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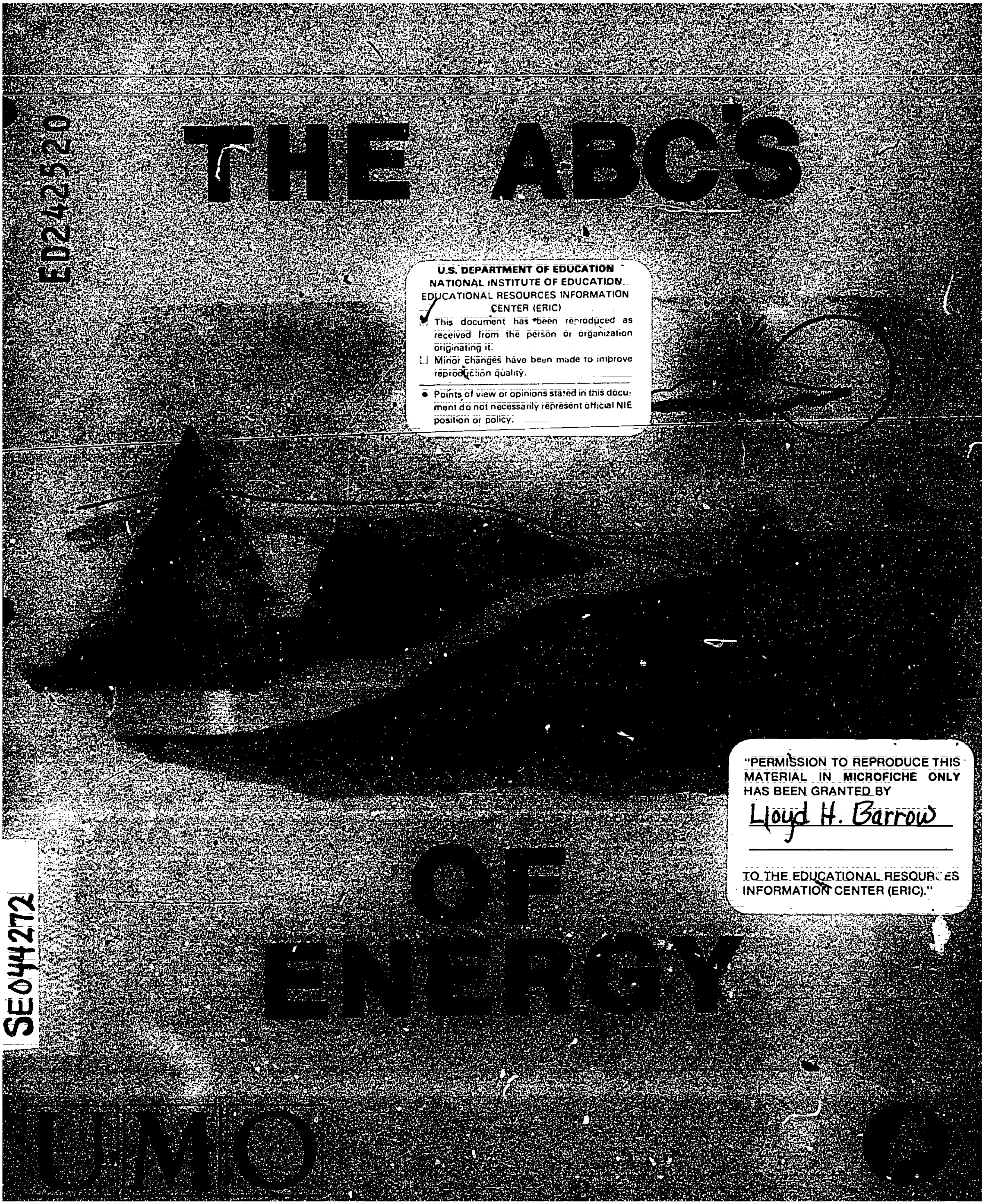
ABSTRACT

This resource guide consists of activities related to 26 separate energy topics (one for each letter of the alphabet). Topic areas are: approaches to problems related to energy shortages; biomass; conserving energy; demand for energy in the year 2000; economics and energy; fossil fuels; geothermal energy; hydroelectric power; insulation; energy related jobs; electrical uses of energy; liquid fuels; measuring heat; nuclear energy; oil shale; people from Organization of Petroleum Exporting Countries (OPEC); questions students have about energy and the economy; radiation; solar heating; tidal power; carpooling; ventilation and infiltration; wind power; energy conservation; energy values; and zones of home heating and how the thermostat works. Activities are divided into three recommended categories within each topic area (K-6, 7-12, and K-12). In addition to activities, each topic area includes an overview, teacher background information, and list of resource materials. Activities are suitable for science, social studies, language arts, art, mathematics, and industrial arts lessons. (BC)


THE ABC'S
OF
ENERGY
UMO

THE ABC'S

OF

ENERGY

EDITED BY

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COLLEGE OF EDUCATION

UNIVERSITY OF MAINE AT ORONO

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PREFACE

The A,B,C's of Energy, a K-12 interdisciplinary resource guide consisting of twenty-six separate energy topics (one for each letter of the alphabet), contains information that teachers can use to teach energy education in their classrooms. Since energy is a multifaceted dilemma with political, economic, social, and moral/ethical implications, this resource guide contains activities for use in not only science and social studies classes but also other disciplines, such as language arts, mathematics, art, and industrial arts.

The format of this guide provides for much flexibility since each topic is designed with its own overview, teacher background information, student activities, and resources. The student activities are divided into three recommended categories: K-6, 7-12, and K-12. Therefore, the teacher may infuse all or any part of the guide into the existing curriculum.

As teachers infuse energy education into the existing school curriculum, this guide should be a valuable teaching resource. Since the energy problems of the 1970's and the 1980's have not only immediate but also far-reaching ramifications, educators should stress the global effect of the energy dilemma, the need for energy conservation and exploration of new energy sources, and the implications of current energy supplies and demands. The February, 1981 issue of National Geographic, describes the energy situation: consumption, world energy resources, finiteness of fossil fuels, conservation, and new energy sources.

ACKNOWLEDGEMENTS

This guide was produced by the participants of a two week energy institute at the University of Maine at Orono (UMO). This institute was funded by the United States Department of Energy under their Faculty Development Program and the College of Education and the College of Science and Engineering of UMO. The emphasis for this institute was science, economics, and technology of energy. Dr. Lloyd H. Barrow, Assistant Professor of Science Education at UMO directed the institute with the assistance of Dr. Anne Pooler, Dr. Constance Perry, Mr. John McDonough, Mr. Karl Webster, Mr. Walter Turner, Dr. Constance Holden, and Ms. Karen O'Neill. Ms. Betty L. Bitner, doctoral candidate, facilitated the institute follow-up activities. The participants of the institute were : Jane Abbott, Camille Albert, Paul Beauparlant, Ramona Blanchette, Richard Chalmer, Louise Cole, Curt Jack, Dan Deraspe, Herb Dobbins, Brenda Eddy, James Ervin, John Gato, Art Giasson, Harvey Giasson, Ken Gordon, Bob Guyette, Edson Hadlock, Irvin Krupke, Sal Perry, Donna Pietroski, Jeff Rattray, Brian Rowe, Michael Schaab, Henry Stupakewicz, Bette Tompkins, Carleton Vaughan, Don Watkins, Ralph Wentworth and Allan Word.

We wish to thank Ms. Brenda Collamore and others for the typing of this monograph.

The original drafts were developed by the 1980 energy education workshop participants. This workshop was funded by the same sources as the 1981 workshop. The draft edition of the A,B,C's of Energy was edited by Lloyd Barrow and Ed Hodgdon. The participants at the institute, who compiled the preliminary drafts for each letter were (alphabetical order): Donald Adams, B. J. Allen, Patricia Brookhouse, Philip Brookhouse, C. John Beeuwkes, James Booker, Michael Bunker, David Christie, Nancy L. Clifford, Charles Cote, Jr., Luci Dostie. Keith Dunson, Ronald Edgecomb, Robert S. Fairweather, Lawrence Greenleaf, Arnold Hopkins, Anne Hussey, George Jacobs, Paul LaGrange, Emily B. Lane, Will Labbe, Alfred W. Lee, Richard Lord, Jr., Jeanne Lourey, Paul M. MacDonald, David Mann, Philip J. Marcoux, Peter Mendall, David Morrow, Richard I. Niles, Christina Pastore, George B. Powers, George Quintal, Jr., Glenna J. Smith, Richard F. Staples, David L. Trainor, Robert L. Watts, and Richard Weirich. The manuscript was typed by Ms. Mary Brown. The artwork was done by Ms. Melanie Hodgdon.

Editors

Lloyd H. Barrow
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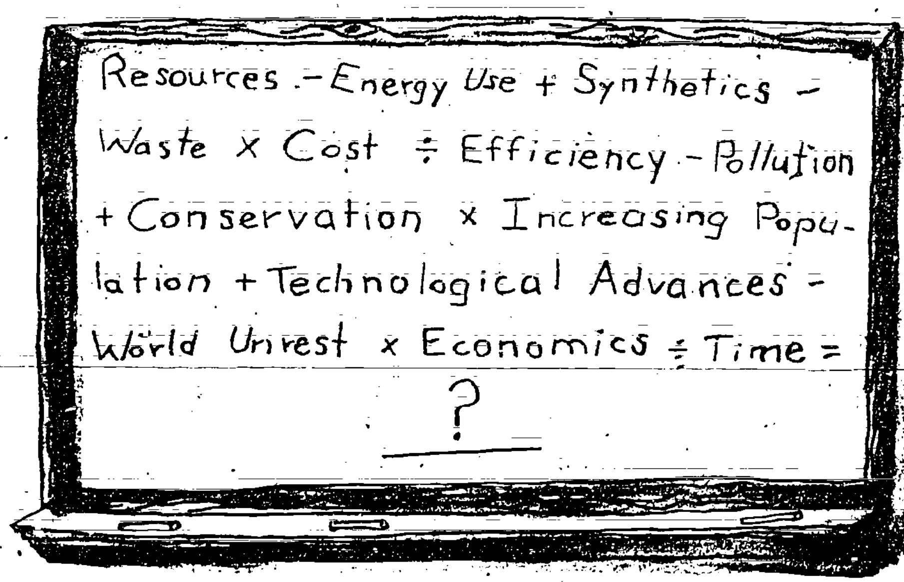
TABLE OF CONTENTS

A IS FOR APPROACHES TO PROBLEMS RELATED TO ENERGY SHORTAGES



OVERVIEW:

Students examine the pattern of energy use in this country from a historical point of view. The activities focus on the increasing demand for energy fostered by an expanding population, elevated standard of living, increase in leisure time, and the social association of high consumption with success and happiness. Students categorize their own energy use, i.e., life-supporting, convenience, recreation, etc., and suggest ways for reducing energy consumption. The activities chart the advantages and disadvantages of a selection of alternative energy sources currently being explored. On the basis of personal conservation techniques, generalizations are made regarding national and world-wide conservation measures.

TEACHER BACKGROUND:

Our society today has been referred to as a class of over-consumers, a group of people whose demand for energy will soon exceed supply. One must address the social cost of the economics of energy and arrive at his/her choices and needs. The energy crisis has been alluded to as a "measure of our willingness to let technology define the obvious--the limits of our creativity, self-reliance and political participation." There is a need for cooperation among individuals on a national and international basis. The instilling of good energy values will lend a spirit of cooperation, stability, and economy to our nation. Since the profit margin is often too much of a factor, building codes are stated, but often never enforced. In order to arrive at solutions to the gross overuse of energy, one must exhibit the need to redirect personal life-styles by devoting time to energy education and to auditing and monitoring his/her energy use.

From an economic standpoint, the American of the twentieth century has become too dependent on urbanization, electrification, and motorization. Unwise consumption of natural and man-made resources cause pollution. In providing the basic needs for man, one faces energy shortages. Energy is required not only to keep our high productivity farms in operation, but also to produce the increased supply of nitrogen-fertilizers required to elevate their levels of productivity. The agricultural system is dependent upon mechanization and petroleum usage, and thus competes with other industries which also depend upon petroleum or petroleum by-products in the U.S. Because the U.S. has a petroleum based economy, the costs of goods and services is intimately tied to the price of this commodity. In response to the faltering economy, jobs are eliminated, but pressures by unions have come into play to increase the job market and to expand industry--an obvious economic inconsistency. Rising energy prices have also contributed to inflationary trends. Rising prices, competition, international embargos, and lack of ecomomic cooperation among countries have also contributed to the economic-based dilemma.

Government in the U.S., although espousing energy cutbacks and revisions, has done little to alleviate the energy crisis. As demonstrated recently, there is a foreign influence operative in the U.S. foreign and domestic policy, particularly in the area of energy supplies. The United States, assuming that as long as its needs are provided for that other nations will have to survive as best they can, has become complacent regarding the worldwide energy shortage which threatens developed nations. Lack of government mandates and controls allows the spread of strip mining into otherwise productive and prosperous agricultural areas.

Another aspect of the energy shortage problem is the conflict over alternative energy sources. Each of the various power sources has its share of advocates critics. Thus, the American dream is in jeopardy because of the energy crisis. It is time to educate/reeducate the public to assess and redefine the needs and choices available. Until conservation efforts are supported, one stands to lose the guarantee of life, liberty, and the pursuit of happiness.

STUDENT ACTIVITIES FOR PROBLEMS RELATED TO ENERGY SHORTAGES:

Recommeded for K-6:

1. List as many alternative energy sources as possible.
2. List 10 ways in which energy is wasted and how we can slow down/prevent the waste.

Recommended for 7-12:

1. Complete the following Lanauage Arts activities, Poetry and Energy (Gause, 1978):

   a. Discuss the importance of energy.
   b. Identify energy concepts of past and present poets in relation to theirs by writing a paragraph of comparison.
   c. Show how energy concepts are funny as well as informative by writing a limerick on energy; demonstrate the importance of energy communication by making a booklet.
   d. Write an original poem to demonstrate his/her knowledge about energy.

2. Interview different segments of the population to assess energy anxieties and patterns.

3. Serve as an energy monitor at home or at school. Establish definite criteria for monitor.

Recommended for K-12:

1. Construct a time line of U.S. energy use; discuss reasons for changes in energy use patterns from a socio-economic standpoint.

2. Collect advertisements, particularly for products requiring comparatively high energy use for relatively low value received, e.g., electric can openers, electrically-operated toys, air conditioners, highly-automated cars, etc.; discuss sales techniques used by the manfacturers to induce purchase.

3. Research alternative forms of energy. Share the information by making bulletin board displays, posters, and scrapbooks, or oral presentations.

4. Select an individual conservation measure, e.g., taking shorter showers, turning on only one light in a room, walking to school, etc. Maintain this resolution for a week. Discuss their reactions; speculate on the probable success of and reaction to enforced conservation. Compare the habit pattern one month later.

5. Research how the paper industry uses energy for production and what measures it has taken to prevent environmental pollution. Include what alternative sources of energy, if any, the industry proposes to utilize in the future. Include conservation measures.

6. Invite guest speakers from fields of architecture, public utilities, and industry to speak on energy trends in their fields.

7. Construct a graph showing U.S. consumption of fossil fuels for a particular period.

8. Compare the use of energy in a developing country and the U.S. Use DOE publication, "Bringing Energy to the People: Ghana and the U.S."

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B IS FOR BIOMASS

OVERVIEW:

Students explore the different sources of biomass energy and examine the positive and negative aspects of each. The activities focus on the biomass sources, their advantages and disadvantages, the impact of over-population, the construction of a calorimeter, the availablity of the different biomass sources in their locale, and surveys of local wood use.

TEACHER BACKGROUND:

"The word biomass describes all solid material of animal or vegetable orgin from which energy may be extracted. Plant products, such as corn husks, branches, or peanut shells, waste paper, and dung are examples of biomass fuels. Biomass can be heated, burned, fermented, or treated chemically to release energy." (Biomass I Science Activities in Energy.) In terms of energy it is used as a quantitative tool to help determine the amount of energy that a given system provides. For example, when one discusses the amount of lumber that can be harvested from an acre of land, one is discussing the yield of that ecological system in terms of its biomass.

The term biomass describes trees in a forest, kelp in the oceans, phytoplankton and zoophankton in the seas, waste, alfalfa, and certain plant conversions. All of these have positive and negative aspects which will be discussed later.

All living matter is composed of carbon atoms strung together in various ways with other chemicals. Although the energy stored in these carbon compounds can be released in several ways, perhaps the most common method is oxidation. Oxidation of an organic compound results in a release of energy whereby the compound is converted into another substance. When one throws a log of firewood into a woodstove, oxidation occurs. When the organic matter (the wood log) is oxidized (burned) by the heat of the flame and the air (draft), the lower molecular weight compounds (creosote) result.

Petroleum and coal represent biomass that existed millions of years ago. In response to the tremendous pressures and temperatures experienced when these plants/animals remains were buried, the carbon structure was altered. Oil and coal are still carbon compounds with many of the same characteristics of biomass, but these fossil fuels have a much higher energy content per unit weight than living biomass.

In photosynthesis, the plant utilizes the energy of the sun to synthesize carbohydrates from carbon dioxide and water, such as carbohydrate - starch in potato. Animal biomass derives its energy by consuming plant biomass, resulting in the storage of energy in some form, such as carbohydrates, fat, or protein.

Biomass represents energy in a stored form. This energy can be used for a variety of purposes depending upon environmental conditions. For example, the energy available in 100 kilograms of biomass might be burned for heat or consumed as food.

How practical is biomass? Meyers and Witt (1981) investigated several biomass sources and concluded the following:

1. Since garbage is dispersed over such a vast area, it is only practical to collect 16% of the million of tons of waste matter.

2. To use arable land to grow alfalfa for fuel is improvident when we consider the food shortage. To fuel one 2000 MWe steam cycle power plant, it takes 250-500 hundred square miles of tillable land. Not only must one consider the yield but also the expenses of biomass. With a biomass yield of 10 to 30 tons per acre annually in optimal dryweight and with the fossil fuel expense to till and to harvest the land at approximately $150 per acre, this biomass source is absolutely inpractical and wasteful.

3. The conversion of plants to oil is impractical since it costs $20 for seven barrels per acre and $10 for processing the oil with a total of $30, which exceeds the current price of oil.

4. Gasohol, produced by converting starch residues from processed corn, wheat, potatoes, beets, and barley into 200 proof grain alcohol and by mixing nine parts of unleaded gasoline with the 200 proof grain alcohol, is a viable biomass. Meyers and Witt (1981) concluded the following positive results: gasohol powered vehicles consumed 11.9 gallons per mile vs. 11.2 on gasoline, carbon monoxide emissions declined 32%, and average hydrocarbon

emissions decreased 7%. They found one negative aspect, the cost of gasohol per gallon is slightly higher than that of gasoline. This cost can be reduced if gasohol is produced on a larger scale.

Trees as a biomass have both positive and negative aspects. The positive points of trees as a biomass include the following: (1) yield a higher percentage return than other plants. (2) store energy well, and (3) give off pollution. The negative aspects include the following: (1) develop demand for wood as a replacement for oil and gas, (2) produce equipment to burn wood on a small scale, and (3) develop the wood fuel industry.

If one uses all th biomass sources combined, one will fulfill only 25% of his/her energy needs per year. Therefore, even though biomass is a viable energy alternative, other energy sources must not be ignored.

STUDENT ACTIVITIES FOR BIOMASS:

Recommended for K-6:

1. Observe a biomass pyramid to see the energy lost at each level of a food chain.

2. Go to a farmer's cornfield or any grain field. Find out how many people it will feed if they eat the corn vs. the number that it will feed if the cattle eat the corn first.

3. Make a study of an overpopulated country. Hypothesize why less meat is eaten in that country.

4. List all the uses for wood, e.g., lumbering, construction, furniture, pulp/paper, etc.

5. Conduct local wood energy use surveys of their community.

6. Identify some of the types of trees that grow locally; determine the advantages/disadvantages of each type.

7. Observe the growth rings of a tree; discuss what the rings indicate about the environment and properties of trees.

Recommended for 7-12

1. List advantages and disadvantages of burning wood for energy, e.g., cost, safety, convenience, reliability, capacity for renewal, etc.

2. Calculate the heat equivalents of several common firewoods.

3. Complete a quadrat study to determine the biomass of the producers and consumers in the quadrat.

4. Build a calorimeter to compare the calories in a gram of peanuts, lichen, grass, wood, and corn. Use a bar graph to plot data.

Recommended for K-12

1. Role play representatives of various industries as forest resources are divided up in the future. Summarize problems of priorities and competition arising from increased pressures on a finite source.

2. Design a community which derives its energy for industry, transportation, and homes from biomass.

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C IS FOR CONSERVING ENERGY

OVERVIEW:

Students will become familiar with several simple energy-saving techniques, such as insulation, weatherproofing, and personal conservation techniques derived from home energy audits and personal energy use monitoring. Students study home weatherproofing techniques. They examine the local effects of the energy crunch, including compensatory methods. The students will use surveys of local practices to formulate suggestions for cutting down on energy use, e.g., the substitution of paper wrappers for plastic, planned car pooling, and the elimination of styrofoam containers for the packaging of fruit, vegetables, and meats.

TEACHER BACKGROUND:

Energy and Man's Environment, Inc., (EME) has defined energy conservation as "the useful life of the earth's energy resources through wise and efficient management." This definition implies both responsible use of and conservation of natural resources. Stobaugh and Yergin (1979) describe three types of conservation: curtailment, overhaul, and adjustment. Curtailment refers to forced conservation, such as during the coal strike of 1977 and 1978. Overhaul refers to changing lifestyles. Adjustment refers to such things as insulating homes, and making automobiles, appliances, etc., more efficient. While there has been fear among the public that conservation measures will cripple the economy, reduce the standard of living, and increase unemployment, facts indicate that such fears are unfounded. Industries which have cut back on their energy use (some by 40% and more) have more money to invest in other areas, such as expansion and increased production. The fifteen most energy-intensive industries in the United States, employ only 6% of the work force, while less energy-intensive industries tend to be more labor-intensive. Americans, with one-sixth of the world's population, consume 30% of th orld's energy. Sweden and West Germany, which both maintain a standard of living comparable to that of the United States, do so on less than 60% of the energy America uses.

There are three prime reasons why Sweden consumes less energy. The Swedish Volvo and Saab average 24 miles per gallon; the Amercian cars average 13 miles per gallon. Sweden's insulation regulations require that heat loss does not exceed 0.6 BTU's (British Thermal Units) per hour per square foot for any new edifice. The United States' insulation regulations apply to FHA homes only. FHA requires heat loss not to exceed 12 BTU's per hour per foot. Another difference exists in the use of public transportation. Americans use public transportation 8% of their passenger miles; Swedes use public transportation 18% of their miles. Co-generation is widely utilized in Sweden. Large coal and oil-fired utility plants are located near cities and towns. Steam, after it has been used to generate electricity, is piped to homes and other buldings to furnish space heating.

Transportation and heating, each consumes approxiamtely 25% of the total energy. Manufacturing, lighting, and household and business appliances consume the other 50%.

The growth of electrical usage is an example of wasted energy. Two-thirds of the fuel, usually not captured for co-generation, is lost as waste heat and in transmission over power lines. Rather than rewarding economical energy use, rate structures give a 15-30% discount to large energy users. The proliferation of household electrical appliances and heating sources has tended to concentrate heavy peak-hour usage, causing the utilities to produce additional capacity to meet these peak load.

Instead of consuming more energy in the future, one can choose to consume less or the same amounts of fuel much more efficiently. While energy conservation is not an energy source, it can buy us time--the time to develop alternative energy sources and methods. A recent study reports that the U.S. could meet all its new energy needs for the next twenty-five years simply by productively using the energy it now wastes. Also, a dollar invested in an energy conservation method makes more net energy available than a dollar invested in developing new resources. Because of the energy cost of production, a barrel of oil saved is more valuable than a new barrel of oil produced.

Some avenues toward conservation include the following:

1. In industry:
   a. Use waste heat for co-generation.
   b. Redesign lighting systems.
   c. Recycle building heat.
   d. Use waste materials for fuel.

2. In the home:
   a. Design more efficient homes.
   b. Landscape for winter protection and summer shading.
   c. Make houses tight with insulation and weatherproofing.

d. Retrofit for solar heating assistance
e. Orient homes for winter use of sun and summer use of prevailing breezes

3. In transportation:
a. Encourage mass transit and carpooling
b. Encourage purchase of fuel-efficient vehicles with tax credits
c. Restructure driving habits
d. Revitalize railroad lines
e. Piggy-back long distance trucks on rail cars

4. In general:
a. Recycle--metals, glass, animal and plant waste products, paper, plastics--EVERYTHING
b. Conduct energy audits--of your home, your driving habits, life-style, comfort levels, etc.

Energy conservation with only one cost change of lifestyle is the most expedient solution to the energy problem.

STUDENT ACTIVITIES FOR CONSERVING ENERGY:

Recommended for K-6:

1. Conduct a traffic analysis, counting vehicles and numbers of passengers in each and discuss carpooling as an alternative. Can use bar graphs to represent data.

2. Develop energy conservation posters and have a poster contest.

3. Test the insulating ability of various materials by insulating jars/cans with different insulating materials and by filling the jars/cans with 100°C. Water. Check these temperatures every 15/30 minutes. Compare the rate of cooling. (Refer to I for more activities.)

4. Graph the miles per gallon, model, and make of the family car(s). Discuss.

5. Prepare a questionnaire on energy conservation. Administer to four persons and compare their results in class.

6. Make draft detectors. (Direction on C-3.) Check school windows for drafts, then weatherstrip the windows with masking tape and recheck. Discuss infiltration and heating.

Recommended for 7-12:

1. Keep an energy log for a few days. Note what activities they perform that require a particular kind of energy; discuss which ones could be eliminated.

2. Practice reading an electric meter. Chart family's energy use for a given time period. (Refer to K is for Kilowatt.)

3. Conduct a home energy audit. The Office of Energy Resources, Augusta, Maine 04333, has a computer analysis home energy audit (REAP).

4. Locate two buildings, one insulated and one uninsulated. Record temperatures at the center of the building, halfway to the outside wall and about 1 cm from the outside wall. Compare the temperature readings on each building. Discuss/draw conclusions on the effect of insulation in energy conservation. List ways the buildings could be made more energy efficient.

Recommended for K-12:

1. Conduct a packaging survey, counting plastic and paperbased wrappings. Discuss the energy used to produce them and the possible reasons for their use.

2. Visit a power plant, water purification plant, recycling center, or solar building. Relate these to conservation methods they use.

3. Fill out a chart on their personal water use. Use Sheet C-1. Compare and discuss results. Which procedures could one use to save on hot water?

4. Participate in a photo/picture contest to demonstrate good energy conservation.

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SHEET C-1 "C" IS FOR CONSERVING ENERGY

Sample Family Water Use Table			
ACTIVITY	AVERAGE AMOUNT FOR ONE USE	CHECK FOR EACH	TOTAL
taking a shower	20 gallons		
taking a bath	30 gallons		
flushing a toilet	3 gallons		
washing hands or face	2 gallons		
drinking	1/4 gallon		
brushing teeth	1/4 gallon		
washing dishes	8 gallons		
cooking a meal	5 gallons		
automatic dishwasher	32 gallons		
(other)			

ENERGY CONSERVATION

Let us assume that is is necessary to cut back our use of energy substantially. The following are proposals to accomplish this task. Your goal is to rank these proposals in order of preference.

A. Lower air pollution standards so industries can burn high sulfur coal rather than oil or natural gas.

B. Ban all driving of private cars on Sunday.

C. Impose a $10 limit on the purchase of gasoline.

D. Double the price of electricity and natural gas to discourage household use.

E. Ration gasoline so every driver can obtain only a certain amount.

F. Allow the price of energy to float until it reaches the market price.

G. Allow gasoline to be purchased only on an odd/even system.

H. Ban the use of recreational vehicles and air conditioners.

I. Nationalize the oil companies.

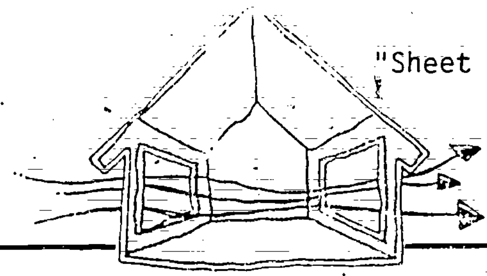
Rank your preferences with 1 being your first preference, and 9 your lowest preference.

Rank	Proposal	
1	________	Highest
2	________	
3	________	
4	________	
5	________	
6	________	
7	________	
8	________	
9	________	Lowest

Directions:

1) Have students rank their preferences.
2) Discuss the implication of their ranking.

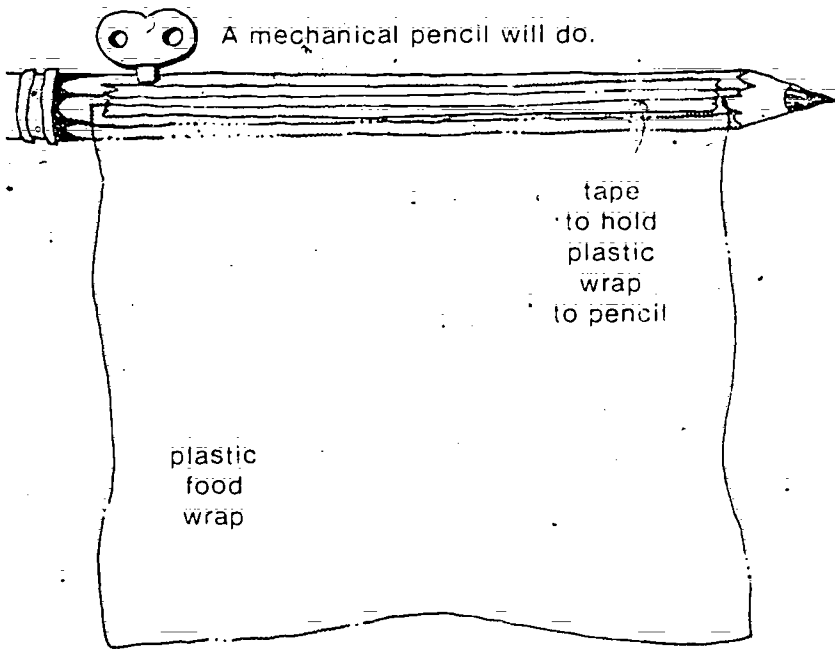
IS YOUR HOUSE DRAFTY?



