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ABSTRACT

This manual is a resource guide on energy conservation for teaching mathematics from grades seven to twelve. It contains 25 student activities which are grouped into four goal oriented units. The main objectives of the project are to increase the student's understanding that: (1) Natural laws limit energy availability; (2) Energy consumption affects both man and his environment; (3) Human values and attitudes affect energy usage; and (4) Energy consumption is necessary to maintain our life style. (SB)

IDAHO
ENERGY CONSERVATION RESOURCE GUIDE
for
MATHEMATICS GRADES 7-12

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Governor

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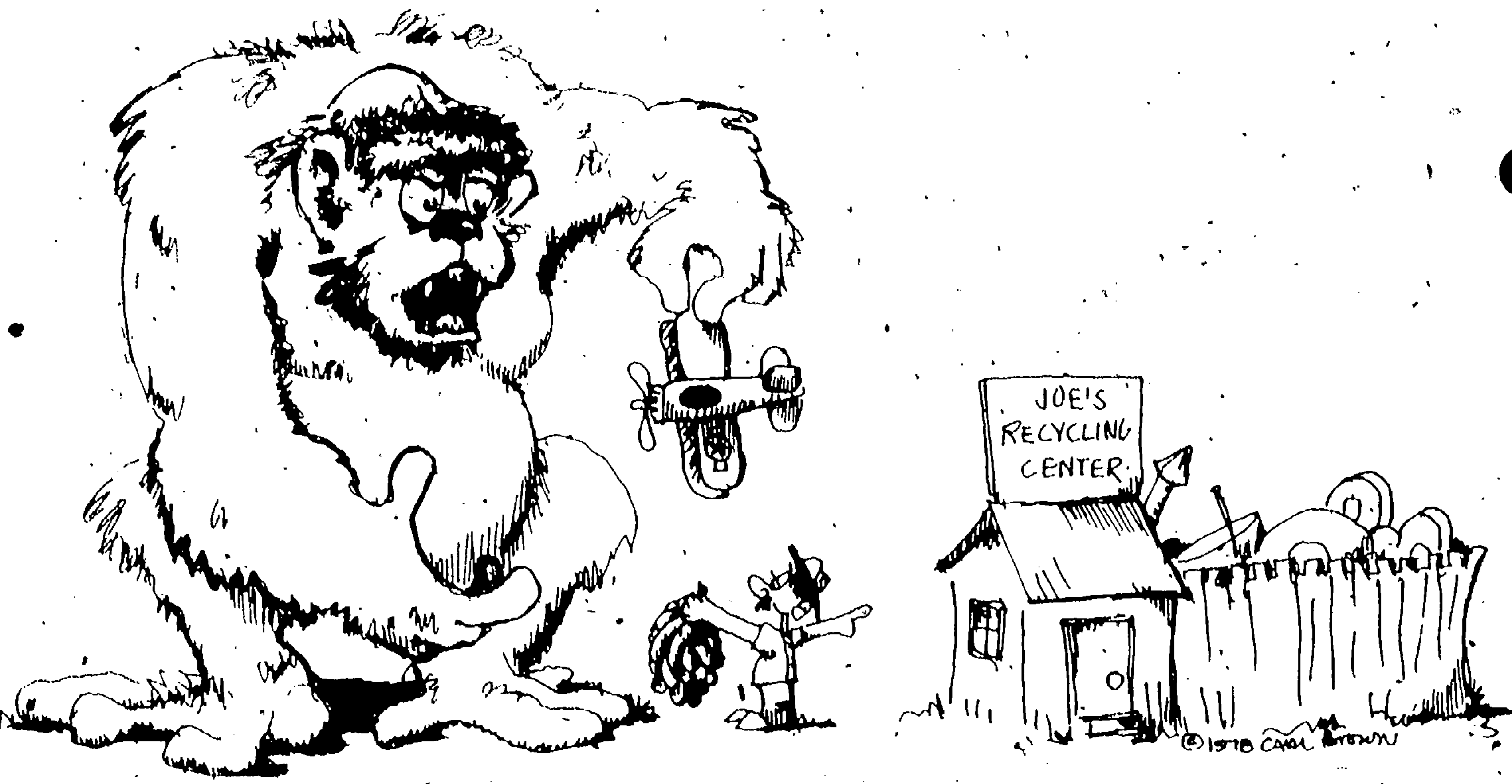

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"The Energy Crisis can be the most effective teaching aid of the decade."

S. David Freeman
Commissioner
Tennessee Valley Authority

INTRODUCTION

In recent years Idahoans have become increasingly concerned about the energy situation and aware of the importance of energy in our lives. Experts now tell us that unless some immediate steps are taken we will not be able to provide for our future energy needs as a nation. New research and technology can alleviate part of the problem but, more immediately, we must reduce energy use. An effective energy conservation program can result in substantial energy savings, extend the life of present energy supplies, and provide us the much-needed time to explore alternatives.

Traditionally, the educational system of our country has been called on to explore and resolve societal problems. The energy situation is a unique opportunity for educators since it reflects a complex set of problems that require changes in values, attitudes and lifestyles. The instructional program in a school can examine these problems and can assist in student awareness of the alternatives and consequences of energy decisions.

This resource guide has been prepared to assist teachers in incorporating energy concerns within the school curriculum. It is intended to provide a basic framework of objectives for different subject areas and to provide examples of activities for teaching towards the stated objectives. Resources are listed to aid the teacher in developing additional activities. It is anticipated that these materials will be a starting point and that teachers will go farther in this important area of instruction.

MATHEMATICS

Energy and mathematics are not mutually exclusive. Therefore, these activities should not be interpreted as an isolated energy unit in Mathematics. Rather, they should be incorporated into the total curriculum, across subject areas, wherever possible. Mathematics may be used to quantify or calculate energy topics. Or energy topics may be used to illustrate mathematics concepts.

The following mathematics skills and concepts are included in this unit:

1. Compute what fractional part one number is of another.
2. Compute fractional parts of whole numbers.
3. Express fractions in simplest forms.
4. Express an application as a proportion.
5. Solve a proportion.
6. Add, subtract, multiply and divide decimal numbers.
7. Write numbers in scientific notation.
8. Solve a percent problem.
9. Compute percent increase and decrease.
10. Construct and interpret line, bar and circle graphs.
11. Use metric measurement.
12. Apply statistics and probability concepts to energy problems.
13. Solve maxima-minima problems.
14. Solve algebraic equations and interpret formulae.
15. Apply mathematic skills to consumer-related problems.

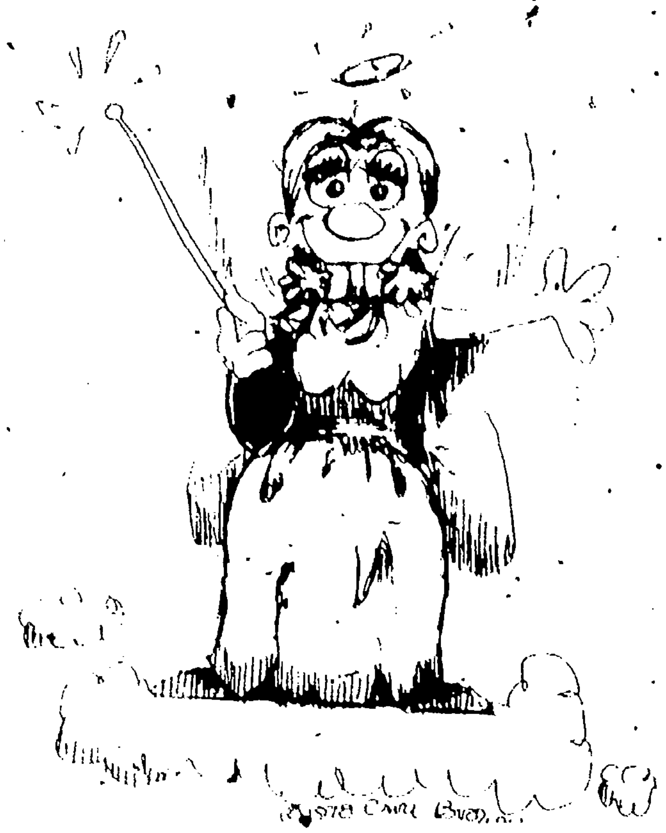
IDAHO ENERGY CONSERVATION RESOURCE GUIDE

PROJECT GOALS

This project has four goals. They are easily recalled by the the following acronymn:

LUV Energy Conservation

LUV represents the key words in the first three goals.



