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HOW MUCH DO YOU KNOW ABOUT ENERGY?  
A QUIZ FROM THE ENERGY LAB

Energy Laboratory  
Massachusetts Institute of Technology

Working Paper No. MIT-EL 78-025WP  
October 1978

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I. INTRODUCTORY

1. Energy is the equivalent of

- A. Force
- B. Power
- C. Momentum
- D. Work

Answer: (D)

Energy is often defined as the equivalent of or capacity for doing work. However, the other three are related to energy.

Drew J. Bottaro

2. Match each item in the left-hand column with one item in the right-hand column.

- A. Force
- B. Power

- i. Rate at which energy is transferred to an object
- ii. Transfers energy to an object when applied over a distance

Answer:

- A. (ii)
- B. (i)

Energy sometimes is defined as the work resulting from application of a force to an object that moves a certain distance. (Momentum is application of a force over an interval of time.) Power, on the other hand, indicates the rate at which energy is transferred.

Drew J. Bottaro

3. Which of the following is not a unit of measurement for energy?

- A. Kilowatt-hour
- B. Joule
- C. BTU (British Thermal Unit)
- D. Calorie
- E. Horsepower

Answer: (E)

Horsepower is a unit of power, like kilowatts. Applied over an interval of time (say, one horsepower-hour or one kilowatt-hour) it becomes a measurement of energy. The others are energy measurement units.

Drew J. Bottaro

4. Match each energy unit in the left-hand column with its definition in the right-hand column.

- A. Watt-hour
- B. Joule
- C. BTU
- D. Calorie

i. The energy required to raise one pound of water one degree Fahrenheit.

ii. The energy required to accelerate one kilogram from rest to one meter per second

iii. The energy required to raise one kilogram of water one degree Centigrade

iv. The energy transferred by one ampere under one volt pressure for one hour

Answer: A. (iv)  
B. (ii)  
C. (i)  
D. (iii)

Of the units listed, all are metric units except the BTU. Energy consumption in the U.S. is often measured in "quads" or quadrillions of BTU's. One quadrillion =  $10^{15}$  = 1,000,000,000,000,000. The Calorie mentioned above is the same calorie used to measure energy in food (sometimes called the "large" calorie or kilo-calorie). Another calorie (with a small "c") is measured using only a gram of water. One BTU equals 252 small calories or .252 food Calories, and one Calorie equals 3.96 BTU's. An alternative and equivalent definition of the joule is watt-second. Since there are 3600 seconds in a hour, 3600 joules equal one watt-hour. Completing the chain, 3.413 BTU's = one watt-hour. Hence all energy units are transformable from one to the other.

Drew J. Bottaro

5. Energy may take many forms. Which of the following is not a form of energy?

- A. Light
- B. Heat
- C. Electricity
- D. Radio waves
- E. Gravity

Answer: (E) - Gravity.

All forms of energy are convertible from one to another. The laws of thermodynamics, however, set limits on the efficiency with which the conversion can usefully be made.

Drew J. Bottaro

6. True or False: Energy is never lost; it is merely transformed from one form to another.

Answer: TRUE

This is the law of conservation of energy.

Drew J. Bottaro

7. What happens to the light from light bulbs?

- A. It remains as light.
- B. It disappears when the lights are turned out.
- C. It is absorbed by surrounding materials and converted to heat.
- D. It is reflected by surrounding materials until it returns to the light bulb as electricity.

Answer: (C)

In other words, turning on ten 100 watt lights for one hour will heat your dwelling as much as turning on one 1000-watt electric heater for one hour. If the light were to remain as light, you would see it when the lights were turned out. And the light cannot just "disappear"; if it did so, it would violate the law of conservation of energy.

Drew J. Bottaro

8. What happens to the chemical energy in the food you eat?

- A. The excess over your needs is stored as body fat.
- B. It is used to heat your body.
- C. It is lost to the environment surrounding you.
- D. All of the above.

Answer: (D)

The average adult, in fact, throws off heat at the same rate as a 100-watt bulb.

Drew J. Bottaro

9. True or False: Perpetual motion machines, while not presently available on the open market, can be designed and, when operating, will contribute to meeting national energy needs.

Answer: FALSE

Perpetual motion machines cannot exist. Any energy taken from a machine will slow its motion, thus reducing the energy remaining in the machine. Without additional inputs of energy, the machine will eventually stop.

Drew J. Bottaro

10. Does the ENERGY in coal differ in any fundamental way from that in, say, oil?

Answer: NO

The energy in oil and coal and other fossil fuels is often called "primary energy," to distinguish it from other forms of energy such as electricity. It takes 3 to 4 units of primary energy to make one unit of electricity. People transform primary energy to electricity because electricity is a more useful form for some uses.

Drew J. Bottaro, Subramanyam Kumar

11. A 600W hairdryer necessarily uses more energy than a 60W light bulb.

Answer: NO

The POWER of a device (measured in watts) measures the rate of using energy (energy = power x time). If the lightbulb is used for more than ten times (in this case) the time the hairdryer is used, it will "use" more energy, otherwise equal or less energy.

David Griffiths

II. CONSUMPTION

1. What percentage of the energy consumed in New England is consumed in home heating?

- A. 10%
- B. 20%
- C. 30%
- D. 40%

Answer: (B)

Richard D. Tabors

Source: J. J. Donovan and W.P. Fischer, "Factors Affecting Residential Heating Energy Consumption", Technical Report No. MIT-NEEMIS-76-002TR, April 1976.

2. What proportion of the energy consumed in the United States is consumed in home heating?

- A. 10%
- B. 20%
- C. 30%
- D. 40%

Answer: (A)

Source: Ibid

Richard D. Tabors

3. True or False: Newer homes are more energy-efficient than older homes.

Answer: TRUE

Source: Ibid

Richard D. Tabors

4. What percentage of homes in Massachusetts are heated by electricity?

- A. 7%
- B. 13%
- C. 20%
- D. 25%
- E. 35%

Answer: (B)

Source: Ibid

Richard D. Tabors

5. What percentage of new home starts in the United States are electrically heated?
- A. 10%
  - B. 20%
  - C. 30%
  - D. 40%
  - E. 50%

Answer: Nearly 40% of new home starts, 38.5%, in the United States are electrically heated.

Source: Arthur D. Little report for the New England Regional Commission, "Energy Flows in New England, Historical and Projected", the value given is for 1974.

