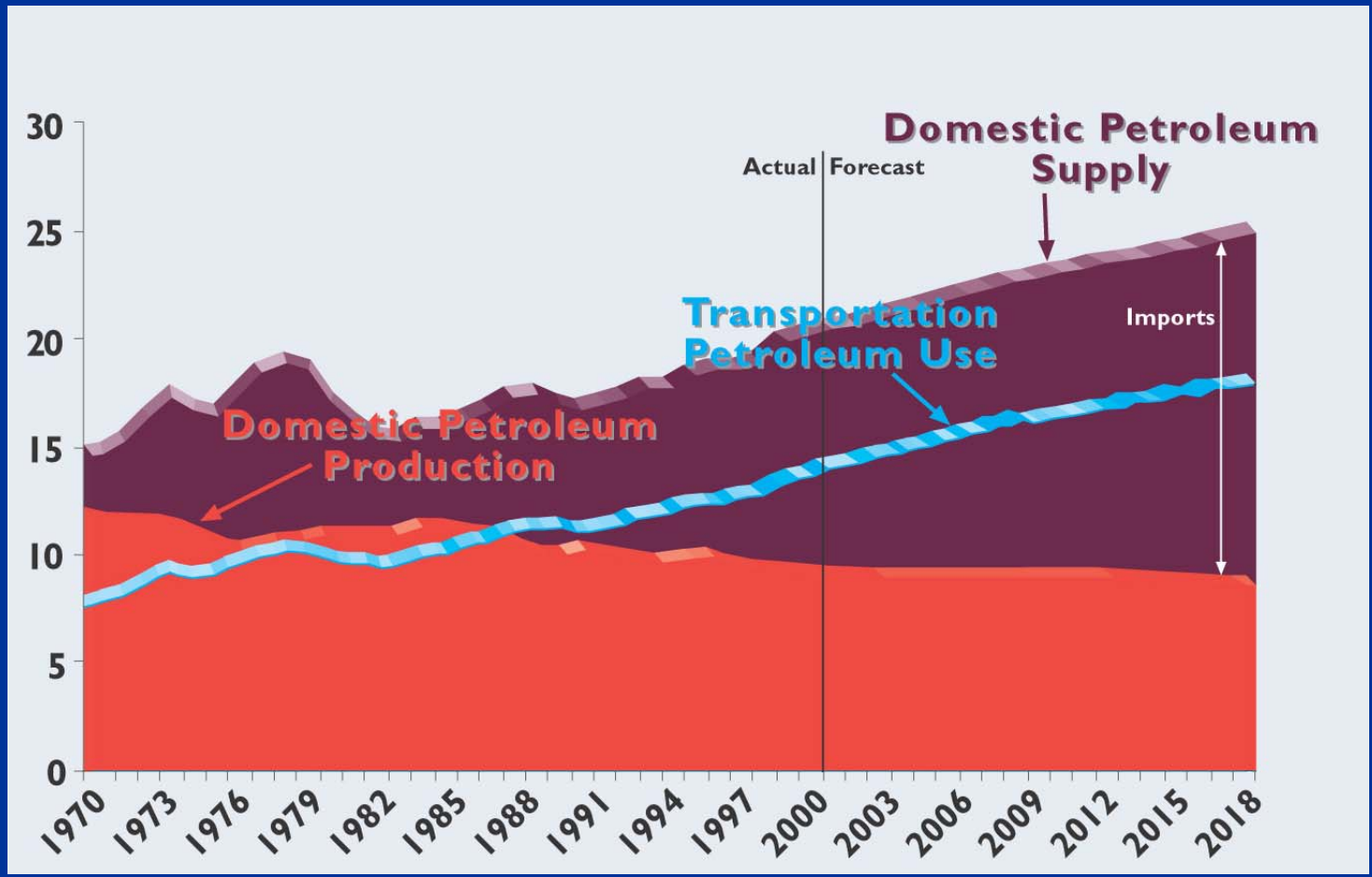
U.S. Energy Consumption by Source

1850-1999



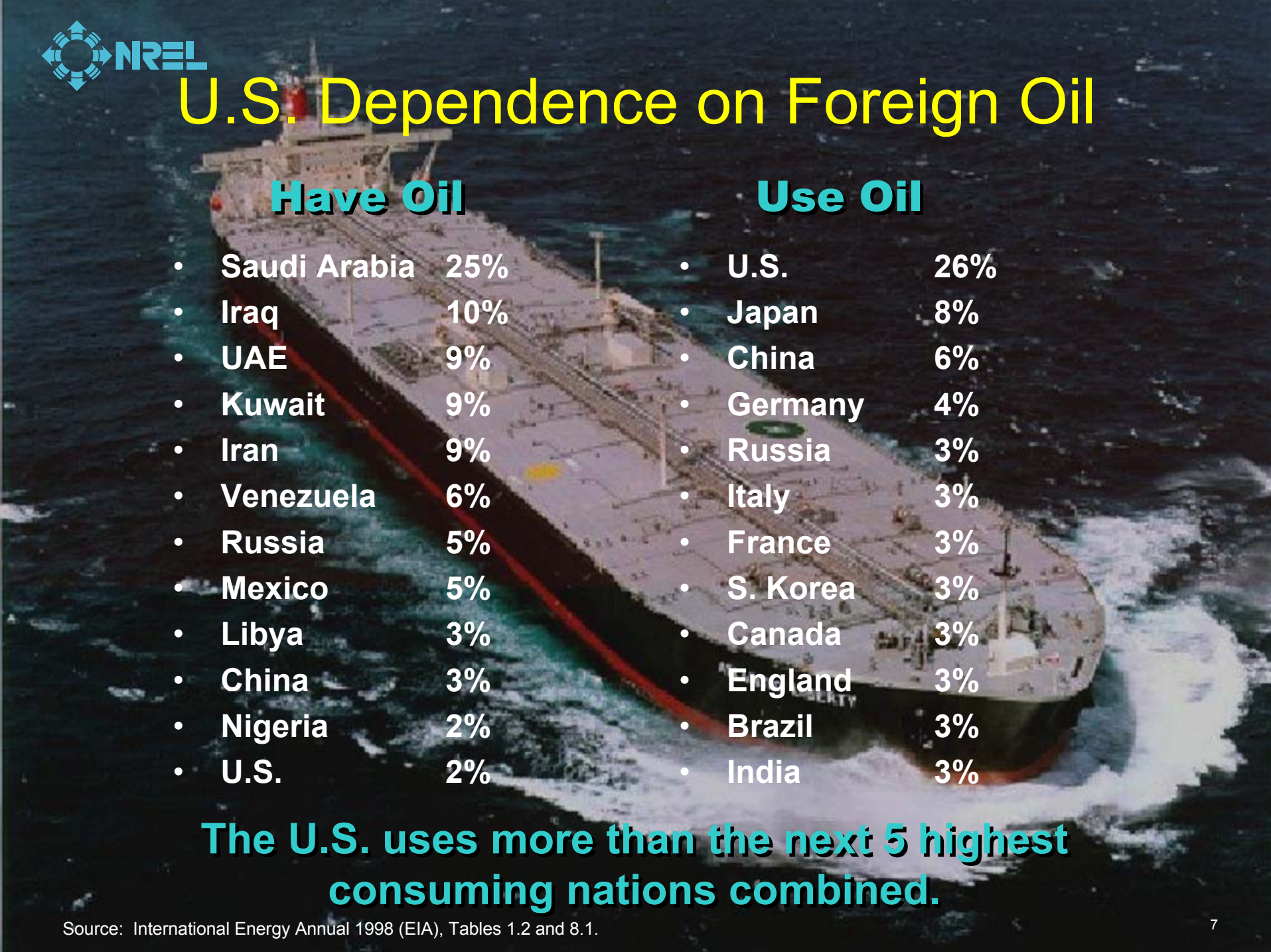
Source: 1850-1949, Energy Perspectives: A Presentation of Major Energy and Energy-Related Data, U.S. Department of the Interior, 1975; 1950-1996, Annual Energy Review 1996, Table 1.3. Note: Between 1950 and 1990, there was no reporting of non-utility use of renewables. 1997-1999, Annual Energy Review 1999, Table F1b.

Domestic Production with Transportation Use
1970-2020



Source: EIA Annual Energy Review 1997 Tbls 2.1, 5.1 and Annual Energy Outlook 1999 Tbl 11