These key words are:

1. Laws
2. Use
3. Values

The fourth goal is Energy Conservation.

Goal 1. Natural LAWS determine the availability of energy.

There are conditions and limits to our use of energy. Activities under this goal describe what energy is, what forms it takes, and how it can be converted from one form to another. These activities emphasize that all earth's resources are limited.

Goal 2. USE of energy affects both people and their environment.

Everyone depends upon energy. Activities under this goal examine how energy use affects both our natural environment and our economic, political and cultural systems. These activities emphasize that energy use influences the lifestyle for both present and future generations. Lifestyle, in turn, is influenced by our choice of technology.

Goal 3. Our VALUES determine how we use energy.

Energy problems can not be solved by technology alone. Activities under this goal encourage us to analyze our personal energy habits and to accept the responsibility for our actions. They emphasize that changes in energy use and changes in values and attitudes are interrelated. These activities offer us some tools for gathering information, for making decisions, and for providing input to our economic, political and cultural systems.

Goal 4. ENERGY CONSERVATION is necessary to maintain our lifestyle.

There are both long-run and short-run solutions to energy problems. Activities under this goal encourage the development of both new energy sources and of more efficient ways to use energy. They emphasize that energy conservation is an effective and essential tool.

ENERGY ATTITUDE SURVEY

Teacher Note: Use this as a pre and post survey to see if the study of this material has affected change in student attitudes.

1. Do you believe there is an energy shortage? ___yes ___no ___don't know.

2. Do you believe you have been given a realistic picture of the energy situation facing the United States? ___yes ___no ___don't know

3. Do you believe most Americans are energy "wasters"? ___yes ___no ___don't know

4. Do you believe most Americans are energy "conservers"? ___yes ___no ___don't know

5. Do you believe Americans are "spoiled", self indulgent and reluctant to take responsibility for the future? ___yes ___no ___don't know

6. Do you believe it is the responsibility of every U.S. citizen to conserve energy voluntarily? ___yes ___no ___don't know

7. Do you believe Americans will conserve energy only when government controls are imposed? ___yes ___no ___don't know

8. Would you be willing to reduce your standard of living to conserve energy? ___yes ___no ___don't know

9. Do you believe you as an individual can make an impact on energy consumption? ___yes ___no ___don't know

10. Would you conserve energy to save money? ___yes ___no ___don't know

11. Do you think the money saved is worth in convenience of conserving energy? ___yes ___no ___don't know

12. Do you think the energy saved is worth the inconvenience of conserving energy? ___yes ___no ___don't know

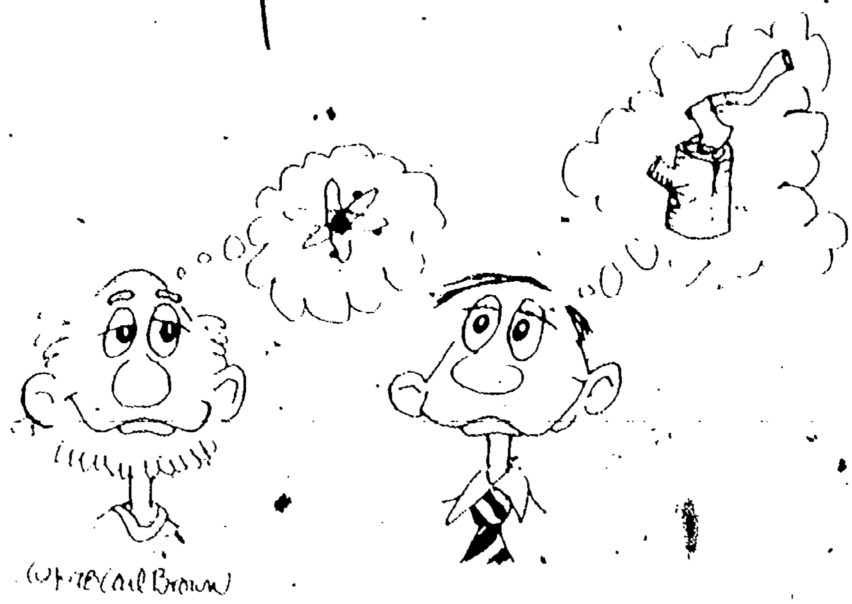
13. Do you feel technology will "bail us out" of the energy shortage? ___yes ___no ___don't know

14. Do you feel you have any input or participation in the energy usage decisions made by your family? ___yes ___no ___don't know

15. Are you going to <u>do</u> something to save energy? ___yes ___no ___don't know

Take a tally for the Energy Attitude Survey and find the percentages for each response.

GOAL 1: NATURAL LAWS DETERMINE THE AVAILABILITY OF ENERGY.



Activity 1: Sources of Energy

Objective: For the student to be able to describe different sources of energy and to explain the historical importance of each.

Resources:
1. The Energy Challenge
2. ERDA Fact Sheets
3. Local Utility companies

Procedure:
1. Students will research and report upon different sources of energy
2. Make a chart showing available resources in Idaho and present percentage amounts used each year.
3. Prepare a graph of one source of energy and use a "timeline" to show the known or probable beginning of that source and how it has been used over the past 200 years.

Activity 2 Wind Power

Objective: The student will be able to demonstrate that energy can be transformed from one form to another.

Resources: Library resources
Ask for information regarding use of wind energy.
Write to:
Public Information Division 3161
Sandia Laboratories
Albuquerque, New Mexico 87115

Procedure: This activity can be used to motivate the students to trace power (movement of air) back to its original energy source (the sun) and speculate on further uses of this mechanical energy.

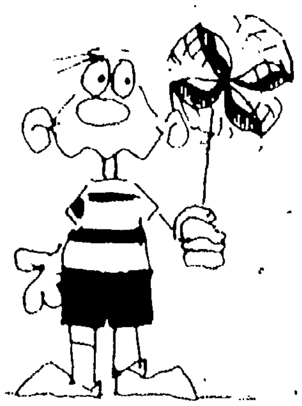
Since energy cannot be created or destroyed, let the students trace the energy pathway backwards as far as they can. We usually regard the sun as the ultimate energy source, but is the sun "creating" energy or just changing its form?

Have the students construct several pinwheels from plastic over-head projector sheets, a pin and a small stick (a pencil will do).

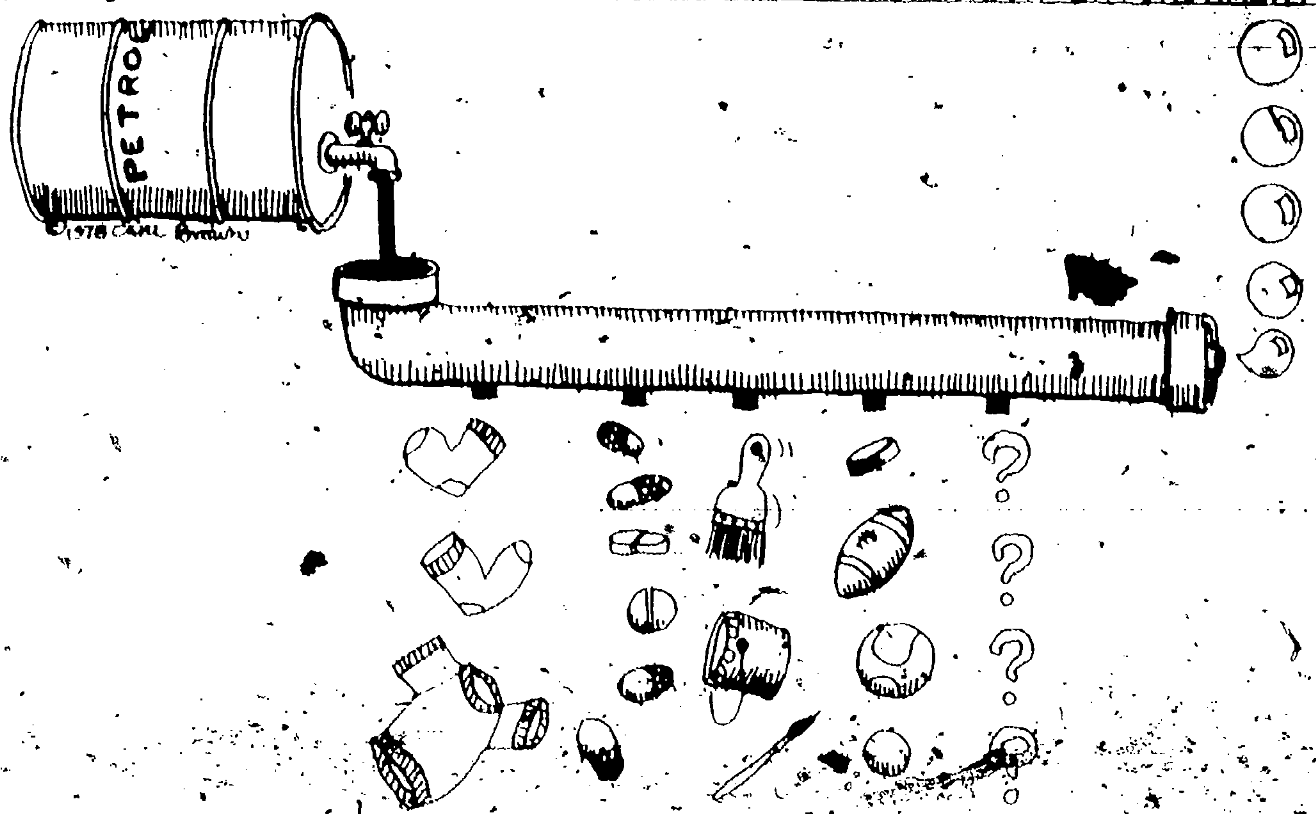
Go outside and demonstrate the production of mechanical energy. Look for the windiest spots on the school-yard and experiment with wind speed at various elevations such as on the fire escapes as opposed to ground level.

