

OUR FUTURE

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American Association of Petroleum Geologists

May 11, 2003

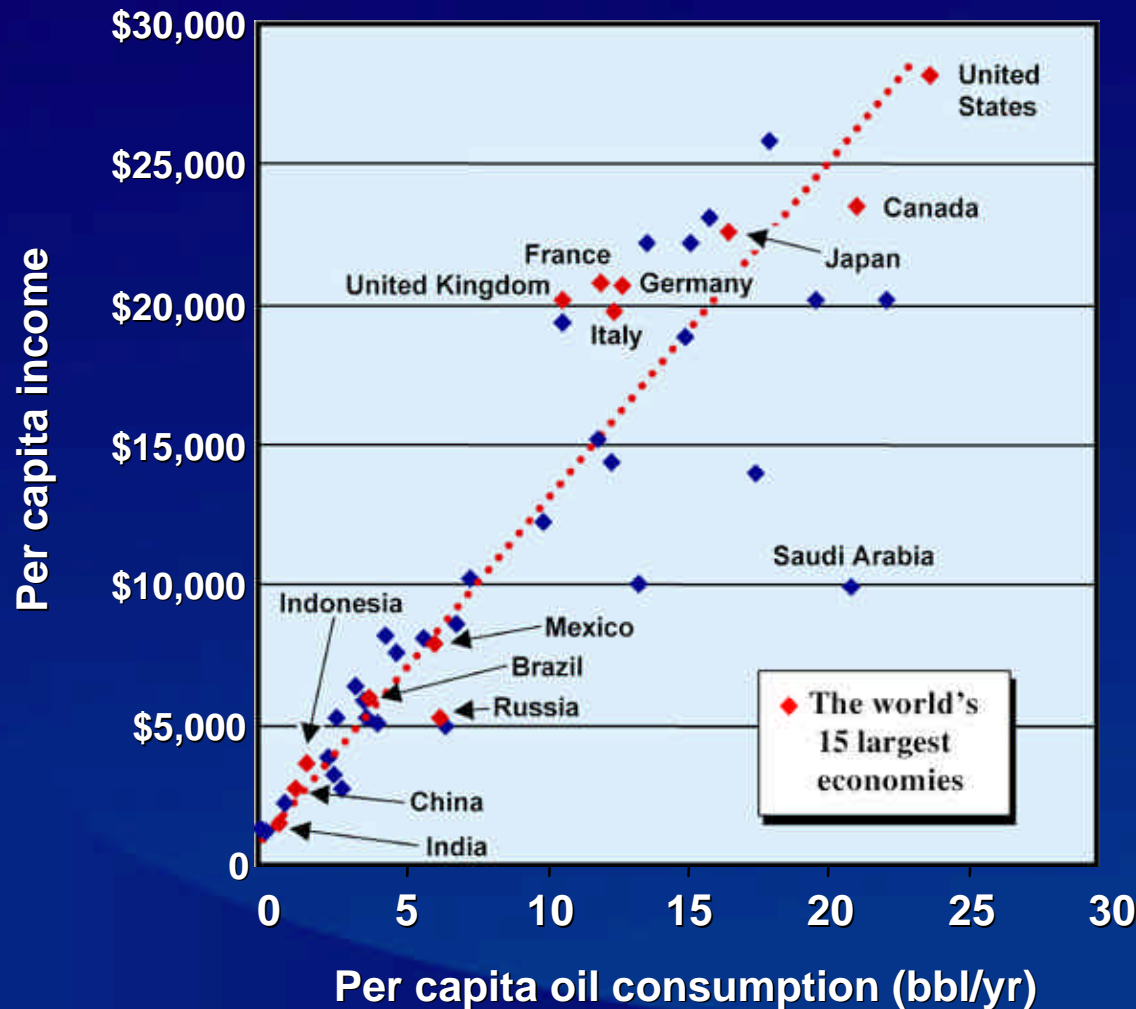
Perceptions

- Exploration – Dead
- Alternative Sources
Replacing Fossil Fuels
- Running Out of Fossil Fuels

Key Questions:

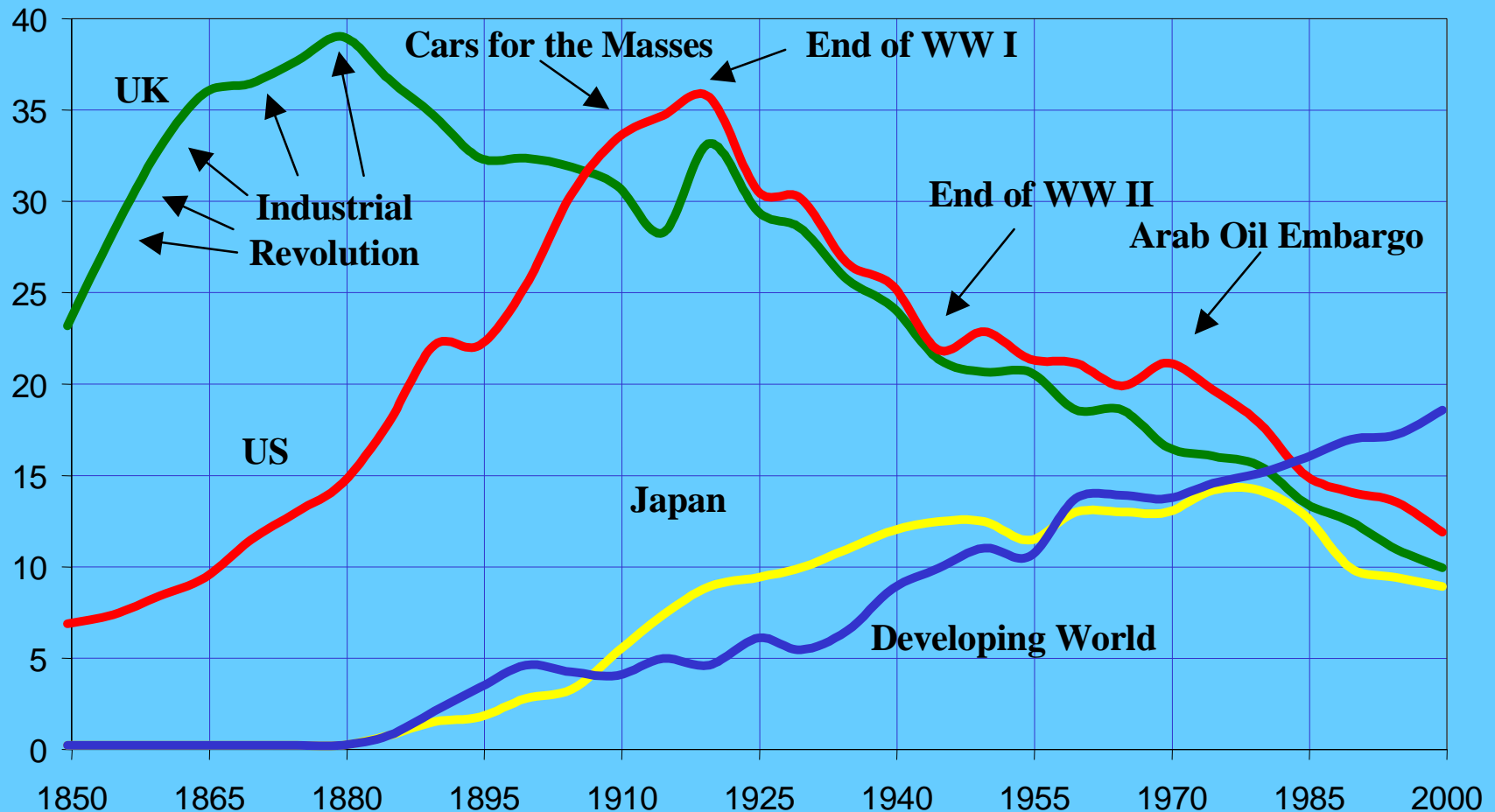
- What will be the primary ENERGY SOURCE in the future?
- Who is going to be looking for NEW reserves in the future?

Energy Consumption as an Indicator of the Wealth of Nations



Energy Consumption per Dollar of GDP

Energy Use per Unit of Gross Domestic Product (MBTU/\$)



Will Our Pattern of Energy Use Change?

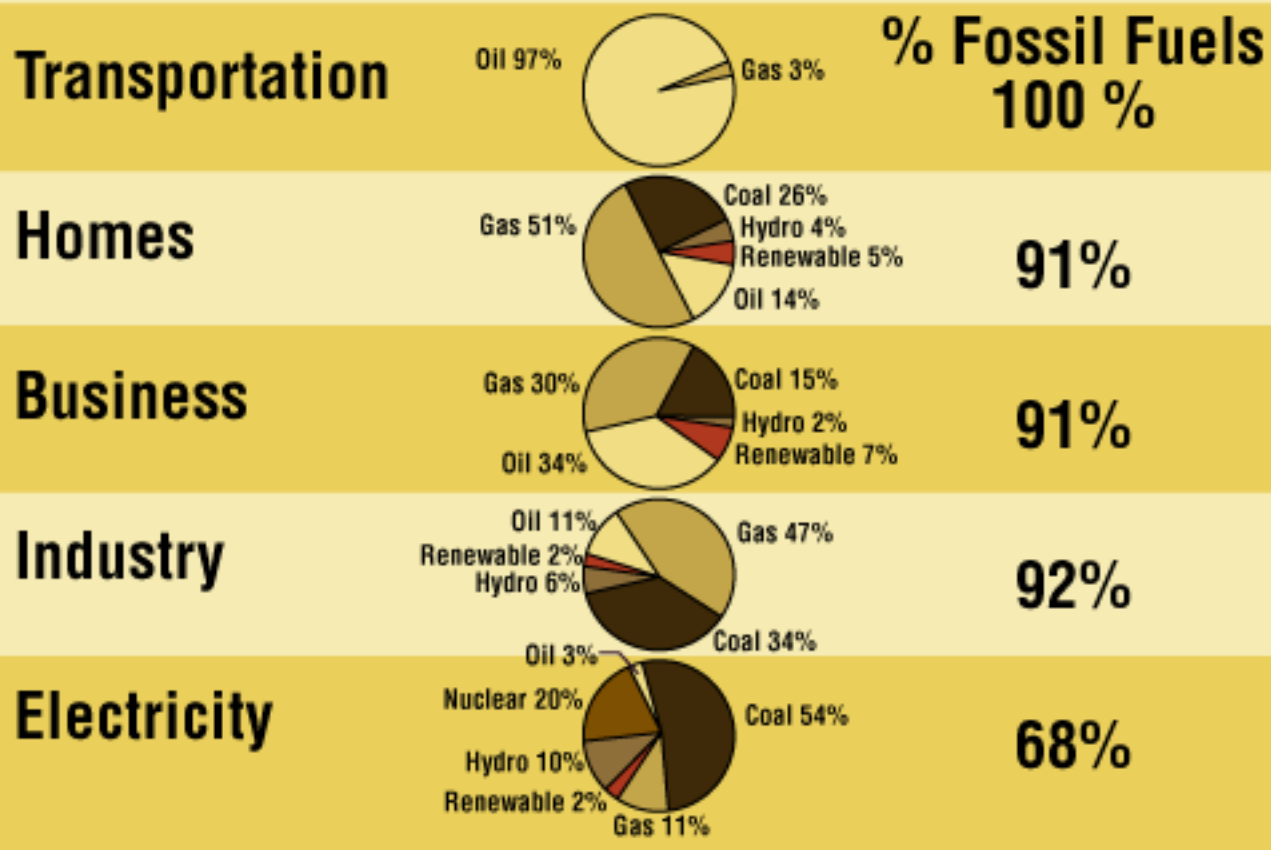
Current Worldwide Consumption:

