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ABSTRACT

This resource book contains descriptions of over 100 classroom activities designed to illustrate concepts relating to energy, its production, characteristics, use, and conservations. Each activity integrates the energy lesson into a concept that relates to one or more subject areas common to public school curricula. Many of the activities included in the document were developed by public school teachers. In addition to teaching activities, an annotated bibliography of energy teaching resources available from ERIC is provided. (RE)

ENERGY ACTIVITIES FOR THE CLASSROOM:

VOLUME II

Selected and Developed by

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Mary-Lynne Bowman

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and Environmental Education
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December 1978

ENVIRONMENTAL EDUCATION INFORMATION REPORTS

Environmental Education Information Reports are issued to analyze and summarize information related to the teaching and learning of environmental education. It is hoped that these reviews will provide information for personnel involved in development, ideas for teachers, and indications of trends in environmental education.

Your comments and suggestions for these publications are invited.

John F. Disinger
Associate Director
Environmental Education

Sponsored by the Educational Resources Information Center of the National Institute of Education and The Ohio State University.

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PREFACE

Energy continues to be a matter of great concern in the United States and elsewhere around the world. The production, distribution, cost, and use of energy affects individual budgets, family life styles, governmental actions, and international relationships in many ways.

Since 1973 increasing attention has been given to "energy education." National and state governments have prepared an enormous number of leaflets, pamphlets, booklets and films pointed generally toward increased conservation efforts. Local gas and electric utilities have undertaken similar efforts. Large corporations involved in the production, distribution, and sale of energy have made increasing use of various forms of media to present their concerns about America's energy problem. And many school systems, encouraged by funding from the U.S. Office of Education or the Department of Energy, have prepared materials judged to be helpful in promoting study of energy-related questions.

The amount of energy education material now available is far greater than most teachers can integrate into their programs of instruction. Thus the teacher or curriculum developer is faced with the task s/he is uniquely qualified to accomplish—selecting that which is most appropriate to accomplish the objectives for the particular learners involved.

This resource booklet of energy teaching activities draws heavily on the ideas and materials developed by public school teachers which have become a part of the bank of teaching resources collected by the ERIC Clearinghouse for Science, Mathematics and Environmental Education.

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Documents bearing SE numbers are in the local collection of the Information Reference Center for Science, Mathematics, and Environmental Education, and have not been announced through Resources in Education as this volume goes to press. Persons wishing to secure such materials should locate them from other sources; in most cases this will be the listed publisher or organization.

The activities, designed for student use in elementary through high school classes, are "action-oriented" and involve student participation throughout the school community. Each activity has been classified by the authors according to the most appropriate level, subject matter and energy concept involved. In addition to being classified in these categories, each activity contains (1) a statement of purpose on how the activity may be used, and (2) a reference to a source where the activity may be found in more detail or with variations.

It is hoped that the teachers who use these materials will recognize that the classified categories and statement of purpose serve only as a guide in selecting appropriate activities and should not be considered a fixed structure. In fact, it is recommended that teachers check for activities in the other grade level sections that may be appropriate for use or to adapt for use for their own particular set of learners.

The references cited in specific activities as well as some additional ones found in the final section of this booklet should be useful to persons interested in obtaining more energy study ideas and activities.

Herbert L. Coon
Mary Lynne Bowman

December, 1978

BASIC CONCEPTS FOR ENERGY STUDY

modified from Mengel, Wayne. Energy: Key to the Future, Dutchess County Board of Cooperative Educational Services, Poughkeepsie, New York, 1974, ED 092 395.

1. Energy is so basic that nothing moves or is accomplished without it.

   Pg. 11, 26, 57, 131

2. Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

   Pg. 8, 12, 23, 27, 69, 70, 75

3. Presently, most of our energy requirements are met through using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

   Pg. 9, 10, 30, 66, 92, 105, 107, 135

4. Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

   Pg. 3, 4, 5, 6, 17, 24, 28, 32, 40, 45, 47, 55, 61, 73, 83, 88, 94, 97, 98, 114, 136, 143

5. The production, distribution, and use of energy have environmental, political, social, and economic consequences.

   Pg. 13, 14, 15, 16, 19, 31, 33, 35, 38, 41, 42, 43, 50, 51, 53, 64, 78, 80, 81, 90, 91, 100, 101, 113, 116, 120, 122, 126, 127, 128, 129, 130 137, 138, 141, 142, 144

CLASSIFICATION OF ENERGY ACTIVITIES

Grade Level:	Elementary school	
	Elementary-junior high school	
	Elementary-junior-senior high school	
	Junior high school	
	Junior-senior high school	
	Senior high school	
Subject Area:	Science	including health, nature studies, home economics, drivers education, etc.
	Mathematics	including arithmetic, geometry, industrial arts, etc.
	Social Studies	including geography, population, history, etc.
	Language Arts	including reading, creative writing, etc.
	Fine Arts	including music, art, theater, etc.

BREAKDOWN OF ACTIVITIES BY CATEGORY

(Some activities fall into more than one subject area.)

	Category	Number of Activities
Grade Level:	Elementary school	15
	Elementary-junior high school	22
	Elementary-junior-senior high school	3
	Junior high school	17
	Junior-senior high school	13
	Senior high school	8
Subject Area:	Science	36
	Mathematics	17
	Social Studies	46
	Language Arts	21
	Fine Arts	7

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ENERGY ACTIVITIES FOR THE CLASSROOM: VOLUME II

ELEMENTARY SCHOOL

PURPOSE:	To demonstrate energy savings by cooking with covered pans rather than uncovered pans.
LEVEL:	Elementary School
SUBJECT:	Science
CONCEPT:	Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.
REFERENCE:	Science Activities In Energy: Conservation. The American Museum of Atomic Energy, Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, Tennessee 37830.
ACTIVITY:	Cooking with uncovered pans wastes heat. Demonstrate this to your class as follows:

1. Heat up a hot plate.
2. Pour two cups of water into a pan. Keep pan uncovered.
3. Place pan on hot plate and time how long it takes for the water to boil vigorously.
4. Empty the pan and let it cool.
5. Add two more cups of water and cover the pan.
6. Place covered pan on hot plate and again time how long it takes the water to boil.

Did covering the pan save energy?

Another activity you may wish to try is to perform the same experiment this time by cooking an egg for seven minutes in a covered pan and one for seven minutes in an uncovered pan. Crack both eggs immediately after they are taken off the heat. Which egg is more thoroughly cooked? Why?

PURPOSE: To test the effects of air pressure in bike tires in regard to energy usage.

LEVEL: Elementary School

SUBJECT: Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Science Activities In Energy: Conservation. The American Museum of Atomic Energy, Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, Tennessee 37830.

ACTIVITY: Because friction makes machines harder to move, bikes (and cars) require more energy to move if their tires are soft than if they are properly inflated. Demonstrate this phenomenon to your students as follows:

Ask two students with similar type bikes and of similar weight to bring their bikes to school. Inflate one bicycle's tires to normal pressure and the other's to half that amount. Have students ride side by side at the same speed. When they reach a selected line on the ground, they should coast the rest of the way. Compare how far each goes. Is it important to check tire pressure on your bicycle? What about your family car?

PURPOSE: To construct a draftometer and test your school and/or home for air leakage.

LEVEL: Elementary School

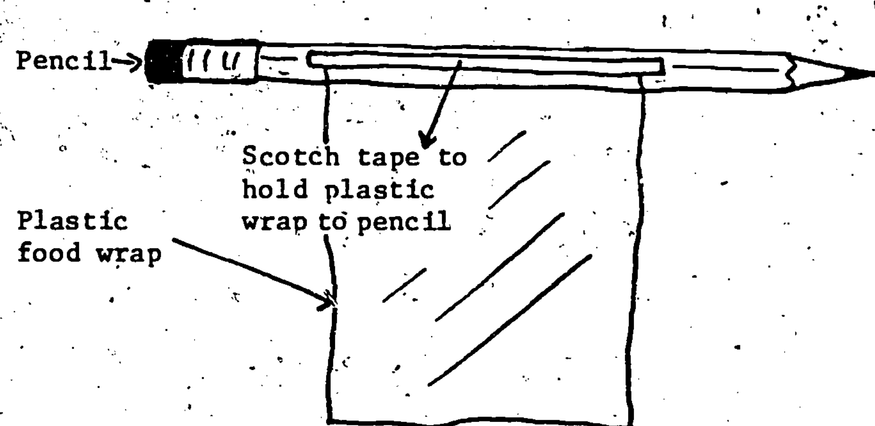
SUBJECT: Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Science Activities In Energy: Conservation. The American Museum of Atomic Energy, Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, Tennessee 37830.

ACTIVITY: With a simple draftometer you can demonstrate how air (and hence heat and cold) moves through even the smallest of spaces in a school building or home.

To make a draftometer, cut a strip of plastic food wrap 12 cm x 25 cm. Scotch tape the food wrap to a pencil to hold it in place. Blow on the plastic gently to assure that it responds to air movement.



Note: Forced air furnace must be off to use draftometer.

Test your school for leakage by holding the draftometer near the edges of windows and doors. If the plastic moves there is a draft.

Explain to your students that the warm air will be pushed upward and out by the cold air that comes in.

Demonstrate this by placing a thermometer near the ceiling and one near the floor to measure the room's temperatures.

Increasing the temperature will only speed up the waste of fuel.

Look for dirt collected around doors and windows. What does it prove?

Have students check their homes for drafts with their gadget. Test the fireplace with the damper open and closed. What is the difference?

Visit a hardware store and find out what is available to close air leaks around windows and doors.

PURPOSE: To demonstrate why the color of the roof and walls of a house can be important in determining the amount of heat and air-conditioning the house will use.

LEVEL: Elementary School

SUBJECTS: Science
Mathematics

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Science Activities In Energy: Conservation. The American Museum of Atomic Energy; Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, Tennessee 37830.

ACTIVITY: Materials Needed:

- 4 juice cans
- Poster paint: white, black, green and red
- Hot water, close to boiling
- 4 thermometers
- Food coloring

With poster paint in colors listed above, paint each juice can a different color. Next, fill each can with the same amount of hot water. Add food coloring to the hot water corresponding with the color of the can. Note: Add drops of all colors together to get black and add no color to the water in the white can. Put a thermometer in each cup. Record the temperature of water in each can every three minutes until the water cools. Make a graph of the results.

Which color held heat best? What is the best color to paint a house to keep it warm in winter? Would a house with a dark roof be more or less expensive to air-condition in the summertime?

PURPOSE:	To demonstrate the concept of non-renewable energy resources.
LEVEL:	Elementary School
SUBJECTS:	Science Fine Arts
CONCEPT:	Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.
REFERENCE:	The Energy We Use: Grade 1. National Science Teachers Association and U.S. Department of Energy, Technical Information Office, P.O. Box 62, Oak Ridge, Tennessee 37830. ED 153 846.
ACTIVITY:	Place an animal cracker for each of your students in a plastic bag. Let the class examine the crackers. Now let each child eat a cracker. Look again at the plastic bag. All of the crackers which were in the bag are gone. Those animal crackers are gone forever. Explain to your class that in a similar way we have a certain amount of coal, oil and gas on earth. When we use it up, it is gone forever. We say that our coal and oil and natural gas are non-renewable. Once used up they are gone forever.

Burn a candle in an aluminum pie pan. Let your students carefully feel the heat energy. Observe the light energy. Once the candle is completely burned down, its energy is dissipated—it cannot be used again.

Ask your class to think of some of their daily activities. If we used up all of our natural gas, coal and oil, which would they have to stop doing? Have each student draw a picture to show which activity he/she would miss the most.

PURPOSE:	To demonstrate that the winter sunlight can be hot when concentrated.
LEVEL:	Elementary School
SUBJECTS:	Fine Arts Science
CONCEPT:	Presently, most of our energy requirements are met through using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.
REFERENCE:	Beverly Hotze, Elementary School Teacher, Mark Twain Elementary School, Westerville, Ohio.
ACTIVITY:	Explain to your students that all of the earth's energy originally comes from the sun. Some might believe that winter sun is not hot—particularly in colder climates. This activity demonstrates that even the winter sunlight can be concentrated into a source of much heat.

Saw a small tree or branch with bark into ¼ to ½ inch thick pieces—one for each child in your class. Drill a hole for a leather shoe lace and make a pendant. Ask students to write or print their names on the wood using a heavy lead pencil. Pick a sunny day to take your class out-of-doors. Show the students how to use a magnifying glass to concentrate the sun's rays onto the writing on the pendant. The dark graphite absorbs more of the sun's energy and will burn the imprint into the wood. After the names are burned into the wood, spray each pendant heavily with acrylic spray and hang overnight to dry. The results are a fun pendant that can be worn in the classroom and is particularly useful on field trips.

PURPOSE: To illustrate the importance of the sun as an energy source.

LEVEL: Elementary School

SUBJECTS: Science
Fine Arts
Language Arts

CONCEPT: Presently, most of our energy requirements are met through using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Lee County Energy Action Cards. Lee County Schools, Fort Myers, Florida, 1976. SE 024 758.

ACTIVITY: With your class plant beans in two small containers. After the bean plants have sprouted and grown four or five inches, place one plant in a dark place and keep the other in the light for one week. When the week is up, ask your class to observe the differences in the two plants. Compare the conditions for growth of the one in the dark with the one in the light. Bring out the fact that sunlight made the difference and that sunlight is necessary for the growth of most plants. We get light from the sun. The sun is a primary source of energy for all green plants on the earth.

Now have each of your students create and illustrate a story entitled "The Week the Sunlight Didn't Arrive."

PURPOSE: To identify and understand energy-related words.

LEVEL: Elementary School

SUBJECT: Language Arts

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

REFERENCE: Energy In The Classroom Vol. II: Activities Guide for 4-7, Virginia Energy Office, 823 East Main Street, Richmond, VA 23219. ED 141 066.

ACTIVITY: As a language arts experience, ask children to locate and circle the hidden energy words in the letter matrix shown below.

Engage the class in discussing or reviewing what each word means.

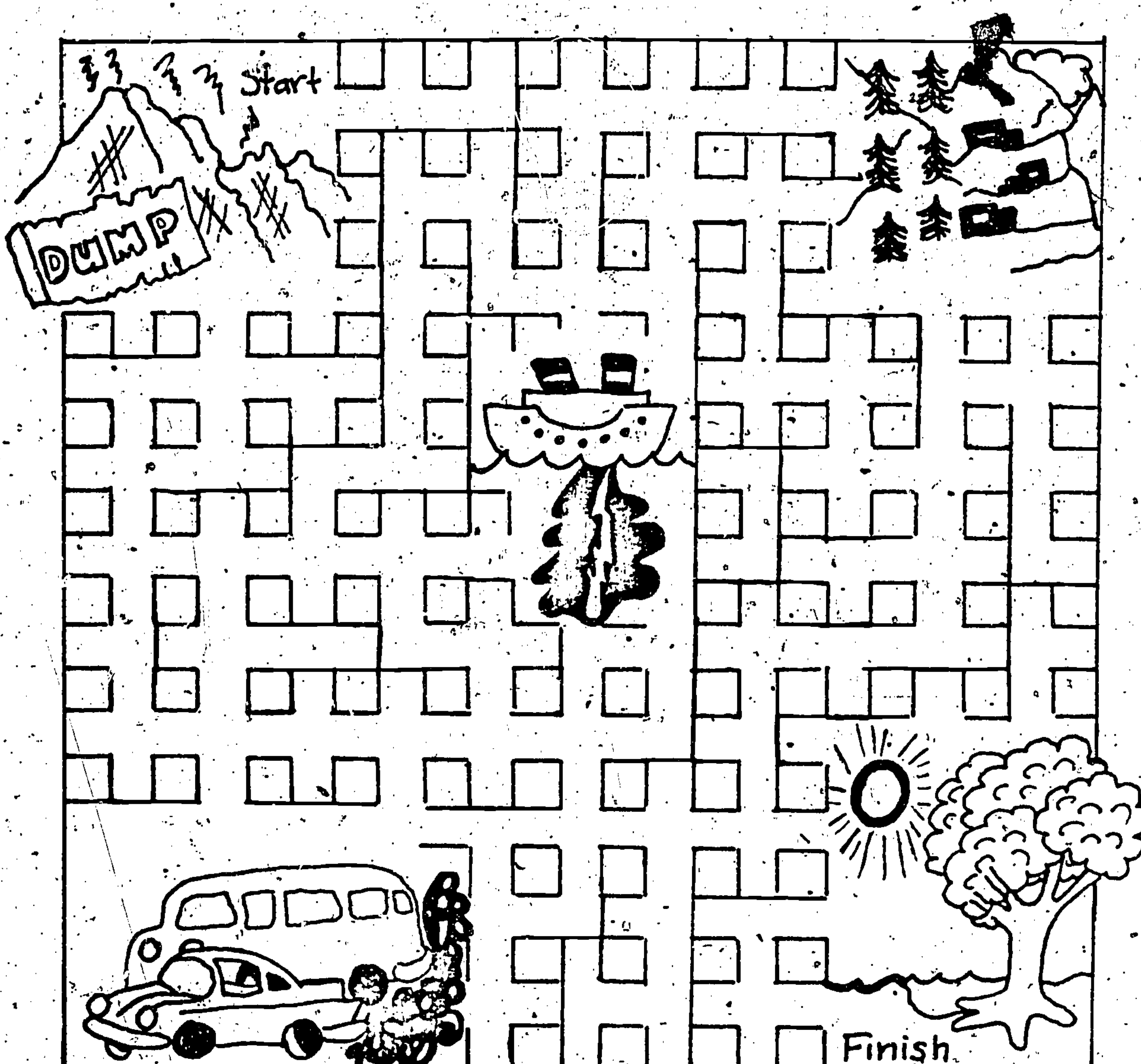
Elicit from the class another list of 15-20 energy-related words and ask children who might be interested and able to develop their own hidden word matrix that could be used in another language arts lesson.

G	H	C	N	I	T	H	G	I	L
O	R	B	D	E	R	N	M	D	E
T	A	E	T	R	E	T	I	L	C
R	E	I	T	S	T	O	L	B	D
A	V	H	A	E	E	N	E	A	N
U	A	S	W	T	M	S	A	G	U
Q	S	T	O	E	K	O	C	H	O
F	U	E	L	O	I	L	L	C	P
Q	S	A	I	H	E	A	T	I	H
W	P	M	K	C	O	A	L	B	K

Locate and Circle

KILOWATT		STEAM
METER	LITER	GAS
MILE	QUART	SAVE
KILOMETER	POUND	HEAT
INCH	TON	LIGHT
FUEL OIL	COKE	COAL

PURPOSE:	To provide an energy-related language arts experience.
LEVEL:	Elementary School
SUBJECT:	Language Arts
CONCEPT:	Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.
REFERENCE:	ENCORE (Energy Conservation Resources for Education). Department of Industrial Education, Texas A & M University, College Station, Texas 77843. SE 025 401.
ACTIVITY:	Distribute copies of the maze. Ask children to get as quickly as possible from the garbage dump to the land of clean air and water while avoiding along the way polluters that use or waste the most fuel.



PURPOSE:	To conduct a survey to determine whether energy concerns are more or less newsworthy today than they were 10 years ago.
LEVEL:	Elementary School
SUBJECTS:	Social Studies Language Arts
CONCEPT:	The production, distribution, and use of energy have environmental, political, social, and economic consequences.
REFERENCE:	Lee County Energy Action Cards. Lee County School, Fort Myers, Florida, 1976. SE 024 758.
ACTIVITY:	Collect local newspapers for one week. Divide pages among your students and ask them to cut out any article and/or advertisement that is energy-related. Make a bulletin board display of this week's energy news. Assign students to go to a local newspaper office and ask to review the newspapers printed the same week ten years ago. Have students write the headings of articles/advertisements related to energy at that time.

Compare the number of energy articles printed for the two weeks. Have the energy concerns changed from 10 years ago? If so, how?

Now ask students to write a short energy article describing what they predict the energy concerns will be 10 years from now.

Complete your bulletin board display showing "energy news" for the 30-year span.

PURPOSE: To examine bicycles as energy savers.

LEVEL: Elementary School

SUBJECTS: Social Studies
Language Arts
Fine Arts

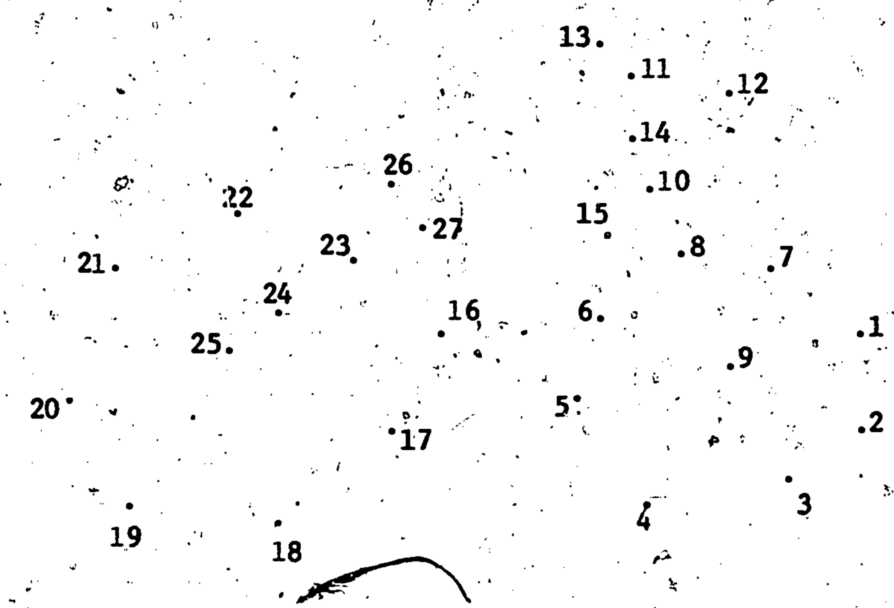
CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Energy in the Classroom, Activity Guide for K-3. Virginia Energy Office, 823 East Main Street, Richmond, VA 23219, 1975.

ACTIVITY: Involve primary school children in completing the drawing below. Older elementary school children may respond to the challenge of making a freehand drawing of a bicycle and rider.

Review with pupils the fact that transportation by bicycle is the most energy-efficient form of transportation available. Bicycling requires, for example, about one-half as much energy as walking. In addition to saving energy, cycling is an excellent form of exercise.

Engage the class in discussing whether they or their parents use bicycles for short trips to the store to pick up a quart of milk, loaf of bread or other small items. Should their families make more use of bicycle transportation? Is it safe to ride bicycles from their homes to nearby stores? What do they think about special "small roads" just for bicycles?



