Teaching Activity : Unquenchable Thirst

Introduction: The United States relies primarily on the fossil fuels- oil, natural gas and coal- for our energy, In 1991, the burning of these fuels accounted for about 88% of our energy consumption. An additional 8% was provided that year by uranium fission used in nuclear reactors and another 4% of our total energy came from *renewable* or continuous resources (mostly from water power). The world use pattern is similar.

Because the deposits of nonrenewable resources are finite, it is important to know how much is left and how much energy these resources can provide before they are used up. The oil age has been a unique age in the history of humankind - an age of inexpensive, abundant energy and rapid growth in both technology and technology-related problems. As we near the end of this age, we are challenged to use the last of its convenient (though no longer inexpensive)m energy resources to invent and deploy new technologies and related attitudes that will carry humankind into the next phase of its existence.

The amount of energy we have left depends on remaining resources of different fuels. However, oil is sold by the barrel, coal by the ton and natural gas by the cubic foot. This makes it difficult to compare the amounts of energy involved. To make comparisons, it is necessary to know the amount of energy available from a barrel of oil or a ton of coal. The *energy content* of a fuel is the amount of energy released when one unit of mass of that fuel is consumed. The energy content varies from fuel to fuel; with oil and gas provide more energy per pound than coal and nuclear fuel has a huge energy content. Tables like the one below Are used along with estimates of how much oil, gas, coal and uranium remain in the ground, to gain some idea of the amount of energy available to the U.S and the world from these fuels.

ENERGY CONTENT OF VARIOUS FUELS

Fuel	Common Units	Energy per Pound	Energy per Kilogram
Coal	25×10^6 Btu/ton	3, 150 Calories (13×10^6 Joules)	6930 Calories (2.9×10^7 Joules)
Crude oil	5.8 x 106 Btu/bbl.	4900 Calories (20.5×10^6 Joules)	10.780 Calories (4.5×10^7 Joules)
Natural gas	1,031 Btu/cf.	5,000 Calories (20.9×10^6 Joules)	11,000 Calories (4.6×10^7 Joules)
Uranium	----------	8.86×10^9 Calories (3.71×10^{13} Joules)	1.95×10^{10} Calories (8.17×10^{13} Joules)

NOTE: 1,000 calories = 1 kilocalorie = 1 Calorie bbl = barrel, cf = cubic foot
BTU= British Thermal Unit

Objective:

- To analyze a graph of U.S. energy consumption from 1875 to 1980;
- To evaluate the energy content of different types of fuels;

Important Terms: Renewable/ nonrenewable resources, nuclear fission, fossil fuels, hydroelectric, geothermal, solar/wind, Quads (10^{15} BTUs), calories, barrel, ton;

Materials: Copy of graph of U.S. Energy Consumption 1875-1980, **Student Activity Sheet,** paper and pencil;

Procedure

Part I : U.S. Energy Consumption 1875-1980

1. Pass out a copy of the graph of **U.S. Energy Consumption**.
    - Discuss and analyze the graph with the class.

2. Instruct students to get together with a partner and answer the questions relating to the graph in the **Analysis** section.

Part II: Energy Content of Selected Fuels

1. Pass out copies of the table of energy content and the graph of U.S. energy history from 1860-1980.
    - Read over and discuss the data presented in the two formats.

2. Instruct students to work in partners and answer the questions in the **Analysis** section.

Student Activity Sheet # 1

ANALYSIS

Part I. Graph of U.S. Energy Consumption 1875-1980

1. What was the principal U. S. Energy source in :
   a. 1875 _____ b. 1910 _____
   c. 1960 _____ d. 1980 _____

2. Why do you think that fossil fuels became so popular after 1880?_____
   _____
   _____

3. Which 2 forms of energy have been developed the least? _____
   _____

4. What new factor became significant around the year 1960 that allowed the U.S. energy consumption to continue to grow? _____

5. What type of energy source reached about 30 Quads in 1980?_____

6. At what point in history did solar energy first appear as a viable energy source?
   _____

7. What is the total amount of energy provided by domestic oil and natural gas?
   _____

8. Energy consumption in the U.S. totaled 10 Quads in 1900. How many years did it take to double that consumption? _____

9. How long did it take to grow from 20 to 40 Quads? _____

10. How many years did it take to double that ?_____

11. What appears to be the average doubling time in the 3 previous questions? _____

12. The equation which relates doubling time to percent annual growth is:

$$\text{Doubling Time (years)} = \frac{70}{\text{\% annual growth rate}}$$

- Use your answer to number 11 to determine the approximate % annual increase in American consumption for the time period you examined.