Richard D. Tabors

6. In 1974 what % of the energy used by all consumers in New England, (i.e., residential, commercial, industrial, transportation and electrical utilities) was lost between its import into the region and final end use?
- A. 15%
  - B. 30%
  - C. 45%
  - D. 55%

Answer: (D)

Source: Ibid

Richard D. Tabors

7. In 1975, which New England industry was the largest energy consumer?
- A. Food industry
  - B. Electronics industry
  - C. Chemicals and allied products
  - D. Pulp and paper industry

Answer: (D)

Source: Statistics compiled from U.S. Department of Commerce, Bureau of the Census, "Fuels and Electric Energy Consumed" in Annual Survey of Manufacturers 1975, September 1977

Susan K. Raskin



8. In 1975, which United States industry was the largest consumer?

- A. Petroleum industry
- B. Chemicals and allied products
- C. Primary metal industries (i.e., steel, copper, iron, etc.)
- D. Pulp and paper industry

Answer: (C)

When energy produced from within the company is included, such as coal mines operated by steel companies, primary metal industries constitute the largest. However, chemicals and allied products actually purchase more energy.

Source: Federal Register

Susan K. Raskin

9. In 1975, did the largest energy purchasing industry, chemicals and allied products, also spend the largest dollar amount for energy it consumed?

- A. Yes
- B. No

Answer: (B)

Chemicals and allied products purchased less expensive energy, for example oil, than higher cost energy, for example, electricity.

Source: Op. Cit., Annual Survey of Manufacturers

Susan K. Raskin

10. Which of the following industries spends the most for the energy it purchases?

- A. Petroleum industry
- B. Chemicals and allied products
- C. Primary metals industry
- D. Pulp and paper industry

Answer: (C)

Source: Ibid

Susan K. Raskin

11. Which of the following is a non-fossil fuel energy source?

- A. Oil
- B. Natural gas
- C. Coal
- D. Solar

Answer: (D)

Source: Ibid

Susan K. Raskin

12. Which of the following events occurred during the Arab Oil Embargo in 1973-74?

- A. Cars would line up to obtain gasoline
- B. Natural gas was restricted
- C. Farmers were unable to get fuel to harvest crops
- D. All of the above

Answer: (D)

Source: Energy Outlook for the 1980's, December 1973

Susan K. Raskin

13. Fill in the blank: The United States consumes \_\_\_\_\_ times as much energy per capita as the countries of Western Europe.

- A. 45
- B. 175
- C. 3
- D. 100

Answer: (C)

Source: Ibid

Susan K. Raskin

14. The first use of petroleum was for

- A. Medicinal purposes
- B. Heating buildings
- C. Producing electricity
- D. Lighting streets

Answer: (A)

Source: Ibid

Susan K. Raskin

15. Oil was first discovered in the United States in the state of:

- A. Texas
- B. Pennsylvania
- C. Louisiana
- D. California

Answer: (B)

Source: Ibid

Susan K. Raskin

16. Fill in the blank: New England heating oil consumption \_\_\_\_\_ between 1975 and 1976.

- A. Increased
- B. Decreased
- C. Remained the same

Answer: (A)

Source: Yankee Oilman, March 1978

Susan K. Raskin

17. Between 1974 and 1975, total New England industrial energy consumption per employee

- A. Increased
- B. Decreased
- C. Remained the same

Answer: (A)

Source: MIT

	Years	
	1975	1974
Purchased Fuels and Electric Energy (in billions KWH equivalents)	115.7	103.7
Total industrial Employment (000)	1418.0	1312.0
Energy Consumed/Employee (million KWH equivalents per employee)	81.594	79.040

Susan K. Raskin

18. Between 1974 and 1975, only one industry in New England increased its energy consumption. In which New England industry did energy consumption increase?

- A. Lumber and Wood
- B. Metal products
- C. Apparel
- D. Furniture

Answer: (D)

Source: Op. Cit., Annual Survey of Manufacturers 1975, September 1977.

Susan K. Raskin

19. The largest energy-consuming agency in the United States Federal Government is:

- A. U.S. Department of Defense
- B. U.S. Department of Energy
- C. U.S. Department of Interior
- D. U.S. Department of Transportation

Answer: (A)

Source: FEA, Washington, D.C.

Susan K. Raskin

20. In 1974, in New England, the majority of the energy consumption is composed of:

- A. Coal
- B. Natural Gas
- C. Solar
- D. Petroleum Products

Answer: (D)

21. And in New England this form of energy comprised \_\_\_\_\_ percent of the total amount of energy consumed.

- A. 35%
- B. 50%
- C. 80%
- D. 95%

Answer: (C)

Source: Bureau of Mines and Brookhaven National Laboratory

Susan K. Raskin

22. In 1974, how much of the total U.S. energy was consumed in New England?

- A. 15.1%
- B. 2.0%
- C. 4.2%
- D. 10.3%

Answer: (C)

Source: Brookhaven National Laboratory, The Energy Situation in New England

Susan K. Raskin

23. New England gets most of its refined petroleum products from:

- A. Venezuela
- B. Saudi Arabia
- C. United States
- D. Caribbean

Answer: (C)

Source: Brookhaven National Laboratory

Susan K. Raskin

24. The average price for selected energy products in New England is higher than in the United States for all of the following except:

- A. Electricity sold to industrial customers
- B. Residual oil sold to a utility
- C. Heating oil sold to households
- D. Coal sold to utilities

Answer: (B)

Source: Ibid

Susan K. Raskin

25. All of the known Georges Bank natural resources would supply enough energy to support the United States for:

- A. 1 month
- B. 1 year
- C. 3 years
- D. 5 years

Answer: (A)

Source: Conservation Law Foundation

Susan K. Raskin

26. What percentage of your home's total energy consumption goes for heat?

- A. 20%
- B. 30%
- C. 50%
- D. 70%

Answer: (D)

It's hard to believe, but the correct answer is 70% for an average household. That's why home insulation can have such a large impact on your energy bills.

Source: Tips for Energy Savers, Federal Energy Administration

Gary Taylor

27. Did total energy consumption in the United States increase or decrease between 1973 and 1974? Did it increase or decrease between 1974 and 1975?

Answer: (decrease, decrease)

1973: 74.7 quads  
1974: 73.0 quads  
1975: 70.6 quads

Source: Energy in Focus, Basic Data, Federal Energy Administration,  
May 1977, FEA/A-77/144

Neil L. Goldman

28. Total energy consumption in the United States in BTU's changed how (in %) between 1975 and 1976?

- A. increased 5%
- B. decreased 2%
- C. increased 10%
- D. increased 2%

Answer: (A)

1975: 70.6 quads  
1976: 74.2 quads  
+5.1% increase

Source: Ibid

Neil L. Goldman

29. Approximately \_\_\_\_\_% of the United States total energy consumption in 1976 was used for electricity generation.

- A. 20%
- B. 30%
- C. 40%
- D. 50%

Answer: (B) 28.8%

Source: Ibid

Neil L. Goldman

30. Over the period 1950-1976 in the United States the growth rate (per year) in electricity use was approximately

- A. 1%/yr
- B. 3%/yr
- C. 6%/yr
- D. 10%/yr

Answer: (C) 5.7%

Source: Ibid

Neil L. Goldman

31. Over the period 1950-1976 in the United States the growth rate (per year) in total energy use was approximately

- A. .2%/yr
- B. 1%/yr
- C. 3%/yr
- D. 6%/yr

Answer: (C) 3.05%

Source: Ibid

Neil L. Goldman

32. Approximately what percentage of United States total energy requirements were satisfied by fossil fuel imports in 1977?

