Physics 9, January 29, 2008

- Course Description.
- Energy in the News.
- General Introduction of the concept of Energy.
- Sources and Uses of Energy.
- Why is Energy in Transition?

Energy In Transition

Physics 9 - Energy

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Why take Physics 9?

Curiosity about Energy – What is it? How does it transform?

To gain practice at approaching real issues quantitatively.

To become more "Scientifically literate".

To have some fun while learning basic Physics.

To become more aware of our impact on the environment and what we can do about it.

Welcome sheet

- Energy and the Environment, 2nd edition, Robert A. Ristinen and Jack J. Kraushaar (Wiley & Sons, Inc., NY 2006) available at Amherst Books.
- Energy and Introduction to Physics and Energy Facts and Figures, Robert Romer. (relevant text is available in the Physics department office for $61.50).

Assignments and Intellectual Responsibility

- Discuss various elements of the course.
- Discuss code of intellectual responsibility.
- Pass out assignment #1 and equipment.

Tentative Physics 9 Syllabus Spring 2008

Tentative syllabus for Physics 9 for the Spring of 2008
? Marks refer to items that are uncertain at this time
Items in green are presently scheduled
All items are subject to change

week	topics	readings	demos	hw-projects	In-class lab	guest lectures/trips/films	Seminars (4:30 PM)
29-Jan	Energy Forms/units/conversions	E1, R1		shower heating			
5-Feb	kinetic+potential energy	R2+R3	cannonball		Cons. Of Energy		
12-Feb	laws of thermodynamics	E3-3.3,3.6	heat engines		Mech equiv. of heat		
19-Feb	DC Electricity	R8		DC electric set			
26-Feb	AC electricity/magnetism	R8	motor	motor kit	Elec equiv. of heat		
4-Mar	AC electrical generation/inductio	E3.4, R9	induction	generator kit			
11-Mar	Wind/Hydro/geothermal	E5				Wind: Manwell (Umass)	3/13
	recess						
25-Mar	Power transmission	E3.5, R9	transmission lines			Power Plant visit 3/27 (8:30 AM)?	
1-Apr	Carbon based fuels	E2					
8-Apr	Nuclear	E6			radioactive decay?	"Chernobyl Heart"?	
15-Apr	Solar/Fuel cells	E4	Fuel Cell	solar cells		"The Power of the Sun"?	Gregory (Evergreen Solar) 4/17
22-Apr	Pollution, Global Warming	E9+10				"Inconvenient Truth"?	Ethanol: Lynd (Dartmouth) 4/24?
29-Apr	Conservation, cogeneration	E7,8		final projects?		Brassard (Amherst) 4/29?	
6-May	summary			final projects?			

R = Energy, an Introduction to Physics by Romer
E = Energy and the Environment, 2nd edition by Ristenen and Kraushaar

State of the Union, *Excerpts on Energy Policy*, January 28, 2008

To build a future of energy security, we must trust in the creative genius of American researchers and entrepreneurs, and empower them to pioneer a new generation of clean energy technology. Our security, our prosperity, and our environment all require reducing our dependence on oil.

Last year, I asked you to pass legislation to reduce oil consumption over the next decade, and you responded. Together we should take the next steps. Let us fund new technologies that can generate coal power while capturing carbon emissions. Let us increase the use of renewable power and emissions-free nuclear power. Let us continue investing in advanced battery technology and renewable fuels to power the cars and trucks of the future. Let us create a new international clean technology fund, which will help developing nations like India and China make greater use of clean energy sources. And let us complete an international agreement that has the potential to slow, stop, and eventually reverse the growth of greenhouse gases.

This agreement will be effective only if it includes commitments by every major economy and gives none a free ride.

The United States is committed to strengthening our energy security and confronting global climate change. And the best way to meet these goals is for America to continue leading the way toward the development of cleaner and more energy-efficient technology.

To keep America competitive into the future, we must trust in the skill of our scientists and engineers and empower them to pursue the breakthroughs of tomorrow. Last year Congress passed legislation supporting the American Competitiveness Initiative, but never followed through with the funding. This funding is essential to keeping our scientific edge. So I ask Congress to double federal support for critical basic research in the physical sciences and ensure America remains the most dynamic nation on earth.

January 30, 2007 (Flashback)

World Scientists Near Consensus on Warming

By JAMES KANTER and ANDREW C. REVKIN

PARIS, Jan. 29 — Scientists from across the world gathered Monday to hammer out the final details of an authoritative report on climate change that is expected to project centuries of rising temperatures and sea levels unless there are curbs in emissions of carbon dioxide and other gases that trap heat in the atmosphere.

Scientists involved in writing or reviewing the report say it is nearly certain to conclude that there is at least a 90 percent chance that human-caused emissions are the main factor in warming since 1950. The report is the fourth since 1990 from the Intergovernmental Panel on Climate Change, which is overseen by the United Nations.

The report, several of the authors said, will describe a growing body of evidence that warming is likely to cause a profound transformation of the planet.

Among the findings in recent drafts:

¶The Arctic Ocean could largely be devoid of sea ice during summer later in the century.

¶Europe's Mediterranean shores could become barely habitable in summers, while the Alps could shift from snowy winter destinations to summer havens from the heat.