U.S. Dependence on Foreign Oil

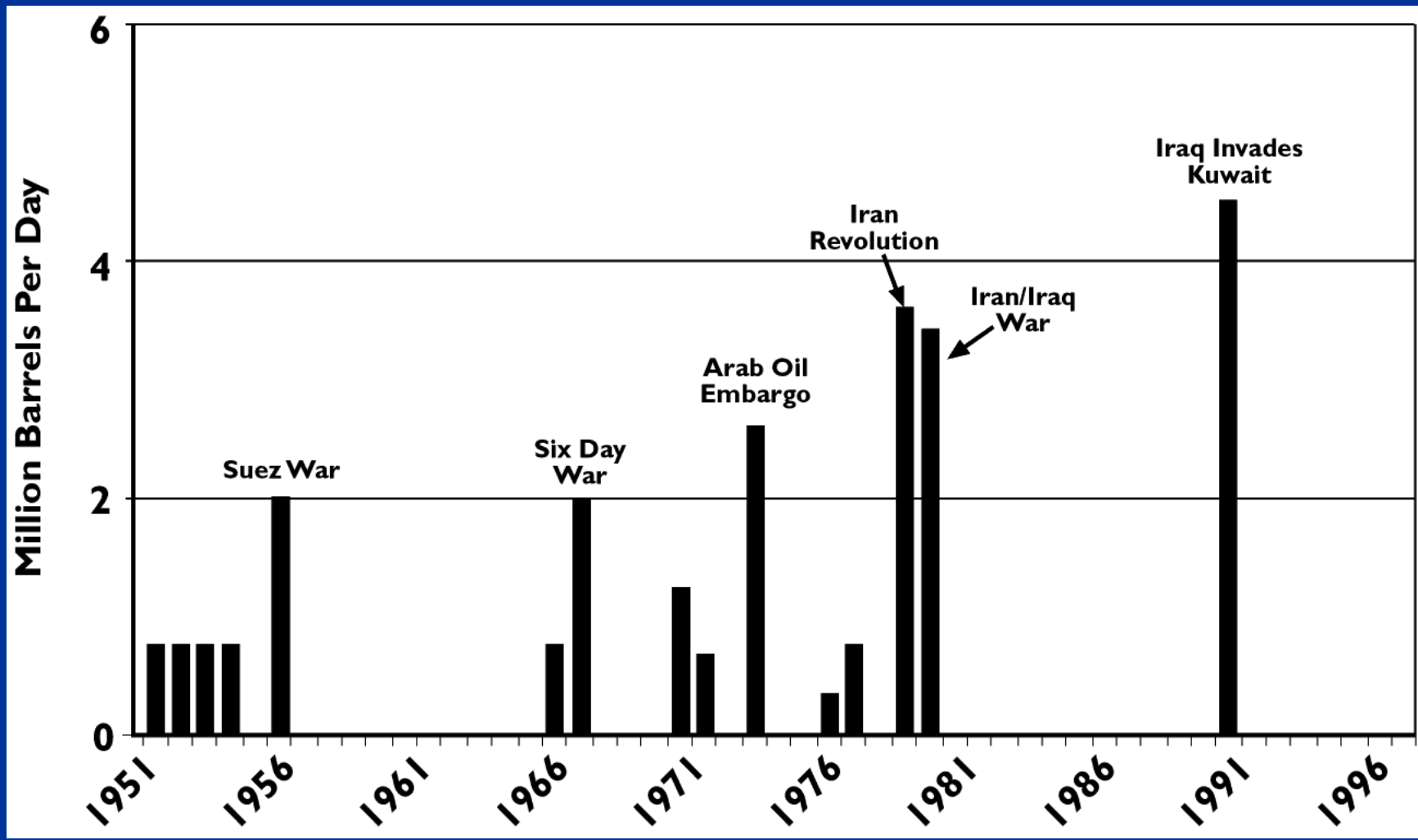


Have Oil		Use Oil	
• Saudi Arabia	25%	• U.S.	26%
• Iraq	10%	• Japan	8%
• UAE	9%	• China	6%
• Kuwait	9%	• Germany	4%
• Iran	9%	• Russia	3%
• Venezuela	6%	• Italy	3%
• Russia	5%	• France	3%
• Mexico	5%	• S. Korea	3%
• Libya	3%	• Canada	3%
• China	3%	• England	3%
• Nigeria	2%	• Brazil	3%
• U.S.	2%	• India	3%

The U.S. uses more than the next 5 highest consuming nations combined.