PURPOSE: To compare the use of energy in children's recreation at the turn of the century with the recreational energy usage of today's youth.

LEVEL: Elementary School

SUBJECTS: Social Studies
Fine Arts
Language Arts

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: Ask your students to interview someone who has lived through the turn of the century (a great-grandparent, senior citizen, etc.) to find out the kind of games they played, what their favorite toys were, and what kind of family recreation they enjoyed when they were about the same age as your students are. Perhaps some of the people interviewed will have samples or pictures of recreation that was popular during the late 1800s/early 1900s that could be shared. When your students have completed this task and shared their findings, conduct a class survey and make a list of the popular games, toys and family recreation of today's youth.

Divide your class into two groups, asking one group to make a mural of "Yesteryouth Recreation" and the other group to construct a mural depicting recreation of today's youth. Each child should be responsible for one form of recreation, toy, game or family fun, and a paragraph describing his/her choice. When the murals are completed, discuss the kinds of energy used by both groups of people. Who used the most energy in recreation—yesterday's youth or today's?

PURPOSE: To investigate the feasibility of bringing the grocery store to the householder.

LEVEL: Elementary School

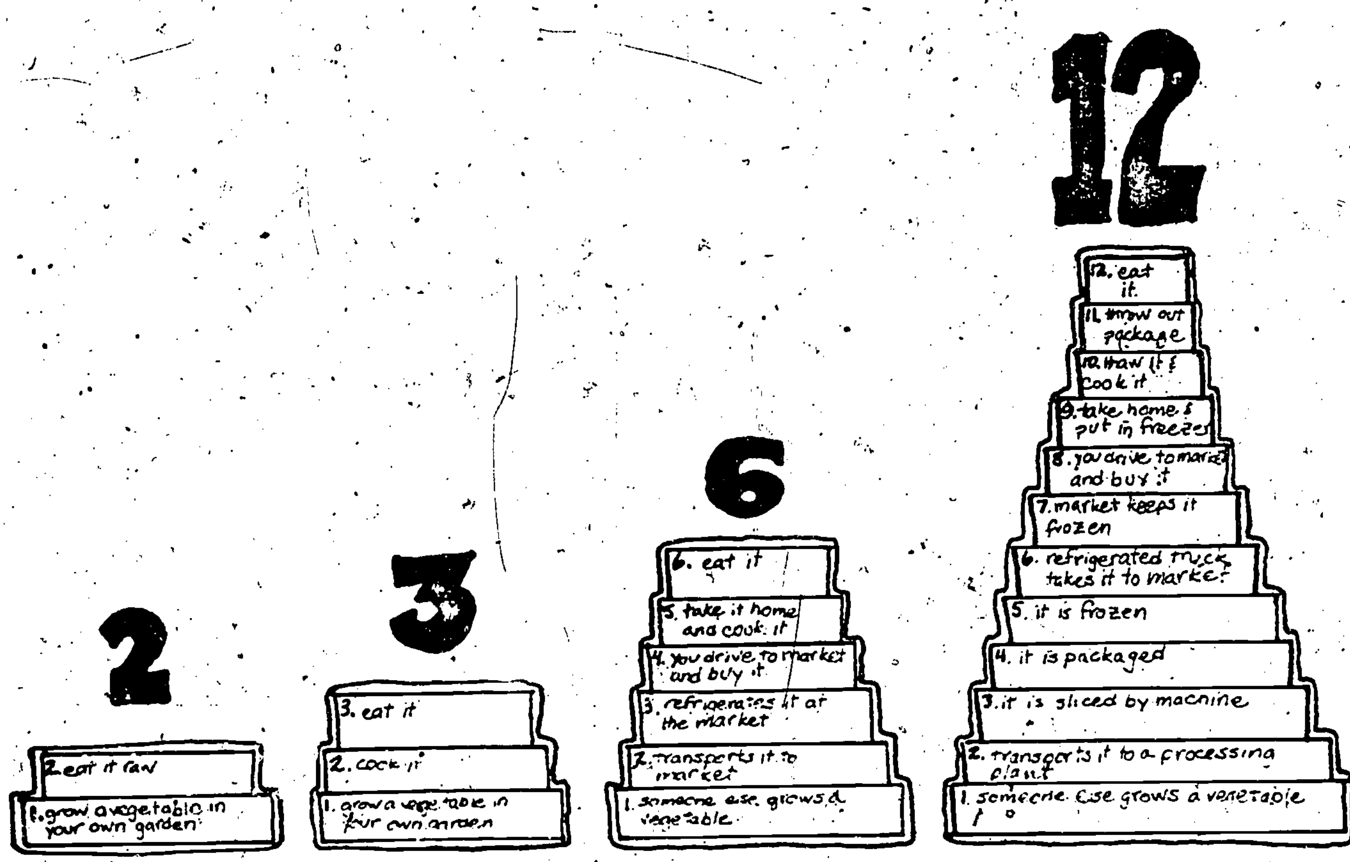
SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: Share with your students the fact that in the 1920s and 1930s many grocery store owners also had a "traveling grocery store;" i.e., a grocery store built on the chassis of a truck containing staples regularly needed by most people. This traveling store would make daily rounds through the community and people could do their shopping in front of their own home. (You may wish to compare the traveling store to the ice cream man to help your class understand the concept.)

Explain that these traveling stores could not carry all items contained in a modern super market and that when people began to have two car families and gasoline was relatively inexpensive, people preferred to jump in the car and go to the super market where they had a bigger selection. Point out that gasoline costs are rising and our society is becoming aware of the need to conserve energy and discuss whether or not the traveling store would be a good idea today. Divide the class into groups of four and have each group make a list of the items they believe would be appropriate for today's traveling store; i.e., items most people need regularly. Compile the lists and formulate a class list of items that were selected most frequently. Ask students to take the lists home and see if parents agree with the items and whether they believe a traveling store could make a "comeback" in today's society. If the response is positive, you may wish to contact a local grocery store to share with the manager potential community support for a traveling store.

PURPOSE:	To analyze amounts of energy involved in various types of food production and consumption.
LEVEL:	Elementary School
SUBJECT:	Social Studies
CONCEPT:	Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.
REFERENCE:	Energy Activity Guide. Park Project on Energy Interpretation, National Recreation and Park Association, 1601 N. Kent Street, Arlington, VA 22209.
ACTIVITY:	On the chalkboard draw the following pyramids illustrating the "energy steps" required in various types of food production and consumption.



Point out to your class that if we use things as close to the way nature makes or uses them, we are probably saving energy; i.e., stay as close to the source of things as possible to conserve energy.

Ask your students to keep a daily log for one week of the number of energy steps used in each of their families' total vegetable consumption. This should include salads, frozen and canned vegetables, etc. Compare class results. Discuss whether and/or how seasonal changes might make a difference in their tally.

PURPOSE: To show how energy availability will affect future life styles.

LEVEL: Elementary School

SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social and economic consequences.

REFERENCE: Jones, John (ed.). Energy and Man's Environment: Activity Guide: Future Sources of Energy. 0224 S.W. Hamilton-Suite 301, Portland, OR. SE 025 399.

ACTIVITY: Divide the class into groups of four. Ask each group to list the characteristics of a life style that they would find most satisfying. One representative from each group will then act as a group using their combined lists to arrive at a list characterizing the "good life."

Now, ask your students to imagine that due to a shortage of gasoline, gas will be permanently rationed to five gallons per week. Discuss how this would affect the possibility of living the "good life" as previously described by your class. Discuss other aspects of gas rationing that would cause inconvenience or change consumer patterns.

Ask your class to again work in groups and design a life style using the characteristics of the "good life" which could fall within the five gallons of gasoline ration.

ENERGY ACTIVITIES FOR THE CLASSROOM: VOLUME II

ELEMENTARY-JUNIOR HIGH SCHOOL

PURPOSE: To demonstrate the process of converting solar energy to electricity.

LEVEL: Elementary-Junior High School

SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Science Activities In Energy: Solar Energy. The American Museum of Atomic Energy; Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, Tennessee 37830.

ACTIVITY: Materials Needed:

Solar cell
Motor with spinner disc
Lamp with 100-watt bulb

Converting solar energy directly to electricity is one of the most exciting new notions related to the use of sunlight. The following experiment shows how this process works.

1. Connect a solar cell and motor as illustrated:

2. Aim the solar cell out a sunlit window and notice how fast the motor turns.

3. Now hold the photocell near a 100-watt bulb out of the sunlight and notice how close the solar cell has to be to the lightbulb to be equal to the energy from the sun.

You may wish to experiment with bulbs of different wattages.

Try this experiment at different times of day such as 10 a.m. and 3 p.m. and in windows facing different directions.

Ask your students which direction would be best to aim the solar cell if you couldn't move the cell during the day to follow the sun. Why?

PURPOSE: To build a snow shelter or "quin-zhee" to demonstrate that snow can be an insulator of heat and sound.

LEVEL: Elementary-Junior High School

SUBJECT: Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Haynes, Jane, Graduate Student, The Ohio State University, Columbus, Ohio.

ACTIVITY: Materials Needed:

snow shovels for making snow pile
smaller shovels or other utensils for use in excavating
2 sheets of heavy plastic about 6' x 8'
one to be used as a gound cover inside "quin-zhee"
the other can be used to remove excavated snow
2 buckets to aid in removing snow from inside "quin-zhee"
thermometer
candle

As a class project, construct a snow shelter called a quin-zhee that can be used for winter camping or in a survival emergency as follows:

a. mix all snow to ground level at the construction site by turning it over with a shovel

b. make a snow pile 5 to 7 feet high and 8 to 10 feet in diameter

c. remove apex to reduce ceiling weight

d. allow snow pile to crystallize and harden for 1-2 hours (the higher the temperature the longer it takes to harden)

e. tunnel into the base on the lee side—the opening should be just large enough for a person to enter sliding on his stomach

f. excavate inside, be sure to expose the ground, keep walls at the base 10" thick and ceiling at least 6" thick. Check with a thin probe.

g. construct vents—1"-2" holes to allow fresh air to enter and foul air to escape

-one in the ceiling
-one near the base of the door

h. cover doorway with a flap of plastic pegged to snow above the door

Have students check the temperature outside and then inside the "quin-zhee" with different numbers of students inside.

Next add a lighted candle and check the temperature.

Ask students to observe sound insulating qualities of snow while inside the "quin-zhee".

PURPOSE: To examine the basic importance of energy.

LEVEL: Elementary-Junior High School

SUBJECT: Science

CONCEPT: Energy is so basic that nothing moves or its accomplished without it.

REFERENCE: Where Does America Get Its Energy? —Energy Conservation Activities for Young Learners. Office of Conservation Education, Federal Energy Administration, Washington, DC.

ACTIVITY: Ask each student to select any item that they can see in their home, school, or street. Ask the student to list the kind of energy associated with the item. If it moves what energy makes it run? Does it transform energy from one kind to another? Does it store energy? What kind? What kinds of energy were used in its manufacture? What energy do you need to use it?

Assign a one-page essay in which students should attempt to describe the "energy chain" associated with the object they chose.

PURPOSE: To demonstrate how to store solar energy and test various materials to determine which materials store solar energy best.

LEVEL: Elementary-Junior High School

SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Science Activities In Energy: Solar Energy. The American Museum of Atomic Energy; Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, Tennessee 37830.

ACTIVITY: Materials Needed:

- Cardboard box
- Black paint
- 4 small metal cans
- 4 thermometers
- Sand, salt, water and torn-up paper

One of the biggest problems of making widespread use of solar energy is finding ways to store it when the sun is not present. The following experiment gives a clue as to how such storage is accomplished:

1. Fill one metal can with sand, one with salt, one with water and one with torn-up paper and place a thermometer in each can.

2. Paint the cardboard box black, and put the cans in the box.

3. Place the closed box in the sun for one-half hour.

4. Remove the cans and watch the temperature fall. Stir occasionally.

Which temperature falls the slowest? Which stores solar heat the best?

PURPOSE: To develop understanding of the term "degree day."

LEVEL: Elementary-Junior High School

SUBJECT: Mathematics
Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Robert L. Steiner, Science Educator, Ohio State University.

BACKGROUND: When actual heating or cooling requirements are considered the number of degree days per year is of major importance. Students can be involved in a long-term data collection project in this activity.

A Degree Day (DD) is defined as the difference between 65°F and the average of the daily high and low temperatures. If the average is below 65°F, it is a heating condition (HDD) and if the average is above 65°F, it is a cooling condition (CDD). The sum of the HDD for the year gives the yearly HDDs. Similarly the sum of the CDD gives the year's CDDs.

Daily high and low temperatures can be obtained from a maximum-minimum thermometer, a recording thermograph, or from local newspapers, radio or television newscasts. The U.S. Weather Bureau can usually provide the past year and local long-term averages for HDD and CDD for comparison purposes.

ACTIVITY: Involve students in calculating the heating degree days for a severe winter month in Columbus, Ohio as recorded in the data presented on the following page. Secure data from your local weather station for the same month and compare.

A class or small group of students may undertake to keep running records of HDD and CDD over a period of several months using data from their own thermometers or from the local weather station.

On the following list are the high, low and average temperatures (rounded) for February 1978. These temperatures were recorded at the Port Columbus U.S. Weather Bureau Station.

Date	High	Low	Average	HDD 65-avg)
1	19	- 3	8	57
2	22	13	18	____
3	23	6	15	____
4	24	10	17	____
5	23	13	18	____
6	13	3	8	____
7	15	0	8	____
8	21	8	15	____
9	24	5	15	____
10	24	- 5	10	____
11	26	0	13	____
12	30	14	22	____
13	28	11	20	____
14	28	5	17	____
15	23	- 4	10	____
16	29	20	25	____
17	28	11	20	____
18	23	8	16	____
19	22	1	12	____
20	24	1	13	____
21	25	8	17	____
22	19	8	14	____
23	26	4	15	____
24	30	23	27	____
25	34	28	31	____
26	28	21	25	____
27	26	16	21	____
28	33	15	24	____

________ HDD
February 1978

PURPOSE: To dramatize the enormous amount of gasoline used by American motorists.

LEVEL: Elementary-Junior High School

SUBJECT: Mathematics

CONCEPT: Presently, most of our energy requirements are met through using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

ACTIVITY: Secure from the school custodian a 42-gallon barrel or have someone as an art project make a profile of a barrel to be displayed on a classroom wall. On the barrel or paper facsimile show the percent of oil used to make gasoline, jet fuel, and other products depicted on the drawing below.

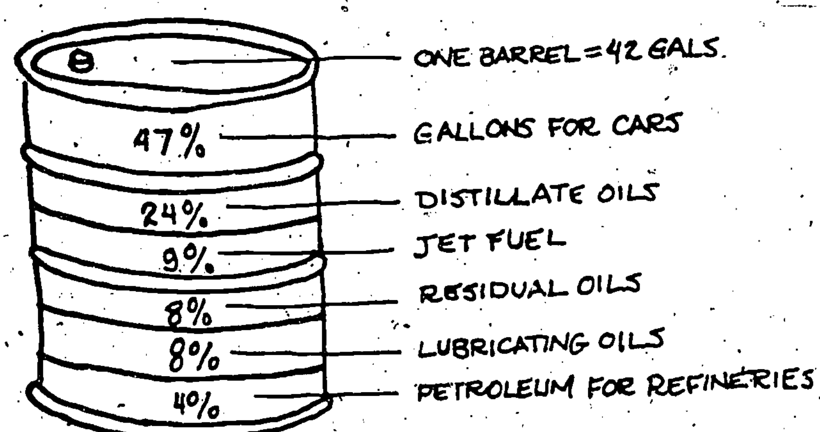
Ask each child, as a homework assignment, to bring to class the actual mileage on the speedometers of their family car(s). Ask, also, that a parent estimate the average miles per gallon for the car(s). (If the mileage can't be estimated readily, use 15 mpg which is slightly better than the national average.)

Using the data brought to class, have each child calculate the number of gallons of gasoline that have been burned in his family car(s). How many barrels of crude oil were needed to produce that amount of gasoline? How many gallons of gasoline and barrels of oil have been used in the total class' family cars?

If every classroom in the school used gasoline at the same rate how much has been used by the entire school?

What, if anything, is being done by some families to curtail gasoline consumption?

WHERE THE OIL GOES



PURPOSE: To investigate the importance of individual gasoline savings.

LEVEL: Elementary-Junior High School

SUBJECT: Mathematics

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Tips For Energy Savers. Federal Energy Administration, Washington, DC 20461, U.S. Government Printing Office, 1975. 0-586-806.

ACTIVITY: Share with your class the following information:

There are more than 100 million registered automobiles in the U.S. A typical car, with an average fuel economy of less than 13.7 miles-per-gallon, travels about 10,000 miles each year—and consumes well over 700 gallons of gasoline.

Altogether, these automobiles consume some 70 trillion gallons of gasoline each year—or about 14 percent of all the energy used in the United States, almost three-quarters of all gasoline used and 28 percent of all petroleum.

The importance of individual gasoline savings cannot be overemphasized. If, for example, the fuel consumption of the average car were reduced just 15 percent through fewer daily trips, better driving practices, and better maintenance, the nation's consumption of petroleum would fall by over 680,000 barrels per day, or about 4 percent of demand.

If every automobile consumed one less gallon of gasoline a week (an average of about 13 miles of driving), the Nation would save about 5.2 billion gallons a year, or about 7 percent of the total passenger car demand for gasoline. Survey your students to ascertain the number of cars in each family.

Calculate the number of gallons of gasoline that could be saved by your students' families per year if each driver consumed one less gallon of gasoline each week.

Using the current cost of gasoline per gallon, calculate the amount of money that your class' families could save.

PURPOSE: To estimate the amount of gasoline used to transport students to and from schools in your district.

LEVEL: Elementary-Junior High School

SUBJECT: Mathematics

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Lee County Energy Action Cards. Lee County Schools, Fort Myers, Florida, 1976. SE 024 758.

ACTIVITY: Set up a class interview with your school system's transportation supervisor or your school principal to find out:

1) How many school buses are used daily.
2) Number of miles each bus goes per day.
3) How many gallons of gas each bus uses each day.
4) Average daily number of students that ride the bus to and from school.
5) Number of walking students per day.
6) Average number of students in daily attendance in your district.
7) Number of days per year school is in session.

Using the information obtained from the interview, assign students the following mathematics problems:

1) Calculate miles per gallon for each bus.
2) Calculate gallons of gas used by school buses per year for your district.
3) Add the number of walking students to busing students and subtract from average school attendance. Figure the average daily number of students using private transportation to get to school.
4) Figure the average percentage of students using the school bus service.
5) How many gallons of gasoline does it take to bus each student per day?
6) How many gallons of gasoline does it take to bus each student per year?

PURPOSE: To determine fuel efficiency of students' family cars.

LEVEL: Elementary-Junior High School

SUBJECTS: Mathematics
Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY:

1. Plan with the class to get parental cooperation in determining miles per gallon obtained by family cars during a common period of time such as Saturday morning to Saturday morning (one week). Plan, if possible, for children to accompany parents to the gasoline station and record initial mileage, gallons needed to fill the tank the second time, and final mileage. Ask students (with parental help if needed) to calculate miles per gallon.

2. When data are brought to class the following Monday, organize it into a matrix under headings such as subcompact, compact, full size, station-wagon and/or other categories deemed appropriate (such as engine size or vehicle weight).

   What kinds of cars were most efficient? Why? Was this a good experiment? How could it have been improved? Whose father or mother gets the best mileage? The worst? Why? Is it a good idea for the EPA to report to the public the results of their mileage tests on new cars? What kind of car will pupils buy when they get old enough?

2. A. Keep a log of all trips made by automobile for two weeks.

   B. Separate list into those which could have been eliminated by using the telephone, those which were within walking distance, those which would have been very difficult to walk, and those which were impossible to walk.

   C. For a two-week period can you cut down on the trips within walking distance?

   D. How much gasoline was used in the two-week period? Calculate the number of gallons, the cost per gallon and the total cost of fuel.

   E. Combine lists for the classroom.

F. Outline the advantages of walking short distances rather than driving (energy conservation, parking, risk of accident, pollution, exercise, social aspects, environmental appreciation, economy, etc.). List the disadvantages (time consuming, inconvenience, small children at home, etc.).

G. Do the same for various means of public transportation.

PURPOSE: To visualize differences in population, energy consumption, and per capita energy consumption for geographical regions of the world.

LEVEL: Elementary-Junior High School

SUBJECTS: Mathematics
Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Robert L. Steiner, Science Educator, Ohio State University.

BACKGROUND: Although a table of numbers can accurately present data, it is often difficult for a non-abstract reasoning individual to develop an understanding and appreciation for what is indicated by the data.

This activity is designed to help students pictorially represent and compare data for geographical regions of the world. Students with mathematical facility could develop their own methods for presenting the data, but for many students the activity will probably work best if the data and scale are given to them. The important idea which the student must grasp is that the <u>area</u> of each circle is representative of the data for the geographical region. This activity can be done individually, but probably will be more successful if done in groups.

ACTIVITY: The table on page 37 contains data for regional and World population, energy consumption, and per capita energy consumption. This data have been used to determine the radii of circles for each piece of data so that the area of the circle is proportional to the data it represents. (Remember the area of a circle is proportional to the radius squared.) The value of the radius (r) of the world data is arbitrary and can be set according to criteria such as availability of paper size. Setting the radius of the world population, energy consumption and per capita energy consumption the same so that the circles have identical areas seems to be the best procedure. The activity can be highlighted using colored paper, one color for population, another for energy consumption and a third for per capita energy consumption.

The circles representing geographical populations should be arranged in a row with the corresponding geographical energy consumption circles arranged in a row below the population circles. After the students have had an opportunity to examine and compare the population and energy consumption and hopefully develop some feeling for per capita energy consumption, the circles representing the geographical per capita energy consumption should be placed in a row below the corresponding population and energy consumption circles.

Before and/or after the appropriate circles are drawn and displayed questions such as the following may be discussed: Does every geographical region or individual use, on the average, about the same amount of energy? What factors help determine how much energy a country and/or individual uses? In what countries would you expect the most energy to be used? Why? What will happen as all countries use and/or demand more energy?