- A. 10%
- B. 25%
- C. 40%
- D. 50%

Answer: (B) 25.8%

Source: United States Department of Energy, Monthly Energy Review, March 1978.

Neil L. Goldman

33. In 1976 the United States imported more petroleum from Saudi Arabia than from any other country. Which country was second in line?

- A. Nigeria
- B. Iran
- C. Libya
- D. Venezuela

Answer: (A)

Source: Ibid

Neil L. Goldman

34. From which non-OPEC country did we import the most petroleum in 1976?

- A. Netherlands Antilles
- B. Bahamas
- C. Virgin Islands
- D. Canada

Answer: (D)

Source: Ibid

Neil L. Goldman

35. Currently, the principal U.S. foreign market for coal exports is:

- A. Canada
- B. Europe
- C. Japan
- D. Mexico

Answer: (A)

Source: Ibid

Neil L. Goldman

36. How many nuclear electric power plants are fully operational in the United States as of January 1978?

- A. 35
- B. 65
- C. 95
- D. 125

Answer: (B)

Source: Ibid

Neil L. Goldman



37. In 1977, approximately what percentage of United States petroleum demands were satisfied by imports?

- A. 30%
- B. 40%
- C. 50%
- D. 60%

Answer: (C) 53.9%

Source: Ibid

Neil L. Goldman

38. Did the average real selling price per gallon of regular gasoline increase, decrease or remain the same between 1974 and 1975? Between 1975 and 1976? Note that by real price we mean excluding the effects of inflation.

Answer: (decrease, decrease)

In constant 1975 dollars:

Year	Average Price (in cents)
1974	57.7
1975	56.2
1976	55.8

Source: Energy in Focus, Basic Data, Federal Energy Administration, May 1977, FEA/A-77/144

Neil L. Goldman

39. In terms of real prices, was the average retail selling price per gallon of regular gasoline in 1976 higher or lower than that in 1960?

Answer: Lower

In constant 1975 dollars:

Year	Average Price (in cents)
1960	57.6
1976	55.8

Source: Ibid

James W. Meyer, Neil Goldman

40. In December 1977 the average cost per barrel of imported crude oil to refiners was:

- A. \$5
- B. \$15
- C. \$20
- D. \$25

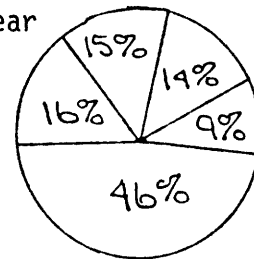
Answer: (B) \$14.74

Source: Ibid

Neil L. Goldman

41. Given the 'pie' diagram and list of sources concerning electricity generation by source in the U.S. in 1976, attach each source to its corresponding percentage on the 'pie'.

- Hydroelectric
- Petroleum
- Coal
- Natural Gas
- Nuclear



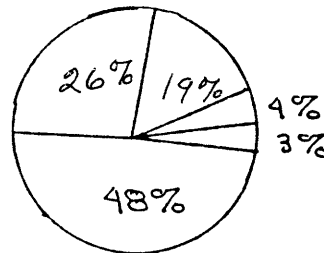
- Answer: Coal 46%  
 Petroleum 16%  
 Natural Gas 15%  
 Hydroelectric 14%  
 Nuclear 9%

Source: Ibid

Neil L. Goldman

42. Given the 'pie' diagram and list of sources concerning total energy consumption by fuel type in the United States in 1977, attach each fuel type to its corresponding percentage on the 'pie'.

- Coal
- Natural Gas
- Nuclear
- Hydroelectric
- Petroleum



- Answer: Petroleum 48%  
 Natural Gas 26%  
 Coal 19%  
 Hydroelectric 4%  
 Nuclear 3%

Source: Ibid

Neil L. Goldman, Jack Howard

43. Through 1977, in which year was domestic energy production highest?

Answer: 1972, 62.1 quads

Source: Ibid

Neil L. Goldman

44. True or False: Domestic energy production has been declining yearly since 1972.

Answer: TRUE

Source: Ibid

Neil L. Goldman

45. The average daily total energy consumption per person in the United States in 1976 was equivalent to

- A. 1 gallon of oil
- B. 3 gallons of oil
- C. 7 gallons of oil
- D. 20 gallons of oil

Answer: (C) - 6.82 gallons

Source: Ibid

Jack Howard, Neil Goldman

46. The United States has about 6% of the world's population. It consumes what percent of the world's energy?

- A. 10%
- B. 35%
- C. 50%

Answer: (B)

Source: Energy Outlook for the 1980's, December 1973

David Adler, Neil Goldman

47. In order to bring the world's per-capita energy use up to that of the United States by the year 2000, it would require an increase in total energy consumption of

- A. 100%
- B. 500%
- C. 1000%

Answer: (C)

(when the 75% increase in population over the next 22 years is considered).

David Adler

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### III. TECHNOLOGY

1. Fusion energy is released by

- A. the spontaneous melting of radioactive materials
- B. a chemical reaction in radioactive materials
- C. the combining of light nuclei into a heavier nucleus plus energy
- D. the action of neutrons on uranium or plutonium fuel

Answer: (C)

James W. Meyer

2. Fission energy is released by

- A. the "splitting" of heavy nuclei into lighter nuclei plus energy
- B. the chemical burning of uranium in a reactor
- C. the explosion of an atomic bomb in a containment vessel
- D. the fusion of uranium and plutonium nuclei by spontaneous melting

Answer: (A)

James W. Meyer

3. A fuel cell

- A. is something like a storage battery run backwards
- B. is used to make gasoline from crude oil
- C. is used to generate hydrogen and oxygen from water
- D. is a new kind of long lived storage battery

Answer: (A)

James W. Meyer

4. The basic energy source of the sun is

- A. the fusion of hydrogen nuclei to form helium nuclei plus energy
- B. the fission of uranium to produce lighter nuclei plus energy
- C. cosmic rays
- D. solar wind
- E. X-rays

Answer: (A)

James W. Meyer

5. The basic source of the earth's geothermal energy is
- A. stored solar energy collected over the millenia
  - B. decay of radioactive elements in the earth's interior
  - C. volcanoes
  - D. salt domes