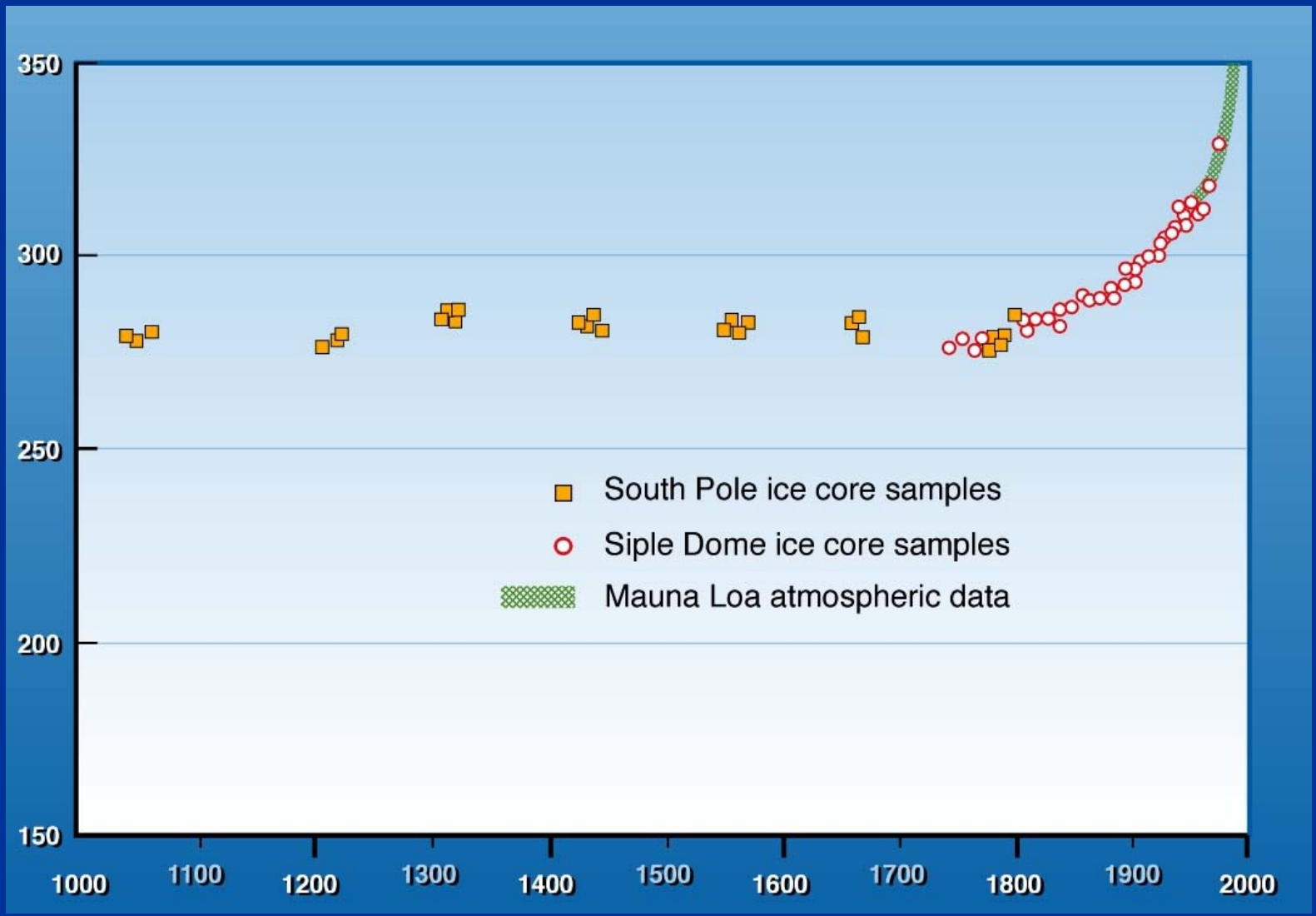
Source: International Energy Annual 1998 (EIA), Tables 1.2 and 8.1.

National Security Events Related to Major Disruptions in Fuel Supply



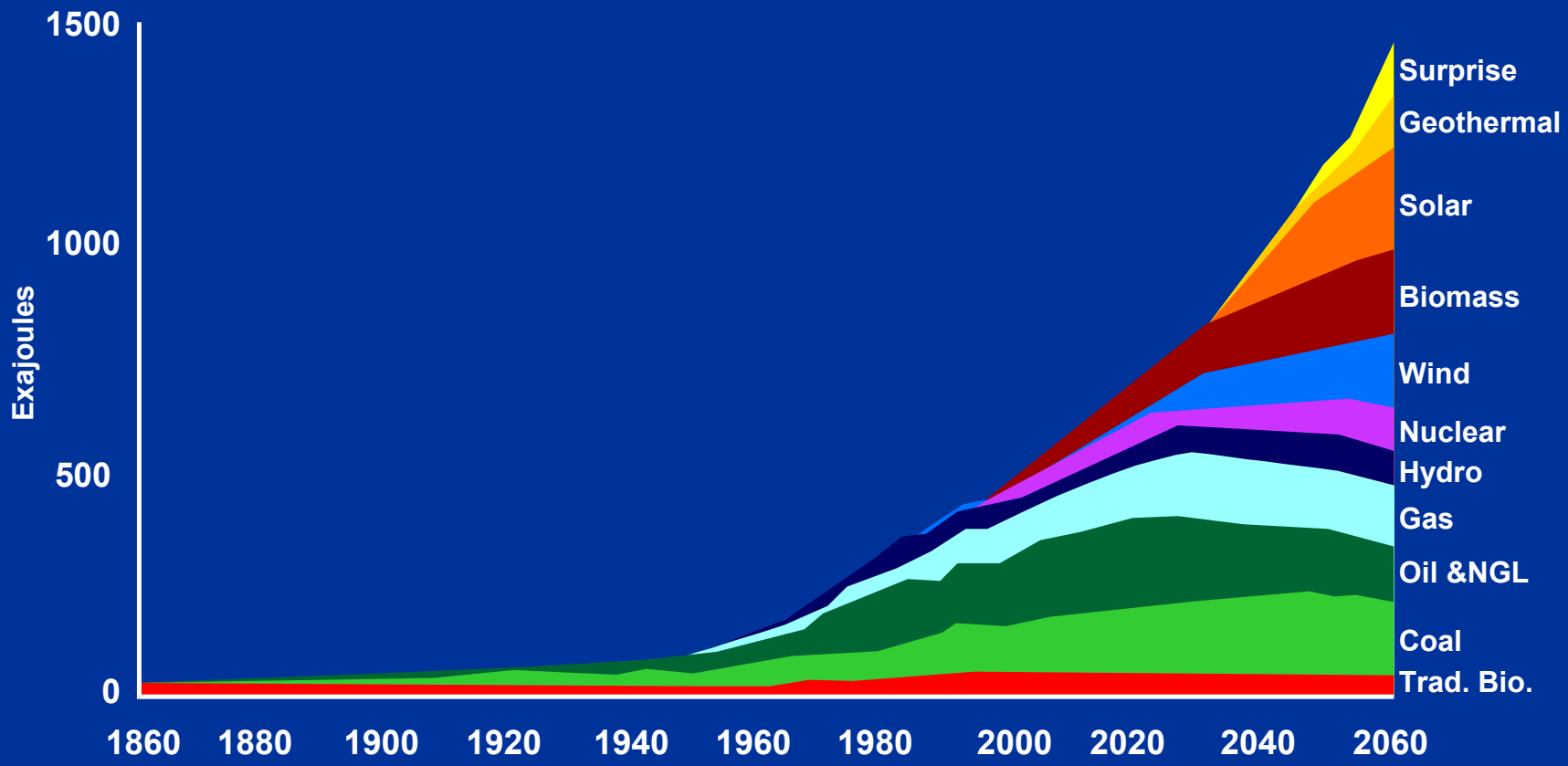
Source: http://www.eia.doe.gov/emeu/25opec/All_25_Anniversary.xls
Barrels of oil per day removed from world markets as a result of conflicts.