¶Growing seasons in temperate regions will expand, while droughts are likely to ravage further the semiarid regions of Africa and southern Asia.

The Preservation Predicament

By CORNELIA DEAN, NY Tinmes, January 29, 2008

Conservation organizations that work to preserve biologically rich landscapes are confronting a painful realization: In an era of climate change, many of their efforts may be insufficient or beside the point.

Some scientists say efforts to re-establish or maintain salmon runs in Pacific Northwest streams will be of limited long-term benefit to the fish if warming makes the streams inhospitable. Others worry about efforts to restore the fresh water flow of the Everglades, given that much of it will be under water as sea level rises. Some geologists say it may be advisable to abandon efforts to preserve some fragile coastal barrier islands and focus instead on allowing coastal marshes to migrate inland, as sea level rises.

Any Other Bright Ideas?

Any Other Bright Ideas?

By JULIE SCELFO, NYTimes, January 10, 2008

After more than eight months of intense deliberations between Congress and bulb manufacturers, environmental groups and other parties, a law that requires light bulbs to become more energy efficient became part of the energy bill that President Bush signed into law on Dec. 19.

Over a three-year period beginning in 2012, all new bulbs will have to use 25 percent to 30 percent less energy for the same light output as today's typical incandescent bulbs. Given that the vast majority of bulbs now on the market that meet those standards are compact fluorescents, which use 70 percent less energy and last 6 to 10 times longer than incandescents, Americans may have little choice but to accept them as part of the future.

What is Energy?

It is the stuff that makes things go.
(a friend's definition)

The ability to do work. (Physics Definition).

Work = Force · distance.

Force is what you measure with a scale (e.g. pounds).

Forms of Energy

- Kinetic = $(1/2)\ mv^2$. Energy of motion.
- Gravitational Potential = energy stored in raising an object up. $U = Weight \times height = mgh$.
- Chemical = energy stored in molecular bonds.
- Nuclear = energy stored in nuclear bonds.
- Thermal = energy in molecular motion, vibration and rotation.
- Electrical = energy associated with stored and moving charges.
- Radiation = energy of electromagnetic waves.
- Mass Energy = mc^2.

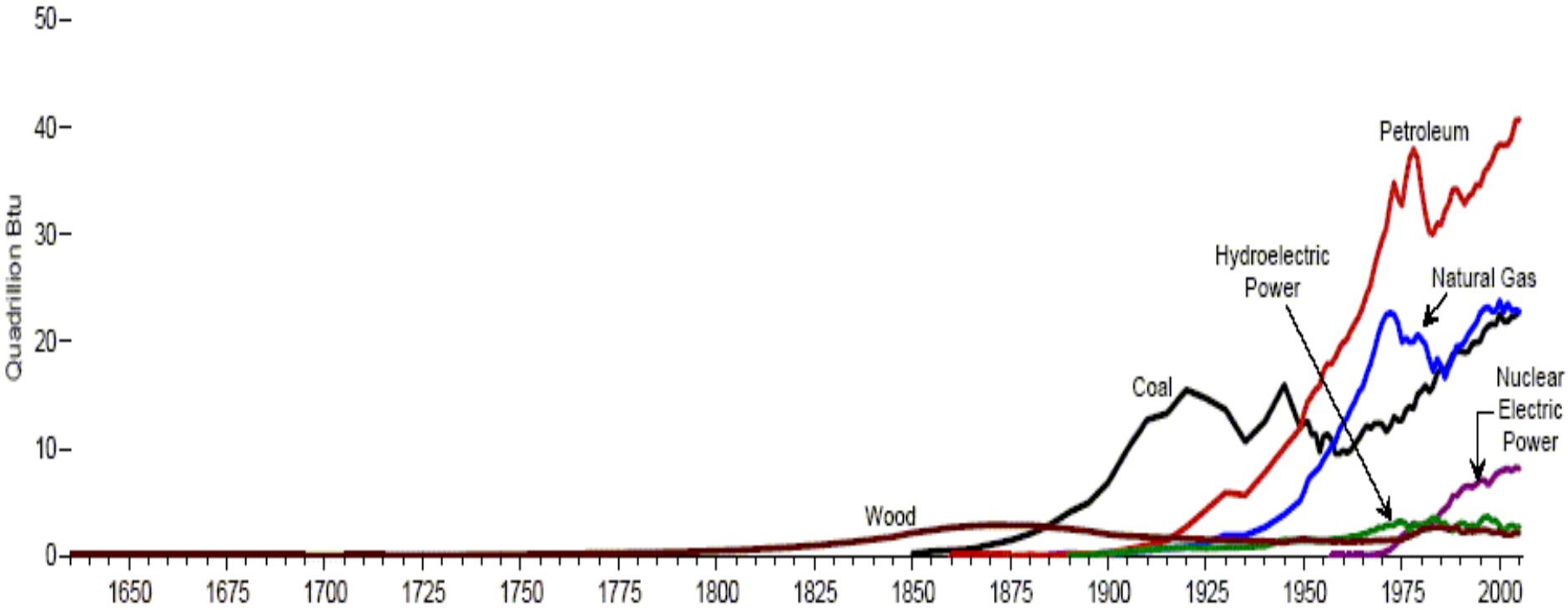
Examples of Energy

• Kinetic	A truck going down the road.
• Gravitational Potential	Water at the top of a waterfall.
• Chemical	Food, oil, battery
• Nuclear	Reactor fission, fusion in the sun
• Thermal	Hot water in your shower
• Electrical	Toaster, computer, TV.
• Radiation	Sunlight
• Mass Energy	The annihilation of a particle and it's anti particle.