World and Regional Population, Energy Consumption and Per Capita Energy Consumption[1]

	Population (millions)	% of World's Population	Radius	Energy Consumption Q's(10^{15} BTU)	% of World's Consumption	Radius	Per Capita Consumption 10^7BTU	% of World's Per Capita Consumption	Radius
North America	231	6.2	.25r	72.68	35.9	.60r	31.5	586	2.42r
Caribbean America	129	3.4	.18r	4.32	2.1	.15r	3.35	62	0.79r
Other America	166	4.4	.21r	3.44	1.7	.13r	2.07	38	0.62r
Western Europe	359	9.6	.31r	39.22	19.4	.44r	11.0	204	1.43r
Middle East	111	3.0	.17r	2.59	1.3	.11r	2.33	43	0.66r
Far East	1172	31.2	.56r	15.43	7.6	.28r	1.31	24	0.49r
Oceania	22	0.6	.08r	2.54	1.3	.11r	11.5	213	1.46r
Africa	369	9.8	.31r	3.66	1.8	.13r	0.99	18	0.43r
Communist Countries	1194	31.8	.57r	58.70	29.0	.54r	4.91	91	0.95r
World	3753	100.0	1.00r	202.39	100.1	1.00r	5.38	100	1.00r

[1]Cook, Earl. 1976. Man, Energy, Society. San Francisco, W.H. Freeman. (p. 258). The original data is for 1972 and has been converted to BTU units and rounded off.

PURPOSE: To investigate individual family energy consumption.

LEVEL: Elementary - Junior High School

SUBJECTS: Mathematics
Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Robert L. Steiner, Associate Professor, Science/Mathematics Education, The Ohio State University, Columbus, Ohio.

ACTIVITY: Have students determine their family's consumption of electricity, natural gas or fuel oil, and gasoline for the past year. If the family does not have past records available, it is possible to get these from the utility companies. Gasoline estimates can be made from the number of miles driven the previous year, divided by the approximate number of miles per gallon obtained for the family automobile(s).

Students should compare the energy consumption for the different energy sources on a month-to-month basis. Different family's utility bills should be compared* with differences and similarities discussed and tentatively accounted for.

Ask the students to compare this year's utility bills with last year's, on a month-by-month basis, and account for differences or similarities. A calculation of cost per energy unit for this year compared to last year should also be made.

Have students read and record the family electric KWH meter and natural gas meter. They should read the meters again exactly one week later. This provides base line data on family energy consumption. Based on what the students have read and learned about methods of individual energy conservation, ask the student and his family to make a concerted effort to conserve electricity and natural gas during the next week's period of time. At exactly the same time of day one week later, the students should read the meters again and compare the amount of energy used during the one-week intervals, one of normal consumption and the one of a concerted conservation effort. Students should be cautioned to take into account large differences in outside temperature or weather or absence from the home as they make the comparison.

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*Some families may consider this an infringement of privacy, so this data and activity should be strictly voluntary.

Ask the students to discuss how successfully their family was able to conserve and to determine the percentage difference in consumption for both electricity and natural gas. Have them determine how much money their family could save over a year's period of time if they continued their conservation efforts (percent conservation of energy times their family's estimated total energy cost for each energy source).

PURPOSE: To sense distance and time involved in transporting energy.

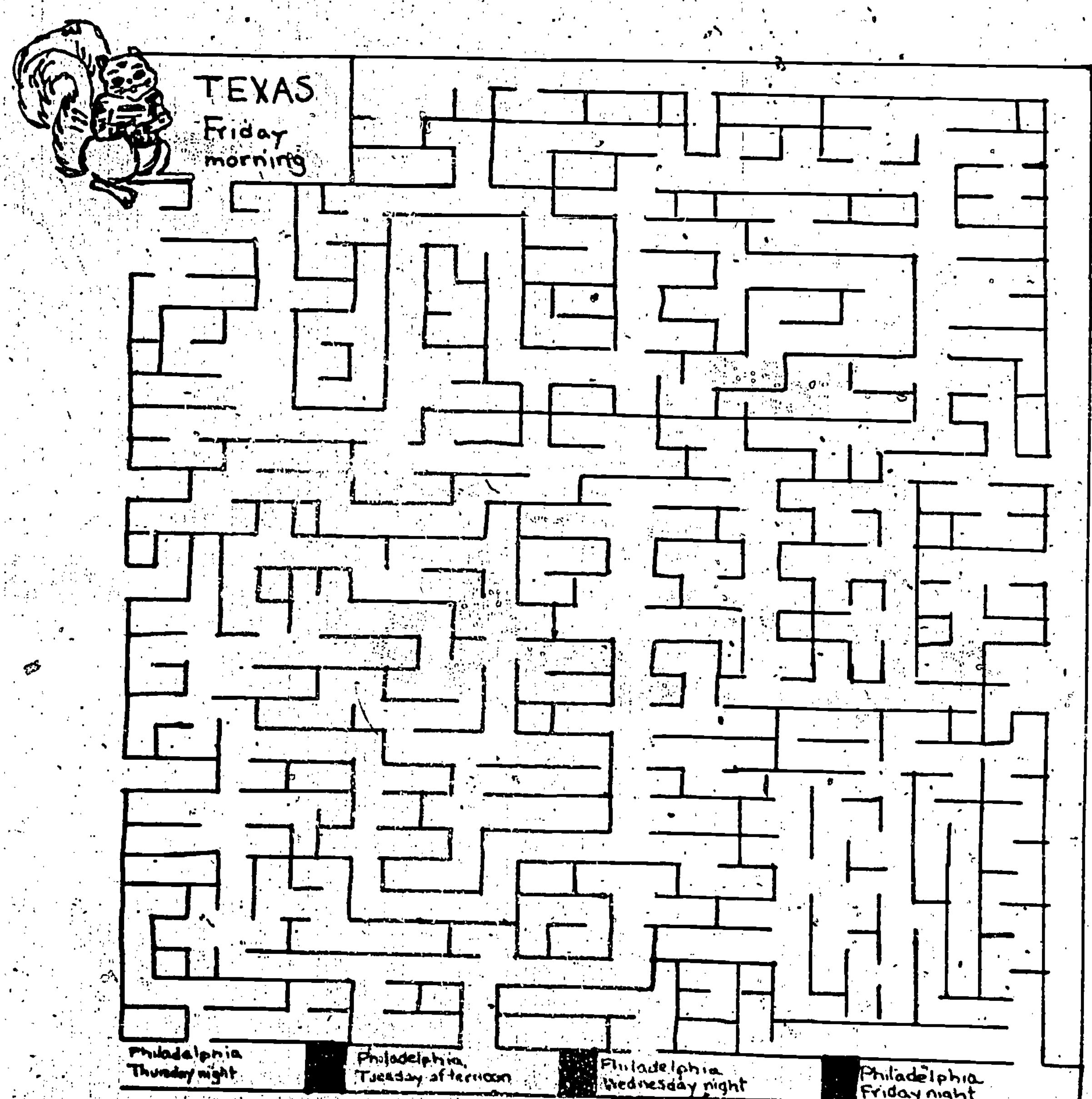
LEVEL: Elementary-Junior High School

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: <u>Energy</u>. Pennsylvania's Energy Curriculum for the Middle Grades, Pennsylvania Department of Education, Harrisburg, PA 17126. SE 025 380.

ACTIVITY: With the aid of a map, indicate that natural gas is transported long distances by pipe lines. The gas is pushed along at about 15 miles per hour. When would gas that is produced in Amarillo, Texas on Friday morning reach Philadelphia? Ask students to complete the maze below to find out.



PURPOSE: To examine relationships between recreational activities and energy usage.

LEVEL: Elementary-Junior High School

SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: Engage the children in listing the recreational activities most popular with their families and with others in the community. The list will likely include such things as vacation travel, bicycling, hiking, reading, playing ball, swimming, attending sporting events, taking a ride in the family automobile, listening to the radio or records, watching television, and so forth.

After the list has been developed on the chalkboard, ask the children to delete the activities that require electricity or use of the family automobile. Since persons living in colonial America did not have access to electricity or to automotive transportation, their recreational pattern of activities was far different from ours today.

Develop a list of "colonial time" popular recreations. How many of them are still possible today? How many are popular today? Are increasing energy costs changing pupil's recreational habits? What changes are likely in the years ahead?

PURPOSE: To become more aware of energy used to package consumer goods.

LEVEL: Elementary-Junior High School

SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: Develop on the chalkboard with input from the pupils a list of all the packaging materials that come into their homes during typical weekend shopping. The list will certainly contain paper, waxed paper, tin cans, glass, plastic, and possibly aluminum. Often two or more substances will be used to package a single product such as toothpaste.

Ask selected children to find out the natural resources and energy needed to produce various packaging materials. Ask an individual or small group of pupils to interview a supermarket manager to see if he believes that some of materials sold in his store might be "overpackaged."

Discuss what, if anything, can be done to save energy in this aspect of our distribution system.

PURPOSE: To examine relationships between lifestyles and energy usage.

LEVEL: Elementary-Junior High School

SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Oklahoma Energy Awareness Education, Energy Education Activities, Grades 4-12. Oklahoma State Department of Education, Oklahoma City, 1977. ED 153 820.

ACTIVITY: Ask students to interview someone who is old enough to remember what life was like before the days of great usage of oil and natural gas. (A grandparent or elderly neighbor will likely be very pleased to be asked.) Ask questions such as those below and others that individual students can think of. Ask students to record responses for subsequent reporting and class discussion.

As final questions, ask the person being interviewed to indicate how he finds life more enjoyable now as a result of much greater use of energy. In what ways does he like "the good old days" better?

A final phase of the activity might be to ask each student to write briefly on what he or she believes would be an "ideal mix" of old and new lifestyles.

1. What kind of lights did you use in your home? ____ ____________. How was it heated? ________________
2. What fabrics were clothes made of? Was clothing harder or easier to take care of?________________
3. What sort of washing machine did you have?__________
4. What kind of stove (and what kind of fuel) did your family use for cooking?_____________________________
5. Did you have a refrigerator? What kind?___________ How did you keep your food fresh?________________
6. How was food packaged when it came from the store? ______________ What did milk come in?____________
7. What sort of soap did you use? Did it clean as well as the cleaners we have now?_____________________
8. How was your water heated for bathing and laundry? ____

9. Did your family have a car? ______ If not, how did you travel? How did you get to school? ______
______

10. Did you have a radio? What did it look like? ______
______ Did you go to the movies? ______

11. What kinds of entertainment did you enjoy? ______
______

PURPOSE: To examine major uses and sources of energy.

LEVEL: Elementary-Junior High School

SUBJECTS: Social Studies
Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

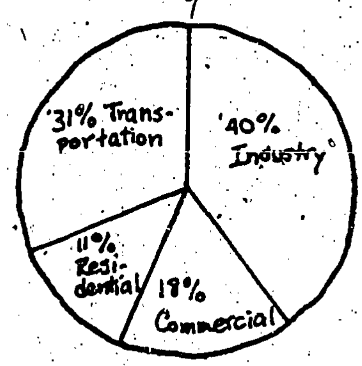
REFERENCE: Oklahoma Energy Awareness Education, Energy Education Activities, Grades 4-12, Oklahoma Department of Education, Oklahoma City, 1977. ED 153 820.

ACTIVITY: Present to the class (with answers deleted) the two graphs and accompanying questions shown below. After students have answered the questions individually, engage the class in a discussion of what individuals and schools can do to conserve energy.

WHERE WE GET OUR ENERGY - HOW WE USE IT[1]

Graph A divides our energy use into four groups. In what group do we use the most energy? *industry* What ranks second? *transportation* In what ways do you use energy in each of these two groups? What group(s) gives you the most opportunity to cut down on your energy consumption?

Graph A



Which groups use energy when you do each of the following? Check the box or boxes in the appropriate columns.

	Industry*	Transportation	Commercial	Residential
1. Take a hot bath				
2. Drive to a hamburger stand				
3. Fly in an airplane				
4. Switch on air conditioning				
5. Buy a new baseball				
6. Ride a school bus				

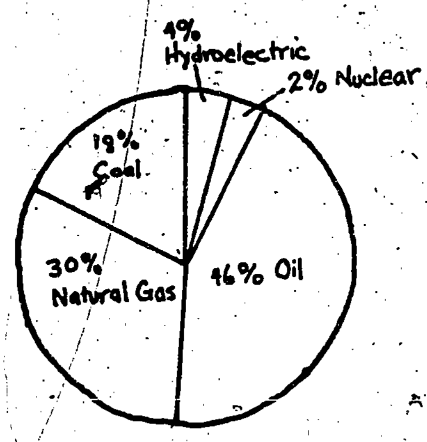
(cont.)

[1]FEA, The Energy Challenge.

	Indus-try*	Transpor-tation	Commer-cial	Residen-tial
7. Blow dry your hair at home				
8. Buy a frozen pizza				
9. Ride a motor bike				
10. Manufacture a motor bike				

**Every item that includes a product could also be checked under "Industry".*

Graph B



Graph B shows five primary sources of energy. These five sources supply Americans with most of their energy. They light and heat the buildings in which we live, work and play. They fuel our vehicles. They run the machines that work for us and manufacture and process the goods we use and the foods we eat. Look at Graph B and answer these questions.

1. What energy source do we use most? *oil*
2. Which do we use mostly for heating our homes? *natural gas*
3. What energy source provides most of the fuel for our transportation? *oil*
4. Which one makes most of our electricity? *coal*
5. What is a possible reason why we use so little hydro-electric energy? *not very much falling water*
6. Why is electricity not shown on this chart? *it is a secondary source*

PURPOSE: To demonstrate the importance of electricity in our daily lives.

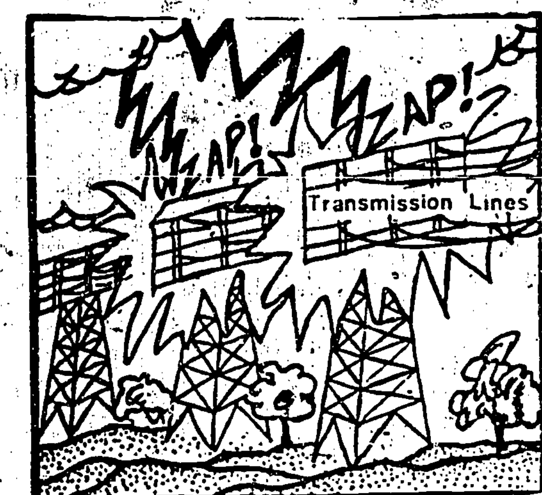
LEVEL: Elementary-Junior High School

SUBJECTS: Social Studies
Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Networks: How Energy Links People, Goods and Services. National Science Teachers Association, prepared for U.S. Department of Energy, Educational Programs Division, Technical Information Office, P.O. Box 62, Oak Ridge, TN 37830, and Lee County Energy Action Cards. Lee County Schools, Fort Myers, FL, 1976, SE 024 758.

ACTIVITY: Read or distribute to your class the following summary of the New York City Blackout included in the National Science Teachers' Association document cited above.



New York City Blackout, July 13, 1977

"New York City stopped at about 9:30 on a hot summer night. The television screen went blank. And lights went out all over the giant city. Over in the amusement park the "Wonder Wheel" stopped with people at the top. It took a long time for workmen to crank the wonder wheel down by hand and let the frightened people get on the ground again.

"Trains stopped running. Airports closed down. All airplanes had to go to airports in Newark, New Jersey or Philadelphia, Pennsylvania where the lights were

still on. There were no more red and green traffic lights. It became so dangerous to drive with traffic going in every direction that some people left their cars and began their long trip home on foot. Other people had to walk home in the dark when the subways and the in-city electric trains had no more electric power. When the people got to their apartment buildings, they found they had to walk up to their apartments using the stairs. The elevators didn't work either! Inside, the apartment air was hot and stuffy because fans and air conditioners quit running. People opened their windows to get some air and shook their heads in amazement at the darkness all around. Some people laughed at the darkness, but most grew very worried. All of a sudden the neighborhood seemed so different. So many dark places. What if they should get sick? Who could help them if the lights went out in the hospital?

"As a matter of fact, in Bellevue Hospital, the city's largest hospital, doctors completed knee surgery on a patient by candlelight. And candles burned in nearly every room of the giant hospital.

"They were used in theatres and restaurants, too. But in some places there were no candles that could be lighted. The actors and the audience had to leave dark theatres and go out into the dark streets.

"'What's wrong?' everyone asked everyone else.

"What went wrong was caused by lightning. During an electrical storm—which means lots of thunder and lightning—way over in Westchester County, lightning hit important power lines. These power lines connected the major power plant and the smaller power plants around New York. These power plants shared the electrical system.

"The lightning hit a large transformer near the Nuclear Generating Plant, starting a fire. The fire caused the transformer to explode and the nuclear power plant had to shut down. Engineers tried to get power from the substation to get the electricity to run the city, but they overloaded the system. The whole electrical system broke down, and blacked out a city of 10 million people!

"When the electrical system didn't work, New York didn't work."

Discuss some of the problems that were created by the loss of electricity. Discuss with your class how your school routine would be affected if you lost the electricity for one hour; i.e., no light (this would create a problem in restrooms and showers, etc., or any room without window lighting), no clock, no bells, no P.A. system, no ventilation, no heat, etc.

Design a "Blackout" plan for your school. Discuss with your principal the feasibility of turning off the power for one hour to create a "do-it-yourself" blackout.

Develop and test a plan to reduce the amount and length of time you use artificial lights in your school.

PURPOSE: To simulate an environmental impact statement by studying the energy usage of a family member.

LEVEL: Elementary-Junior High School

SUBJECTS: Science
Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: Ask each student to select one family member to study his/her energy usage. Suggest they record every energy use by their chosen subject for one-half hour each weekday and one hour a day on the weekend for one week. Instruct them to observe each energy use to determine whether it was wise or wasteful; i.e., upon vacating a room were lights, T.V., etc. turned off? Did subject know what he/she wanted from the refrigerator prior to opening the door or did he/she stand with the door opening while deciding what was wanted? Did subject take a bath or shower? (Showers use less energy.) Did subject close outside doors tightly when entering or leaving the house?

The following chart example may prove helpful to students as they collect data:

Example Chart

Subject: *Mother
Day: *Monday
Time: From *4:30 P.M. to *5:00 P.M.

Energy Use	Wise	Wasteful	Comments
1. *Turned kitchen light on to peel potatoes for dinner			*Turned off light when left kitchen
2. *Took brother to football practice in car			*Brother could walk the 3 blocks
3. *Opened & shut door tightly when leaving the house			*No excessive heat loss to home
4. *Stopped for gasoline on way home from taking brother			*Did not make extra trip in car

At the end of the data collecting week, ask each student to share their findings. Evaluate as to whether each subject was generally energy "wise" or "wasteful".

PURPOSE: To examine how life styles have changed as a result of increased high energy technology.

LEVEL: Elementary-Junior High School

SUBJECTS: Social Studies
Language Arts

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Transportation and the City, Grades 8, 9. Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy. National Science Teachers Association, 1742 Connecticut Avenue, NW, Washington, DC 20009.

ACTIVITY: Interview someone who is old enough (grandparents, if available, would be ideal) to remember what life was like before the days of many automobiles, high technology, plastic, electronic games, television; and multiple electrical appliances. Ask this person the questions on these pages and others you may think of.

1. How did you heat your home? ______
   What kind of fuel did you use for cooking? ______

2. What did a workweek consist of in days and hours?
   ______

3. How did you get to work? ______
   To school? ______
   Did your family own a car? ______ If so, do you remember the name of your family's first car? ______ How much did it cost? ______

4. What kinds of entertainment did you enjoy? ______
   ______

5. What was clothing made of? ______
   How was it kept clean? ______
   What kind of a laundry machine did you have? ______
   How did you heat the water? ______
   What were soaps like? ______
   How did you dry clothes? ______

6. What were the eating facilities like in your school?
   ______
   The bathrooms? ______
   What did you have for school supplies? ______

7. Today, plastics are used so much in packaging.
   What did you use? ______________________
   Was milk delivered? ______________________
   How did you keep food from spoiling? ____________

8. What was your home lighted by? ______________

9. Did your family go on vacation? ____________
   If so, how did they get there? ______________

10. What were roads like then? ________________

11. What happened to your old schoolhouse? ________
    How did your school change with the coming of school buses? ______________________

12. How do you think the car changed things in your town (or city)? ______________________

PURPOSE: To investigate energy saving vacation suggestions.

LEVEL: Elementary-Junior High School

SUBJECTS: Social Studies
Language Arts

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Tips for Energy Savers. Federal Energy Administration, Washington, DC, Publication FEA/D-77/212.

ACTIVITY: Ask students to write a summary report of their last family vacation. Where did they go? What did they see that they remember? What unusual activities were available at the vacation site? How many miles did they travel?

When some of these reports are read (possibly orally to the class), it will become apparent that some families traveled extensively during their two or three-week vacation time.

Present to the class the following tips to save energy while taking vacations from the reference cited above.

- Vacation at home this year. Discover nearby attractions.
- Choose a hotel or campground close to where you live. A nearby hotel or campground often can provide as complete and happy a change from routine as one that is hundreds of miles away.
- Plan to stay in one place if you vacation away from home. "Hopping around" takes transportation energy.
- Take a train or a bus instead of the family car. Save gasoline and relax.
- Rediscover the pleasures of walking, hiking, and bicycling during your vacation. They're the most energy-conserving means of transportation and the healthiest for most people.
- Save energy at home if you're going away. Remember to turn off lights, lower heating temperatures in winter, and turn off air-conditioning in summer.

Discuss the suggestions. Would it be possible to have a great vacation if a family followed one or more of the ideas? Which ones?

Finally ask that pupils review the suggestions with their parents. Ask each pupil to report briefly, in writing, parental reaction to the advice.

PURPOSE: To find if the demands being made of the public to successfully deal with the energy crisis are in opposition to the desires, beliefs, and behaviors of the general public.

LEVEL: Elementary-Junior High School

SUBJECTS: Social Studies
Language Arts

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Oklahoma Energy Awareness Education, Energy Education Activities, Grades 4-12, Oklahoma State Department of Education, Oklahoma City, 1977. ED 153 820.

ACTIVITY: Have students use questions such as the following to survey their friends, business people, and leaders in the community concerning their desires, needs, and aspirations. Have the class discuss their findings to see if they are consistent with the existing needs of society to deal effectively with the energy crisis.

1. Do they plan to buy a new automobile in the near future? Why or why not? What are the qualities they are looking for in a vehicle? What is their use for the vehicle?

2. What appliances do they plan to purchase? Do they feel these appliances are necessary? What appliances do they have in the home that they consider important to their lifestyle? Ascertain type of appliance—refrigerator (self defrosting?), television (colored? second set?), air conditioners, etc.

3. What are their vacation plans for the year?

4. What do they consider a comfortable temperature in the home? (During the winter, summer?) Do they attempt to maintain this temperature?

5. How much driving do they do each month? Where do they drive? (Consider all members of the family.) Do they participate in car pools or use public transportation?