Atmospheric Concentration of CO_2



Source: Adapted from W.M. Post, T.H. Peng, W.R. Emanuel, A.W. King, V.H. Dale, and D. DeAngelis. *American Scientist*, 1990. "The Global Carbon Cycle."

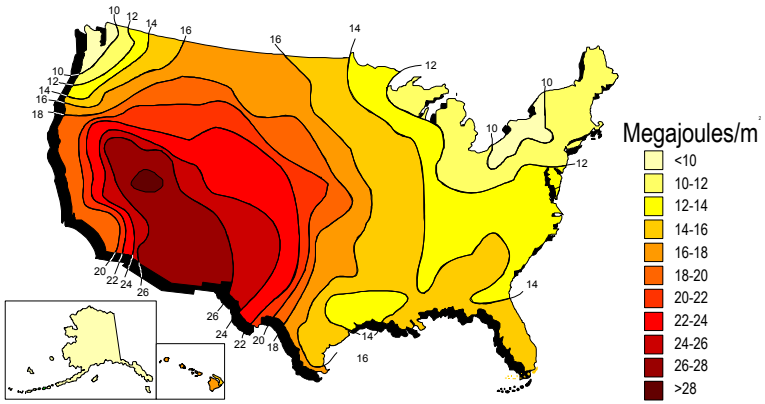
Shell Sustained Growth Scenario



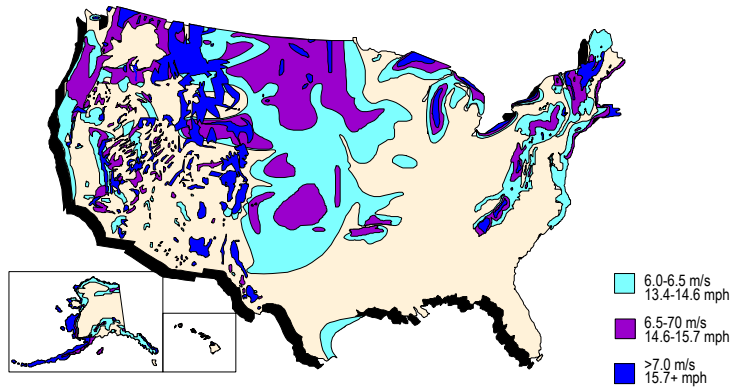
Sources: 1995; Shell, The Evolution of the World's Energy Systems, 1995