The rotating pinwheel is mechanical energy. In what ways can this energy now be used? LET THE STUDENTS USE THEIR IMAGINATIONS.

Discuss the following questions:
1. Can a house be supplied with all its energy from a giant pinwheel?
2. What are some problems involved with wind energy?



GOAL 2: USE OF ENERGY AFFECTS BOTH PEOPLE AND THEIR ENVIRONMENT.



Activity 1: Energy and World Economy

Objective: The student will be able to use graphs to help explain how the availability of energy influences world economy.

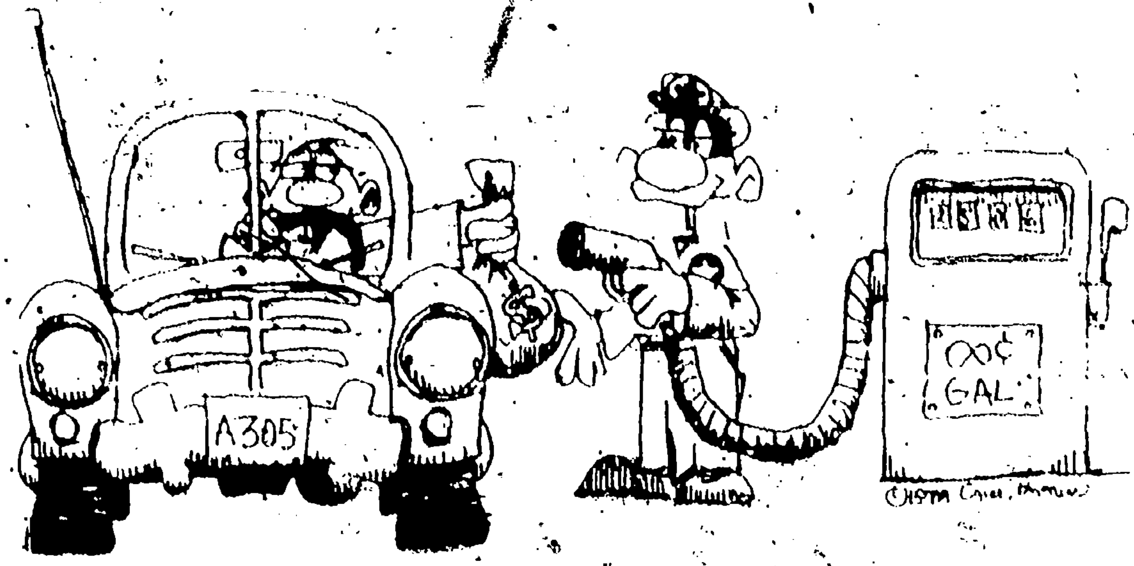
Resources:
1. U.S. Department of Commerce
2. Major Oil Company
3. Energy Administration
4. NSTA Fact Sheets
5. Magazines and Newspapers

Procedure: Study how foreign oil costs affect Americal prices.

1. Make a graph showing percentage amounts of oil from the Middle East and South America.

2. Follow one barrel of oil from well, through refinery and to consumer to show how cost to consumer is determined.

3. Discuss how foreign countries affect American economy by controlling the availability of energy. The following questions can help guide discussion:
   1. At present, which countries must influence our economy by controlling energy resources?
   2. Which countries will probably have the most influence in the future?
   3. What can we do to lessen the influence of foreign countries upon our economy?

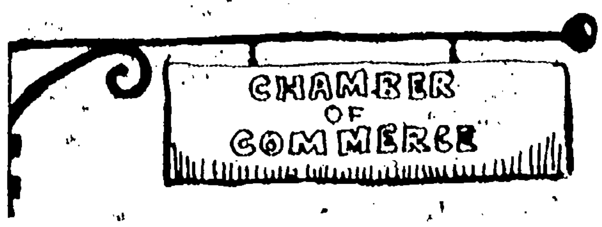


Activity 2: Energy and Local Economy

Objective: The student will be able to explain how the availability of energy influences local economy.

Resources:
1. Local Chamber of Commerce
2. Banks and Loan Companies
3. Moving Companies
4. Other community resources

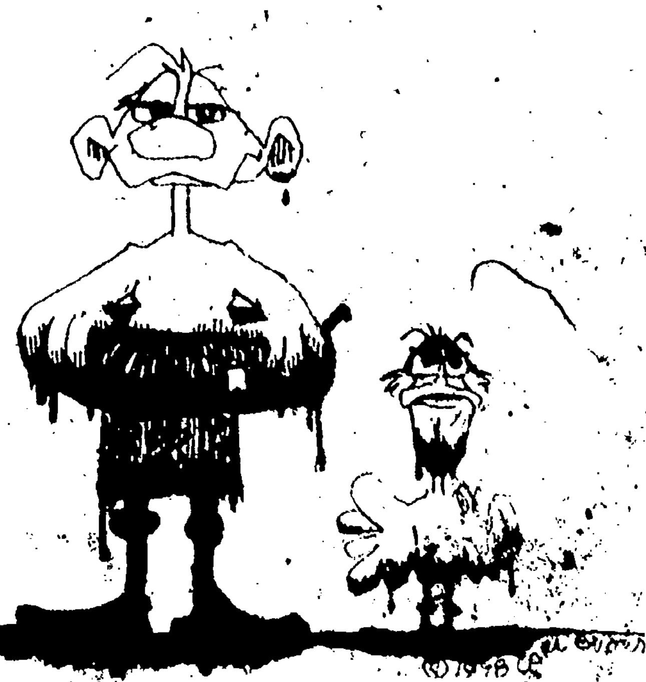
Procedure:
1. Assume your area is hit by "gas shortage". Compare good employment rate with possible employment rate with gas shortage. Discuss possible effects, such as:
   1. Stations close, etc.
   2. Residents move.
   3. Effect on stores, farms, travel



Related Activity:

Study the effects of an oil spill on a local small town on the coast.
a. fishing harmed for a year
b. tourist trade down
c. longterm economic effects

Example: Santa Barbara, California Chamber of Commerce



Activity 3: Energy and Wall Street

Objective: For the student to be able to use charts to help explain how the availability of energy influences Wall Street investment.