6. Do they have an automatic washer and dryer? How often do they use these appliances?

Students might also ask the people being interviewed a series of questions concerning the use of energy which indicate how they view the energy crisis.

1. Have you reduced the amount of gasoline for driving purposes? Why or why not?

2. Do you turn off lights in the house when they are not needed? Why or why not?

3. Have you lowered the temperature in your home? (When going to bed? When away? All of the time?) Why or why not?

4. Have you attempted to reduce the amount of hot water used?

5. Do you think there is a fuel shortage? Why or why not?

6. Do you feel utility bills are reasonable? Why or why not?

7. Do you drive at the legal 55 m.p.h. speed limit?

After compiling, presenting, and discussing the findings, attempt to draw some conclusions concerning the type of information and approach needed to arouse the public awareness of the problem being considered.

1. The information obtained will be most useful if students can understand the point of view from which the public views the situation. Role playing would be a means of establishing the point of view of those whose behavior is in opposition to conservation and those who are convinced of the need for conservation.

2. The class might also consider the type of approach they feel will be most effective in dealing with the energy problem from the information accumulated. Would "lecturing" or an authoritative approach be useful? Would logical reasoning be successful? Would an appeal to humanitarian interest be successful?

PURPOSE: To identify commonly used things around the home that use energy.

LEVEL: Elementary-Junior High School

SUBJECT: Language Arts

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

REFERENCE: <u>ENCORE</u> (Energy Conservation Resources for Education), Department of Industrial Education, Texas A & M University, College Station, Texas 77843. SE 025 401.