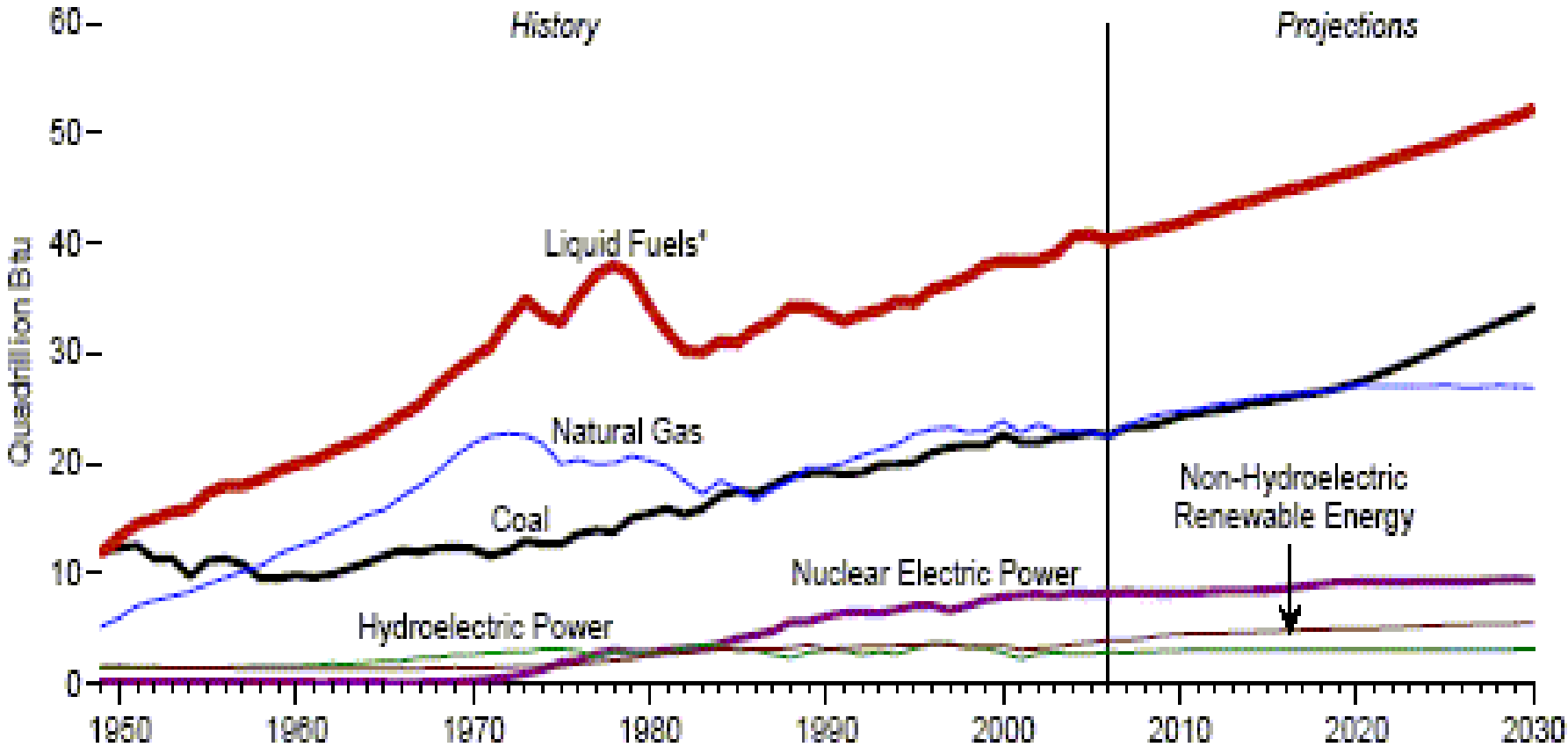
Sources of Energy

- Sun
- Fossil fuels
- Biomass - Food
- Hydroelectric
- Nuclear reactions - Geothermal
- Wind

Energy Consumption by Source, 1635-2006 (QBtu)