MATERIALS:

Pencil (a long strip of poster board works well, too)
Scotch tape (double-stick tape is handy)
Plastic food wrap

Make a draftometer by following these instructions:

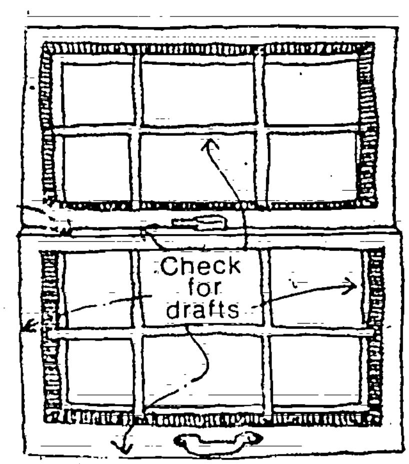


NOTE: Forced air furnaces must be off to use draftometer or you'll get false drafts.

Cut a 12-cm by 25-cm strip of plastic food wrap.

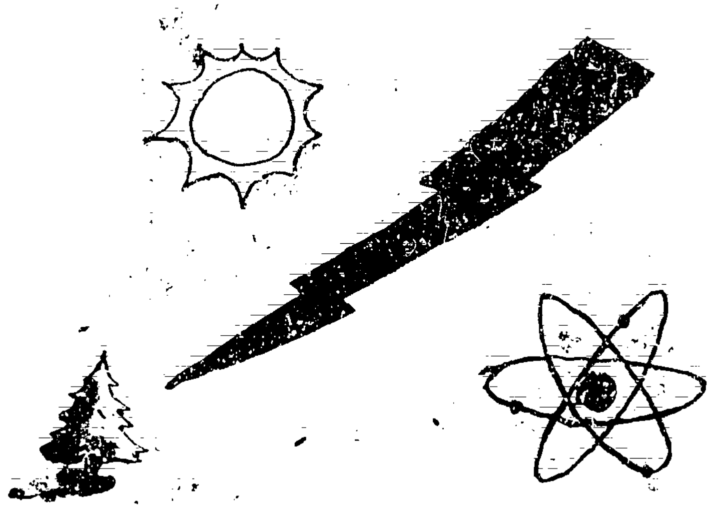
Tape the wrap to the pencil.

Blow the plastic gently and see how freely it responds to air movement.



Test your home for air leaks by holding the gadget near the edges of windows and doors.

D IS FOR DEMANDS FOR ENERGY IN THE YEAR 2000



OVERVIEW:

Students should understand the current energy needs and the ways of meeting them if they desire to project future energy uses. This topic will help the students develop an understanding of the different means of producing and using energy.

TEACHER BACKGROUND:

What will the turn of the century bring? Each of us has undoubtedly speculated, guessed, and wished about life in the 21st century. Each of us would perhaps paint a much different picture of life in the year 2000. The experts have made the following projections for energy:

A comprehensive study of the future recently completed by our government warns of a world that will be increasingly crowded, hungry, polluted, and unstable by the year 2000, unless international action heads off the problems. Former Secretary of State Edmund Muskie, presenting the massive study "Global 2000," said, "World population growth, the degradation of the earth's natural resource base, and the spread of environmental pollution collectively threaten the welfare of mankind." Global 2000 is not a prediction. If we begin now, we will say in twenty years that Global 2000 was wrong. What a glorious achievement that would be ! But specifically, what are the projections for our energy future?

A recent report of a panel on energy future assembled by the National Academy of Science looked at 4 different plausible scenarios for energy demand in the U.S. The scenarios were constructed out of careful engineering analysis of trends in various sectors, combined with econometric and input-output analysis. The results were extraordinary--that in the year 2010 using almost 20 percent less than used today, very similar conditions of habitat, transportation, and other amenities could be provided in the U.S. with continuing economic and population growth. The fundamental conclusion is that there is much more flexibility toward reducing energy demand than has been assumed in the past. What will be the energy sources that will meet that demand?

Generally, this is the direction taken when looking at the energy future--the supply side (often our projections arising therefrom are bound by conventional wisdom, folklore, the inability to incorporate political forces, etc.). For example, according to an organizer of International Sun Day, forty percent of our energy could come from solar energy by the year 2000 if we make dramatic moves now On the other hand, the editor of World Oil disagrees saying the source (solar) will have the impact over the next quarter century of "a mosquito bite on an elephant's fanny." There seems to be two distinct groups seeking to supply our energy future--the "old solar" versus the "new solar."

Many refer to "new solar" as renewable energy resources, i.e., wood, wind, water, and, of course, solar. One might also include two other new energy sources, conservation and recycling, which are really old concepts that went out of style with the advent of cheap "old solar" energy. As a whole, the energy supplied from the "new solar" sources, particularly solar, is of a low technology level and of a decentralized nature. With virtually unlimited supply of "new solar" energy and the rapidly rising prices of "old solar" resources, the transition is inevitable. The transition will be slow since institutional barriers must be overcome, attitudinal changes made, and in some cases, new lifestyles adopted. For these and other reasons, such as the exclusion of external costs from "old solar" sources in the year 2000, our primary energy source will still be "old solar." Excluding conservation, "new solar" will probably only contribute 20 to 30 percent to our energy needs. As the highly technologized, centralized "new solar" projects come on line, this forecast will change more dramatically in the 21st century.

Some people see our energy future based on the fossil fuels, i.e., oil, coal, gas, nuclear, etc. While the supply and demand for each individual source would vary depending upon the specific industry giving the report, there is consensus that all would supply energy from a highly technologized, centralized source, and all would agree at some point that theirs is a finite energy resource. Although estimates of resource availability vary, one thing is certain as the resources become scarce, prices will rise and the tide will then turn toward "new solar."

STUDENT ACTIVITIES FOR ENERGY IN THE YEAR 2000:

Recommended for K-6:

1. Interview some people in the community whose jobs have already been or might be altered by energy uses. Share with classmates.

2. Talk to principal and/or parents about problems with energy consumption in school. Work on ways to reduce these costs and chart on a graph in the hall.

3. Check meters in homes to determine daily changes in energy consumption. (Refer to K is for kilowatt.)

4. Experiment with easy minor home improvements, such as thicker curtains. Share findings with classmates.

5. Construct a collage of energy consuming devices. Discuss either orally or in written form an energy-saving alternative. Project how these will be used in the year 2000.

6. Have a representative from a solar energy business as a resource speaker.

7. Draw pictures or write essays on the types of energy that they use in their homes today and will probably use in the year 2000.

8. List all the things that they do in a 24 hour period that requires energy.

Recommended for 7-12:

1. Discuss how lifestyles influence the amount of energy that people use.

2. Discuss the pros and cons of the different types of energy production facilities in their community.

3. Research some alternative energy resources and report on their findings.

4. Design a community complete with its own power generating facility.

5. Role play a town meeting in which part of the class must sell the idea of an energy facility to the rest of the class.

6. Discuss the concept of Energy Independence. Is it practical?

7. Discuss: How Are We Paying for Our Energy Affluence?

8. Discuss the idea that a civilization can continue to grow forever--but at what price?

9. Compare the availability of solar power, oil, coal, and nuclear for a period of 150 years on a graph. Indicate that an investigation will be needed on states where there is either a moratorium in effect or a licensing period for nuclear energy.

10. Discuss the dangers or pitfalls of allowing the production of solar materials to become the exclusive province of large oil or utilities companies.

11. Discuss ethics of the U.S.A.'s consuming 1/3 of the world's energy with only 1/6 of the world's population.

Recommended for K-12:

1. Determine the energy sources of their community.

2. Discuss what life would be like if they could only use ½ the energy they use now.

3. Discuss the concept of advertising as a reason they use the energy they do.

4. Discuss the role of energy conservation and lifestyles in energy utilization.

5. Identify the reasons underlying the changing energy policy in the U.S. from the 1700's to the present.

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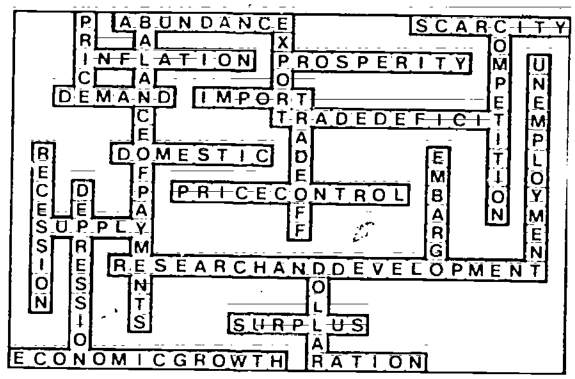
E IS FOR ECONOMICS AND ENERGY



OVERVIEW:

Students will learn the principles of energy economics and the importance of energy conservation.

TEACHER BACKGROUND:

The principles of energy economics include competition, monopoly, cartel, windfall profits, supply and demand, environmental impacts, and scarcity itself. To understand energy economics, one should comprehend the meaning of these terms.

Economics is the science of allocating scarce resources. Only scarce resources command a price or need to be allocated. Scarcity compels people to make choices about the most effective utilization of these resources. The price of a scarce good represents what a buyer has to give up to get the good and what a seller has to receive to give up the good. When a good becomes scarce, the price usually increases.

Competition exists whenever real or potential producers have the opportunity to make more profit by lowering their price enough to sell more goods (though at a lower profit on each). If gasoline stations buy gas at 60¢ per gallon and are all independent, they tend to sell their gas for about 65¢ per gallon because they need about a 5¢ profit per gallon to stay in operation. Whenever there is true competition, a station which raises its price too high will lose enough sales that even at the higher price, its total profits drop because other stations are selling the gasoline at a lower price.

Monopoly exists when a seller sets a price without losing sales to competition. If a gasoline station is the only one in town, it will be able to charge more for gas, up to a point when one of three things occur: (1) its customers use less gas; (2) they find another location to purchase their gasoline; or (3) somebody opens a competing gas station because it is such a profitable business. Monopolies are usually undesirable because they can earn an unfair profit and because they restrict the availability of goods. "Natural monopolies," such as water, natural gas, electric, and telephone utilities, regulated by the government, are such that once one firm has installed the necessary pipes or wires, it is both expensive and undesirable to have another firm compete with them. A monopoly has two effects: it makes too much profit and it sends an incorrect price signal and forces people to use too little of its own goods and too much of other substitute goods. Regulations attempt to eliminate these problems.

A cartel exists when independent sellers band together to act like a monopoly. Some nations approve of selected cartels (usually on the grounds that they lead to more economic stability), but in the United States such an agreement would be termed collusion and would violate anti-trust laws. A cartel or trust has most of the economic characteristics of a monopoly. OPEC (Organization of Petroleum Exporting Countries) is clearly a cartel. Although the cartel does charge too high a price, the price is limited by the demand for the cartel's product.

Windfall profits are usually taken to mean unexpected or unearned profits-especially those that exceed the profit a supplier needed to count on before she/he went into business. When OPEC placed an embargo on oil in late 1973 and raised oil prices dramatically, U.S. oil and gas automatically were worth much more than they had been. Since these profits are usually made by large companies at the expense of people who depend on fuels for heating and transportation, their unfairness has led the U.S. to maintain various kinds of price controls.

Supply and demand are widely misunderstood. A shortage of fuel does not mean that people are using more fuel than is produced-it means they want more than they are using.

Environmental impacts are called externalities by economists and refer to goods which are not incorporated in the market. These goods include water, fresh air, and a healthy environment. These goods are used freely and therefore, could be used excessively.

The following scheme outlines economics and energy:

Economics	Science
Resources	Wood, Gasohol, Coal.......
Wants	Environmental Impact
Needs	Energy, Warmth (comfort level)
Scarcity	Finite Resources
Choices	Type of Energy (amount of BTU's

Values/Choices

Opportunity Costs	Environmental Concerns (Pollution and Depletion)
Trade-Offs	Safety Margins

Supply and demand are two of the most important factors in economics. Supply indicates the quantity that sellers are willing and able to offer for sale at various prices at a given period of technology, the price of other products, resource prices, expectation of producer, and the number of producers in the market. Demand determines the price of the good and the amount of the good produced. Five main influences of demand include the following: (1) consumer preferences or tastes, (2) consumer income, (3) consumer expectations, (4) prices of other products, and (5) the number of consumers in the market.

Economists have divided energy usage into present, short-term, and long-term. They have grouped energy resources into the following categories: (1) petroleum and products, (2) transitional resources (non-renewable), i.e., nuclear, natural gas, coal, imported power, peat, and geothermal, and (3) ultimate resources, i.e., hydro and tidal, wood, solar, alcohol fuels, wind, and solid wastes.

Questions To Consider:

1. How can conserving energy affect supply and demand?
2. What are your biases toward various energy sources? Why?
3. How do these biases affect your discussion of economic issues from the point of view of worker, consumer, and citizen?
4. How have these biases changed?

If one hopes to address the energy dilemma, it is imperative that one understands energy economics.

STUDENT ACTIVITIES FOR ECONOMICS AND ENERGY:

Recommended for K-6:

1. Pretend that she/he is a form of transportation and tell a story about it. The story could include pictures, poems, and demonstrations.

2. Complete short reports on whales, including what whale oil was used for, why the cost of whale products increased, and what happened to the number of whales. Discuss the relationship of whales and whale byproducts with petroleum and its byproducts.

3. Instruct students on how to read an electrical meter (See K is for Kilowatt.) and have them keep track of their electrical consumption for a week. At the end of the week, compare the differences in household consumption. Attempt to determine why the readings differ.

4. Plan and prepare meals that can be prepared entirely without fossil fuels.

5. Issue labels of different industries to the students. Have the student role play the industry. Let one person play the role of fossil fuels. Perhaps, have all the industries connected to the fossil fuels. Note what happens. Discuss the implications.

6. Make posters showing roles of fossil fuels in our economy.

7. Make a collage of energy uses.

8. Set up a contest in which students will try to save the most on their monthly electric bills. This will involve reading the electric meter. (Refer to K is for Kilowatt.)

Recommended for 7-12:

1. Explain at least three ways that the energy and ecology situations relate to each of the following economic conditions: inflation, trade deficits, value of the American dollar, unemployment, and productivity.

2. Bring to class at least three articles from current magazines or newspapers covering some aspects of the relationships among energy and economics.

3. Set up a debate team(s) to research and to dispute the following points:

   a. Benefits of nuclear reactors vs. risk
   b. Benefits of coal vs. environmental pollution
   c. Benefits of solar vs. cost effectiveness
   d. Benefits of oil vs. source of supply

4. Compare the advantages/disadvantages of the internal and external engine.

5. Prepare graphs of the U.S. balance of payment with OPEC countries since 1970.

6. Prepare an energy audit on their homes.

7. Compare energy values and cost of wood, coal, and other energy sources.

8. List as many industries as possible that are totally independent of fossil fuels. Discuss the advantages/disadvantages of this step.

9. Utilize the provided activity lessons on the following:

   a. Hot water audit
   b. Meter reading
   c. Room orientation
   d. Sun orientation/wind orientation
   e. Marketing trip evaluation

10. Report on articles in periodicals that are related to special interest groups and how they are trying to affect the types of energy used or explored. Perhaps, a debate will ensue.

11. Do a research paper on various countries' energy consumption and production policies. Correlate their findings with what is happening in the United States.

12. Conduct a poll of gasoline consumers. Set up hypothetical situations and ask them to respond. Use different costs per gallon.

Recommended for K-12:

1. Prepare a list of ways that their families have conserved energy.

2. Analyze why certain energy resources cost more. Consider supply and demand.

3. Investigate energy economics around the home and school. Discuss ways of becoming more economic.

4. Complete crossword puzzle, Sheet E-1.

5. Hold a town meetng in which energy needs and energy conservation for the school, home, and town are discussed.

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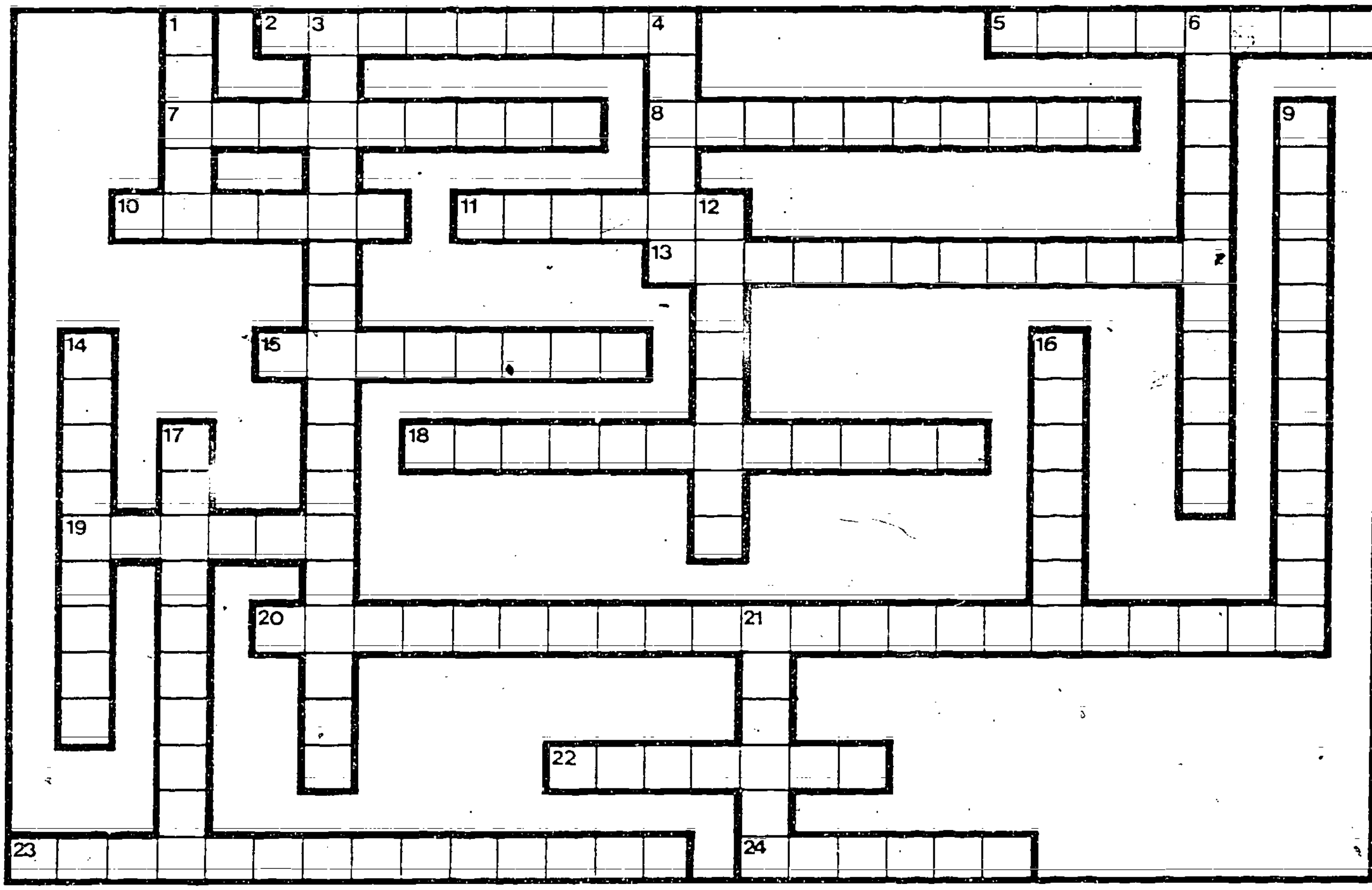
ECONOMIC ESSENTIALS



ACROSS

2 A plentiful supply of means or resources.

5 Smallness of quantity or number in proportion to the wants or demands.

7 A condition existing when prices rise and money goes down in value.

8 A description of a time when most people are employed and prices are not rising rapidly.

10 Term describing need for or call for a product.

11 To bring in goods from another country for the purpose of selling them at home.

13 When a country imports more than it exports to another country. (2 words)

15 Products produced in one's own country.

18 When the government sets a limit on the cost of a product to consumers (2 words)

19 The amount of goods actually available.

20 A branch of industry which comes up with new ideas and new products. (3 words)

22 When there is more of a product than is needed or wanted.

23 A sign of the health of the economy. (2 words)

24 To limit the amount of goods available to the public when supplies are short.

DOWN

1 The amount of money asked or paid for a product.

3 Term describing the amount of money countries owe one another for imports and exports. (3 words)

4 When a country sells goods by carrying or sending them to another country.

6 A condition in the marketplace which may cause prices to go down.

9 A state existing when people are out of work.

12 What is gained and lost when certain decisions are made. (2 words)

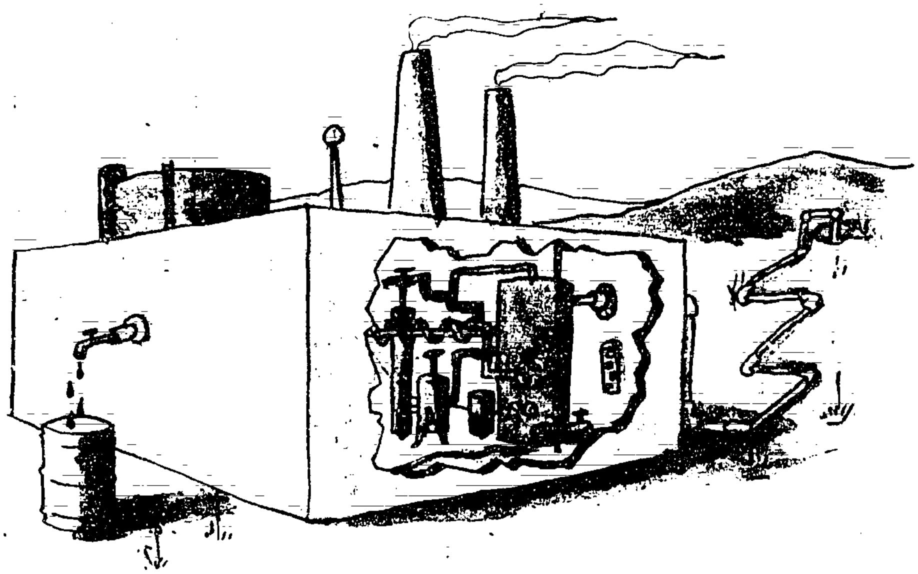
14 A temporary decline in business activity when business has generally been good.

16 When a country limits all trade or trade of a certain product with another country.

17 A period of time with a business slow down, increased unemployment, falling prices, and lower salaries.

21 A unit of money for payment of goods.

F IS FOR FOSSIL FUELS



OVERVIEW:

The student is introduced to the concept of how fossil fuels are formed and why they represent a limited resource. They explore the type of energy derived from fossil fuels, the U.S. dependency upon them, and the advantages/disadvantages of each.

TEACHER BACKGROUND:

Fossil fuels consist of coal, crude oil and natural gas. They are produced when organic matter is trapped under sediment and buried for long periods of time at very high temperatures.

Coal, the most abundant fossil fuel, is "a combustible sedimentary rock formed from the remains of plant life" (Foley, 1976, p. 115). Although coal is found throughout the world, approximately two-thirds of the coal reserves are located in the United States, the Soviet Union, and China. The United States has almost one-third of the coal reserves. It is estimated that the present known coal reserves could last more than 200 years. Two-fifths from underground mines (mostly east of the Mississippi) and three-fifths from surfaces or strip mines (in both the east and west) make up the United States' known coal resources.

Coal undergoes coalification which describes the processes of changes from peat to anthracite. The following are the main types of coal: lignite, bituminous, and anthracite. Temperature and pressure, both increasing with depth, decide the conditions in coalification. The better coals are found in greater depths. The original vegetation deposits, the kinds of silts where decay happened, the degree of the decay prior to sealing the deposit, and the geological processes determine the characteristics of the coal. Although the original vegetable deposits consist of carbon, hydrogen, and oxygen produced by photosynthesis, through the process of coalification the level of carbon increases. Anthracite has the highest level of carbon. The use of coal is determined by its characteristics.

Natural gas is relatively pure in composition; its combustion yields mostly carbon dioxide (CO_2) and water (H_2O). Unfortunately, the oils and coals contain impurities, such as compounds of sulfur and oxygen as well as salts and water. When these sulfur compounds and nitrogen compounds and water, are burned, they produce environmental pollutants, such as sulfur dioxide (SO_2), nitrous oxide (NO_2), and particulates. These pollutants can be reduced by burning fuels that are low in impurities, by using the low sulfur coal and by "filtering" the exhaust gases of facilities that burn fossil fuels. The 165,000 wells across the nation supply 26% of the nation's energy needs. New gas fields exist in the Rocky Mountain Region and the Gulf coast of Louisiana.

Crude oil is composed of a heterogenous mixture of hydrocarbons ranging from the heavy weight fractions, such as lubrication oils, to the light weight fractions, such as gasoline/kerosine. The differential weights of these fractions can be utilized to separate the different compounds either by using simple fractional distillation process or by employing a catalyst to "crack" the larger molecules into smaller ones--Catalytic Cracking.

Our industrial society was created around the different fractions obtained from crude oil; our transportation systems are based on a light weight 1-20 carbon atoms per molecule liquid possessing a certain energy density (gasoline/kerosene). We heat our homes with another light weight high energy density liquid--heating oil; our machines operate only because of the friction reducing effect of lubricating oils. Our society has not only become "hooked" on the energy available in the different fractions of crude oil, but also on the characteristics of that particular fraction: "In 1980, Americans consumed more than one fourth of the world-wide production of 60 million barrels a day." For example, ethanol can power an internal combustion automobile as well as gasoline, but one can not go as far or as fast as one could with gasoline. Thus, we can see that the problem of finding an energy alternative is more complicated than locating a material that will provide energy for it must provide energy in a form that is convenient for us to use. Convenience is a key concept in helping us understand why the United States has approximately 5% of the world's population, but consumes 35% of the world's energy. Convenience is also responsible for much of our pollution problem. For example, gasoline is much more than a simple fraction derived from crude oil. It starts with this fraction called "straight run" gasoline, and adds all sorts of chemicals. When these additives are burned, they contribute to the pollution.

Although each of the three fossil fuels has many advantages and disadvantages, only three will be listed.

Advantages/disadvantages of the three discussed fossil fuels:

1. Coal

   A. Advantages

      1. Availability
      2. Abundance - level of production for at least next two hundred years
      3. Security of supply

   B. Disadvantages

      1. Manpower (possible strikes and declining)
      2. Transportation
      3. Environmental concerns

         a. Proper reclamation of mine sites
         b. Global climatic changes created by increased carbon dioxide from burning coal.
         c. Emissions from coal stacks that do the following:

            (1) Erode buildings
            (2) Poison lakes
            (3) Damage lungs

2. Natural Gas

   A. Advantages

      1. Clean, without a waste disposal problem.
      2. Convenient - mostly produced in the U.S.
      3. Cheap

   B. Disadvantages

      1. Industrial customers reluctant to switch to natural gas because of incremental pricing.
      2. Federal price controls
      3. Decreased production

3. Oil

   A. Advantages

      1. Convenient
      2. Multi-purpose
      3. Amount of BTU's per gallon

   B. Disadvantages

      1. Dependence on imported oil
      2. Limited new domestic wells
      3. Environmental implications

Distribution of Fossil Fuels:

Distribution of oil:

Middle Eastern countries	53%
African countries	16%
The U.S.S.R., Romania & other eastern European countries	15%
U.S.	5%
Other countries throughout world	11%

Distribution of natural gas:

U.S.S.R.	30%
U.S.	16%
Iran	11%
Algeria	6%
Other countries	37%

Distribution of coal

U.S.	33%
U.S.S.R., western Europe, and China	67%

As our energy demand increases, the pressure on a finite resource, such as the fossil fuels, translates itself into energy shortages. Our society depends upon petrofuels. This dependency, we have not curtailed. If this dependency continues, the United States will witness not only environmental but also political and economic implications.

STUDENT ACTIVITIES FOR FOSSIL FUELS:

Recommended for K-6:

1. List all the products that are made from petroleum. (Refer to to "A Is For Approaches to Problems Related to Energy Shortages.)
2. Make posters to demonstrate ways we are depleting the world oil reserve through extravagant or wasteful activities and ways we could slow the process.
3. List substances in their daily lives that are produced from fossil fuels. Cut pictures from magazines that illustrate uses of fossil fuels.
4. Prepare posters on fossil fuel products.
5. Prepare bar graphs showing how our energy needs have increased from 1850 and how our energy uses have moved from coal to petroleum.
6. Compile a list of their daily oil uses and possible conservation steps.

7. Play "Energy Use Inspectors" and tour school and/or homes to inspect how fossil fuels are used. List the wise and wasteful uses of fuel consumption.