•Oil	40%
•Natural Gas	24%
•Coal	22%
•Nuclear	7%
•Renewables	7%

- We rely on hydrocarbons today and “alternative sources” provide for only a small part of our needs*
- Economics and Technology will determine the future*

US Consumption Similar to Worldwide Pattern

Fossil Fuels Provide 85% of Our Energy



The New Energy Economy

- Wood (1800s)
- Coal
- Oil
- Natural Gas
- Hydrogen (envisioned)

Carbon
content:

High

Medium

Low

(Zero)

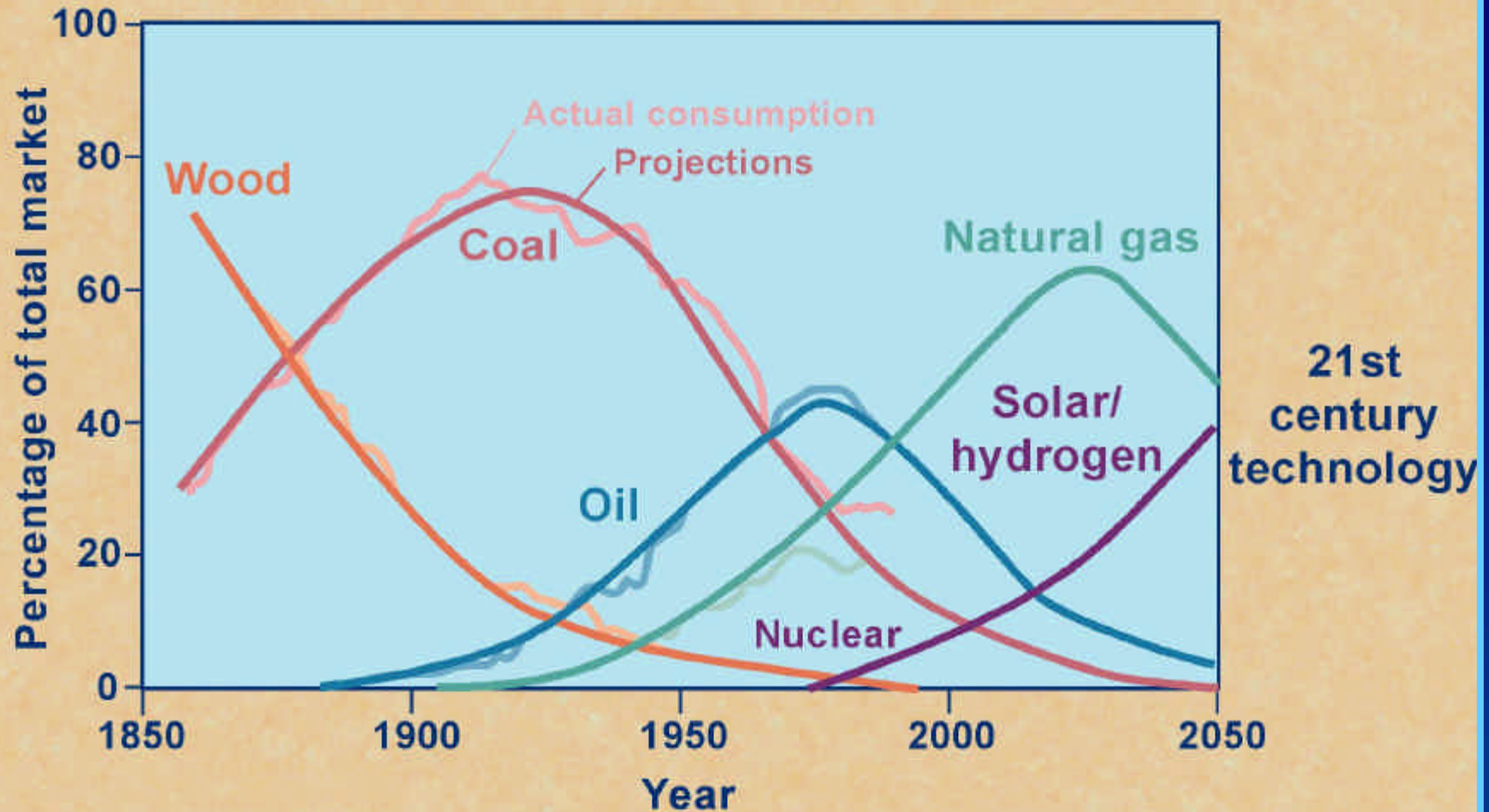


Increasing:

- Cleanliness
- Energy intensity
- Technological sophistication

The emerging “**hydrogen economy**” better characterized as a “**fuel cell economy**” that will run on natural gas--i.e. a “**natural gas economy**”

Energy Sources Through Time



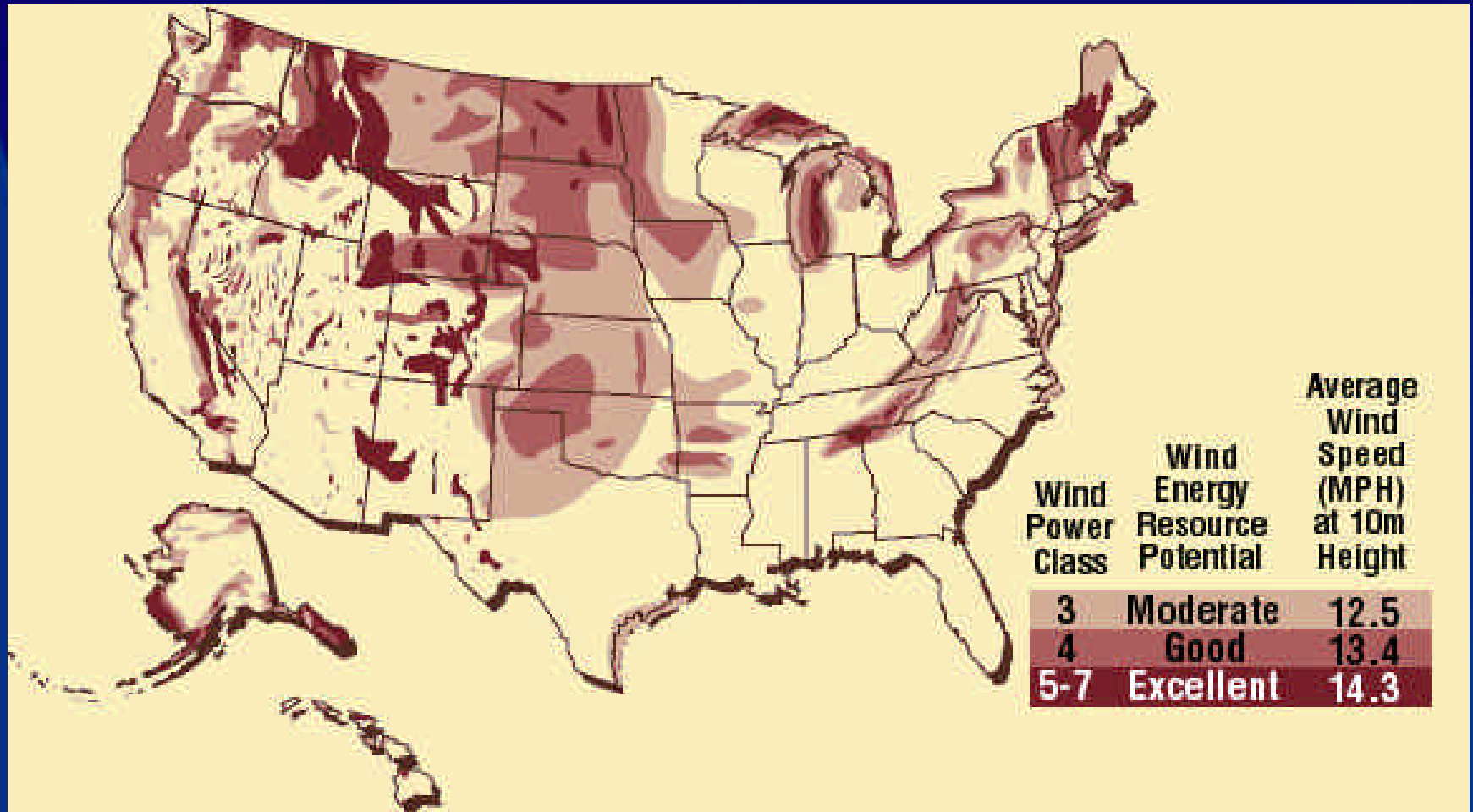
Marchetti and Nakicenovic (1994)

QA c5605c

Wind Energy

- The most frequently mentioned renewable source of energy is wind power.
- The critical problem with wind power is the overwhelming dependence on geography.