Energy Consumption History and Outlook, 1949-2030

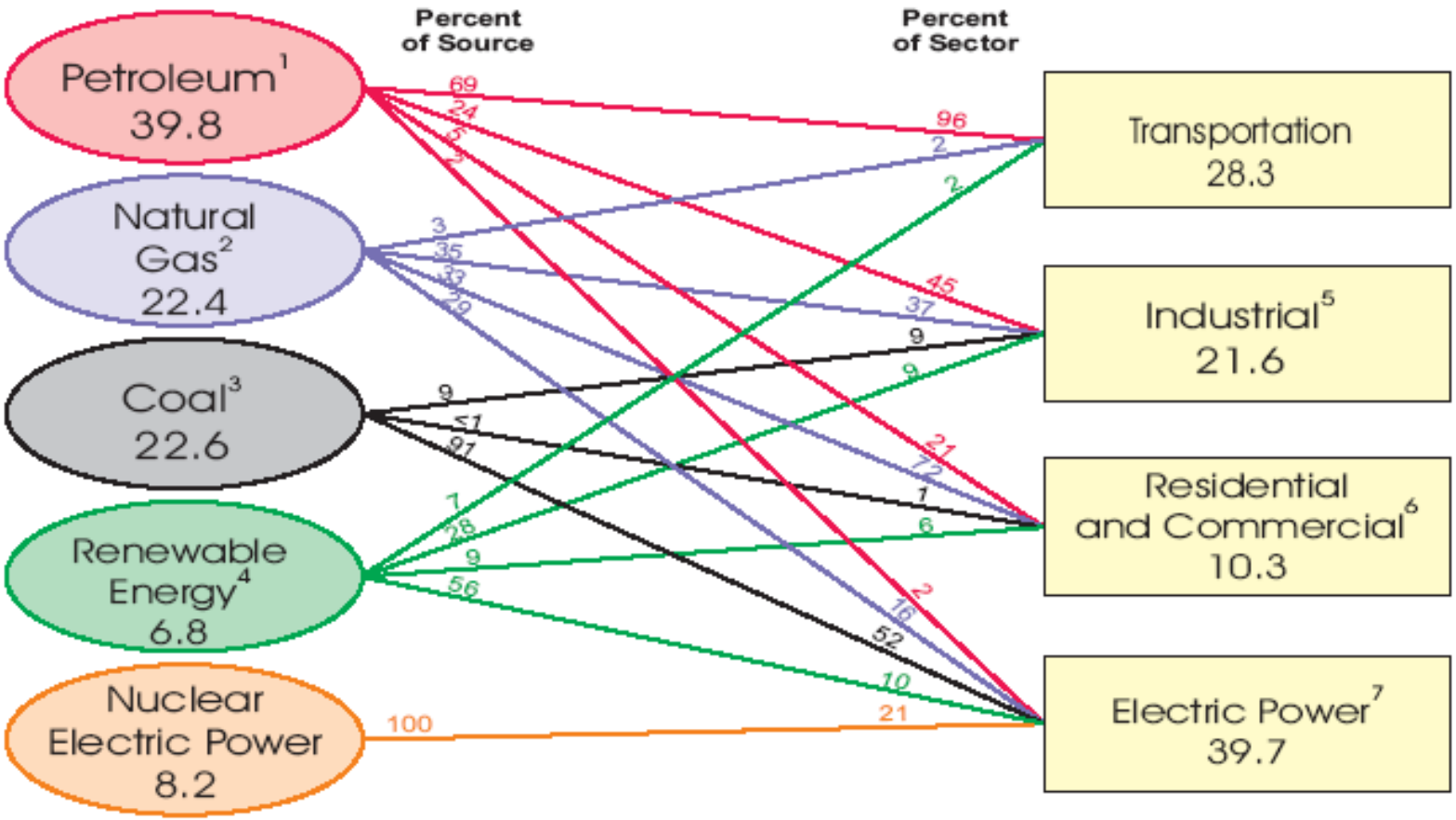


How does Energy get used?

- Transportation – to move things and people.
- Industrial – to make things.
- Residential - heating, lighting and appliances.
- Commercial – offices and stores.

U.S. Primary Energy Consumption by Source and Sector, 2006

(Quadrillion Btu)