Answer: (B)

James W. Meyer

6. Domestic oil burning furnaces
- A. are 95% efficient in converting the energy contained in oil into useful heat in the home
  - B. meet varying demand for heat in the home by turning on and shutting off (cycling on and off for different periods of time)
  - C. are operating poorly if they run continuously to supply the heat demand during the coldest weather
  - D. require no cleaning and maintenance as long as they operate

Answer: (B)

James W. Meyer

7. Domestic gas burning furnaces
- A. are 95% efficient in converting the energy contained in the gas into useful heat in the home
  - B. meet varying demand for heat by turning on and off
  - C. must have a pilot flame in order to ignite

Answer: (B)

James W. Meyer

8. Domestic electric resistance house heating

- A. is the most expensive in terms of first cost
- B. competes favorably in identical homes with oil and gas heat at today's New England prices for the three energy sources.
- C. is the only alternative we have when we run out of oil and gas
- D. provides the least efficient conversion of primary fuels such as oil, coal and gas into useful heat in the home, even though it is over 95% efficient in the home.

Answer: (D)

The overall (system) efficiency of electrical resistance heating (from power station to home electric heater) is low, varying from 15% to 35%. Even though the heater itself may be close to 100% efficient in converting electricity to heat, the overall efficiency is limited by the inefficiencies in generation of the electricity from primary fuels such as coal and oil, and in transmission. Domestic gas and oil burning furnaces, by comparison, are from 35% to 50% efficient and represent a much better match of energy resource to end-use. Even better from this last viewpoint would be a Solar-thermal space heating system.

Source: FEA Energy in Focus, Basic Data, FEA/A-77/144, May 1977., Earl Cook, "Man, Energy, Society," W.H. Freeman and Co., San Francisco

Subramanyam Kumar

9. It has been estimated that the burning of coal and oil may be increasing the carbon dioxide content of the atmosphere by about
- A. 20% each decade
  - B. 2% each decade
  - C. less than 1/4% per decade

Answer: (B)

Tom Neff

10. All other things being equal, increasing atmospheric carbon dioxide would:
- A. cause immediate global cooling since carbon dioxide would reflect sunlight back into space
  - B. cause an increase in skin cancer by allowing more ultraviolet radiation to penetrate to the earth's surface
  - C. cause global warming by trapping heat produced by sunlight and by man's activity

Answer: (C)

CO<sub>2</sub> is transparent to most incoming wavelengths but traps infrared or heat radiation, leading to a "greenhouse" effect.

Tom Neff

11. Air pollution levels in urban areas in the U.S. have generally
- A. increased significantly over the past decade
  - B. stayed about the same
  - C. decreased significantly in the past decade

Answer: (C)

Tom Neff

12. The dominant source of lead in our environment is due to
- A. coal plant emissions
  - B. use of gasoline that contains lead
  - C. the manufacturing of paint

Answer: (B)

Tom Neff

13. Coal plant emissions of sulfur and nitrous oxides
- A. affect people with prior respiratory problems
  - B. increase the acidity of rain
  - C. both of the above

Answer: (C)

Tom Neff

14. True or False: A heat pump can not operate when the outside temperature drops below 10°C.

Answer: FALSE

Above absolute zero (-273 Celsius) all matter contains heat energy. Commercial devices (heat pumps), which act like refrigerators-in-reverse, are available for home heating -- they extract up to four times as much heat energy from the atmosphere as the electrical energy they consume.

David Griffiths

15. True or False: Taping plastic foil over windows reduces heat loss because most plastics are poor heat conductors.

Answer: FALSE

It's true that most plastics do not conduct heat very well, but even with heavy "4 mil" plastic the insulating effect of such thin material is slight. However, the layer of "dead" air trapped between the plastic and window, and the exclusion of drafts, reduce heat loss considerably.

David Griffiths



16. True or False: Television commercials which advertise 6 inches of fiberglass as having the same heat insulating properties as 11 feet of stone are essentially correct.

Answer: TRUE

This is perfectly true for correctly installed insulation, and some foam materials are considerably better.

David Griffiths

17. True or False: A vapor barrier is installed with insulation to prevent dampness from entering the house from the outside.

Answer: FALSE

It is to prevent moist air inside the house from passing through the insulation and condensing on the cold outside wall. Apart from "drying" the air to the point of discomfort, condensing vapor is an efficient heat transport mechanism to the outside! Other unwanted effects are the loss of (heat) insulating properties when many insulating materials become damp (through condensation), and the rot of the building itself because of the consequent dampness in the walls.

David Griffiths

18. A solar flat plate collector is a device for:

- A. collecting rainfall
- B. collecting flat plates
- C. converting solar energy into heat

Answer: (C)

A flat plate collector has tubes welded to a metal plate. The collector is set facing the sun and gets heated. Water (or air) pumped through the tubes then pick up this heat; the hot water can be used directly, or for space heating, among other uses.

Subramanyam Kumar

19. A solar cell is a device for:

- A. imprisoning the sun
- B. converting sunlight into heat
- C. converting sunlight into electricity

Answer: (C)

The principal advantage of a solar cell (which is shaped like a wafer) is that it converts sunlight directly into electricity without any moving parts.

Subramanyam Kumar

20. Solar cells are presently manufactured from:

- A. Silicon
- B. Iron bars and cement
- C. Wood

Answer: (A)

Cadmium sulphide and gallium arsenide are other candidate materials for solar cells, although the technologies for manufacturing such cells are less advanced than Silicon solar cell technology.

Subramanyam Kumar

21. Solar cells carry no environmental hazards.

- A. true
- B. false

Answer: (B)

The principal hazard associated with silicon cells is in their manufacture; silica particulates are released to the atmosphere. There is no hazard involved in their use. Cadmium sulphide and gallium arsenide cell manufacture is accompanied by toxic release of cadmium/cadmium sulphide and arsenic trioxide respectively. Also, cadmium sulphide and gallium arsenide cells have the potential to release toxic gases into the atmosphere if exposed to a fire, such as a roof fire.

Source: Thomas L. Neff, "Social Cost Factors and the Development of Photovoltaic Energy Systems," Draft Report, Energy Laboratory, M.I.T., prepared for the United States Department of Energy, May 1978.