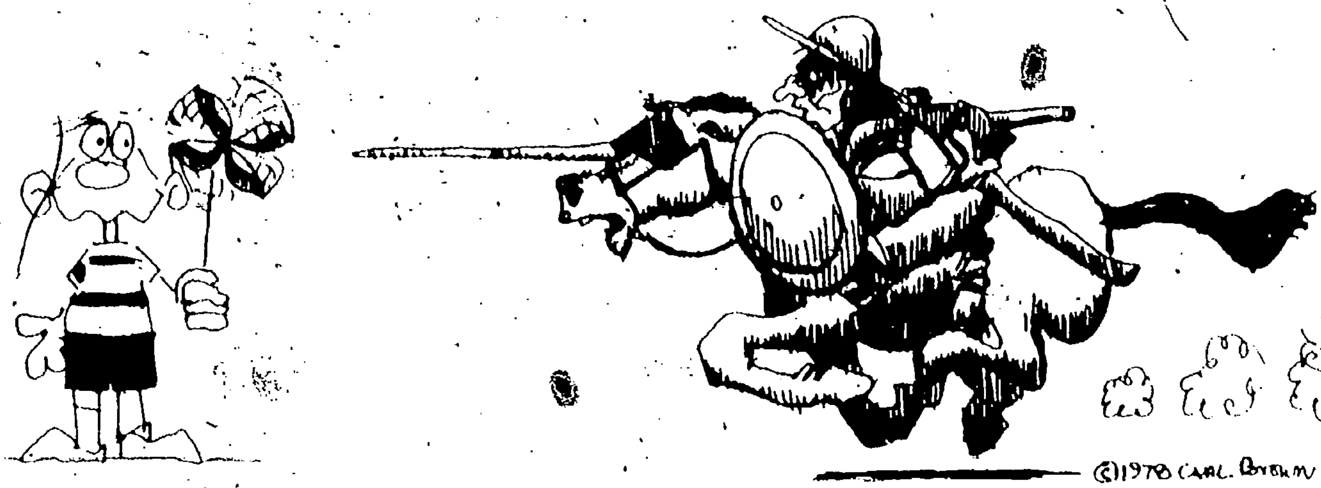
Resource: New York Stock Exchange of local investment company

Procedure: Study economics of Wall Street investors in time of crisis.

A. Compare charts of investments during "good times" and "crisis periods".

B. Discuss the following questions:

1. How can the availability of energy resources affect investments?
2. Which "good times" and "crisis" on your charts were related to the availability of energy?



Activity 4: Energy and The Individual

Objective: The student will be able to compute and explain how energy is used by different sectors of our economy.

Resource: EOM - 1028 U.S. Department of Energy, an Energy Education/Conservation Curriculum Guide for Home Economics Teachers (p. 7-11).

Procedure:

1. Prepare a circle graph indicating the percent of energy used by the industrial, transportation, residential, and commercial sectors

2. Calculate the percent of industrial energy utilized in each industrial end use

EX: $\frac{16.7}{41.2} = \frac{X}{100}$

$40.5 = X$

$\therefore$ 40.5% of industrial end use is process steam

3. From the calculations in activity 2, construct a circle graph indicating the percent of industrial energy dedicated to each industrial end use.

4. Prepare a circle graph indicating the percent of transportation energy consumed by each element.

5. Calculate the percent of residential energy utilized in each residential end use.

EX. $\frac{11.0}{19.2} = \frac{X}{100}$

$57.3 = X$

∴ 57.3% of residential end use is space heating

6. Prepare a circle graph of the calculation results in activity 5, indicating the percent of residential energy dedicated to each residential end use.

7. Calculate the percent of Commercial energy utilized in each commercial end use.

EX. $\frac{6.9}{14.4} = \frac{X}{100}$

$47.9 = X$

∴ 47.9% of commercial end use is for space heating

8. Prepare a circle graph of the calculation results in activity 7, indicating the percent of commercial energy dedicated to each commercial end use.

a. Discuss how the use of energy by different sectors of the economy affects the individual. The following questions can help guide discussion:

1. How do different sectors of the economy pass their cost of energy on to the individual?

2. How can the individual help keep down the cost of energy used by different sectors of the economy?

Examples include conservation, consumer advocacy and legislation.

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Activity 5: Energy and the Family

Objective: For the student to be able to calculate the importance of energy costs to the family budget.

Resources: 1. HCP/U3841-0002 Mathematics in Energy
2. Tips for Energy Savers

Procedure: Teachers note: This activity should be handled tactfully. Some families will not want to reveal their incomes. You can avoid this problem by using your income to illustrate the activity. Or you can "make-up? incomes for imaginary friends.

1. Given the yearly family income and the fractional part of the income spent on energy, calculate the amount of money spent on energy.

EX. Income = $14,000
Energy = 1/20

$$A = \frac{1}{20}(14,000)$$

$$A = \$700$$

2. Given net monthly income and the dollar amount spent for electricity, heat or gasoline, calculate the fractional part of the net income spent on these commodities.

EX. Net Inoome = $750
Electricity = $30

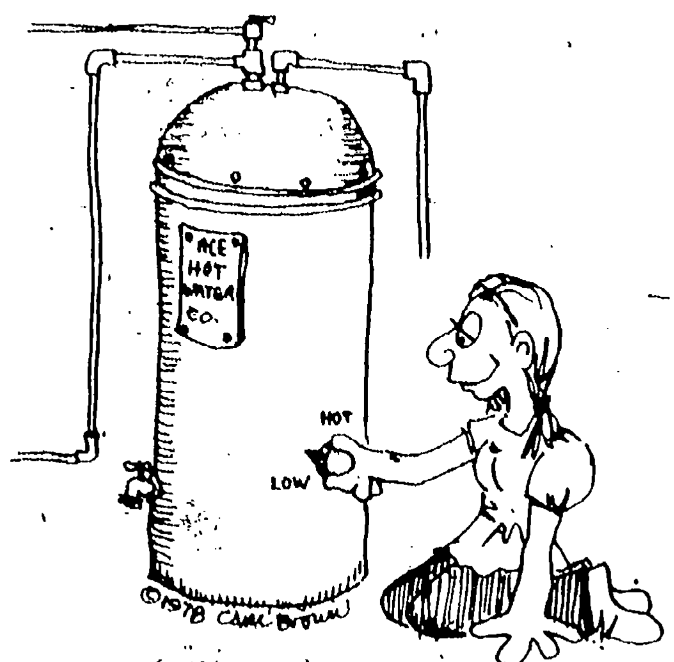
$$\frac{30}{750} = \frac{1}{X}$$

$$30X = 750$$

$$X = \frac{750}{30}$$

$$X = 25$$

$$1/25 = F.P.$$



3. Given energy consumption rations under different conditions, determine the percent increase or decrease.

EX. Electricity = $60 August
Electricity = $69 December

$$\frac{X}{100} = \frac{69 - 60}{60}$$

$X = 15$

$\therefore$ 15% increase

4. Discuss how families can reduce their consumption of energy. Students can explain techniques used successfully by their own families.

Related Activities

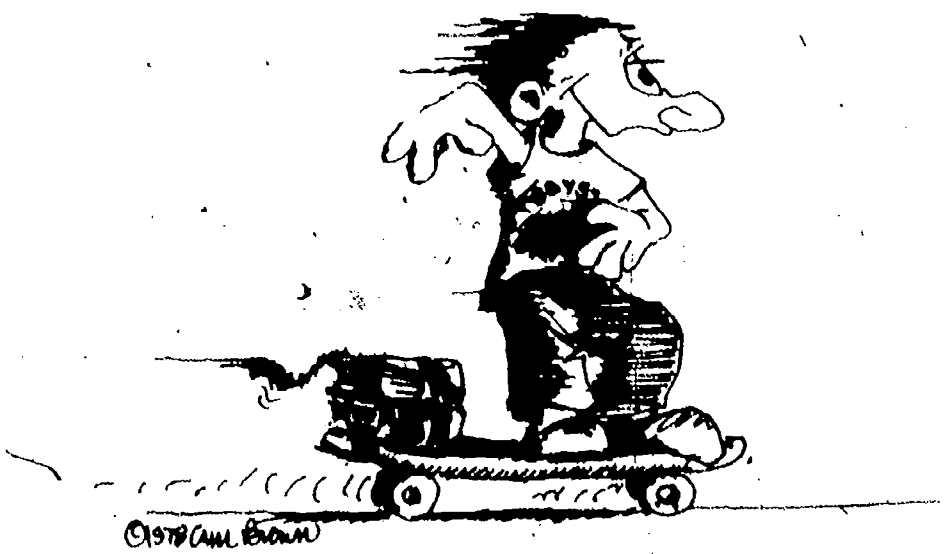
1. Given a bar graph indicating the percentage of energy converted to useful work for different sources, determine the most efficient and least efficient sources.

