Energy in a Changing World

Roger Taylor

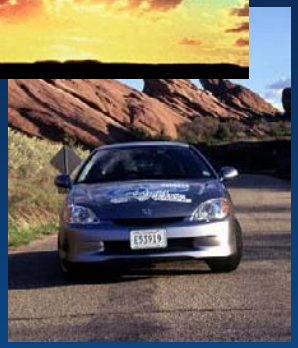
National Renewable Energy Laboratory

Major DOE National Laboratories

Major NREL Technology Thrusts

Supply Side

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

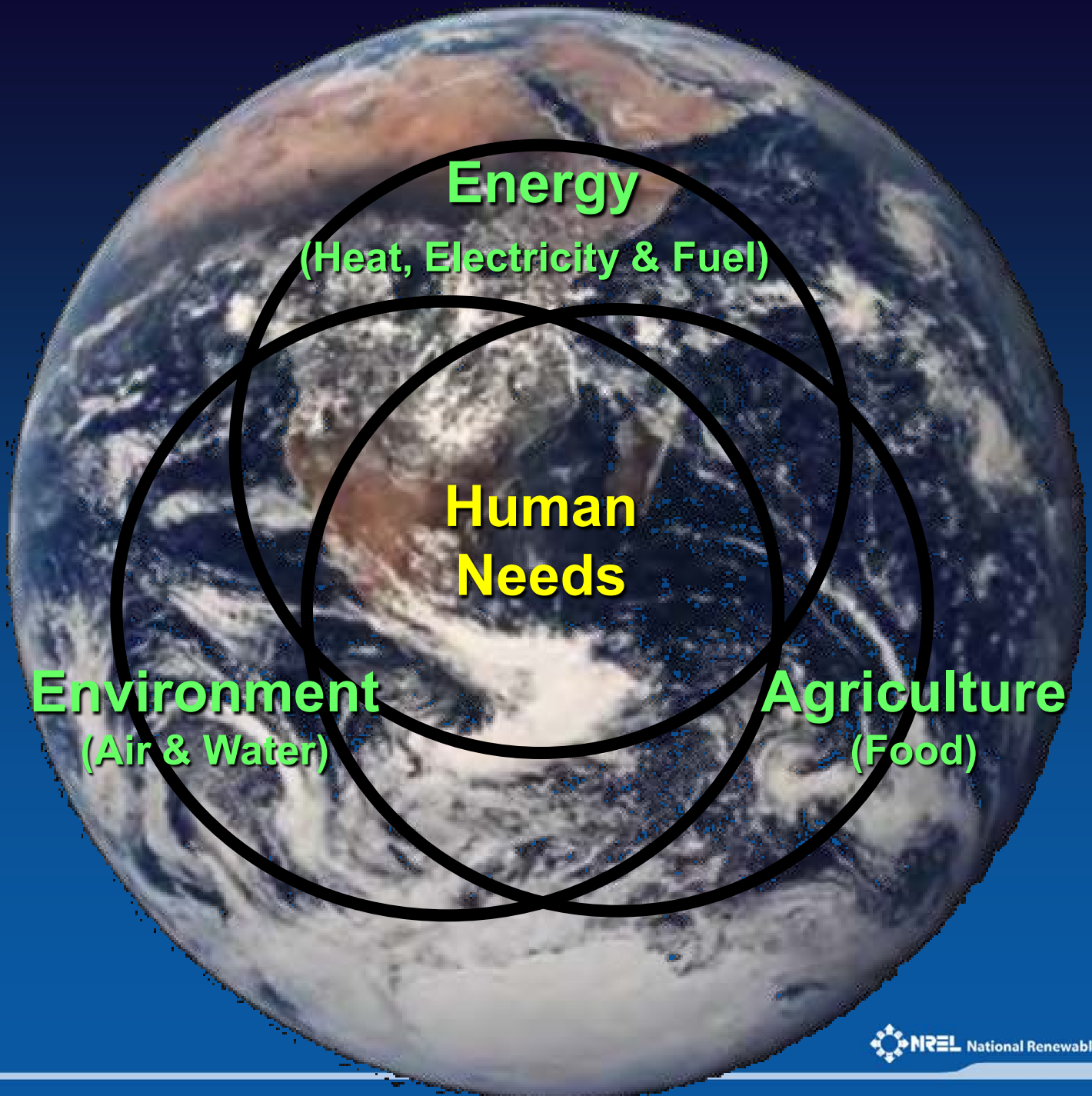


Demand Side

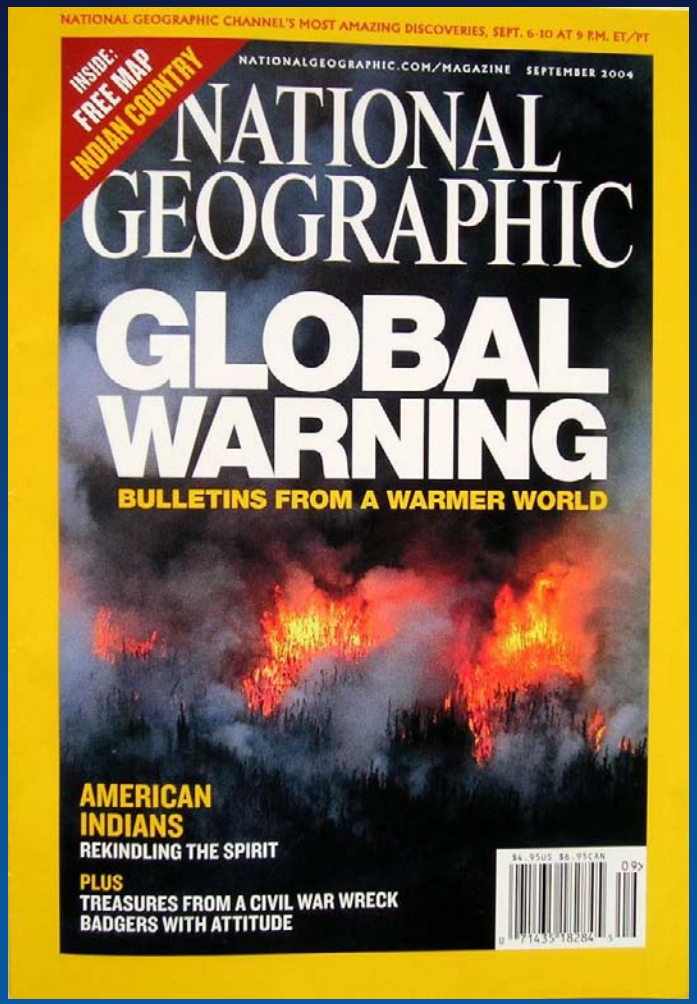
- Hybrid Vehicles
- Fuels Utilization
- Buildings Energy Technology
- Federal Energy Management
- Advanced Industrial Technologies

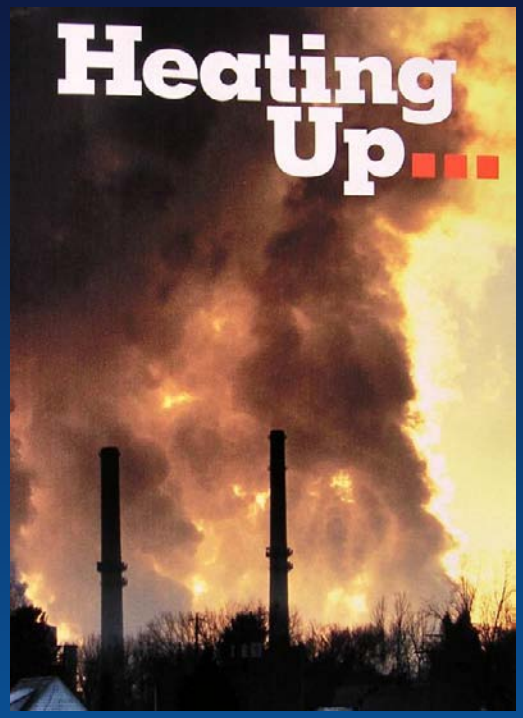
Cross Cutting

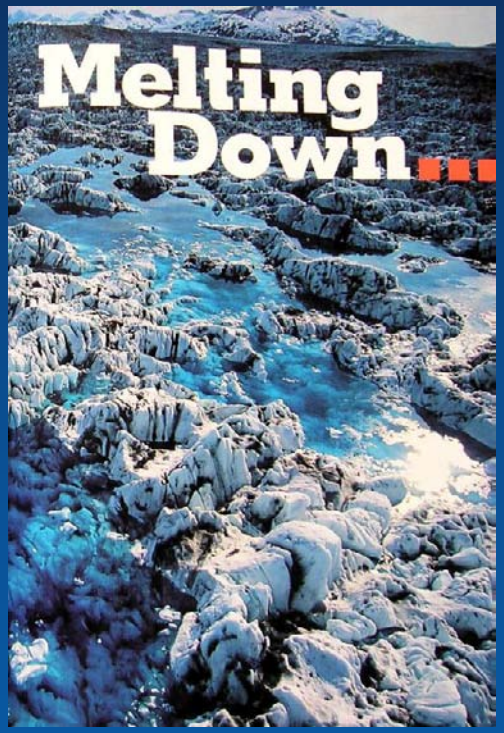
- Basic Energy Science
- Analytical Studies
- International Programs
- **Tribal Energy Program**


Energy
(Heat, Electricity & Fuel)
Human
Needs
Environment
(Air & Water)
Agriculture
(Food)