Subramanyam Kumar

22. Name at least three forms in which solar energy is potentially available to us.

Answer: Sunlight, wind energy, ocean thermal gradients, biomass (e.g. through photosynthesis)

Subramanyam Kumar

23. Compared to electricity supplied by conventional power plants, a unit of electricity generated by solar cells presently is

- A. cheaper
- B. comparable in price
- C. about an order of magnitude more expensive

Answer: (C)

Subramanyam Kumar

24. The efficiency with which a solar cell converts incident sunlight into electrical energy:

- A. is as high as 90%
- B. is more like 50%
- C. ranges from 5-20%

Answer: (C)

Single crystal cells are at the upper end of this range, while polycrystalline cells are at the lower end. Efficiency also varies (within this range) depending on the material from which the cell is made.

Source: Gandel, Martin, G., et. al., Lockheed Missiles and Space Company, Inc., "Assessment of Large-Scale Photovoltaic Materials Production," prepared for United States Environmental Protection Agency, August 1977.

Subramanyam Kumar

25. Advanced alternatives to the conventional internal combustion automobile engine include the gas turbine, the Stirling engine, the Rankine (steam) engine and the electric powered vehicle. Compared to the internal combustion engine, these alternatives

- A. have potential for better fuel economy
- B. are more expensive
- C. are less polluting
- D. all of the above

Answer: (D)

However, the fuel economy potential of these alternative engines is yet to be demonstrated convincingly on the road under typical driving conditions.

Subramanyam Kumar

26. What is the efficiency of electric generation from fossil fuels through steam to electricity in conventional power plants?

- A. greater than 75%
- B. about 50%
- C. less than 40%

Answer: (C)

Source: Hottel & Howard, New Energy Technology - Some Facts and Assessments

Subramanyam Kumar

27. How much energy is available from sunlight at the earth's surface? What fraction of the energy incident on the earth is absorbed by the atmosphere?

Answer: About 1KW per square meter of area perpendicular to the sun rays at noontime on a clear day. This is the about the maximum possible; the amount is dependent on time of day, year and location on the earth's surface. About 30% of the solar energy available outside the atmosphere is absorbed by the atmosphere.

Subramanyam Kumar

28. How many ways can energy be stored?

Answer: 1. Fuel storage (ex. a coal pile or a barrel of oil)  
2. Electrochemical storage (batteries)  
3. Material storage (ex. pumped water storage or stored water in the dam in a hydroelectric power plant)  
4. Thermal storage (ex. a tank of hot water)  
5. Mechanical storage (ex. flywheels)

Subramanyam Kumar

29. Gas turbines for stationary power plants are used mainly to accommodate

- A. baseload requirements
- B. peaking power requirements

Answer: (B)

Gas turbine power plants use more expensive fuel but are capable of quick start-ups and shutdowns, unlike steam power plants.

Subramanyam Kumar

30. A key problem associated with using much of the coal in the U.S. is that the coal contains a lot of sulfur which can cause pollution problems. To eliminate much of the sulfur, some experts want to develop a solvent refined coal (SRC) process. SRC results from:

- A. coal mines that are profitable
- B. a process of dissolving and heating coal, reacting it with pressurized hydrogen, followed by filtering and distillation
- C. excess rainfall in Appalachia
- D. coal soaked in paint thinner

Answer: (B)

Chris Alt

31. Another technique for coping with high sulfur coal is fluidized bed combustion (FBC). FBC consists of

- A. playing with matches on top of a water bed
- B. burning an underground coal seam
- C. inducing pulverized coal to react with minerals containing sulfur-dioxide -absorbing calcium.

Answer: (C)

Chris Alt

32. Some of the advantages of FBC would include:

- A. eliminating the need for expensive stack gas "scrubbers" in electric power plants
- B. generating waste products that can be recycled
- C. both (A) and (B)

Answer: (C)

Chris Alt

33. Another option being explored is the feasibility of in-situ, or underground coal gasification (UCG). Some of the advantages of UCG include:

- A. minimal environmental impact
- B. enabling recovery of many otherwise unrecoverable coal reserves
- C. production of high BTU gas (i.e. comparable to natural gas)
- D. (A) and (B) from above

Answer: (D)

Source: FASST News, March 1977, Vol. 6, #2, "The Burning Coal Issue"

Chris Alt

34. Which of the following fuels commonly are found together?

- A. oil and coal
- B. uranium and natural gas
- C. oil and natural gas

Answer: (C)

Gas, oil, and water are often found together. Gas is lighter than oil, and oil is lighter than water, so gas is sometimes encountered above oil in an exploration hole.

John C. Houghton

35. The average solar flux in Boston is what fraction of that in Miami?

- A. 33%
- B. 50%
- C. 67%

Answer: (C)

David Adler

36. Abu Dhabi is

- A. a phrase from a song made popular by Ella Fitzgerald
- B. the name of the Saudi Arabian Oil Minister who organized the OPEC cartel
- C. an oil-rich country on the Persian Gulf

Answer: (C)

Abu Dhabi contributed 2.6% of total world's oil production last year.

Source: BP Statistical Review of the World Oil Industry.

David O. Wood

37. OTEC is:

- A. a government energy agency
- B. an oil cartel
- C. an energy technology
- D. a unit of measurement for sunlight

Answer: (C) Ocean Thermal Energy Conversion

Paul Carpenter, David O. Wood

38. Why is surface mining of coal expanding more rapidly than underground mining?

- A. because reserves of surface-mine coal are greater
- B. because surface mining does less harm to the environment.
- C. because surface-mine coal is of higher quality
- D. because surface mining is cheaper

Answer: (D)

Ingo Vogelsang

39. Which is the most abundant fossil energy resource?

- A. Oil
- B. Natural gas
- C. Coal

Answer: (C)

Ingo Vogelsang

40. What is the approximate amount of sulphur contained in the coal burned in the U.S. in 1977?

- A. 100,000 tons
- B. 1,000,000 tons
- C. 10,000,000 tons

Answer: (C)

Ingo Vogelsang

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Nuclear

41. Nuclear power provides what percentage of electricity in the U.S.

- A. 2%
- B. 12%
- C. 40%

Answer: (B)

Tom Neff

42. Nuclear electricity is

- A. cheaper than all other sources of energy
- B. about the same price as electricity from coal nationally but slightly cheaper in New England
- C. more expensive than electricity from natural gas in New England

Answer: (B)

Tom Neff

43. Which of these is a risk of nuclear power?

- A. the very small chance that an accident will release large amounts of radioactivity
- B. the chance that a reactor will explode like an atomic bomb
- C. the possibility that the reactor will produce surges of electricity which ruin household appliances.

Answer: (A)

Tom Neff

44. Though no member of the public has been killed by nuclear power, a very bad nuclear accident would

- A. immediately kill hundreds of thousands of people
- B. kill only a few people but double the chance of cancer for millions of people
- C. kill several thousand people living nearby and increase cancer risks for others by less than 1%.