8. Locate on a map the major coal, oil, and gas producing areas in the United States.

Recommended for 7-12:

1. Discuss why fossil fuels are a non-renewable resource.

2. Make posters to demonstrate how crude oil is refined into the various products which we use.

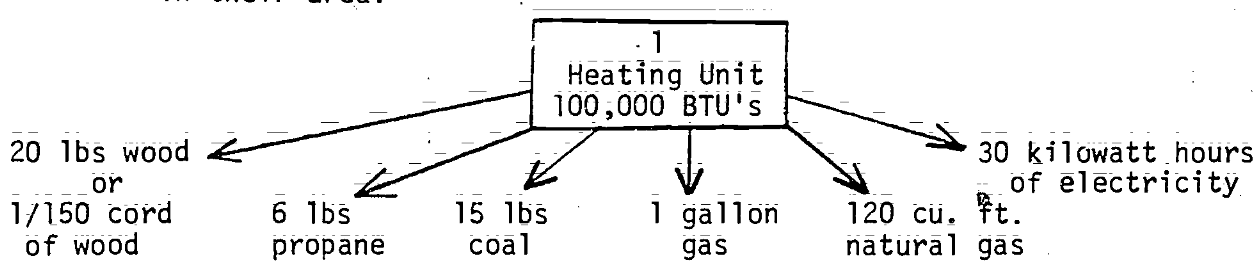
3. Discuss the types of pollutants that are produced when fossil fuels are burned and what can be done to reduce these pollutants. Discuss the results of these pollutants.

4. Discuss the reasons why the U.S. has such a high per capita consumption of energy.

5. Debate whether we should increase the use of coal. (If we continue to use coal at the current rate, it will last for about 200 years.

6. List the ways driving habits contribute to energy waste. Explore ways to conserve.

7. Use the diagram below. Research the cost of the energy sources. After finding the cost, determine which energy source is cheapest in their area.



Recommended for K-12:

1. Discuss what it would be like to live in a society without fossil fuels.

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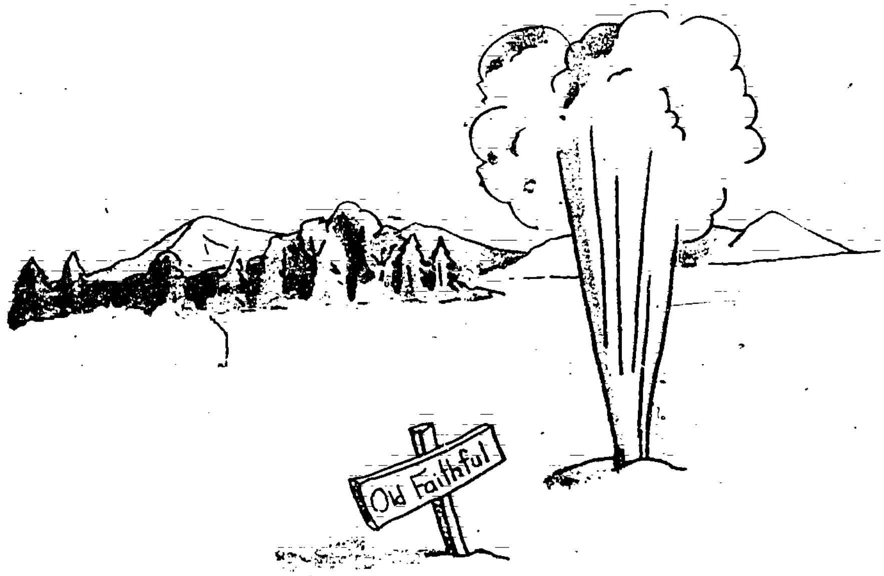
G IS FOR GEOTHERMAL ENERGY



OVERVIEW:

The student is introduced to the idea of what geothermal energy is and its relative importance in the total energy picture.

TEACHER BACKGROUND:

GEO (meaning earth) and THERMAL (meaning heat) represents heat supplied by the interior of the earth. Geothermal power, or energy, is power generated by natural steams or hot water beds trapped below the surface of the earth. The steam from the geothermal source can be used to turn a turbine generator to produce electricity just like steam from oil, coal, or nuclear plants.

There are three forms of geothermal energy that we can tap:

1. Hydrothermal Reservoir. These reservoirs have natural circulating hot water or steam and are of the most desirable type. The geysers in California are examples of this type. The steam that they generate can be used to turn turbines to produce electricity.

2. Geopressured Reservoir. The geopressured reservoirs are made up of porous sands containing water or brine. The water is hot water or pressured water and can be used to power a turbine.

3. "Hot Rocks" Reservoir. These systems are widely distributed. If we drill deeply enough, they should be available everywhere. It is estimated that the earth's temperature in most places increases at 100°F per mile drilled; however, geothermal power plants need a minimum temperature of 400 to 500°F to operate and water tends to cool down with increased distance from the source of heat.

Geothermal energy is not a new idea, for as early as 1890 homes were heated by natural streams in Boise, Idaho. The countries of Italy, New Zealand, and Japan have been generating large quantities of electricity from geothermal sources for some time. Most homes and buildings in Iceland are heated by geothermal power.

Currently, only one area in this country produces sufficient geothermal steam for a large scale production of electricity. This area is the geysers region north of San Francisco. We are presently producing .1 percent of the total energy needs for this country by geothermal power.

How practical is geothermal energy? In theory, getting geothermal energy is a simple task. The energy is extracted from the ground by tapping the ground water. The water is then directed to a power plant which in turn will generate electricity. In practice, however, the process of obtaining geothermal power is difficult. It is difficult to determine the approximate area of the hot rocks. It is estimated that the hole has to be at least 30,000 feet to 50,000 feet deep. The steam released is rich in minerals and caustic chemicals. However, some of these elements can cause rapid deterioration of the steam turbines and may clog pipes.

What are some advantages of geothermal energy?

1. It provides another alternative to our energy problems.

2. Most of the problems of thermal energy are localized in nature. Most people seem to agree that the technology required to overcome the problems is not as complex as fossil or nuclear problems.

3. It may offer less of a pollutant threat than either fossil or nuclear energy.

What are some disadvantages of geothermal power?

1. Geothermal power plants take a considerable amount of maintenance. The hot water is very corrosive and the mineral deposits in the pipes cause problems.

2. Geothermal power has a limited geographic location. Most of this energy is found in the geyser areas such as Yellowstone National Park, New Zealand, Iceland, and Japan. Ninty-five percent in the contiguous United States lies in the western part of the country.

3. The plants are generally small and capable of supplying from 50 to 100 megawatts of electricity. A fossil fired power plant can supply 1000 megawatts of electricity.

4. New wells must constantly be sought out and drilled to maintain the supply flow. Old wells continually decrease in output.

5. Large land areas are required, between 3000 to 5000 acres for a 1000 megawatt plant. Part of this land becomes cluttered up with pipes.

6. Geothermal energy also presents environmental problems:

   a. Blowouts similar to oil blowout can occur and cause damage to plant and animal life.
   b. Gaseous pollutants such as ammonia, hydrogen sulfide and radioactive gases can be discharged in the atmosphere.
   c. Draining of the water from the well may cause cave-ins.
   d. Noise pollution
   e. Seismic activities - possibly.

STUDENT ACTIVITIES FOR GEOTHERMAL ENERGY:

Recommended for K-6:

1. Locate places on earth that utilize geothermal energy.

2. Heat a piece of rock on a wire gauze for five minutes and slowly place several drops of water on the rock. Record what happens and how this could happen in nature.

3. Locate and investigate underground houses and observe the relevance of geothermal conditions.

4. Research the underground potato houses in Maine.

Recommended for 7-12:

1. Investigate the experimental Geothermal Project in New Hampshire.

2. Investigate and evaluate some of the newer relevant magazines: Next, Futurist, Science 81, and Science and Technology.

3. Investigate and evaluate Iceland's 90% heat energy by geothermal.

4. Identify some of the pollutants associated with energy production from geothermal sources. Compare this with pollutants from other sources.

5. Compare electricity that is generated by heated steam with electrical production from oil, coal, nuclear.

Recommended for 7-12 - continued

6. Discuss the factors (economic, social legal) which determine how much/little power a community requires.

7. Take the earth's temperature.
Materials: 1 gallon can, sand for can, 300 watt bulb, thermometer- 0-100^{o}C and long enough to reach the bottom of can, metric ruler, cardboard box to contain can, and scissors.
Procedures: a. Set up as shown in diagram, Figure 1. b. Place light about 30 cm above the sand. c. Turn on light and heat sand for 15 minutes. d. Starting at the bulb end of the thermometer, place masking tape every 2 cm. Do not place tape over the scale of the thermometer. e. Remove the light source and take the temperature of the sand at the surface after 15 minutes. Continue to push the thermometer down 2 cm increments and repeat the temperature taking every 15 minutes f. Plot on graph (Figure 2). (Sheet G-1)

8. Plot the following data (Figure 1) from a well drilled 8Km into the earth's crust on the graph (Figure 2).
a. Calculate the average change in temperature (temperature gradient) for each Km in depth.
b. Calculate the temperature____^{o}C at the center of the Earth (approximately 6,350). (Sheet G-2)

9. The Earth's crust consists of a number of plates that moves approximately a few centimenters a year. Figure 1 illustrates a thin oceanic crustal plate moving gradually downward and below a thicker continental crustal plate. The movement aften produces molten rock, magma. Make a key and color the oceanic crust, continental crust, magma, hot rock, oceans, and volcanic rock. What will occur where the magma comes to the surface? (Sheet G-3, Figure 1)

10. An intrusion in the crust exists (Fig. 2) because the magma has melted the bed rock. After studying figure 2, discuss the following questions.
   a. What is the main source of the geothermal heat?
   b. How does the rainwater penetrate the geothermal heat?
   c. How does the heat penetrate the water?
   d. Where would you place a geyser or hot springs in figure 2? (Sheet G-3, figure 2)

Recommended for K-12:

1. Locate the area in the U.S. that might be suitable for naturally occurring geothermal resources. Relate these areas to population centers.

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Figure 1

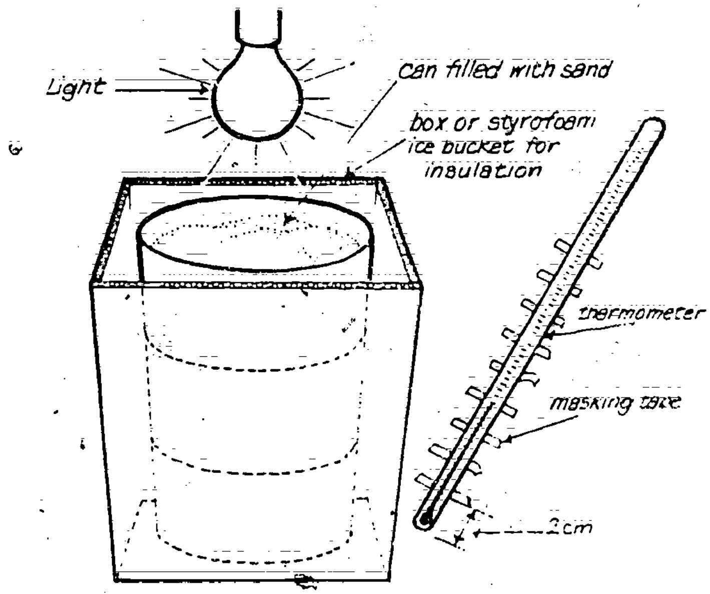


Figure 2

Depth Cm	Temp°C
0	
2	
4	
6	
8	
10	
12	
14	

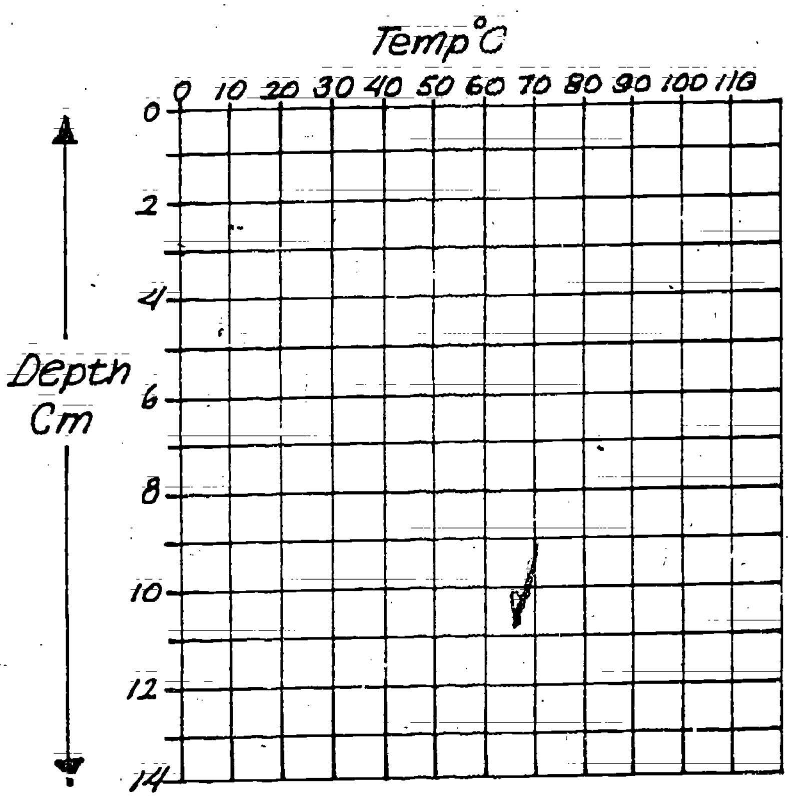
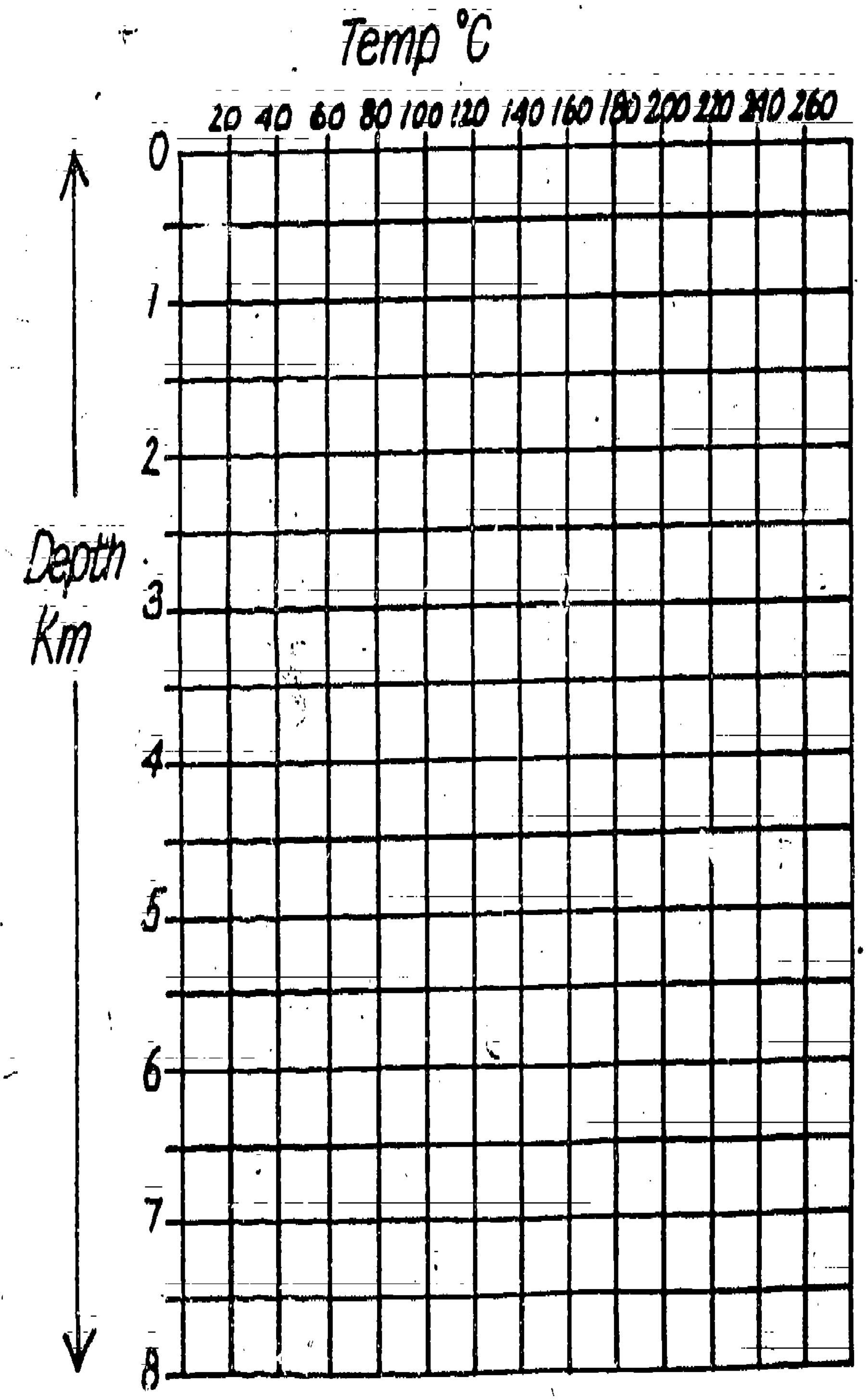


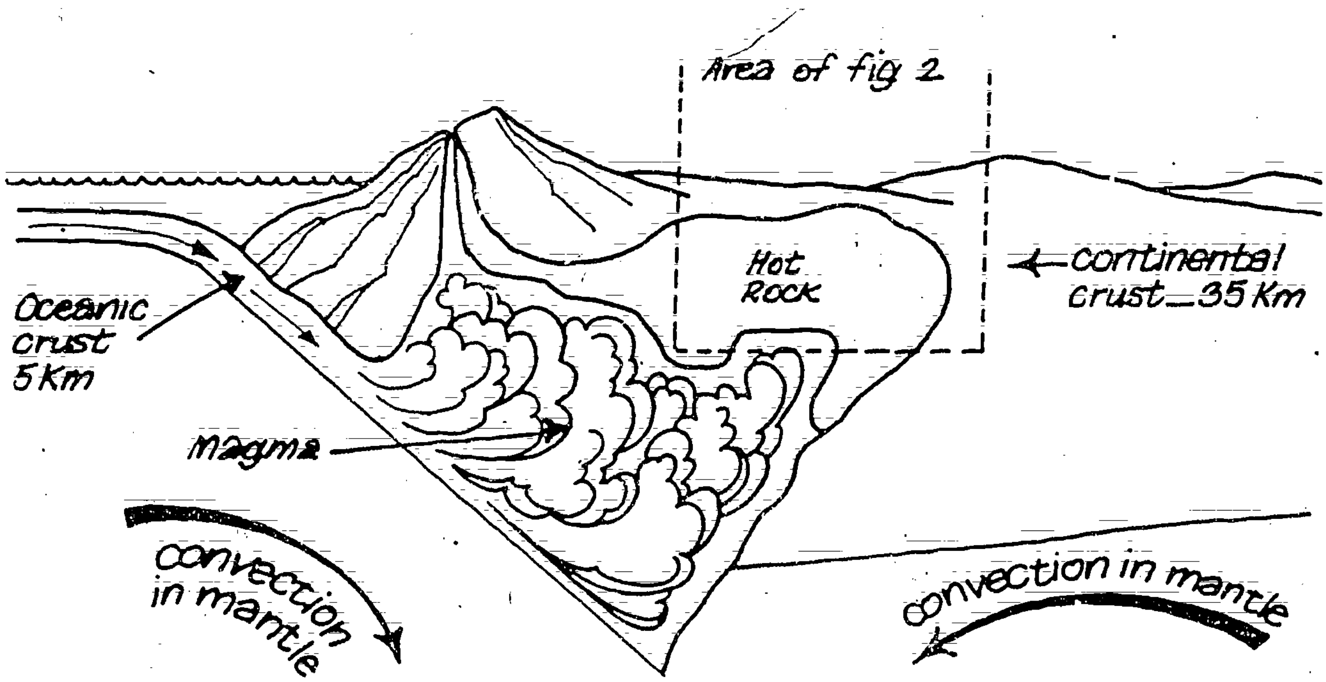
Figure 1

Depth Km	Temp °C
0	15°
1	51
2	88
3	120
4	151
5	179
6	205
7	232
8	257

Figure 2



"Sheet G-2"


Area of fig 2
Hot Rock
continental crust 35 Km
Oceanic crust 5 Km
magma
convection in mantle
convection in mantle

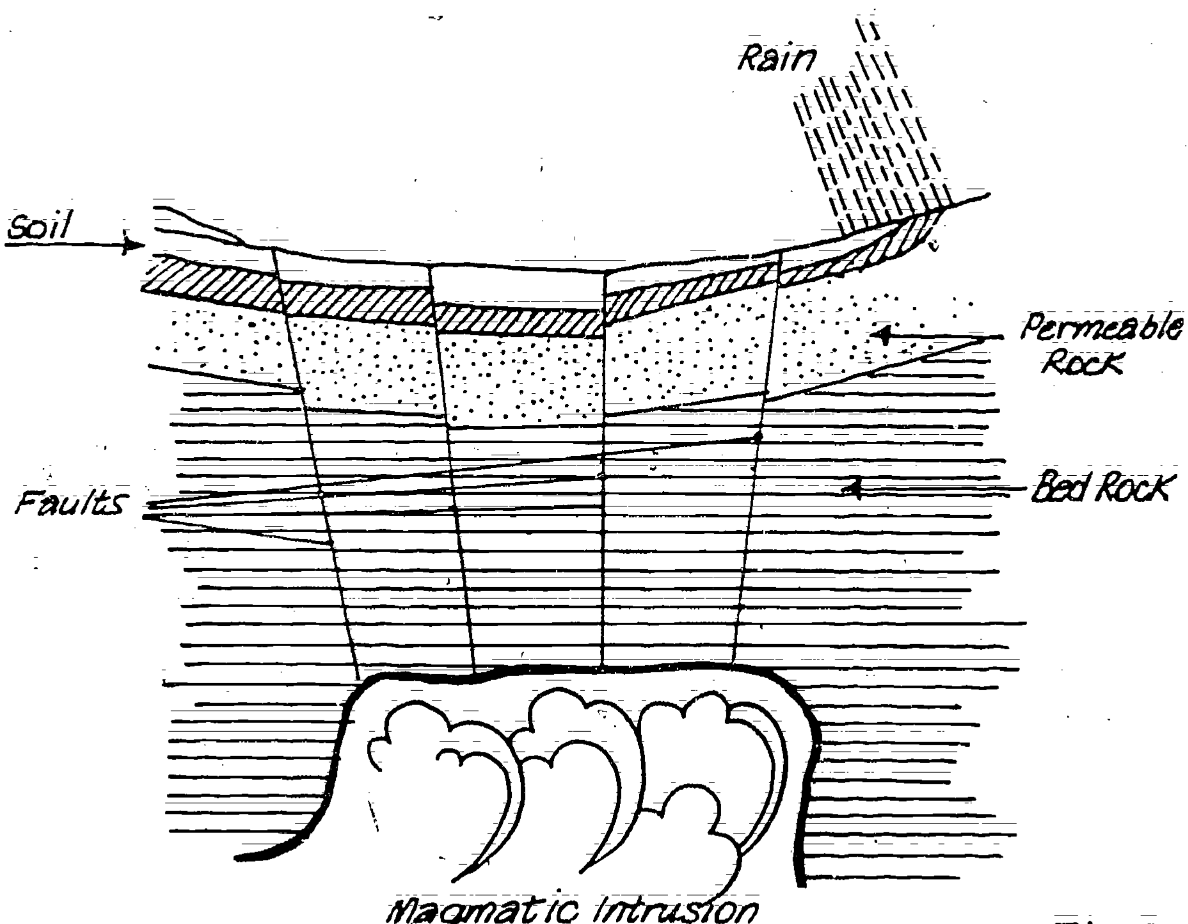
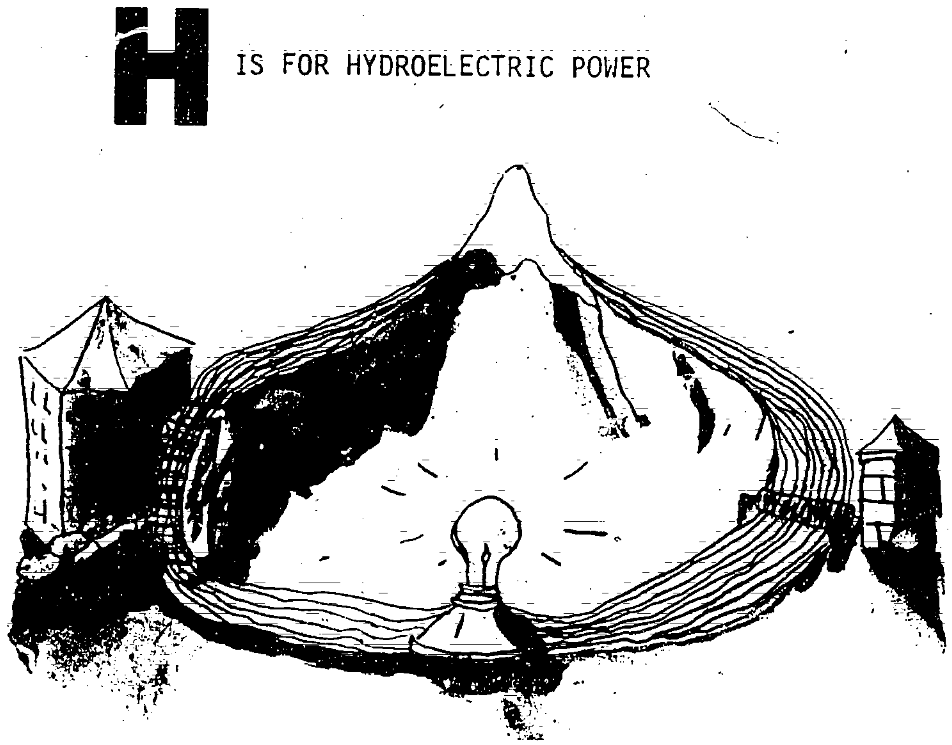

Rain
Soil
Permeable Rock
Faults
Bed Rock
Magmatic Intrusion

Fig. 2

H IS FOR HYDROELECTRIC POWER



OVERVIEW:

Students will obtain a basic understanding of some of the factors, both positive and negative, involved in the production of hydroelectric power. Also, they will investigate the current energy output of hydroelectric power and the potential output if new sites are developed.

TEACHER BACKGROUND:

We live in a world of energy transformation. Hydroelectric power is one way to transform the energy in moving water into useful work. The sun's energy is used to raise water as water vapor to elevations above sea level. Elevating the water above sea level imparts to the water an energy "pontential" because the energy used to move the water is now stored in that water much like the energy used to wind a spring is stored in the spring.

This potential energy is transformed into kinetic energy as the water (water vapor) falls as rain or snow. Kinetic energy is the energy of motion; it is this type of energy that can be trapped to do useful work for mankind. About 30% of the rainfall in the U.S. becomes runoff. The other 70% is evaporated, transpired, or absorbed.

The availability of runoff for hydroelectric power depends on rainfall and topography. Once rainfall and topography provide a source of water, then hydroelectric potential may be calculated by the formula:

$$P = \frac{AVHe}{11.8}$$

where P equals the power expressed in kilowatts, A equals the average cross sectional area of the stream or river, V represents its velocity in feet per second, H represents the height of the water above the position of the turbine (in feet), e is the overall efficiency factor (between 0.50 and 0.70) and 11.8 accounts for the density of water and conversion from foot-pounds per second to kilowatts.

It can be determined from this formula that power is directly proportional to the area of water, its elevations, and its velocity. Therefore, two foot by two foot stream, flowing at a rate of 1 foot per second through a fall of ten feet (very substantial) with a 70% efficient turbine could produce 2.37 Kw.

$$\frac{(4)\ (1)\ (10)\ (.70)}{11.8} = 2.37 \text{ KW}$$

The e representing the overall efficiency factor is especially important because although efficiency can be determined and predicted by scientific and mathematical formulas, the choice of a system demonstrating a particular efficiency ratio is a human choice. When studying hydroelectric power, there are many subsidiary human choice issues to consider.

Hydroelectric power provides us with another energy source, but it does have several drawbacks. Economically, it is not feasible to develop all the world hydro resources since water is needed for other purposes, such as navigation, fisheries, and irrigation. Also, construction of hydroelectric is very costly and time consuming. Another consideration that environmentalist frequently address is the flooding of our wilderness.

Hydroelectric power cannot produce energy on the same level as the fossil fuels, but it is a definite viable energy source.

STUDENT ACTIVITIES FOR HYDROELECTRIC POWER:

Recommended for K-6:

1. Locate water in its three forms on the earth, and discuss the means by which water is recycled (ice to water to vapor to rain, etc.)

2. Invite a representative from a hydroelectric power station to the class to describe how a dam helps produce electricity.

3. Make a political map of their state and highlight hydroelectric power sites on their maps.

4. Draw a map of their state and identify at least five major rivers, their direction of flow, and the points of origin and completion.

5. Find and identify the Mississippi River and five of its tributaries.

Recommended for 7-12:

1. Calculate energy supplies from a variety of situations, including steeply sloped streams vs. nearly level streams, slow vs. fast streams, large vs. small streams, and efficient vs. inefficient turbines.

2. Visit a local hydroelectric site and calculate the amount of energy produced.

3. Research the first site in America to use water power as an energy source in the processing of wheat (South Berwick, Maine).

4. Research water power used by New England factories in the period 1820-1840.

5. Graph the amount of water power areas in the United States over the years 1800-1980. A decrease should be noted in the amount of usage.

6. Investigate the amount of hydroelectricity in relation to other types of energy production in their state.

7. Choose a hydroelectric site and using a map determine the watershed. Discuss the seasonal variation and electricity production.

8. Locate all the hydroelectric sites in the state and determine why they are located at these sites and what the power production is from each

9. Build a waterwheel. Operate it as overshot, undershot, and breast.
   a. Predict first, then measure change by changing volume, speed, etc.
   b. Calculate efficiency of wheel.
   c. Make all the appropriate measurements and estimate watershed (runoff, width/depth/velocity, and the power potential of the stream if dam is built. Use a stream in the community.

Recommended for K-12:

1. Examine a stream or runoff to observe different flow rates based on width, depth, slope, and natural obstacles. Flow rates can be simply estimated by floating objects. Have students experiment with damming, noting the force which the confined water exerts.