2. Given a line graph comparing fuel consumption with speed, determine the speeds for least consumption and greatest consumption.

3. Given the percentages of total residential energy consumed by household appliances, construct a bar graph of the information.

4. Given the average population of each of the past five decades and the average energy consumption of each decade, compute the percent increase in energy use per capita between any two decades.

5. Given the odometer reading at the beginning of one tank fill and the beginning of a second fill, and the quantity of the second fill, compute the miles per gallon or kilometers per liter.



GOAL 3: OUR VALUES DETERMINE HOW WE USE ENERGY.

Activity 1 — Energy and Values

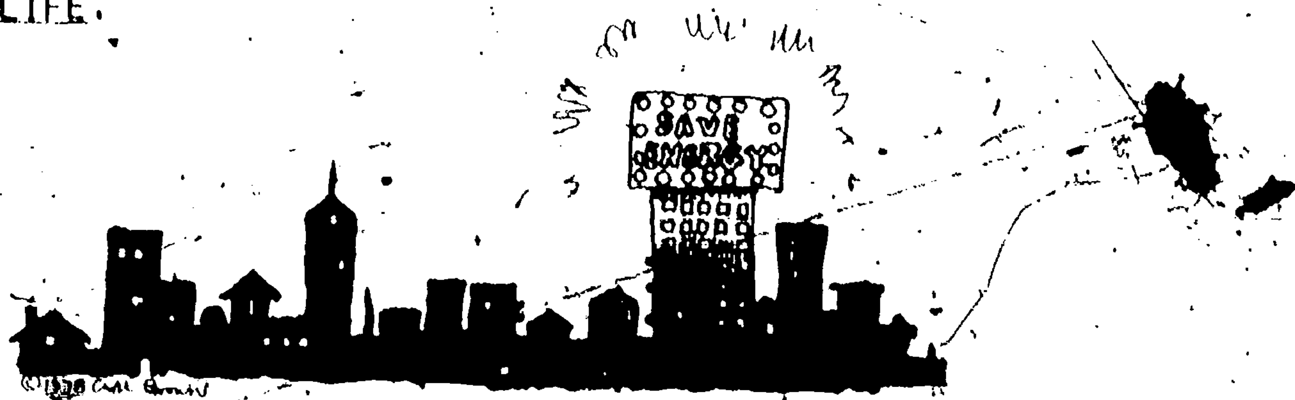
Objective: For the student to be able to explain, on the basis of mathematical trends, how values and attitudes influence energy consumption.

Resource: Energy and Conservation Education
Energy and Man's Environment
Outlook for Energy in the United States to 1985, Chase Manhatten Bank, 1972.

Procedure:

1. The student will research United States population for each five year period from 1940 through 1975, construct a bar graph of the populations for each of these periods, and project population figures for 1980 and 1985.
2. The student will research yearly consumption of barrels of oil by the United States for each five year period from 1940 through 1975, construct a bar graph of consumption for each of these periods, and project consumption figures for 1980 and 1985.
3. Using the figures from Parts 1 and 2, calculate the per capita consumption for each of the five year periods from 1940 through 1975 and project per capita figures for 1980 and 1985.
4. Discuss how the following variables influence our values and attitudes toward energy resources:
   1. Population density
   2. Per capita consumption
   3. Availability of energy
5. Discuss what changes in values and attitudes are needed to reduce per capita consumption of energy.
6. Discuss how people can be encouraged to change their values and attitudes toward energy use.

GOAL 4: ENERGY CONSERVATION IS NECESSARY TO MAINTAIN OUR QUALITY OF LIFE.



Activity Group I. The Need to Conserve Energy

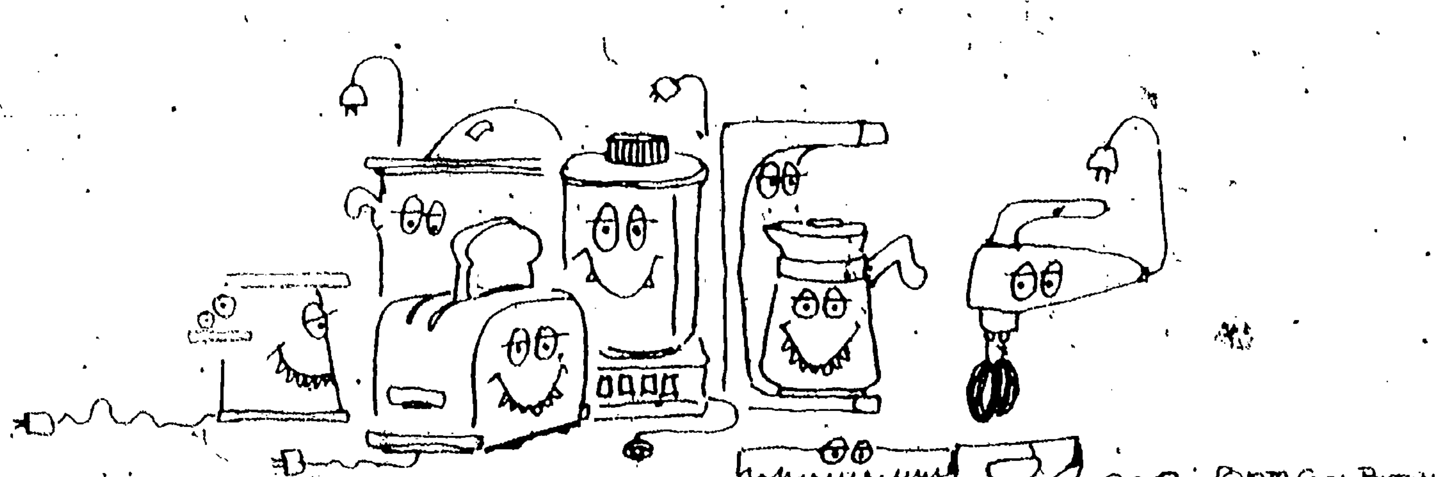
Objective: The student will be able to explain, on the basis of mathematical calculations, the needs for energy conservation.

Resources:
1. ERDA Fact Sheets
2. Mathematics in Energy
3. Energy Conservation in the Home
4. Energy & Man's Environment

Procedure: The following groups of activities address the state objective. The teacher should encourage discussion about the need for energy conservation.

Activity 1 The Energy Environment Simulator is a small computer that indicates various amounts of different resources needed to have environmental harmony.
Students control rate of resource use. Simulator indicates length of availability.
Air quality is a controlled variable.
The Energy Environment Simulator is available through the Mathematics Department of Boise State University.

Activity 2 Have students list energy-using devices in home. Discuss how energy could be saved by using these devices less or in a more efficient manner.



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Activity 3 Topics for class discussion:

A. The U.S. has 6% of the world's population and uses over 50% of all raw materials in the world. We need 29 minerals and we import 18. What happens in other countries is very important to us. Why?

B. Local resource problems are everywhere; how does tourism, urbanization, pollution, zoning, and planning affect your home town?

C. As world populations increase and higher standards of living develop, it becomes vital to practice conservation of natural resources.

Activity 4 Resource: Mathematics in Energy NSTA pp. 31-32 and 63.

The following problems deal with population and energy consumption in the United States from 1920-1979.

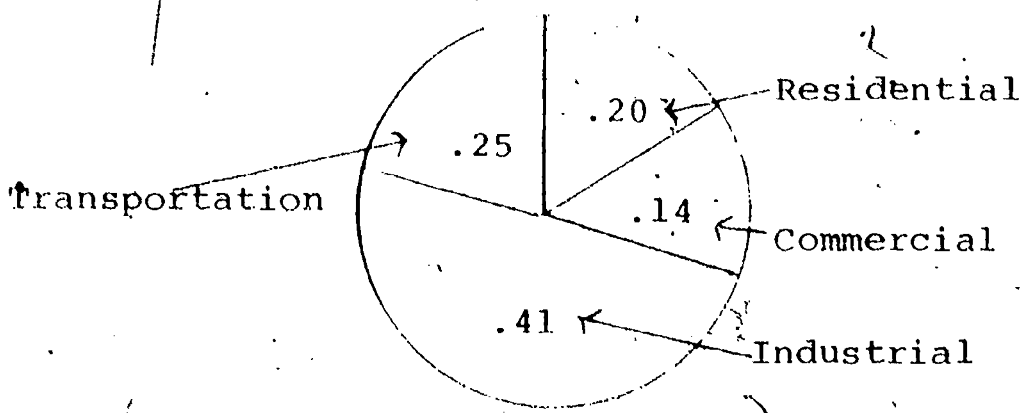
A. Make a bar graph showing population for each decade.