Answer: (C)

Tom Neff

45. Present nuclear reactors use uranium fuel. Breeder reactors would use plutonium which could also be used in nuclear weapons. President Carter has cancelled the demonstration breeder reactor at Clinch River, Tennessee, on the grounds that

- A. it would be unsafe
- B. the need for breeders is less urgent than we thought when we started it and going ahead could accelerate the spread of nuclear weapons by increasing interest in plutonium in other countries.

Answer: (B)

Tom Neff

46. True or False: Electricity costs the same to produce at any time of day.

Answer: FALSE

Electricity usage varies throughout the day and from season to season. Consequently, some electric power generating plants operate all day while others operate only briefly during the periods of daily peak usage. (The highest peak usually occurs on the hottest day of the year when air conditioning usage is greatest.) The cost of electricity produced by the plants used during peak power generation can be as much as ten times as high as the cost of electricity generated by plants used more or less continuously.

Drew Bottaro

47. What percent of a typical residential electricity bill pays for fuel and power plant construction?

- A. 30%
- B. 45%
- C. 60%
- D. 75%

Answer: (A) 30%

The remainder of the costs are associated with transmission and distribution of electric power and overhead, e.g. billing, metering.

Source: "Electric Power Transmission and Distribution Systems: Costs and Their Allocation," Martin Baughman and Drew Bottaro, MIT-EL 75-020.

48. Transmission and distribution costs for residential electricity are approximately how large compared to transmission and distribution costs for industrial electricity?
- A. half as much
  - B. as much
  - C. twice as much
  - D. three times as much

Answer: (D)

Industrial users use high-voltage power directly from transmission or high-voltage distribution lines, whereas residential users must have the power reduced to 110 or 220 volts which requires more equipment: transformers, lines and also maintenance. Therefore, transmission and distribution costs are three times as much.

Also, because generation costs for the two types of users are similar, the total cost of residential electricity is nearly twice that of industrial electricity.

Source: Ibid

Drew Bottaro

49. True or False: Coal is the only fossil fuel which cannot be transported by pipeline.

Answer: FALSE

Coal can be transported as a slurry by pulverizing it and adding water. Problems associated with this technology include diverting the water to this use, drying the coal at the end, and crossing railroad lines (railroad companies would rather transport the coal themselves).

Ingo Vogelsang

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#### IV. HOME ECONOMICS

1. How many Btu's are used for cooking each year in the average American household?

Answer: 9.5 million

Source: Rand report R-1641-NSF, "Energy use and conservation in the residential sector: a regional analysis" (p.44).

Anita Clamurro

2. Which type of electrical appliance accounts for the largest percentage of electricity consumed in U.S. households?

- A. television
- B. washer
- C. electric clothes dryer
- D. refrigerator

Answer: Refrigerator.

This is the largest single energy-consuming product in the home, and accounts for 15-20% of residential electricity consumption.

Source: "Consumer appliances: the real cost", M.I.T. Center for Policy Alternatives and Charles Stark Draper Lab., 1974 (p.18-19).

Anita Clamurro

3. Which consumes more energy - a new frost-free refrigerator, or an older model without the "frost-free" feature?

Answer: frost-free refrigerator.

(14 watts/cubic foot, vs. 10w/cf for manual defrost)

Source: Ibid

Anita Clamurro

4. It is cost efficient to leave a fluorescent light on rather than switching it off if the light is going to be needed again in:

- A. 20 minutes or less
- B. 5 minutes or less
- C. 60 minutes or less

Answer: A. 20 minutes

Source: William Jones, M.I.T. Energy Laboratory

Anita Clamurro

5. What percentage of the energy input of an incandescent bulb is transformed into visible light?

50%  
30%  
10%

Answer: 10%.

The rest is given off as heat.

Source: "New energy-saving light bulb." Pamphlet published by ERDA Office of Public Affairs, 1976.

Anita Clamurro

6. How many gallons of hot water are wasted in one year by the average leaky hot water faucet?

100  
1000  
3000  
5000

Answer: 5000 gallons

Source: "Cost-effective methods to reduce the heating and cooling energy requirements of existing single-family residences." ABT Associates, Inc., Cambridge, Mass. Report prepared for the U.S. Dept. of Housing and Urban Development (p. 88). "Leaky faucets, and leaky hot water faucets in particular, each waste about 5,000 gallons of water a year."

Anita Clamurro

7. What is the maximum amount of time a car engine should be allowed to idle?

Answer: one minute

For longer periods, it is more efficient to shut off the engine and restart it later.

Source: U.S. Department of Energy Weekly Announcements, Jan. 6, 1978, p.3.

Anita Clamurro

8. What percentage of the fuel used by a gas stove is burned by the pilot light?

- 10 - 15%
- 25 - 30%
- 45 - 50%
- more than 50%

Answer: 47%

A stove with an automatic ignition system rather than a pilot light could mean an average energy saving of 41% in the oven and 53% on the top burners. However, pilot lights add to the heat of a room, which is useful in cold seasons.

Source: Ibid

Anita Clamurro

9. Is it more efficient to heat a small quantity of food using a gas oven or an electric toaster-oven?

Answer: toaster-oven

Source: U.S. Department of Energy Weekly Announcements, March 10, 1978, p.4.

Anita Clamurro

10. What percentage of the fuel used by a gas clothes dryer is burned by the pilot light?

- Approx. 10%
- Approx. 30%
- Approx. 40%
- Approx. 50%

Answer: 40%

Source: Rand report R-1641-NSF, "Energy use and conservation in the residential sector: a regional analysis" (p.103).

11. How much heat is lost from the oven each time you open the door to "peek" during baking?

Answer: 20% heat loss.

Source: U.S. Department of Energy Weekly Announcements, Dec. 9, 1977, (p. 5).

Anita Clamurro

12. Will opening your refrigerator door cool your kitchen on a hot summer day?

Answer: NO

The energy removed from your refrigerator's interior must go somewhere. Generally it is thrown out the back of the refrigerator and into your kitchen. On the whole, your kitchen's temperature will remain the same (or rise a little because the refrigerator's motor will run more).

Drew J. Bottaro

13. In New England, adding storm doors to your house will result in \_\_\_\_\_% energy savings?

- A. 4%
- B. 8%
- C. 16%
- D. 0%

Answer: (A)

Source: J.J. Donovan and W.P. Fischer, "Factors Affecting Residential Heating Energy Consumption", Technical Report No. MIT-NEEMIS-76-002TR, April 1976.