RESOURCES:

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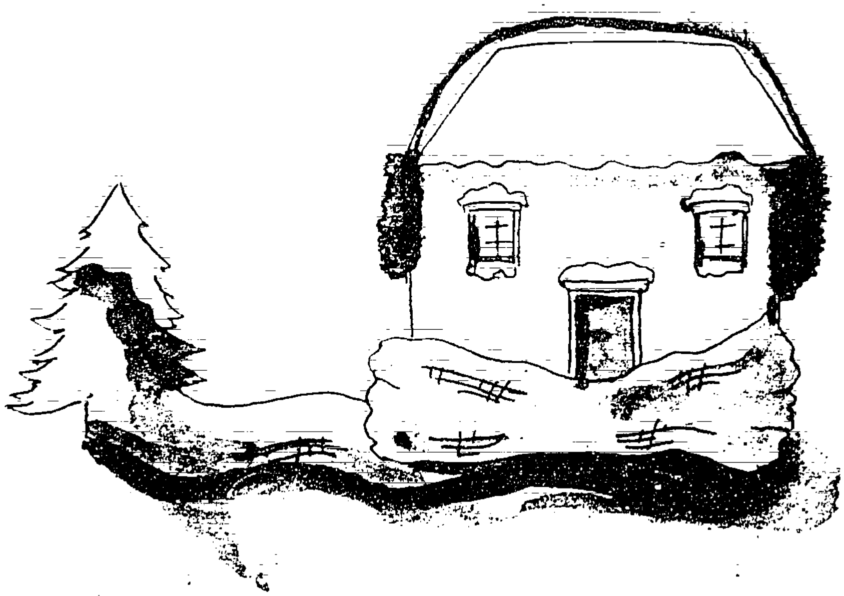
I IS FOR INSULATION



OVERVIEW:

Students learn the importance of proper insulation practices in energy conservation. They investigate the different types of insulation materials, their R-value and their cost. Also, information and procedures for insulating homes will be presented. The students will determine the advantages/disadvantages of insulating their homes.

TEACHER BACKGROUND:

Home insulation is one important way to combat the increasing fuel bills. Properly installed insulation is one of the quickest and most cost-effective way to reduce the cost of home heating and cooling. Governmental and private agencies and utility companies have recognized the need for insulation.

Although any material which resists heat flow is potentially insulation, the homeowner must consider such things as availability, cost, fire resistance, mildew, deterioration of performance, health hazards, odors, and other things in selecting an insulation for his/her home.

Over the years, the insulation industry has developed these principal substances for use in home insulation.

Material	Form	R-Value (per inch of thickness)	Costs
Glass Fiber	Batts, Blankets	3.0-4.0	Low
Mineral Wool	Loose Fill	3.0-4.0	Low
Cellulose Fiber	Loose Fill	3.5-3.7	Low
Vermiculite	Loose Fill	2.2-2.3	Medium
Polystyrene	Board Form	4.0-5.0	High
Urethane	Board, Foamed	6.25	High
Ureafor maldehyde	Foamed	4.0-4.1	Medium

Insulation is rated with a R-value. This number tells the resistance to heat flow. The larger the R-value, the better the insulation. One brand may be thicker than another, but if the two are marked with the same R number, they resist heat flow equally.

Batt and blanket are flexible fiber glass or mineral wool materials. The batt insulation is usually 4' long and available in 15" and 23" widths. Blanket insulation is on a roll and can be cut to the desired length. This type of insulation is best suited to fit between studs, rafters and joists with 16" or 24" spacing. They are sold with or without a paper or foil vapor barrier. Both are flame resistant and are easy to install. Vapor barriers diminish the flow of moisture through insulation to prevent condensation. Vapor barriers should be located on the warm side (inside).

Loose fill insulation consists of vermiculite, mineral wool, glass fiber, and cellulose fiber. It will fill irregular spaces and can be poured between the joists of an attic floor. It can be blown into a wall cavity between the studs. Vermiculite is a poorer and, consequently, more expensive insulator than the mineral wool, glass, or cellulose. Loose-fill glass fiber is better than the vermiculite, but not cellulose fiber. Loose fill insulation must be adequately vapor-proofed on the inside of the house with an approved moisture resistant material. Loose-fill insulation is best for horizontal spaces because of its tendency to settle in vertical spaces and, consequently, to leave cold spots.

Rigid insulation consists of two basic types. Polystyrene is a plastic foam board, blue or white in color. This board form is either extruded or molded and has a lower R value than the urethane. Urethane has the highest R value of any commonly used insulation material. This material is extremely flammable and should be covered with a fire resistant material, such aluminum foil. Urethane can be sprayed as a liquid onto an open wall, or is available in board form.

Foamed-in-place ureaformaldehyde is new on the insulation market and is suitable for filling a wall cavity. Proper application is extremely important to obtain complete coverage, without void spaces, and to keep shrinkage to a minimum and the R to a maximum. This form of insulation is illegal in some states. It is legal in Maine.

In completely uninsulated homes, the most effective and economical insulations are the loose fill mineral wool or cellulose fiber. These may be either poured in manually or blown into the wall and attic cavities by a commercial installer. It has been estimated that the cost of insulation is recovered in one and one half to four years.

In homes under construction, the most commonly used insulation is batts or blankets on the walls, rigid insulation outside the foundation, and blankets, batts, or loose insulation in the attic.

STUDENT ACTIVITIES FOR INSULATION:

Recommended for K-6:

1. Survey the type of insulation found in their personal living quarters. Determine whether more insulation is needed.

2. Test the benefits of insulation by filling one insulated and one uninsulated jar with the same amounts of water, heated to the same temperature. Cap both jars; record the temperatures of each at half hour intervals until they reach room temperature.

3. Take a walking field trip to a local home under construction. Determine what type and amount of insulation is being utilized.

4. Examine a bag of insulation. Discuss the label and different R-values for the various thickness.

5. Compare the temperature readings of an unheated room or garage to an unheated but insulated room in the school or home.

6. Take a shoe box. Cut a $10cm^2$ hole in one side. Place a heat source such as an incandescent lamp inside the box which is placed upside down. Tape various cut out materials over the $10cm^2$ openings. Record the temperatures on the outside of the various materials, e.g., wood, aluminum, foil, fiberglass, beadboard, etc., to determine which is the best insulator.

7. Check the R-values for different building materials. Discuss which materials would be best in school, their homes, new homes being constructed, business, etc.

8. Observe the common characteristics in all the insulation types. Explain how they slow heat transfer.

Recommended for 7-12:

1. Determine temperature difference between the floors and ceilings as it relates to the insulation in our buildings. Put a thermometer on the floor and hang another near the ceiling. Allow at least 5 minutes for the thermometer to register. Then read and record their temperatures. What is the temperature

difference? In other rooms? There is a direct relationship between high temperature differences and the amount of insulation in the walls, floors, or ceilings. Another experiment could be conducted in the classroom, gymnasium or other rooms in the school.

2. Discuss several kinds of weatherproofing and insulating materials as to efficiency, cost, and ease of installation. Small quantities of various materials could be acquired for experimentation.

Recommended for K-12:

1. Determine the school wall insulation by placing one thermometer against a wall and placing another thermometer in the center of the room. Make sure that the two thermometers are at the same height. If there is more than 5°F difference between the two thermometers, the wall is probably not adequately insulated. This activity can be done at several locations in one room or the students can repeat this activity at his/her home.

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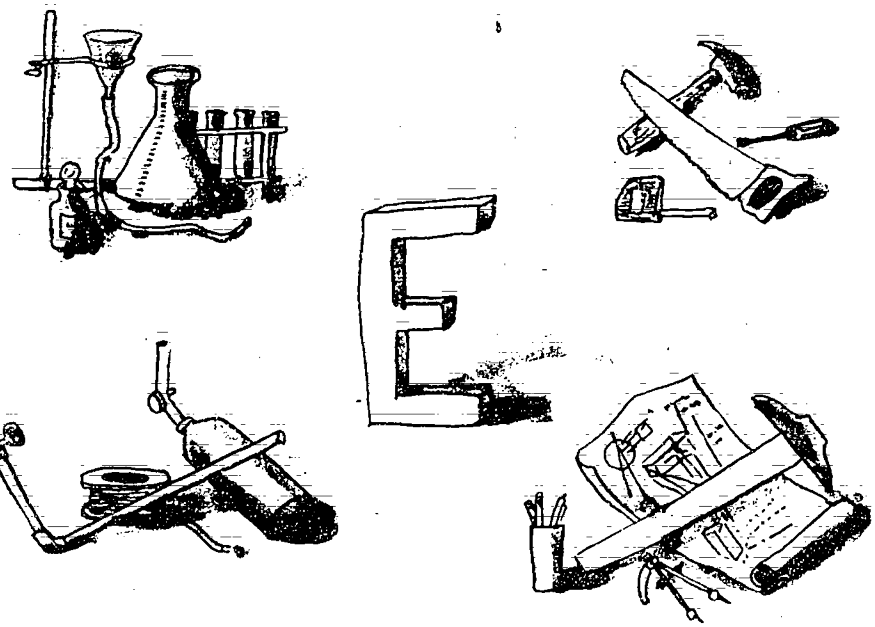
J IS FOR JOBS THAT ARE ENERGY RELATED



OVERVIEW:

Students become aware of existing energy-related job opportunities. This can be accomplished through reading, resource speakers, and, if possible, tours of energy-related businesses. By considering the ways in which old industries, e.g., wagon manufacturing were supplanted by new, e.g., automobile manufacturing, students will become aware that new jobs arise when old industries, jobs, or concepts become obsolete or impractical. In addition, student awareness of locally-available energy-related jobs is heightened by personal contact with employees.

TEACHER BACKGROUND:

As a result of the energy crisis, schools are beginning to realize the necessity for introducing energy career awareness programs. These career awareness programs must inform the students of all new emerging careers in energy. As new energy sources are explored, new careers in energy will emerge. The school must not only institute career awareness programs in energy, but also must develop multidisciplinary curricula that will assure a broad-based education since energy concerns are multifaceted, i.e., political, economic, social, ethical, and scientific.

The accompanying chart from the U.S. Department of Labor and Odom Fanning's February, 1979 article in Career World 2 is a sample of the job opportunities of the present and future energy careers.

Job Name	Usual Training Required	Demand for Workers	Comments
SOLAR ENERGY			
solar engineers	graduate degree	increasing	a new field
electrical engineers	4-year college	increasing	
design engineers	4-year college	steady	specialization often necessary
architects	graduate degree	steady	demand high for energy planners
envir. engineers	4-year college	increasing	
civil engineers	4-year college	steady	
architectural technicians	2-year college	steady	
engineering technicians	2-year college	increasing	demand high in some areas
engineering technologists	4-year college	increasing	demand high in some areas
sheet metal workers	apprenticeship	increasing	important in solar field
plumbers	apprenticeship	steady	
electricians	apprenticeship	steady	
ironworkers	apprenticeship	steady	
welders	apprenticeship	steady	
laborers	on-job experience	steady	
equipment operators	on-job experience	steady	
OIL INDUSTRY			
petroleum engineers	4-year college	increasing	
envir. engineers	4-year college	increasing	
chemical engineers	4-year college	increasing	
chemists	4-year college	increasing	
geologists	4-year college	increasing	
geophysicists	graduate degree	increasing	
engineering technicians	2-year college	increasing	demand high in some areas
engineering technologists	4-year college	increasing	demand high in some areas
laboratory technicians	2-year college	increasing	
welders	apprenticeship	steady	
ironworkers	apprenticeship	steady	
oil well drillers	apprenticeship	increasing	requires special training
laborers	on-job experience	steady	
truck drivers	on-job experience	steady	
equipment operators	on-job experience	steady	

Job Name	Usual Training Required	Demand for Workers	Comments
COAL INDUSTRY			
mining engineers	4-year college	increasing	
civil engineers	4-year college	steady	
geologists	4-year college	increasing	
geophysicists	graduate degree	increasing	
analytical chemists	4-year college	increasing	
envir. engineers	4-year college	increasing	
mine safety inspectors	4-year college	increasing	
coal gasification engineers	4-year college	increasing	very high demand
engineering technicians	2-year college	increasing	demand high in some areas
engineering technologists	4-year college	increasing	demand high in some areas
laboratory technicians	2-year college	increasing	
laborers	on-job experience	steady	
miner's assistants	apprenticeship	increasing	
truck drivers	on-job experience	steady	
equipment operators	on-job experience	steady	
POWER PLANT JOBS			
electrical engineers	4-year college	increasing	
power engineers	4-year college	increasing	
mechanical engineers	4-year college	steady	
design engineers	4-year college	steady	high demand in a few areas
envir. engineers	4-year college	increasing	
nuclear engineers	4-year college	steady	some special training required
nuclear physicists	graduate degree	increasing	
civil engineers	4-year college	steady	
engineering technicians	2-year college	increasing	demand high in some areas
engineering technologists	4-year college	increasing	demand high in some areas
laboratory technicians	2-year college	increasing	
envir. monitors	4-year college	increasing	
pipefitters	apprenticeship	steady	special certification for nuclear work
electricians	apprenticeship	steady	
carpenters	apprenticeship	steady	
welders	apprenticeship	steady	
ironworkers	apprenticeship	steady	
boilermakers	apprenticeship	steady	

Job Name	Usual Training Required	Demand for Workers	Comments
POWER PLANT JOBS (CONTINUED)			
painters	apprenticeship	steady	
sheet metal workers	apprenticeship	increasing	special certification for nuclear work
bricklayers	apprenticeship	decreasing	
laborers	on-job experience	steady	
truck drivers	on-job experience	steady	
equipment operators	on-job experience	steady	

The Information Bulletin, November 2, 1980 of ERIC/SMEAC describes materials on energy-related careers. This bulletin includes descriptions of many areas of energy careers, such as education, technology, etc.

STUDENT ACTIVITIES FOR JOBS THAT ARE ENERGY RELATED:

Recommended for K-6

1. List jobs which are no longer found today, i.e., carriage builders, butter churn builders, candle dippers, etc., and corresponding industries/jobs which are found today, i.e., car mechanic/assembly plant worker, food plant/trucker, electrician, etc. Discuss why these job changes have occurred and speculate on which jobs will still be in demand in the year 2000.

2. Use DOE unit, Community Workers and the Energy They Use (Grades 1-3) to study energy-related occupations.

3. Watch a favorite T.V. show; identify energy-related jobs.

4. Role play energy-related jobs or play charades.

5. Write and perform a short play or puppet show characterizing an energy waster and his/her conscience.

6. Write a story about one energy-related career of interest to them.

7. Draw posters to illustrate energy-related occupations, e.g., oil derricks, oil truck drivers, etc.

Recommended for 7-12:

1. Conduct an Energy Fair.

2. Research job requirements and rsponsibilities and prepare posters, reports, etc.

3. Research a case-study of how changes in technology energy sources and energy availability have changed the work roles of older citizens and their friends throughout their lives.

4. Select an energy-related occupation and interview a person working in that field and report on it.

Recommended for K-12:

1. Have resource speakers from various energy-related fields describe their jobs.

2. Create what life will be like in the year 2001. Their description can include homes, transportation, school, jobs, entertainment, etc.

3. Take a field trip to an energy-related industry, such as a power plant, solar home, solar panel construction, etc.

RESOURCES:

Current Energy and Ecology, Volume 2, No. 4 December, 1979.

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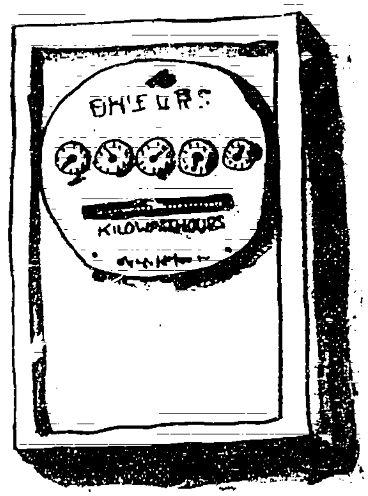
Wilson, Mitchell. Energy: Life Science Library. New York: Time-Life Books, 1970.

Wood, George and Harry Carpenter. Our Environment: How We Use and Control It. Boston: Allyn and Bacon, 1956.

K IS FOR KILOWATT AND THE ELECTRICAL USES OF ENERGY



OVERVIEW:

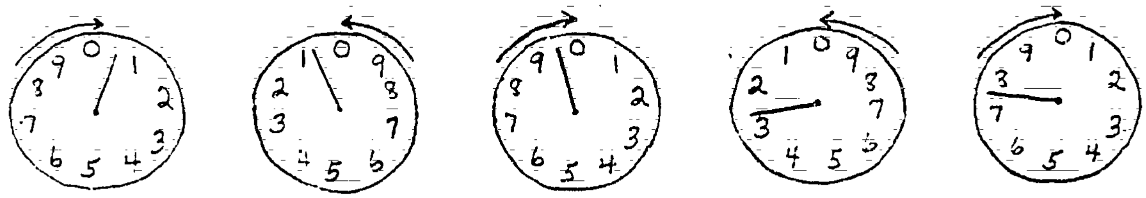
Students explore their present electricity uses and investigate ways to utilize this resource more wisely. Students learn the fundamental concepts of electricity and the electric consumption of a variety of regularly used applicances. Also, they learn how to read an electric meter.

TEACHER BACKGROUND:

The kilowatt is a unit of electrical power. One kilowatt (kw) is equal to 1000 watts, a watt being defined as the product of the voltage (electrical force) and the amperage (electrical current). An expression used more commonly than kilowatt is kilowatt-hour (kwh), a measure of electrical energy. A kilowatt-hour is the amount of electricity it takes to light a 1000 watt light bulb for 1 hour (or a 100 watt for 10 hours). We pay for the electricity we use by the kilowatt hour.

To determine how much electrical energy is used in a building, a kilowatt-hour meter is used. All electricity going into the building is sent through a meter which keeps track of the amount used. Inside the meter revolves a metal disk connected to a small motor. The more current that flows through the motor, the faster the disk moves. The motor is connected to a set of gears which turns the hands on a set of dials. By reading the numbers indicated on the dials, it can be determined how many kilowatt-hours have been used in a period of time. The user is then billed by the electrical utility at a rate per kilowatt-hour for the electricity used.

To read a meter like the one below, record the last number passed by the pointer. Each dial turns in the opposite direction from the next one. When the pointer is between two numbers, it is the smallest of the two numbers that should be recorded. The meter below would be read as 00927 kilowatt-hours. Since the measurement is accumulative, the present reading must be subtracted from the most recent reading to determine the kilowatt hours used in that time period.



In the United States, we depend on electrical energy for most of our power and lighting needs. In addition to our homes, most schools, churches, theaters, stores and streets are lighted electrically. Without electrical energy, we would find it difficult to get through the day. In our homes, besides lighting, we use electricity to run stoves, refrigerators, washers, dryers, air conditioners, small appliances, electric blankets, television sets, stereos, razors, hair dryers and a host of other devices. We often use electrical energy when another of energy might be as efficient and much less costly or wasteful. Examples of this would be if we used an electric clothes dryer when a clothesline could be used or an electric blanket where we could add another blanket or quilt.

There are many farms in this country, and they are big users of electricity. For example, electricity is used to pump water, grind feed, incubate chicks, milk cows, and convey potatoes to storage bins to name a few examples. Electrical energy which has brought many changes to industry has allowed the manufacturing of more products at a lower per unit price. Electric motors made production lines safer and more efficient. They are capable of doing work ranging from drilling microscopic holes to lifting giant locomotives. Many metals are extracted from ores by electrical processes. Almost any industrial need for power or heat can be met with electricity. Electricity can be said to have created its own industrial revolution.

Most electrical power for the public is generated from water, oil, coal, and nuclear materials in large power plants. Thousands of these plants in the United States generate billions of kilowatt-hours per year. These plants are owned and operated by federal or local governments or private companies. Many billions of kilowatt-hours are also generated by industries for their own use.

After electricity is generated at power stations, it is sent at high voltage through transmission lines. Transformers reduce the voltage to the level needed by the user--usually 110 and 220 volts for household use, to the level needed by the user.

It is important to review electrical safety, such as checking cords, avoiding the use of electricity while in water, and avoiding overloading.

Since World War II the American family has purchased and uses many small applicances daily. Sheet K-1 outlines the appliance, watts, usage, annual KWH, and annual cost @ 5¢/KWH.

STUDENT ACTIVITIES FOR KILOWATT AND THE ELECTRICAL USES OF ENERGY:

Recommended for K-6:

1. Cut out articles and advertisements from magazines and newspapers. Make notebooks of those which promote waste of electricity and those which promote energy conservation. Discuss the items and try to determine why a particular group of advertiser takes a particular point of view.

Recommended for 7-12:

1. Read their home meters on regular time intervals for several days to determine the time of day or time of week their family uses the most energy and determine what activities might be altered to reduce consumption.

   Calculate how many kilowatts are used for a given activity (e.g. fixing and eating breakfast, "cleaning up" -- including showering, washing/drying hair, using electric toothbrush or shaver, etc.)

2. Record their family's electricity usage for one week, then put conservation practices into effect and monitor for a second week. Record any differences.

3. Set up displays of small electrical appliances and pictures of large ones with label cards showing the wattage of each. Research and discuss whether it is more energy-efficient to use toaster-ovens, microwave ovens, electric frypans, slow cookers, crepe-makers, sandwich toasters, popcorn poppers, etc., than to use an electric range for various types of cooking.

4. Investigate the rate structure of the power company serving the area in which one lives. Do all customers get the same rate? Is there a different rate for farm use? Industrial use? Commercial use? Is there an incentive for using less electrical energy?

5. Devise an experiment to determine how much light is given off by a 40W fluorescent bulb as compared to that given off by a 40W incandescent bulb.

7. Build an electrical generator (hand crank or bicycle power). Try to light a bulb.

8. Using a battery, a bulb, and a wire, try to light the bulb. Draw the procedure.

9. How many different ways can you find to light the bulb? Draw all possible ways. Hint: Remember the lazy bulb.

10. Using two pieces of wire, how many ways can you light the bulb? Draw all possible ways.

Recommended K-12:

1. Practice reading electrical meters.

2. Make posters, bulletin board display, or brochures dealing with ways to save electricity -- in the home, at work, at school, in recreation, etc.

3. Make a list of 10 electrical devices that students use regularly. Research and discuss how people 200 years ago did the same things that he/she does, but without today's appliances. Were they able to do things he/she discussed. For example, wash clothes with a washboard and hang them on a clothes-line to dry, or saw and drill wood with hand saws and drills. Some communities are close enough to restored historical villages, such as Old Sturbridge Village in Massachusetts or King's Landing in New Brunswick where costumed staff members actually "live" like people of the past. Field trips to theses places could focus on the historical uses of energy, particularly electrical energy.

4. Guest speakers could be invited to speak, i.e., representatives of power companies could explain how power is generated and transmitted to the consumer, home economists could talk about energy, representatives of various industries could speak about how electrical energy is used in their industries, members of conservation groups could speak on the need for conservation and wise use of electrical energy, etc.

5. Take a field trip to an electrical generating plant.

6. Investigate "fuel adjustment charges" and explain how they affect electric bills.

RESOURCES:

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"Electricity, the Servant of Modern Man." Compton's Encyclopedia. Volume II. Chicago: F.E. Compton Company, 1973.

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Sheet K-1

HOUSEHOLD ELECTRIC APPLIANCE USAGE

	Average Wattage	Average Hours Used Per Month	Approx. Cost Per Hour @ 5.7¢/KWH	Average KWH Per Month	Approx. Cost Per Month @ 5.7¢/KWH	YOUR USAGE OR COST
Food Preparation						
Blender	300	**	1.7¢	**	$ **	
Broiler (portable)	1,140	6	6.5	7	.40	
Can Opener	100	**	.6	**	**	
Coffee Maker	1,200	10	6.8	12	.68	
* Cooker/Fryer/Dutch Oven	1,200	3	3.7	2	.11	
Corn Popper	575	1	3.3	**	.04	
* Fondue/Chafing Dish	800	2	2.1	**	.04	
* Frying Pan	1,200	11	4.2	8	.46	
Microwave Oven (high)	1,450	11	8.3	16	.91	
Mixer (hand/stand)	115	**	.7	**	**	
* Range (total)	12,000	40	8.3	58	3.31	
6" surface unit (high)	1,400	--	8.0	--	--	
8" surface unit (high)	[illegible],500	--	14.3	--	--	
Oven bake (standard)	3,200	--	5.8	--	--	
Oven bake (self-clean)	3,200	--	4.6	--	--	
Oven broil	3,000	--	17.1	--	--	
Self-cleaning feature	4,000	--	13.0	--	--	
* Sandwich Grill/Waffle	1,200	--	5.5	3	17	
Slow Cooker	100	50	.6	5	.29	
Toaster	1,146	3	6.5	3	.17	
Toaster Oven	1,500	10	2.2	4	.23	
Warming Tray	140	4	.8	**	.03	
Food Preservation						
* Freezer (15 cu. ft)						
Manual Defrost	340	720	.8	100	5.70	
Automatic Defrost	440	720	1.2	150	8.55	
* Refrigerator/Freezer						
Manual Defrost (10-15 cu. ft.)	300	720	.5	60	3.42	
Automatic Defrost (16-18 cu. ft.)	450	720	1.2	150	8.55	
Automatic Defrost (20 cu. ft.)	500	720	1.3	160	9.12	

undry						
Clothes Dryer	4,856	17	27.7	83	4.73	
Iron	1,100	9	3.3	5	.29	
Washing Machine (Automatic)	512	18	2.9	9	.51	
alth & Beauty						
Hair Dryer						
Soft Bonnet	400	2	2.3	1	.06	
Hand Held	1,000	2	5.7	2	.11	
Hair Setter/Curlers	350	3	2.0	2	.06	
Heat Lamps (infrared)	250	4	1.4	1	.06	
Shaver	15	**	**	**	**	
nforting Conditioning						
Air Conditioner (room)	1,000	133	4.3	100	5.70	
Bed Covering	177	240	.5	21	1.20	
Dehumidifier	257	366	1.5	94	5.36	
Fan (window)	200	70	1.1	14	.80	
Heater (portable)	1,500	17	8.6	25	1.43	
Heater (Quartz)	1,500	17	8.6	25	1.43	
Heating Pad	65	12	.2	**	.02	
Heating System						
Burner Motor	266	226	1.5	60	3.42	
Warm Air Fan	292	274	1.7	80	4.56	
Hot Water Circulator	120	250	.7	30	1.71	
Humidifier	177	79	1.0	14	.80	
Water Bed	350	720	1.2	150	8.55	
ertainment						
Hi/Fi/Stereo	100	90	.6	9	.51	
Radio	7	60	**	**	.02	
Television						
B & W tube type	100	180	.6	18	1.03	
B & W solid state	45	178	.3	8	.46	
Color tube type	240	183	1.4	44	2.51	
Color solid state	145	186	.8	27	1.54	
ipment						
Auto Engine Heater	750	135	4.3	101	5.77	
Clock	2	720	**	1	.06	
Dishwasher	1,201	25	4.6	30	1.71	
Garage Door Opener	230	65	1.3	15	.86	
Garbage Disposal	445	**	2.5	**	**	
Heat tape (24 ft.) @ 7 watts per ft.	168	720	1.0	121	6.90	
Lights (5-60 watt lamps)	300	150	1.7	45	2.57	
Sewing Machine	75	13	.4	1	.06	

Equipment (cont.)

Tools						
3/8" Drill	300	**	1.7	**	**	
7" Circular Saw	800	**	4.6	**	**	
Vacuum Cleaner	630	6	3.6	[illegible]	.23	
* Water Heater (Family of 4)	4,500	720	3.2	400	22.80	
Water Pump	600	33	3.4	20	1.14	

TOTAL USAGE ________ KWH x .05

= $ ________

Customer Service Charge 5.70

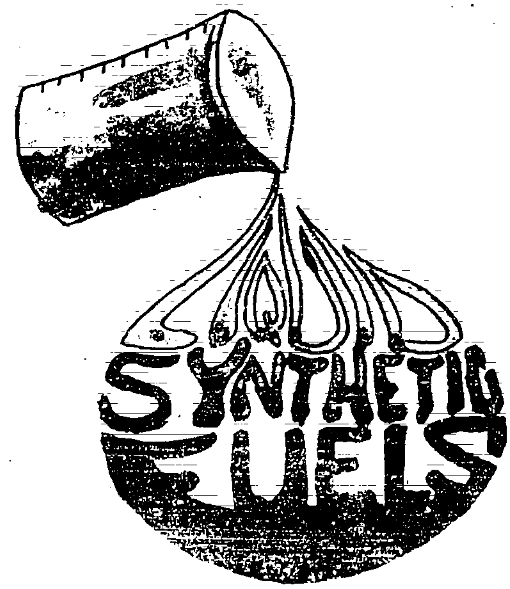
TOTAL $ ________

* Indicates thermostatically controlled applicances; cost are based on an estimated "on" time.

Cost Per Hour are based on monthly hours use. 720 Hours = total month.

** Indicates average usage is less than 1 hour or 1 KWH; or cost is less than .01¢ per hour or $.01 per month.

L IS FOR LIQUID SYNTHETIC FUELS



OVERVIEW:

The student becomes aware of the similarities and differences between a synthetic fuel economy and a petroleum-based economy. The uses of synthetic fuels in the past are compared with modern uses of these resources. Some of the problems associated with their use are presented.

TEACHER BACKGROUND:

Weaver (1981) defines "synfuels as fuels synthesized from sources other than crude oil or natural gas and used in place of them or their derivatives, primarily for transportation and heating boilers."

The problems involved in synthetic fuel (synfuel) production involve serious economic considerations. The federal government has established a level of support in the order of $260 million to produce less than ten percent of our energy needs by the year 2000. At this rate, synfuels will be at least twice as costly as their regular counterparts.

Beyond the concern and the threat of carcinogenic by-products associated with synfuel production, the economics of the water requirements is a concern. There are three basic water requirements: one is a raw material (hydrogen), the second is for cooling (one and two together amount to double the water requirements of an electric power plant of the same energy output), and the third water requirement is for the reclamation of the 400 acres a year that will be stripmined. In the arid regions where the coal is found, water is also used for agriculture. There could be serious conflicts over how the limited water supply will be used.