ACTIVITY: Try to find the words (which are listed below the puzzle) in the puzzle below. When you find a word, put a circle around it and mark the word off the list so you will know when you have found them all. Answer the two questions on the next page.

```
C N Q X R Q D B R O I L E R T F V M Z C G
M I X E R W L N G T Q S D P R W S O P J H
Z S S R F E Q T P V P F G N V C X T T Z W
S M K M N Q F R J O E R E T S C D O H Z A
C R P D L A K R J G N T R D M N N R D H S
L H E M N O I S I V E L E T T S L C J M H
T R N F L V J M V G G D S N M F L Y P K I
L L N R P M K X L F E F W D M K C C Q G N
S Q P E L E C T R I C R A N G E F L R W G
E C T E H S W H G Q X R A C Q Z K E R G M
W K P Z D L F L R J K H D T X C G R J S A
I H G E V S H W K J K X Z P O V E N Z P C
N Y N R K X M J X M J J L L K R A D I O H
G T F K R C V A C U U M C L E A N E R A I
M R L I G H T S V Q J H W J H T N H R I N
A L S A J T V G M V N W H N D X K P X R E
C J L C W A T E R H E A T E R Z F C G C Q
H D D K F N G F H Q W R X S Y G Z H Z O D
I A P K N M M L K H D R W J E G P L C N C
N R I M N H T O A S T E R G R A T Z R D F
E P L R R X G S W S T M C F R V M E F I N
V D F T D H L N J E D G P G X N H W D T X
K V L P M R N D G M R L D Z K S Q W V I P
K Q S R C S Y N W T F N X V A W F X P O Z
W N Z D P X A E Q Y O R G W S C T Z V N C
M J F H I R O N R H V G H H Z R J Z K E X
C R J P S R Q H P N G S D M D Q S L D R C
L S D A U T O M O B I L E Z F T X C Z V W
T K G C J G V H C D G T F S T D R W V C Q
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<u>Things Around the Home That Use Energy:</u> air conditioner, automobile, blender. broiler, clock, dishwasher, dryer, edger, electric range, freezer, gas range, hair dryer, iron, lawn mower, lights, mixer, motorcycle, oven, phonograph, radio, refrigerator, sewing machine, stereo, television, toaster, vacuum cleaner, washing machine, water heater, and fan.

What energy using devices are around your home that were not around your grandparents' home? Your great-grandparents' home?

<ins>ENERGY ACTIVITIES FOR THE CLASSROOM: VOLUME II</ins>

ELEMENTARY-JUNIOR-SENIOR HIGH SCHOOL

PURPOSE: To initiate energy conservation projects in your school.

LEVEL: Elementary-Junior-Senior High School

SUBJECTS: Science
Mathematics

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Michael Hayfield, Principal, Huber Ridge Elementary School, Westerville, Ohio.

William J. Vorlicky, Principal, Mark Twain Elementary School, Westerville, Ohio.

William Ellis, Business Manager, Westerville City Schools, Westerville, Ohio.

BACKGROUND: The rising cost of energy has stimulated many public school officials to embark on energy conservation programs. The following is an accounting of an energy conservation project in two elementary schools within the same district—one heated by gas; the other, electrically heated. It is presented to serve as an illustration of ways to cut energy costs in a school building as well as to demonstrate that the difference of building structures is a factor in planning energy conservation projects.

Huber Ridge Elementary School is heated with gas wall units. It is a traditional school with 28 classroom units off main hallways. Water pipes are enclosed within the outside walls. There are two windows in each classroom unit.

Mark Twain Elementary School is electrically heated and cooled. It is an open concept plan with 19 clusters surrounding an instructional media center and the restrooms. There are very few windows in the building.

Windows in both schools were checked for cracks in the caulking and all were repaired. Doors were also checked to assure that they fit snugly when they were closed.

It was determined that the greatest heat loss occurred when outside doors were opened. In an effort to cut down the number of times the doors were opened, both schools initiated the following procedures:

-Only the main door entrance was utilized. All doors were locked from the inside.

- Adults were posted at the main door before school, during recess breaks and at dismissal times to assure that the doors were closed quickly and tightly after students entered and left the building. Instructions were given to open the doors only when there was a substantial group of students ready to enter or leave the building.

- Recess schedules were adjusted so that children coming from the playground were going through the doors at the same time other groups were going out of the building.

Other conservation practices in both schools included:

- disconnecting half of the light bulbs in non-instructional areas such as hallways, gymnasiums, bathrooms, etc.

- turning off the outside lighting.

- shutting lights off in every room when it was not in use.

- unplugging extra appliances.

- turning on exhaust fans only when absolutely necessary.

The school heated by gas turned off the heat at 11:00 a.m. daily, and took advantage of the body heat generated in each classroom. Heat was not turned on again until 7:00 a.m. This practice necessitated pouring antifreeze in the water pipes to keep them from freezing. All classroom doors were kept closed to guard against heat loss.

In the all-electric building it was determined that the practice of shutting off the heat at a given time daily would not save energy since the central heating system was designed to be sensitive to maintaining a constant temperature. If the heating system was turned off, the building temperature would drop considerably overnight. When the heat was turned back on the next morning, a greater amount of energy would be utilized to compensate for the lower building temperature than would be saved by turning off the heat. Thus, in this school the thermostats were lowered to 65° during the winter months and raised to 70° during warmer weather.

Both schools sent notes home to parents to ask their cooperation with the conservation projects and to inform them of the location of the main entrance door. Parents were also asked to send a sweater with each child that could be kept in the building.

The school district's business manager estimated these conservation practices lowered the energy usage in the gas-heated building by 35 percent and in the electrically controlled building by 20-25 percent.

ACTIVITY: Share with your class the above energy conservation projects. Discuss the applicability of these energy-saving practices for your school. What additional things could you do in your school to cut energy costs? Draw up an energy conservation plan for your school and present it to your principal. Perhaps your students could actively participate by doing the window caulking and door monitoring. Estimate the energy savings by comparing "before" and "after" energy costs for your building.

PURPOSE: To examine residential electrical consumption as a function of time of day and individual user.

LEVEL: Elementary-Junior-Senior High School.

SUBJECT: Mathematics
Science
Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Robert L. Steiner, Faculty of Science and Mathematics Education, The Ohio State University, Columbus, Ohio.

ACTIVITY: In order to give students a feeling for the phenomenon of peak usage of electricity and differences in individual residential consumption, it is helpful to examine consumption patterns. Have students read the individual electric kilowatt-hour meters of a half dozen of their neighbors on an hourly basis over a 24-hour period. Between the hours of midnight and 6:00 a.m., the total consumption could be determined and divided by the number of hours elapsed to get an average hourly usage rather than reading the meter during the early morning hours. Each reading should be rounded off to the nearest ½ kilowatt-hour. (Be sure that the students ask permission of their neighbors and explain what, why and when they will be doing this meter activity.) Have the students prepare a table of the data, showing the time of day, meter reading, number of KWH's used during each 1-hour time interval, and the cumulative number of KWH's used for each neighbor. Have the students plot, on rectilinear graph paper, the cumulative consumption of each of the neighbors as a function of time of day. All data can be plotted on the same graph using different colors or symbols for each neighbor. Have the students explain why differing amounts of electricity are used by the individual neighbors.

Have the students determine the total number of KWH's of electricity used by all the neighbors during each of the 1-hour intervals. The students should prepare a bar graph of the hourly consumption as a function of time of day. A bar graph of all data for all students might be prepared also.

The following types of questions and issues might be raised with the students:

-How did the hourly consumption vary during the 24-hour period?

-How would you account for this variation?

-About how much variation would there be for a city of 500,000 people?

-Would you expect industrial and commercial usage patterns to be similar to residential usage patterns?

-What advantages would there be to the electric utilities if consumption of electricity was constant throughout the day and night?

-How could this type of consumption pattern be encouraged?

PURPOSE: To examine the promise of solar energy.

LEVEL: Elementary-Junior-Senior High School

SUBJECT: All

CONCEPT: Presently, most of our energy requirements are met through using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Solar Energy Education Packet for Elementary and Secondary Students. Center for Renewable Resources, 1028 Connecticut Avenue NW, Washington, DC 20036, Telephone (202) 466-6880. $3.75 per copy.

ACTIVITY: Involve students, teachers, and parents in celebrating a SUN DAY. The popularity of the first one held on May 3, 1978 indicates that a designated SUN DAY can be an important educational event in energy education.

Secure a copy of the 58-page booklet referenced above. Review the many ideas and activities suggested and select those most promising to do in your classrooms, as a school, or a community. The booklet contains an extensive annotated bibliography that identifies many publications and other sources of information regarding solar energy.

Involve school and community leaders in designating a week and special day in May to be the climax of activity related to solar energy and the energy problem generally.

ENERGY ACTIVITIES FOR THE CLASSROOM: VOLUME II

JUNIOR HIGH SCHOOL

PURPOSE: To demonstrate understanding of how energy can be changed from one form to another.

LEVEL: Junior High School

SUBJECT: Science

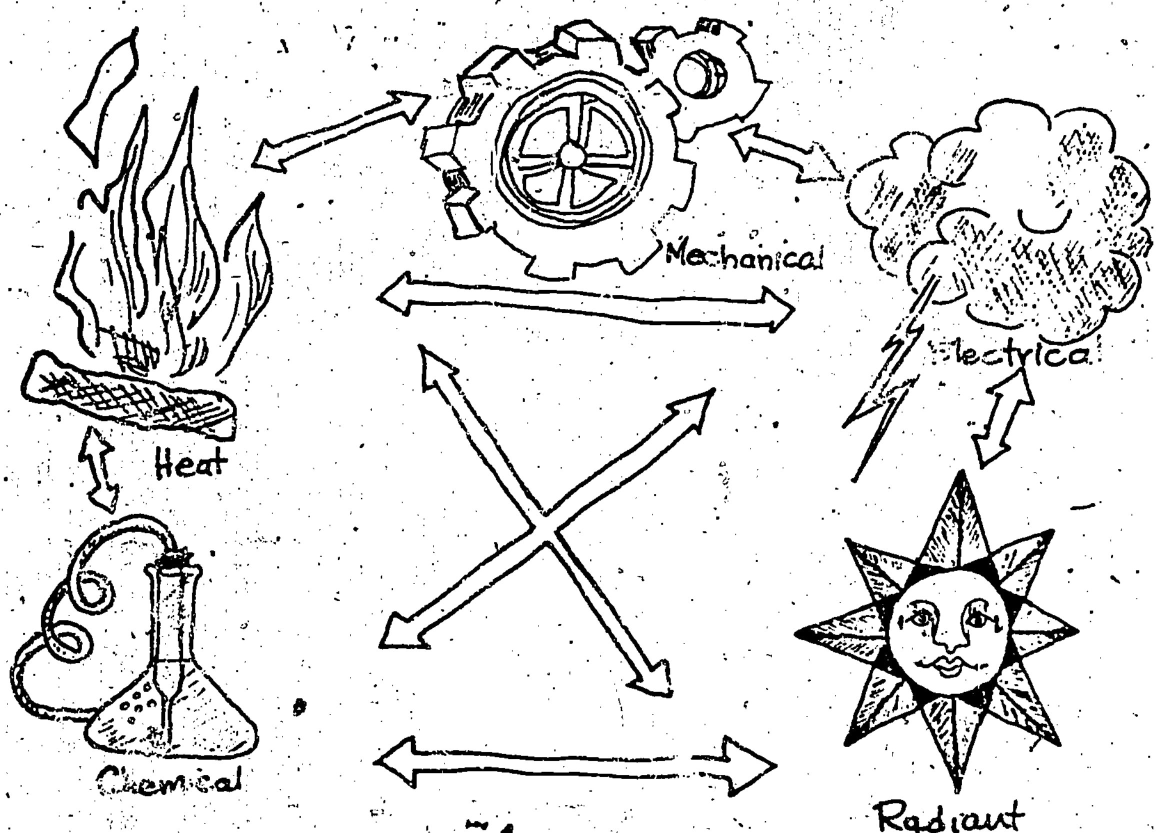
CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Energy. Pennsylvania's Energy Curriculum for the Middle Grades, Pennsylvania Department of Education, Harrisburg, PA 17126. SE 025 380.

ACTIVITY: Use an illustration such as the one below as part of a post-test to measure student understanding of the convertability of energy from one form to another. Ask students to give at least two examples of how or where mechanical energy is turned to electrical, electrical to mechanical, mechanical to heat, heat to mechanical, and so on around the circle and wherever reversible arrows are shown.

Ask students to explain with several examples how energy losses around the circle and across it increase entrophy.

Energy changes from one form to another



PURPOSE: To demonstrate that heat energy can be changed into mechanical energy.

LEVEL: Junior High School

SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Fowler, John (ed.). Energy, Engines, and the Industrial Revolution: Grades 8-9. National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, DC 20009 and U.S. Department of Energy, ED 153 843.

ACTIVITY: Materials Needed:

medicine dropper	scissors
test tube (attached to support rod)	pencil with eraser
bunsen burner	manila circles
stopper (one-hole)	ruler
needle	compass
	thimble

When a fuel such as gasoline is ignited, the *chemical* energy is converted to *heat* energy. This *heat* energy is converted to *mechanical* energy of the pistons in the engine, which causes the rotation of the flywheel. Some of the *mechanical* energy is then used to turn the generator to convert *mechanical* energy to *electrical* energy. Some of the *electrical* energy is converted to *light* energy for the headlights, and *heat* energy in the cigarette lighter.

Prepare a series of statements such as the following to help students identify energy by what it does:

When you clap your hands, you change muscular energy to *(motion)* and to *(sound)*.

When you are talking, you change *(mechanical)* energy to *(sound)*.

When striking a match, you convert *(chemical)* energy to *(heat)* and to *(light)*.

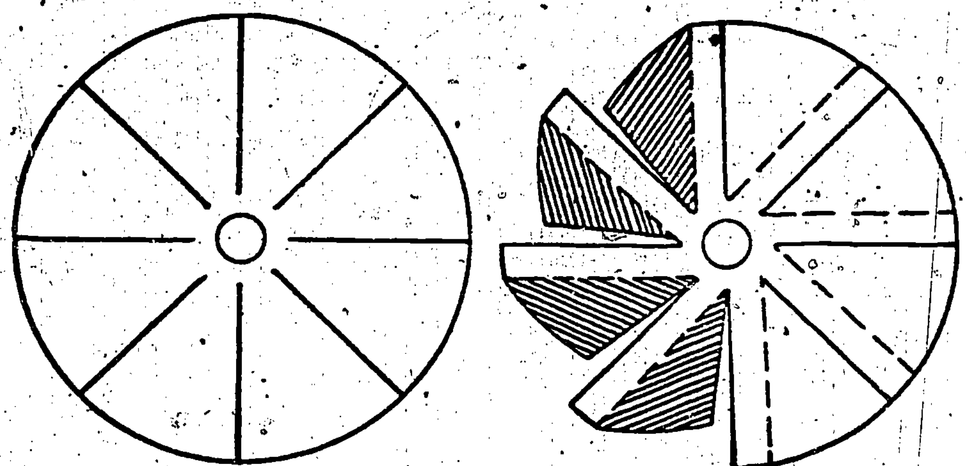
To demonstrate energy conversion under observable conditions make and operate a model of a steam turbine. Begin by making the turbine wheel. Use the compass to draw a circle five inches in diameter in the manila folder. Use the same center for the compass, and draw a 1-inch diameter circle inside the larger circle.

Place the thimble open-end down on the center of the circle you have drawn, and draw a third circle around the thimble.

Use the scissors to cut along the inside of this small circle, and insert the thimble into the hole. Use the ruler to draw eight lines to the inner circle so that you have a large circle divided into eight equal parts.

Cut along the lines to the drawn inner circle. Next bend half of each section back along the dotted lines in the diagram (see below). The paper halves should show right angles.

Insert the needle into the rubber eraser of a pencil. Place the paper turbine wheel over the tip of the thimble and set the inside of the thimble on top of the needle.



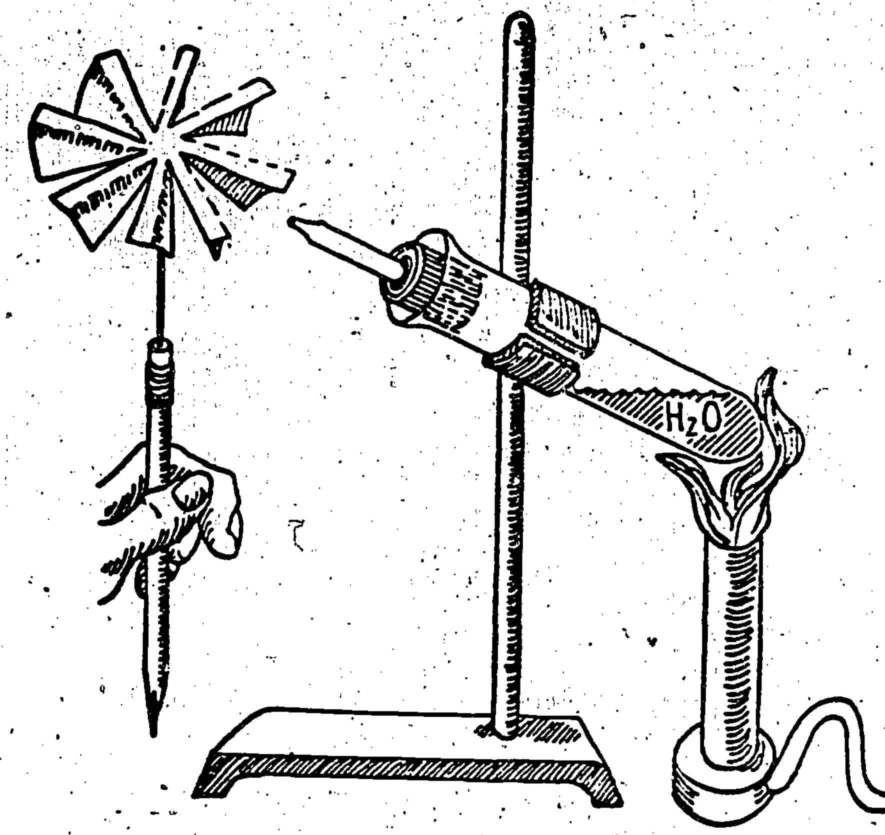
Operating the Turbine

Put about 1 inch of water in a test tube and assemble the outside of the medicine dropper and insert it carefully through the one-hole stopper. Insert the stopper into the open end of the test tube, but don't push it in too tightly. Light the bunsen burner and heat the water in the test tube. Answer these questions:

1. What changes do you see?
2. Is energy involved in these changes? How?

Hold the pencil with the thimble top of the turbine attached in such a way that it turns freely, and direct the path of the steam against the paper blades of the turbine.

1. What is happening to the blades?
2. Can you explain why this is happening?
3. Is work being done? How?



Ask the students to tell how energy was converted to other forms. Ask how these conversions help people.

Where was energy stored? *(In the chemical energy of natural gas, alcohol, or water.)*

How was chemical energy converted? Into what? *(It was converted into heat.)*

What did the turbine convert the heat energy into? *(Mechanical energy.)*

The overall conclusion might go something like this: You have demonstrated how stored energy (chemical energy) in natural gas can be converted into heat and how this heat can be converted into mechanical energy.) Ask: What use can a turbine be put to? *(A turbine is a heat engine. It changes heat energy into mechanical energy and can turn a generator which produces electrical energy.)*

PURPOSE: To conduct an experiment to determine t.e :sulating qualities of a variety of insulating mat...als.

LEVEL: Junior High School

SUBJECT: Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Steven Altman and Gregory Passewitz. Understanding Energy: The Challenge of Tomorrow; A Teachers Guide; A Pilot 4-H Project. Canfield Area Extension Center, Canfield, Ohio 44406.

ACTIVITY: Materials Needed:

- fruit juice cans
- black paint
- ice cubes
- insulating material (cotton balls, styrofoam, newspaper, plastic, fiberglass, cloth, etc.)

Divide the class into groups of 3 or 4. Four groups will work as a unit. Provide each group a fruit juice can and insulation material.

Group 1.--No insulating material
Group 2.--Paint outside of can black
Group 3.--Insulating material of measured thickness
Group 4.--Different insulator, same thickness as Group 3.

Other groups choose different insulating material, but with the same thickness as Group 3.

After all cans have been prepared, place an ice cube in each one. Place all cans either in sun or shade. Check the ice cubes at 15-minute intervals until the first one is melted. Continue to check until all ice cubes are melted. Record the time it takes to melt each ice cube.

Questions:

1. How did the black paint affect the insulating qualities of the can?
2. Which material served as the best insulator?
3. Which was the poorest?
4. How can this knowledge be used to conserve our energy supply?

5. Should builders be required to insulate homes? Stores? Factories?

6. How is your own home insulated?

7. What are some of the common materials used in home insulation?

8. How is the insulating ability of any material measured? (R-value)

9. Do the materials used for building homes, such as bricks, wood, siding, etc., have any insulating value? If so, try to find out how much.

10. Where are the places a house might need to be sealed to prevent cold air from coming in and warm air from escaping?

PURPOSE: To compare fluorescent and incandescent lighting.

LEVEL: Junior High School

SUBJECTS: Science
Mathematics

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Michael Zamm and Barry C. Sammuel. Energy Conservation Education: An Action Approach. Council on the Environment of New York City, 51 Chambers Street, Room 228, New York, NY 10007, 1977.

ACTIVITY: Materials Needed:

Foot-candle meter
Appropriate desk-size wood or cardboard surface
40 W* fluorescent light
200 W* incandescent bulb

*W = watt

Show the class the demonstration apparatus. Ask the students if they know the names of the two different types of light bulbs. (Fluorescent and Incandescent.*)

*Fluorescent Lamp—a glass tube coated on the inside with a fluorescent substance that gives off light when activated.

*Incandescent Lamp—a lamp in which the light is produced by a filament of conducting material contained in a vacuum or gas and heated to incandescence by an electric current.

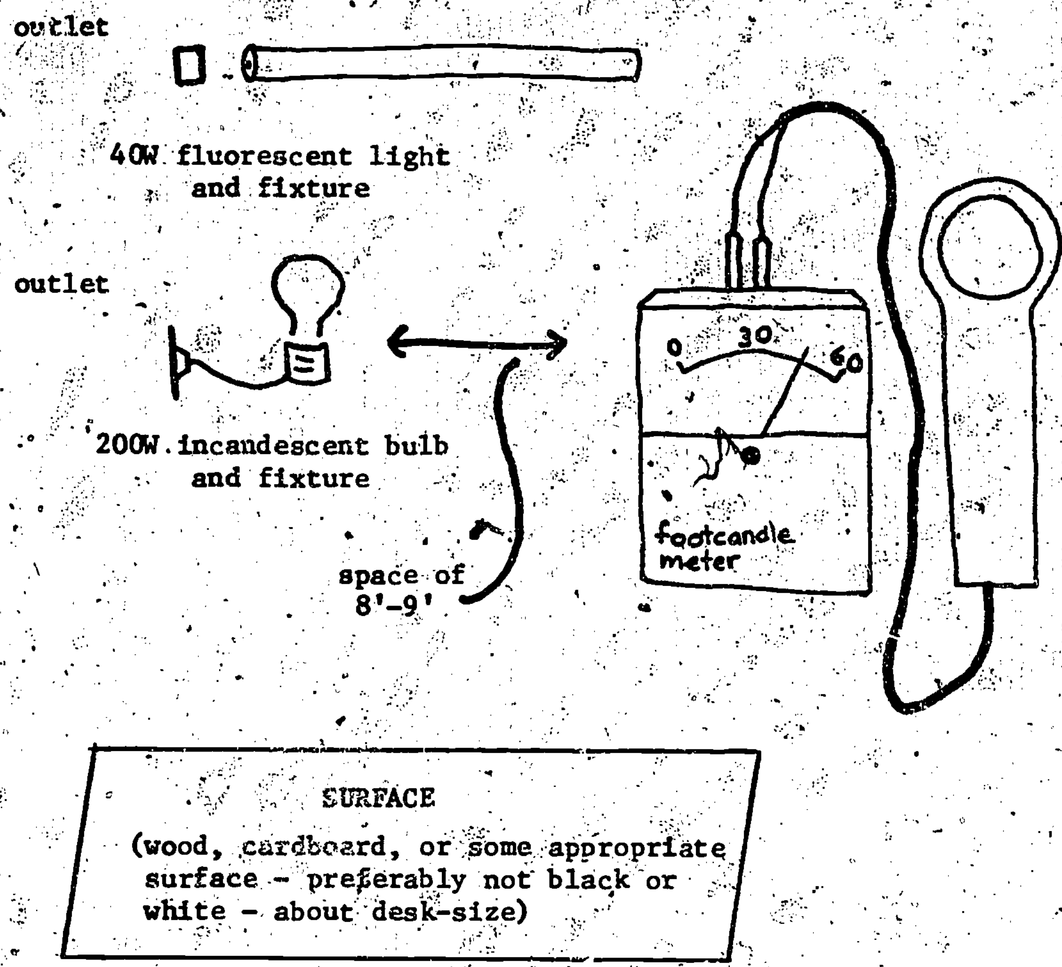
What type of bulb is being used for lighting our classroom?

Tell the class that you are going to demonstrate the amounts of light produced by fluorescent and incandescent bulbs on a surface.

Using the materials shown in the following diagram, the students should see that a 40 W fluorescent bulb projects slightly more light on a surface at a distance of 8 ft. to 9 ft. (about 15 footcandles*) than a 200 W incandescent bulb (about 12 footcandles*).

*Footcandle—a unit for measuring illumination; it is equal to the amount of direct light thrown by one international candle on a square foot of surface every part of which is one foot away.

Fluorescent *vs.* Incandescent Lighting



a) Window shades should be closed.

b) Fluorescent and incandescent fixtures are required to carry out this demonstration.

c) The light source should be directly in front of (at as little angle as possible) the surface. The distance and angle between the light source and surface should be consistent for both types of lighting.

d) Footcandle measurements can also be taken from overhead lights that are already in place.

e) Call or write a science supply house to obtain a footcandle meter if you do not have one in your school or laboratory. Some good ones are Edmund Scientific, Markson, Nafco, Turtox-Cambosco, Ward's Natural Science Establishment.

f) Metric equivalencies for footcandles

1 Footcandle = 1 lumen per square foot
1 Lux = 1 lumen per square meter
1 Lux = 1 meter-candle
Number of luxes = footcandles x 0.76

Ask the students which type of bulb uses electricity more efficiently and thus conserves electricity better. (The incandescent bulb used 5 times as many watts as the fluorescent while projecting less light on a surface.)

Are we using the most energy-conserving bulbs in our room? If not, consider motivating the class to discuss replacement of incandescent by fluorescent bulbs with the school principal and custodian.

How could we calculate the savings in kilowatt hours that occur by using fluorescent bulbs? Students can compute the kilowatt hour savings produced by one fluorescent vs. one incandescent bulb over time by using the formula:

$$\text{Kilowatt hours} = \frac{\text{watts x hours}}{1000}$$

Subtract the figure for the fluorescent bulb from the figure for the incandescent bulb to obtain the kilowatt hour savings. This can be done for a classroom by assuming that the usual classroom with incandescent light has five 200 W bulbs (1000 W). By replacing each 200 W incandescent bulb with a 40 W fluorescent, we are using 200 W of fluorescent lighting to provide the same amount of surface light. Using the kilowatt-watt formula, the savings can then be tabulated. In addition, fluorescent bulbs last 7 to 10 times longer than incandescent bulbs.

Now, ask your class to count the number of incandescent bulbs in the school hallways and offices and calculate the savings in kilowatt-hours if the bulbs were replaced replaced by fluorescent bulbs. Savings in terms of oil, coal, and money can also be calculated. If possible in your particular school plant, motivate the class to consult the custodian and administration and start a project to change from incandescent to fluorescent lighting. Foot-candle levels for different rooms and surfaces can be determined and lighting reduced within standards. Consult with your custodian

Suggest that students conduct a similar project in the buildings in which they live and that they involve their parents, other tenants, and the landlord in the project.

PURPOSE: To figure the cost of operating a clothes dryer and estimate the energy savings if people hung clothes out-of-doors to dry.

LEVEL: Junior High School

SUBJECTS: Mathematics
Science

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Lee County Energy Action Cards. Lee County School, Fort Myers, Florida 1976 SE 024 758 and Michael G. Mashchak, Science Teacher, Lehman High School, Canton, Ohio.

ACTIVITY: Students can calculate the cost of operating appliances in their homes when the following information is available; the appliance wattage, the number of hours it operates, and the cost of electricity.

Review with the class the definitions of the following basic electrical terms: volt, amp, watt, kilowatt, and kilowatt-hour (KWH). Then give the class the following formulas:

$$\text{Watts} = \text{Amps} \times \text{Volts}$$

$$\text{KWH} = \frac{\text{Amps} \times \text{Volts} \times \text{Hours of Use}}{1000 \text{ watts}}$$

$$\text{KWH} = \frac{\text{Wattage} \times \text{Hours}}{1000 \text{ watts}}$$

Call the local electric utility to find the average cost per KWH for all residential customers. It is possible to get a more accurate figure by dividing the amount of your electric bill by the number of KWH used during the billing month.

Operation for the test appliances can be determined by multiplying the KWH by the cost per KWH.

Example: A styling hair dryer uses 330 watts and its "on" time is 4 hours per month. How many KWH's are used, and what does it cost to operate?

$$\text{KWH} = \frac{\text{wattage} \times \text{hours}}{1000 \text{ watts}}$$

$$\text{KWH} = \frac{330 \times 4}{1000} = \frac{1320}{1000} = 1.32 \text{ KWH}$$

Now to find the cost of operation, multiply the KWH by the cost per KWH ($.038). This figure should be substituted by the figure given to you by your local electric company.

$$1.32 \times .038 = 0.05016$$

The hair dryer would cost about $.05 to operate for one month.

With your class, set up an investigation to figure approximately how much energy is used by the families of your students to dry clothes in an electric clothes dryer.

Ask each student to inquire at home for an average number of hours their family uses a clothes dryer weekly. Summarize the dryer hours for all families in your class. Follow the procedure in the above example figuring the number of KWH's used and the cost of dryer operation. Note: A clothes dryer uses approximately 5000 watts.

Do a clothes "poll" in your class to find out how many families have clothes lines outside.

From weather records, determine the number of days clothes could have been dried outdoors in your community and compute this figure into weeks.

How much energy could be saved if your class' families hung clothes out on the line each week the sun was shining? How much money would this method of drying clothes have saved?

PURPOSE: To compare energy used in making food containers with the energy of food packaged in the containers.

LEVEL: Junior High School

SUBJECTS: Mathematics
Science

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Energy, Food and You—An Interdisciplinary Curriculum Guide for secondary schools including ideas and activities on global food problems, energy and resource use, the U.S. food system, and energy-efficient alternatives (first draft). Washington State Office of Public Instruction, Office of Environmental Education, Olympia WA 98501.

ACTIVITY: Ask students to bring to class a variety of empty food containers made of paper, glass, steel, aluminum, and plastic.

Using information available on the containers or their labels, generally expressed in calories per certain weight serving, calculate the energy available from the food in each container (one food or "large" Calorie equals 3.968 BTU).

Weigh each container and use the appropriate value from the table below to calculate the energy used to make the container.

Energy required to make food packaging material:

Paper:	20,400 BTU/lb	or	44.9 BTU/gm
Glass:	7,628 BTU/lb	or	16.8 BTU/gm
Steel:	14,795 BTU/lb	or	32.6 BTU/gm
Aluminum:	98,616 BTU/lb	or	217.2 BTU/gm
Plastic:	18,544 BTU/lb	or	40.8 BTU/gm

Compare the amounts of energy used to make containers from different packaging materials with the amounts of energy in the packaged food. Is the ratio better in large or "economy" sized packages rather than the smaller size? Which packaging material is most energy-efficient? What can be done to save energy in food packaging? Why isn't more being done to save energy in this aspect of our food distribution system? What, if anything, can be done by individual shoppers?

PURPOSE: To investigate the pattern of population and energy consumption in the United States (1750-2100).

LEVEL: Junior High School

SUBJECT: Mathematics

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Robert L. Steiner, Associate Professor, Science/Mathematics Education, The Ohio State University, Columbus, Ohio.

ACTIVITY: Sometimes a logarithmic graph of exponential growth can be deceiving in terms of helping students grasp the impact of continual growth, or of constant growth rate. A rectilinear graph can help dramatize exponential growth. The following activity is designed to illustrate the rapid increase of exponential growth as a function of time. Large rectilinear bar graphs of the United States population and energy consumption as a function of time illustrate this growth phenomenon quite nicely. In addition the ratio of the energy consumption bar to the population bar gives a qualitative indication of per capita energy consumption for each of the represented years. The following data are reasonably accurate[1] although the extrapolation data are based on constant growth rates of about 3 percent for energy consumption and 1 percent for population.

Year	Population (millions)	Energy Consumption (0's - 10^{15} BTU's)
1750	1.2	0.24
1800	5.2	0.70
1850	23.2	2.60
1900	80.0	10.00
1950	153.0	38.00
2000	290.0	140.00
2050	470.0	560.00
2100	780.0	2000.00

Use the following scales to measure out and cut appropriate lengths of adding machine tape to represent the different populations and energy consumptions for the years listed in the above table.

For Population: let 1.0 meter of tape represent 100 million people

For Energy: let 1.0 meter of tape represent 100 BTU's of energy consumption

[1] Averages from several different sources were used to arrive at population and energy consumption figures.

Using the floor, align the bars for energy consumption and population as a function of time. Initially have separate graphs for population and for energy consumption. After these graphs have been examined and discussed, place the common time period energy bar and population bar adjacently, forming a bar graph which represents per capita energy consumption as a function of time. A comparison of the respective levels of the two adjacent bars for each of the years gives a qualitative estimate of the change in per capita energy consumption in the United States.

PURPOSE: To consider alternative transportation systems other than the personal automobile.

LEVEL: Junior High School

SUBJECTS: Social Studies
Mathematics

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Transportation and the City: Grades 8, 9. National Science Teachers Association and U.S. Department of Energy, Technical Information Office, P.O. Box 62, Oak Ridge, Tennessee 37830. ED 153 844.

ACTIVITY: Ask each student to pick any car he or she wishes to own, the "zingier" the better, with the initial cost of the car being no object. However, he or she must be able to afford to run this dream car; i.e., you must be able to pay for the gas, oil and all repairs. After students have made their selection, list the various choices on the chalkboard.

Now ask what features on an auto are the most important. List these on the board as general topics. Next call for a vote of agreement on each one.

Students may mention some or all of the following:

____Good-looking paint job	____Convertible
____Sporty lines	____Big size
____Whitewalls	____Four-speed transmission
____Air conditioning	____Designer interiors (customized vans, denim upholstery, Pucci, etc.)
____Good gas mileage	
____Powerful engine	
____Vinyl top	____Engine reliability

Suggest to the students that they think about their "dream" car again. Ask, "Why did you pick this car? What would you use it for?" As students think about these questions and make suggestions, distribute the following student activity chart showing the names of 1976 cars, and ask students to find their "dream" car on the list. (If they cannot find it, have them choose a car from the list that is a good second choice for them.)

STUDENT ACTIVITY CHART

Model	Manufacturer	MPG*
Chevette	GM-Chevrolet	36
Civic CVCC	Honda	44
Corolla Sedan	Toyota	32
Datsun B-210	Nissan	42
Datsun 290SX	Nissan	26
Accord CVCC	Honda	42
Celica GT	Toyota	26
Rabbit	Volkswagen	34
Fiat 128	Fiat	27
NW Station Wagon	Volkswagen	28
Opel (Isuzu)	Isuzu	27
Vega	GM-Chevrolet	28
Dodge Colt	Mitsubishi	35
Pinto	Ford	30
Mazda GLC	Toyo Kogyo	38
Mustang II	Ford	26
Datsun 280Z	Nissan	21
Volvo 244	Volvo	22
Gremlin	American Motors	23
Maverick	Ford	24
Volare	Chrysler - Plymouth	20
Nova	GM-Chevrolet	22
LTD II	Ford	17
GTO	GM-Pontiac	17
Trans Am	GM-Pontiac	17
Matador	American Motors	15
Cutlass Supreme	GM-Oldsmobile	18
Cougar	Ford	16
Ford	Ford	15
Buick Electra 225	GM-Buick	18
Plymouth	Chrysler-Plymouth	15
Silver Shadow	Rolls Royce	12
Chrysler	Chrysler-Plymouth	13
Bonneville	GM-Pontiac	17
Eldorado	GM-Cadillac	14
Buick Wagon	GM-Buick	18
Ford Wagon	Ford	13
Chrysler Wagon	Chrysler-Plymouth	12
Continental Mark V	Ford	13
Toronado	GM-Oldsmobile	15
Grand Prix	GM-Pontiac	17
Thunderbird	Ford	17
Mercedes 280 SE	Dailler-Benz	16
Seville	GM-Cadillac	16
Chevy Van V-8	GM-Chevrolet	18
Dodge Van V-8	Chrysler-Dodge	16
Ford Van V-8	Ford	16
VW Bus	Volkswagen	23

*January 1977 Gas Mileage from EPA City/Highway Test Cycle.
Source: "1977 Gas Mileage Guide for New Car Buyers," U.S. Environmental Protection Agency, January 1977 (Second Edition) Fuel Economy, Pueblo, Colorado 81009—Single copies; Fuel Economy, FEA, DPM Room 6500, Washington, DC 20461—Bulk copies.

What is the gas mileage rate for your car? If new regulations came out saying that cars must get 20 miles to the gallon, does your car qualify? How much would gasoline cost you each week for your car, if gasoline costs 65 cents a gallon, and you travel 250 miles a week? Have students figure their costs.

Suppose your car gets 20 MPG. Divide the number of miles traveled—250 divided by 20. This result will be the number of gallons used. Then multiply that figure by 65 (250 divided by 20 multiplied by 65 = $8.12). What will your "dream" car gasoline costs be?