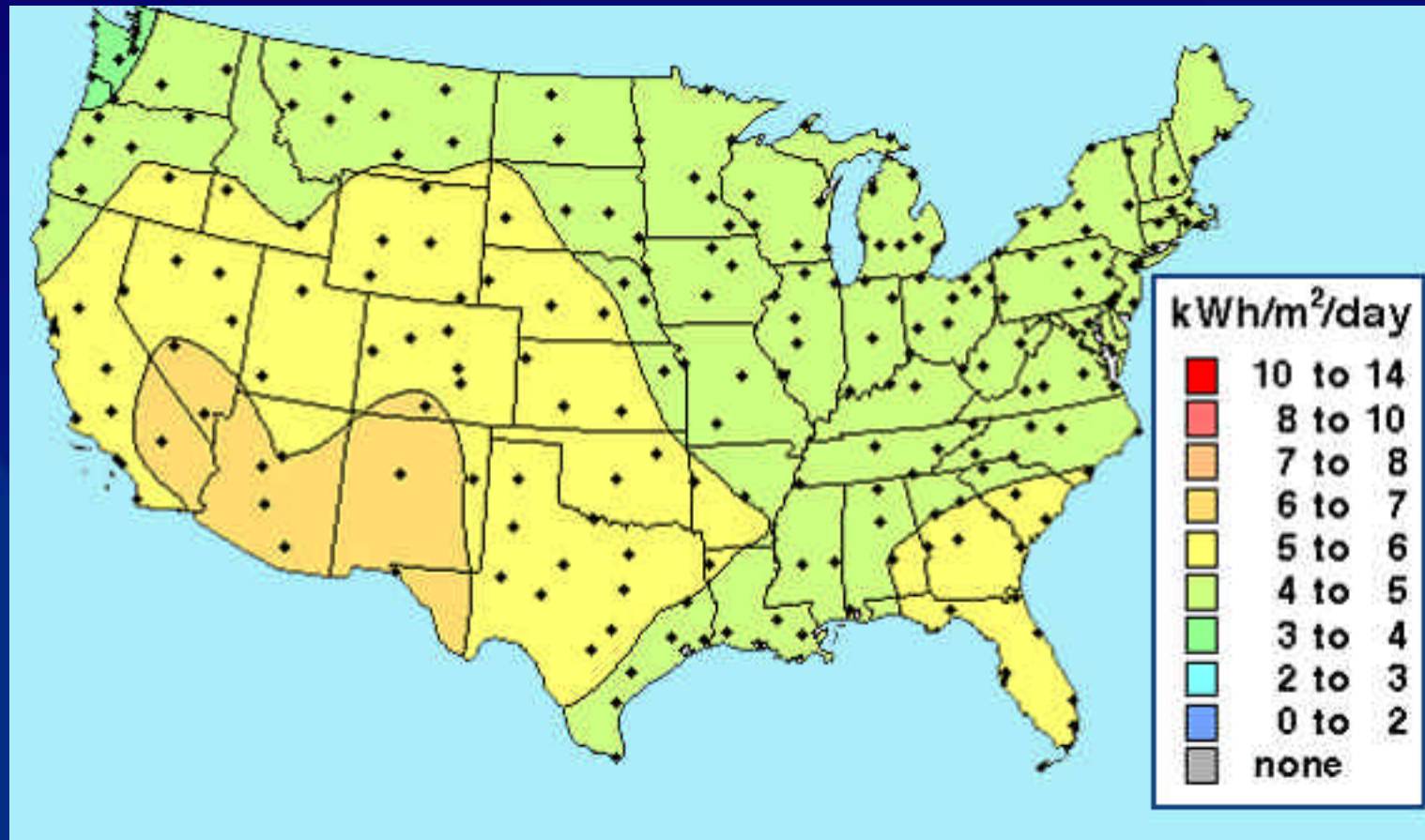
A Map of Average Wind Power in the United States



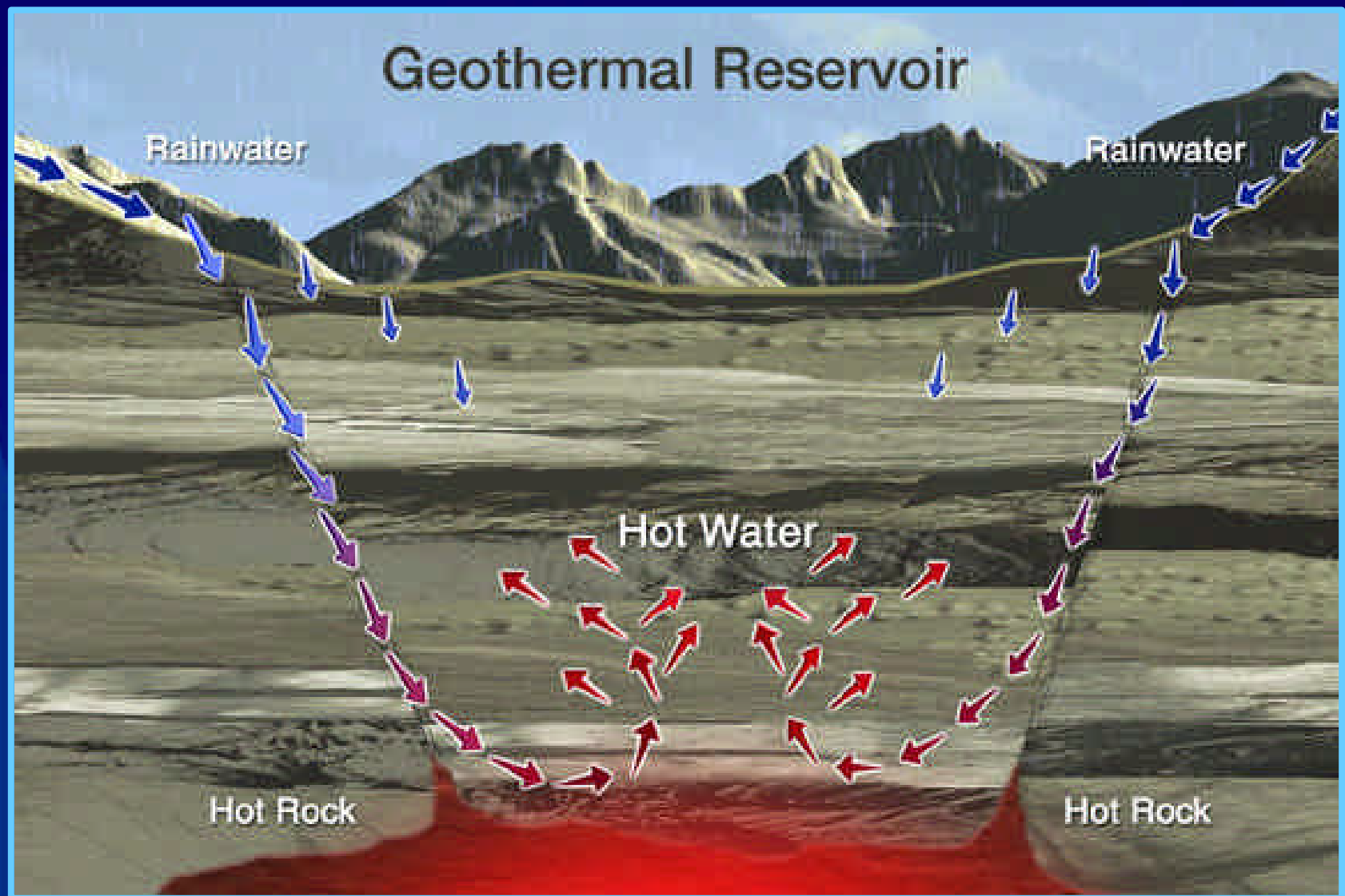
Solar Energy

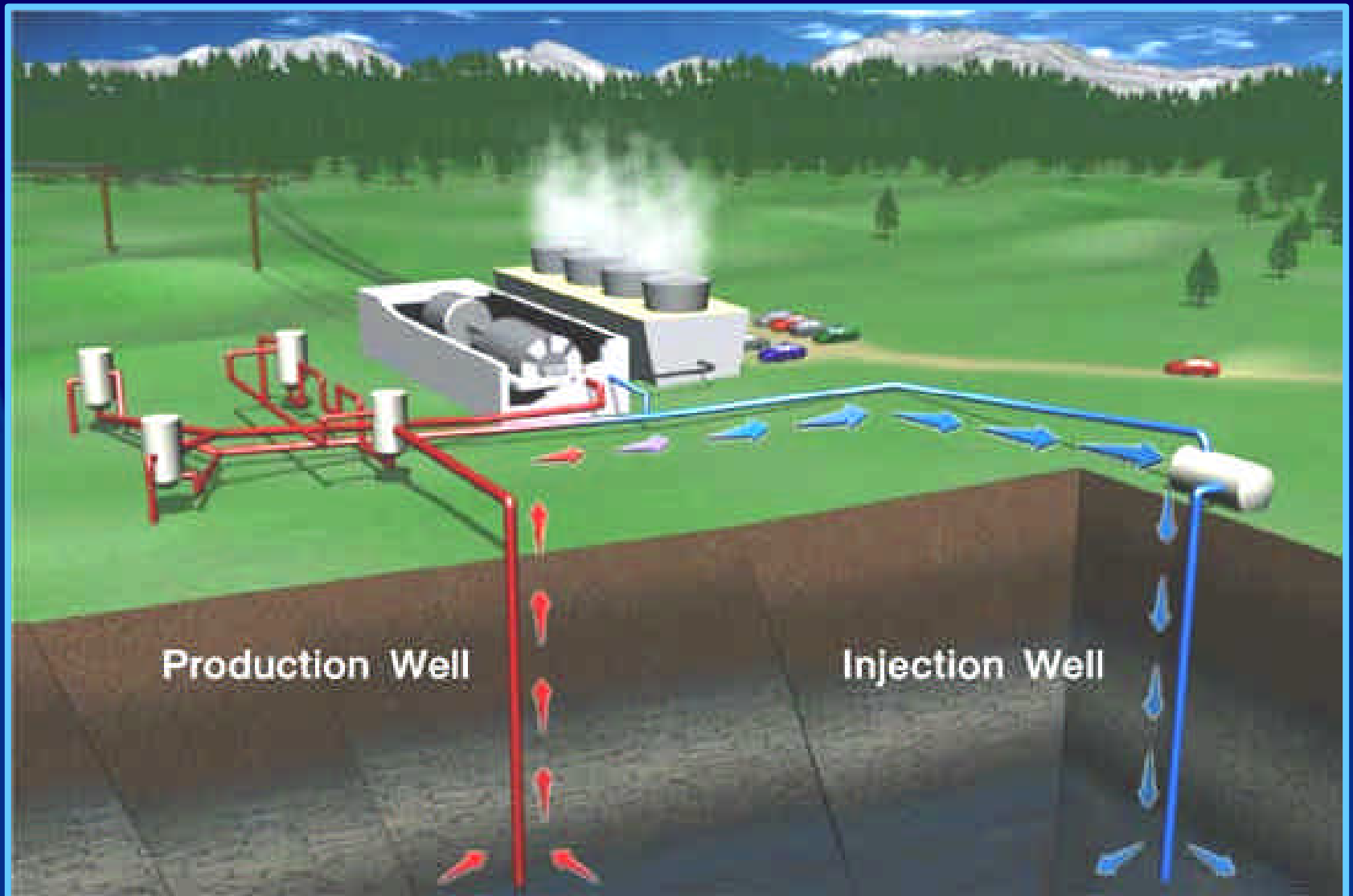
- Again, the critical problem with solar energy is the overwhelming dependence on geography.
- Two types of solar energy have been envisioned, direct thermal uses for homes and office buildings, and power generation. The first is obvious; the second is far more complex and challenging.
- Highly diffuse form of energy.