Synthetic fuel gets its name because of the synthesis of the carbon of coal with the hydrogen of water into a hydrocarbon. Technically, gasohol and the oil obtained from shale are not synfuels because there is no forced hydrogenation involved in their production, they are often lumped into this category. Coal is primarily carbon, whereas a liquid fuel is a hydrocarbon. The higher the hydrogen content, the more volatile the fuel. Heavy fuel oil has a ratio of six carbon to one hydrogen while gasoline has one carbon to two or three hydrogens. Obviously, since there are sixteen carbon atoms in coal, a very large quantity of water is required for the hydrogenation. One advantage in this process is the reduction of sulfur from the final product.

The 1973 Arab Oil Embargo hurt the United States because it had become so dependent on petroleum as our major energy feedstock. In order to understand this overdependence, one must understand why oil has been the product of choice since the early 1900's. The cost of obtaining and refining oil was deceptively cheap in the U.S. because of domestic sources and the exploitation of foreign oil sources, sophisticated technology, and the volume of consumption in relation to real supply. Not only was oil cheap, it was extremely convenient to use because it was a liquid. Although other energy feedstocks have their own advantages, oil gives us a higher energy rating per unit of volume of weight. This ratio makes it relatively economical to transport and to use as a fuel. Weight and volume are two factors that are necessary to control closely in order to be cost-effective in shipping. Liquid fuels include petroleum and its by-products, alcohols, organic oils, and oil made from coal.

The history of liquid fuels goes back to recent pre-history. Animal fats were used in liquid and colloidal form as a fuel for lamps and torches to provide heat and light. They were very valuable and used as barter and trade. In fact, the grave robbers of Tutankhamun's tomb forsook most of the gold trappings of royalty, only to pilfer the more precious oils contained in the alabaster amphorae. The Biblical story of the Marriage Feast indicates the use of oil as fuel.

Through history there were chance discoveries of tars and oils, but organic oils were the primary material used for lighting. Solid fuels were used for heating and industrial purposes. The production of organic oils was either a cottage industry or an industry concentrated in major cities of well-developed cultures. The real breakthroughs in production and use came later in the 1800's.

The liquid fuel industry did not become widespread until the advent of whaling on the oceans of the world. Whale oil suddenly became very popular as a fuel for illumination. Although petroleum was discovered in 1859, and coal oil was produced in volume around this time in different countries, but whale oil remained the major liquid fuel. Then, the whale population started to dwindle because of fishing pressures--there were no longer enough whales to make the wide-scale slaughter profitable.

Many homes outside city lighting limits relied on coal oil (kerosene) to combat rising whale oil prices which paralleled an increasing demand in Western countries for a cheap, convenient fuel for illumination and heating. From this research came acetylene, propane and natural gas. Gaseous fuels were used for lighting and for several purposes but with the advent of the motor car, the demand for a liquid fuel, but skyrocketed. Many of the first cars used alcohol as a fuel but this was replaced by the cheaper petroleum fuels.

The factor which produced a petroleum-based economy (its high energy density and ease of transport) was also the causes of its decline. With dwindling petroleum resources the rush to discover a substitute has a monetary incentive now; even the government is offering money to develop new synfuel plants. The future offers the shale oil in the Rockies, the tar sands in Alberta, Canada, and advanced recovery technology for the development of syncrude. These techniques hold down costs that are currently prohibitive both economically and environmentally. But that may change, given the Middle East situation. Other synfuel projects include the production of oil from waste and refuse, the production of alcohols as an additive or substitute (done before in World War II), and the transformation of coal to various gases and liquids.

The major monetary and technological concentrations of the U.S. government and industry seem to lie in the production of synthetic liquid fuel from our major energy feedstock--coal. Even more specifically, the Solvent Refined Coal (SRC) process has received much attention. An SRC plant near Catlettsburg, KY, has been subsidized by the U.S. Government as a demonstration plant. It can produce the equivalent of 20,000 billion barrels (bbls) of petroleum a day from 6000 tons of high-sulfur coal. Many implications and questions arise. If it is illegal to burn high-sulfur coal as a fuel because of its high sulfur content, what provisions are being made to process the sulfur? Is it cost effective to transport 6,000 tons of coal per day? What are the environmental costs of accelerating the production of coal? Is the coal industry ready? Is the high demand for water necessary in this process justified from an environmental/economic position? These questions must be addressed.

STUDENT ACTIVITIES FOR LIQUID FUELS (SYNTHETICS):

Recommended for 7-12:

1. Discuss how to produce ethanol/methane from water.

2. Compare the relative energy values of certain liquid fuels (methane, methanol, ethanol, synfuel) to gasoline, coal, and wood.

3. Discuss the advantages and disadvantages of a synthetic fuel program.

4. Discuss the concept that our "waste production" still contains a lot of usable energy and a considerable amount of much needed resources.

5. Discuss the history of synthetic fuel use in Europe.

6. Make a poster showing names or pictures of different forms of synfuels and other liquid form fuels that can be used in place of petroleum products.

7. Do a newspaper/magazine se..rch for articles on coal.

Recommended for K-12:

1. Discuss the history of whaling in the U.S. (why we needed whale oil, and why we continue whaling in the 1970's).

2. Visit a marine/seafaring museum or a coal or shale mine.

3. Show related films (whaling, coal mining, etc.). Discuss its relationship to this unit.

RESOURCES:

Anderson, L. and David Tillman. Synthetic Fuels From Coal. John Wiley and Sons, New York, 1979.

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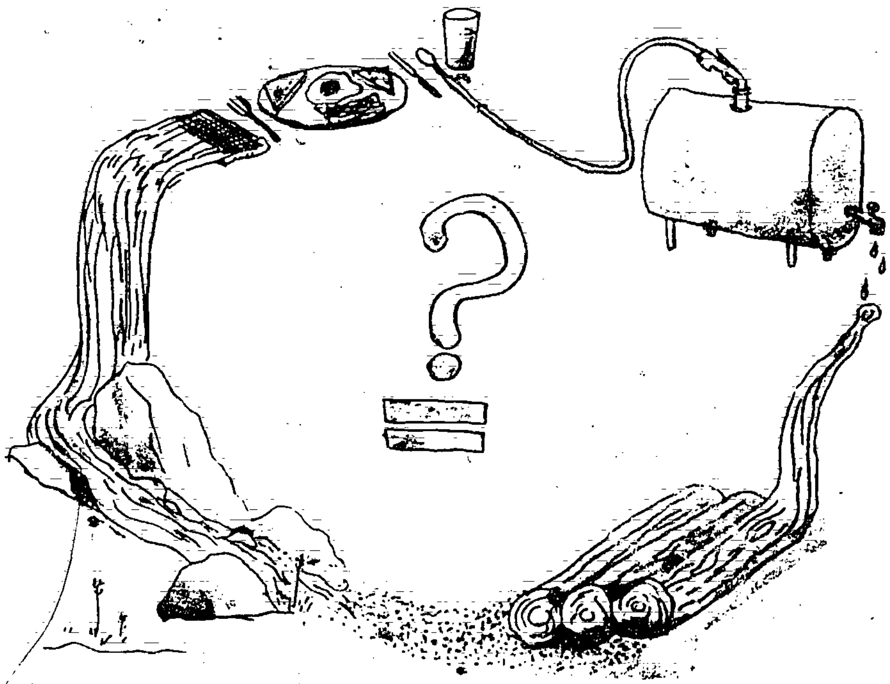
M IS FOR MEASURING HEAT



OVERVIEW:

The students learn that matter is capable of storing energy and that this energy may be measured in standardized units. The importance of variables, such as the mass and specific heat of sample materials to the storing capacity of the material, will be introduced, and analogies will be drawn among the energy found in such diverse substances as wood, food, gasoline, and heated metal.

TEACHER BACKGROUND:

Energy is a prime concern of governments in the world today. One of the simplest forms of energy to understand and to monitor is heat energy. Heat energy is easy to recognize, since we experience it in many everyday circumstances. Children should readily equate heat and energy if encouraged to recall that using energy (playing hard) causes them to feel hot (take off a coat or extra clothing), or that providing something with energy (rubbing sticks together) will transmit heat to that item (sticks get hot). Once this correlation between heat and energy is established, the concept of energy can be measured by measuring the amount of heat involved. Specific heat is defined as a ratio of the heat content of an object to the heat content of a standard substance, usually water. The formula for specific heat is the following:

$$\text{Specific Heat of metal} = \frac{\text{Mass of Water} \times \text{Specific Heat of Water} \times \text{Difference in temperature of water}}{\text{Mass of metal} \times \text{difference in temperature of metal}}$$

Unit Name	Symbol	Definition
Calorie or Kilo-calorie	Cal/Kcal	The energy required to heat 1kg of water by 1°C.
British Thermal Unit	BTU	The heat required to raised the temperature of 1 lb. of water 1°F.

A British Thermal Unit is equal to about a quarter of a Calorie.

Matter can be converted to energy (heat) by oxidizing (combusting) it; the amount of energy possessed by the matter can be measured using various types of calorimeters. This method is used for generating the very familiar Calorie content of various foods, but here the capital "C" in Calorie indicates that 1 Calorie = 1,000 calories. While the combustion of wood, yielding heat directly, is commonly understood, the student should not be left with the notion that the food which he/she eats provides heat in the same manner, i.e., yielding heat directly, since the combustion of food is largely a chemical process. Although there is actual waste heat given off during this breakdown, we do not strictly receive energy for our bodies in the form of a "mini furnace!"

STUDENT ACTIVITIES FOR MEASURING HEAT:

Recommended for K-6:

1. Post on a bulletin board a list of activities in which we use heat, e.g., for cooking, for hot water, for home heating, etc.

2. Experiment on various materials (by heating one end) and separate heat conductors from heat resistors. Then establish orders of conductivity and resistance.

3. Mix 100 ml water at 80°C. and 300 ml of water at 20°C., then measure the temperature of the resulting mixture. Which quantity of water has the most effect in determining the result temperature?

4. Put 100 ml of water at room temperature in a beaker and heat it over a candle for 5 minutes, then measure the temperature of the water. Repeat using an alcohol heater. Compare the temperatures.

5. Place three objects, of different materials, such as a piece of wood, aluminum, glass, etc., at the same heated temperature on a piece of paraffin wax. Which material contains the most heat?

Recommended for 7-12:

1. Experiment with the ability of different materials to release their stored heat by placing objects of different mass and composition in containers of same temperature/ same volume of water and by measuring the temperature rise for each. (The objects must be heated).

2. Formulate "per unit" energy yield for a variety of items, including food items. Use tables that give energy content of fuels and foods.

3. Do a research paper on how increasing man's ability to produce and control heat has allowed him to become more advanced.

4. Measure the specific heat of a metal, such as copper.

   a. Immerse 500g of copper or brass into boiling water for 5 minutes.

   b. Place the hot metal (100°C.) into 500g of water at 20°C.

   c. Measure new combined temperatures.

   d. Calculate the specific heat. Use the following formula:

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

S = specific heat
X = final combined temperature

5. Make and use a calorimeter.

To measure or observe the effects of heat, some sort of heat trapping device is needed to protect the things under observation from outside conditions. One such device is called a calorimeter and is readily purchased from a science supply house. However, a "homemade" calorimeter can produce satisfactory results.

The main parts would be two tin cans (with the labels and tops removed). One can should be the size of a concentrated fruit juice can and the other at least an inch larger in diameter, possibly a canned fruit can. A wooden block or a piece of styrofoam, or other insulating material should be placed in the bottom of the larger can so that the top of the smaller can is flush with the top of the larger can when the smaller can is placed inside the other. Pins could be placed on the insulation to keep the small can from sliding. The air space is needed between the cans to provide an insulation between the contents of the inside can and the effects of the conditions on the outside of the calorimeter. The remaining insulating barrier is a wooden block with two holes in it, one to allow a wire stirrer through, and the other large enough to hold a stopper with a thermometer inserted through it. The bottom of the block should have a piece of flannel glued or stapled to it so that air cannot readily circulate to and from the top of the inner can

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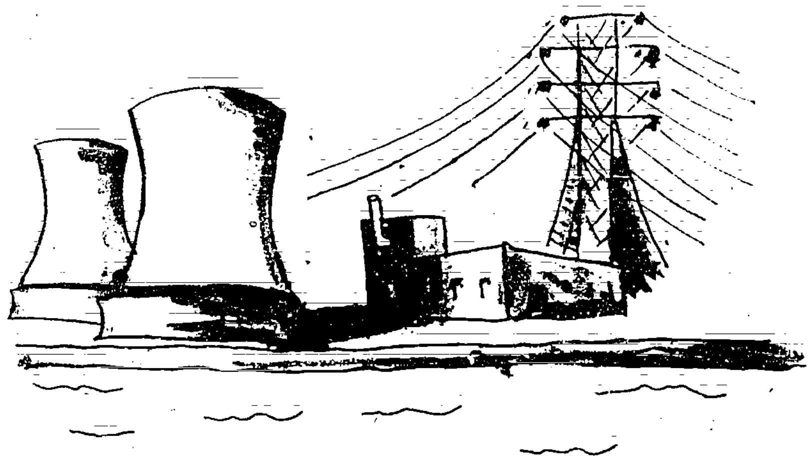
N IS FOR NUCLEAR ENERGY



OVERVIEW:

Students will examine the processes, the history, and the advantages/disadvantages of nuclear energy. Also, they will assess the impact of Three Mile Island on society.

TEACHER BACKGROUND:

Nuclear energy is created by the two processes, fission and fusion. In fission, the atoms of uranium 235 are bombarded inside a nuclear reactor by neutrons. This bombardment results in the splitting of the uranium atom usually into two smaller atoms and particles. When the uranium splits, heat is released along with more neutrons to continue the process.

Since nuclear reactors are very complex and require many safety precautions, they cannot be used as a direct source of heat. The heat produced in a large reactor, however, can be used to heat water which creates steam and generates electric power. Fission occurs and is controlled in the nuclear reactor. The nuclear reactor, consisting of fuel, which produces the energy, of a moderator, which controls the speed of the neutrons, and of the coolant, which removes the heat generated in the reactor, recovers the heat that is used to produce the electricity.

The fuel for nuclear fission power reactors is uranium-235 which is found in the earth's crust and in a wide variety of geological situations. Stream-laid sandstone in Colorado, Utah, New Mexico, Wyoming, and South Dakota have yielded most of the uranium produced in the United S[illegible] has been estimated that the United States has a supply of at le[illegible] million tons of this fuel (uranium-235 and uranium oxide combi[illegible] a typical 1,000 megawatt power reactor requiring 5900 tons of [illegible] oxide over its 40 year operating lifetime, the United States possesses enough fuel to supply projected reactor needs until approximately 2020.

In addition to uranium, water is necessary for operating a nuclear power plant. It is estimated that 330,000 gallons of water flow through a reactor per minute. A nuclear power plant functions much like a fossil fuel power plant. Both use steam to drive a turbine generator that produces electricity.

Not only the fuel, but also the moderator and the coolant are necessities in a nuclear reactor. The moderator both controls the activity of the neutrons and prevents the nuclear reactor from turning into a bomb. The coolant, which circulates through the reactor core, removes the heat, thus preventing a reactor melt down.

The following table lists the types of reactors, their acronyms, the fuels, the coolants, and their moderators.

NAME	ACRONYM	FUEL	COOLANT	MODERATOR
Magnox	---	Natural uranium	Carbon dioxide	Graphite
Advanced gas-cooled	AGR	Enriched uranium	Carbon dioxide	Graphite
High temperature gas-cooled	HTGR	Enriched uranium	Helium	Graphite
Boiling water reactor	BWR	Enriched uranium	Boiling light water	Light water
Pressurized water	PWR	Enriched uranium	Pressurized light water	Light water
Canadian deuterium uranium	CANDU	Natural uranium	Pressurized heavy water	water
Steam generating heavy-water reactor	SGHWR	Enriched uranium	Boiling light water	Heavy water
Liquid-metal fast breeder reactor	LMFBR	Plutonium dioxide uranium dioxide	Molten sodium or molten sodium and potassium	None required

The light water reactor, either the pressurized-water reactor (PWR) or the boiling water reactor (BWR), is the most common type in the United States. The PWR, enclosed in a welded steel pressure vessel, operates at a pressure approximately 150 times that of the atmosphere. The water carries the heat from the uranium core to the electricity-producting parts of the nuclear plant. The system consists of three separate, but interlocking loops (see Sheet N-1).

The BWR, the simplest reactor, has water boiling within the reactor core. The turbines use the steam directly to produce electricity.

Fusion, the other type of nuclear energy, refers to the combining of two hydrogen nuclei to form a new atom a[illegible] other particles. Although there are approximately thirty different f[illegible] reactions, only those that use deuterium, tritium, a[illegible] lithium are a[illegible]able. Fusion requires a temperature of about 100 million °C. The substances become gaseous; the atoms lose their electrons. This high energy state is called plasma. Since this plasma cannot be held in a container, a system must be found to stabilize the temperature and to extract the energy. At this time, [illegible] are no fusion nuclear reactors.

The development of nuclear energy was born out of a need to obtain a controlled reaction before the Germans who had already split the atom. It, therefore, developed from a military need rather than from a peaceful one.

U. S. Nuclear Chronology

1942	first man-made atomic chain reaction at the University of Chicago, director Enrico Fermi
1945	first atomic explosion; bombing of Hisoshima and Nagaski
1946	Atomic Energy Commission (AEC) formed by U. S. Congress
1951	production of significant amounts of electricity by nuclear power in Idaho
1953	Atoms for Peace Program by President Eisenhower
1954	first nuclear powered submarine
1957	first full-scale nuclear power plant; Price-Anderson Act
1959	first nuclear powered cargo vessel
1961	first nuclear powered generator in space
1974	Atomic Energy Commission - dissolved; Energy Resource and Development Administration (ERDA) and Nuclear Regulatory Commission (NRA - created)
197[illegible]	Price-Anderson Act renewed

Since these developments, other nations have developed nuclear technology. Currently, there are approximately thirty-five countries in the world with nuclear fission power programs, including 238 operating power reactors and another 548 power reactors under construction. Many countries such as Belgium 23%, Switzerland 17%, and Sweden 22%, get a large amount of their energy from nuclear power.

Currently, the United States has 70 licensed power reactors which provide 13% of the country's electricity. Another 126 plants are now planned and/or under construction. New England has seven operating nuclear power plants which provide 35% of its electricity. Another three plants are under construction in New England..

Facts About Nuclear Power

1. It is not imported.
2. The known and probable resources of uranium deposits are 1.8 million tons.
3. The supply of uranium-235 will last 20-30 years.
4. It emits only minimal chemical or particulate pollution into the atmosphere.
5. Nuclear powe[illegible]oduced electricity costs approximately 3¢ per kwh; oil fired c[illegible]proximately 8¢ per kwh.
6. Persons res[illegible]ar a nuclear power plant [illegible]ceive less than 5 millirems o[illegible]ion per annum (See N-2 [illegible] radiation sources).
7. When uranium [illegible]ned, radon, a radioact[illegible] is emitted.
8. Radon decays to the isotope lead 210 which is radioactive for a hundred years.
9. Nuclear power plants are constructed to restrict releases of radioactive material well below permissable levels.
10. When the uranium ore is milled and refined, thousands of tons of tailings, waste ore, remain. Tailings emit radon gas.
11. The fuel rods must be transported to the core of the nuclear reactors.
12. One-fourth of the fuel rods are "spent" each year and must be removed from the reactor core.
13. These "spent" rods which are radioactively and thermally "hot", must be stored in cool water ponds.
14. These "spent" rods contain biologically dangerous plutonium, cesium 137, strontium 90, and iodine 131.
15. "Half-life" denotes the time in which half of the atoms of a radioactive material will decay. (Ex.: If the "half-life" of a radioactive material is fifty years half of the material will decay in 50 years, half of the remainder in the next 50 years.)
16. Theoretically, the spend rods can be reprocessed to be used for breeder reactors or in atomic bombs.
17. The average time for construction of a nuclear power plant and for a plant to "come on line" is 14 years.
18. Because of the increased federal, state, and local requirements, the cost of constructing a nuclear power plant today is almost double that of a few years ago.

19. There is no proven method for safe and economic disposal of nuclear waste, but suggestions include burial in "stable salt domes," encapsulation in glass as practiced in France, and burial at sea.

20. It was estimated in 1976 that the waste going into storage then would not become safe for approximately 2,500 years.

Occupational exposure can be 30 times that received by the general public.

22. In normal operation, more than 99.99 percent of these radioactive substances stay within the full assemblies; the small amount that escapes from the fuel enters the reactor coolant system. A minute amount is released into the environment.

23. The natural safeguards in a nuclear water-moderated power reactor plant prevent the nuclear reactor from becoming a bomb.

24. The ability of the fuel material to retain most fission products, the fuel element cladding, the walls of the reactor vessel, and the containment system serve as barriers in reactor systems to prevent significant amounts of radioactivity from escaping into the environment at the time of an accident.

25. Since a nuclear power plant has a useful life of approximately 40 years, plans for decommissioning must be considered.

26. Transportation of nuclear materials, including nuclear waste, is becoming a problem since some states and municipalities have banned transport of the radioactive wastes through their areas.

27. Although stringent regulations for packaging nuclear wastes for transport exist, some people still fear an accident.

28. Radioactivity is not detected by human senses except in massive doses.

29. An additional impact in the operation of nuclear power plant is that the excess water is super heated, thereby causing thermal pollution.

The Incident at Three Mile Island, March 28, 1979: (EPRI Journal, p. 10-11)

1. As a result of maintenance work, the main feedwater pumps shuts off. Emergency feedwater flow is blocked by two valves that inadvertently had been left closed sometime during the previous two days.

2. When feedwater flow stops, heat removal from the primary system decreases.

3. At seconds, relief valve on the pressurizer opens to reduce momentary overpressure but fails to close when pressure drops. Operators are unaware valve is open.

4. Reactor shuts down at 8 seconds.
5. Pressure in primary system continues to fall and triggers automatic injection of emergency cooling water into the core. At 5 minutes this is throttled by operators, who believe the system is overfilled with water because the pressurizer is full.
6. Water begins to boil in the core.
7. Increasing steam volume forces water into the pressurizer. The high water level in the pressurizer continues to mislead operators into believing the primary system is overfilled.
8. Operators discover the closed valves in the emergency feedwater lines and open them at 8 minutes.
9. Insufficient water remains for proper operation of reactor cooling pumps. Pumps begin to vibrate excessively. Last two pumps are shut off at 1 hour, 40 minutes.

The event at Three Mile Island, a pressurized water reactor, Middletown, Pennsylvania, on March 28, 1979, has had an impact on nuclear power industry. The New York Times-CBS poll indicated that the U.S. public support for nuclear power has decreased from 69 to 46% since the event. Prior to this event, opponents of nuclear power were concerned with the hazards of waste disposal and the hazards of nuclear weapons proliferation. After the events, the people changed their minds because they felt that they had been deceived. They had believed that such an event was almost impossible.

Subsequently, the Electric Power Research Institute at the advisement of prominent utility executives established the Nuclear Safety Analysis Center (NSAC) to investigate the technical and operational factors that caused the problem, to recommend steps for improvement in reactor safety, etc. The nuclear industry in response to the needs of operation and management of nuclear power institute focuses on standards in the operation and management of nuclear power plants, program training, plant designs, etc.

President Reagan has proposed a five-point program which will lift the restraints on the U.S. nuclear energy program.

Obviously, the nuclear energy issue is multifaceted. The insurance industry's position of limited liability, as reflected by the Price-Anderson Act, illustrated the economic nature of nuclear power; the Nuclear Referendum in Maine demonstrated the emotional or personal concern of nuclear power.

Students should be encouraged to investigate beyond the popular media reporting which can be inaccurate and sometimes biased. Therefore, students should explore a number of reputable, unbiased sources.

STUDENT ACTIVITIES FOR NUCLEAR ENERGY:

Recommended for 7-12:

1. Compare and contrast the future use of nuclear energy with other forms of energy.

2. Research the Three Mile Island and other related nuclear incidents. Investigate the impact of the movie "China Syndrome" on public opinion about Three Mile Island. Determine how the Price-Anderson Act is related to the Three Mile Island incident.

3. Compare and contrast the different types of nuclear reactors. List advantages and disadvantages of each.

4. Re... on the steps involved in the design, construction, and operation of a nuclear power plant. Consider the environmental impact statements, compliances with building standards, maintenance of operational records, and lifetime. Records from the Maine Yankee are on file at the state library.

5. Make diagrams of fission power plants.

6. Invite representatives from local power companies to speak on nuclear energy.

7. Debate pros and cons of nuclear power.

8. Research the safety record of nuclear, oil, coal, and hydro power plants.

9. Research and discuss safe methods for transportation of nuclear materials.

10. Research and discuss the Nuclear Regulatory Commission and its history.

11. Discuss reasons why it takes 14 years to put a "plant on line" and outline the steps involved.

12. C[illegible] a simple dry ice cloud chamber, and use it to observe [illegible]rticle movement.

Recommende[illegible] -12:

1. Discuss how a nuclear power plant produced electricity, how it is like other types of power plants, and how it is different.

2. Role play the inhabitants of a farming community 100 miles from a large city where a nuclear reactor is slated to be constructed.

3. Compare and contrast the pollutants associated with a nuclear fission power plant and other power plants.

4. Compare and contrast nuclear fission with nuclear fusion. Research the history and future of nuclear energy in other parts of the world.

5. Locate the worldwide uranium reserves; show how the location of these reserves affect countries that depend upon nuclear fission.

6. Research how a referendum is organized and how it becomes a law. Research the results as well as the campaigns of both sides in the 1980 Maine Nuclear Referendum. Discuss the language of the referendum and the manner in which the campaign was conducted.

7. Hold a mock referendum on nuclear power. Choose five students for pro and five for con. Designate all other students to be the voting public.

8. Take a field trip to a power generating plant. Compare the processes of different power plants.

9. Use dominoes to demonstrate the chain reaction in the fission of a fissionable materials, such as U-238.

10. Collect articles on nuclear energy. Include uses in medicine, industry, and energy.

11. Locate current and planned nuclear power plants. Discuss reasons for these sites. Compare a map of current sites with a map of five years ago. What are the implications?

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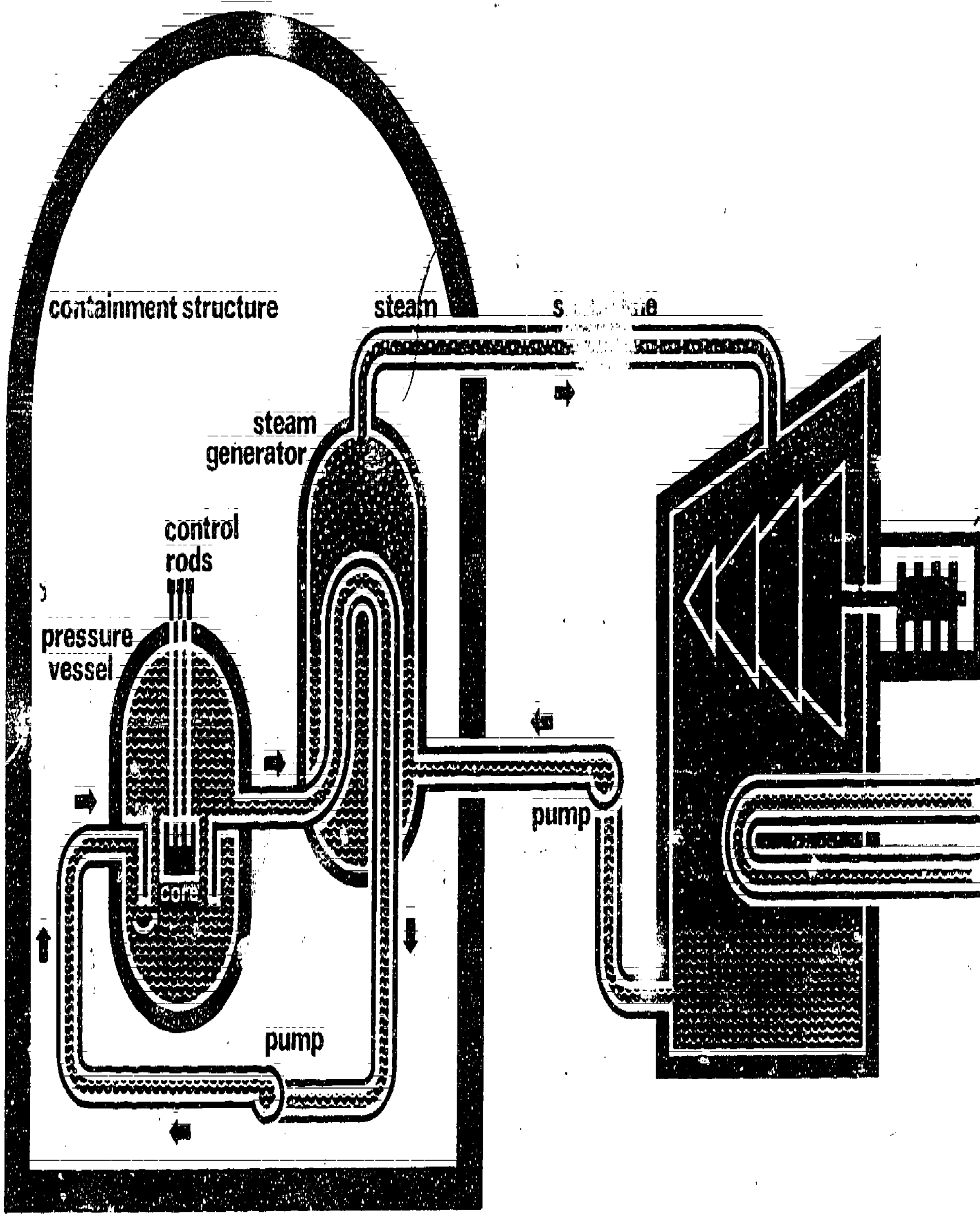
Pressurized water reactor (PWR)



SHEET N-1

92

93

85A

Atomic Industrial Forum, Inc.