We Live in a Changing World

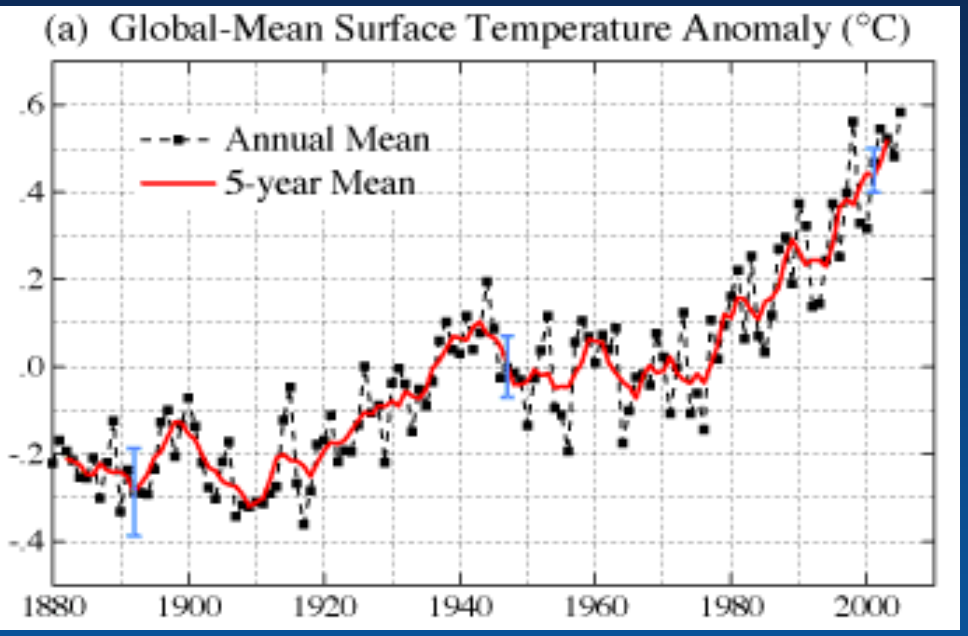


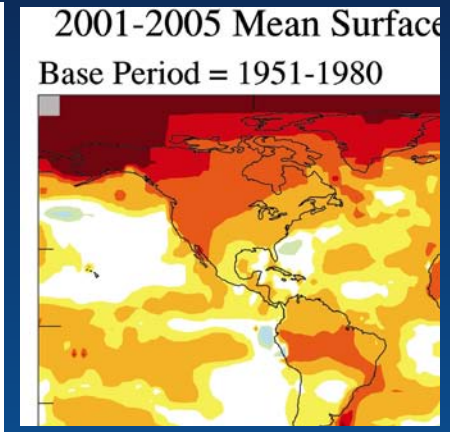




Where Carbon Reduction is a Requirement

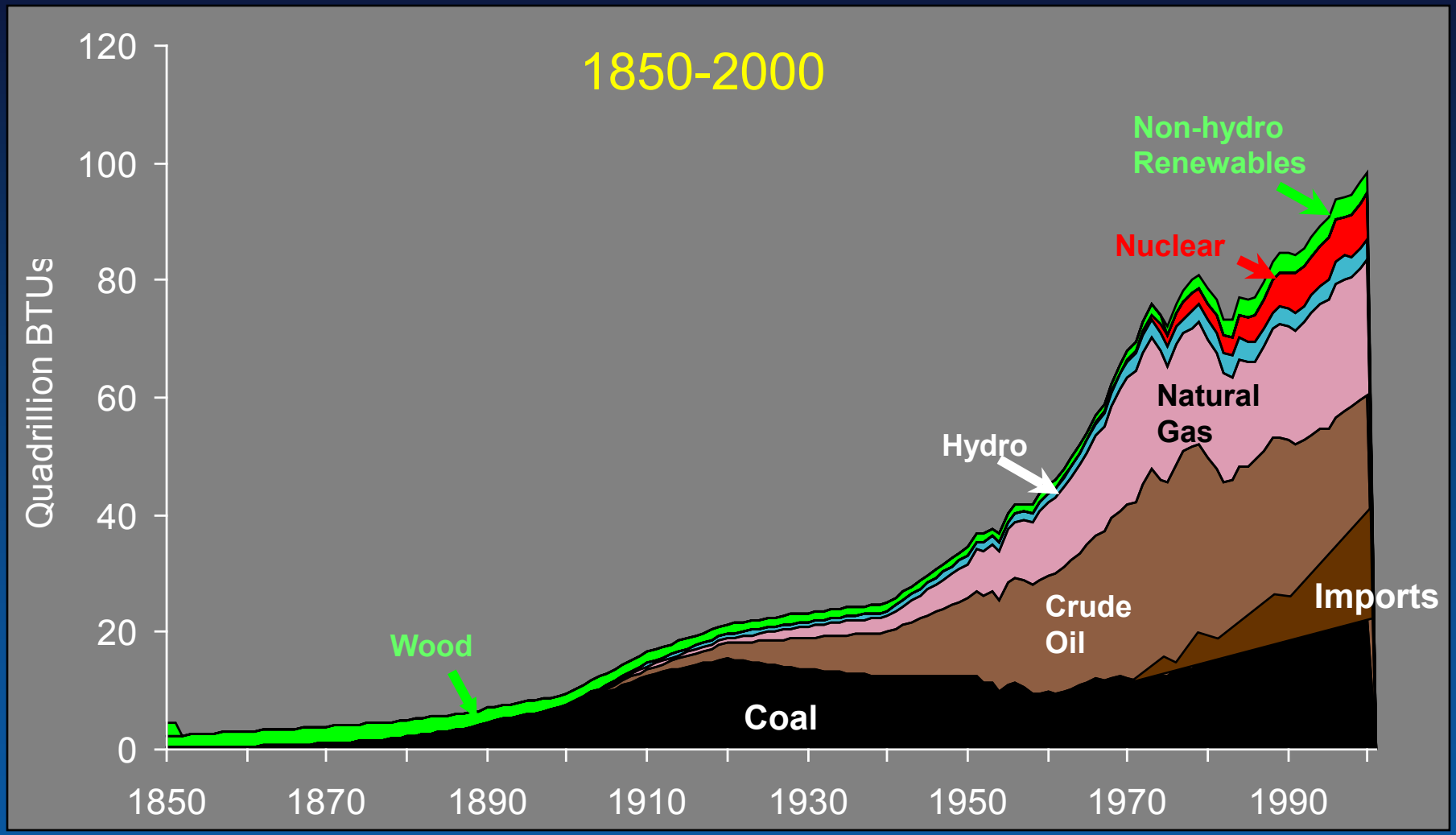
2005 Warmest Year on Record





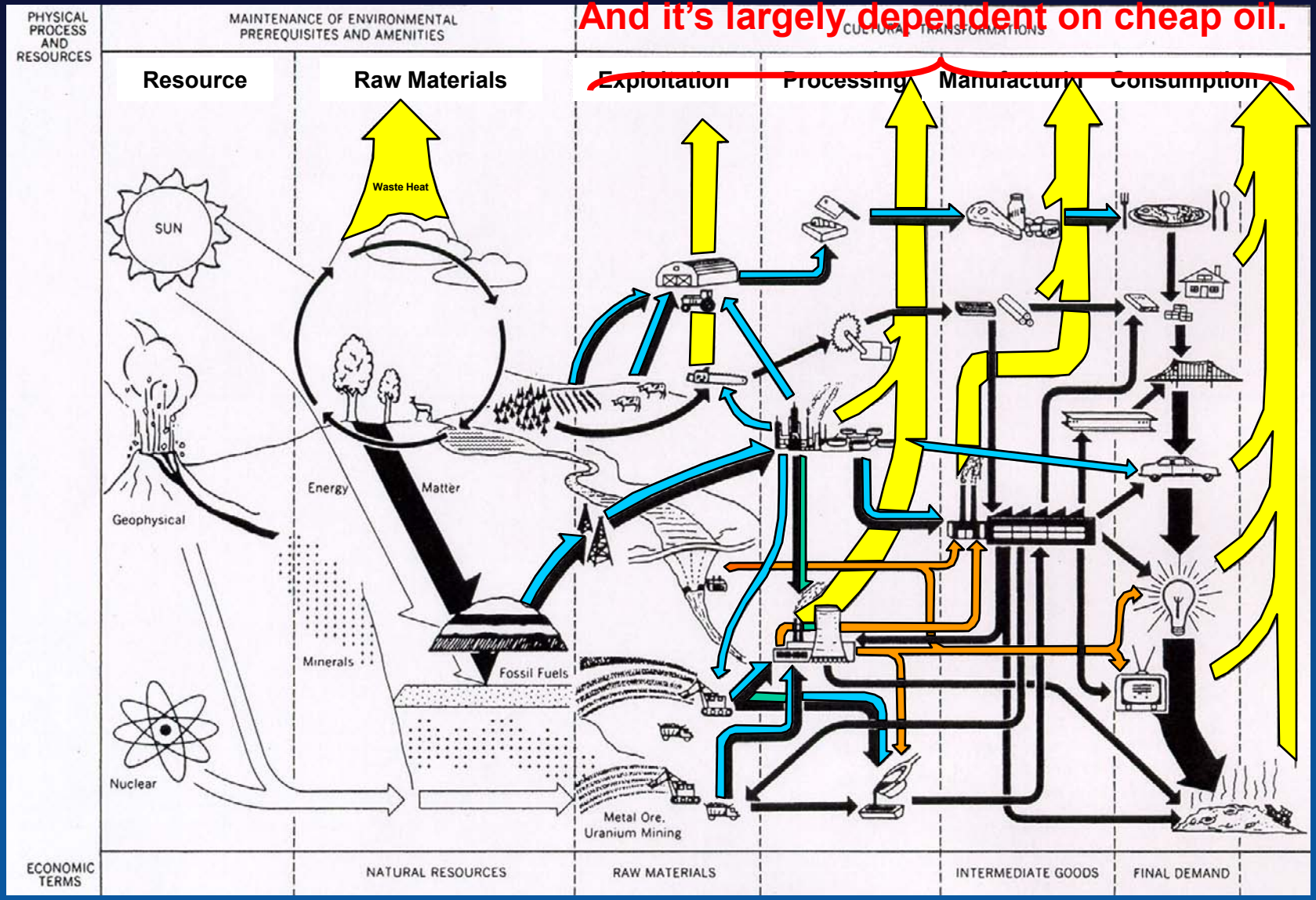
Warming of 0.2°C/decade over last 30 years