_____

Analysis

Part I: U.S. Energy Consumption 1875-1980

13. If we continue to grow (from 1875) at the rate you calculated in question #12, what would our energy consumption (in Quads) be in the year 2050. _____

14. Do you think that this type of growth can continue until 2050? _____
Forever? _____ Explain. _____
_____
_____
_____
_____

Part II: Energy Content of Selected Fuels (Graphs B and Data Table A)

1. Combine the information from the graph with the information from the table, plus your knowledge of American history, and speculate as to why the transition from wood to coal took place. _____
_____
_____
_____

2. Was the transition mentioned in #1 based on more than just the average energy content of the fuels? Explain. _____
_____
_____
_____

3. Give a reason or two why it is useful to know about the energy content of various fuels and foods. _____
_____
_____
_____

4. What happened as the use of coal became more popular? _____
_____
_____
_____

Student Activity Sheet #1

ANALYSIS

Part II: Energy Content of Selected Fuels

5. What types of new environmental problems were introduced by burning coal?

_____

_____

_____

_____

6. What eventually began to replace coal? Why? _____

_____

_____

7. What 20th century event coincides with the rise in the use of petroleum? _____

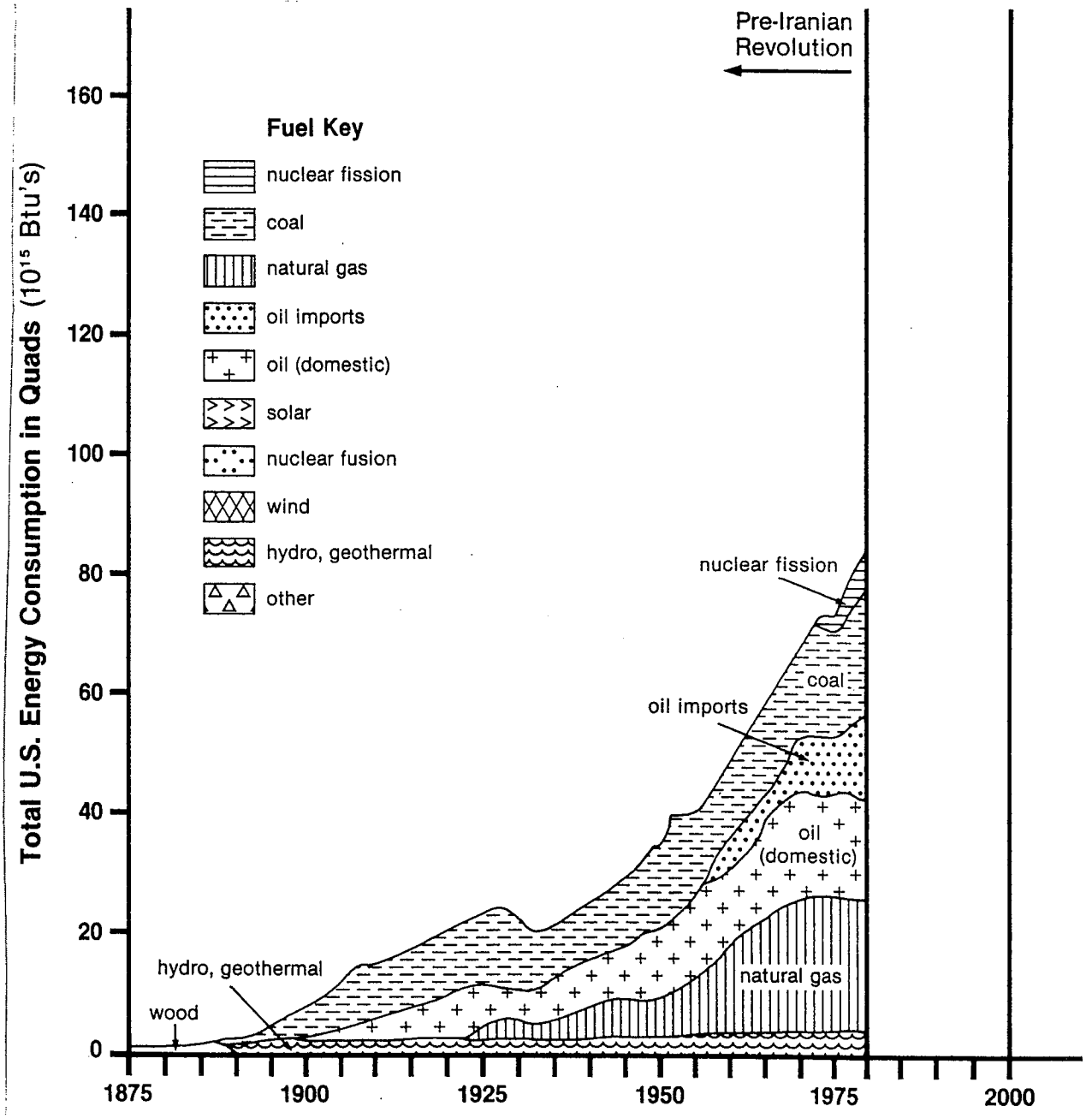
_____

8. Why do you think that the term "energy crisis" was applied to the time period around 1975-1980? _____

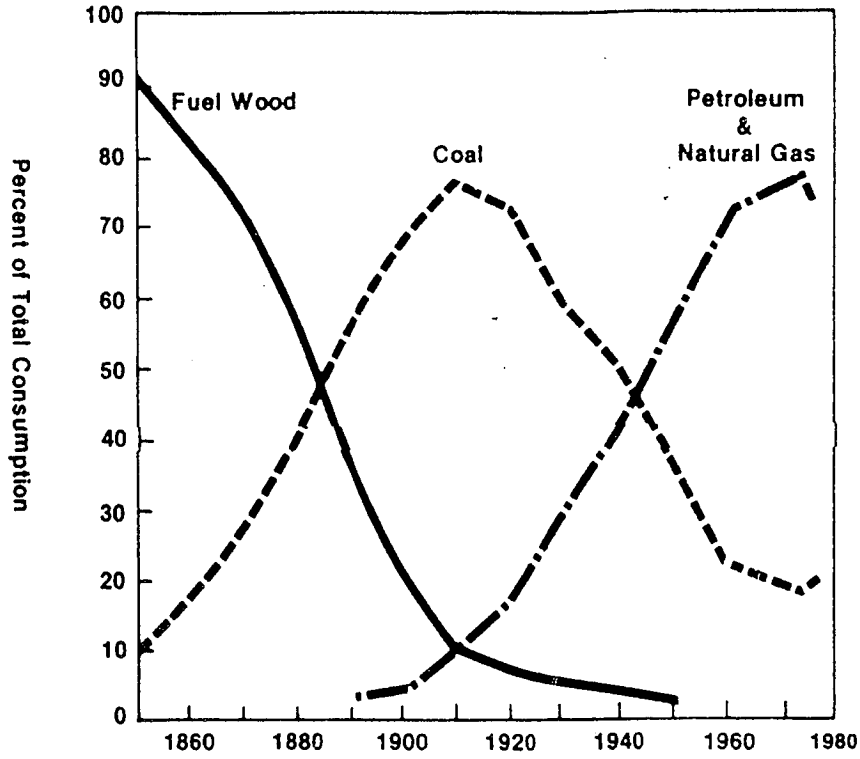
_____

_____

GRAPH A: U.S. ENERGY CONSUMPTION 1875-1980



GRAPH B: ENERGY HISTORY OF THE U.S.



The United States has shifted to different fuel use patterns. (Source: U.S. Bureau of Mines and Federal Energy Administration.)

Revolutionary War	1775–83
Railroads *begin* in Eastern U.S.	1830–1850
Civil War	1861–65
Ford *begins* mass production of automobiles	1908
WWI	1914–18
WW II	1939–45
Most American families have a car.Modern air travel.	1950–1965
The term "Energy Crisis" surfaces.	1975–1985

DATA TABLE A: THE ENERGY CONTENT OF SELECTED FUELS

ITEM	ENERGY CONTENT (cal./g)
WOOD	2,760
COAL (Stove coal)	7,200
FUEL OIL	10,800
NATURAL GAS	11,000
GASOLINE	11,530
KEROSENE	11,000
ALCOHOL (DENATURED)	6,400