Average Daily Solar Radiation in the United States

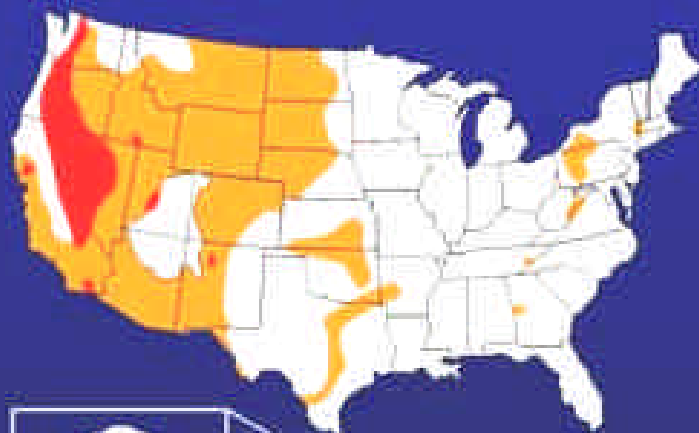


Geothermal Energy





U.S. Geothermal Potential

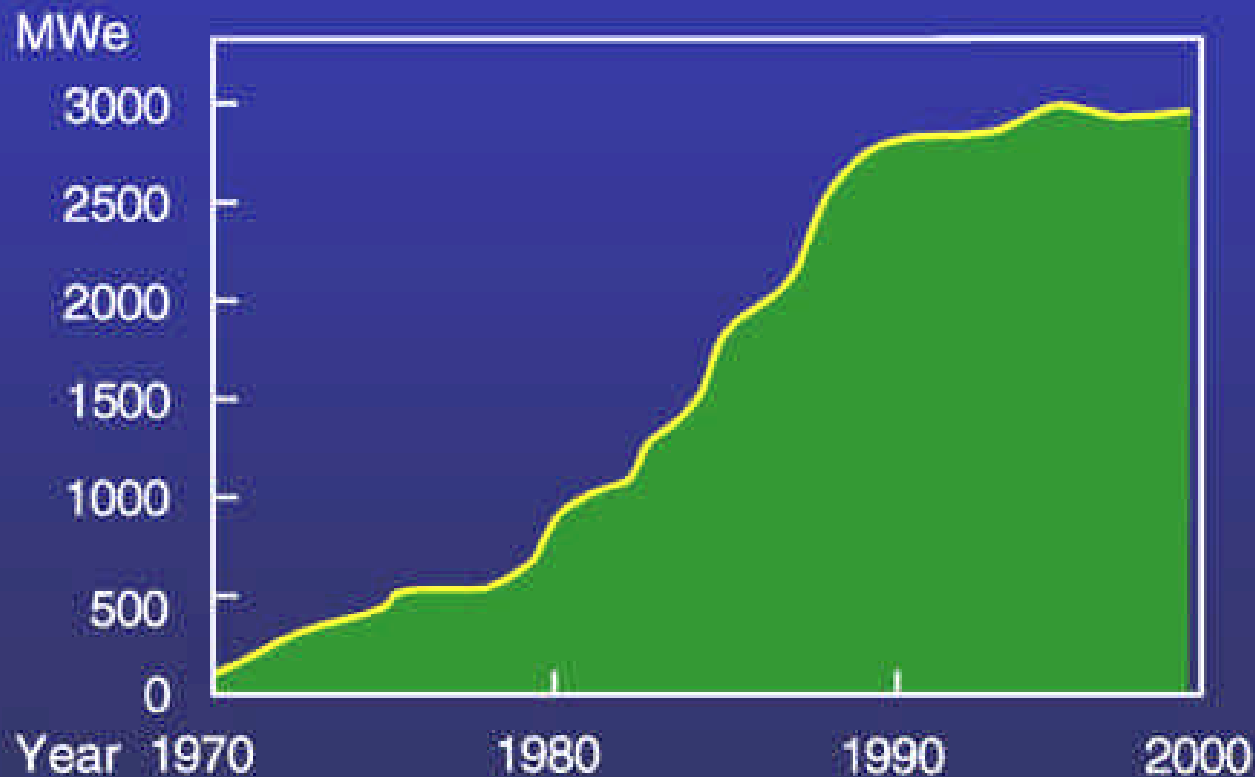


- Direct Uses
- Power Plants and Direct Uses

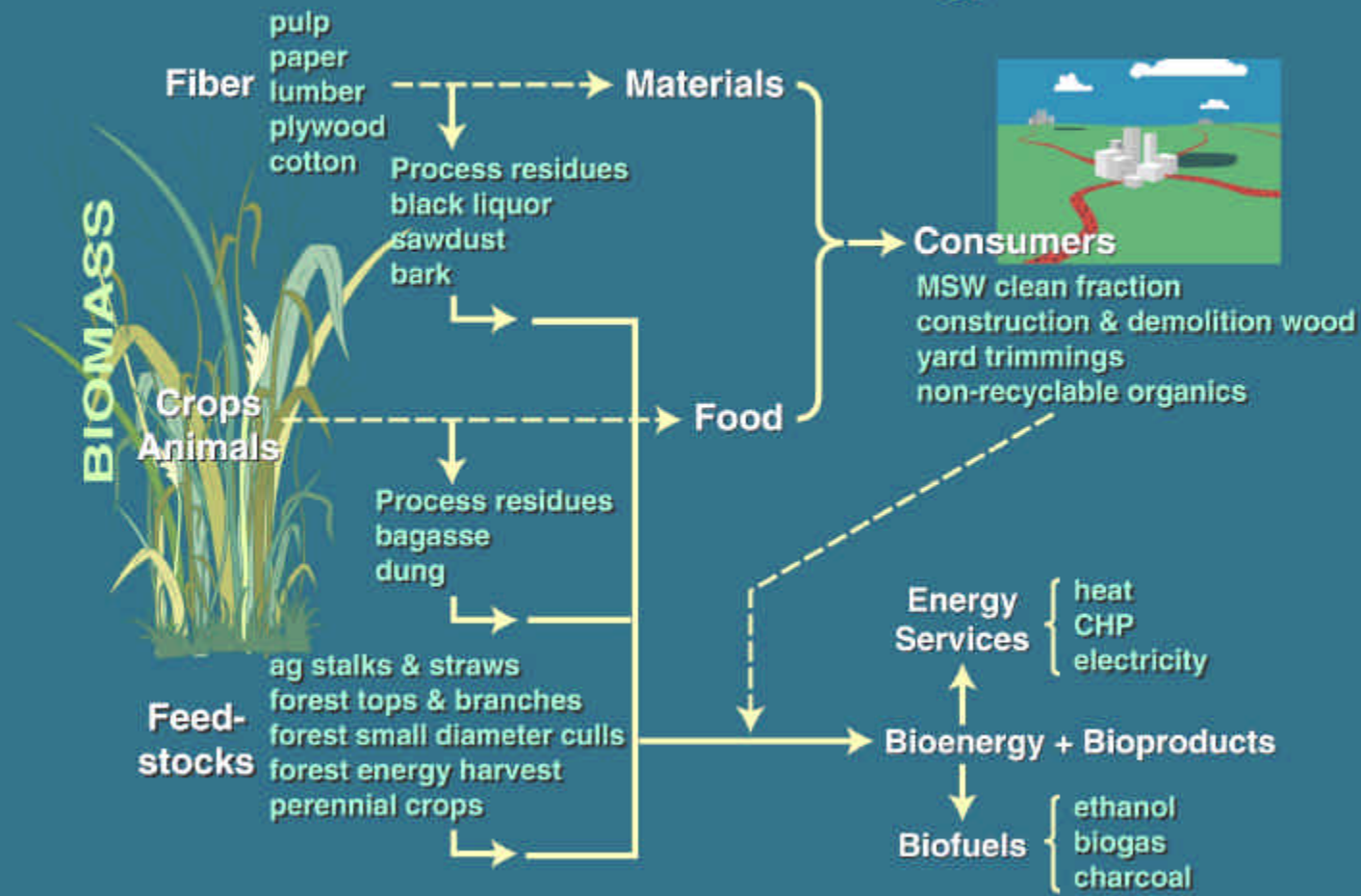


- Geothermal Heat Pumps

Growth in U.S. Geothermal Power



Biomass to Bioenergy



Other Energy Sources

China's Magnetic-Levitation Train



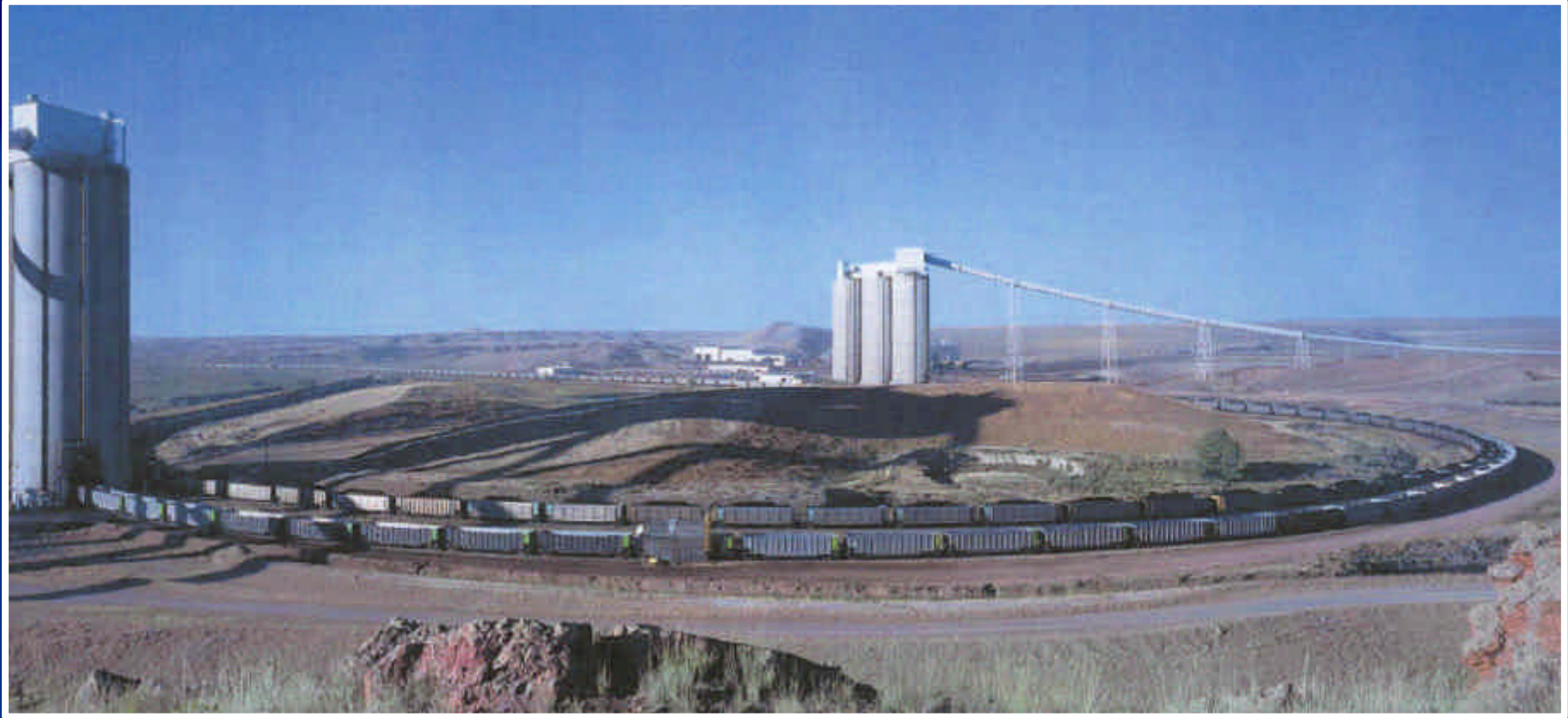
Diablo Canyon Nuclear Power Plant



South Texas Nuclear Power Plant



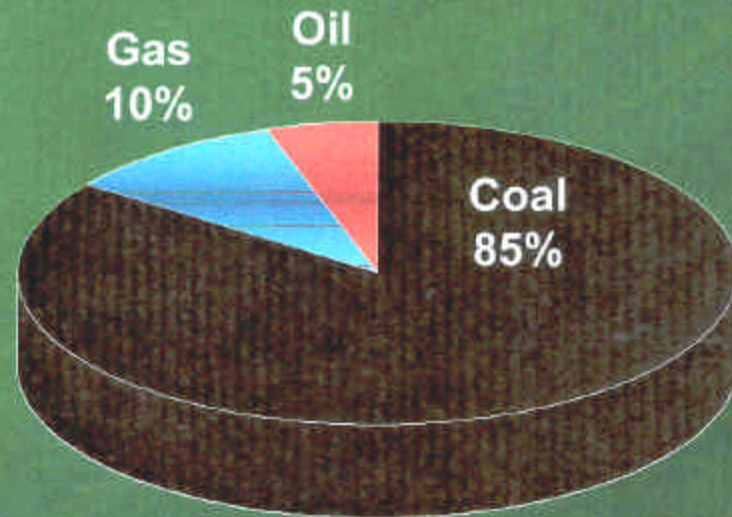
Coal is America's Most Abundant Energy Source



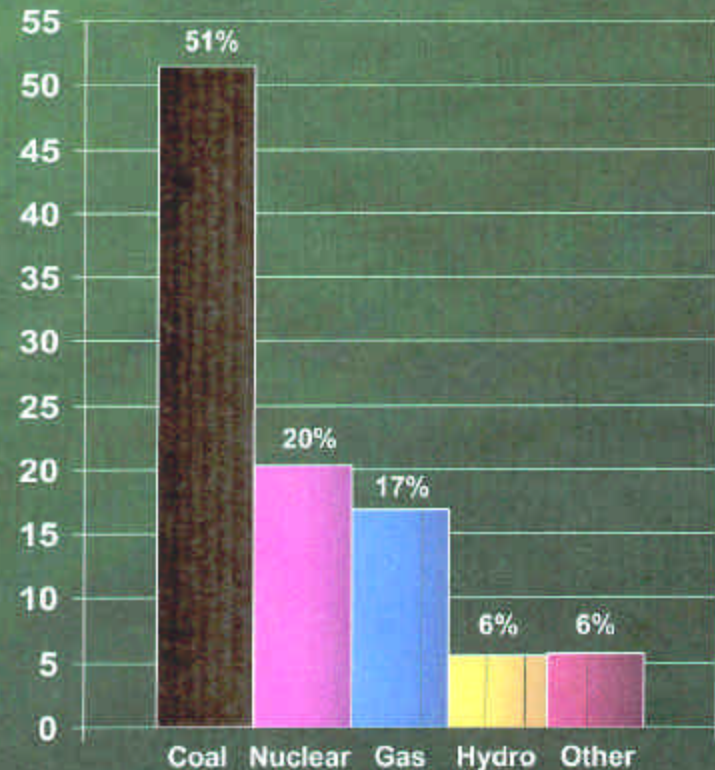
Peabody's 75 Million Ton-Per-Year North
Antelope Rochelle Mine

Coal & Gas: 95% of U.S. Resources, 68% of Electricity

U.S. Fuel Resources



Electricity Fuel Sources



Ultimately recoverable demonstrated reserves on Btu basis.