Where U.S. Energy Consumption Continues to Grow

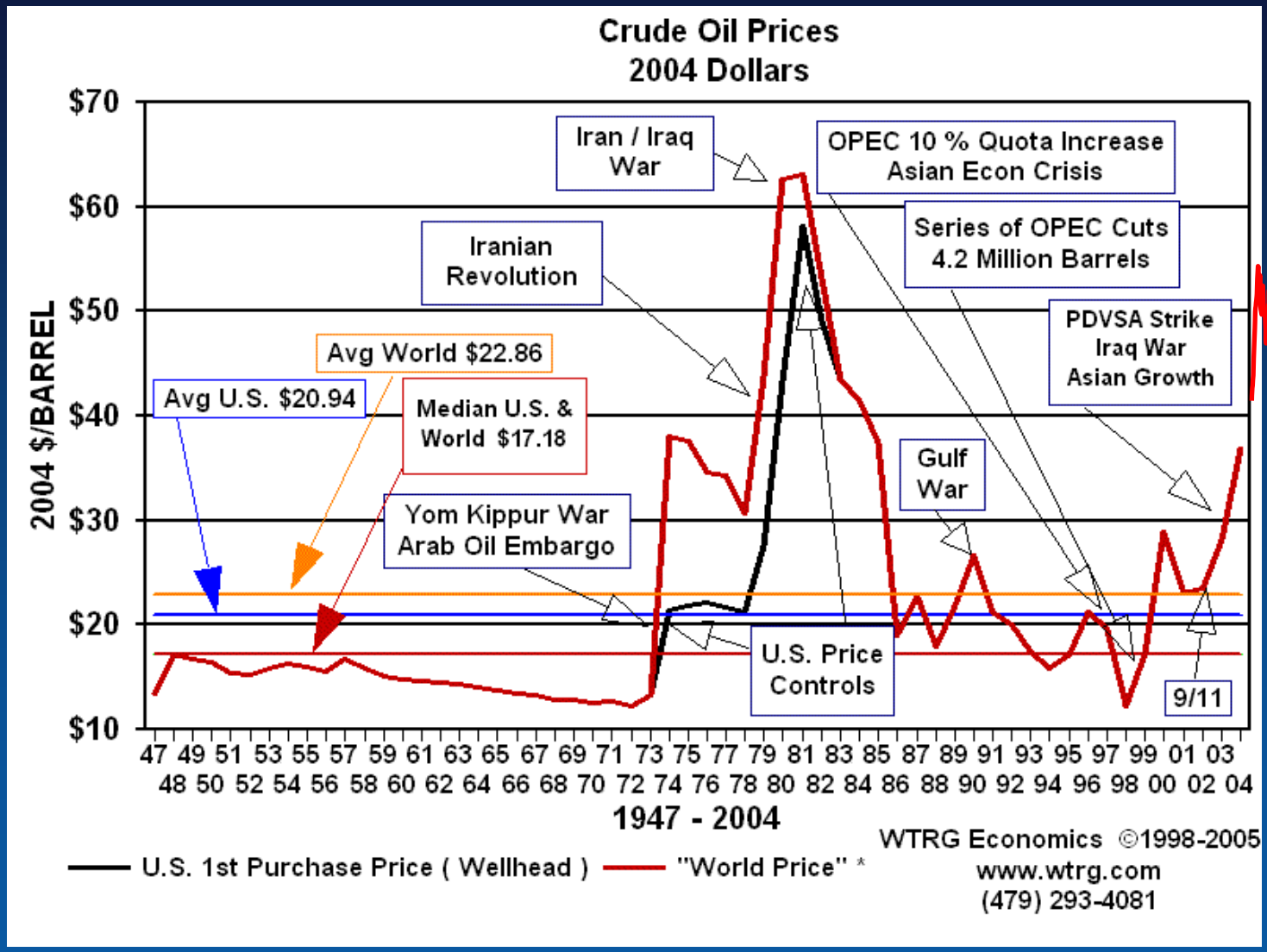


Source: 1850-1949, Energy Perspectives: A Presentation of Major Energy and Energy-Related Data, U.S. Department of the Interior, 1975; 1950-2000, Annual Energy Review 2000, Table 1.3.

Where the global economy is very complex



Increasingly volatile, increasingly upward

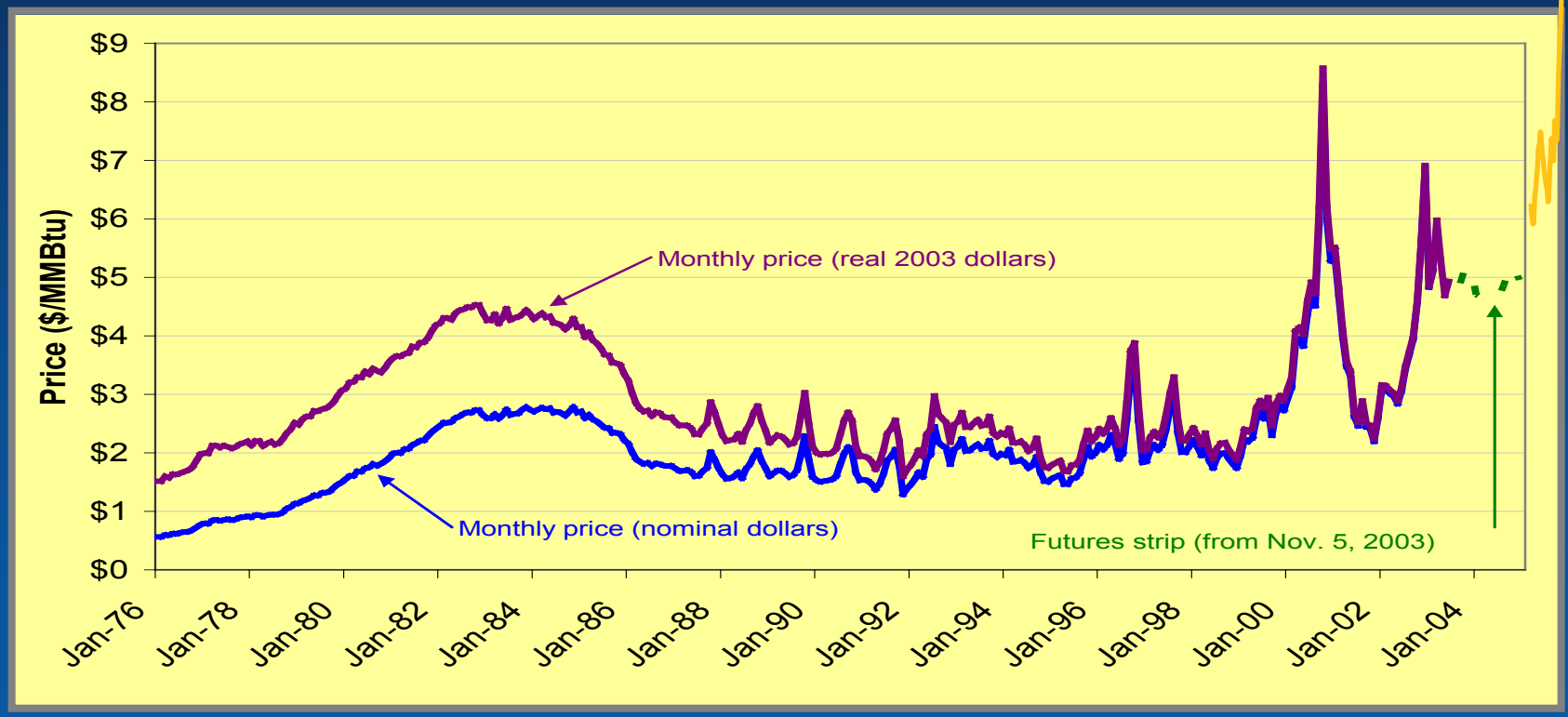


~$95/bbl

~$77/bbl

~$60/bbl

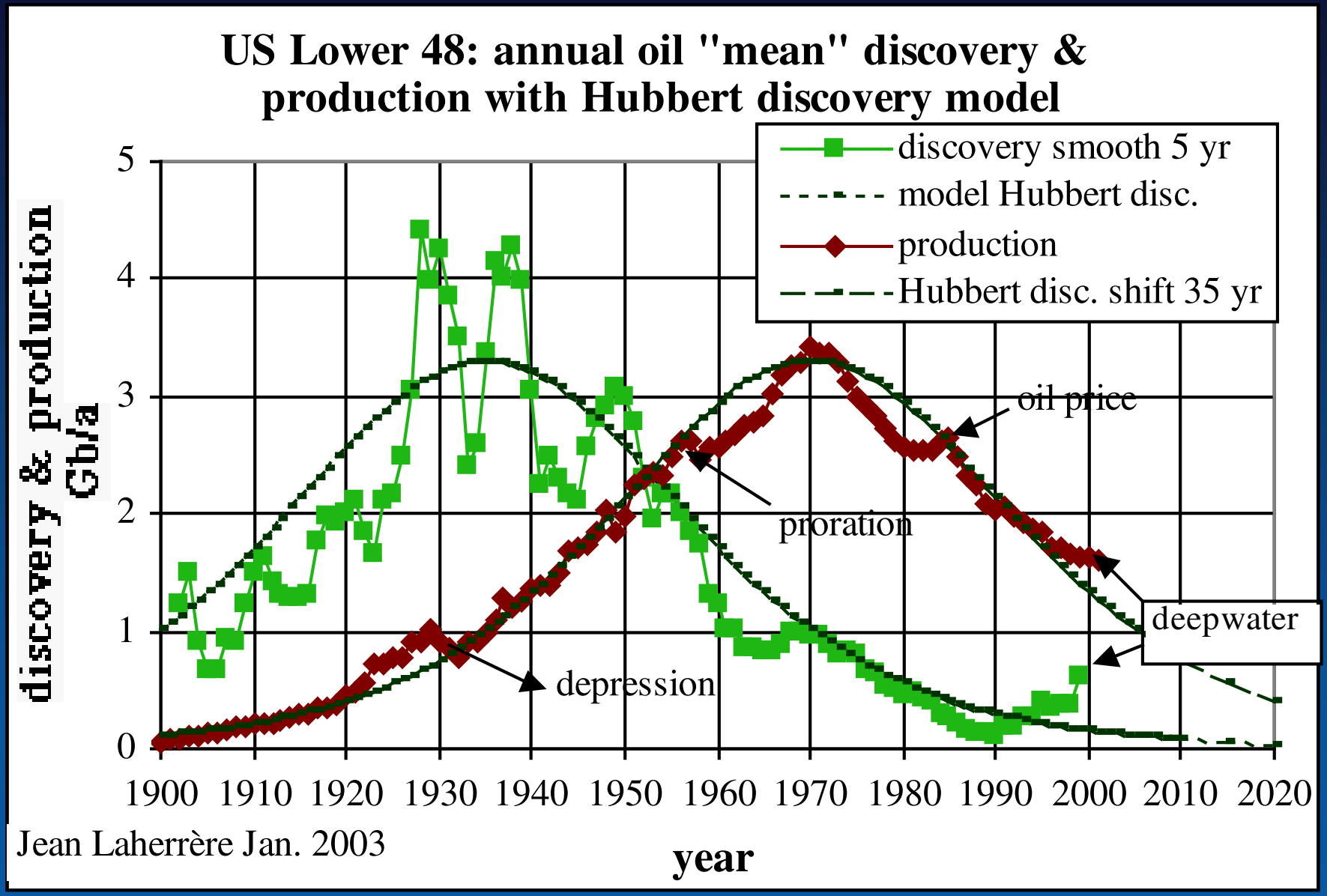
After a decade of low prices, natural gas prices are now more volatile at a higher level.