Table 1 shows the average dose from natural radiation in the U.S.

Table 1
U.S. Average Natural Radiation Dose

Source	Dose (mrem/year)
Cosmic radiation	40
Radionuclides in rock, soil, etc.	26
Radionuclides in the body	24
Total	90

Man-made radiation adds to the average does that everyone receives. Most significant is the dose from medical and dental x-rays. A small amount of radioactivity is also received from fall-out from weapons testing and from nuclear reactors. Table 2 gives some examples of man-made radiation exposures that give an average of 100 mrem per year to everyone in the U.S.

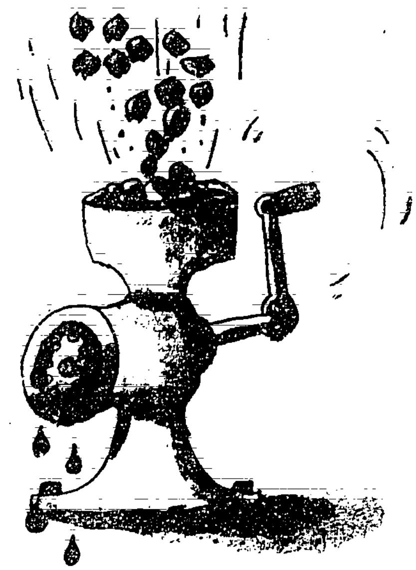
Table 2
Man-made Sources of Radiation

Source	Dose
Environmental	
Nuclear weapons testing	7 mrem/year
Consumer products such as TV, luminous watches, microwave ovens	1 mrem/year
Nuclear reactors living at site boundary	0.03 mrem/year
Nuclear reactors (average person in the popluation)	0.01 to 0.001 mrem/year
Medicine and Dentistry	
Chest x-ray	22 mrem
Whole mouth dental x-rays	910 mrem
Breast mammography	1,500 mrem
Pacemaker insertion with fluoroscopy	132,000 mrem
Radiation treatment for bone cancer	6,000,000 mrem

Note: The doses listed for medicine and dentistry cannot be directly compared with each other because of various factors which influence radiation effects.

Radiation effects are not dependent solely on the amount of radiation received. Other factors must be considered. The rate at which a radiation dose is received is an important factor in determining its effect. This is because living tissue is not inert. As soon as damage is produced, healing begins. Thus, if a particular dose is delivered over a long period, it is possible that repair keep up with the damage, so that no detectable change would be produced. On the other hand, if the same dose is delivered all at once, the change may be noticeable.

O IS FOR OIL SHALE



OVERVIEW:

The students investigate oil shale, its origin, the process of extraction, the environmental/economic implications, and potential energy output. Also, they grasp the difference between petroleum reserves and oil shale.

TEACHER BACKGROUND:

Oil shale, formed in many geological periods and found in many parts of the world, is a sedimentary rock of fine-grainedness which contains kerogen. When kerogen, is heated to 300-400°C in a retort, it separates into both gaseous and liquid hydrocarbons. Although these extracted liquid hydrocarbons resemble crude oil, they must be upgraded before refining.

Oil shale holds its oil very tightly. Even at 1 atmospheric pressure after detergent washings, the oil remains locked in the rock. Becuase it is difficult to retrieve, it has not been a competitive source of petroleum. With the spiraling prices for petroleum, however, oil shale has become a profitable resource.

Oil shale formation is far less restricted than well oil. It can occur whenever organic matter is deposited within sediments. Since it is essentially part of the rock, it doesn't require elaborate "salt dome structures" to contain the liquid.

The oil shale reserves in the western part of the United States are fairly close to the surface which makes it cheaper to harvest the rock, whereas, we are presently having to expand our research for conventional petroleum resources into the continental shelf which increases the cost of the oil from this process.

Oil shale may be easy to obtain, but oil from that shale is not. The oil is bound so tightly and in such dilute amounts that many tons of shale must be literally crushed and washed to produce significant amounts of oil. The massive amount of water which must be used in the refining process must be considered when evaluating the environmental and economic costs of this energy source. Speculations on the amount of energy obtainable from oil shale range from amounts capable of supplying the total U.S. fuel requirements for 10 years to not enough to provide the transportation needs of the U.S. for 1 year. The environmental damage done by strip mining for oil shale might be cost-effective if the former energy estimate were correct, but hardly worth it if the latter estimate were correct. Therefore, a more exact estimate of proven reserves is very important.

Therefore, before oil shale is developed farther, one must consider the advantages in relation to the potential energy output.

The potential energy that an energy reserve could furnish depends upon two things: How much is there (how much can be economically mined) and how rapidly it is used. For example, in 1960 the total U.S. supply of crude oil consisted of 32 billion barrels, but in 1975 the figure was 33 billion barrels. Even though many billion barrels of oil had been used in this interval, the total reserve had increased because of the number of new oil finds. The problem with this picture is that in 1960 this reserve was enough to supply the U.S. for 12.8 years, whereas in 1975 the 33 billion barrels would only last 11.3 years. Thus, even with all the new oil discoveries, the reserve was shrinking due to increased demand. Demand for petroleum products is still increasing, and the number of wells is decreasing each year. The problem is one of how long will the reserve last and what is our real need for energy.

STUDENT ACTIVITIES FOR OIL SHALE:

Recommended for 7-12:

1. Prepare leaflets, badges, or T-shirts regarding environmental conservation practices or positions.

2. Determine the longevity of the energy reserves such as oil, coal, oil shale, etc., based on available information. Determine which factors cause this estimate to increase/decrease.

3. Calculate the volume of rock that would have to be mined to provide 100% of the U.S. energy supply for 1 year if oil shale were the only source of energy used. Equate this area to the size of the students' town, county, and state.

4. Discuss the role of water in the refining processes of different energy resources (Refer to "L" is for Liquid Synthetic Fuels).

5. Discuss the various ecological dangers which might result from mining different energy resources.

6. Discuss the sequences leading to the formation of petrofuels (Refer to "F" is for Fossil Fuels).

7. Plan a class project of writing to various agencies for more information on oil shale.

8. Develop a chart on the kinds of mining extraction methods, such as fracturing, in site mining, etc.

9. Develop a chart on conservation measures introduced as a result of this new technology, such as (a) explosive fracture studies on oil shale, (b) organic contaminants introduced into ground water by in site or shale retorting, and (c) the physical properties and geotechnical properties of a fine-grained spent shale waste.

10. Participate in periodic brainstorming sessions in which students suggest the long range effect of oil shale extraction. (All participants are now hypothetically full-time residents of Denver, Colorado.)

11. Develop a year-long geological timetable. The school year is 180 days from early September to early June. Thus, a room-length scale of geologic time is constructed on a drapery valence and hung above the chalkboard with a hash mark for each of the 180 days. Since most estimates place the age of earth at 4 to 5 billion years, each school day (hash mark) corresponds to approximately 18 million years. A movable arrow is used to indicate the present date. As the oil shale discussion unfolds, markers are used to record events, such as the formation of oil shale (Birthday Party) and duration and significance.

Recommended for K-12:

1. Locate places in the United States where oil shale is found.

2. Examine physical characteristics of shale.

3. Discuss the environmental implications of the development of oil shale.

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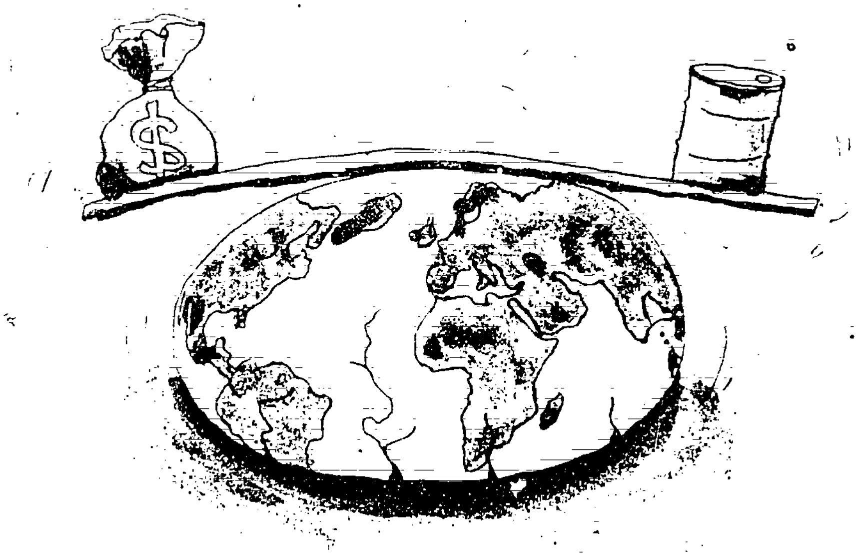
P IS FOR PEOPLE FROM OIL EXPORTING COUNTRIES



OVERVIEW:

Students can become more familiar with OPEC countries by studying their geography, people, and customs. As dependence on petroleum in our everyday lives is emphasized, students will recognize the world influence of OPEC.

TEACHER BACKGROUND:

Organization of Petroleum Exporting Countries (OPEC) is an association of 13 nations, most of which depend heavily on oil exports for their income and foreign trade. The members of OPEC are Algeria, Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.

OPEC provides a common policy for its member nations. For example, it establishes prices, taxes, and various trade rules on the oil exported by those countries. Currently, the members of OPEC produce more than half the oil used in the world. They also supply about 85% of the oil imported by non-member nations. As a result, OPEC has a major influence on the petroleum industry throughout the world.

The Organization of Petroleum Exporting Countries was established in 1960 and has four main governing bodies. The OPEC Conference, the highest authority of the organization, meets twice a year to formulate general policies. The Economic Commission advises the conference on oil price matters. The Board of Governors, which consists of one representative from each member nation, meets at least twice annually. It supervises the affairs of the Secretariat, the administrative branch of OPEC. The Secretariat has permanent headquarters in Vienna, Austria.

Because of its addiction to oil and love for the automobile, the United States is dependent upon imported oil from the OPEC nations. This dependency places the United States in a vulnerable position since throughout history many of these oil exporting nations have faced bitter struggles which threaten to cut off oil supplies to the United States and other oil dependent countries. Both the Arab Oil Embargo of 1973-74, and the Iranian revolution of 1979 had traumatic effects. Although the oil embargo continued only for six months, it contributed to one of the worst recessions in United States history in forty years. Another possibility is the loss of oil from Libya and Algeria, two nations with a history of feuds, religious hatred, and nationalist strifes. Far worst than any of the above is the possibility of total cut off of Persian Gulf oil.

The United States must assess its needs and find alternative energy sources.

STUDENT ACTIVITIES FOR PEOPLE FROM OIL EXPORTING COUNTRIES:

Recommended for K-6:

1. Request literature on an OPEC country from its embassy in Washington, D.C.

2. Using an outline map of all the OPEC nations in the world; identify the capitals and/or one other major city of the OPEC countries.

3. Using a bar or line graph, show the annual oil exports to the United States since the 1973-74 Oil Embargo.

4. Group six students together based on one common denominator, such as eye or hair color, and have them attempt to make school decisions to which they must all agree to abide. Have them list problems they encountered in their organizational meetings and relate them to the OPEC meetngs where common accord on all oil exportation must be agreed.

Recommended for 7-12:

1. Describe the size, population, language(s), religion(s), political state, leader, and products that are exported and imported (Sheet P-1).

2. Determine the per capital income (total revenue divided by population) for one OPEC country. (How does their per capita income compare with the U.S.?)

3. Divide students into groups. Assign each group one OPEC country to report on its political, cultural, and religious aspects. Present orally to class.

4. Report on the estimated and proven petroleum reserves, number of new wells drilled each year, number of barrels pumped last year, and total revenue from the sale of petroleum for one OPEC country.

5. Use Lord Bryce's definition on conservative, liberal, and radical to categorize each of the 13 nations according to the standard of oil exportation price demands. The publicity of OPEC meetings in the United State press and television will provide adequate resource information. (Bryce's definition: conservative - make little or no change; liberal - change the present, perhaps increase prices of oil; radical - destroy the present, create a new system, e.g., organize price increases to a level that would destroy the present economic system. Third World countries would replace United States and Europe as powers.)

Recommended for K-12:

1. Name and locate OPEC nations on a world map.

2. Locate samples of products made using petroleum (gasoline, vaseline, grease, plastics, insulation, synthetic fibers, etc.) and those not using petroleum. Don't forget petroleum used for harvesting, transporting, or packaging.

RESOURCES:

"Algeria: Learning to Live With Independence," National Geographic. August 1973, p. 200.

"The Arab World, Inc.," National Geographic, October, 1975, p. 494.

"Arabs and Their Money - Threat to West?" U.S. News, August 6, 1979, p. 39.

Bird, K. "Tomorrow Belongs To OPEC," Nation, December 13, 1980, 231: 636-640.

"Boosting Aid To Soothe an Angry Third World," Business Week, February 4, 1980, p. 42.

"Can OPEC Control Itself," Newsweek, June 9, 1980, p. 70.

"Cartel In Confusion," Newsweek, December 31, 1979, p. 30.

"Changes In OPEC That Are Driving Oil Prices Wild," Business Week, October 29, 1970, p. 77.

"Conflict Over Countering the Cartel," Business Week, July 30, 1979, p. 56.

"Dry-land Fleet Sails The Sahara," National Geographic, November 1967, p. 696.

"Economy Becomes A Hostage," Time, November 25, 1979, p. 40.

Engler, R. "Letting Big Oil Do It," Nation, October 25, 1980, 231: 393+.

"Englishman's Advice - Stand Up to OPEC," U.S. News, November 26, 1979, p. 35.

"France's Stepchild, Problems and Promises," National Geographic, June, 1960, p. 768.

"Gabon: Ambassadors of Good Will," National Geographic, Sept. 1964, p. 297.

"Gloomy Oil View," Time, June 30, 1980, p. 47.

"Here They Come Again: Less Production, More Profit," Time, Dec. 17, 1979, p. 69.

"How The Dollar Cushions OPEC's New Price," Business Week, June 9, 1980, p. 29.

"Indonesia, the Young and Troubled Island Nation," National Geographic, May, 1961, p. 579.

"Iran: Desert Miracle," National Geographic, January, 1975, p. 2.

"The Kurds of Iraq," National Geographic, March 1975, p. 364.

"Kuwait, Aladdin's Lamp of the Middle East," National Geographic, May, 1969, p. 636.

Marshall, E. "Planning for an Oil Cutoff," Science, July 11, 1980, 209: 246-271.

"New Recycling Crises for Petrodollars," Business Week, June 23, 1980, p. 120.

"The Niger: River of Sorrow, River of Hope," National Geographic, August 1975, p. 152.

"Now It's OPEC That Has a Problem," U.S. News, June 23, 1980, p. 9.

"Oil, The Dwindling Treasure," National Geographic, June 1974, p. 792.

"OPEC Fails to Make a Fix," Time, December 31, 1979, p. 22.

"OPEC Raises the Ceiling," Time, June 23, 1980, p. 14.

"OPEC's Algerian Bazaar," Newsweek, June 23, 1980, p. 63.

"OPEC's at Work and Play," Newsweek, December 31, 1979, p. 32.

"OPEC's New Pincer Ploy," Time, April 14, 1980, P. 83.

"OPEC's New Prices: The Last Boost?" Newsweek, February 18, 1980, p. 80.

"OPEC's Woes Are Good News For Consumers," U.S. News, Febraury 25, 1980, p. 78.

"The Peoples of the Middle East," map supplement, National Geographic, July, 1972.

Pricing of Oil Divides OPEC," Newsweek, May 19, 1980, p. 60.

"Rip-off Time Once Again," Time, August 13, 1979, p. 41.

"Saudi Arabia: Beyond the Sands of Mecca," National Geographic, January 1966, p. 1.

"Saudis Lose Control of Oil Prices," Business Week, June 23, 1980, p. 27.

"A Special Report in the Public Interest, Energy Facing Up to the Problem, Getting Down to Solutions, National Geographic, February 1981.

Stobaugh, Robert and Yergin, Daniel, "Energy: An Emergency Telescoped," Foreign Affairs, September 1980, 58: 563-595.

"Venezuela's Crisis of Wealth," National Geographic, August 1976, p. 175.

Woff, L.L. Facing Up to OPEC: A Decade of Alternatives," U.S.A. Today, March 1980, 108: 17-19.

Yanomamo, "The True People," National Geographic, August 1976, p. 211.

SHEET P-1 P IS FOR PEOPLE FROM OIL EXPORTING COUNTRIES NAME______________

OPEC Member Country	Area of Country	Population of Country	Principal Language(s)	Principal Religion(s)	Type of Political System	Head of State	Products Imported	Products Exported
ALGERIA								
ECUADOR								
GABON								
INDONESIA								
IRAN								
IRAQ								
KUWAIT								
LIBYA								
NIGERIA								
QATAR								
SAUDI ARABIA								
UNITED ARAB EMIRATES								
VENEZUELA								

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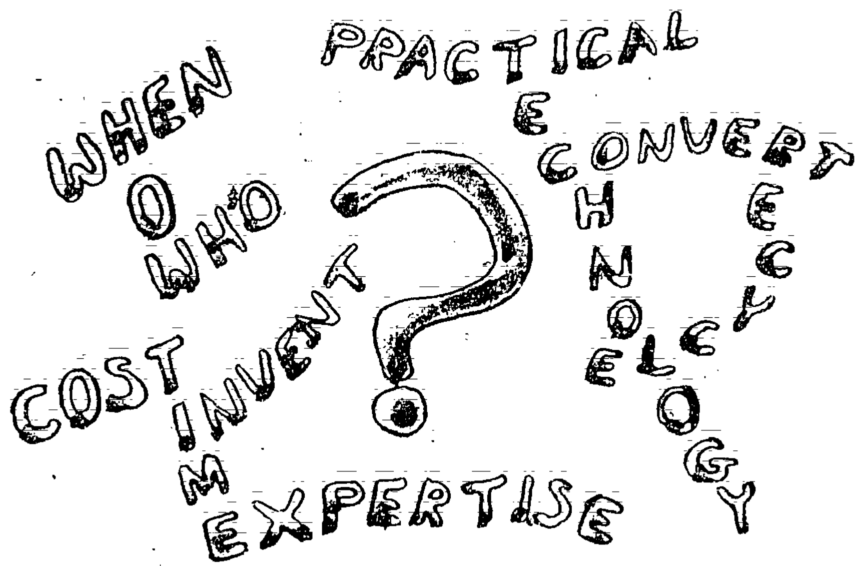
Q IS FOR QUESTIONS STUDENTS HAVE ABOUT ENERGY AND THE ECONOMY



OVERVIEW:

Although a selection of commonly asked questions about energy is included in this unit, students should be encourage to generate their own questions. Recommendations for resources for each area are given after each question, along with pertinent comments. Because of the broad nature of these questions, no background information is provided.

COMMON QUESTIONS AND RESPONSES:

A. Is there really an energy crisis, or is it just a trick by the oil companies?

As the concept of finite supply is virtually alien to today's youth, students should be directed to review the formation of petroleum products to reaffirm the distinction between using a tree, which can be replaced in 20-50 years, and using oil, which cannot be replaced for several million years. The rising rate of energy use should also be mentioned, as figures which claim that our resources (coal, for example) will "hold us" for the next 260 years <u>at our present rate of use</u> are very misleading.

Suggestions for further reading: "F" is for Fossil Fuels

B. What are the differences between nuclear, solar, wind, wood, and coal power?

Students often find it difficult to recognize that sunlight, uranium, coal, wood, and running water are all related in that they represent energy sources. A power plant utilizes water publicity. Any individual putting conservation practices into effect in his/her own life will be more likely to spot and complain about public and industrial waste.

Suggestions for further readings: "C" is for Conserving Energy

SUGGESTED ACTIVITIES:

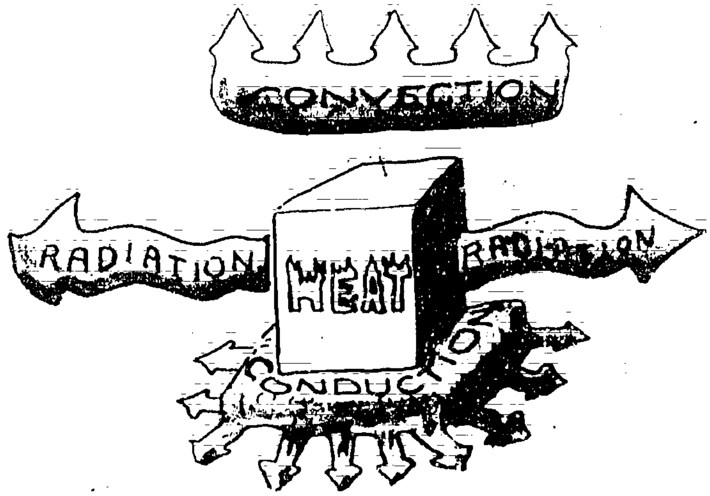
Recommended for 7-12:

1. Generate a question survey to be given to adults. The students should research the correct answers so they can share them at the end of the interview.

Recommended for K-12:

1. Write their own questions and exchange them. By having the students share their answers, they will be exposed to more than one possible explanation of the same question.
2. Interview parents and grandparents to determine energy changes and costs since they were children.

R IS FOR RADIATION AND OTHER MEANS OF HEAT TRANSFER



OVERVIEW:

Students investigate the three types of heat transfer: conduction, convection, and radiation. Students identify areas within their homes in which each type of heat loss occurs.

TEACHER BACKGROUND:

Heat is transmitted by conduction, convection, and radiation. Since people can only exist within a very narrow range of temperatures, one should understood heat transfer. Although people at the South Pole have survived a few moments at -100°F. and test pilots have survived "cooking" at 400°F. for a few minutes, the human body can tolerate only a few degrees change in its survival temperature without serious and irreversible damage.

Historically, man has always needed shelter with a livable temperature for survival. Today, man has produced a society heavily dependent upon fossil fuels for heat. Since fossil fuels are finite, one must reassess the basic thoughts about heat transfer methodology.

Conduction is the transfer of heat through a substance by direct molecular contact. Every object consists of atoms. If one vibrates these atoms, the object "gets warm". The more energy one applies to the object, the faster the atoms move and the hotter it seems. This action is not localized. The excited atoms "bump" into other adjacent atoms much like a crowd of people trying to get out of a small space. As atoms farther

from the source are excited that portion of the object warms up. This process continues until the energy in the excited atoms isn't sufficient to activate another atom. When the heat source is removed or it is far enough from the heat source, the process ceases. This effect is similar to telling a crowd of people in a room that there is a fire. As the people become excited and rush from the room, they bump into each other. This hectic situation continues until the people feel safe. Likewise if someone suddenly tells a room full of crazed people that the whole thing is a mistake, the energy level of the people will fall rapidly just by "removing the source of energy." This analogy explains why heat or activity travels away from the source of heating. How fast and how far from the energy source the distrubance is felt depends upon the characteristics of the medium. One does not rush out of a room as quickly if he has to confront football players rather than children. Just as children can be pushed around more easily than football players, atoms in a metal rod can be pushed around more easily than atoms in a ceramic rod. Heat can be transferred by conduction, convection, and radiation.

Convection is the transfer of heat by the movements of liquids and gases. When liquids and gases increase in density as they are cooled, the warmer, lighter fluids rise. Convection currents are the currents of liquids and gases formed by unequal heating. The rise of heated gases up a chimney are an example of convection current.

Both conduction and convection depend upon a meduim of transmission (air, water, or solid). Radiation is the transfer of energy in waves through space. Radiation can apply to either the process by which energy is being transferred or the form of energy itself. Homes can be heated by radiation. Solar heating depends upon the radiation of the sun.

How many people have praised the warming character of a wood stove and cursed the draft near their windows! Both of these examples, one good and the other bad, represent heat transfer. Since heating and cooling, which can only be really understood by understanding how heat is transferred, are such a vital part of one's total energy use, it is imperative to talk about these forms of energy use.

STUDENT ACTIVITIES FOR RADIATION:

Recommended for K-6:

1. Discuss what happens in terms of heat transfer when one goes outside in January in one's snowsuit. Determine what happens when one comes in and stands by the fire in his/her snowsuit and why it is better to keep the snowsuit on outside. Will one get warm faster by the fire with it on or off? Why?

2. Make posters of effects of radiation, conductions, convection on people in various situations, e.g., magazine pictures of people on beach, touching ice, standing by fire, skiing, etc.

3. Observe a lava lamp; discuss convection as a movement of fluid (wax) up and down. Also, discuss as a method of heat transfer.

4. Use a draftmeter to explain how to construct measure infiltration of cold air (by convection) in the school or home.

5. Analyze the importance of closing storm doors. (Since the concept of money as a finite quantity is intangible to most small children, set up a hypothetical situation with an exact amount of money. Give them a list of monthly bills, such as utilities, taxes, rent, etc. Ask them to list their needs and desires. Have them determine whether or how they can decrease some expenditures, such as for heating by exercising better energy habits.

Recommended for 7-12:

1. Discuss factors which enhance/retard heat loss by conduction, convection, and radiation.

2. Discuss advantages of a "sealed" window over a non-sealed window in terms of heat loss through the three heat transfer methods.

3. Using a light as a heat source, heat four baby food jars or beakers of sand - black, brown, white, et al. Record temperature every 30 seconds for 15 minutes. Turn off light. Record temperature every 30 seconds for 15 minutes. Graph results. Do all materials absorb radiated energy at same rate? Do all color materials radiate energy at some rate? Discuss relationship of black/white and color and heat transfer.

4. Discuss the importance of surface color and surface temperature to radiational heating. (The DOE packet "Solar Energy I" has several activities that pertain to this activity.

5. Analyze the electromagnetic spectrum to determine where along this energy continuum infrared (heat) energy occurs. Relate this low energy radiation to the Greenhouse effect.

6. Demonstrate the ring and ball apparatus. Discuss the expansion caused by conduction.

7. Research the terrestial heat effect. Examine the relationship of the terrestial heat effect and the three methods of heat.

Recommended for K-12:

1. Discuss the advantages of placing thermal shutters over windows or of closing drapes/curtains at night. Discuss how these measures disrupts the convection-cooling cycle, which is responsible for large heat losses.

2. Discuss the advantages of single, double, and triple paned-glass windows in terms of heat loss. Relate this to cost of materials, aesthetics, and monetary savings.

RESOURCES:

Goldstein, R.J. Heat Transfer In Energy Conservation. Presented at the Winter Annual Meeting of the American Society of Mechanical Engineers in Atlanta, Georgia on November 27-December 2, 1977.

Hartnett, J.P. Alternative Energy Sources. Academic Press, 1976.

S IS FOR SOLAR HEATING

OVERVIEW:

The students explore the feasibility of solar energy, its advantages and disadvantages. They learn the basic principles of solar collection and the methods, direct and indirect, for solar heating.

TEACHER BACKGROUND:

Energy from the sun is called solar energy. It is the result of the continuous nuclear reactions taking place inside the sun. Solar energy is sometimes called radiant energy. The sun generates along a large portion of the electromagnet spectrum (light, infrared, radio, ultraviolet, and X-rays). About 30% of the solar energy that strikes the earth is reflected back into space. Another 23% is absorbed by the earth's atmosphere. Forty-seven percent is absorbed by the earth's surface. Most of this absorbed energy consists of visible and infrared light.

When this radiation strikes an object, a portion of it is absorbed and transformed into heat energy. The heat energy is then stored in the material itself or conducted to surrounding materials, thus warming them. Heat can also be carried off by air and water flowing past these warm materials in what is called conduction and convection heat flow. It is obvious to anyone who has walked barefoot over a sun-baked pavement that a material can be heated by the sun. It is not obvious, however, that the pavement radiates some of the heat away in the form of infrared rays. This thermal radiation back into space keeps the earth from over-heating and saves us from frying to a crisp.

Glass is the miracle substance that makes modern solar heating possible. It transmits shortwave visible light, but it absorbs long wave infrared radiation. Once inside, the sunlight is transformed into heat energy which will not be radiated back outside. This phenomenon is known as the "greenhouse effect". An example of the "greenhouse effect" is the hot stuffy car as a result of being left in the sun with closed doors and rolled up windows.

The basic principles of solar collection from home heating and cooling are embodied in the greenhouse. The sun's rays pass through glass or a transparent plastic and are absorbed in a dark surface. The heat produced cannot escape readily because thermal radiation and warm air currents are trapped by the glass. The accumulated solar heat is then transported to the living quarters or stored for later use.

There is often an overabundance of solar energy when it is not needed; none at all when it is most in demand. Some means are required to store the collected solar heat to use at night or during periods of cloudiness. Any material will absorb heat if it is colder than its environment, and will lose heat if it is hotter than its surroundings. The objects inside a house, e.g., the walls, floors, and furniture, can, therefore, serve as heat storage devices. Extra heat can be stored in insulated tanks of water or beds of gravel located within the rooms or in a cellar.

The simplest means to heat a home is by the direct method, sometimes called passive. The sun's rays, penetrating directly into the house, heat the massive internal structures, such as concrete floors and fireplace bricks. This method is best used on well insulated homes because the heat input is generally small. The advantages of passive solar are its low costs; the disadvantages are in the low heating potential and in the low realiability.

Indirect methods for solar heating (active solar) generally use rooftop solar collections and separate heat storage devices. After being heated in the collector, the liquids or air is moved through pipes or ducts. Pumps or fans are required to circulate liquids or air through the collector and back to the insulated heat storage containers. Tanks of water or piles of rock can be used for storage of heat which is recirculated to the rooms. These systems are called active systems because they need mechanical power to move heat. Advantages of this type of system are that it requires little owner attention if properly designed and installed, and it is more readily applied to existing homes. The disadvantage of active solar is the cost of the collector, the storage tank, and the installation.