U.S. Renewable Energy Resources

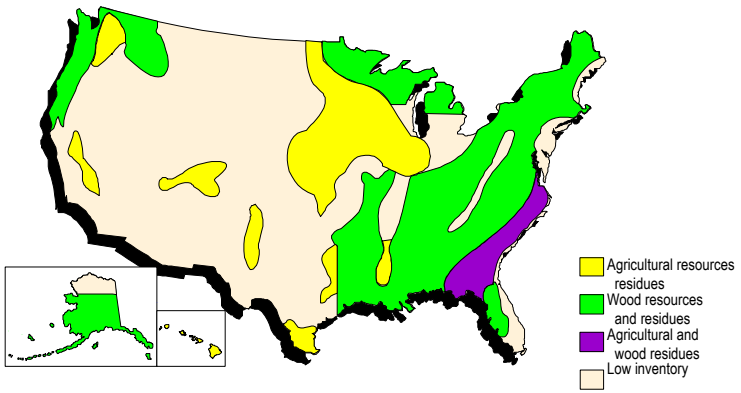
Solar



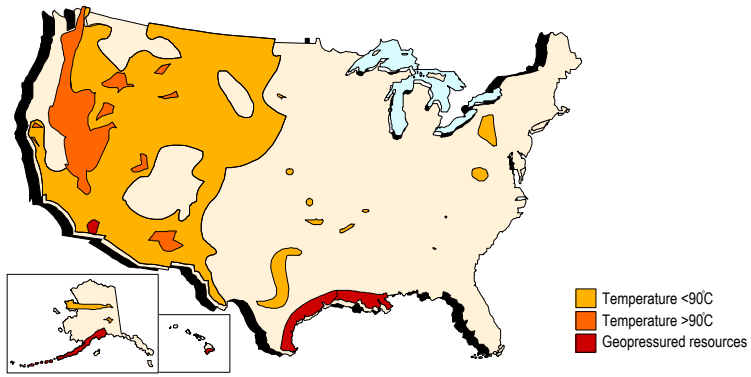
Wind



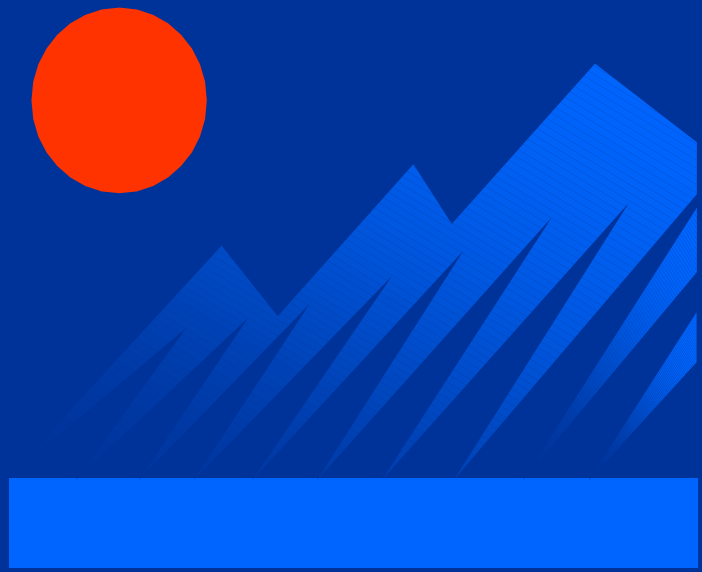
Biomass



Geothermal



National Renewable Energy Laboratory



Operated for the U.S. Department of Energy by
Midwest Research Institute • Battelle • Bechtel

Major DOE National Laboratories

Formation of SERI/NREL

- 1974 — Solar Energy Research Development and Demonstration Act; Section 10, Public Law 93-473
- 1975 — National Research Council: “Establishment of a Solar Energy Research Institute Committee" Report; Colorado site selected – MRI
- 1977 — SERI opened doors
- 1991 — President Bush renamed the Solar Energy Research Institute to the National Renewable Energy Laboratory and elevated its status in the laboratory system