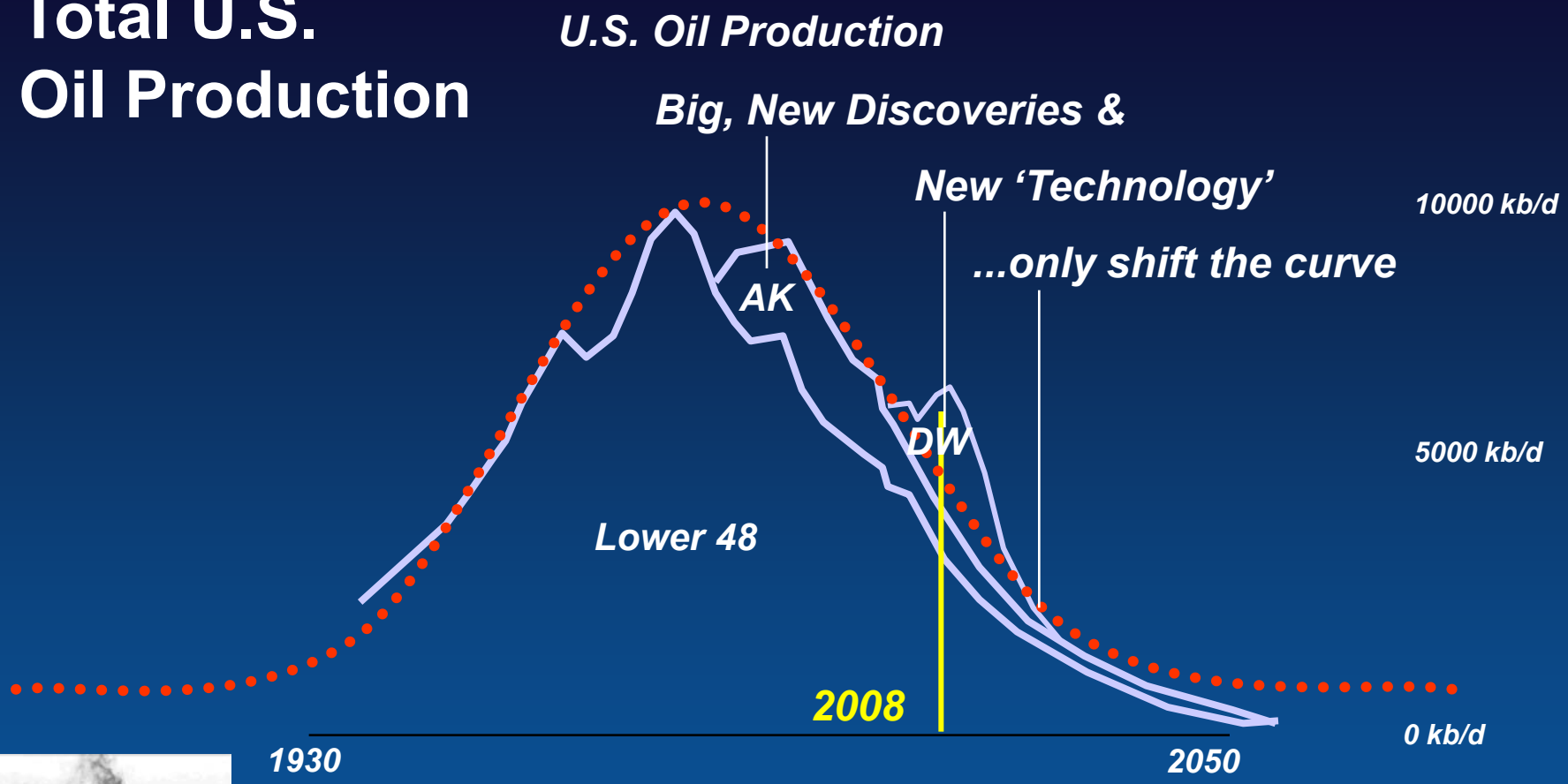
~$15 MMBTU Henry Hub

~$8.00 MMBTU

US Lower 48 Oil Discovery & Production



Total U.S. Oil Production



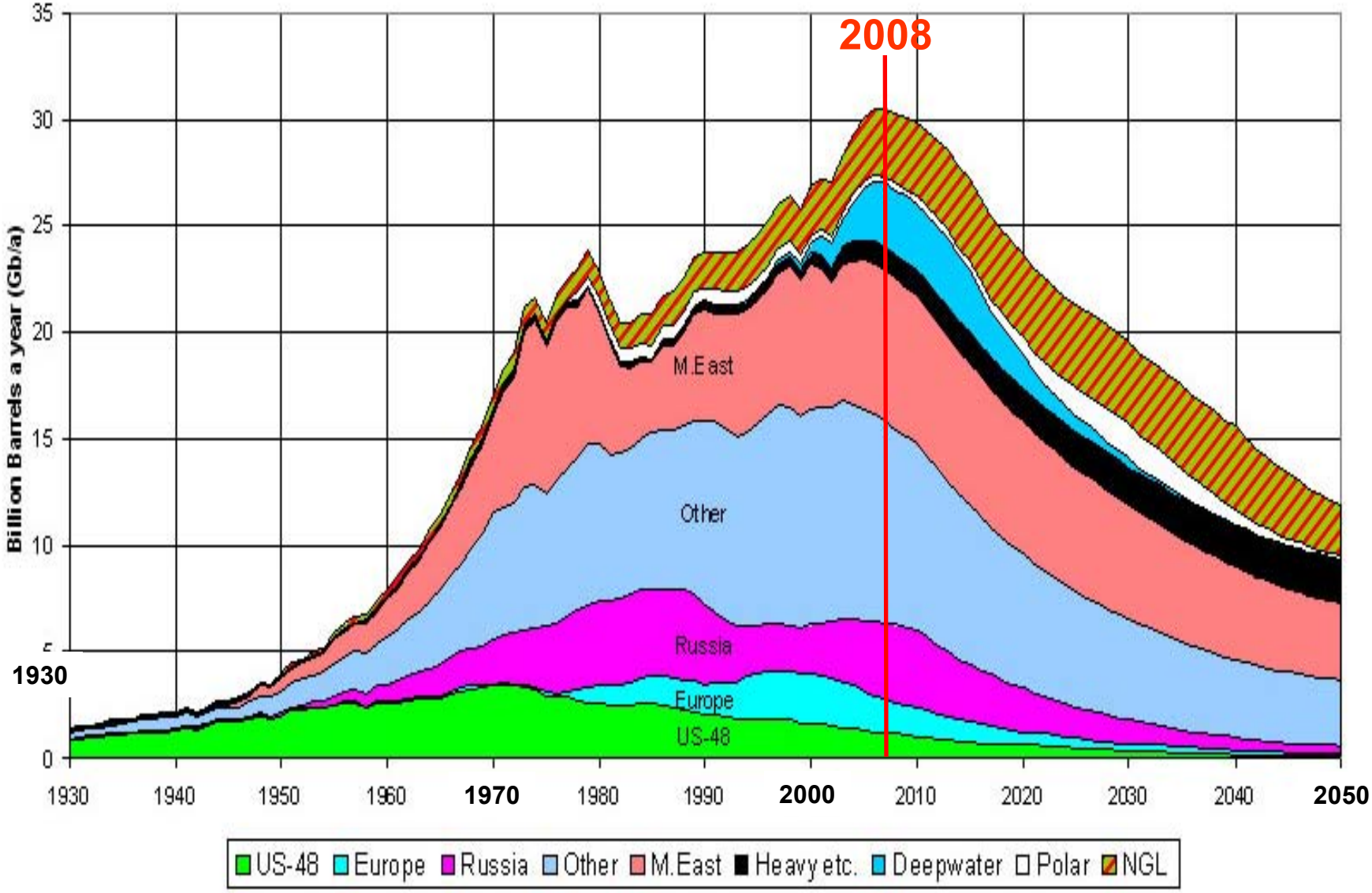
Lower 48

Alaska

Deepwater

Source: Tom Petrie at Denver World Oil Conference

The Age of Oil



7 Generations Span The Age of Oil

Our Great Grand Parents

Our Grand Parents