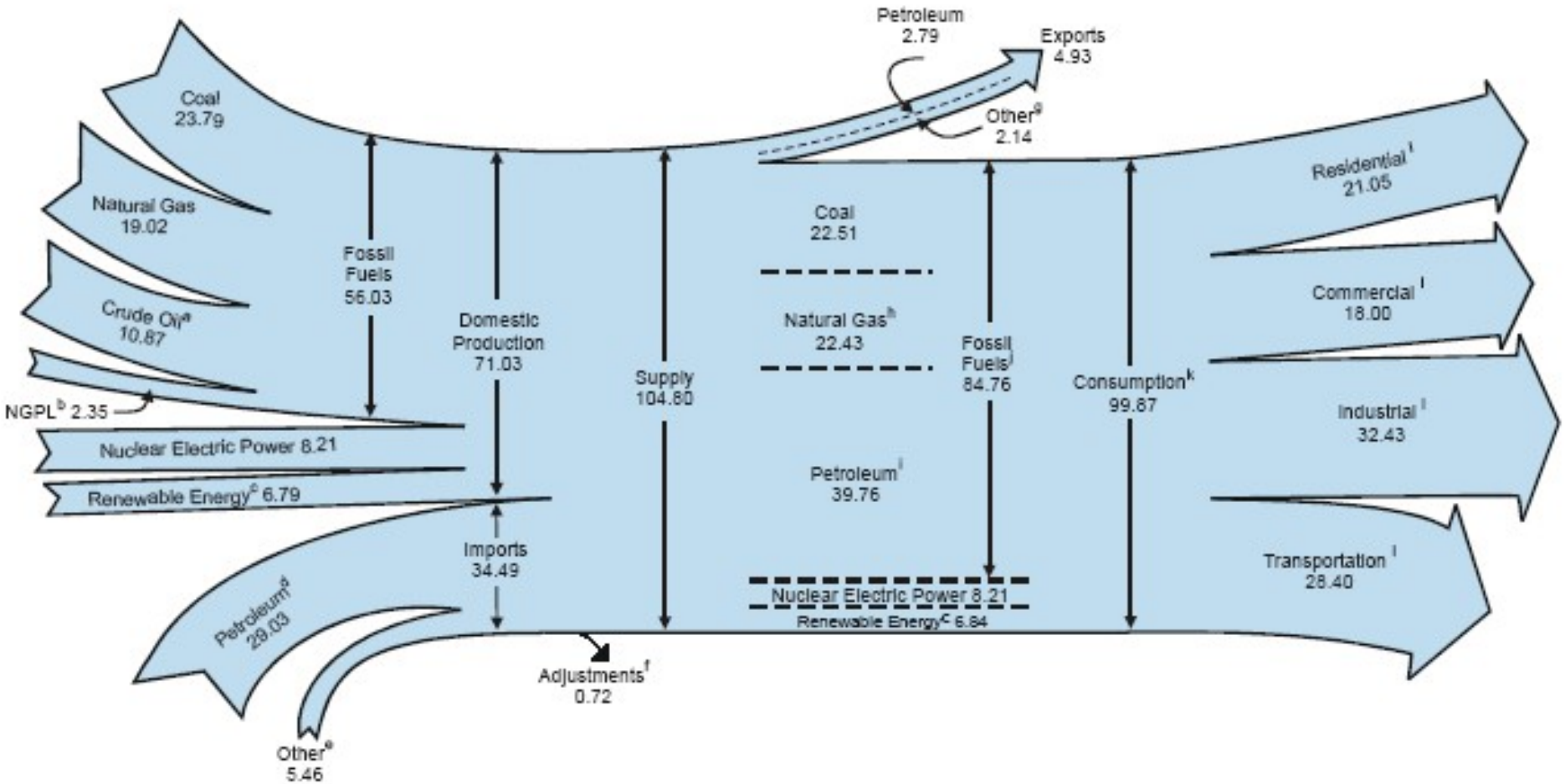


[1]Excludes 0.5 quadrillion Btu of ethanol, which is included in "Renewable Energy."
[2]Excludes supplemental gaseous fuels.
[3]Includes 0.1 quadrillion Btu of coal coke net imports.
[4]Conventional hydroelectric power, geothermal, solar/PV, wind, and biomass.
[5]Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.
[6]Includes commercial combined-heat-and-power (CHP) and commercial electricity-only plants.
[7]Electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public.

Note: Sum of components may not equal 100 percent due to independent rounding.

Sources: Energy Information Administration, *Annual Energy Review 2006*, Tables 1.3, 2.1b-2.1f, and 10.3.

Diagram 1. Energy Flow, 2006
(Quadrillion Btu)



[b] Natural gas plant liquids.
[c] Conventional hydroelectric power, biomass, geothermal, solar/PV, and wind.
[d] Crude oil and petroleum products. Includes imports into the Strategic Petroleum Reserve.
[e] Natural gas, coal, coal coke, fuel ethanol, and electricity.
[f] Stock changes, losses, gains, miscellaneous blending components, and unaccounted-for supply.
[g] Coal, natural gas, coal coke, and electricity.
[h] Natural gas only; excludes supplemental gaseous fuels.
[i] Includes 0.06 quadrillion Btu of coal coke net imports.
[k] Includes 0.06 quadrillion Btu of electricity net imports.
[l] Primary consumption, electricity retail sales, and electrical system energy losses, which are allocated to the end-use sectors in proportion to each sector's share of total electricity retail sales. See Note, "Electrical Systems Energy Losses," at end of Section 2.

Notes: • Data are preliminary. • Values are derived from source data prior to rounding for publication. • Totals may not equal sum of components due to independent rounding.

Sources: Tables 1.1, 1.2, 1.3, 1.4, and 2.1a.

Why is "Energy in Transition"?

US consumption rate of Oil = 7 Billion barrels/year

Known US oil reserves = 30 Billion barrels

If we used only our own oil how long would this last?

30 Billion barrels/(7 Billion barrels/Year) = about 4 years!

But what about the world?