Whether or not solar heating is cost efficient for a specific site depends upon a variety of factors, such as orientation of the building, slope of the collector, and the number of degree-days at the site. Much of this type of information is presented in the reference books at the end of this section.

STUDENT ACTIVITIES FOR SOLAR HEATING:

Recommended for K-6:

1. Take two boxes. Paint one black and one white. On a sunny day, set these in the window for 10 minutes. Measure the temperature in each box. Which one is higher?

2. Take two boxes painted black. Place a red brick in one and nothing in the other. Place both boxes in the sun for 30 minutes. Take the temperature of each. Remove from sun and insert the thermometer through the side of each box so that it is measuring the temperature near the center, but not touching the brick. Check the temperature every minute for 30 minutes. This illustrates the principle of Thermo-Mass.

3. Take four styrofoam cups. Paint two black and leave two white. Place tap water in each cup. Place the one black and one white in a sunny area; place the other two in a shaded area. Measure the temperature every thirty minutes.

4. Discuss reflection as it influences passive solar heating. What factors increase/decrease this effect? Decorate a model house with foil flocked designer wallpaper in one room and regular wall-paper in another. Compare the heat retention.

5. Experiment with the heat storage capabilities of sand, salt, water, and air that have been in the sun for 30 minutes. Graph the results every two minutes for ten minutes. (Several other activities are in the DOE publication Solar Energy I).

Recommended for 7-12:

1. Construct a model greenhouse with a wooden frame and poly-ethylene cover on the school property. Study the "greenhouse effect," its causes and effects.

2. Build a solar cooker.

3. Discuss the factors which influence the amount of sun available (angle of sun, latitude, season, clouds, and particulates in atmosphere).

4. Examine the concept of "thermal storage" as a means of making solar energy more desirable, i.e., the type of storage media, carts, and requirements for redesigning homes.

5. Design a solar community in which the total energy demand is supplied by either active and/or passive solar. What types of changes in the community will make the design feasible?

6. Discuss the advantages and disadvantages of a photovoltaic conversion of sunlight to electrical energy.

7. Discuss the novel "Solar Engines," such as the solar furnace, solar cell, and Sterling engine.

8. Construct a solar hot water heater. Directions are located in the DOE publication Solar Energy II.

9. Experiment with heat storage capabilities of Thermol 81[R] energy storage rods. Determine the eutectic salts that work on the phase change principle.

Recommend for K-12:

1. Research what is needed to build a passive/active solar collector in the town (orientation, glass area, angle of collector, etc.) and its cost.

2. Discuss some of the advantages and disadvantages of solar energy, such as the cost, weight of the structure, etc.

RESOURCES:

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Harnett, J.P. Alternative Energy Sources. Academic Press, 1976.

Lovins, A.B. World Energy Strategies. Friends of the Earth International, 1975.

Maine Solar Site Evaluator, Maine Office Energy Resources, Augusta, Maine.

Merrill & Gage. Energy Primer. New York: Dell, 1978.

McDaniels, David. The Sun. John Wiley and Sons, 1979.

Oatmen, E.F. Prospects for Energy in America. H.W. Wilson Company, 1980.

"Passive Design: It's A Natural." Solar Energy Research Institute, Golden, CO, 1980, SERI/sp-432-521R.

Ruedisili and Firebaugh. Perspectives on Energy: Issues, Ideas, and Environmental Dilemmas. New York: Oxford Univ. Press, 1978.

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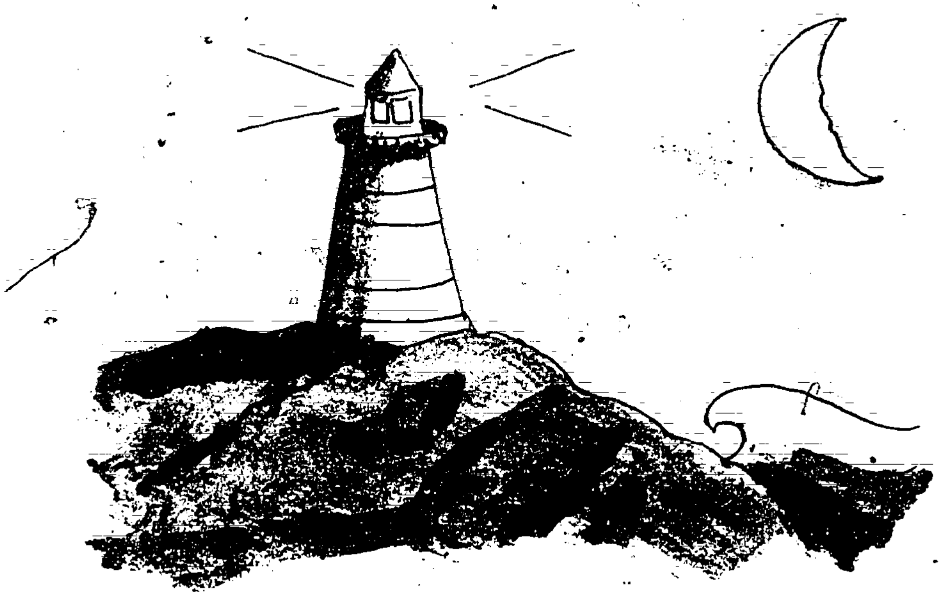
Stoner, C.H. Producing Your Own Power. Rodale Press, 1974.

Vezirogulu, T.N. Alternative Energy Sources: An International Compendium. Washington, D.C.: Hemisphere Publishing Company, 1978.

T IS FOR TIDAL



'ERVIEW:

The question of where tidal fits into the larger energy picture is ıtroduced, and some of the problems associated with tidal power are discussed.

:ACHER BACKGROUND

Energy taken from the tide is not unlike energy taken from other forms moving water. Hydroelectric power utilizes the potential induced when ter, as water vapor, is transported up mountains and allowed to flow back the seas. Tidal power utilizes the potential energy produced in the World's eans in response to the gravitational attraction of the other planets. (Refer "H"is for Hydroelectric for an explanation of potential and kinetic energy).

The forms by which one takes this energy differ to some degree since the de does not flow continuously, but rather proceeds by waves. Whether the ergy is extracted by a turbine or by an induction pump, the principle is e same--moving water gives its energy to some sort of mechanical motion. understand the physics of water waves requires an indepth understanding meteorology, bathometry and the physics of waves in general, but one has ly to stand on a beach during a storm to know that the energy locked in ves is substantial.

The problems with tidal-power fall into a technological and a biological tegory. The technical one is simpler to solve, for example, how to design system that can take some of the energy from a wave but will withstand the constant battering, how to overcome the constant corrosion prevalent in sea water, how to secure such a huge structure to the bottom and be sure that it won't wash up on the beach after a storm, etc. These types of problems can all be answered if it becomes important enough for us to do so. It is the second class of problems that pose a more serious threat to the feasibility of power generation from tidal forces.

Water in motion carries sediment. Whenever one slows the water down, some of the sediment must be dumped. When water does work, such as turning a turbine blade, it loses some of its energy and is slowed down. When one combines these two principles into a wave generated power station, the sediment normally carried by the water is deposited. This deposited sediment presents a problem. Since certain organisms live in the muds/sands of the sea bottom, a large number would die from all that sediment. Consequently, there should be a serious alteration of the ecology of the entire area. One solution to the sediment problem is to build a dam to trap sea water at high tide which then can be used as a hydroelectric reservoir (see letter "H"). There are several potential sites.

The point of this discussion is that an ecological system is not a static thing, always remaining the same regardless of what forces act upon it. Most ecosystems are in a fine balance and sometimes even a small force is sufficient to upset them. Thus, there are two questions which must be asked whenever considering an alternative energy source. Can we develop the technology to use the resource, and what is the damage to the environment when we develop the alternative? One must understand the environment so that he will know what he is doing when he puts in that harmless little facility. The question one must constantly ask himself/herself is progress at what price?

STUDENT ACTIVITIES FOR TIDAL:

Recommended for K-6:

1. Discuss causes of tides. Earth-sun moon models can be used to explain 'spring' and 'neap' tides.
2. Take a field trip to the ocean at low tide to examine tidal zone. Discuss both the environmental and physical aspects of tides.
3. Build a water wheel and demonstrate how moving water can produce useable work.

Recommended for 7-12:

1. Locate on a world map the areas most suitable for tidal power projects. Discuss the reasons why s/he considers these areas promising.
2. Research some of the problems associated with the generation of power from the tide/waves.

3. Design a tidal-power project and try to "sell" the idea to the rest of the class.

4. Research the legal and land use priorities questions involved with tidal power production.

5. Determine the relative amount of energy the tidal facilities could provide relative to the power from oil/nuclear power facilities.

6. Generate electricity using a water turbine and generator in a nearby stream. Demonstrate the electricity produced using a lightbulb or other suitable D.C. device.

7. Build a ripple tank and wave generator. Study the mathematics of of waves and the motion of waves as they approach and break up in shallow water.

Recommended for K-12:

1. Construct a long low tray (approximately 1' x 3' x 2"). Build a beach at one end and fill the tray up about halfway. Make waves in the tank by placing a rule or similar shaped object in and out of the water at regular intervals. Study the effect of the waves on the beach. Vary the shape and length of the beach as well as placing various objects near or at water-line to discover their effects on the deposition-erosion process.

2. Role play a town meeting to discuss the desirability of allowing a wave power station to be built outside their harbor. Have some of the students role play fishermen, oystermen, as well as town businessmen.

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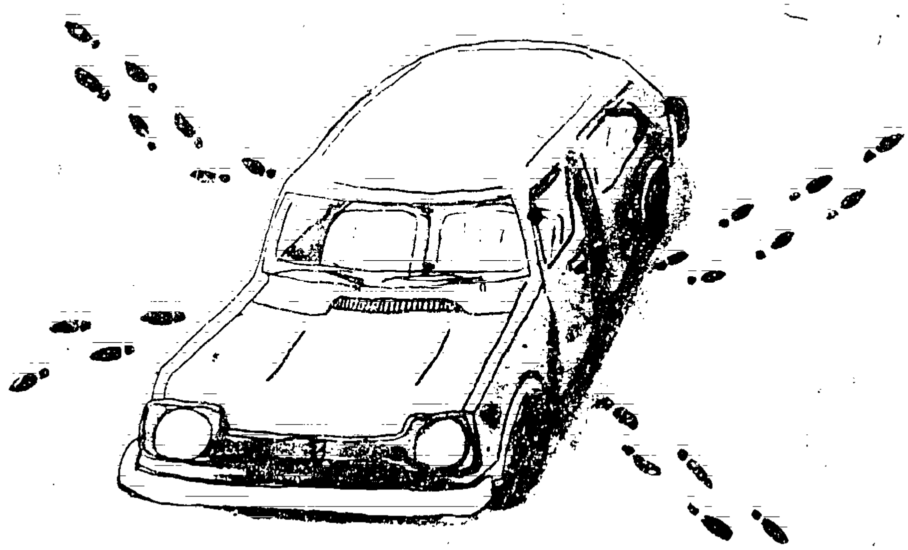
U IS FOR U-CAN SAVE ENERGY BY CARPOOLING



OVERVIEW:

Students will become aware of the advantages of carpooling. They are challenged to apply the carpooling concept to their own family and neighborhood, and are encouraged to participate actively in the establishment of carpool groups locally. In addition, students are enabled to share their ideas and suggestions through posters, games, art, speakers and discussions.

TEACHER BACKGROUND:

As educators in the 80's, we have a definite responsibility to help our children become energy conscious. Perhaps the most difficult, though the most obvious area of concern, is that of automobile use. Today's children have grown up with the convenience of the automobile. Even though they hear much grumbling about the price of gasoline, the automobile is still here, still moving, and still a crucial (or so they think) fiber of their existence.

The cold hard facts are these. There are more than 100 million automobiles in the U.S. These automobiles comsume some 76 million gallons of gasoline a year, or use 14% of all the energy in the U.S., almost 3/4 of all gasoline used, and 23% of all petroleum or oil.

During the 1973-74 Oil Embargo period, transportation conservation was an important measure. Gas lines, the threat of rationing, weekend gas station closings, odd-even gas purchases, and the fear of a cut-off forced many Americans into a new energy awareness. The Federal Government legislated a 55 m.p.h. speed limit which was hailed as a great and noble cause. It had an effect not only on conservation but also on traffic fatalities (9500 fewer that year). Over night the American automobile industry, upon which much of our nation's soundness of economy is built, plunged into a crisis of still echoing proportions. American automakers had failed to heed the signs of the times and were left with a plethora of dinosaurs in the age of the import. Relics of bygone time, they cluttered new and used car lots. Those gas guzzling luxury cars of yester-year became bargain basement items. But, of these small car prices--out of sight! Those who already owned a small car rejoiced; those who did not, shuddered. If new car prices were bad, the news at the gas pump was not encouraging. Gasoline edged up over the dollar mark and is still headed toward the two dollar mark with no relief in sight. European countries have little sympathy because they have long endured high energy costs and point to "cheap" U.S. energy as a cause of our conspicuous consumption.

If the financial cost of gasoline is high, the cost to the environment may be greater still: damage to health, effects of pollution on materials (rust, corrosion, need for repainting, cost of protective coatings), and damage to residential properties and vegetation. Exhaust from automobiles and other vehicles of transportation are major contributors to the problem of air pollution. Lead and carbon monoxide are only two of the pollutants that can potentially cause damage to man.

What is the educators' role? Educators should focus on changing attitudes. They should emphasize the importance of conservation. They should stress the following points: the finiteness of fossil fuels, the need for consolidating short trips, carpooling, and the importance of warming up the automobile engine.

STUDENT ACTIVITIES FOR U-CAN SAVE ENERGY BY CARPOOLING:

Recommended for K-6:

1. Create collages dealing with carpools. Have the purpose be one of generating awareness and interest.

2. Design a city that will facilitate mass transit best, as well as carpooling.

3. Present projects and discuss carpooling at the Back-to-School Night.

Recommended for 7-12:

1. Make up a game in which kids rate their families' auto habits. For example, keep a log of the family car's daily usage. Award points for carpooling, consolidated trips, biking, or walking in lieu of single passenger trips, and unnecessary driving. Encourage students to help devise rules for the game.

2. Help adults set up carpools to their activities.

3. Conduct group discussions. Suitable topics include the following: use of cars by teens, restricting car use to those over 18, and young adults' responsibilities toward the future. After this opener (or openers) set up conservation projects to be carried out by the student body. Set up a carpool number to call for arranging rides.

4. Conduct surveys and try to predict how consumer choices and spending patterns with regard to the automobile may change as a result of energy shortage. Does the carpool seem more attractive? What sacrifices might they be willing to make?

5. Obtain copies of the U.S. Energy Department's interdisciplinary unit called "U.S. Energy Policy--Which Direction?" Read Isaac Asimov's "The Nightmare of Life Without Fuel." This particular piece of future literature is sure to spark some strong reactions in your students. A good follow-up might be to bring in other pieces of science fiction or future literature for class collaboration. What do scientists and authors envision as our energy future? Take some past science fiction and check to see whether or not past predictions have come to pass.

6. Compile a list of their dream cars. Direct them to obtain vital statistics on these automobiles. Plan imaginary trips, computing costs of driving the dream car. Plan another trip that is a form of carpooling. Calculate the difference in expenses and the probable savings for the last two categories. How do your students feel about their dream cars after the project is completed.? By the way, don't miss the chance to make a display from the dream car project--after all, we all need dreams!

7. Report on the gasoline rationing program during WWII. How did it work? What were the major problems? What were the costs of administering the program? How does the situation differ today? Find out the comparative costs of a 1980's gas rationing program.

8. Write essays or editorials:

   "Why I prefer energy efficient automobiles."

   "Carpools--a great way to meet people and make friends."

9. Create carpooling commercials which may be read on the school intercom system or local radio/TV stations.

10. Study the city. Determine the best place(s) for carpooling lots. Take the suggestions to the City Council.

Recommended for K-12:

1. Survey the number of passengers in cars. Determine how many cars would have been needed if each car carried four passengers.

Conduct at industry, at business, and at parking lots. Chart the the information.

2. Design T-shirts or badges that encourage carpooling. Wear them on the same day to make an impressive statement. Perhaps the principals may designate a special day for the observation by carpooling. Publicize the event on the radio or in the newspaper.

3. Invite community energy consultants to speak to the class.

4. Construct a diorama or bulletin board for the classroom, the whole school, or the public library.

5. Investigate existing carpool programs in their communities. Invite participants to their classrooms or interview them on cassette tape recorders. The skill of conducting an interview is reinforced by this activity.

6. Keep a personal or family energy log for a week/month's time. What areas could they predict savings for if they make efforts at conservation?

7. Develop bulletin boards that emphasize the present world situation and the need to conserve gasoline. Encourage carpooling.

8. Poll their neighborhood to see who carpools and why. Make up a simple questionnaire that will not threaten potential poolees.

9. Make posters to encourage adults to carpool. Put them around the community.

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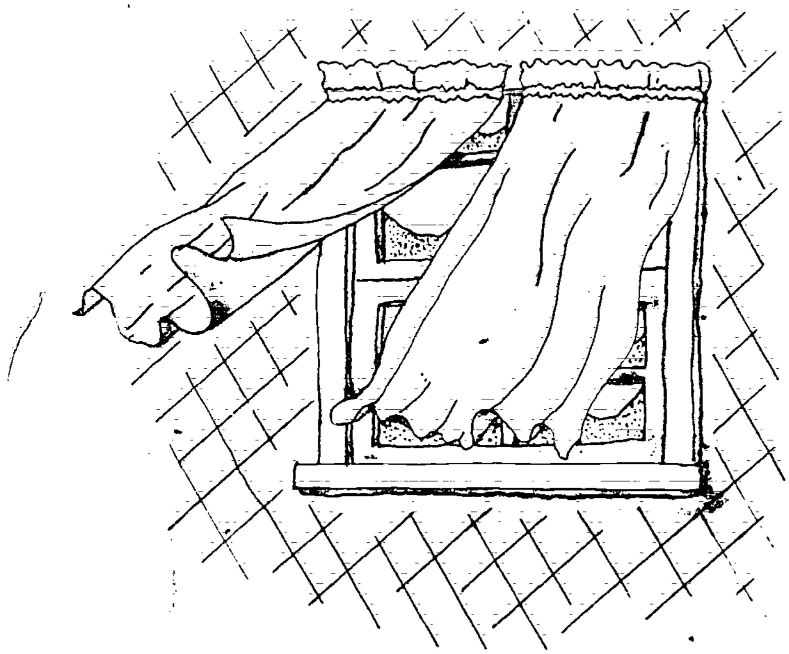
V IS FOR VENTILATION



OVERVIEW:

The concept of ventilation is presented. What it is, why is it important, and how much is enough?

TEACHER BACKGROUND:

Ventilation, the deliberate control of the cirulation of air through a house, can be done by fans and blower systems which move air through a house at a predetermined rate. Most ventilation experts feel that the average residence needs one complete change of air each hour to control humidity and odors.

Does the wind still blow through your house after you close all the doors and windows? If so, you have a infiltration problem. Air comes in around windows, doors, electrical outlets, chimneys, fireplaces, etc.

Consider that you have a one eighth inch crack around all your doors and windows. Two outside doors 73" X 36" and ten outside windows 48" x 28", the total length of this one eighth inch crack is the same as the perimeter of all the doors and windows or 1,976 inches. Multiply this by 1/8 inch and you have the total area of this crack as being 246 square inches. This is the same as having a 15.7" square hole in your wall.

What can you do about this problem? Caulk, and weatherstrip. Inexpensive caulking guns and weatherstripping are available which can solve most of your problems. Be sure to caulk where the trim and siding meet around your windows. If necessary, remove the inside trim around windows and doors and fill the space between the window and framing with insulation. Electric outlet infiltration can be solve' by removing the cover plate and installing insulating pads made espec..lly for that purpose. Special weatherstripping for doors and windows will pay for their cost in fuel savings within a relatively short time.

Another factor to consider is how often and how long are doors left open? You lose heat through the normal opening and closing of doors--if an outside door of your house is opened and closed fifty times each day and if each cycle takes thirty seconds, it is the same as having a 4 1/2 ft. square hole in the side of your house for about one half hour per day. If the air moves through this hole at 1 mile/hour, you could exchange up to 53550 cubic feet of air. This is equal to about five complete air exchanges or sixty cents worth or oil.

Infiltration problems can be solved. A dollar spent weatherstripping or caulking could very well pay for the investment within a few months.

STUDENT ACTIVITIES FOR VENTILATION:

Recommended for K-6:

1. Open the top half of the window, then the bottom half. Note which ventilated the room best. Try both.

2. Take a walking field trip to observe types of vents in homes.

3. Set a fan in a window blowing out and then in. Evaluate which is the most effective.

4. Nail two boards together. Place a bead of caulking at the seam. Determine the effect of the caulking.

5. Record inside temperature on a hot and windy day, then open windows on the side of the house away from the wind. After a period time, read the thermometer again.

Recommended for 7-12:

1. Research the local building codes concerning ventilation. How does this code compare with other area codes? When was the code established?

2. Compare the cost and lifetime of various caulks. The students can practice forming caulking beads.

Recommended for K-12:

1. Construct a draft indicator (loop a facial tissue over a clothes hanger) and record places in their home where infiltration occurs. Compare the infiltration around caulked and non-caulked windows with draft indicators. Note you can use your hand as a draft indicator.

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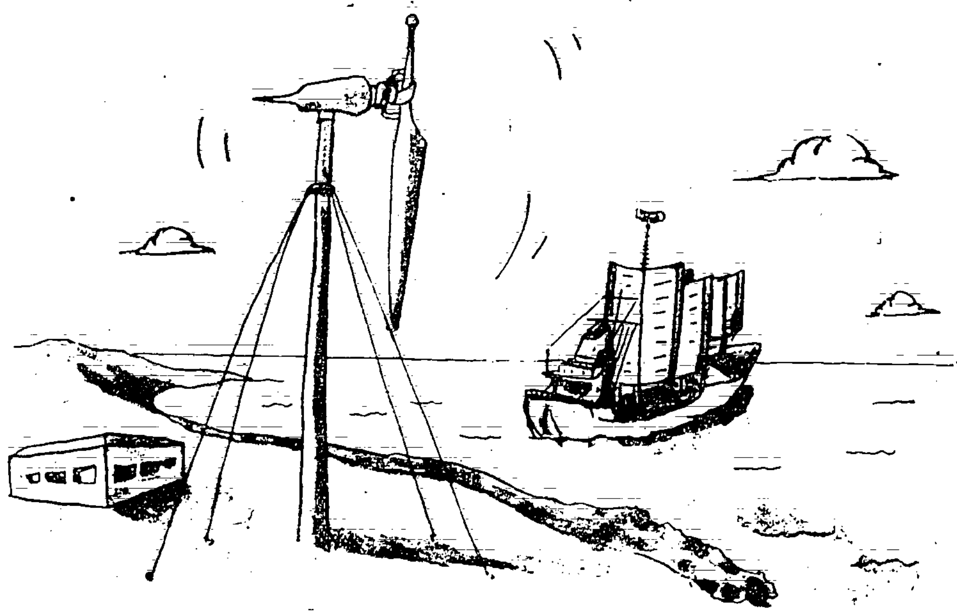
W IS FOR WIND POWER



OVERVIEW:

Students will become familiar with the causes of wind, equipment for measuring wind, and ways by which wind has been and can be utilized as an alternate source of energy.

TEACHER BACKGROUND:

As oil prices rise, more and more Americans are putting their gas-guzzling cars to rest and turning to sources other than oil to heat their homes. Wind energy is one source to which some have turned.

Using the wind as a source of energy is not a new idea born in the age of the 1970's, but an old one utilized by people centuries ago. The earliest use of wind power was by the Egyptians over 5,000 years ago in sailing the Nile. The Persians in 200 B.C. were grinding grain by using the wind. The Netherlands became the world's most industrialized nation by the seventeenth century primarily because of its extended use of wind power. They used the wind to pump water, grind grain into flour, and transport their commodities to other nations. In more modern times, Europe had over 30,000 windmills in the 1800's. The first electricity was generated from the wind in Denmark in 1880. By 1951, Denmark had 3,000 windmills generating electricity.

By the mid-nineteenth century, before Lincoln had even considered the Presidency of the U.S., windmills were producing an annual energy output equivalent to nearly 12 billion tons of coal. The development of the steam engine temporarily slowed down the growth of the windmill industry, but it soon picked up again as small farms and homestead sprung up all over the midwest and west. By the 1930's, the peak of the windmill era, over 300 windmill companies were in existence throughout the world. In the early 1940's the largest windmill ever built was constructed in Rutland, Vermont. It was over 110 feet tall and had braces with a 175 foot diameter. Its output was rated at 1,258 Kilowatts (Kw). It ran only intermittently until 1945 when it lost a blade and was not repaired.

With the introduction of the Rural Electrification Agency (REA) in the United States which brought about cheaper and more convenient electricity, the windmill industry plummetted. From over 300 companies in the thirties, the number fell to about six major companies in the early seventies, at which time a new trend upward began.

Can the energy of the winds be utilized enough to make a significant dent in our energy demands? How much energy can one expect to obtain from a given windmill? Is wind energy dependable? What is the cost of wind energy--is it free? These are some of the questions that must be considered in our evaluation of wind energy.

Wind is a renewable source of energy brought about by the sun by uneven heating of the earth's surface, making it a form of solar energy. During daylight hours, the sun heats the land more than the oceans. Even though equal amounts of energy may be reaching both land and ocean, much of the heat reaching the ocean areas is used to evaporate water while most of that reaching the land areas is used in warming the land surface. The warmer land heats the air in contact with it, and it expands and rises. Colder, more dense air moves in to fill the void, thus winds are born. During the nighttime hours, the process is reversed as the land cools off rapidly. The water, having a larger heat storage capacity, therefore, cools more slowly. Warmer ocean air masses rise; cooler land air masses move into the voids causing off-shore winds.

Winds are produced near uneven land masses in similar ways. Southern exposed slopes of mountains are warmed by the sun, and the heated air near these slopes rises creating winds. The cooler air from the northern slopes fall, creating winds. In a given region (a town or even a schoolyard), the wind will not be the same from one place to another or through the same day. Topographical features (hills, woods, buildings, etc.) create areas of high air activity and shelter. Although the rotation of the earth is not a direct cause of winds, it does affect the direction of the already moving air masses by causing them to twist.

Although the direct and instantaneous utilization of wind's power is relatively simple (as demonstrated by its early historical use), there are many problems concerning the regular collection and conversion of wind power to usable electricity. The most serious is that the wind does not always blow. The weather bureau says that winds blow only 35% of the time although regional differences must certainly be considered. The wind does not always have the proper strength or direction. Too low or high wind speed causes the wind turbine not to function. The ideal wind speed range is from 10 to 30 miles per hour. Because of its inconsistency and resulting unreliability, some form of power storage is required. Possible storage techniques include the use of batteries and the electrolysis method in which water is electrically broken down into its hydrogen and oxygen components during times of wind, and energy is released by their recombination during non-wind periods.

The cost of collecting and converting wind energy to usable electical energy has been estimated at four to five times that of other sources.

There are currently many variations on the windmill theme. These styles include the familiar four arm Dutch type, the multi-armed type traditionally used to pump water, the sail type, the egg beater type, and the new wind turbines. In addition, even newer possibilities including placing windmills off-shore, building tiers of windmills, or using tunnels to direct the wind are being investigated. Also, conversion efficiency is rising. Efficiencies of 70%, doubling the current figure, are now theoretically possible.

The energy of the sun that is transferred to the winds of the earth is over 10^{21} kw hours per year. That is more than a hundred times the energy used by the U.S. in that same period of time. Obviously this cannot all be harnessed, but the Energy Research Development Association (ERDA) hopes to have 1% of our electrical energy coming from wind power by the year 2000. Although the outlook for wind power looks bleak for the country as a whole, there is undeniably energy available in the winds to anyone willing to harness it, and wind energy could certainly be a useful local energy source.

STUDENT ACTIVITIES FOR WIND POWER:

Recommended for K-6:

1. Visit a windmill. One is located at N.M.V.T.I.

2. Build a cardboard model of a windmill to demonstrate to class.

3. Draw or otherwise represent artistically the various types of windmills. Their renditions should be based on documented sources.

4. Investiage such variables as standing facing the wind versus standing paralled, standing at the top of a hill or a jungle gym versus in a ditch or a gully or a group of trees. On which side of the school building is the "force" of the wind greatest? Is the windiest side always the same side (on a clear breezy day versus just before a storm).

Recommended for 7-12:

1. Calculate power output of wind propellers of varying lengths and under varying wind velocities given that the length of one side of one square is equal to the propeller length, the area of each square being 1.2 watts' worth of energy produced, and given that the length of one side of one cube equals a wind velocity of 10 mph, the volume of each cube being 120 watt's of energy produced.

2. Build a model of windmill from wood with an electro-magnetic generator to produce electricity (light a light bulb).

Recommended for K-12:

1. Carry out selected activities from Wind Energy Department of Energy Science Activities (DOE/R-0037) dealing with wind.
2. Discuss the problems which may be encountered if/when high rise structures affect wind generation units.
3. Sponsor a class or school-wide paper model airplane contest. For older grades, test each model experimentally and keep data. Hold discussions on design features and award prizes.
4. Research recreational uses of wind. Draw posters illustrating these uses.