Our Parents

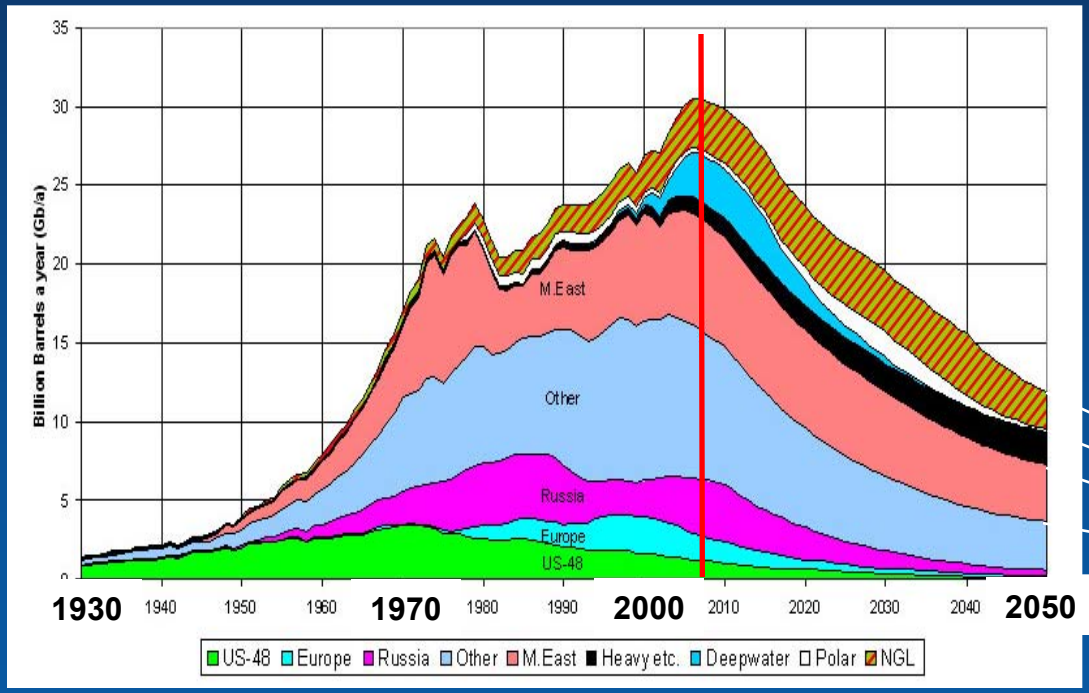
Our Generation

20 80

Our Children

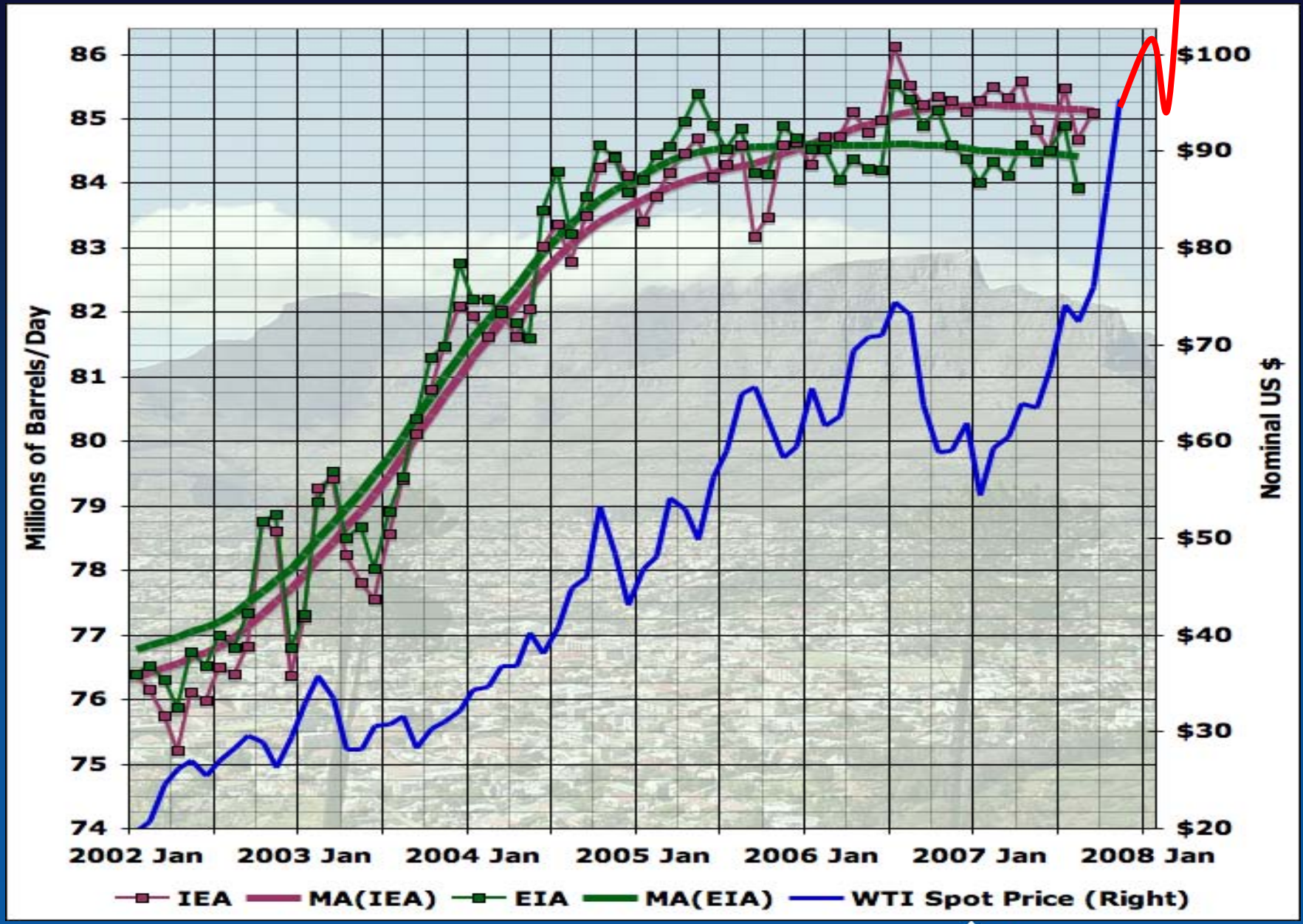
Our Grand Children

Our Great Grand Children



2100

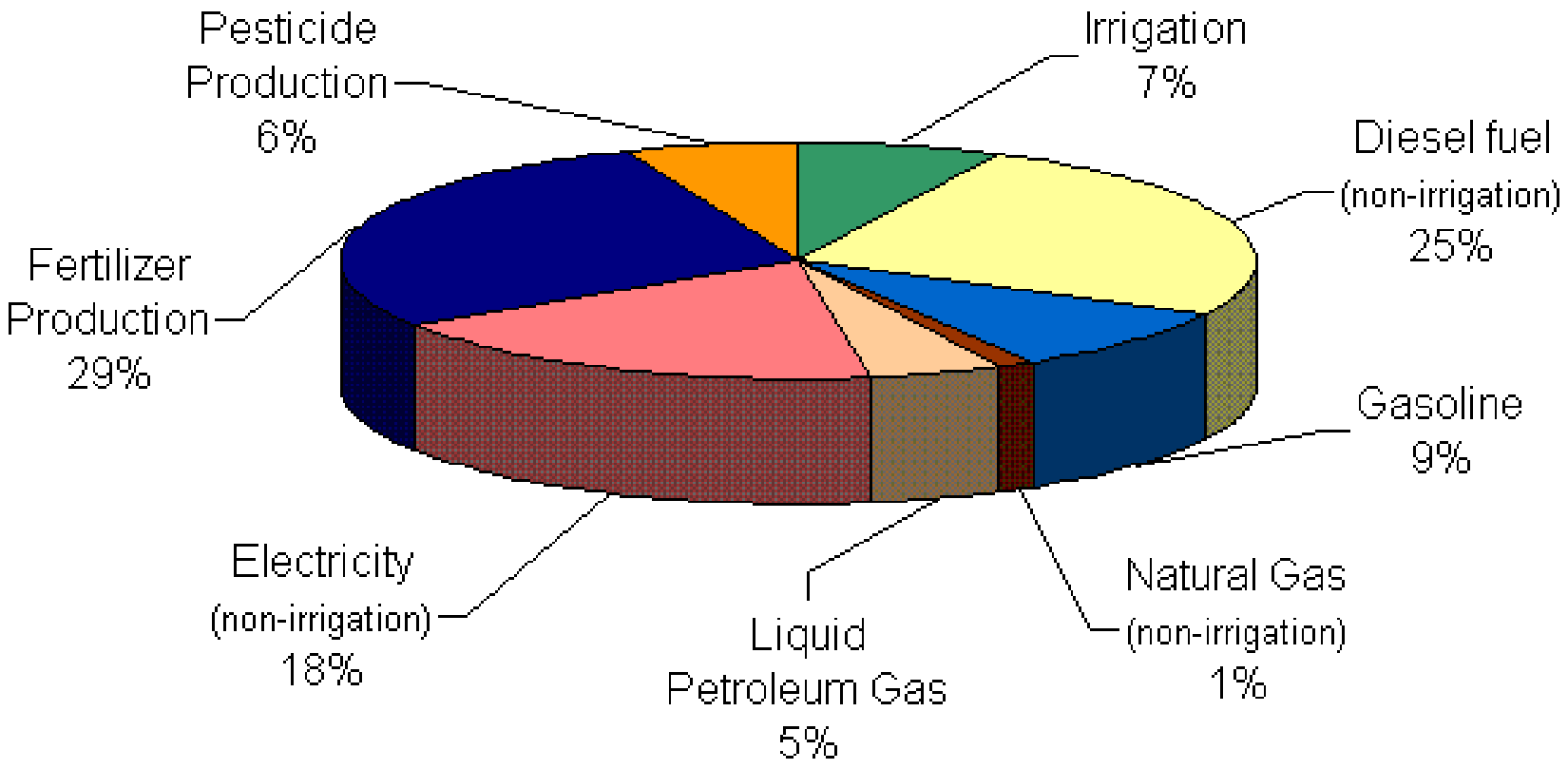
Peak Oil Graph from: ASPO.com - Colin Campbell 2004



Source: The Oil Drum

U.S. Farm Energy Use, 2002

~75% Petroleum (assuming electric Irrigation)