Conclude this part of the lesson by suggesting the following question: "Can you afford your dream car?" Many students will be reluctant to give up their dream. Use this opportunity to introduce students to a consideration of alternate transportation systems. Should we begin to think of a car as transportation rather than a "dream machine?" Why are there so few mass transportation systems in American cities? What are some advantages in using buses, commuter trains, and airplanes? How might more automobiles cause more city problems?

Now, have students consider the concept of passenger miles per gallon. This is a term that refers to the number of people that can be carried by an amount of fuel for one mile. PMPG is figured by dividing the number of people in the carrier into the amount of fuel used by the carrier. Once you have helped the students understand this, you can then lead them to consider the relationship between the single-passenger car and efficiency.

Distribute Tables 1 and 2 below and on the following page. Ask the students, "Which is the most efficient type of transportation? The least efficient? How can we determine efficiency?" (Keep the focus on efficiency by asking: "Would the same amount of gasoline used to carry one individual in the average commuting automobile carry at least 10 persons the same distance in a bus, train, or jet airplane?")

Table 1

Types of Urban Transportation	Fuel Mileage (Average) (MPG = Miles Per Gallon)
Automobile	18.0 MPG
Van	16.0 MPG
Bus	3.3 MPG
Commuter Train	.1 MPG
DC Jet	.25 MPG

Table 2

Form of Trans-portation	Number of People	MPG	Fuel Needed for 20-Mile Trip (in gallons)	Fuel Per Person (PMPG)*
Car	1	18.0	1.11	1.11
Car	2	18.0	1.11	.56
Car	4	18.0	1.11	.28
Van	1	16.0	1.25	1.25
Van	2	16.0	1.25	.630
Van	8	16.0	1.25	.165
Bus	5	3.3	6.10	1.20
Bus	20	3.3	6.10	.31
Bus	40	3.3	6.10	.15
Train	1000	.1	200	.20
Airplane	100	.25	80	.80

*Passenger miles per gallon are determined by dividing the number of people into the amount of fuel used.

Using Table 1, ask each student to write the answer to the following questions:

"Which type of urban transportation listed on Table 1 gets the most miles from each gallon of gasoline? *(Automobile)**

Using Table 2, ask each student to write answer to the following questions:

1. Which vehicle gets the most miles per gallon (MPG)? *(Automobile.)*

2. Which uses the <u>most fuel</u> for a 20-mile trip into the city? *(Train.)*

3. Which uses the <u>most fuel per person</u> for a 20-mile trip into the city? *(Van with one person.)*

4. Which uses the <u>least</u> amount of <u>fuel per person</u> for this trip? *(Bus with 40 persons.)*

5. If the 1000 people who rode on the commuter train drove a car to the city instead, how much additional fuel would be used? *(1000 persons would use 1110 gallons of gasoline, compared to 200 gallons, so an additional 910 gallons would be used.)*

6. How much fuel is saved by having 40 people ride a bus instead of using 20 cars with two people in each car? *(22.2 gallons instead of 6.1 gallons—so 16.1 gallons of fuel are saved.)*

Ask each student to now write a summary paragraph for each question below.

1. Are mass transit systems, like buses and commuter trains, always more efficient than cars? Explain. *(Mass transit types of transportation are energy efficient when they are running with full passenger loads.)*

2. Suppose the mayor of your city appointed you as the new director of mass transit systems. He or she wants your ideas on the serious problem of too many cars in the city and the underused public transportation facilities. What would you say in a letter to the mayor? *(Encouraging people to use mass transit facilities continues to be very difficult. In theory, people should turn to mass transit facilities because they are more energy-saving. In fact, people will not use them until they can save time and money, and have greater convenience than they do with the car. There are some things that city governments do today to encourage higher use of mass transit facilities, but they are only partly working. Some ways are by raising parking fees, reducing the number of parking lots, partial subsidizing of bus and train costs, and supplying fleets of minibuses. These provide the kind of door-to-door convenience that attracts passengers and discourages the use of the automobile.)*

Note: Appropriate answers are in parentheses.

PURPOSE: To examine efforts of a small California city to reduce energy usage.

LEVEL: Junior High School

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: A Survey of Model Programs: State and Local Solar/Conservation Projects. Center for Renewable Resources, 1028 Connecticut Avenue, NW, Suite 1100, Washington, DC 20036.

ACTIVITY: Review with the class the following description of Davis, California efforts to save energy. Discuss with the class the applicability of some of Davis' actions to their own towns or cities. Ask students, as a homework assignment, to get parental reaction to Davis' plan and write a short paper in which students discuss what parents think about such city planning activities.

One of the best comprehensive energy conservation programs is being run by Davis, California, a small city 12 miles outside Sacramento. The Davis' City Council convened a committee of architects, meteorologists, planners, and citizens to survey energy use in the city and to make recommendations for reducing fuel consumed in space heating and cooling by 50 percent. The group drafted a new ordinance controlling building design elements such as window area and orientation (it requires that houses have limited window area on the north, west and east exposures), amount of insulation, building heat storage capacity and building orientation so as to make maximum use of natural heating and cooling. The final ordinance was accepted by the City Council. The changes have already reduced the city's electrical consumption by 10 percent and the natural gas consumption by 40 percent.

Davis' experience with its building ordinance prompted it to implement a broader energy conservation program; the city contracted a group called Living Systems to draft a comprehensive energy plan. The Living Systems plan, completed in June 1976, touches on land use, solar energy utilization, city procurement policies, and transportation. Maximum use of bicycles and walking is encouraged; the city of 35,000 residents now has 28,000 bicycles, seven-foot-wide bike lanes, and streets closed to automobiles. Zoning will be altered to make it possible for buildings to take best advantage of south-facing windows and thus optimize the effects of natural heating.

The plan calls for extensive planting of trees along streets and parking lots to create a natural cooling effect in summer. The city itself will switch to small energy-saving vehicles for its fleet. The Davis plan will also guarantee "sun rights" in new residential developments so that owners of solar equipment need not fear that their systems will be shaded by neighboring buildings in the future. The city expects to reach its goal of 50 percent energy use reduction within 10 years. (Contact: Janice Jacobson, City of Davis, 218 F Street, Davis, CA 95616, (916) 756-3740, Ext. 65.)

PURPOSE: To examine the practicality of various energy sources for home heating.

LEVEL: Junior High School

SUBJECTS: Science
Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: Homes in some communities in the United States are heated by oil, natural gas, coal, wood, geothermal energy, solar energy, or by electricity made from some of the above energy sources or from nuclear energy.

Indicate to the class that it has the task of deciding what energy it prefers to see used in a new city of 50,000 persons to be located near their school.

Student committees might be assigned the task of researching, through reading and interviews with knowledgeable persons, one kind of energy. Is it presently available? Is it likely to be available 50 years from now? How does its cost compare with that of other forms of energy? Does its use have harmful environmental effects?

Have each committee report its findings to the class including a judgment about the practicality of using their type of energy for the new city.

After each group has reported and made its recommendation, the entire class can review options available. Does a clear-cut choice become apparent?

PURPOSE: To investigate the extent to which our food tastes and habits have resulted in energy usage.

LEVEL: Junior High School

SUBJECTS: Science
Social Studies
Home Economics

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Steven Altman and Gregory Passewitz. Understanding Energy: The Challenge of Tomorrow; A Teacher's Guide; A Pilot 4-H Project. Canfield Area Extension Center, Canfield, OH 44406.

ACTIVITY: Arrange to have a pizza party. If possible involve parents or school lunchroom personnel to make the party a very low-cost or no-cost activity. Ask the persons preparing the pizza to use a great variety of ingredients: tomatoes, flour, cheese, fish, meat, peppers, mushrooms, onions, etc. During the party, engage the students in identifying the ingredients they see or taste and list them on the board.

For each ingredient ask that two or three students research that food and report to the class on some of the energy required to make that food available for the pizza. Energy from the sun for plant growth, energy to cultivate and harvest food crops, energy to can the foods, and energy to transport the foods are examples of the energy involved that can be learned from adults through interviews or from reference sources.

After the individuals or groups have reported to the class engage the entire class in considering the extent to which our food tastes and habits have resulted in heavy energy usage. Discuss how a very serious energy shortage might change our eating habits.

PURPOSE: To review energy-related vocabulary.

LEVEL: Junior High School

SUBJECTS: Social Studies
Science
Language Arts

CONCEPT: Presently, most of our energy requirements are met through using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Our World of Energy. Energy Education Advisory Council, Philadelphia Electric Company, 2301 Market Street, P.O. Box 8699, Philadelphia, PA 19101.

ACTIVITY: Use word lists and meanings such as the following as part of the evaluation of learning resulting from a study of energy. The matching list is on the following page.

Match the correct words and meanings:

____ 1. Transformer	a. A fan or waterwheel used to power electric generators
____ 2. Photosynthesis	b. Coal, oil, natural gas
____ 3. Consumer goods	c. Food producing process in plants
____ 4. Muscle power	d. An emergency switch that protects the wiring in a house
____ 5. Space heating	e. Can make voltage higher or lower
____ 6. Energy conversion	f. Things we want to buy
____ 7. Energy consumption	g. Energy we use
____ 8. Turbine	h. Energy used to heat our homes, schools and businesses
____ 9. Hydroelectric	i. Term used in measuring electricity
____ 10. Fossil fuels	j. Electricity produced by water power
____ 11. Circuit breaker or fuse	k. Electrons in motion
____ 12. Electricity	l. Energy stored in man's muscles
____ 13. Kilowatt	m. Changing energy from one form to another
____ 14. Crisis	n. man-made
____ 15. Solid waste	o. natural surroundings
____ 16. Solar	p. ocean power
____ 17. Embargo	q. stop, does not permit
____ 18. Air pollution	r. trash
____ 19. OPEC	s. electricity produced directly from light
____ 20. Tidal power	t. giving off radiation
____ 21. Synthetic	u. steam and hot water beneath the earth's surface
____ 22. Geothermal	v. organization of petroleum exporting countries
____ 23. Environment	w. turning point; unstable condition
____ 24. Radioactive	x. dirt
____ 25. Particulate	y. dust, smoke, fumes
____ 26. Photo-voltaic	z. the sun

PURPOSE: To learn about famous people in energy.

LEVEL: Junior High School

SUBJECTS: Language Arts
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Michael Zamm and Barry C. Sammuel. Energy Conservation Education: An Action Approach. Council on the Environment of New York City, 51 Chambers Street, Room 228, New York, NY 10007, 1977.

ACTIVITY: Involve students in researching people who have contributed to energy research and development. Use the descriptive list of famous people in energy as a starting point for individual or committee research. Divide famous people by historical periods, by energy types, or in any other way conducive to class research.

SOME FAMOUS PEOPLE IN ENERGY*

Isaac Newton (1643-1727) formulated the three basic laws of motion, defining mass, inertia and force and their relationship to velocity and acceleration. Newton also formulated the concept of universal gravity—unthought of till then. To make his theoretical concepts and laws usable, he developed a new math called the calculus.

Benjamin Franklin (1706-1790) discovered in 1752 that the discharge of electricity produced by the friction machine was the same as lightning in the heavens. He developed the lightning rod.

Andre-Marie Ampere (1775-1836), George Ohm (1787-1854), and Alessandro Volta (1745-1827) all lived about the same time. People were aware that electricity and magnetism existed, but lacked knowledge of their relationship and ways of measuring them. In 1792, Volta found he could arrange some metals in series so as to produce a momentary flow of electricity; the volt was named for him. Ampere discovered the mathematical relationship between electricity and magnetism and was the first to develop a measuring technique for electricity; the amp (or ampere) was named for him. Ohm established the idea of resistance (meaning exactly what it says) and formulated a law of the relationship between current, voltage, and resistance.

Michael Faraday (1791-1867) discovered that when a piece of metal is moved into a magnetic field, an electric current is produced in the metal (induction), and that electricity could be produced from a magnetic field. Similar discoveries were also being made independently at the same time by Joseph Henry in America. Faraday's concepts led to the invention of the dynamo, later called the generator, and the motor.

James P. Joule (1818–1889) was a physicist who established that various forms of energy—mechanical, electrical and heat—are basically the same in that they can be changed, one into another. In 1843, he published his measurement for the amount of work required to produce a unit of heat; this value of the mechanical equivalent of heat is generally represented by the letter J and the standard unit of heat is called the joule.

William Thompson (Lord Kelvin, 1824–1907) played a major rôle in the development of the conservation of energy law. He formulated the absolute temperature scale (273°K = 0°C = 32°F). Absolute zero is the temperature at which there is no molecular motion. Kelvin also helped in the development of the dynamic theory of heat, the mathematical analyses of electricity and magnetism, and basic ideas for the electromagnetic theory of light (as opposed to the wave theory).

Thomas A. Edison (1847–1931) was an inventor who, in 1879, created the first incandescent bulb. The same year he began to manufacture these bulbs and opened the first power plant in New York City.

Albert Einstein (1879–1955) formulated concepts which led to: the development of atomic energy; the theory of relatively which relates mass to energy, and the photoelectric theory whereby electricity is obtained from light, among other sources.

Other Important Contributors to Energy Development

Robert Hooke (1635–1703)
Daniel Bernoulli (1700–1782)
Henry Cavendish (1731–1810)
Joseph Priestley (1733–1804)
James Watt (1736–1819)
Charles Augustin de Coulomb (1736–1806)
John Dalton (1766–1844)
H. C. Oersted (1777–1851)
Humphrey Davy (1778–1829)
Joseph Louis Gay-Lussac (1778–1850)
Sadi Carnot (1796–1832)
Joseph Henry (1799–1878)
Hermann Hemholtz (1821–1894)
Jean Joseph Etienne Lenoir (1822–1900)
James Maxwell (1831–1879)

Willard Gibbs (1839-1903)
Elijah McCoy (1844-1928)
Karl Benz (1844-1929)
Howard Lewis Latimer (1848-1928)
Heinrich Hertz (1857-1894)
Rudolph Diesel (1858-1913)
Pierre (1859-1906) and Marie (1867-1934) Curie
Ernest (Lord) Rutherford (1871-1937)
Charles Parsons (1854-1931)
George Westinghouse (1846-1914)
Granville T. Woods (1856-1910)
William Stanley (1858-1916)
Charles Steinmetz (1865-1923)
Guglielmo Marconi (1874-1937)
Niels Bohr (1885-1962)
Linus Pauling (1901 ---)

Students should discover other key figures in the development of energy as they do their research.

*Encyclopedia Britannica, Encyclopedia Britannica Education Corporation, Chicago, 1976.

PURPOSE: To examine the advantages and disadvantages of deep-mining and strip-mining coal.

LEVEL: Junior High School

SUBJECTS: Social Studies
Language Arts

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: ENCORE (Energy Conservation Resources for Education), Department of Industrial Education, Texas A & M University, College Station, Texas 77843. SE 025 401.

ACTIVITY: Select two or three people to debate for deep-mining and the same number to debate for strip-mining. Provide adequate time for the debators to prepare their case by researching encyclopedias and other written sources of information, by interviewing science teachers, engineers, miners, or other knowledgeable persons.

Select a student timer and conduct the debate in formal style with each debator having time (3-5 minutes) for formal presentation and 1-2 minutes for rebuttal of arguments presented by the opposite side.

After the debate is concluded, ask class members to decide which side won. Ask the class also to indicate if they favor expanded deep-mining or strip-mining of coal to meet the U.S. goal of greatly increased coal production in the years ahead.

PURPOSE: To explore different careers in the energy or energy-related fields.

LEVEL: Junior High School

SUBJECTS: Language Arts
Social Studies
Career Education

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Michael Zamm and Barry C. Sammuel. Energy Conservation Education: An Action Approach. Council on the Environment of New York City, 51 Chambers Street, Room 228, New York, NY 10007, 1977.

ACTIVITY: Ask your students to name some of the natural sources of energy; i.e., oil, coal, natural gas, sun, wind, water, atoms, etc. As a class, formulate a list of the kinds of workers who help in finding these sources of energy; i.e., geologist, oceanographer, mining engineer, etc. In a second column formulate a list of the people who help tap the natural sources of energy and deliver them to us; i.e., engineers, construction workers, miners, technicians, truck drivers, etc. In a third column list the jobs needed in researching and developing some of the alternative sources of energy like solar, geothermal, etc. For example: architects, engineers, mechanics, plumbers and construction workers all help install solar collectors on a house. Chemists, physicists and engineers would do research on such developments. Architects, construction workers, electricians and appliance mechanics—TV, air conditioning, etc.—would help in conserving energy by building houses that have proper insulation, heating systems and design.

The following chart may act as a guide:

Energy Careers

Finding Energy Sources	Conventional (e.g., oil, gas) Energy Development, and Delivery	Alternative Source Development and Conservation Technology
Geologist	Engineers (mechanical civil, electrical)	Chemist
Oceanographer	Construction worker	Physicist
Mining engineer	Mechanic	Architect
________	Miner	Engineer
________	Technicians (electrical and nuclear)	Mechanic
________	Truck driver	Construction worker
	________	Electrician
	________	Appliance mechanic
		Truck driver
		________

Using the committee approach, divide the class into four or more committees for the four areas outlined in the Energy Careers list and any other categories you can think of. Give each student the opportunity to select a particular career that he or she is interested in and have the students prepare reports on the functions performed by the career specialty; the educational and occupational requirements for achieving a career in the specialty, future job possibilities in that area, etc. Feel free to expand or change the career categories in any manner you wish.

PURPOSE: To examine energy-related career possibilities.

LEVEL: Junior High School

SUBJECT: Language Arts

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: Develop with input from the class a list of new careers and jobs that might develop as the U.S. works its way out of the present energy crisis. Greater attention to insulating homes, greater production of coal and natural gas, researching and developing energy sources such as wind, geothermal, bio-mass and others is under way. Rapid expansion of solar energy-related businesses is occurring.

A list of 20 or more jobs should be identified easily by students and teacher. Ask that each student select one of the vocational possibilities and write, after appropriate research, a short paper describing the aptitudes, skills, education, and experience needed to be successful in that type of work.

PURPOSE: To examine the effectiveness of cartoons as a medium for depicting energy-related issues.

LEVEL: Junior High School

SUBJECT: Fine Arts
Language Arts

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: As an extra credit assignment, students might be asked to make or trace or collect (or a combination of these procedures) cartoons that relate to energy. Herblock, Mauldin and other syndicated cartoonists continue to produce very effective drawings that depict what government is doing or is not doing relative to the energy shortage, the importance of the "oil sheiks" in determining the economic status of western countries, the attitudes of Americans toward saving energy and many other aspects of the energy problem.

Ask students who are interested in the assignment to assemble in a notebook 15-20 cartoons. Each cartoon should be analyzed briefly (1) in terms of the feelings that are being depicted and (2) the extent to which the student agrees or disagrees with the message of the drawing.

ENERGY ACTIVITIES FOR THE CLASSROOM: VOLUME II

JUNIOR-SENIOR HIGH SCHOOL

PURPOSE: To calculate the heat produced when various fuels burn.

LEVEL: Junior-Senior High School

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met through using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Energy. Pennsylvania's Energy Curriculum for the Middle Grades, Pennsylvania Department of Education, Harrisburg, PA, 17126. SE 025 380.

ACTIVITY: At an appropriate time during a study of fuels, burning, or oxidation reactions, present the chemical reactions shown below. Ask students to calculate the amount of heat produced per gram of fuel used for the four reactions.

Discuss the disadvantages and advantages of each fuel:

1) The burning of coal

Carbon (coal) + oxygen gas produces carbon dioxide gas + heat

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} + 94{,}000 \text{ cals/12 gms}$$

Calculate the calories per gram of carbon burned

$$\frac{94{,}000 \text{ calories}}{12 \text{ gms}} = \_\_\_\_\_\_ \text{ per 1 gm of carbon}$$

2) The burning of hydrogen

Hydrogen gas + oxygen gas produces water + heat

$$H_{2(g)} + \tfrac{1}{2}O_{2(g)} \rightarrow H_2O_{(1)} + 68{,}300 \text{ cal/2 gms}$$

Calculate the calories per gram of hydrogen burned

$$\frac{68{,}300 \text{ calories}}{2 \text{ gms}} = \_\_\_\_\_\_ \text{ per 1 gm of hydrogen}$$

3) The burning of octane (a petroleum product used in automobiles)

octane + oxygen gas produces water vapor + carbon dioxide + heat

$$C_8H_{18(1)} + \frac{25O_{2(g)}}{2} \rightarrow 9H_2O_{(g)} + 8CO_{2(g)} +$$

$$1{,}305{,}000 \text{ cal per 114 gms}$$

Calculate the calories per gram of octane

$$\frac{1,305,000 \text{ calories}}{114 \text{ grams}} = \underline{\qquad\qquad} \text{ calories per gm}$$

4) The burning of methane (natural gas)

methane + oxygen gas produces water vapor + carbon dioxide + heat

$CH_{4(g)} + 2O_{2(g)} \rightarrow 2H_2O_{(g)} + CO_{2(g)} +$ 210,000 cal per 16 gms

Calculate the calories per gram of methane

$$\frac{210,000 \text{ calories}}{16 \text{ gms}} = \underline{\qquad\qquad} \text{ calories per gm.}$$

PURPOSE: To promote understanding of conflicting arguments about the safety of nuclear power.

LEVEL: Junior-Senior High School

SUBJECTS: Science
Social Studies

CONCEPT: Presently, most of our energy requirements are met through using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Energy. Pennsylvania's Energy Curriculum for the Middle Grades, Pennsylvania Department of Education, Harrisburg, PA 17126. Citing an article from "Science News," January 17, 1976. SE 025 380.

ACTIVITY: Have students study carefully the contrasting positions stated by proponents and opponents of nuclear power summarized in the article below.

Discuss the article with particular attention to how the truthfulness of the contrasting positions can be verified. Which arguments are irrefutable? Which "experts" can be trusted? How can you be sure?

THE GREAT NUCLEAR POWER DEBATE
A SUMMARY

*The debate over nuclear energy is heating up again, with opposing positions more solidified than ever. A recent Harris Poll shows 63 percent of Americans favor more nuclear power plants, but another poll shows 40 percent still have no firm opinion. During this year's elections, referenda on allowing construction of more nuclear reactors will appear on ballots of at least two states and recent Congressional hearings have highlighted the issues involved. In this first article of a two-part series we present the contrasting, and often irreconcilable, positions of nuclear advocates and opponents. The second article will concentrate on the most controversial aspect of the debate, the breeder reactor.**

Economics

Opponent

Utilities are beginning to realize that nuclear power isn't the blessing it was thought to be. Within the last two years they have cancelled or delayed orders for the equivalent of 130 large nuclear plants. Construction costs range from 10 to 46 percent higher than conventional plants. Uranium prices have tripled over the last two years. Reactors would never have gotten this far (8 percent of the country's power-generating capacity) without huge Government subsidies; before they can develop further, more huge subsidies will be needed to build new enrichment plants to transform natural uranium into the fuel used by reactors. Once built, the reactors have not performed as reliably as hoped, running at less than two-thirds capacity. The breeder reactor looks even worse: Development costs are projected to be $11 billion, but the actual cost of building a breeder demonstrator project at Clinch River, Tennessee has escalated from $700 million in 1972 to $1.7 billion today.

Advocate

Despite construction cutbacks caused by the recession, nuclear energy is still a bargain, generating electricity at 40 percent less than the cost of fossil fuel plants, even after considering construction costs. In 1974 nuclear plants saved the country the equivalent of 163 million barrels of oil—some $2 billion worth. The price of uranium is such a small part of the total cost that it could quadruple again and nuclear energy would still be cheaper than conventional power. The initial Government subsidy of nuclear reactors has long since been surpassed by private investment, and the projected economic benefits of the breeder reactor are more than 12 times the cost. Of the cost increases at Clinch River, 60 percent were due to inflation and 20 percent were due to design changes. Nuclear plants are as reliable as conventional ones: From 1964 to 1973, conventional plants operated an average of eight and one-half months a year; nuclear plants, around nine.

Danger From Accidents

Opponent

The official Government study of reactor safety, the so-called Rasmussen report (SN: 8/31/74, p. 117 and 11/15/75, p. 310) has been severely criticized for underestimating human error (SN: 11/23/74, p. 330) and not adequately considering contamination of land areas by radioactive fallout following a major accident (SN: 5/31/75, p. 286). The study's methodology is questionable, assumptions such as adequate evacuation procedures are unrealistic, and the Environmental Protection Agency says the resulting casualty figures are too low by a factor of 10. Since the report came out, one of the "accidents that couldn't happen" did: A technician at the Browns Ferry, Alabama, reactor complex set fire to the electrical control system, while using a candle to check for air leaks. The emergency core cooling system was knocked out, water in the reactor vessel dropped dangerously low, workers argued with firemen for five hours before following their advice on how to extinguish the fire, and no evacuation plans were set in motion.

Advocate

The key finding of the Rasmussen report was that an individual's chances of dying from a nuclear accident are about the same as being hit by a meteorite—one in five billion. This methodology is imprecise but is the most sophisticated available, and a factor of 10 one way or the other is practically meaningless. For workers in all aspects of the nuclear business, the most danger arises in uranium mines, not around reactors, and new mining safety regulations are improving those conditions. The Browns Ferry incident demonstrates just how well the nuclear safety systems are designed to compensate for human error. Despite a fire directly under the control room, no evacuation was needed and no damage was sustained by the reactor, core or coolant piping. Despite loss of control over some of the cooling systems, alternative methods were available and successfully employed. There were no injuries and no release of radioactivity. Regulations governing worker conduct are constantly being updated to prevent accidents.

Environmental Effects

Opponent

In the normal operation of nuclear plants, some radioactive materials will inevitably escape and expose the public. Reactors also give off more waste heat than fossil-fueled plants of the same generating capacity, and this thermal discharge has already adversely affected the ecology of rivers and lakes. The biggest problem, though, is what to do with nuclear wastes. Already 200,000 tons of discarded uranium left over in spent fuel has accumulated in 20,500 steel vessels at Oak Ridge and other sites. Some wastes remain dangerously radioactive for thousands of years—long after steel drums rust away. Not only is there a danger to the public of being exposed to the cancer-causing radioactivity of these wastes, but some of them, including plutonium, are so chemically toxic that accidental ingestion of even very small amounts can cause death. Even if one assumed that secure, long-range storage of these wastes could be found, the cost—including constant guarding for thousands of years—would be very large.

Advocate

The amount of radiation escaping from reactors is minuscule compared with naturally occurring radiation on earth; the average person receives one-ten thousandth as much radiation from the nuclear industry as from natural sources or medical X-rays. Thermal discharge could be used constructively—say, to heat homes, as in some other countries—if the public would accept it. Annual costs of all environmental effects associated with reactors are less than half those associated with coal-fired plants. Nuclear wastes are really not as much of a problem as some have claimed: Long-lived wastes are only half a percent of the total wastes, and these are now molded into insoluble solid masses. By 2010 the total volume of these solid wastes could fit comfortably into a single abandoned salt mine (a very stable geologic formation) at negligible cost. The spent uranium at Oak Ridge is being saved for use in the breeder reactor, where its value could be trillions of dollars. Plutonium is less toxic than many industrial chemicals in common use.

Terrorism

Opponent

Even if the problems of normal reactor operation, occasional accidents, waste transportation and storage could be overcome, no way has been found to calculate the impact of nuclear terrorism, or to adequately prevent it. A nuclear bomb can be made from only 10 to 20 pounds of plutonium, which is copiously produced in every reactor and shipped elsewhere for fuel reprocessing. On an NET television program, an undergraduate student demonstrated how easy it would be to steal some plutonium and design a bomb—which experts from the Swedish Defense Ministry said would explode. But the aim of the American nuclear industry is not just to build reactors here, where some safeguards do exist, but rather to export its technology, inevitably to countries whose obvious political instability will virtually assure nuclear weapons proliferation. To prevent nuclear theft and terrorism in the United States will require establishment of what some have called a "garrison state;" to prevent it abroad, nothing can be done.