B. Do research to discover per capita energy consumption for each decade.

C. Project energy consumption per capita from 1970-1980.

D. Project (estimate) population of 1980.

Activity 5 The circle graph below shows a breakdown of energy consumption by decimal part in the U.S.



Total U.S. energy consumption was approximately $18.7\% \times 10^{15}$ calories in 1976. Using the decimal parts given in the graph, calculate the number of calories used in each category.

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Activity Group 2: Ways to conserve energy

Objective: The student will be able to explain, on the basis of mathematical calculations, the effectiveness of different ways of conserving energy.

Resources:
1. Mathematics in Energy
2. Transportation and the City (Activity #9)

Procedure: The following group of activities address the stated objective. The teacher should encourage discussion about the following:

1. How energy conservation affects the student
2. How the student can bet started on his/her own energy conservation program.

Activity 6

Given the average fuel consumption for an uninsulated home, and the average consumption for an insulated home, determine the percent decrease in consumption.

EX: Insulated = 900 Gallons Oil
Uninsulated = 1600 Gallons Oil

$$\frac{X}{100} = \frac{1600 - 900}{1600}$$

X = 43.75%

Activity 7

Given national potential energy savings in 10^{15} calories:

Thermostat set back (68° day/60° night)	.37
Water heating (120°)	.15
Air Conditioning (78°)	.03
Hot water use (1/3)	.12
Furnace Tune-up	.15
Air Conditioner Tune-up	.23
Insulated ceilings	.18
Weather stripping	.08
Storm Windows & Doors	.04

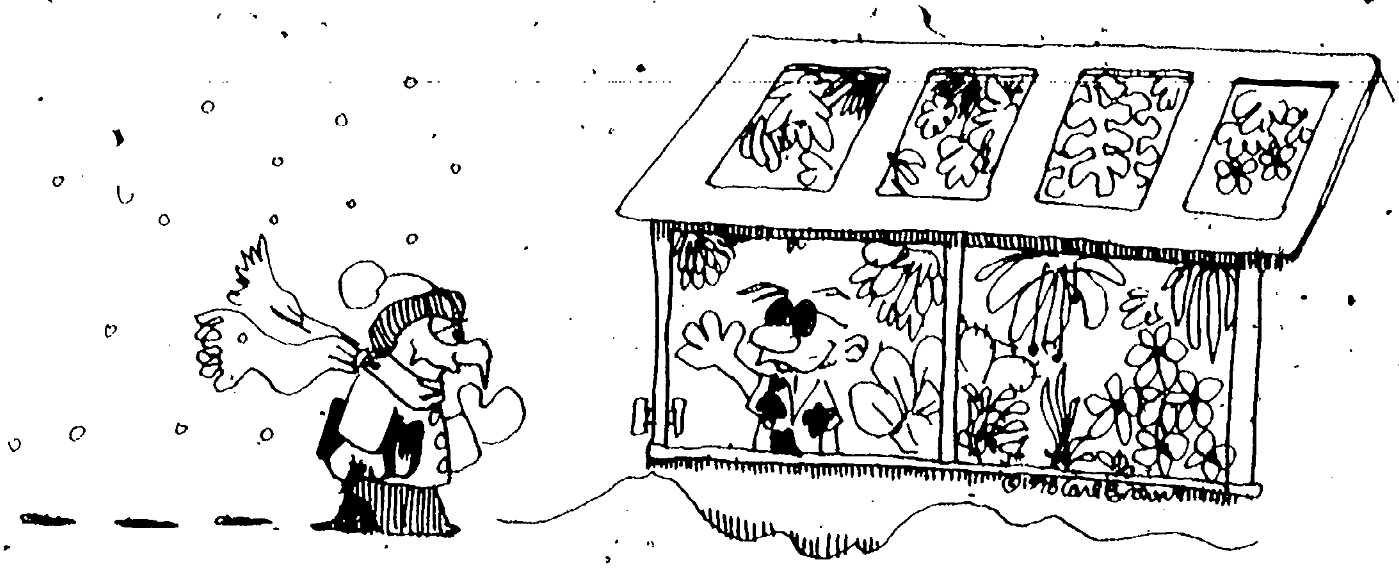
Determine the number of calories (in scientific notation) saved by each action and the total number of calories saved.

Activity 8 — Given the roof areas of two buildings and the number of calories solar energy received by one, determine the amount of solar energy received by the other.

EX. Roof 1 = 1600 sq. feet
Roof 2 = 1200 sq. feet
1.5×10^9 cal/year

$$\frac{X}{1600} = \frac{1.5 \times 10^9}{1200}$$

$X = 2 \times 10^9$ cal/year



Activity 9 — Given the percent reduction in utility bills from the installation of solar heating panels, the current utility bill, and the cost of the installed solar unit, determine:

a - the new projected utility bill
b - time required to pay for the solar unit

EX: Solar cost = \$5000
Current bill = \$700/year
Bill Reduction = 60%

a - projected new bill = .40 (700)
= \$280

$$b - \text{time} = \frac{5000}{700-280}$$

= 12 years

Activity 10 Given gasoline consumption rates at different speeds, trip length, and per gallon price, determine total consumption and cost for the trip at different rates of speed.

Activity 11 Given the miles per gallon consumption figures for two automobiles and trip mileage calculate the percent increase or percent decrease in fuel consumption.

EX. Auto 1 = 10 m.p.g.
Auto 2 = 12.5 m.p.g.

$$\text{Comsumption 1} = \frac{200}{10} = 20 \text{ gal.}$$

$$\text{Consumption 2} = \frac{200}{12.5} = 16 \text{ gal.}$$

$$\frac{X}{100} = \frac{20-16}{20}$$

X = 20% decrease

Activity 12 Given the miles per gallon consumption figures for an automobile before and after tune-up, determine the percent increase in mileage.

Activity 13 Given the percent increase in mileage from a drop in speed, and the mileage at one speed, determine the mileage at the other speed.

EX. Drop in speed: 70 mph ---- 50 mph
Increased mileage = 20%
70 mph ------ 25 mpg

Determine: mpg at 50 mph
X = 25 + .20 (25)
X = 30 mpg

Activity 14 Given the following type table:

Mode	Number	MPG	Gal/20mi.	PMPG
car	1	18	1.11	1.11
car	2	18	______	______
car	4	18	______	______
van	1	16	1.25	______
van	2	16	______	______
van	8	16	______	______
bus	5	3.3	6.1	______
bus	20	3.3	______	______
bus	40	3.3	______	______
train	1000	.1	200	______
plane	100	.25	______	______

Calculate the missing amounts.

DEFINITIONS AND ENERGY EQUIVALENTS

Definitions

barrel : A liquid volume measure equal to 42 gallons (about 5.6 cubic feet).

billion : One thousand million, or 10^9.

BTU : "British Thermal Unit", the amount of heat energy that must be supplied to one pound of water to raise its temperature through one Fahrenheit degree. It takes about 74 BTUs to bring one cup (8 fluid oz.) of water from room temperature (70°F) to its boiling temperature (212°F).

Calorie (calorie) : See kilocalorie, below.

fossil fuel : Any naturally occurring fuel of an organic nature -- usually used to describe coal, crude oil, and natural gas.

heat rate : A way of expressing the thermal efficiency (see below) of electric power plants: equal to ratio of BTU input (from primary fuel) to kilowatt-hour output (electricity).

kilocalorie : A unit of energy, often written as "Calorie" in food-science literature, equal to 3.969 BTU (one calorie = 0.001 Calorie). Per capita food energy consumed in the U.S. in 1970 averaged 3300 Calories.

kilowatt (kw): A unit of power, equal to 1000 watts, or 0.948 BTU per second.

kilowatt-hour (kwh) : A unit of energy, equivalent to 3,413 BTU (0.948 BTU per second times 3,600 seconds.)

megawatt (Mw): A unit of power, equal to 1000 kilowatts, or 1,000,000 watts.

quadrillion : One thousand trillion, or 10^{15}.

therm : Used somewhat interchangeably to mean either 100 cubic feet of natural gas, or 100,000 BTU.

thermal efficiency : The ratio of the energy delivered by a process to the energy extracted from the primary fuel feeding the process; both input and output are usually expressed in BUTs, and the ratio as a percentage (necessarily less than 100).

ton : Used here to mean a "short ton," or 2,000 pounds.

trillion : One thousand billion, or 10^{12}.

watt : A unit of power, most often applied to electricity. A power of one watt implies energy is being consumed at the rate of 0.000948 BTU per second.