Richard D. Tabors

14. Adding storm windows in a New England home will result in \_\_\_\_\_% energy savings.

- A. 0%
- B. 11%
- C. 20%
- D. 31%
- E. 5%

Answer: (B)

Source: Ibid

Richard D. Tabors

15. Do simple inexpensive conservation measures really have much of an impact upon utility bills?

Answer: Yes

You can save about 3% of your fuel costs for each degree you reduce the average temperature in your home. Thus a home kept at 65° costs about 20% less to heat than the same home at 72°. In older homes merely caulking and weatherstripping doors and windows (cost only about \$25 for an average sized house) can cut heating bills as much as 10%. So in many cases significant energy savings can be realized without large outlays of cash.

Source: Tips for Energy Savers, Federal Energy Administration

Gary Taylor, David Griffiths



16. How much can you reduce your heating bills by using fireplace to provide supplemental warmth?

- A. 3%
- B. 7%
- C. 10%
- D. 12%
- E. None of the above

Answer: (E)

Using your fireplace without special precautions can increase your heating bills. While the radiant heat from the fireplace benefits only one room, a large amount of heated air drawn from the rest of the house is lost up the chimney. The furnace must therefore work harder to keep these other rooms warm so heating bills can actually go up because of the fireplace.

Source: Tips for Energy Savers, Federal Energy Administration

Gary Taylor, David Griffiths

17 Which takes the most water, a bath or a 5 minute shower?

Answer: The bath takes more water.

Average tubs require about 30 gallons while the average shower (5 minutes at 4/gal/min) takes about 20 gallons.

Source: Tips for Energy Savers, Federal Energy Administration

Gary Taylor

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## V. INSTITUTIONS AND POLICY

1. The 'Seven Sisters' of energy refers to:
  - A. a mountain range in Oregon undergoing geothermal development
  - B. the federal agencies combined to form DOE
  - C. Exxon, Texaco, Mobil, Standard Oil of Cal., Shell, British Petroleum, Gulf.

Answer: (C)

Dan Saltzman

2. The Secretary of the Department of Energy is
  - A. Arthur Schlesinger
  - B. Russell Peterson
  - C. James Schlesinger
  - D. John O'Leary

Answer: (C)

Since the 1973-74 oil embargo, a number of new federal and state agencies have been formed to deal with various aspects of our energy problems. At the federal level two Administrations were created; the Federal Energy Administration (FEA) and the Energy Research and Development Administration (ERDA). The FEA was established as a direct response to the embargo to implement and enforce petroleum product price regulations, and to develop and publish data and information on energy use and resources. ERDA was established as a consequence of reorganizing the Atomic Energy Commission. Regulation of Nuclear construction and operation was assigned to the Nuclear Regulatory Commission (NRC) while responsibility for nuclear research, development and demonstration (R,D&D) was assigned to ERDA. In addition, other energy related, R,D&D responsibilities were either transferred to ERDA from existing agencies or established as new objectives. Recently, the FEA, the Federal Power Commission (FPC), and ERDA have been combined into a single cabinet level agency, the Department of Energy.

In addition to the new federal agencies many state governments have organized new agencies to help deal with state and local issues relating to energy use and production. For example all the New England states have established state energy offices. In Massachusetts the state energy office has been very active in providing information to homeowners and industry on conservation possibilities, in providing analyses of likely future developments in state energy needs, and in supporting state planning for development of potential sources such as Georges Bank.

David O. Wood

3. The Organization of Petroleum Exporting Countries (OPEC) was organized in
- A. September, 1960
  - B. October, 1973
  - C. August, 1947
  - D. None of the above

Answer: (A)

The Organization of Petroleum Exporting Countries (OPEC) was not organized just to implement the embargo of 1973-74. The OPEC was formally organized in 1960 as a response of the producing countries to the U.S. oil import quotas of 1959. These quotas reduced the demand for imported oil to the U.S. and led to a reduction in international oil prices. In response, Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela, later joined by others, formed OPEC to assist in coordinating their natural oil policies. While the initial purpose was to resist price decreases, developing circumstances of increasing demand and cartel cohesion lead to conditions where price increases were demanded and obtained in the early 1970's and subsequently to the three-fold price increases of 1973-74.

David O. Wood

4. The IEA is the
- A. Industrial Energy Administration
  - B. International Energy Agency
  - C. International Environment Administration
  - D. International Economic Association

Answer: (B)

David O. Wood

5. True or False: The International Energy Agency (IEA) was organized by the major petroleum importing countries as a response to the threat of oil embargos and shortages.

Answer: TRUE

(4. and 5.) One response of the United States and other industrialized oil importing nations to the 1973-74 oil import embargo was to establish the International Energy Agency. The IEA, located in Paris, administers agreements among its members concerning national conservation objectives, and distribution of oil imports in the event of another oil embargo. The organization represents the only international initiative of the industrialized oil importing nations to prepare for another unanticipated oil shortage.

David O. Wood

6. For most states electricity prices are regulated by
- A. Department of Energy
  - B. Federal Power Commission
  - C. Federal Energy Regulatory Commission
  - D. State Public Utility Commission

Answer: (D)

David O. Wood

7. The only state without a public utility commission regulating electricity prices is
- A. Texas
  - B. Massachusetts
  - C. New Hampshire
  - D. Alaska

Answer: (A)

David O. Wood

8. True or False: An important feature of President Carter's energy program is the use of taxes to regulate energy prices at replacement costs.

Answer: TRUE

David O. Wood

9. True or False: The U.S. petroleum storage reserve program maintains government inventories of crude and refined petroleum for use in a future embargo.

Answer: TRUE

David O. Wood

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## VI. ECONOMICS AND PITFALLS

1. True or False: Gradual removal of natural gas price controls may create shortages of a much larger scale than has been experienced up to now.

Answer: TRUE

If it is determined that the price is to rise at  $x\%$  per year, this means that a gas producer will get  $x\%$  interest for keeping his gas in the ground instead of selling it to the consumers. The higher  $x$ , the larger the danger of shortages.

Knut Mork

2. True or False: Continued price control of natural gas may mean higher gas prices to New England consumers than no price control.

Answer: TRUE

Price controls regulate the price for gas transported across state lines. If these prices are kept low, producers in Texas and Louisiana will prefer to sell their gas locally at higher prices. In order to satisfy consumer demand, New England utilities may have to import liquified natural gas at much higher prices and pass the higher cost on to the consumers.

Knut Mork

3. True or False: There is less need to economize on electricity in states and regions that have cheap and abundant hydro power.

Answer: FALSE

Electricity can be transmitted among states and regions (although with some transmission loss). Thus, one kwh saved of hydro power means that it can be used to save (almost) one kwh of fossil fuel generated electricity.

Knut Mork

4. True or False: Increasing gas mileage for automobiles indefinitely and arbitrarily ensures less use of the nation's resources.

Answer: FALSE

After some point, production of cars with higher gas mileage may be so expensive in terms of other resources (labor, materials, capital) as to potentially outweigh the energy saving.