Source: USGS, National Assessment of United States Oil & Gas Resources; U.S. Coal Reserves; Energy Information Administration Monthly Energy Review, March 2002, calendar year 2001 data.

Hydrogen is Everywhere

- But it has to be Extracted from Fossil Fuels (Natural Gas) or water
- In short, you need Energy to get Energy

“Making Hydrogen with fossil fuels and Nuclear Power is like making a nicotine patch that’s carcinogenic”

-- Dan Becker – Sierra Club

Fuel Cell Coleman Powermate “Air Gen”





Is the World Running out of Oil and Gas?

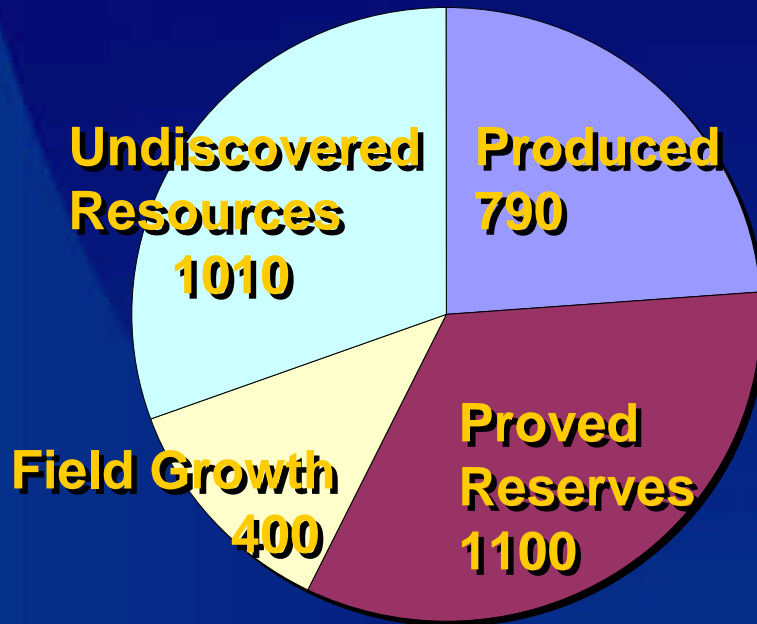
*From “known sources” alone,
the world may have 8 to 9 decades
of oil and gas available*

*There are reasons to suggest that this
time frame is too conservative*

World's Ultimate Recovery of Oil and Natural Gas (1997)

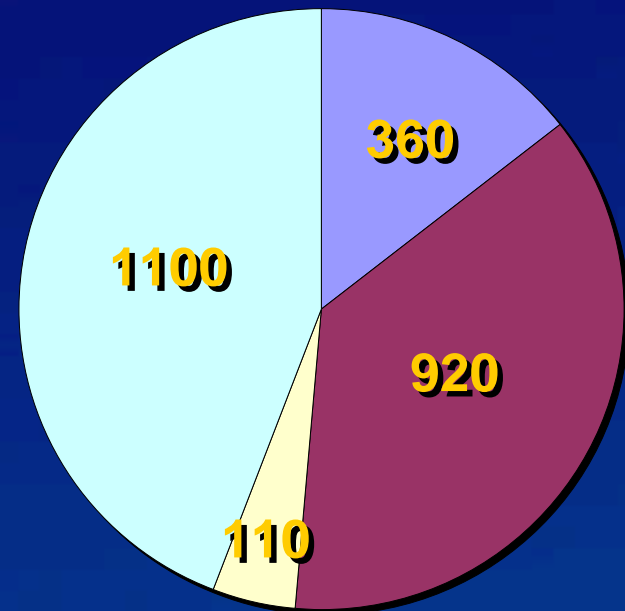
(Billions of Barrels or equivalent)

Oil



3,300

Gas



2,490

Does the world have enough resources?