Advocate

Relative to the nuclear power debate, the issues of terrorism and proliferation are simply red herrings—there are much easier ways to go about either. In the first place, the "10 to 20 pounds" of bomb material refers only to the weapons-grade, metallic plutonium-239, which never exists as such anywhere in the whole nuclear fuel cycle. It would take from 200 to 900 pounds of unprocessed nuclear fuel to make a very crude bomb, or 25 to 70 pounds of the reprocessed plutonium oxide—a much more difficult substance to handle than the weapons-grade metal. Designing a bomb may be simple (though none of the Swedish "experts" had actually ever built one), but preparing the materials requires an extensive industry, and assembling the device without cooking oneself is actually quite a trick. Conventional terrorism is a more immediate threat to civil liberties, and the best way to encourage responsibility among developing countries is through creation of a working partnership, based on such projects as nuclear power.

Alternatives

Opponent

Ultimately, the reason nuclear power development should be halted is that so many better alternatives are available, and needed development funds have been usurped by nuclear research. Some 40 percent of the energy consumption in the United States is unnecessary to begin with, according to some estimates. Savings of that amount could easily be obtained in buildings and cars, through careful redesign. The unemployment picture could be brightened if we let people take back some of the jobs machines took from them. For energy increases over the short term, more coal could be used if the proper environmental protection devices were installed. Geothermal, solar and wind energies are waiting to be tapped in endless supply in various geographical areas and these alternate sources have the added advantage of lending themselves to small, labor-intensive development. Finally, if one insists on nuclear energy, why not wait until the much safer fusion process is perfected, probably in the next century?

Advocate

Ultimately, the reason nuclear power must be developed is that no other viable alternatives are available, despite greatly increased funding. The wasteful elements of society cannot be changed overnight; the best estimate is that conservation can hold down total energy growth to 2 percent a year—still fast enough to double demand in 35 years. Even modifying 10 percent of the country's homes to solar heat would save at most 1.5 percent of our energy needs, but would cost at least $70 billion. Energy and jobs go together—just restricting oil imports to their 1973 levels would ensure a 10 percent unemployment rate over the next 15 years, if history is any guide. Power-generating plants using solar or wind energy are now extremely expensive, causing the power they would generate over their lifetime to cost two or three times as much as that from nuclear or coal. Opening new coal mines and power plants and installing pollution devices will take years and a huge investment. Fusion is still chancy.

PURPOSE: To examine the varying demand for electricity at different times of a day and the concept of time-of-day pricing.

LEVEL: Junior-Senior High School

SUBJECTS: Science
Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

BACKGROUND: A factor that affects the price of electricity is heavy consumer use that results in "peak loads" on a generating station during relatively short periods of time. Home use tends to be heavy in the morning, late afternoon, and early evenings—little electricity is used between 11:00 p.m. and 6:00 a.m. in most homes.

Many factories operate only one or two shifts per day. Typically retail stores make heavy use of electricity only during daylight and early evening hours.

Weather also affects electrical use. Heavy air conditioner use on very hot summer afternoons results in very large demands for electrical power.

Since electricity cannot be stored, an electric power station must have available a much higher generation capacity than is usually required. Some units, generally the most inefficient, may be operated as little as 20 percent of the time. Since idle equipment is expensive, the reserve or unused capacity adds significantly to the cost of our electricity.

ACTIVITY: Ask three or four students to read their electric meters according to a definite pattern over a 24-48 hour period of time. A suggested pattern might be 6:00-8:00-10:00 a.m.-12:00 noon-2:00-4:00-6:00-8:00-10:00 p.m.

How many kilowatts of electricity are used during each two-hour block of time? Is the pattern of use consistent for each student's family? If not, can the discrepancies be explained?

Finally, engage the class in discussing the merits of time-of-day pricing. Such an arrangement (possible through special meters) would result in electricity costing more during periods of very heavy demand and less during periods of light demand such as from 10:00 p.m. to 6:00 a.m. How many families would (or could) change their pattern of using electricity to take advantage of such an arrangement?

PURPOSE: To examine driving habits in students' families.

LEVEL: Junior-Senior High School

SUBJECTS: Science
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: <u>Energy In The Classroom Vol. III: Activity Guide for 8-12</u>, Virginia Energy Office, 823 East Main Street, Richmond, VA 23219. ED 141 067.

BACKGROUND: The Federal Energy Administration in a small pamphlet "Don't Be Fuelish" estimated that if the fuel consumption of the average car were reduced by 15 percent petroleum consumption in the United States would drop by over 28 million gallons per day. At 60 cents per gallon this would result in savings of about $17 million per day or over $6 billion per year.

ACTIVITY: Ask each student to rate all of the car drivers in his family on a good, average, poor basis on the 11 recommended driving practices listed below. Discuss the ratings. Do parents tend to rate higher or lower than students? Is there a difference between the ratings given to men or to women drivers? Have any students' families made deliberate efforts to modify driving habits?

1. Start slowly by accelerating gently except when entering high speed traffic lanes or when passing. Hot rod driving and jerky acceleration can increase fuel consumption by 2 miles per gallon in city traffic.

2. Avoid unnecessary braking and try to anticipate the traffic ahead. When the traffic light far ahead turns red, take your foot off the accelerator immediately. The light may turn green again by the time you reach the intersection. If not, there's still a fuel saving. In coasting, the car's kinetic energy maintains propulsion rather than the burning of additional fuel. There is then less energy to be dissipated in braking. Don't tailgate. This necessitates additional braking, too.

3. Drive at moderate speeds. As your speed increases, so does your car's wind resistance—a big factor in gasoline mileage. Most automobiles get about 28 percent more miles per gallon on the highway at 50 miles per hour than at 70 and about 21 percent more at 55 than at 70.

4. Drive at steady speeds. Hold a steady foot on the accelerator as long as traffic conditions permit. On the highway, "see-sawing" or repeatedly varying the speed by 5 miles per hour can reduce gas mileage by as much as 1.3 miles per gallon.

5. Save gas when changing gears. If you drive a car with a manual transmission, run through the lower gears gently and quickly for a minimum gasoline consumption, then build up speed in higher gear. If you drive a car with an automatic transmission, apply enough gas pedal pressure to get the car rolling, then let up slightly on the pedal to ease the automatic transmission into high range as quickly as possible. More gas is consumed in the lower gears.

6. Avoid unnecessary use of air conditioning equipment. When in use, it reduces fuel economy by as much as 2½ miles per gallon.

7. Avoid excessive idling. The average American car consumes a cup of gasoline every 6 minutes when idling. When you stop the car, don't idle the engine for more than a minute. If you are waiting for someone, turn off the engine. It takes a lot less gas to restart the car than it does to idle it.

8. Break gas-wasting habits. For instance, don't pump the accelerator or race the engine when your car isn't in motion. It wastes gasoline. And use the brake pedal rather than the accelerator to hold your car in place on a hill.

9. Plan short trips carefully. Short trips are costly in terms of gas mileage. A vehicle started cold and driven 4 miles may average about 8 miles per gallon. The same vehicle warmed up and driven 15 miles may average nearly 13 miles per gallon. However, don't idle the engine to warm it (a wasteful practice). Drive slowly the first few blocks.

10. Consolidate your driving. Combine short shopping and commuting trips to reduce the miles traveled for each action. Patronize shops in your immediate area as much as possible to reduce mileage.

11. Pre-plan your trips. Figure out which route will require the least fuel. Allow for the fact that freeway driving is nearly twice as economical as driving in heavy city traffic. Travel during off-peak traffic times whenever possible. Use routes with a minimum number of traffic lights and stop signs.

PURPOSE: To examine the issues involved (including energy conservation) in "bottle bill" legislation.

LEVEL: Junior-Senior High School

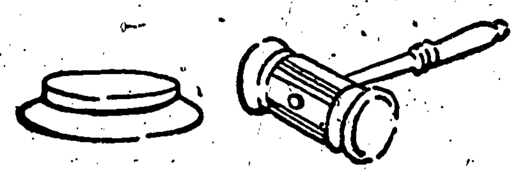
SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: "The Message in the Bottle." Illinois Office of Education, 100 North First Street, Springfield, IL 62777.

ACTIVITY: Present to students (preferably in written form) the following background information on bottle bill legislation introduced in Illinois and a number of other states.

BACKGROUND ON THE BOTTLE BILL



In 1972, a law went into effect in the state of Oregon which required that a five-cent deposit be charged on most beer and soft drink containers, with the deposits being refunded to whoever returns the containers to the store. This law requires deposits even on throwaway, nonreturnable cans and bottles. Before passage of the law, only refillable glass bottles had deposits on them and could be redeemed for cash.

The Oregon law was intended mainly as an anti-litter measure, but backers also argued that there would be substantial savings of energy and raw materials as well as a reduction in solid waste.

Since the enactment of the Oregon law, a number of other states have adopted similar laws either by acts of their legislature's or through the referendum process. These states are Vermont (1973), South Dakota (1974), Michigan (1977), and Maine (1977). Efforts to enact beverage container deposit laws have been made in many other states. In Illinois, such legislation has been introduced repeatedly in the General Assembly, only to fall far short of passage.

Opponents of the deposit law contend that it would cause some people, mainly in the container manufacturing industries, to lose their jobs. Further, they contend that consumers are entitled to choose for themselves between returnables and throwaways. They point to the large investment they have in throwaway containers, not only at a manufacturing stage but also in distribution and retailing. Finally, they say that requiring deposits on throwaway cans and bottles will raise the prices of beer and soft drinks.

Supporters of the law counter that new jobs will be created to handle the greater volume of returns. Further, they contend that consumer choice should be restricted whenever a product is shown to have harmful environmental effects. They say that increased costs, if there are any, can be passed on to beer and soft drink consumers, but that everyone, including those consumers, will save in terms of tax money spent on litter pick-up and solid waste disposal.

After students have read the above background information ask each student to complete the questionnaire on the next page.

Analyze class responses to Questions 1, 6, 12 and 17. What does the class judge to be the lowest deposit change that would get most of the cans and bottles picked up?

Analyze class responses to Questions 2, 7, 11 and 18. What does the class judge to be the deposit change that would least discourage consumption of beverages? If a discrepancy exists between these two deposit charges, how would students, as legislators, resolve the difference?

Examine responses to Question 5. How important did the class rate conservation of energy and other national resources? Attempt to explain the high or low rating given.

LITTER AND CONTAINER DEPOSIT QUESTIONNAIRE

___ 1. When you find nondeposit beverage cans and bottles on the ground, do you pick them up and put them in a waste container?

a. yes b. no.

___ 2. If no deposit were charged on any beverage bottle and can, you would:

a. buy more, b. buy the same number, c. buy fewer.

___ 3. If you saw someone throw a beer or pop can onto a public highway, you would be:

a. very angry, b. slightly annoyed, c. unconcerned.

___ 4. Which of the following materials makes up the largest part of litter?

a. paper, b. plastic, c. glass, d. metal,
e. miscellaneous (all other materials).

___ 5. Which of the following reasons would you regard as the most important in objecting to litter?

a. unsightliness (it's ugly),
b. danger to people and wildlife,
c. cleanup costs,
d. blockage of sewer drains and drainage ditches,
e. damage to lawn mowing and farming equipment,
f. waste of energy and other national resources.

___ 6. Would you pick up a beverage container and carry it to a store if you could earn a deposit of 5 cents?

a. yes, b. no.

___ 7. If a deposit of 5 cents were charged on all beverage bottles and cans, you would:

a. buy more, b. buy the same number, c. buy fewer.

___ 8. Which of the following methods would most effectively reduce litter?

a. enforce more strictly present anti-litter laws using more police,
b. increase fines for littering,
c. charge a deposit on all beer and pop containers, whether or not they are refillable, to ensure their return,
d. impose a cleanup tax on businesses that sell commonly littered items,
e. more cleanup campaigns and anti-litter advertisements,

___ 9. If you saw someone throw a beer or pop can into your neighborhood park, you would be:

a. very angry, b. slightly annoyed, c. unconcerned.

___ 10. What kind of beverage container is most common in litter?

a. the returnable, deposit type,
b. the nonreturnable, throwaway type.

___ 11. If a deposit of 10 cents were charged on all beverage bottles and cans, you would:

a. buy more, b. buy the same number, c. buy fewer.

___ 12. Would you pick up a beverage bottle or can and carry it to a store if you could earn a deposit of 10 cents?

a. yes, b. no.

___ 13. Compared to throwaways, the per-ounce cost of beer and soft drinks sold in returnable bottles is:

a. more expensive, b. less expensive, c. the same.

___ 14. A deposit charged on all beer and soft drink bottles and cans sold today would be:

a. a good idea, b. a bad idea, c. undecided.

___ 15. Which of the following materials makes up the largest amount of litter?

a. beverage bottles and cans,
b. vehicle scrap,
c. food wastes,
d. paper and plastic packaging and containers.

___ 16. If you saw someone throw a beer or pop can into your front yard, you would be:

a. very angry, b. slightly annoyed, c. unconcerned.

___ 17. Would you pick up a beverage container and carry it to a store if you could earn a deposit of 20 cents?

a. yes, b. no.

___ 18. If a deposit of 20 cents were charged on all beverage bottles and cans, you would:

a. buy more, b. buy the same number, c. buy fewer.

PURPOSE: To become aware of problems associated with gasoline rationing in the United States.

LEVEL: Junior-Senior High School

SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

BACKGROUND: When the U.S. rationed gasoline during World War II there were about 25 million automobiles on the road. In 1975 the country had registered, according to the World Almanac, more than 130 million vehicles.

A complex system that often led to black marketing and other efforts to bend the rules was created to ration gasoline "fairly." Car owners received "A," "B," "C," or "X" stickers that were pasted on the auto windshields. The "A" sticker entitled the car owner to a basic ration of four gallons a week which was later reduced to three gallons. The "B" sticker entitling the owner to extra gas was given to persons who could prove their cars were needed to get to work. The "C" sticker, and more gasoline, was given to workers such as physicians who could prove that extra gasoline was necessary in their job. The "X" sticker exempted a vehicle from rationing and was available to very few drivers.

Ration books and stamps accompanied stickers. Buying gasoline required stamps as well as money. The service-station operator was required by the Office of Price Administration to turn in stamps to account for all the gasoline he purchased and sold.

Speed limits were reduced to 35 miles per hour and a driver caught speeding could lose his gasoline ration.

During a period in 1943 when the gasoline "A" ration was three gallons per week, the Office of Price Administration banned all "pleasure driving." Essential driving was defined by OPA to include "necessary" shopping, getting medical attention, attending funerals or church services, and meeting emergencies involving threats to life, health, or property.

While OPA reported good compliance by a large majority of motorists, a black market developed using counterfeit or stolen stamps. By the summer of 1944 several hundred black marketers had been convicted and several thousand drivers had their gasoline rations revoked for using illegal stamps.

ACTIVITY: Review with the class the U.S. experience with gasoline rationing summarized on the previous page. As a homework assignment, urge students to discuss with grandparents or other older persons their judgments about the effectiveness of the gasoline rationing system used during World War II.

Discuss as a class, or in small groups, the applicability of such a rationing system in the United States today. In the event that a very severe gasoline shortage predicted by some people actually develops is rationing inevitable? What other options are available?

PURPOSE: To conduct a public opinion poll on energy issues.

LEVEL: Junior-Senior High School

SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Energy In The Classroom Vol. III: Activity Guide for 8-12, Virginia Energy Office, 823 East Main Street, Richmond, VA 23219. ED 141 067.

ACTIVITY: Ask each student to use the energy opinion questionnaire reproduced below with at least two adults and two students of their age group.

Poll data obtained and analyze to determine areas of agreement and disagreement between adults and students.

Analyze and discuss, if possible, differences of opinion which appear to be related to income level, level of education, and field of work of the respondents.

ENERGY OPINION POLL

This is a public opinion poll. We are interested in your views of our energy crisis. Please take a few minutes to fill out this questionnaire so that we may have a better understanding of our community.

Please check the appropriate answer in the column next to each question.

__Yes __No 1. Do you believe there is an energy crisis?
__Yes __No 2. Does the energy crisis affect you?
__Yes __No 3. Does the energy crisis affect your family?

4. Who is affected most by today's energy crisis? Number each category according to priority. Number 1 is most affected and number 10 is least affected.

__ oil companies
__ industry
__ local cities or towns
__ small businesses
__ poor people
__ politicians
__ diplomats
__ coal miners
__ your family
__ electric utilities

Check the appropriate answer to tell us how you feel about each statement.	Strongly Agree	Slightly Agree	No Opinion	Slightly Disagree	Strongly Disagree
5. In our community, mass transit could conserve energy.	___	___	___	___	___
6. Most people should be willing to carpool or take the bus to work rather than drive their own car.	___	___	___	___	___
7. Major oil companies are sincere in their search for new energy sources.	___	___	___	___	___
8. Cheaper sources of energy would be just as beneficial to the major oil companies as to the consumer.	___	___	___	___	___
9. Today's energy balance hinges on the Middle East situation.	___	___	___	___	___
10. The U.S. is right in supporting Israel regardless of the threat of another Arab oil embargo.	___	___	___	___	___
11. Coal is cheaper than oil, and therefore should be used whenever possible, even at the risk of air pollution.	___	___	___	___	___
12. There are many beneficial effects of our energy crisis.	___	___	___	___	___
13. Many lives have been saved by driving 55 mph; therefore, the speed limit should never go above that level.	___	___	___	___	___
14. New automobile engines have been developed which considerably increase gasoline mileage.	___	___	___	___	___
15. The government will help us all by imposing gas rationing in the near future.	___	___	___	___	___

	Strongly Agree	Slightly Agree	No Opinion	Slightly Disagree	Strongly Disagree
16. Gas rationing is the best way to make Americans use less gasoline.	___	___	___	___	___
17. Twenty years ago there was no color television and most people did not have dishwashers or clothes dryers. We would be better off if these appliances were taken off the market.	___	___	___	___	___
18. Businesses should save energy by removing all advertising lights.	___	___	___	___	___
19. Thirty years ago there was no energy crisis. Technology is responsible for our problems today.	___	___	___	___	___
20. No one has a right to keep their house heated above 68° in the winter time.	___	___	___	___	___
21. Electric utilities should be forced to reduce rates so that everyone, regardless of income, is able to have all the electricity they need.	___	___	___	___	___
22. It is not my responsibility to take energy conservation seriously. After all, what difference does my attitude make?	___	___	___	___	___
23. Most of our energy and environmental problems come from the careless wasting of our resources.	___	___	___	___	___
24. The energy crisis has caused most American families to reduce driving, turn back their thermostats, and educate themselves about the energy situation.	___	___	___	___	___

	Strongly Agree	Slightly Agree	No Opinion	Slightly Disagree	Strongly Disagree
25. Major oil companies contrived the energy crisis, causing long lines at the gas stations and increased prices.	___	___	___	___	___
26. If the government took over control of our natural resources and imposed strict regulation on energy consumers, the energy crisis would disappear.	___	___	___	___	___
27. Increased federal spending is justified to support scientific research into alternative sources of energy.	___	___	___	___	___
28. Industry consumes a major portion of our energy and therefore should pay a higher price for it.	___	___	___	___	___
29. Nuclear power is really the answer to the energy crisis. Scientists know all they need to know about reactor safety.	___	___	___	___	___

30. Just how important is the energy crisis in America? Number each problem according to its priority in our society. Number 1 is most important and number 10 is least important.

___ moral decay
___ environmental pollution
___ planning, design, construction problems
___ drug abuse
___ racial tension
___ inflation
___ unemployment
___ the energy crisis
___ government corruption
___ big business

PURPOSE: To examine the relationships between major inventions and increased energy usage.

LEVEL: Junior-Senior High School

SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: Ask each student to list on a sheet of paper eight major inventions of the past 100-150 years. From the individual responses develop on the chalkboard a master list to show range of responses and the several inventions listed by many students. It is very likely that the automobile, airplane, radio, television, motion pictures, electric light and several others will be cited often by students.

Typically, inventions require an energy source such as electricity or a petroleum product to make them operate. List beside each major invention the energy it requires.

After using the above procedures as introduction, ask each student to select one of the inventions as an area for individual study. Through encyclopedia-type research, the student should develop insight into the importance of the invention together with an assessment of how increasing energy costs will affect it. The research might well be summarized in an oral or preferably written report.

PURPOSE: To examine reasons for the popularity of automobile transportation.

LEVEL: Junior-Senior High School

SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: Develop with input from the class a list of methods of transportation used by persons around the world to move from home to work. Students will likely identify such methods as private automobile, bus, taxi, and commuter train commonly used in the United States and other Western countries. Students, with teacher assistance, can also identify modes of transportation such as walking, bicycling, animal drawn carts, rickshaws, and motor scooters used far more often in lesser developed countries than in ours.

After developing the list, ask each student or small group (2-3) of students to try to list <u>five</u> reasons why the United States has such an enormous number of automobiles. The United States, with more than one registered automobile for every <u>two</u> persons, leads the world in using this form of transportation. Why do we have so many automobiles (per capita) in the U.S.A.?

Ask students to share and discuss the reasons they have cited. Discuss, in general terms, the origins of these reasons. Were they economic, social, political, developed internally by rational thought, motivated externally by outside forces, or others?

Finally, if time and interest permit, speculate on the future of the automobile in the U.S. and the world. Is it likely to be more or less important? Why?

PURPOSE: To examine U.S. efforts to conserve energy.

LEVEL: Junior-Senior High School

SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: The Potential of Energy Conservation. Executive Office of the President, Office of Emergency Preparedness, October 1972.

BACKGROUND: In 1972 (prior to the Arab oil embargo) the publication cited above identified six promising things that could be done to conserve energy. These were:

Improve insulation in homes
Adopt more efficient air conditioning
Shift intercity freight traffic from highway to rail
Shift intercity passenger traffic from air to ground
Shift urban passenger traffic from automobile to mass transit
Introduce more efficient industrial processes and equipment

The energy program enacted by the U.S. Congress in 1978 and signed into law by President Carter, continued to stress the importance of conservation of energy.

ACTIVITY: Review with the class the recommendations made by the President's Office of Emergency Preparedness in 1972.

Ask each student to discuss briefly in writing how he believes the United States has responded to these recommendations. Does the student have personal knowledge or believe that citizens have improved home insulation? Adopted more efficient air conditioning? Shifted freight traffic from highway to rail? Shifted passenger traffic from air to ground? Shifted urban passenger traffic from automobile to mass transit?

Involve students in converting their written answers to a five-point Likert scale of strongly agree, agree, neutral, disagree, strongly disagree and tabulate responses on the chalkboard. Discuss results.

What recommendations have received the most support from the American public in the past six years? Why? What, if anything, can be done to achieve the other recommendations more successfully?

PURPOSE: To examine the relationships between growth of cities and increasing use of energy.

LEVEL: Junior-Senior High School

SUBJECTS: Social Studies
Language Arts

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: Review with the class the fact that prior to James Watts' development of the steam engine, no city on earth had a population of one million people. Today several greater metropolitan areas have a population that exceeds 10 million. The World Almanac identifies more than 120 cities with a population greater than one million.

Cities use enormous amounts of energy. Food must be brought in, waste removed, workers commute from home to work, elevators lift objects, etc., etc.

Ask students to write a paper in which they explain how modern technology, powered by our present energy sources, has made possible the growth of cities.

The assignment might be used as an in-class without preparation activity to introduce the topic of city dependence on energy or it might be assigned as a major paper to be developed with use of out-of-class research.

PURPOSE: To examine relationships between energy costs and lifestyles

LEVEL: Junior-Senior High School

SUBJECTS: Social Studies
Language Arts

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

ACTIVITY: Present to the class an "iffy" question that involves a great change in the amount of energy available to typical American families.

Encourage students as they work individually or in small groups to use the information they have as well as their imaginations in developing answers. Answers might be oral, in short story form, in a play, or in a cartoon.

Pose questions that relate closely to energy usage patterns of students and their families such as:

<u>what if</u> gasoline rationing became necessary and your family travel by car was limited to 50 miles per week?

<u>what if</u> the energy to heat your home costs three times as much as it now does? What would you do to help pay for the greater cost?

<u>what if</u> gasoline stations were closed every weekend?

<u>what if</u> an electric power shortage forced the elimination of night-time athletic events?

<u>what if</u> the cost of gasoline reached $2.00 per gallon?

<u>what if</u> an electric power shortage forced your family to reduce its use by 50 percent?

<u>what if</u> some scientist discovered a way to make "synthetic gasoline" as good as our present fuel but it could be made so cheaply that it would sell for less than 20 cents a gallon?

PURPOSE: To develop vocabulary useful in energy study through use of a word search puzzle.

LEVEL: Junior-Senior High School

SUBJECTS: Language Arts
Science
Social Studies

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

REFERENCE: Oklahoma Energy Awareness Education, Energy Education Activities; Grades 4-12. Oklahoma State Department of Education, Oklahoma City, 1977. ED 153 820.

ACTIVITY: The block below contains at least 60 words applicable to a study of energy. Words may be found on horizontal, vertical, or diagonal lines or in reverse directions. A list of words to be found is furnished. Students should draw around the energy words which they find as has been done for the sample word "power".

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P O P U L A T I O N K T C N R L M R D U B T U
G W R E W C H E M I C A L O B Y A T L N N H S
P A R T I C U L A T E S C I K L S I G E W S G
O T G K N S A V E X D S U S O E S A M G A M E
L E R U D E M A N D S O C S T S A E T M H O N
L R E C R U D E N A E R O U O G L Y L E M G E
U E N V I R O N M E N T A F U E L A A N A E R
T L G E N E R A T I O N H I O M C T E I U O A
I E R S C H O S U N L A M S K I L O W A T T T
O C E D I E L S E T O L A S T E A M G P T H O
N T S L W A S T E R P O T I R N R E A P C E R
H R O M O T U I A V O O R O A T N A S L C R P
S I U C A L O R I E M C O N T R O L O I Q M E
R C R A N W O R K E P O T E N T I A L A M A T
E I C R G E R I A T O M N O I S N E I N B L R
S T E B R N C E I N F M A T T E R Z N C U X O
E Y P O W E R O T I Q U R A N I U M E E S Y L
R D A N V R H I L L T N U C L E A R M O T Y E
V T O R S G A S E O K I N E T I C L E V I N U
E U R E C Y C L I N G T P B A R R E L F O O M
S T O R A G E B Y S H Y D R O C A R B O N S T
```