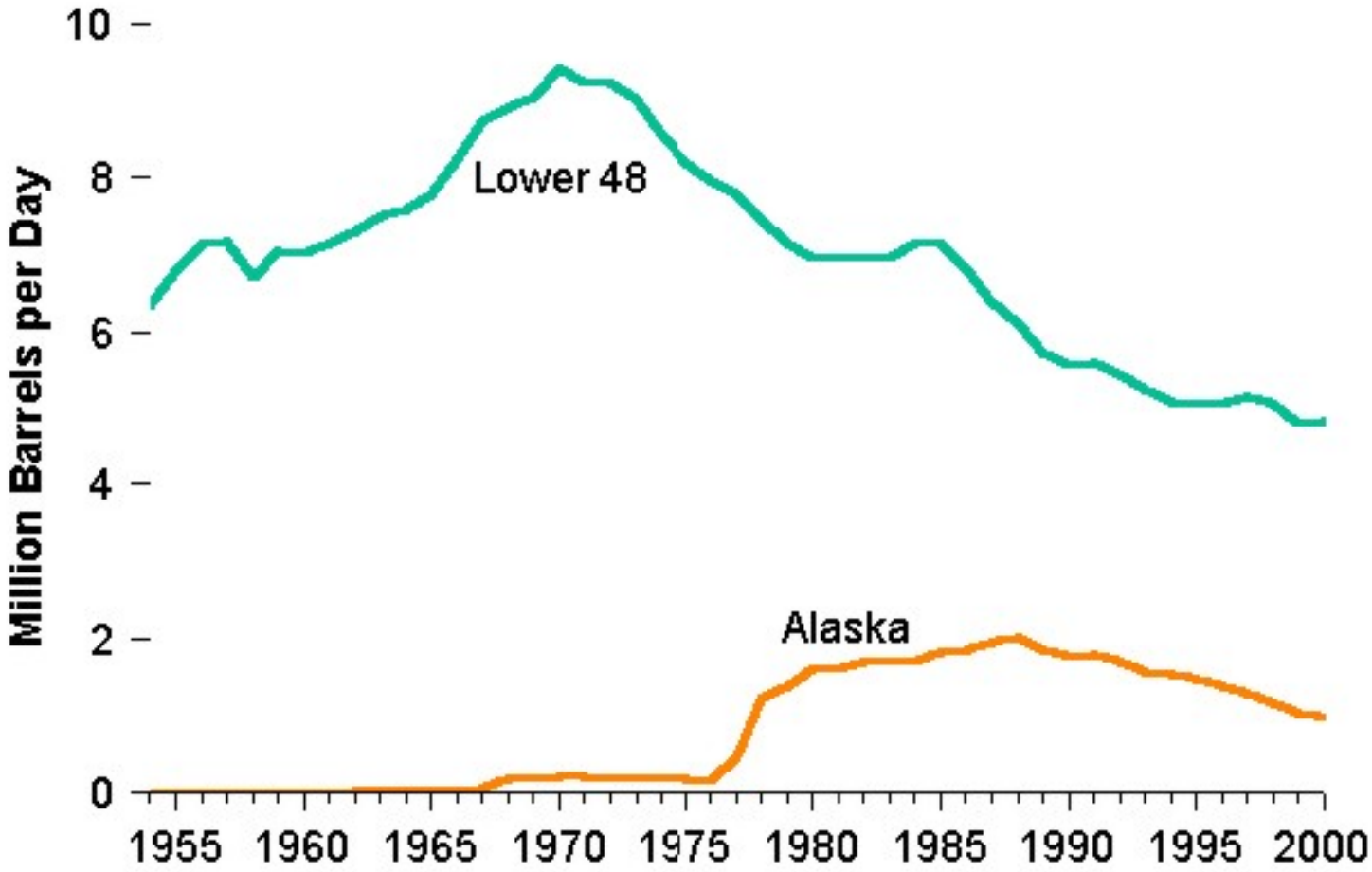
- Known global oil supply is about 1,000 billion barrels
- World consumption rate = 30 billion barrels/year.

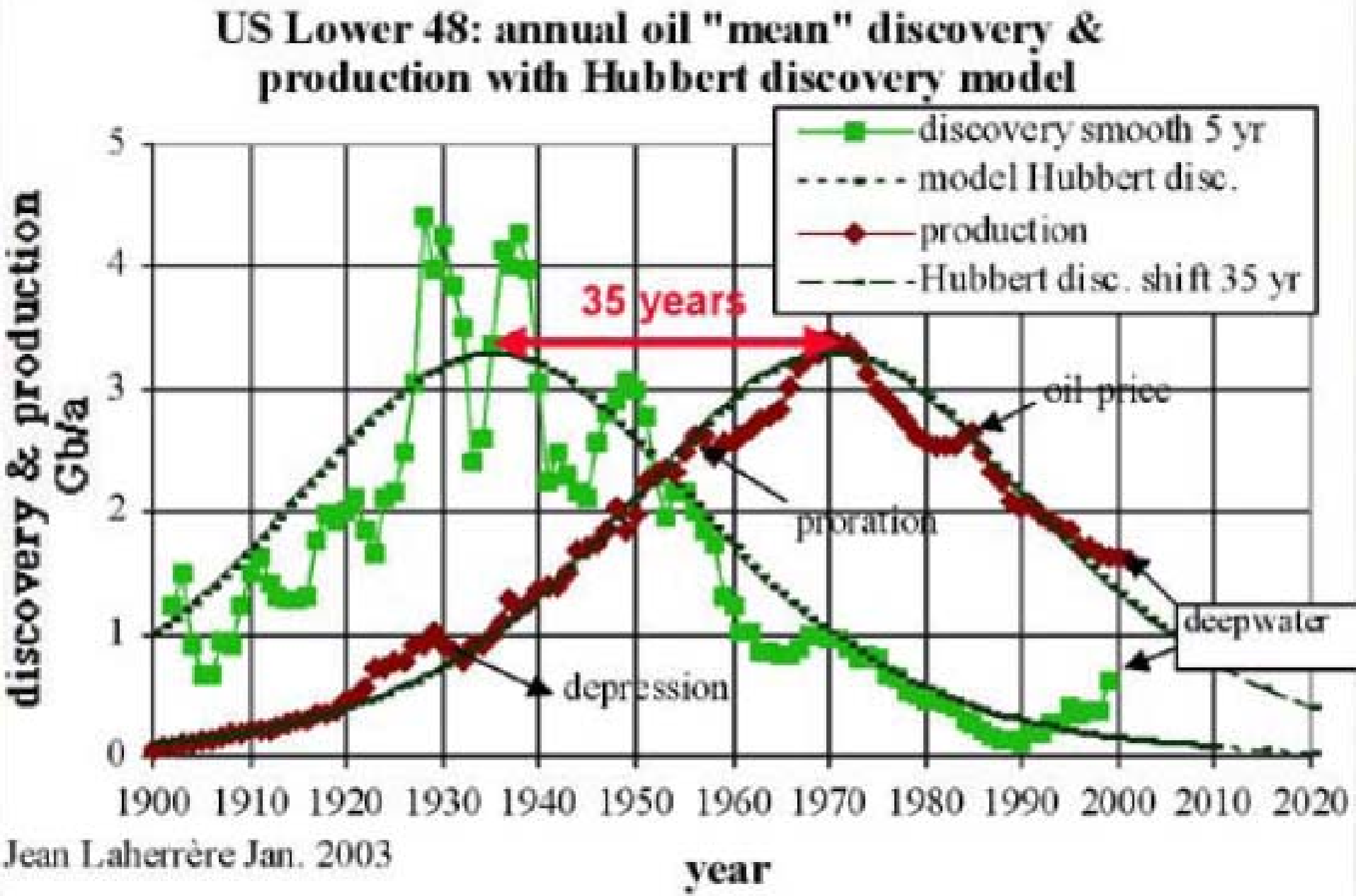
1,000 billion barrels / 30 billion barrels/year = 33 years.