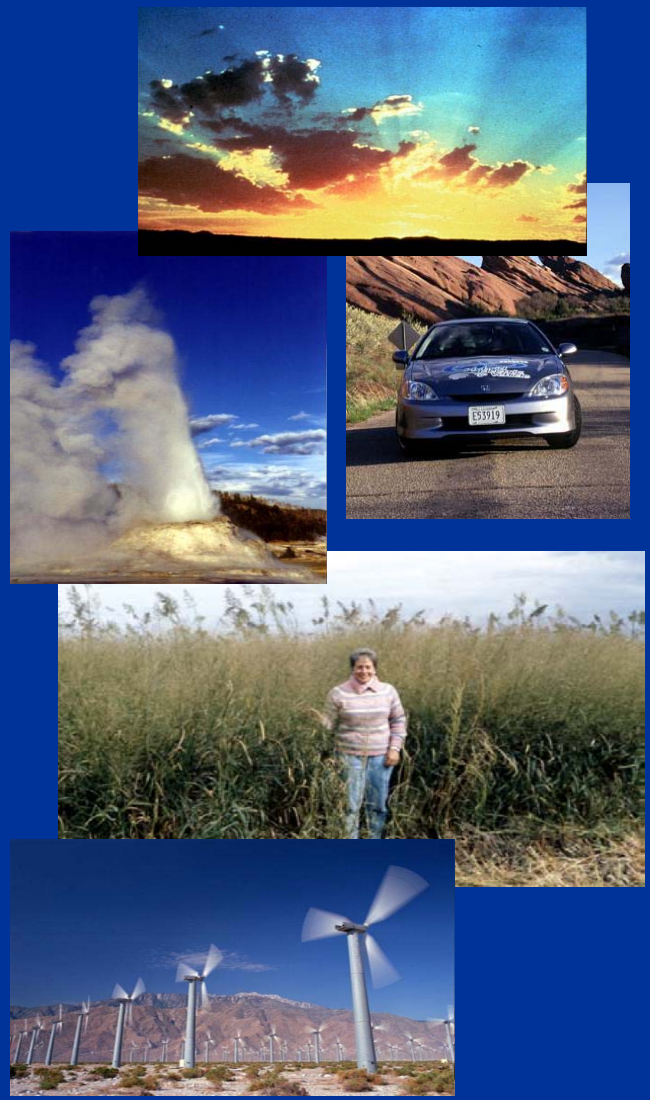
National Renewable Energy Laboratory

- Only national laboratory ***dedicated*** to renewable energy and energy efficiency R&D
- Research spans fundamental ***science*** to ***technology*** solutions
- ***Collaboration*** with industry and university partners is a hallmark
- Research programs ***linked*** to market opportunities

Major NREL Technology Thrusts

Supply Side

- Wind Energy
- Solar Photovoltaics
- Concentrating Solar Power
- Solar Buildings
- Biomass Power
- Biofuels
- Geothermal Energy
- Hydrogen
- Superconductivity
- Distributed Power