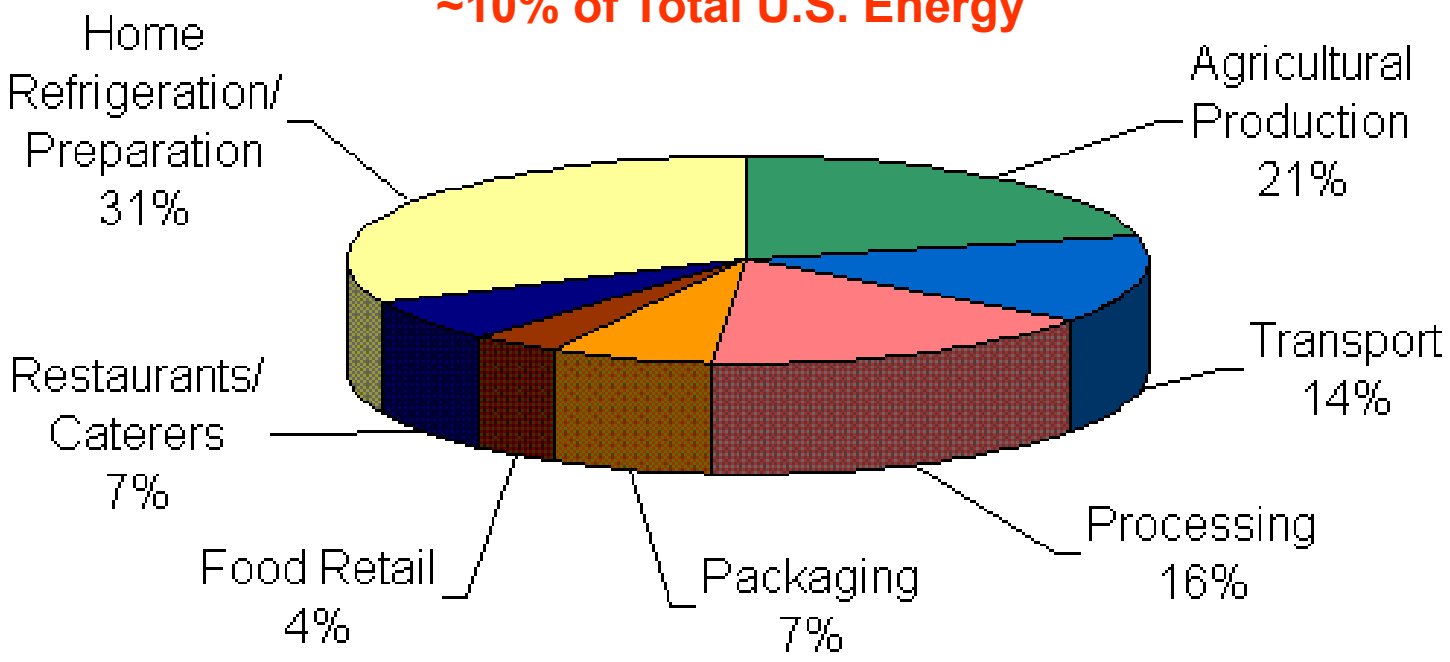


Earth Policy Institute from USDA & DOE data

United States Food System Energy Use

Total = 10.25 Quadrillion Btu

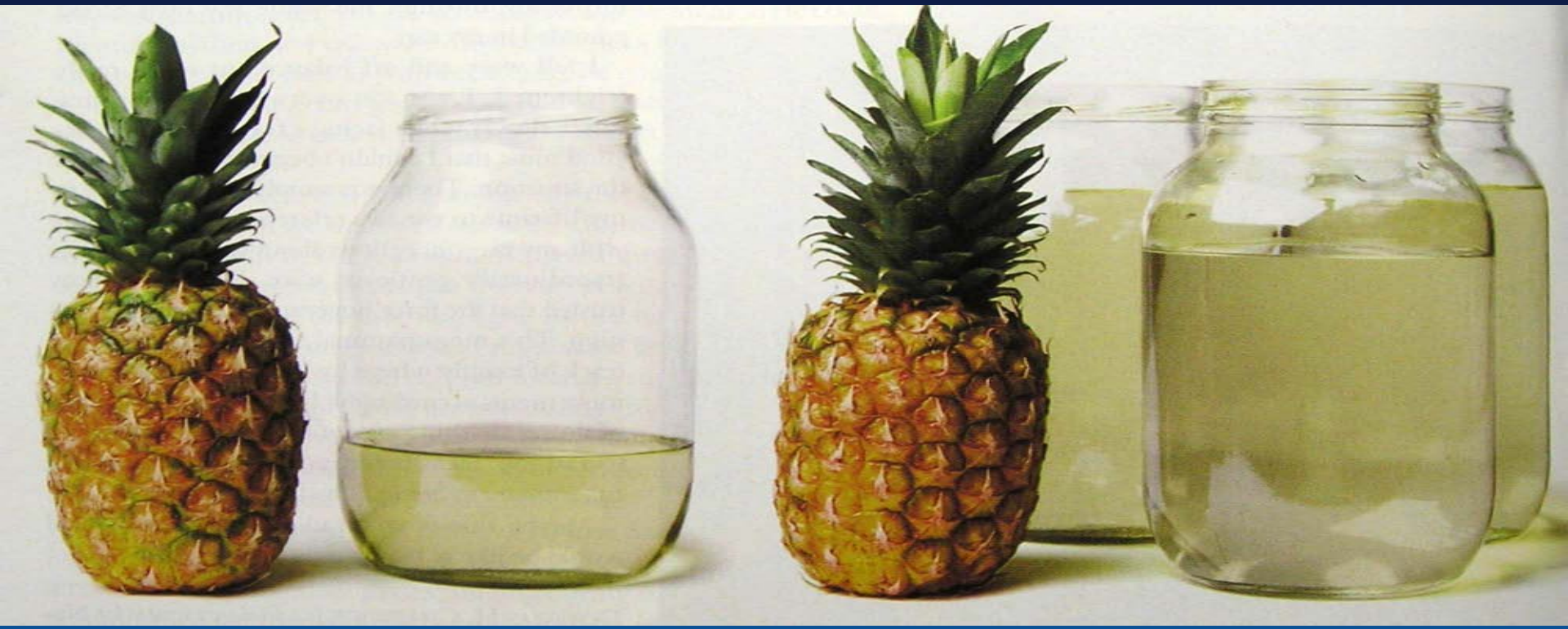
~10% of Total U.S. Energy



Source: Heller and Keoleian

Center for Sustainable Systems, University of Michigan, 2000

Pineapples to Des Moines



By sea from Costa Rica
0.3 gallons

By air from Hawaii
2.8 gallons

Three Great Challenges of the 21st Century

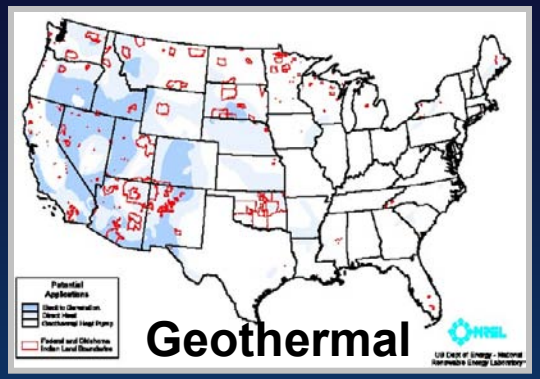
Energy, Climate, Food

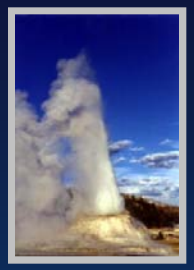
The Perfect Storm

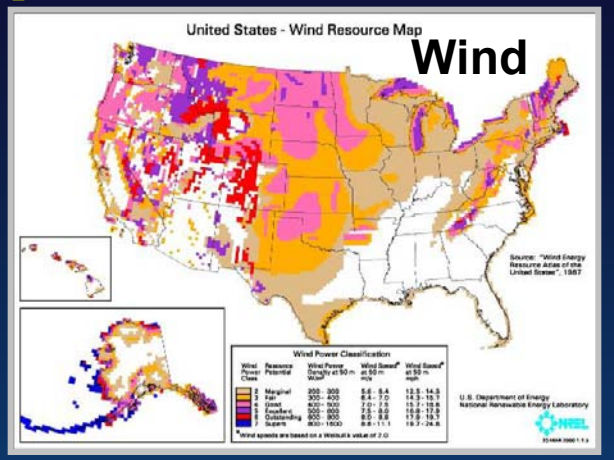
It's time to change direction

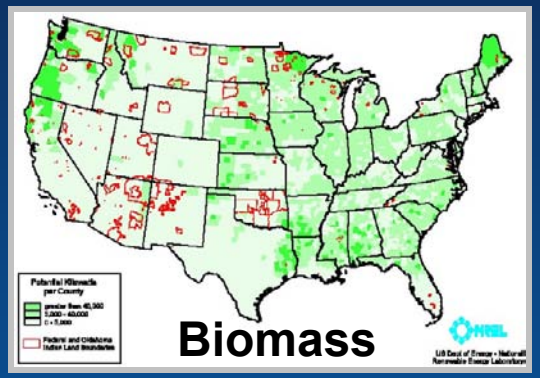
SS Global Economy

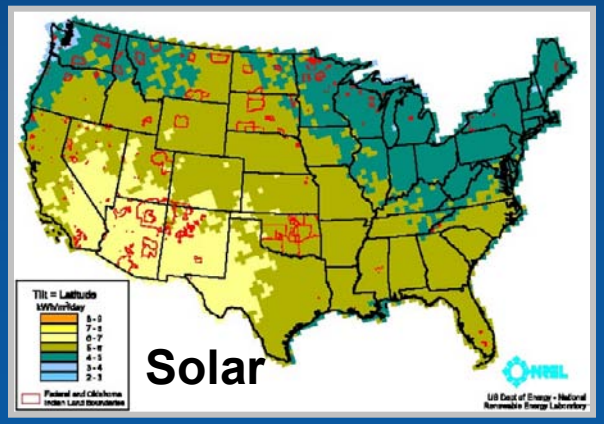
Renewable Resource Options

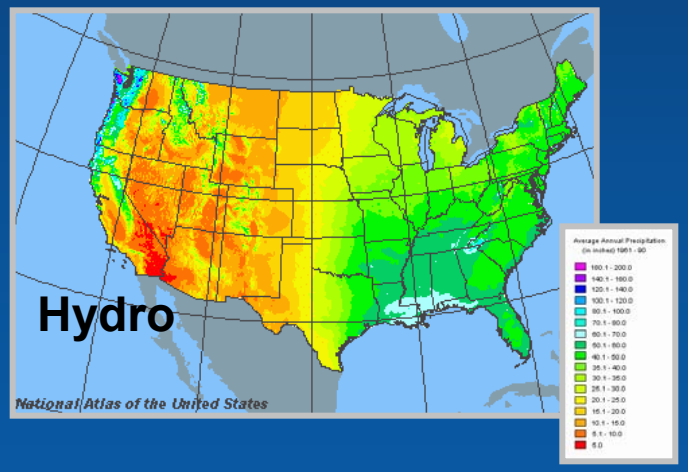










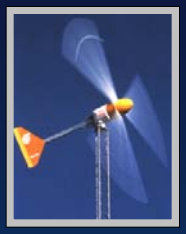


Renewable Technology Options

Power

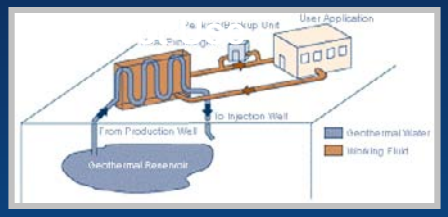
Small Modular Power

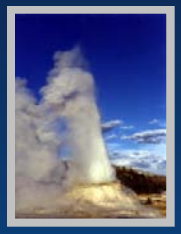
Small Wind



Diesel Hybrids

Direct Use

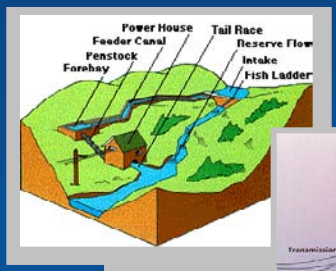


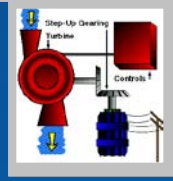


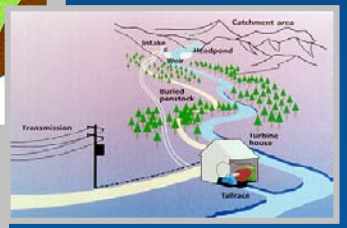
Big Wind

PV - Remote Homes

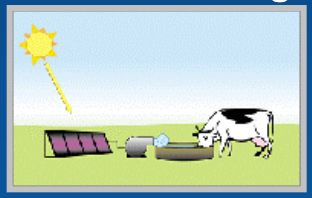
Small Hydro







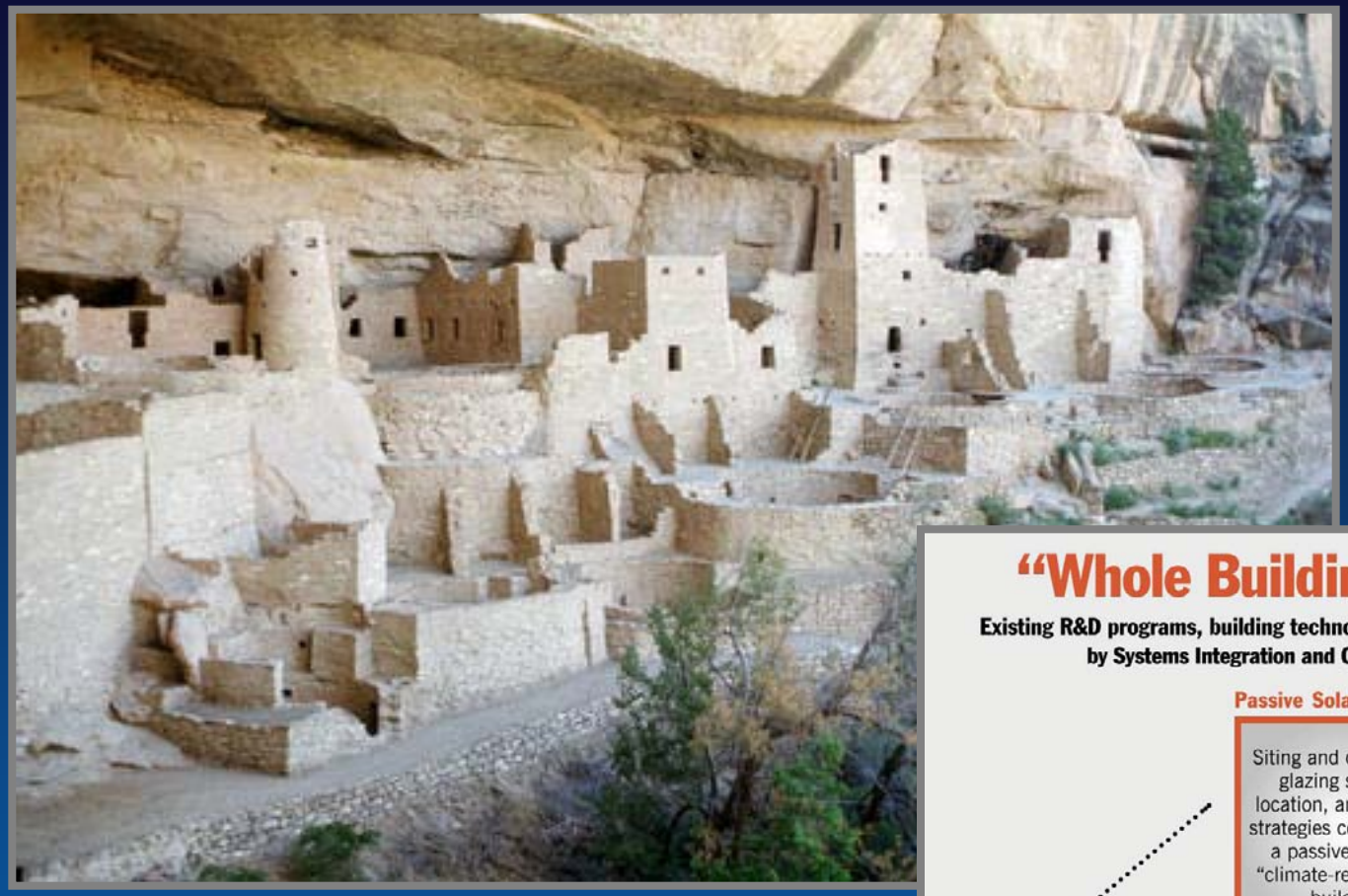
Stock Watering



Process Heat

Buildings

Building Design



"Whole Buildings" Strategy:

Existing R&D programs, building technologies, and components tied together by Systems Integration and Computerized Design Tools.

Passive Solar Strategies