Each day the world consumes:

- *78 million barrels of oil*
- *275 bcf of gas (47 million barrels oil equivalent)*

At current consumption levels,
from Proved Reserves and Field Growth alone

- ***Oil supply can last for 53 years***
- ***and Gas supply for 60 years***

***If even half the “undiscovered resources”
are eventually converted to “proven reserves,”
oil can last for 71 years and gas for 92 years***

Potential in “Unconventional” Resources

Although “Heavy Oil” and “Tar Sands” have been included In “Resources” in the past, new technology and current economics are moving large volumes to “Reserves”

- In 2002, *Oil and Gas Journal* added 175 billion barrels to Canadian **reserves** from Athabaskan sands. Canada now has more **reserves** than Iraq.
- The Orinoco heavy sands in Venezuela may also have as much oil as the Canadian sands

Suncor Energy



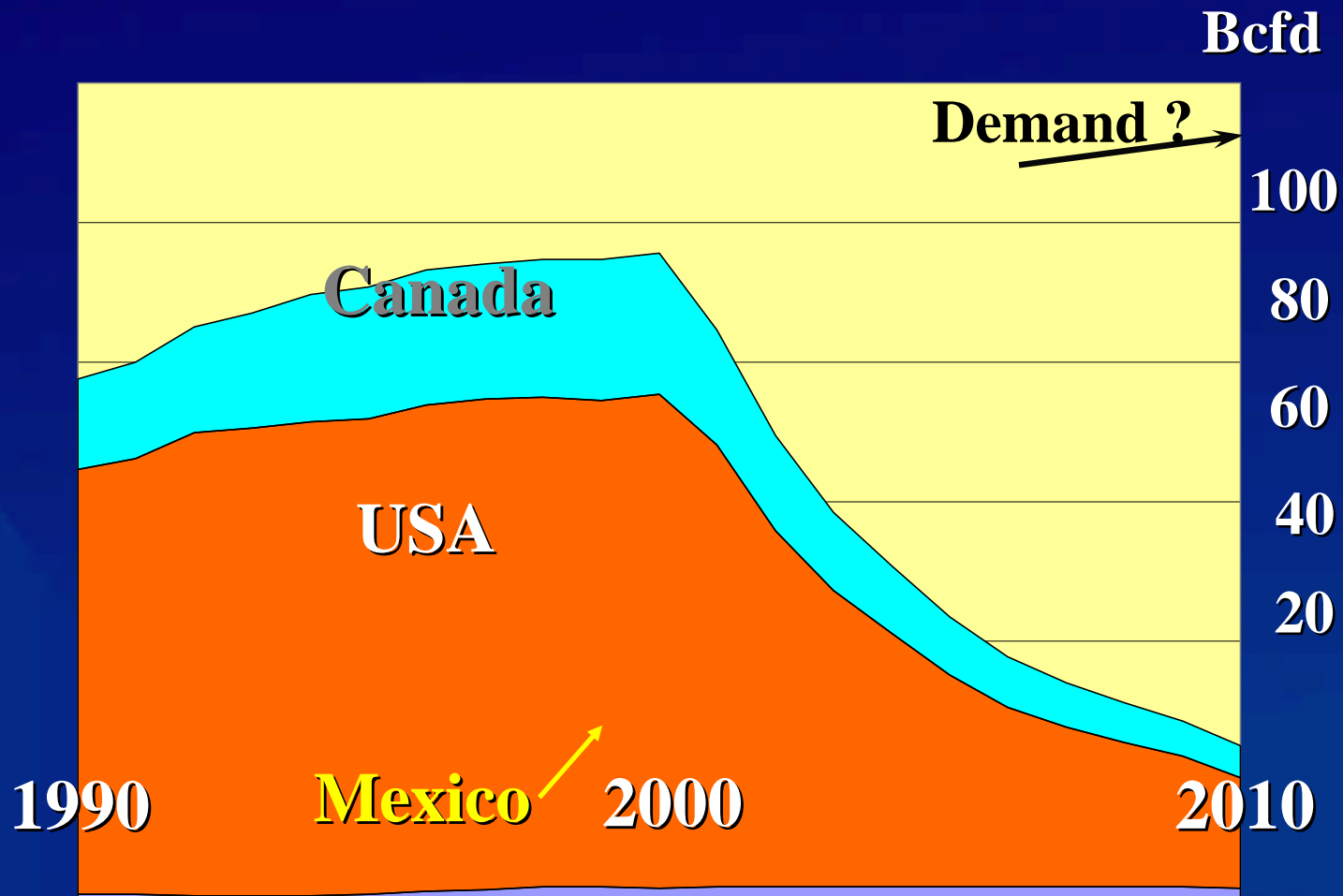
NATURAL GAS PROVED RESERVES

Year End 2000 (trillion cubic feet)

<u>Country</u>	<u>Amount</u>	<u>% of Total</u>
Russia	1,700	32.1
Iran	812	15.3
Qatar	394	7.4
Saudi Arabia	214	4.0
U.A.E.	212	4.0
United States	167	3.2
Algeria	160	3.0
Venezuela	147	2.8
Nigeria	124	2.3
Iraq	110	2.1
Turkmenistan	101	1.9
Malaysia	82	1.5
All others	<u>1,081</u>	<u>20.4</u>
Total	5,304	100.0

Source: *BP Statistical Review of World Energy*, June 2001.

N. America Gas Supply Without Any Drilling or Development



Various Forecasts of U.S. Natural Gas Consumption

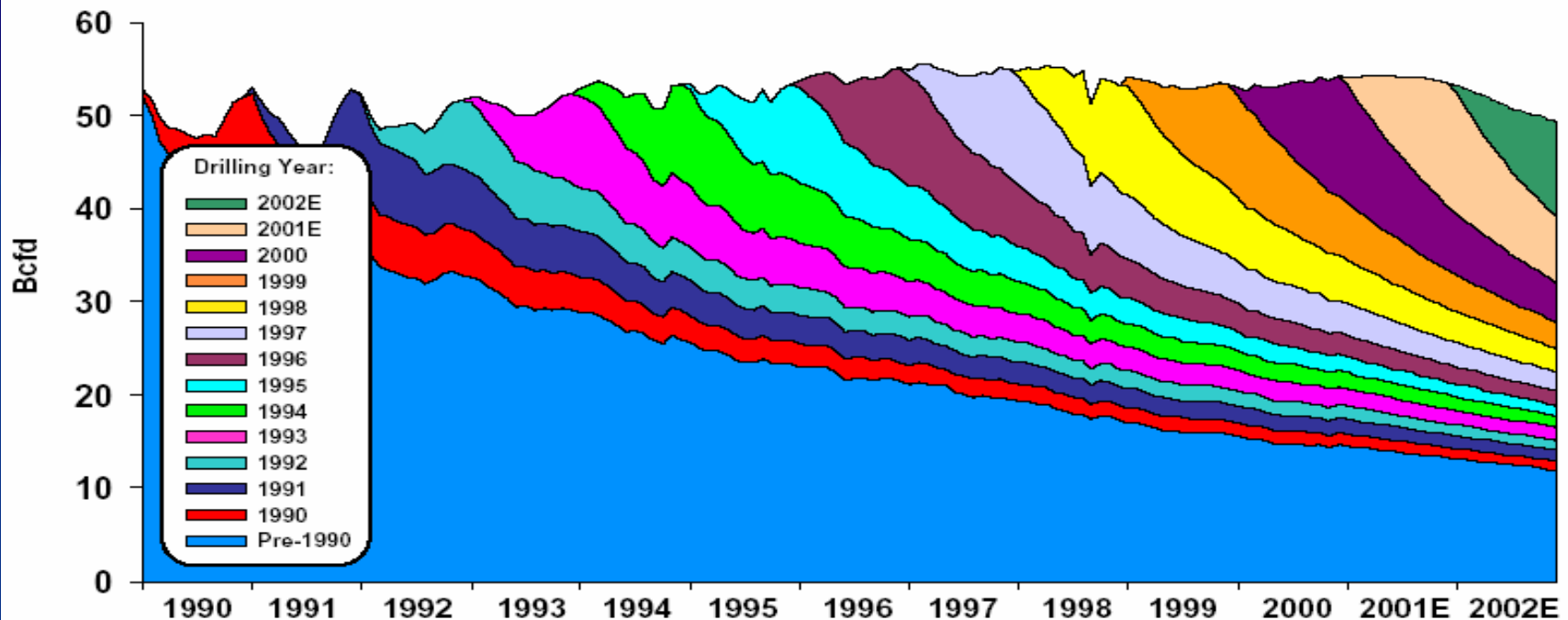
	1999	2000	2003	2008	2010	2015	
NPC/DOE	21.5 59	22.1	Tcf Bcfd		27.7	30.6 82	“Low”
CERA	21.5 59					30.0 82	
Bernard		21.9 60		30.0 82			
El Paso		21.9 60	“plus 25 Bs”		31.0 85		
Duke	21.5 59	“200,000 megawatts of new generation over the next 12 years”			32.0 88		
Economides/ Oligney	21.9 60					26.5 72.5	“High”
Simmons		21.9 60			32.9 90		
		21.9 60			40.0 146		

Age of Energy Gases

- Natural gas will rise toward global predominance of the energy markets.
- It will provide a natural transition to the hydrogen economy.
- Hydrogen-based economy will provide for environmentally sustainable economic growth.