Knut Mork

5. True or False: Importing foreign oil causes unemployment in the U.S.

Answer: FALSE

There is no known relationship between oil import and unemployment. Japan and West Germany are good examples of countries that have depended on foreign oil for years without suffering economic setbacks for that reason.

Knut Mork

6. If fuel prices were permitted to move freely in private markets, would you expect the price in dollars per Btu to be the same for all fuels?

Answer: NO

Because some fuels are more costly or inconvenient to use than others. For example, coal prices would be expected to be below natural gas prices because transportation and storage of coal is more expensive, and pollution problems are more severe.

Knut Mork



## VII. LIFE CYCLE COSTING

We all recognize that for many products, particularly those which use large amounts of energy, the price that we pay to buy the product initially is only a part of the total cost of ownership. If we were able to predict the costs of operation and maintenance over the lifetime of the product it would be possible to combine these future costs with the purchase price. This new cost would then accurately reflect the total cost of owning this product. The method used to combine these present and future costs is referred to as "Life-Cycle Costing". The following questions illustrate some of the features of this concept:

1. If two products have the same initial price, annual maintenance costs, and use the same amount of energy, they will necessarily have the same life-cycle cost.
  - A. True, if their energy costs per year are the same.
  - B. False, because they may have differing lifetimes.
  - C. False, because their energy efficiencies may differ.

Answer: (B)

If all present and future costs are equal, the product with the longer lifetime will have a lower life-cycle cost since it is possible to spread the initial cost over a greater number of years.

Paul Carpenter

2. The use of an energy-efficiency ratio (e.g., the EER of air conditioners) or miles per gallon is the same as employing life-cycle costing.

Answer: FALSE

The EER and MPG figures do not consider the initial product price, lifetime, or maintenance costs.

Paul Carpenter

3. A consumer durable product that has a relatively low life-cycle cost is probably relatively energy-efficient.

Answer: TRUE

The larger the energy cost is in proportion to other costs the more likely that the low life-cycle cost product is also energy efficient. Most consumer durables (automobiles, refrigerators, etc.) have proportionately high energy costs.

Paul Carpenter

4. It is generally better to purchase a product with high energy or maintenance costs late in its life than one with high costs early in its life.

Answer: TRUE

Due to our ability to invest money which we don't spend and earn a return on it, the further costs can be postponed into the future the better. Life-cycle costing incorporates this time value of money concept through the application of a discount rate (or interest rate).

Paul Carpenter

5. Life-cycle costing has long been recognized by the government in its day-to-day purchase decisions but has been generally ignored by the private sector.

Answer: FALSE

Because government agencies are tied to yearly budgets they have been reluctant to pay more initially to save money and energy in the long run.

Paul Carpenter

6. Life-cycle costing, if employed by everyone when purchasing an air conditioner or automobile, could cause which of the following to occur:

- A. producers to produce more energy-efficient products
- B. producers to improve the quality of their product
- C. both of the above
- D. none of the above

Answer: (C)

If everyone used this technique producers would begin to compete with one another by improving durability (lifetime) and by improving energy efficiency in order to sell more of their products. And as consumers we would save money and energy in the long run!

Paul Carpenter

7. Using life-cycle costing, which air-conditioner is cheaper?

	<u>Model 1</u>	<u>Model 2</u>
Price.....	\$500.00	\$650.00
Lifetime.....	10 yrs.	10 yrs.
Discount rate.....	6%	6%
Annual Energy and maintenance costs.....	\$150.00	\$100.00

Answer: Model 2

Despite the high initial price, is cheaper in the long run.

Life-cycle cost (annual) Model 1 = \$217.93

Life-cycle cost (annual) Model 2 = \$188.31

You save over \$29.00 per year by purchasing the higher priced (but more efficient) air conditioner!

Paul Carpenter

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## VIII. CONVERSION TABLE

The following table of Energy Conversion Factors has been assembled to allow for rapid comparison of one energy source with another. The numbers contained in the first column (Btu's) represent the amount of total energy, available in a fixed quantity of material. If you were interested in knowing how much coal was required to equal the amount of energy in a pound of firewood you would read across the firewood row to the intersection of the coal column and find that one pound of firewood equals the energy in .62 pounds of coal.

The energy conversion table is not sufficient to answer the question, "How much firewood relative to electricity do I need to heat my house?" To answer this question requires additional information concerning the efficiency of the device in which the firewood is burned relative to that in which electric heat is generated. While there is sizeable loss in efficiency in generation of electricity and losses in transmission from the power station to the home, once there it can be converted to heat at around 95% efficiency i.e. for every 100 Btu's of electricity, 95 are available to heat the house. The availability of energy in firewood depends upon the fire place (fire box) in which it is burned. Many home fireplaces are less than 10% efficient while "stoves" are now available which are 30-50% efficient, some even higher.

The same arguments listed above cover all other energy sources as well, thus to convert from one to another for any specific application requires information concerning the efficiency of the conversion device along with the energy contained in the material.

CONVERSION TABLE  
(BTU's)

	BTU	Wheat	Gasoline	Heating Oil	Elec- tricity	Natural Gas	Propane	Coal	Firewood	Sun	U <sub>3</sub> O <sub>8</sub>	Cow Dung
1 lb. wheat	6,350		.06	.05	1.86	6.35	.07	.49	.79	1.86	.0253	1.72
1 gal. gasoline	115,160	18.14		.83	33.74	115.16	1.27	8.86	14.40	33.74	.4588	31.12
1 gal. heating oil	138,700	21.84	1.20		40.64	138.70	1.52	10.67	17.34	40.64	.5526	37.49
1 kwh of electricity	3,413	.54	.03	.02		3.41	.04	.26	.43	1.00	.0136	.92
1 cu.ft. natural gas	1,000	.16	.01	.01	.29		.01	.08	.13	.29	.0040	.27
1 gal. propane	91,000	14.33	.79	.66	26.66	91.00		7.00	11.38	26.66	.3626	24.59
1 lb. coal	13,000	2.05	.11	.09	3.81	13.00	.14		1.63	3.81	.0518	3.51
1 lb. firewood	8,000	1.26	.07	.06	2.34	8.00	.09	.62		2.34	.0319	2.16
1 hr. bright sun (per sq. meter)	3,413	.54	.03	.02	1.00	3.41	.04	.26	.43		.0136	.92
1 lb. U <sub>3</sub> O <sub>8</sub> ore (contains 0.1% U <sub>3</sub> O <sub>8</sub> concentrate)	251,000	39.53	2.18	1.81	73.54	251.00	2.76	19.31	31.37	73.54		67.84
Cow Dung (dried)	3,700	.58	.03	.03	1.08	3.70	.04	.28	.46	1.08	.0147	