Siting and orientation, glazing size and location, and shading strategies contribute to a passive solar, or "climate-responsive," building.

Advanced Technologies

Energy-saving appliances, advanced energy controls and thermostats, efficient heating and cooling systems, photovoltaics, and solar water heating systems.

Energy-Efficient Materials

Superior building materials, including high-efficiency windows, insulation, brick, concrete masonry, and interior finish products.

Energy Efficiency

Energy Star Appliances

Refrigerators – Half as much energy

Clothes Washers – Save up to $110 per year

Oil & Gas Boilers – Save up to 10%

Programmable Thermostats – Save up to $100 per year

Efficient Lighting

If every American changed out 5 lights, we'd save $6 billion/year and the equivalent of 21 power plants.

Wind Turbine Sizes and Applications

Small (≤10 kW)

- Homes
- Farms
- Remote Applications (e.g. water pumping, telecom sites, icemaking)

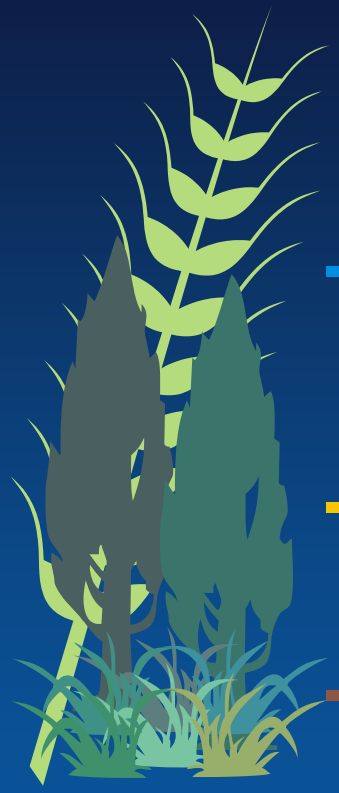
Intermediate (10-250 kW)

- Village Power
- Hybrid Systems
- Distributed Power

Large (250 kW – 2+ MW)

- Central Station Wind Farms
- Distributed Power

Biomass & Bioenergy Flows

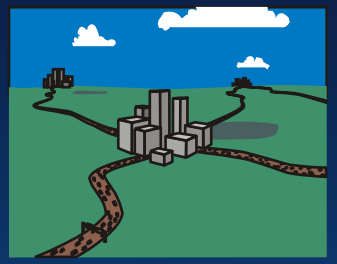


Biomass

Fiber

pulp
paper
lumber
plywood
cotton

Materials



Consumers

MSW clean fraction
yard trimmings
constr. & demolition wood
non-recyclable organics

Process Residues
black liquor
sawdust
bark

Crops, Animals

Food

Process Residues
dung
bagasse

stalks & straws
harvest residues
forest slash
forest harvest for energy plantations