Accelerating US Decline Rates

U.S. Natural Gas Production History* Indicates 27% 2002 Decline Rate



* Representing 94% of Total U.S. Natural Gas Production

Includes Data Supplied by Petroleum Information Corporation; Copyright 1990-2002 Petroleum Information Corporation

Chart Prepared by and Property of EOG Resources, Inc.; Copyright 2002

Unconventional Gas Classification

- Tight Gas Sands
- Coalbed Methane
- Devonian Shale
- Natural Gas Hydrates

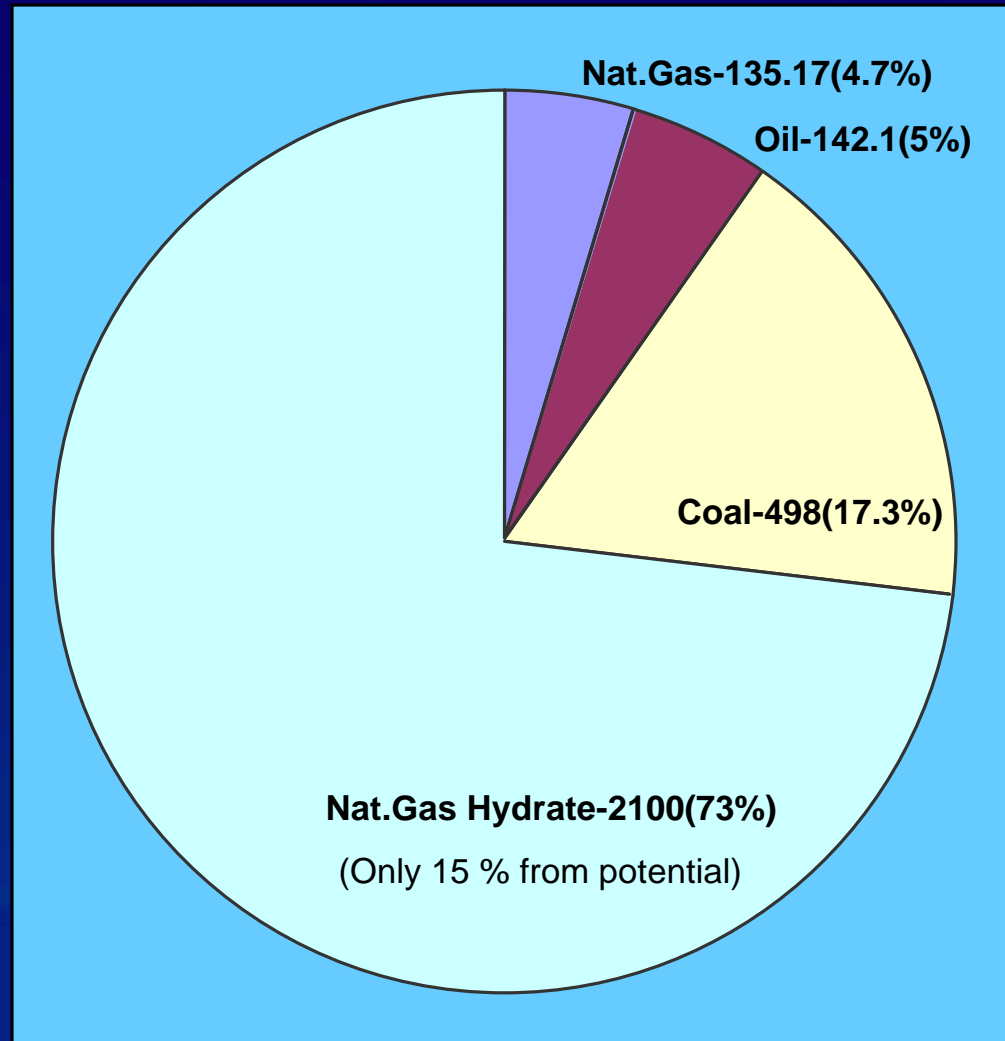
The first three are produced today. Natural gas hydrates, with perhaps the largest volume in place form a considerable future challenge.

Gas Hydrate Resource May Extend the Supply for a Very Long Time

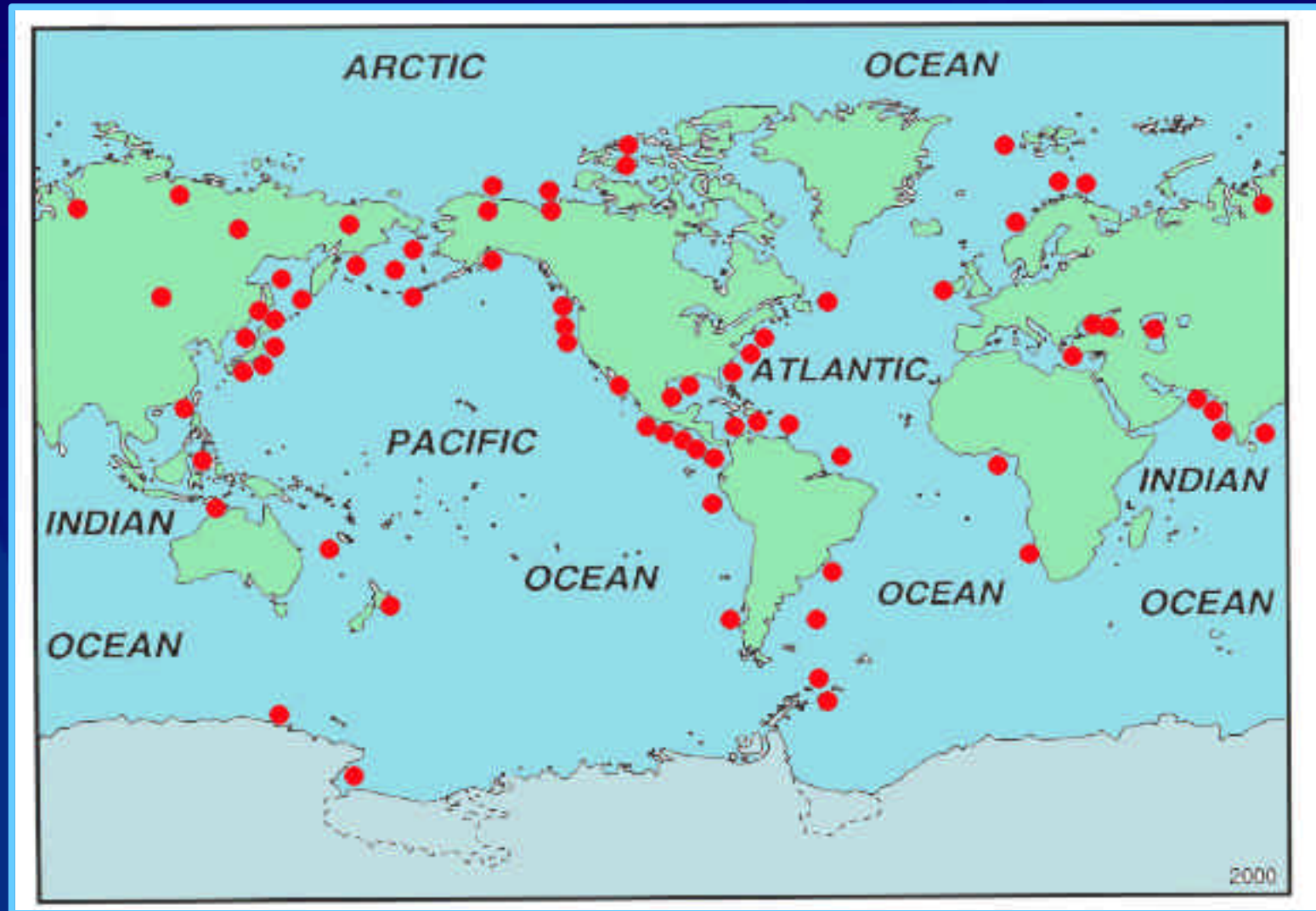
- World's resource of gas hydrates may be as much as ***700,000 trillion cubic feet***. Production technology does not yet exist but no reason to believe that it would not be there in 25 to 30 years