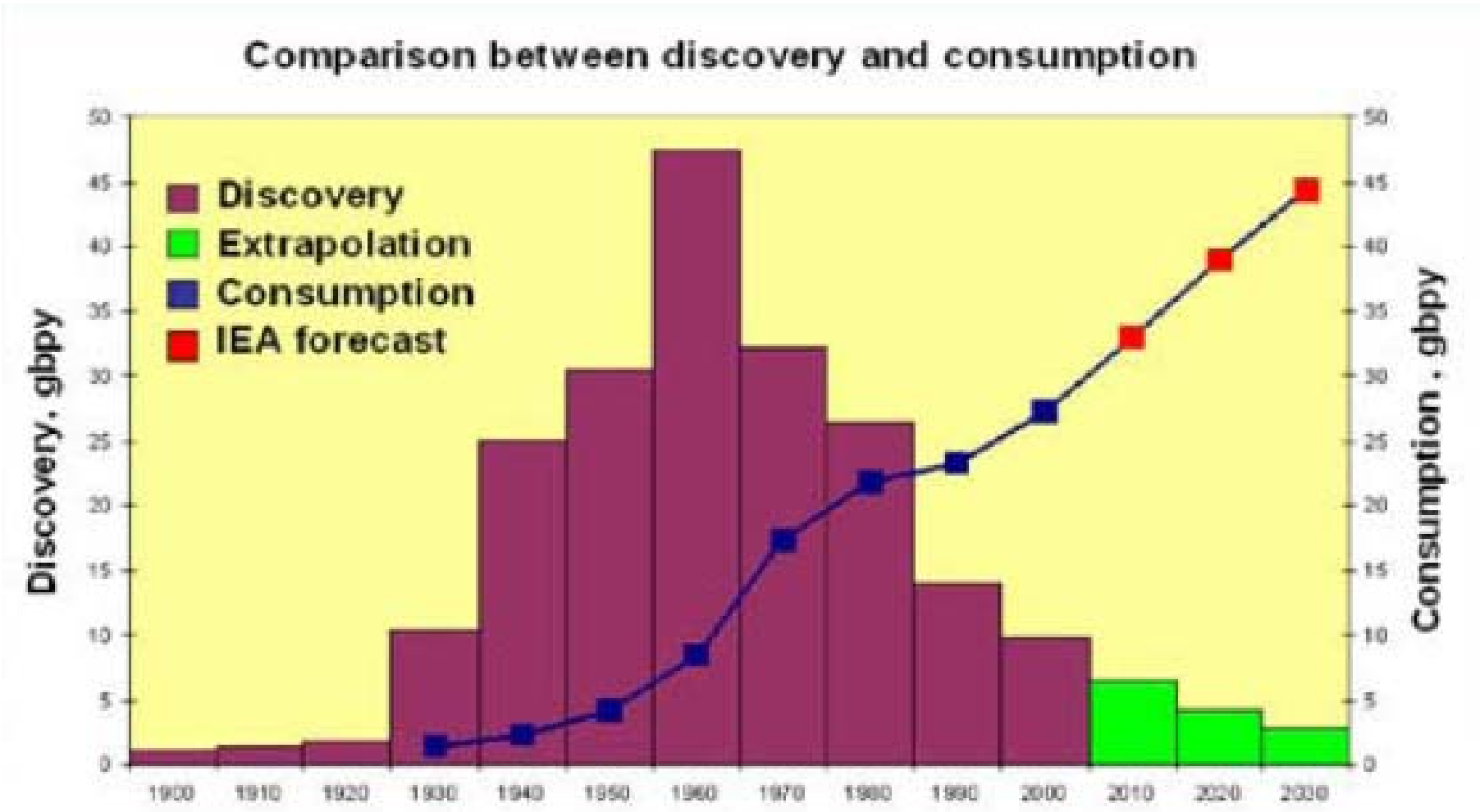
Interesting note

- US has about 3% of the known oil reserves.
- US is responsible for about 25% of the worlds oil consumption.
- US population (291 Million)
  World population (6.5 Billion)
  Less than 3% of the world population.