Bioenergy

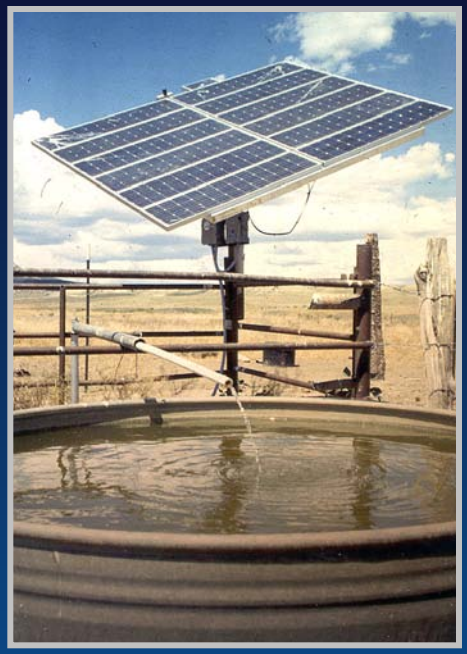
Energy Services

heat
CHP
electricity

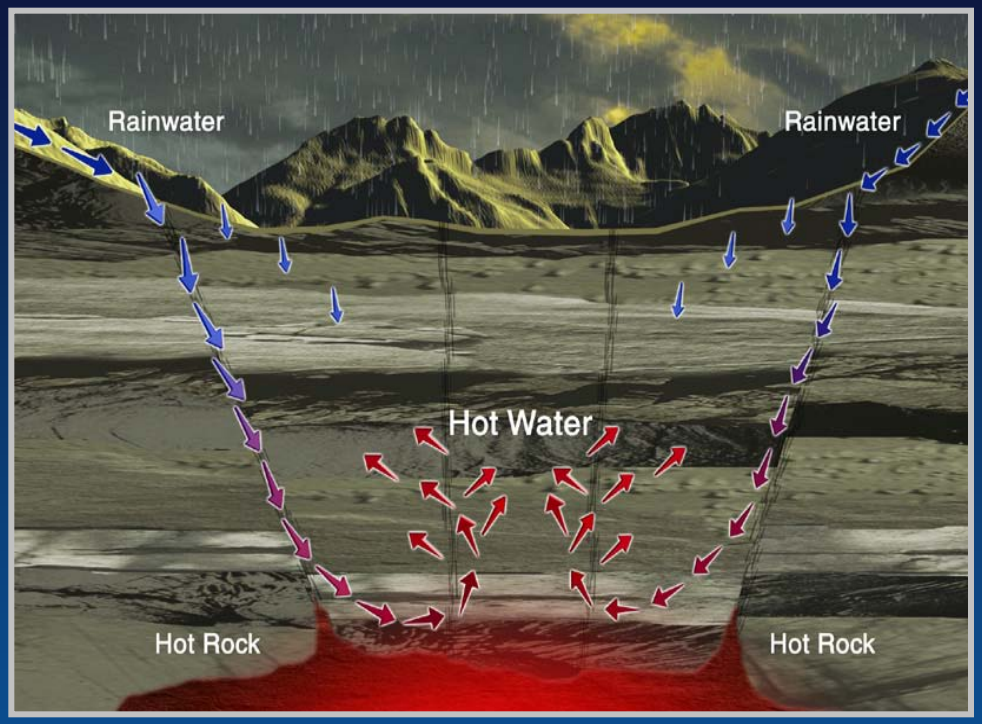
Biofuels

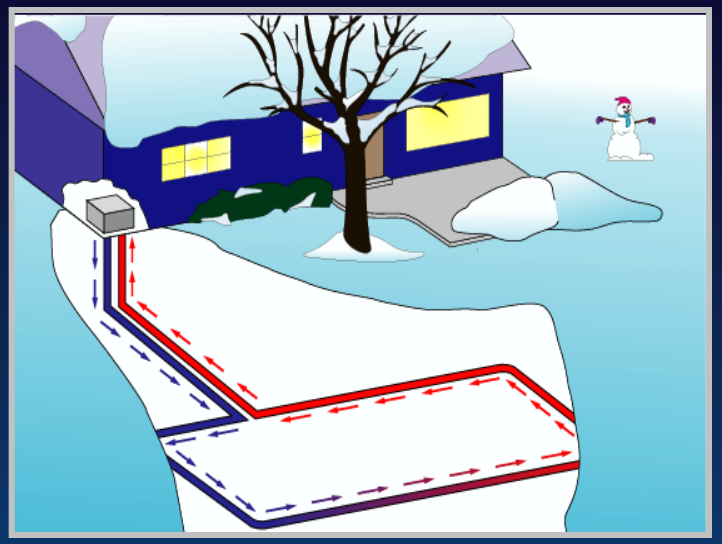
charcoal
biogas
ethanol

Solar Options

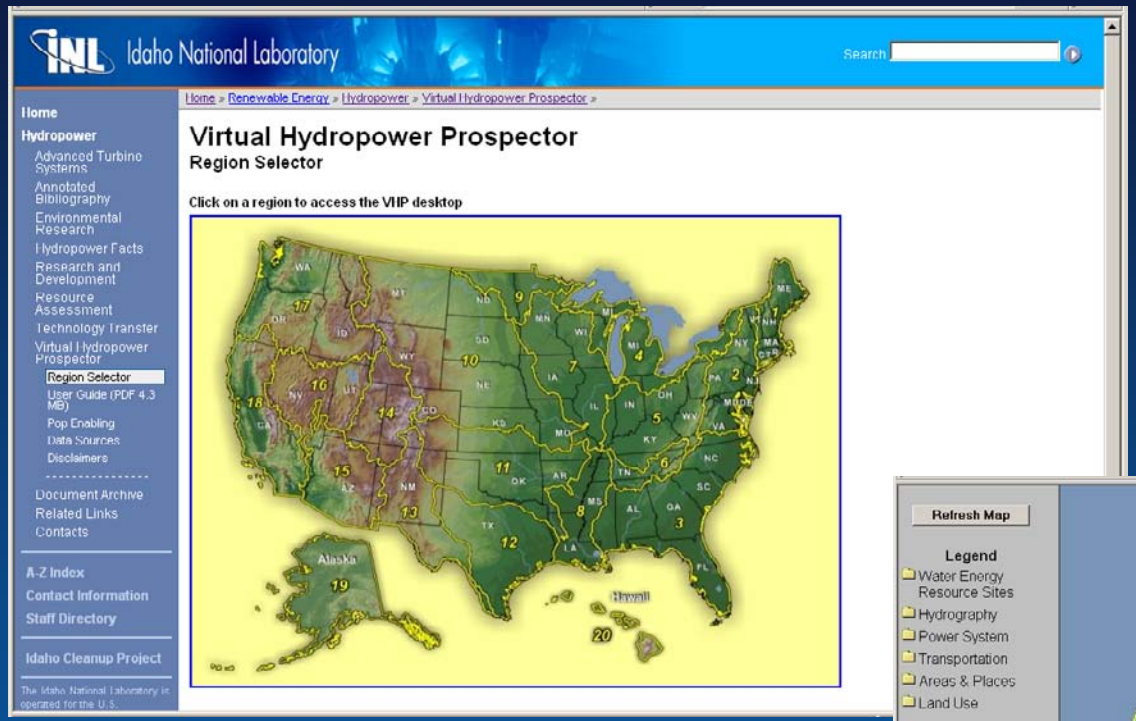


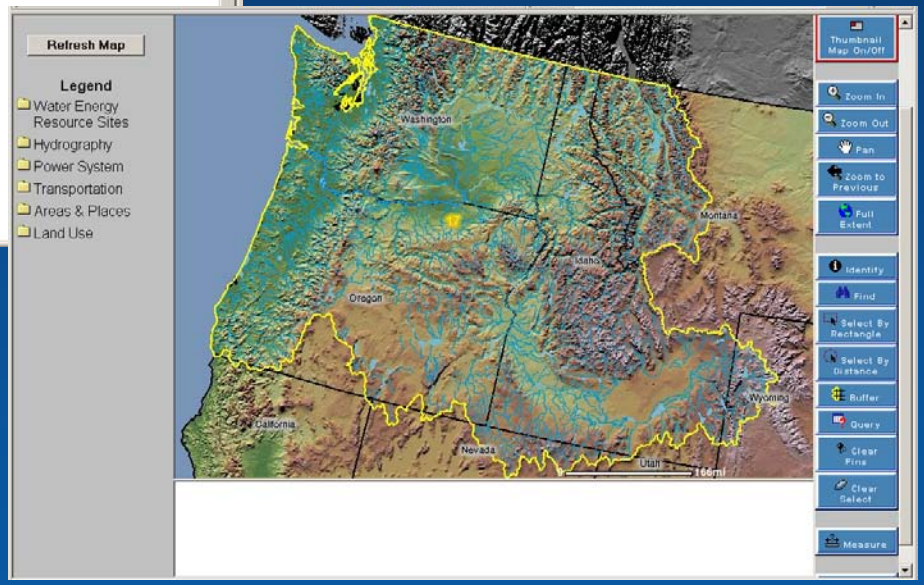
Geothermal Options





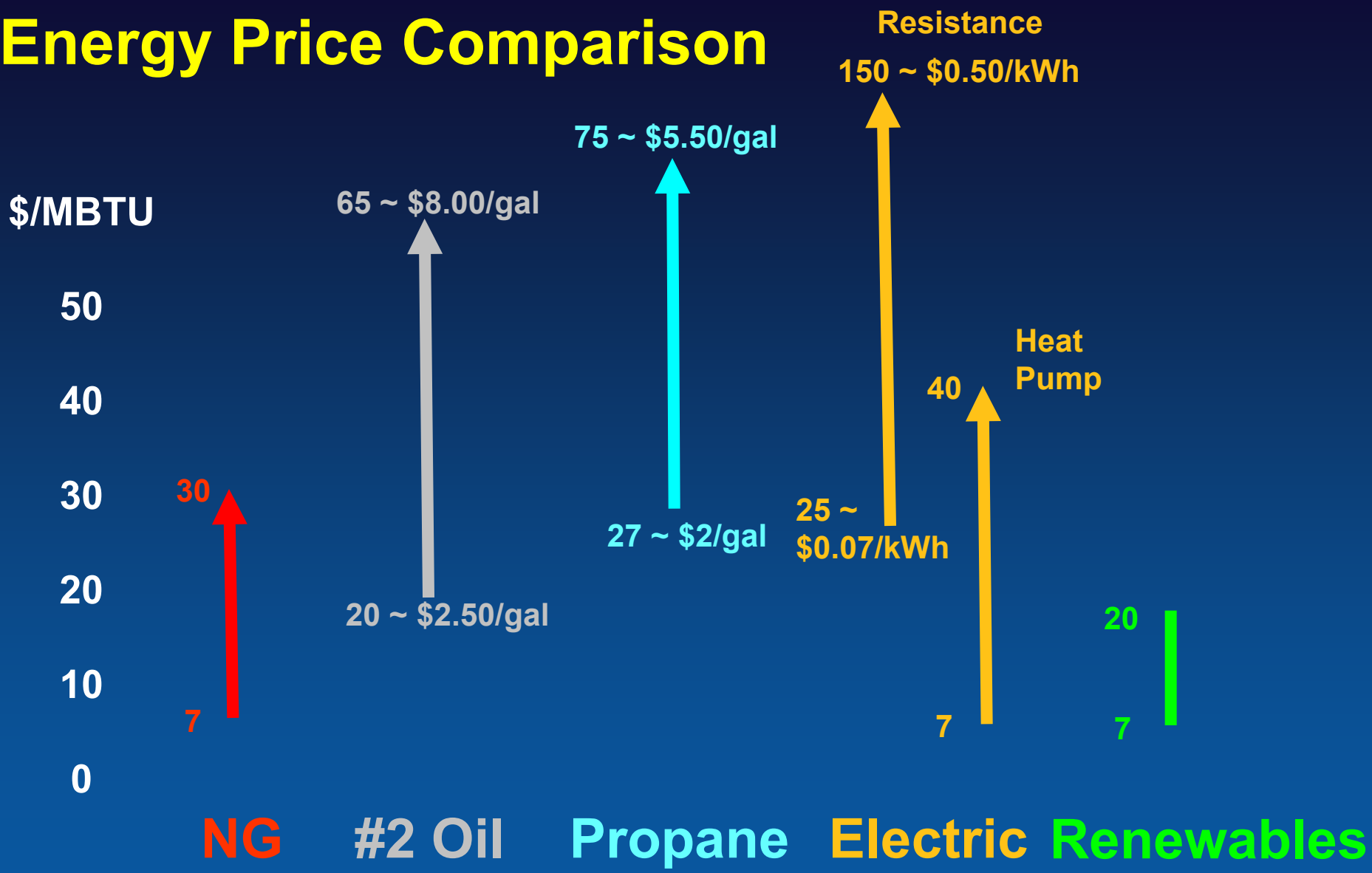
Small Hydro Power





http://hydropower.inl.gov/prospector/

Energy Price Comparison



Some Challenging Questions:

- Where have we come from, and where are we going?
- What can we learn from the past?
- How do we shift from individualism to partnerships?
- How do we improve communication and coordination?
- How do we shift from modernism (new, bigger, faster) to community?
- How do we reduce consumption and produce locally?
- Civilizations are built on surplus. How do we shift from surplus to enough?
- A goal of communities is to provide and protect.
    - How do we move to more local production?
    - How do we shorten the supply chains?
    - How do we move from fuel to food?
- How do we develop our local sources of energy?
    - Heat, power, liquid fuels at a community scale, vs. commercial scale
    - What are our local opportunities for energy efficiency and renewables?

- How do we plan for contraction and avoid collapse?

Tribal Energy Security & Sovereignty Through Local Self-Sufficiency

Economic Dependence

Oil Imports
Fuel at the Pump
National Grid
Coal-based Power
Water Transport
Foreign Manufacturing
Agro-Industry

"He who has the gold, makes the rules."

Community Independence

Self sufficiency
Food
Energy
Water

Skill Rebuilding
Local Production
Regional Sourcing

Sufficiency & Enoughness
Human Satisfaction

"Community of Cooperation"

The Community Energy Development Challenge