***But it is never too early
to plan for transition.....***

Resources of Mineral Energy

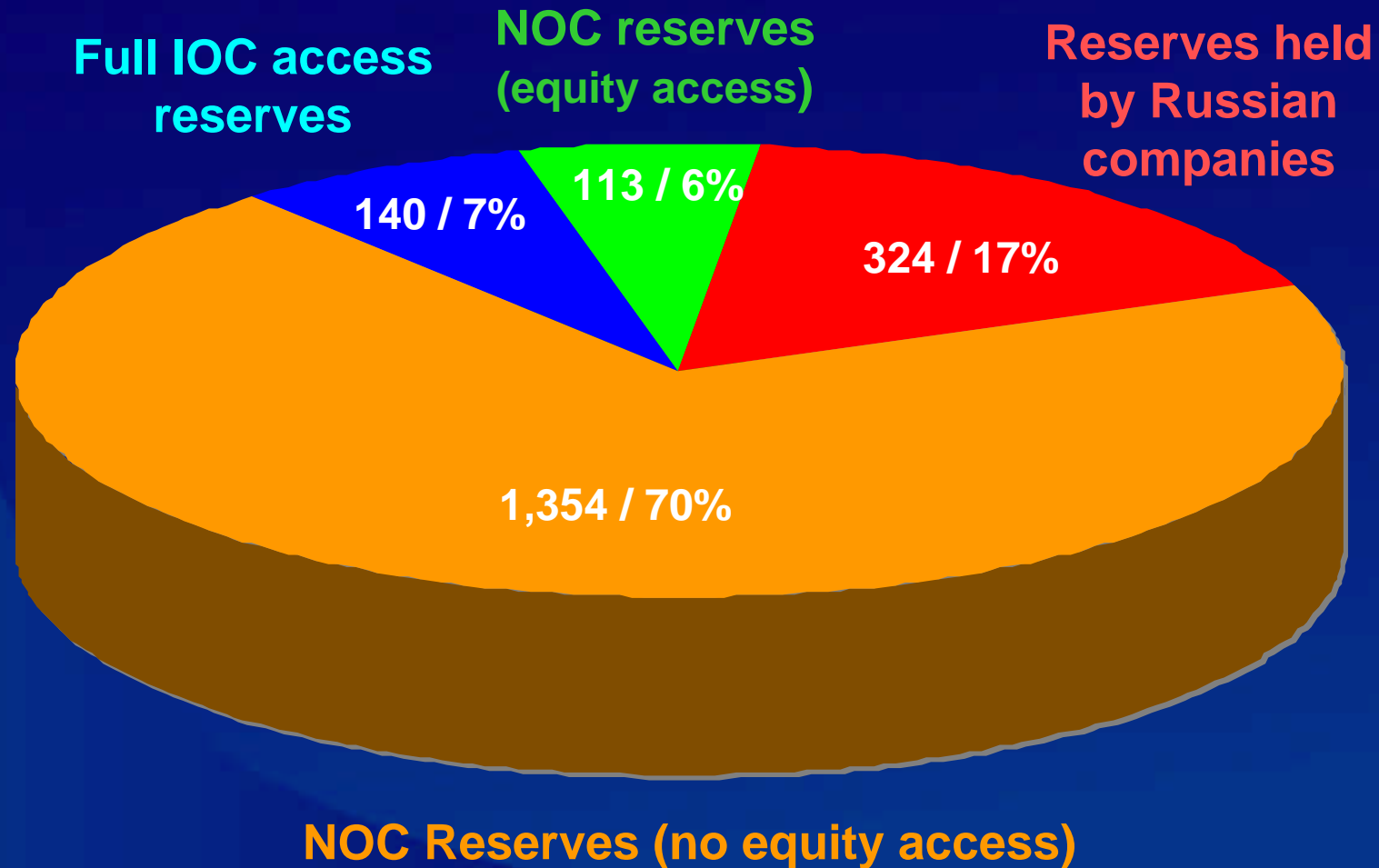


Map of discovered gas hydrate deposits



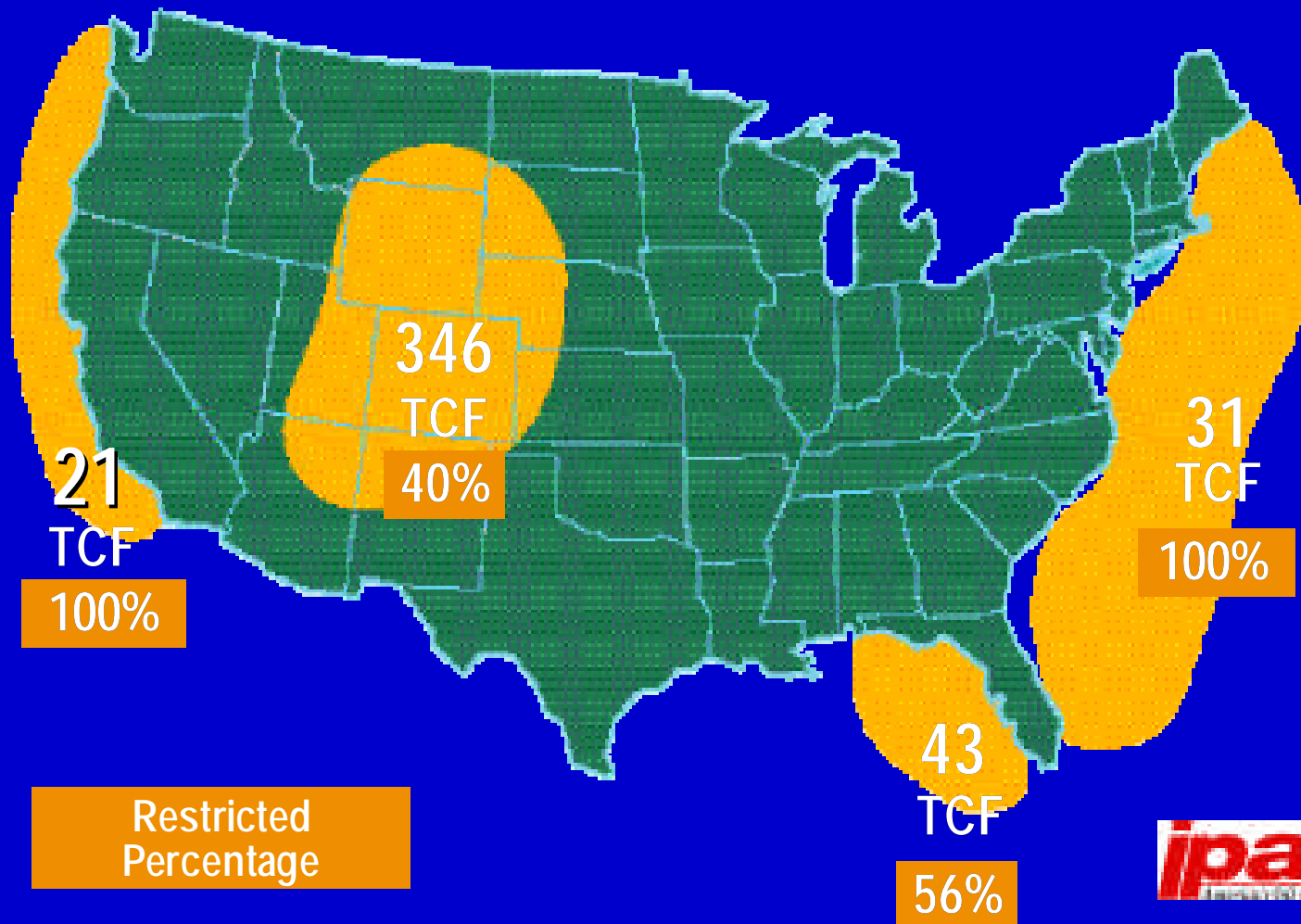
Source – Prof . Michael Economides

Access to Oil & Gas Reserves Constrained

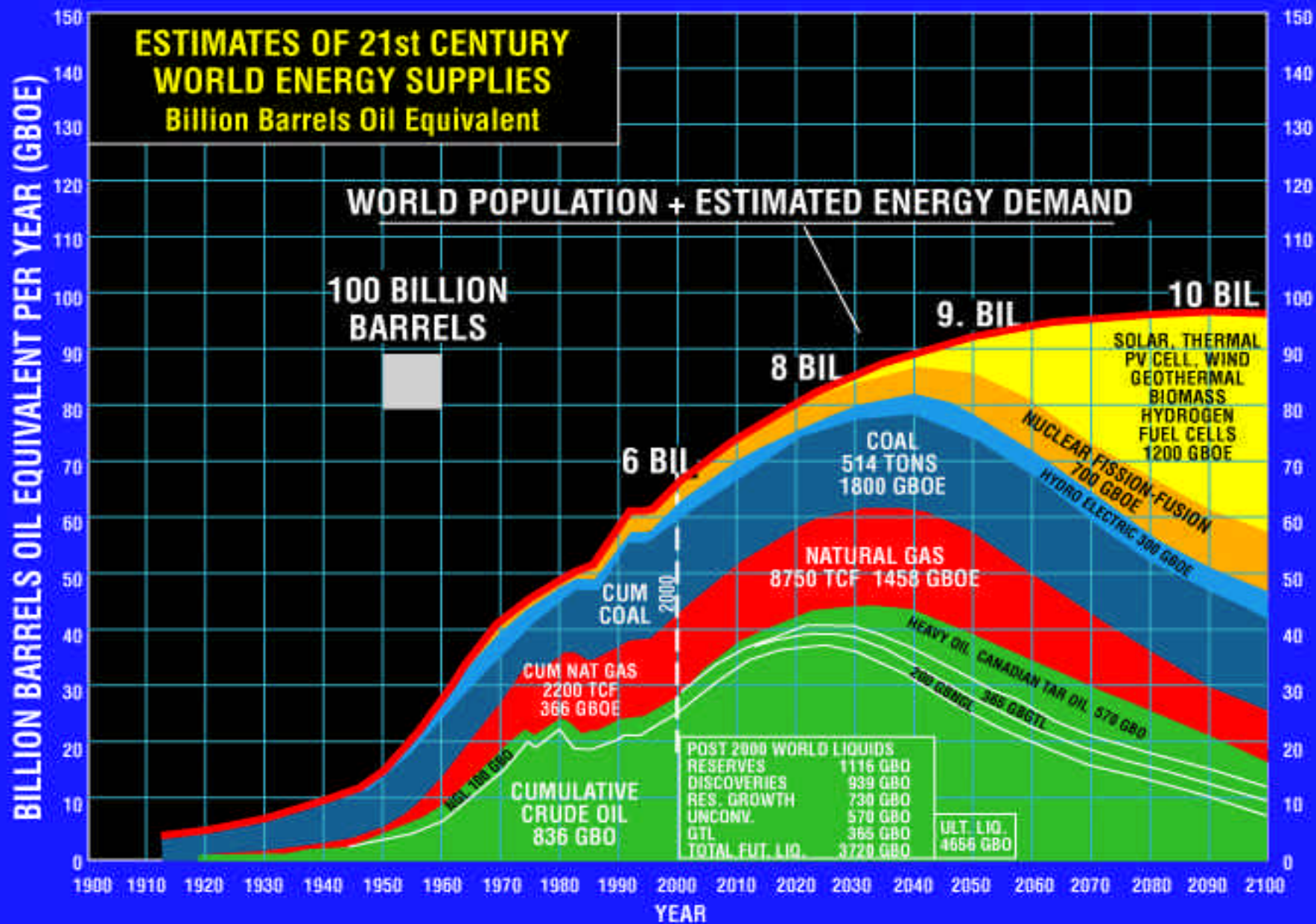


Resource Estimates - Restricted Areas

Estimated Percentage Restricted



AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS



AAPG's Role through Year 2100

- Lifelong partnership with members
- Ethics must be a pillar of behavior for members
- Promote exploration and production technology improvements for natural gas
- Teach combining business with science
- Ongoing collaboration with sister societies

Conclusions:

- What will be the primary **ENERGY SOURCE** in the future?

- Answer** : Hydrocarbons – for a long time

- Who is going to be looking for **NEW** reserves in the future?

- Answer** : You and I – for as long as we want to work