ENERGY EQUIVALENTS

crude oil : 5.8 million BTU per barrel (138,000 BTU per gallon) combustion energy.

natural gas : 1,032 BTU combustion energy per cubic foot.

coal : 13,000 to 10,000 BTU combustion energy per pound, depending upon type (bituminous and anthracite the higher figure, lignite and sub-bituminous the lower).

gasoline : Approximately 125,000 BTU combustion energy per gallon.

One quadrillion (10^{15}) BTU per year is equivalent to burning 472,000 barrels of oil, or 2,660 million cubic feet of natural gas or 130,000 tons of coal per day.

Nine super oil tankers (250,000 "dead-weight tons") carry oil with a combustion energy equivalent of roughly one quadrillion BTU.[12]

The energy available from fissioning one ton of uranium ore (U_3O_8) in a burner reactor is 0.56 trillion BTU.[12]

Strip mining yields, on the average, about 5,000 tons of coal per acre. (A "good" acre can yield as high as 25,000 tons, but the area substantially affected by the stripping may be three to five acres.) Surface mines in the west, with thick seams, often yield approximately 10,000 tons per acre.

GLOSSARY

ACCELERATION. The time rate of change of velocity in either speed or direction.

ALTERNATING CURRENT (AC). An electric current whose direction of flow is changed at periodic intervals (many times per second).

ATOM. The smallest particle of an element which can enter into a chemical combination. All chemical compounds are formed of atoms, the difference between compounds being attributable to the nature, number, and arrangement of their constituent atoms.

ATOMIC ENERGY. The constitutive internal energy of the atom which was absorbed when it was formed; energy derived from the mass converted into energy in nuclear transformation.

BLACKOUT. A total power failure caused unintentionally by storm damage, equipment failure, or overloaded utility equipment. An exceptional situation in which all power is deliberately cut off by electrical generating facilities.

BLANKET INSULATION. Cotton fiber, mineral wool, or wool fiber made into varying thicknesses in a length.

COAL. Solid, combustible, organic hydrocarbon formed by the decomposition of vegetable material without free access to air.

COAL GASIFICATION. The conversion of coal to a gas suitable for use as a fuel.

COMBUSTION. Burning; technically, a rapid oxidation accompanied by the release of energy in the form of heat and light. It is one of the three basic contributing factors causing air pollution. The others are attrition and vaporization.

COMFORT ZONE. The proper temperature, humidity, and air movement to create a feeling of comfort.

CONDUCTOR (ELECTRICAL) A material capable of carrying an electric current.

CONSERVATION. The care or management of natural resources.

CONSERVATION OF MATTER AND ENERGY (LAW OF). The sum of the potential and kinetic energy of an ideal energy system remains constant.

CONSERVE. To manage or use wisely.

CONVECTION. The transfer of energy by moving masses of matter, such as the circulation of a liquid or gas.

CONVENTIONAL HYDROELECTRIC PLANT. A hydroelectric power plant that utilizes streamflow only once as the water passes downstream, as opposed to a pump-storage plant which recirculates all or a portion of the streamflow in the production of power.

CRUDE OIL. Liquid fuel formed from the fossils of animals and plants; petroleum as it comes from the ground.

CURRENT (ELECTRIC). The rate of transfer of electricity.

CURTAILMENT. Cutting back the use of energy resources as opposed to conserving or wisely using energy resources.

DIRECT CURRENT (DC). An electric current that flows in only one direction through a circuit.

DIRECT ENERGY CONVERSION. The process of changing any other form of energy into electricity without machinery that has moving parts. For example, a battery changes chemical energy into electricity by direct energy conversion.

DOUBLE GLAZED WINDOW. Two panes of glass factory-sealed together with a small air space between them. Double glazing has about twice the R-value of single glazing.

EFFICIENCY. The ratio of the useful work performed to the amount of energy used in the process.

ELECTRICAL ENERGY. The energy associated with electric charges and their movements. Measured in watt hours and kilowatt hours. One watt-hour equals 860 calories.

ELECTROCHEMICAL CELL. A cell in which chemical energy is converted to electric energy by a spontaneous oxidation-reduction reaction.

ELECTRON. The electron is a small particle having a unit of negative electrical charge, a small mass, and a small diameter. Every atom consists of one nucleus and one or more electrons.

ELEMENTS. Elements are substances which cannot be decomposed by the ordinary types of chemical change, or made by chemical union.

ENERGY. The capability of doing work. Potential energy is energy due to position of one body with respect to another or relative parts of the same body. Kinetic energy is due to motion.

ENTROPY. Entropy is the capacity factor for isothermally unavailable energy. Every spontaneous process in nature is characterized by an increase in the total entropy of the bodies concerned in the process.

ENVIRONMENT. The sum of all external conditions and influences affecting the life, development, and ultimately the survival of an organism.

FIRST LAW OF THERMODYNAMICS. (Also called the Law of Conservation of Energy). Energy can be neither created nor destroyed.

FISSION. A nuclear reaction from which the atoms produced are each approximately half the mass of the parent nucleus. In other words, the atom is split into two approximately equal masses. There is also the emission of extremely great quantities of energy since the sum of the masses of the two new atoms is less than the mass of the parent heavy atom. The energy released is expressed by Einstein's equation, E = Mc2.

FLYWHEEL. A method of energy storage working on the principle of a spinning wheel. By its inertia, a spinning wheel stores mechanical energy.

FOAM INSULATION. (1) Styrofoam; (2) Rigid foam boards; or (3) Liquid foam insulation.

FOSSIL FUELS. Coal, oil, natural gas, and other fuels originating from geologic deposits of ancient plant and animal life depending on exidation for release of energy.

FUEL. A substance used to produce heat energy, chemical energy by combustion, or nuclear energy by nuclear fission.

FUEL CELL. A device in which fuel and oxygen are combined to produce chemical energy that is converted directly into electricity.

FUSION (ATOMIC). A nuclear reaction involving the combination of smaller atomic nuclei or particles into larger ones with the release of energy from mass transformation. This is also called a thermonuclear reaction by reason of the extremely high temperature required to initiate it.

FUSION. A reaction in which light nuclei combine to form an atom with greater mass.

GAS. A state of matter in which the molecules are practically unrestricted by cohesive forces. A gas has neither definite shape nor volume.

GASOLINE. Mixture of hydrocarbons obtained from petroleum.

GENERATOR. A device that converts heat or mechanical energy into electrical energy.

GEOTHERMAL. As applied to power generation, the use of heat energy obtained through the medium of hot water or steam coming from beneath the earth's surface.

GEOTHERMAL ENERGY. The heat energy available in the earth's subsurface believed to have been produced by natural radioactivity. The thermal gradient of the earth's crust is such that the temperature in a deep well or mine increases by about $1^{o}F$ for each 100 feet of depth.

GRAM. A unit of mass in the metric system; 10^{-3} standard kilogram.

GREENHOUSE EFFECT. A method of using solar radiation to warm underheated areas (window treatments are opened to allow the window to admit and trap the sun's heat).

GROSS NATIONAL PRODUCT (GNP). A measure of economic activity which is the total market value of all goods and services produced in a country. Depreciation and other allowances for capital consumption are not deducted.

HEAT. Energy possessed by a substance in the form of kinetic energy, usually measured in calories or, in space heating, by the British thermal unit. Heat is transmitted by conduction, convection, or radiation.

HEAT CAPACITY. The quantity of heat required to increase the temperature of a system or substance one degree of temperature. It is usually expressed in calories per degree Celsius.

HEAT ENERGY. Energy that causes an increase in the temperature of an object. It may change the object from solid to liquid or from liquid to gas.