US oil production




US Lower 48: annual oil "mean" discovery & production with Hubbert discovery model
discovery smooth 5 yr
model Hubbert disc.
production
Hubbert disc. shift 35 yr
35 years
oil price
proration
deepwater
depression
discovery & production Gb/a
0
1
2
3
4
5
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
year
Jean Laherrère Jan. 2003


Comparison between discovery and consumption
Discovery
Extrapolation
Consumption
IEA forecast
Discovery, gbpy
Consumption , gbpy
0
5
10
15
20
25
30
35
40
45
50
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030

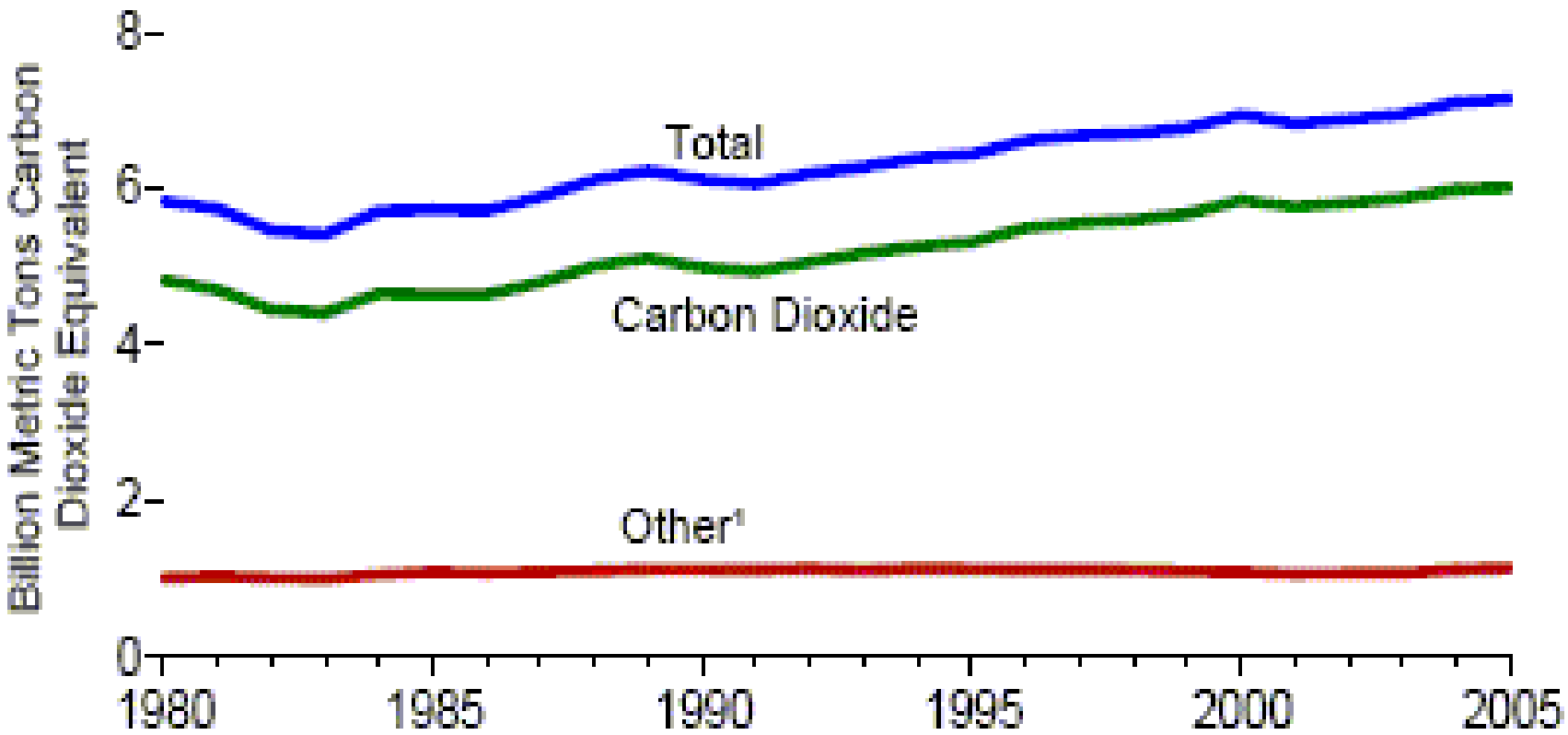
How Soon Will Oil Supplies Peak?

(Christian Science Monitor) , Nov. 9, 2005 *by **John Dillin**.*

"By their nature, the people who explore for oil [like ExxonMobil] are optimists. They have to be, but we are betting our [American] civilization on the assumption that they are right**.“**Robert Hirsch, SAIC

If world crude-oil production hits its peak and then falls within the next five to 10 years, would America be ready? The answer is, almost certainly not.

Greenhouse Gas Emissions, Based on Global Warming Potential



US Natural Gas consumption and production