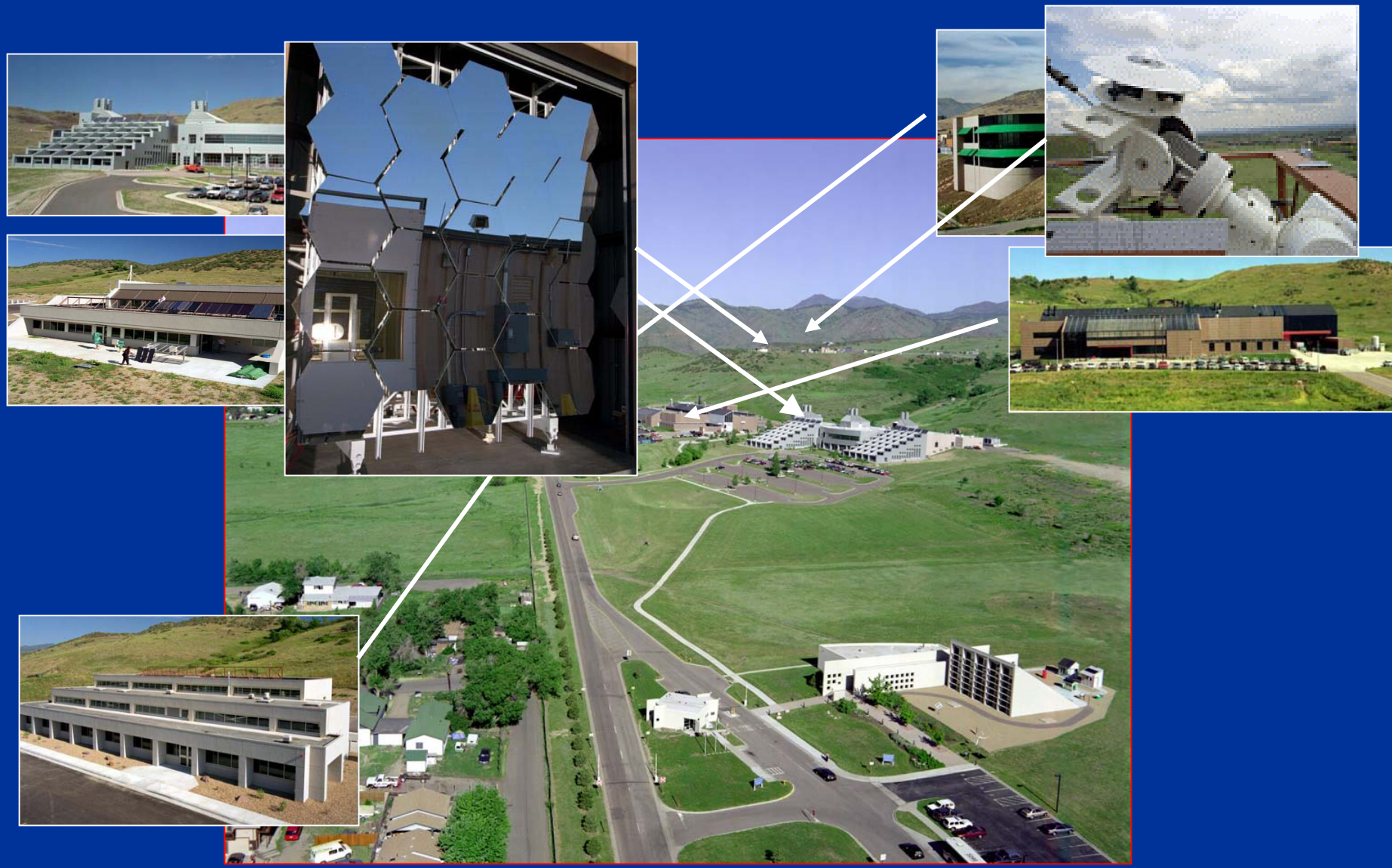
Demand Side

- Hybrid Vehicles
- Fuels Utilization
- Buildings Energy Technology
- Federal Energy Management
- Advanced Industrial Technologies

Cross Cutting

- Basic Energy Science
- Analytical Studies
- International Programs

South Table Mountain Site

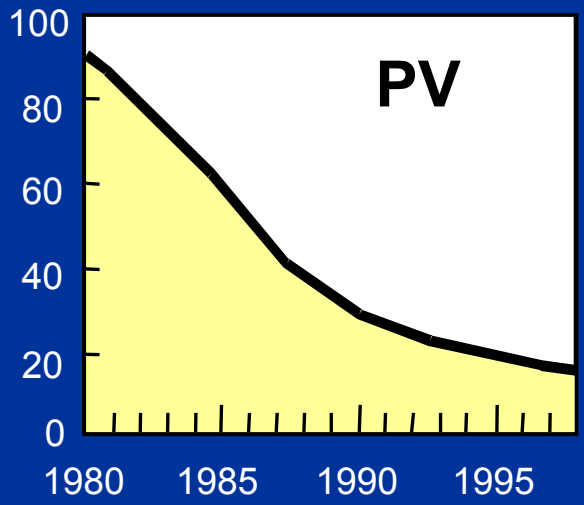


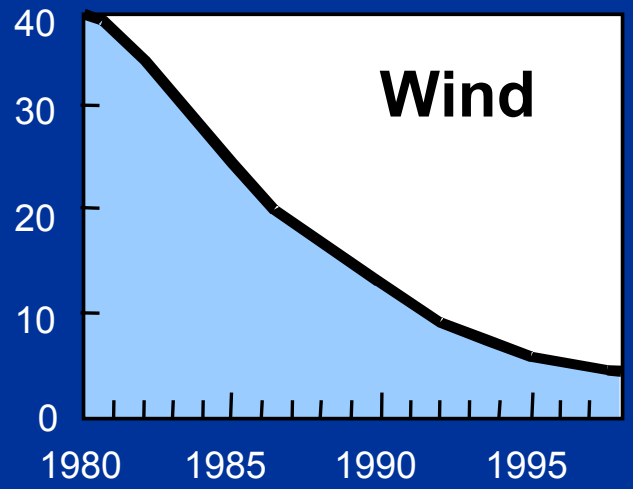
National Wind Technology Center

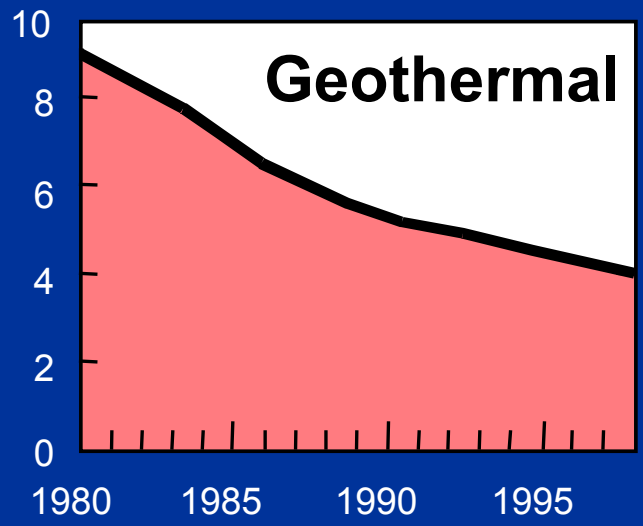
Industrial User Facility

Renewable Energy Cost Trends

Cost of Electricity (¢/KWH)







Source: Billman, Advances in Solar Energy submission, 1/8/99

Agenda

9:00 am – 9.50 am	Solar Programs Overview
10:00 am – 10:50 am	Distributed Energy Resources and Hydrogen
11:00 am – 11:30 am	Superconductivity Program
11:45 am – 12:50 pm	Energy Analysis Overview / Lunch
1:00 pm – 1:50 pm	Biofuels Overview
2:00 pm – 2:50 pm	Bioenergy Overview
3:30 pm – 5:00 pm	Wind Power / Hybrid Test Facility Overview