HEAT PUMP. A device that absorbs heat from the outside air and pumps it into the house. It works in reverse as a standard air conditioner for cooling.

HORSEPOWER. A unit that measures the rate at which energy is produced or used. A man doing heavy manual labor produces energy at the rate of about .08 horsepower.

HYDROELECTRIC PLANT. An electric power plant in which the turbine-generators are driven by falling water.

HYDROELECTRICITY. Electricity production by water-powered turbine generator.

HYDROLOGY. The science dealing with the properties, distribution, and circulation of water and snow.

HYDROPOWER. Power by falling water.

INSULATION. A substance that insulates is one that can slow down the flow of heat or sound.

INTERNAL COMBUSTION ENGINE. Energy is supplied by a burning fuel which is directly transformed into mechanical energy by controlled combustion.

JOULE. A metric unit of work or energy; the energy produced by a force of one newton operating through a distance of one meter.

KILOCALORIE. Heat energy equal to 4.19×10^3 joules.

KILOVOLT (KV). 1,000 volts.

KILOWATT (KW). The unit of power equal to 1,000 watts, 3.413 BTUs, or 1,341 horsepower. Roughly, the power of one kw is capable of raising the temperature of a pound (pint) of water 1°F in one second.

KILOWATT-HOUR (KWH). The amount of work or energy delivered during the steady consumption of one kilowatt of power for a period of one hour; equivalent to 3,412 BTUs.

LIGHT. Radiant energy which an observer can see.

LIQUIFIED NATURAL GAS (LNG). Natural gas that has been changed into a liquid by cooling to about -260°F (-160°C) at which point it occupies about 1/600 of its gaseous volume at normal atmospheric pressure; thus, the cost of shipping and storage is reduced.

MECHANICAL ENERGY. The kind of energy that is released to make objects move.

MEGAWATT (MW). A unit of power equal to 1,000 kilowatts or one million watts.

METHANE. Colorless, nonpoisonous, and flammable gaseous hydro-carbon; emitted by marshes and by dumps undergoing decomposition.

NATURAL GAS. Naturally-occurring mixtures of hydrocarbon gases and vapors occurring naturally in certain geologic formations; usually found associated with oil.

NONRENEWABLE RESOURCES. Depletable energy resources such as the fossil fuels -- coal, gas and oil.

NUCLEAR ELECTRIC POWER PLANT. One in which heat for raising steam is provided by fission rather than combustion of fossil fuel.

NUCLEAR (ATOMIC) FUEL. Material containing fissionable uranium of such composition and enrichment that, when placed in a nuclear reactor, will support a self-sustaining fission chain reaction and produce heat in a controlled manner for process use.

NUCLEAR POWER. Electric power produced from a power plant by converting the energy obtained from nuclear reaction.

NUCLEAR POWER PLANT. Any device, machine, or assembly that converts nuclear energy into some form of useful power, such as nechanical or electrical power. In a nuclear electric power plant, heat produced by a reactor is generally used to make steam to drive a turbine that, in turn, drives an electric generator.

NUCLEAR REACTION. A reaction involving a change in an atomic nucleus, such as fission, fusion, neutron capture, or radio-active decay, as distinct from a chemical reaction, which is limited to changes in eletron structure surrounding the nucleus.

OFF-PEAK. Energy supplied during periods of relatively low system demands.

OIL SHALE. Sedimentary rock containing solid organic matter (kerogen) that yields substantial amounts of oil when heated to high temperatures.

OIL SPILL. The accidental discharge of oil into oceans, bays or inland waterways. Methods of oil spill control include chemical dispersion, combustion, mechanical containment, and absorption.

OPEC (Organization of Petroleum Exporting Countries). An organization of countries in the Middle East, North Africa, and South America which aims at developing common oil-marketing policies.

PEAKING. Power plant operation to meet the highest portion of the daily load.

PEAKING CAPABILITY. The maximum peak load that can be supplied by a generating unit, station, or system in a stated period of time. For a hydroproject, the peaking capability would be equal to the maximum plant capability only under favorable pool and flow conditions. Often the peaking capability may be less due to reservoir drawdown or tailwater encroachment.

POWER. The time rate at which work is done. If an amount of work (w) is done in time (t) the power or rate of doing work is $P = w/t$. Power will be obtained in watts if w is expressed in joules and t in seconds.

PUMPED HYDROELECTRIC STORAGE. The only means now available for the large-scale storage of electrical energy. Excess electricity produced during periods of low demand is used to pump water up to a reservoir. When demand is high, the water is released to operate a hydroelectric generator. Pumped energy storage only returns about 66 percent of the electrical energy put into it, but costs less than an equivalent generating capacity.

PUMPED STORAGE PLANT. A hydroelectric power plant which generates electric energy for peak load use by utilizing water pumped into an elevated storage reservoir during off-peak periods.

R-VALUE. Thermal resistance; computed by the conductivity divided into one. The measure of resistance to heat flow.

RECLAMATION. Act or process of reclaiming; for example, stripmined land should be reclaimed -- replanted and leveled.

RENEWABLE RESOURCES. Non depletable resources; for example, the sun.

RESERVES. The amount of a natural resource known to exist and expected to be recovered by present-day techniques.

RESOURCES. The estimated total quantity of a natural resource such as minerals in the ground; includes undiscovered mineral reserves.

SECOND LAW OF THERMODYNAMICS. One of the two "limit" laws which govern the conversion of energy. Referred to here as the "heat tax", it can be stated in several equivalent forms, all of which describe the inevitable passage of some energy from a useful to a less useful form in any energy conversion.

SOLAR CELL. A photovoltaic cell which converts radiant energy from the sun into electrical energy.

SOLAR ENERGY. Radiation energy from the sun falling upon the earth's surface.

SOLID WASTE. Useless, unwanted, or discarded material with insufficient liquid content to be free flowing.

STATIC ELECTRICITY. Electricity at rest.

STEAM-ELECTRIC PLANT. A plant in which the prime movers (turbines) connected to the generators are driven by steam.

STOCKPILE. A storage pile or reserve supply of an essential raw material; for example, coal is stockpiled in the open air for storage purposes.

STRIP-MINING. A process in which rock and topsoil strata overlying ore or fuel deposits are scraped away by mechanical shovels. Also known as surface mining.

TECHNOLOGY. Applied science.

THERMAL EFFICIENCY. The ratio of the electric power produced by a power plant to the amount of heat produced by the fuel; a measure of the efficiency with which the plant converts thermal to electrical energy.

THERMAL ENERGY. The total potential and kinetic energy associated with the random motions of the particles of a material.

THERMAL PLANT. A generating plant which converts heat energy to electrical energy. Such plants may burn coal, gas, oil, or use nuclear energy to produce thermal energy.

THERMAL POLLUTION. Degradation of water quality by the introduction of a heated effluent. Primarily a result of the discharge of cooling waters from industrial processes, particularly from electrical power generation.

THERMODYNAMICS. The science and study of the relationship between heat and mechanical work.

TRANSMISSION. The act or process of transporting electric energy in bulk from a source or sources of supply to other utility systems.

TRANSMISSION LINES. Wires or cables through which high voltage electric power is moved from point to point.

TURBINE. A motor, the shaft of which is rotated by a stream of water, steam, air, or fluid from a nozzle and forced against the blades of a wheel.

VAPOR. The words vapor and gas are often used interchangeably. Vapor is more frequently used for a substance which, though present in the gaseous phase, generally exists as a solid or liquid at room temperature. Gas is more frequently used for a substance that generally exists in the gaseous phase at room temperature.

VAPORIZATION. The change of a substance from a liquid or solid state to the gaseous state. One of three contributing factors to air pollution; the other are attrition and combustion.

VOLT. The unit of electromotive force. It is the difference in potential required to make a current flow through a resistance.

VOLTAGE. The amount of force employed to move a quantity of electricity; measured in volts.

WATER VAPOR. Water in the form of a gas.

WATT (W). A unit of measure for electric power equal to the transfer of one joule of energy per second. The watt is the unit of power most often associated with electricity (1 horsepower = 746 watts) determined by multiplying required volts by required amperes (volts x amps = watts).

WEATHERSTRIPPING. Reduces the rate of air infiltration by making sure that all doors and windows fit their frames snugly.

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