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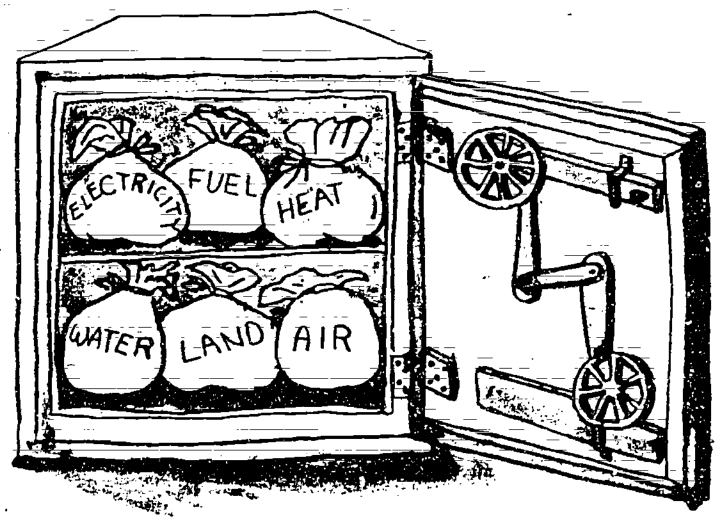
X IS FOR X-CELLENT WAYS TO SAVE ENERGY



OVERVIEW:

Students evaluate their energy use patterns, research techniques of conservation that are realistic, conduct an energy audit in their own home, and develop an energy use priority system. Students get involved in the problem of saving money and conserving energy. Since the student spends 1/3 of his/her time in school during the school year, s/he should be involved in evaluating ways to save energy in the school.

One of the first things a school or district must do in any serious attempt to conserve energy is to start keeping track of energy consumption. Accurate, on-going record keeping is the basis for an energy management program. Consequently, all persons involved in an energy management program must know how much energy is being used, how much it costs and the possible savings resulting from decreased usage.

The students can become a substantial asset in the schools' energy conservation program if they are united in designing and implementing energy saving ideas.

TEACHER BACKGROUND:

Although conservation is widely viewed as an important first step in reducing energy use, people are inclined to blame others not themselves. Since energy conservation is the responsibility of all, everyone must focus on his/her energy use patterns at home, school, and work.

Schools are paying large amounts of money to bring in outside air. In fact, heating and cooling experts contend this is one of the biggest energy and money wasters for schools. One expert says 75% of the energy consumed by schools during the heating season is used to heat outdoor air for purposes of ventilation.

Ventilation requirements are being called into question. Preliminary findings of a study on ventilation by the National Bureau of Standards revealed, that a reduction of the air exchange rate from the normal 4.6 changes per hour to 1.3 changes per hour did not significantly change the indoor environment. Also, the temperature and relative humidity stayed within the comfort range; the oxygen content did not vary from the normal level; and the carbon dioxide concentration level reached a maximum of 0.16% by volume, far below the accepted safety limit of 0.5%.

These findings are important because any reduction in the ventilation rate will contribute significantly to the effort to reduce fuel oil consumption and to save money for schools. Schools are considered "commercial" users of energy, along with hotels and motels offices, hospitals, supermarkets, stores and apartments. Together, these building types account for 90% of the total energy consumed in the commercial market, according to the National Petroleum Council.

The National Petroleum Council came up with 15 energy conservation measures that can be used in these buildings. The measures were ranked by the estimated savings in terms of BTU's, i.e., the first item in each group would result in the greatest savings in BTU's. Note that almost all of the recommendations concern heating and cooling--the prime energy user in buildings.

The measures are as follows:

A. Conservation measures requiring no capital investment.

1. Establish a 65°F temperature level.
2. Establish a night setback level 10° below the daytime level.
3. Reduce lighting levels to a minimum acceptable level, where possible.
4. Establish a cooling comfort level of 78°F during the summer.
5. Cease cooling the building at least one hour before occupants leave.
6. Reduce temperature of general purpose hot water to 120°F except where dishwashers require otherwise.
7. Turn lights off in unoccupied rooms.
8. Turn out yard lights in daytime.

9. Turn off water while brushing teeth or washing dishes.

10. In the winter, open the blinds or curtains during the day where the sun's rays can shine through the window and heat the rooms. The sun's heat will help cut down on the amount of gas, oil, or electric heat used in the house.

11. At night, when the sun has set, close the blinds and curtains to keep heat inside the rooms.

12. Close the door tightly when entering or leaving the house. Remind brothers and sisters to do likewise. In the winter, this will keep the heat in the house. During the summer, this will keep an air-conditioned home cool.

13. Before opening the refrigerator door, ask yourself if it is really necessary and decide how much food and drink you will take out. Tell others why you are doing this. Try to open the door only once to get out what you need.

14. Turn off appliances when they're not being used.

15. Check the bathroom and kitchen hot water faucets to be sure they are not dripping.

16. Take a shower rather than a bath because a shower requires less water.

17. Do laundry in a warm wash and cold rinse.

B. Conservation measures requiring some investment in time and money:

1. Caulk and weatherstrip around all windows and between buildings.

2. Regularly schedule maintenance on equipment and systems.

3. Establish minimum ventilation and fresh air requirements for occupancy periods and zero ventilation during unoccupied periods, where possible.

4. Use restricted flow shower heads (2.5 gallons per minute maximum).

5. Use automatic shutoff faucets in lavatories.

6. Reduce water distribution pressure to a maximum 25 pounds per square inch.

7. Insulate the hot water heater.

C. Conservation measures requiring substantial investment.

1. Insulate ceiling, above or below roof, using insulation having an equivalent "R" factor of 19.

2. Insulate sidewalls using insulation having an equivalent "R" factor of 11.

3. Install storm sash or high efficiency glass.

Schools in the sun belt states and in some other areas of the country have more of a cooling problem than a heating one. What can be done? Here are some tips from Ralph J. Askin, supervising architectural adviser for the California State Department of Education:

1. Older, high-ceiling buildings with large windows and a good system of high/low window natural ventilation should not be altered in most cases, unless air cooling is provided.

2. Solar heat gain is almost completely undesirable, since little heating is needed (considering the heat generated by students and light fixtures). Therefore, shading of outside walls and of all window areas is essential.

3. Other good methods of protecting against solar heat gains are providing light-colored reflective walls and roofing, shading the roof, and providing a ventilated attic or lots of insulation.

Tips on lighting:

1. Replace, where feasible, incandescent lighting with more efficient sources, such as fluorescent, mercury and metal halide lamps.

2. Apply light finishes to walls, ceilings, floors and finishings. Light colors reflect and re-reflect light, increasing by as much as 15% the light that gets to work surfaces.

3. Switch off lights where they are not needed and when space is unoccupied for a period of approximately 15-30 minutes.

4. Use natural light where practical but control glare and reflections.

5. Clean lighting fixtures thoroughly every six months to a year.

6. Investigate use of new fluorescent tubes. They can save up to 15% in energy consumption with a negligible change.

7. Review lighting levels. Standards are being adjusted downward, to more closely meet student needs in specific areas.

8. Post instructions for turning off lights when they are not needed.

9. Install separate switches for rows of fixtures nearest the windows in perimeter classrooms so that daylight may be used when possible.

10. Use photocell controls or time clocks to guarantee that lights are turned off, especially in areas which are difficult to reach and for outdoor lighting.

11. Clean buildings in daylight hours when possible.

STUDENT ACTIVITIES FOR X-CELLENT WAYS TO SAVE ENERGY:

Recommended for K-6:

1. Work in pairs to make posters on Energy-Saving Tips. These posters could be displayed and judged at school or even around town. Awards could be given.

2. Write poems or compositions about energy savings in the schools, home, etc.

3. Compare conservation measures of the 1940's and present day. Make oral presentations. For the very low grades, drawings may be used to illustrate their points.

4. Write a short play on energy tips. Present to class, school, or community.

Recommend for 7-12:

1. Discuss what might happen to their school if the cost for energy doubled and how this would effect their school.

2. Discuss whether their school could utilize a school only alternate energy resource (solar, wind, hydroelectric, etc.). What would be some of the problems if the school decided to do this?

3. Write letters to the editor explaining how the school is saving energy.

4. Play the "Energy Tip Time" in a game show format. Contestants compete for points and prizes as they respond to energy conservation questions. Variations are endless as are game show formats, e.g., Beat the Clock, Let's Make A Deal, etc.

5. Conduct a home energy audit. A free computerized form (REAP) is available from the following:
   The Maine Office of Energy Resources
   State House Station #53
   Augusta, Maine 04333
   207-289-3811

Recommended for K-12:

1. Keep a log of all the travel their family does at 7-day periods and discuss how to save energy by combining trips.

2. Keep a log of all the energy being used for 1 day or a week. Discuss how to conserve energy.

3. Determine where in their school building the energy is wasted.

4. Formulate plans to conserve energy. Use sheet X-2 to determine what energy users from X-1 are necessary.

5. Review "C" is for Conserving Energy and discuss this unit in light of what they determined about their school.

6. Analyze their own energy use habits, e.g., leaving lights on, taking extra-long showers, leaving parked cars running, and taking baths rather than showers, formulate "Energy - Saving Ten Commandments" for themselves, attempt to follow these commandments, and discuss their reactions.

7. Investiage energy wasters at home and school. Estimate the money loss in energy waste vs. the cost of repair or improvement.

8. Compare energy users in the home - now, 1960, and 1940. (Use Sheet X-1.) Interview parents and grandparents for the information.

9. Do a light bulb survey of their homes and school to determine what areas use the greatest wattage. Decide whether the wattage could be reduced.

10. Keep a log of all the ways they have conserved energy for one day or week.

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USING ELECTRICITY

Divide the items from your sheet X-1 into three groups - items that are necessary, items that are luxuries, and debatable items.

NECESSITY	LUXURY	DEBATABLE
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		

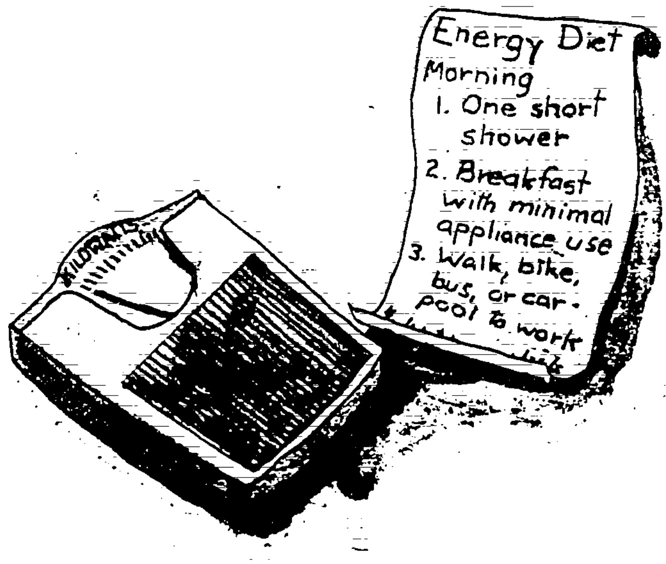
SHEET X-2

ENERGY USERS IN THE HOME

Appliance	Type of Energy	Now	About 1950	About 1940
stove				
lights				
refrigerator				
television				
radio				
water heater				
freezer				
clothes dryer				
fan				
furnace				
vacuum cleaner				
washer				
air conditioner				
hair dryer				
toaster				
fry pan				
organ				
dishwasher				
blender				
mixer				
toothbrush				
saw				
sander				
power tools				
garbage disposal				
garbage compactor				
blanket				
phonograph				
razor				
knife				
hedge trimmer				
garage door opener				
mower				
can opener				

Can you think of others?

Y IS FOR YOU AND YOUR ENERGY VALUES



OVERVIEW:

To fdster a better energy-educated society, it is necessary to cultivate an energy-conscious society. Students will become cognizant of the values of conserving energy, their role in energy conservation and the current trends and ultimate consequences of energy wastefulness. Students will study their lifestyles with direct emphasis upon their energy consumption patterns; they will identify their priorities. Ultimately, they will define their own values about energy use.

TEACHER BACKGROUND:

Public energy concern on a large scale is relatively new phenomenon. Most of this concern, however, is for economic reasons rather than for conserving energy. Our country is guilty of much abuse and misuse of energy. In 1973, we consumed the most energy ever used by any nation in the history of the world. It is estimated that 35% of the energy we consumed was wasted. Since we consume about one-third of the World's energy, one would expect our citizens to be more energy-efficient. Instead, our capitalistic way of life has spawned more and more ways in which we misuse energy. Many of these are directly related to the petro-chemical field which in turn employs a large segment of our work force. Large segments of this field deal with products of the convenience type, often disposable and always expensive to produce in regards to energy.

Our children are not taught values regarding energy use. The culpability is placed on a generation which grew up when energy was inexpensive and readily available. Today's children are caught up in a media-culture which itself is very wasteful. Children spend countless hours watching television, despite studies which demonstrate that it is not good for their development. Programming on television continually shows energy abuse: speeding cars, drag-racing, "souped-up vans, and more. These programs help to promote lifestyles which should not be tolerated in an energy-conscious society.

Children are often given expensive items, such as motorized mini-bikes, snowmoblies, dirt bikes, and automobiles. Often, these energy consumers are abused, as statistics point out that children (young adults) take part in high speed driving, "laying rubber," drag-racing, and other abuses. Although it is unfair to blame all young people, the number is significant enough to warrant an attempt to change their values and life-styles. Our present society is to blame for accepting and fostering this type of behavior; future societies must be less liberal and more energy-efficient.

However, children are not solely responsible for this energy abuse since adults have set poor examples and have failed to teach their children the tremendous importance of conserving energy. The U.S. should consider Sweden as a good example of energy efficiency. Although Sweden has a high standard of living similar to the United States, it is more energy-efficient. Cars in Sweden weigh less, get better gas mileage, and are rarely equipped with energy-using extras, such as air-conditioning and automatic transmissions. In fact, more than seventy percent of the commuters in Sweden get to work by mass transit, bicycle, or foot. Sweden, of course, is much smaller which makes travel much easier; nevertheless, the Swedes have demonstrated a much greater capacity for conserving fuel. Furthermore, they tax large gas-guzzling automobiles and charge higher prices for gasoline.

The Swedish people have also shown energy conservation in heating their homes, despite the fact the average temperature in Sweden is much lower than in the United States. Sweden uses less energy per person to heat their homes, their homes are smaller and better insulated, and their interior temperature is kept lower. Industries also use less energy. We can learn from Sweden.

According to Donald E. Carr in a quote from Energy and the Earth Machine "nothing pays off so fast in energy savings as insulation. If every house had six inches of fiberglass insulation in its attic, and three inches in the walls, Americans could save twenty billion gallons of oil and over trillion cubic feet of gas per year." Despite such overwhelming statistics, many homes in the United States remain uninsulated.

Purcell (1981) points out that Americans spend $4 billion a year to collect and dispose of wastes, throw away enough orgainc waste to replace the energy equivalent of eighty billion barrels of oil a year, and import 91% of their aluminum. Americans spend 9% of their grocery bills on packaging and two-thirds of all paper products, which are thrown away eventually.

Available energy dictates lifestyles; lifestyle dictates energy needs. Students must be encouraged to assess and to alter their lifestyles before energy availability forces them to change.

Often, when people think of energy conservation, they concentrate on fuels for heating and transportation, but do not consider the many other energy uses. Most aspects of our lives depend on energy availability. Without energy sources, we would not have clothing, food, appliances, automobiles, and our other material wants and needs.

Another problem we must face if we hope to redirect lifestyles is the effect advertising plays in our energy picture. We are certainly a consumer-oriented society; we know that any change to reduce consumerism will also affect our economy. Nevertheless, we must begin to take some initiatives in the proper direction.

Many people believe that the answer to a reduction in energy use will be higher prices and taxes imposed on energy-using devices. These people argue that only when the cost of energy becomes prohibitive will they begin to change their ways. Perhaps, this is true to a large degree, but if our children could be taught that wise energy use is a moral obligation of its citizens, we could continue to enjoy our standard of living and be much less vulnerable to oil-producing nations. We could also buy time while technology seeks new energy sources. In addition, if we could encourage our citizens to develop an energy conscience, yes which would look askance at energy abuse and wastefulness, we could begin to feel more self-respect for one another and a new respect for our country with the knowledge that we are doing what is good for the world, for future generations, and for us.

STUDENT ACTIVITIES FOR YOU AND YOUR ENERGY VALUES:

Recommended for K-6:

1. Check the thermostats at home, their locations and their settings. Compare these settings with that of the settings in the school.
2. List the fuel used to heat their homes. State whether that fuel has changed in recent years; list what the parents intend to do about fuel costs in the future.
3. Make a collage of low and no energy use recreational activities.
4. Play energy detectives. Search, record, and correct, where possible, energy-wasting practices in their homes and/or school.
5. Trace the sources of energy they need to play or work. Analyze what they had for breakfast. Where did it originate?
6. Trace the energy used in a fast food product.
7. Discuss processed food, its worth and its energy production cost. (ex. peanut butter)

8. Compute the electricity use for a normal week, then compute the usage when each member has given up one energy-using device. Refer to K for meter reading advice.

9. Play energy charades. Later discuss whether the energy source was imperative.

10. Bring in different types of packaging. Decide why the packaging was used, i.e., protection of the product, advertising, prevention of contamination, etc. Decide whether these materials were necessary and whether they may be recycled.

Recommended for 7-12:

1. List all the electrical appliances that help them to meet their personal needs at home, then determine the wattage of each appliance and the monthly cost for the use of each. Refer to K.

2. Diagram the steps involved in getting a slice of toast (from the seed to the toaster).

3. Recycle an article of clothing or furniture to show respect for energy involved in the manufacturing of it. A mismatched or odd cup and saucer could be converted into a planter; a decorative patch could be applied to work clothing.

4. List energy-related problems facing the nation, their state, and their locale.

5. Develop and write a two-page energy philosophy which is a personal set of energy values. This set of values would be used after leaving home, after getting married, or after establishing a separate household. It must be personal and be in the best interest of the community, the state, and the nation.

6. Henrik Ibsen's "Enemy of the People" entertains the idea of truth and morality in conflict with economics. After the play is read, students could be encouraged to parallel the play's dramatic tension with the clash between environmentalists and energy industrialists, with alternative energy sources advocates, and with big business lobbyists.

7. Arthur Miller's "All My Sons" raise the question of a man's responsibility to his fellow human beings. The play could provoke a variety of assignments focusing on the difference between people's basic needs and their desire for wealth and power and between conservation and extravagance.

8. Robert Frost's "Stopping By A Woods" could be used to initiate a discussion on the role that energy plays on pacing our lives. The poem deals with a man riding in a horse-driven carriage. How does the mode of transportation compare with the attitudes and atmosphere of the poem? How might they change if the poet had taken some other form of transportation? Has something been lost by our progress towards more rapid transit methods?

Recommend for K-12:

1. Turn off all the lights, close the shades, and remain there for a day. This is what it will be like without energy sources. Have students list ways we can change to ensure energy for the future. List renewable sources that can be use.

2. Write a skit on the future without fossil fuels.

3. List ten things that are thrown away in their home or school. Decide whether these items could be recycled. Visit a recycling plant. Decide what natural resources can be recycled.

4. Make a card with a country listed on it. From students research, list the country, population, and percentage of world energy sources used. Shuffle the cards and give one to each student. Distribute 100 M&M according to the percentage of the individual country's energy consumption. Followup ideas: (1) Compare population with consumption. (2) Redistribute energy sources equably according to population. (3) Determine how much of our energy sources are imported; decide how we could produce more here. (4) List some dangers of energy production.

5. Compare the energy consumption of our country of similar population. What are the differences? Similarities? Why?

6. List five recreational activities. Determine their energy uses such as manufacturing of the equipment, transportation to the activities, the energy to light or heat the building, the energy to construct the edifice, etc.

7. Plan a trip. Decide how many miles you will travel. Decide what is the most economical way to travel. Weigh the inconvenience. Decide what is the most important.

8. Consider different ways of producing and preparing food. Determine which method produces the most calories for the least amount of energy; determine which method uses the most energy. Make a chart with your daily activities, then list the calorie needs. Could you eat less to save energy?

9. List five or ten things that you would be willing to give up to protect the environment from energy related pollution.

10. Develop a series of bulletin boards with clippings from current magazines and newspapers which depict energy value trends of this country's government.

11. Investigate and report on the environmental movement and its connection with the use of and the production of energy. Which threats to the environment can be traced to energy production and to energy usage?

12. Make a display of products whose packaging could be made simpler, then design your own.

13. Interview a member of the following: school, post office, hospital, restaurant, and church. Ask them to list ways they could eliminate or cut waste.

14. Design and display school art produced from disposable items.

15. Design a bulletin board to indicate buildings that have made energy changes, such as solar heat, insulation, shrubbery planting, and wood stoves.

16. List ways they can save energy.

17. Collect and weigh wasted paper and packaging in their homes for one week; compare findings with other students.

18. Compile a chart of throw-away products and their durable counterparts, including the price of each item and its expected life.

19. Stage a class discussion on the topic, "What price are we willing to pay for the energy we use?"

20. Compare energy consumption of cooking a meal in a conventional oven, in a microwave ove.. and in a slow cooker.

21. Design a bumper sticker on energy conservation, explain your motive for writing it.

22. List the personal energy conservation actions each student proposes to take as his/her contribution to the energy problem.

23. List all the ways their community, school, or home could reduce energy waste.

24. List the ways in their homes that energy is either misused or wasted

25. Have students sacrifice one energy user for a week. Discuss the impact at the end of the week.

26. Conduct an energy drive. Students will get citizens to give up certain energy uses. The student to get the greatest energy savings wins; the community profits.

27. Make a chart showing typical energy use in their home or school.

28. Conduct an in-school contest on energy saving techniques employed by each homeroom. Rooms may either lose or gain points to their wise or unwise use of energy.

29. Conduct a poster contest with a theme on "Energy Consciousness" or a similar theme.

30. Make a list of energy-using devices which may be found in their homes, then check the ones they could give up.

31. Conduct a survey to determine how many automobiles abuse energy by driving empty, by going too fast, or using too large a vehicle.

32. Set up recycling center for products which can be recycled.

33. Collect items which can be recycled (bottles, cans, newspapers, etc.)

34. Conduct an essay writing contest with a theme relating to the importance of energy conservation.

35. Use Sheet Y-1 with students and parents. First students complete, then parents. Compare results. Discuss.

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To ensure our energy supply for the future we, as individuals and as a society, need to reassess our priorities. Respond to the following questions:

	Strongly agree	Agree	Disagree
1. Do we change our lifestyle and lower our energy demand?			
2. Do we become alert consumers and evaluate the energy efficiency of the product?			
3. Do we demand more and more energy at any cost?			
4. Do we pay more, use less, and protect the environment?			
5. Do we begin again to conserve, recycle, and reuse?			
6. Do we save the energy and resources spent on disposable items by replacing them with durable goods?			
7. Do we find more efficient heating systems, automobile engines, and appliances?			
8. Do we replace the snowmobile with cross-country skiis?			
9. Do we combine many short trips into one trip?			
10. Do we purchase practical clothing that will last for years?			
11. Do we walk or bicycle more rather than the automobile?			
12. Do we add a sweater or blanket rather than turn up the thermostat?			
13. Do we use manually operated equipment when possible?			
14. Do we change our lifestyles so that future generations will be able to enjoy a life.			

Z IS FOR ZONES OF HOME HEATING AND HOW THE THERMOSTAT WORKS

OVERVIEW:

Students learn that the different zones of a home require different amounts of heat and that money can be saved by controlling the time and the degree of heating/cooling. Students learn the importance of adjusting the thermostat to fit the particular situations. Students study thermostats and their uses.

TEACHER BACKGROUND:

The word zone is used in many ways, e.g., parking zone, loading zone, residential zone, etc. When zone is applied to a home, it refers to an area of specialized activity, such as the kitchen, a zone for cooking and eating.

Each room or zone in a home has specific heating or cooling requirements; therefore, the home heating/cooling system should be designed to accommodate the particular activity of that area. Obviously, heating requirements are not the same for all zones. For example, sleeping areas do not have to be as warm as other parts of the home. Many zones do not require heat or require low temperatures unless there is activity.

New homes should be designed to gain full benefit of the sun and the wind without being overburdened by their power. The best location for living and kitchen areas is the south side, whereas the north side is appropriate for the bedrooms and storage. Place a garage on the coldest or windiest side of the home. In warmer climates, shading living areas is energy saving. Also, such natural passive solar orientation of the various activity zones can reduce the need for artificial heat.

In the last twenty years, petroleum products and electrical controls have made heating and cooling zones in our homes and commercial buildings very easy to regulate. Zone heating is achieved simply and effectively through the use of thermostats which activates and cuts off the heat supply at predetermined temperatures. The basic type of thermostat works on the principle that a substance, when heated, will expand. This expansion ability is then coupled with switch contacts which simply turn on or off an electrical impulse. The impulse will then control the mechanism supplying the heat or cold.

Several types of thermostats are available. The bimetallic type of thermostat is made of two dissimilar metals usually invar and brass or other metal, welded together. Since one of the metals expands more than the other, the movement is created, allowing for switch action.

A Bourbon-element type thermostat works when a volatile liquid is heated and is changed into an expanding gas. The warmer expanding gas enlarges the brass billow or tube and again movement is created, which will activate a switch.

Clock thermostats work only at specified times during the day and only allow heat or cold into a zone when it is needed. These thermostats have built-in clocks which automatically control them.

Although correct usage of thermostats will not solve all of the energy problems, it will certainly reduce energy-consumption. Proper, sensible use of thermostats can reduce the heating bill substantially. Keeping the house ten degrees cooler at night for example, can save up to 16% on the annual fuel bill.

STUDENT ACTIVITIES FOR ZONES OF HOME HEATING AND HOW THE THERMOSTAT WORKS:

Recommended for K-6:

1. Sketch a floor plan of their homes showing the location of any thermostats and list the setting of the thermostat.

2. Visit the school boiler room and have the building maintenance supervisor talk about the heating/cooling zones in the school.

3. Read the room temperature and the setting on the classroom thermostat.

4. Use variations of child's games, e.g., Red Light or May I. Certain students can be designated as thermostats and the others as the flow of hot water through a hot water system. This will demonstrate the control of flow.

5. To determine the number of zones, compare the number of thermostats in a multi-zoned hot water system to the number of circulator motors.

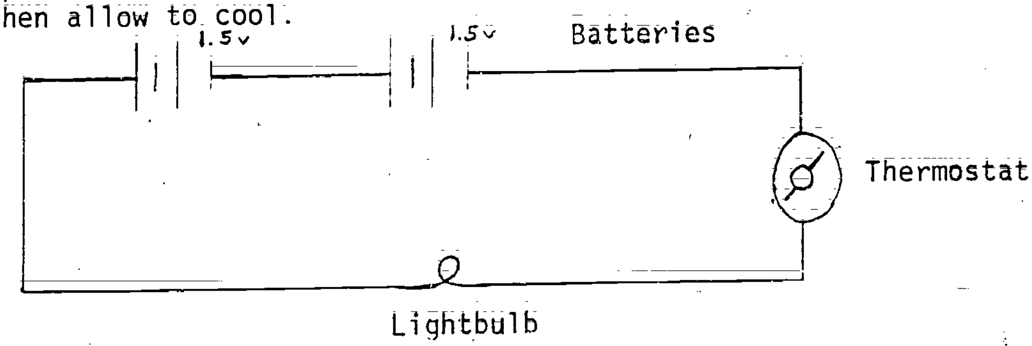
6. Read the temperature in the room and compare it with the thermostat setting.

7. Make a list of the rooms in the home. Tell whether each room is used (morning, afternoon, and evening). Arrange them in order from the most used to the least used. Determine when the temperature could be reduced in each zone.

8. List other devices, such as shades, combination windows, blinds, drapes, and curtains, in the home which aid the thermostat in keeping the room(s) warm or cool.

Recommended for 7-12:

1. Hook up old thermostat to a circuit with a light or bell in series with thermostats. Paint housing of thermostat black and expose to intense light source. When temperature inside thermostat gets higher, the thermostat will open. The cirucit and light will go out or bell will stop ringing. Then allow to cool.



2. Draw a schematic of a bimetallic thermostat or construct a thermostatic switch using a bimetallic strip, bell wire, 1 1/2 volt battery, nail, and a board to which to mount it.

3. Draw a schematic of a Bourbon-element type thermostat.

4. Do a Retrotech audit of their homes. When the cost of heating various areas of their homes has been computed, determine the savings if all zones are heated only to the temperature needed for the activity there.

5. Take a field trip to an all electrically heated home and upon returning, discuss the advantages and/or disadvantages of total electric multi-thermostat systems.

6. To illustrate that heat travels in zones and that the zones vary in temperature, using three thermometers, measure the temperature of the classroom at floor-level, ceiling level, and in between.

7. Draw floor plans of their homes with color coded proposed heating zone layouts.

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EVALUATION OF THE A,B,C'S OF ENERGY

We would appreciate your reactions and suggestions by completing this form and returning it to us. We would appreciate it if you would evaluate any part, or all, of the guide. Thank you for your assistance.

Name of School ____________________

School Address ____________________
Street Town State zip code

What grade(s) do you teach? ____________________

What subject(s) do you teach? ____________________

My overall reaction to this guide is:

5 4 3 2 1
Very Positive Very Negative

Letter of alphabet reviewed/used: ____________________

Please rate the following aspects of the resources or activities of your selected letter on the scale of one to five:

1. The teacher background was:

   5 4 3 2 1
   Sufficient Insufficient

2. The overview was:

   5 4 3 2 1
   Helpful Not Helpful

3. For your grade level, the activities were:

   5 4 3 2 1

4. Regarding the reference sources, they were:

   5 4 3 2 1
   Very helpful Not Helpful

5. My students responded:

5 4 3 2 1
Positively — Negatively

6. The amount of energy education I have taught or will teach this school year is:

5 4 3 2 1
More than 2 weeks — Less than 1 day

7. Regarding National Energy Education Day, March 19, I was:

5 4 3 2 1
Unaware — Aware

8. Did you make any changes in the activities before using it in your class:

Yes_____ No_____

If so, what changes did you make?

9. Do you have any further comments regarding your particular letter or other letters, or the guide in general?

Return this completed form to Dr. Lloyd H. Barrow, 212 Shibles Hall, University of Maine at Orono, Orono, Maine 04469. Telephone inquires (207) 581-7027.