1. atom
2. energy
3. calorie
4. carbon
5. coal
6. community
7. control
8. coolant
9. critical mass
10. core
11. ecology
12. environment
13. fission
14. fusion
15. fossil
16. fuel
17. food
18. element
19. gas
20. hydrocarbons
21. electricity
22. ion
23. kilowatt
24. mass
25. matter
26. nuclear
27. particulates
28. pollution
29. population
30. power
31. recycling
32. smog
33. steam
34. solar
35. geothermal
36. wind
37. water
38. uranium
39. waste
40. appliance
41. generation
42. beat
43. storage
44. BTU
45. demand
46. kinetic
47. petroleum
48. potential
49. chemical
50. coke
51. combustion
52. crude
53. gasoline
54. generator
55. heat
56. resource
57. barrel
58. work
59. sun
60. ? (see if you can find it!)

ENERGY ACTIVITIES FOR THE CLASSROOM: VOLUME II

SENIOR HIGH SCHOOL

PURPOSE: To understand detailed principles of solar heating and cooling.

LEVEL: Senior High School

SUBJECT: Science

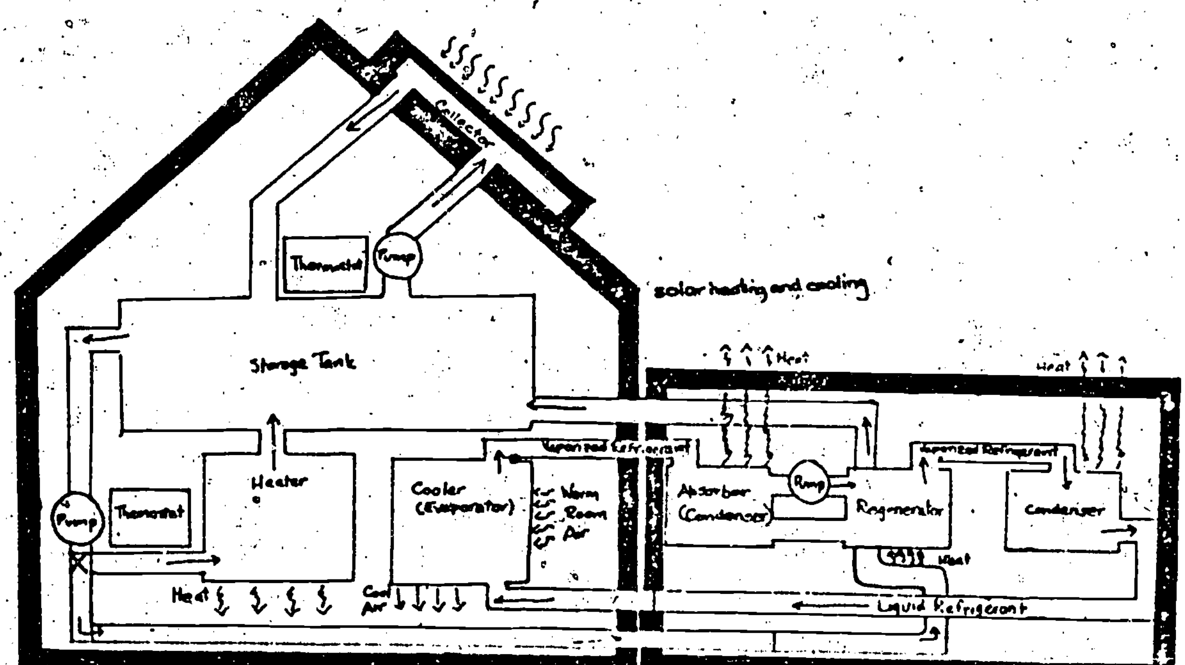
CONCEPT: Presently, most of our energy requirements are met through using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: "Solar Energy for Heating and Cooling." An informational leaflet OPA-008 (3-78) available from U.S. Department of Energy, Office of Public Affairs, Washington, DC 20585.

ACTIVITY: Secure copies of the leaflet which contains a color drawing of the solar heating and cooling system reproduced below. Distribute to students or present the material by overhead projector.

Assign students the responsibility to master understanding of critical components and principles involved in such a system. What improves the efficiency of collectors? What working mediums are used from collector to storage tank or area? What storage mediums are commonly used? Why? How does the absorption refrigeration method work? What materials are used as absorbers?

After thorough study-discussion of the principles involved ask a heating-cooling contractor to come to the class and discuss the practicality of such systems in the area he serves. If he is unable to come to school, students might interview him in his office or by telephone to get his assessment about the problem.



Absorption Cooling System

PURPOSE: To measure student ability to obtain good gasoline mileage.

LEVEL: Senior High School

SUBJECT: Science (Driver Education)

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: It should be possible, at relatively small expense, to modify the fuel system of the school's driver education car so that mileage obtained from a quart of gasoline might be determined.

Near the end of the driver education program, each student in the class should be given the challenge of coaxing maximum mileage from the quart of gasoline allotted to him. Students should be interested in seeing how they rank when compared with others in the class. If it is possible to establish driving conditions that do not vary much, the instructor may wish to establish a minimum mileage figure as one of the conditions for passing the course.

This activity should emphasize to students the importance of factors that affect gasoline mileage such as motor tuning, tire pressure, rapid acceleration, excessive braking, and steady rate of driving.

PURPOSE: To attempt to improve gasoline mileage in student driven cars.

LEVEL: Senior High School

SUBJECTS: Social Studies
Science (Driver Education)

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

BACKGROUND: The cost of gasoline has risen markedly since the OPEC embargo in 1973. Many persons believe that within a few years gasoline prices in the United States will equal or exceed the cost of $1.00 or more per gallon which is now charged in European countries.

Driving habits greatly affect gas mileage and thus the cost of operating an automobile. A report to the Congress by the Comptroller General of the United States includes the following:

> Tests conducted by the Automobile Club of Michigan showed that cars could experience as much as a 44 percent loss in gas mileage when operated by a poor driver as compared to a good driver. To determine the effects of bad driving habits, the test driver made jack rabbit starts, rapid stops, and weaved in and out of traffic. The Club also ran the tests using good driving techniques including smooth acceleration, travel at an even rate of speed, and using brakes only for routine stops. Traveling in mid-afternoon traffic, the test car got 14.36 miles per gallon using good driving habits and 8.11 miles per gallon with bad habits.

ACTIVITY: Suggest to class members who drive their own cars that they make a careful check of the miles per gallon they get as they follow their regular pattern of driving habits. If students already know this figure, this step can be eliminated.

Ask students to check the mileage they can get during a week of driving in which they follow as carefully as they can the good driving habits of smooth acceleration, travel at even rates of speed, and use of brakes only for routine stops.

Collect data from students who participate in the experiment to ascertain increase in mileage per gallon of gasoline consumed. Discuss the results. Are the savings worthwhile?

PURPOSE: To examine the attitude of a public utility company toward mandated pollution control equipment.

LEVEL: Senior High School

SUBJECTS: Science
Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: "Plain Talk About Environment." A consumer report issued by Ohio Edison Electric Company.

ACTIVITY: Distribute to the class the following example quoted from the reference cited. Ask each student to read the material carefully and to decide whether he agrees or disagrees with the thrust of the article.

Ask for volunteers to debate in an informal way the validity of the arguments advanced. Open the debate to a general class discussion to ascertain how many agree with the utility position. Ask those who disagree to present sound arguments to justify their position.

A Case in Point

The Bruce Mansfield Plant being built by Ohio Edison's subsidiary, Pennsylvania Power Company, in Shippingport, Pennsylvania, will cost about $1.4 billion when completed. Almost 33 percent of that total cost will go for pollution control equipment, including an experimental sulfur removal and disposal system required to meet state and federal regulations.

It will require a massive "scrubber" system that uses lime and water to absorb the sulfur oxides from the gases resulting from the coal being burned in the plant's boilers.

It will require about 400 tons of lime per day for each of the three units of the plant—about 400,000 tons per year when the three units are operating.

It will require the largest earth and rockfill dam in the eastern United States to close the end of a valley six miles from the plant to create a disposal area for the waste slurry when it comes out of the scrubber system.

The dam and the disposal site alone will cost an estimated $88 million.

From the system 18,000 tons of waste sludge must be disposed of every day—2,750,000 tons every year.

And the cost of just the solidifying chemicals which must be added to the slurry will total about $3,600,000 a year; and about 10 million gallons of fuel oil will be required to reheat the scrubbed and cooled gases to provide additional buoyancy to enable the gases to rise to greater heights for better dispersion. That oil could heat 7,500 homes each year!

Behind the giant dam, an estimated 200 million tons of waste sludge, solidified by a developing process on a scale never before tried, will fill 1,300 acres during the next 20 to 25 years with unknown long-term environmental consequences.

You Be The Judge

Look at the evidence

1. Ohio Edison's towering chimneys release sulfur oxides high in the air where they disperse over a wide area. Yet state and federal regulations demand that the sulfur oxide content of the air be measured where it comes out of the chimney instead of at ground level where you breathe.

2. Any experimental sulfur oxide removal system is a gigantic gamble with your money. Despite the fact that dozens of other experimental systems have been tried, the technology has not proved either efficient or practical under normal generating plant operating conditions.

3. Finally, even though it is Ohio Edison's goal to minimize SO_2 concentrations from our power plants consistent with public health needs, the actual level of SO_2 that is considered harmful to the environment has not been scientifically established and is open to serious question. We believe that many of the SO_2 control regulations are economically unsound and more stringent than necessary to protect public health and welfare.

It's Time To Speak Out

Write to your legislators, before unrealistic state and federal regulations drive the costs and the price of electricity any higher.

Demand that legislation concerning the environment start with a scientific evaluation of the "pollution problem." And make sure that each request includes a consumer "economic impact" study as well as an "environmental impact" report.

Ask that "real" pollutants be identified clearly and that realistic methods be developed to measure them.

Require that all methods of abatement be accountable in terms of both benefits and costs.

Insist that reasonable degrees of perfection be arrived at. The cost of reaching "perfection" becomes more prohibitive the farther up the scale we attempt to go. The first 50 percent of pollutants can be removed at relatively low cost. But after the 90 percent level is reached, it often costs as much to achieve a further 5 percent than it did the first 50 percent! And absolute perfection, of course, is impossible.

PURPOSE: To examine reasons why the trucking industry is opposed to the national 55 MPH speed limit.

LEVEL: Senior High School

SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

BACKGROUND: The opposition of interstate truck drivers to the 55 MPH speed limit is well known. Equally well known is the fact that on some stretches of interstate highways, large tractor-trailers are driven at average speeds closer to 65 than to 55.

Many truckers are paid on the basis of miles driven in a 10-hour work period. The teamster rate in Columbus, Ohio in the fall of 1978 was quoted at 23.050 cents per mile. Thus, a higher highway speed that enables a trucker to travel an additional 100 miles per day results in an additional $23 of wages earned. The additional fuel charge for the higher speed would, according to teamster officials, be less than half of the additional income.

ACTIVITY: Review with the class the condition outlined briefly above which indicates that simple economics suggests that the 55 MPH speed limit hurts truckers and the trucking industry.

Choose three members of the class to defend the truckers' position. Challenge the rest of the class to come up with the agreements they can to persuade the truckers that they should accept and obey the lower nationwide speed limit.

PURPOSE: To examine arguments for and against higher crude oil prices.

LEVEL: Senior High School

SUBJECT: Social Studies

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

BACKGROUND: The formation of OPEC and the subsequent quadrupling of oil prices had a serious impact on the economies of Western European countries, the United States and Japan. During the last few decades, a high level of economic growth and activity in these countries has been tied closely to "cheap energy"—particularly petroleum and natural gas.

The importance of petroleum as an energy source and as an irreplaceable base for the petrochemical industries is well known. Equally well known is the fact that petroleum exists in finite quantity. Even the wealthiest oil-producing countries in the Middle East are concerned about the depletion of their reserves and ultimate loss of income from the sale of this natural resource.

ACTIVITY: Ask four students to represent the large Middle East oil exporting countries of Saudi Arabia, Iran, Kuwait and the United Arab Emirates. Ask these students to develop and present to the class the strongest possible case they can for doubling the present price of oil ($16 per barrel) <u>within the next three years</u>.

Ask four students to represent the large oil importing countries of Japan, West Germany, France, and the United States. Ask these students to develop and present to the class the strongest possible case they can for the need to maintain or even <u>lower</u> the present price of oil during the next five years.

Ask each student to try to eliminate his personal bias on the question of oil pricing. Simply on the basis of the facts and best arguments presented by the two groups would he vote to increase or maintain present oil prices? Is it possible to be "objective" in considering such a controversial question? How can apparently irreconcilable differences of opinion between the oil exporting and oil importing countries be resolved?

PURPOSE: To investigate the potential of car pooling at your school.

LEVEL: Senior High School

SUBJECTS: Mathematics
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Lee County Energy Action Cards. Lee County Schools, Fort Myers, Florida, 1976. SE 024 758.

ACTIVITY: Survey teachers and students at your school to determine how many, if any, share car pools. Try to find out what keeps more people from car pooling. Check home addresses and schedules of the teachers to determine whether or not any of them could effectively share in a car pool. How many students could share car pools? Check mileage of potential car pool efforts and estimate how much energy could be saved at your school if all those who could, would use car pools. At the rate of $.15 a mile, how much money could your school personnel save by car pooling a week? a month? for the school year?

Start a school campaign to reserve parking spaces for faculty and students who participate in car pools.

PURPOSE: To examine the diversity and complexity of energy problems.

LEVEL: Senior High School

SUBJECTS: Language Arts
Science

CONCEPT: The production, distribution, and use of energy have environmental, political, social, and economic consequences.

REFERENCE: Ideas and Activities for Teaching Energy Conservation Grades 7-12. The University of Tennessee Environment Center, South Stadium Hall, Knoxville, TN 37916, January 1977. ED 137 100.

ACTIVITY: Review with the class the idea that development of additional energy resources in the United States will entail such things as "economic cost," "social cost," and "environmental cost."

With input from the class, develop on the chalkboard a list of current energy development problems in the United States such as:

1. Strip mining of coal.
2. Transportating western U.S. coal to eastern power plants.
3. Off-shore drilling for oil and natural gas.
4. Siting a nuclear power plant.
5. Transporting or storing radioactive fuels or wastes.
6. Siting of electric power lines.
7. Thermal discharges from power plants.

Assign to individual or small teams of students the task of developing a written report on one of the listed problems. Indicate that the report should describe the nature of the problem; its economic, social, and environmental impacts; and alternative solutions.

RESOURCES

ENERGY EDUCATION TEACHING RESOURCES

The general references listed below contain background material and learning activities deemed useful to teachers in elementary and secondary schools. The general references are followed by those specific to elementary and secondary programs of instruction.

All references are identified by an ED number which makes possible easy location of material in the growing number of ERIC microfiche collections distributed widely throughout the United States. Each reference also indicates the cost of microfiche (MF) or hard copy (HC) of the reference if the reader wishes to order a personal or library copy from the ERIC Document Reproduction Service, P.O. Box 190, Arlington, Virginia 22210.

The resumes for each reference are reproduced as found in various monthly issues of Resources in Education, a publication of the Educational Resources Information Center (ERIC) aimed toward early identification and acquisition of reports of interest to the educational community.

General Teaching Resources

ED 111 662 Fowler, John W. Energy-Environment Source Book. Volume 1: Energy, Society, and the Environment. Volume 2: Energy, Its Extraction, Conversion and Use. Washington, DC: National Science Teachers Association, 270p, 1975. (Available from—National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, DC 20009 - Stock Number 471-14692, $4.00 prepaid.) EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This source book is written for teachers who wish to incorporate material on the complex subject of energy into their teaching. This work is divided into two volumes, each with numerous tables and figures, along with appendices containing a glossary, mathematics primer, heat engine descriptions, and nuclear energy discussion. Volume 1 (Energy, Society, and the Environment) deals with energy and its relationship with conservation, the environment, the economy, and strategies for energy conservation. In Volume 2 (Energy, Its Extraction, Conversion, and Use), topics discussed include the rate of energy consumption, future sources of energy, and the increased cost of energy.

ED 11 663 Mervine, Kathryn E. and Cawley, Rebecca E. Energy-Environment Materials Guide. Washington, DC: National Science Teachers Association, 68p, 1975. (Available from—National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, DC 20009 - Stock Number 471-14694, $2.00 prepaid.) EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This publication is a sampling of current energy literature. The references are divided into four separate categories, each directed for a specific audience: readings for teachers, readings for students (grades 8-10); readings for students (grades 5-9); and readings for students (grades K-6). Included in four appendices are guides for films and audio-visual materials, curriculum materials, sources of information, and government documents.

ED 111 664 Smith, Stephen M., Ed. and Others. Energy-Environment Mini-Unit Guide. Washington, DC: National Science Teachers Association, 217p, 1975. (Available from—National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, DC 20009 - Stock Number 471-14696, $3.00 prepaid.) EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This guide contains a collection of mini-units that provide materials for science and social studies teachers in grades K-12. These materials are intended to make teaching more interdisciplinary and to stimulate decision making in young children. Activities are sought that will enable students to: understand and use existing fundamental concepts in the energy-environment area; identify and evaluate personal and community practices, attitudes, and values related to energy-environment issues; and make effective decisions and/or define their views of appropriate actions on energy-environment issues.

ED 129 602 Schwartz, Sid L., Ed. Energy Films Catalog. Energy Research and Development Administration, 1976. Oak Ridge, TN: Energy Research and Development Administration, 82p, 1976. EDRS Price MF-$0.83, HC-$4.67 Plus Postage.

This is the first edition of the Energy Research and Development Administration (ERDA) catalog of available motion picture films. One hundred and eighty-eight films, principally relating to energy, are briefly described and classified into three understanding levels. All films are loaned free, complete borrowing instructions and request forms are provided.

ED 133 192 Energy Education Materials Inventory (e.e.m.i.). Part One: Print Materials. Portland: Energy and Man's Environment Inc, 102p, 1976. EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This publication is one of a six-part inventory of energy education materials. Included in this part is a listing of print materials, including the following: teacher's guides, curriculum guides, ditto masters, textbooks, pamphlets, and posters. For each of the materials listed, the following information is included when available: (1) Title; (2) Author; (3) Availability; (4) Cost; (5) Grade Level; (6) Related Materials; and (7) Evaluation of the Material.

ED 133 193. Energy Education Materials Inventory (e.e.m.i.). Part Two: Non-Print Materials, Part One. Portland: Energy and Man's Environment Inc., 75p, 1976. EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This publication is one of a six-part inventory of energy education materials. Included in this part is a listing of non-print materials including the following: films, filmstrips, slides, transparencies, audio-tapes, and records. For each of the materials listed, the following information is included when available: (1) Title; (2) Author; (3) Availability; (4) Cost; (5) Grade Level; (6) Related Materials; and (7) Evaluation of the material.

ED 133 194 Energy Education Materials Inventory (e.e.m.i.). Part Three: Non-Print Materials, Part Two: 16 mm Films. Portland: Energy and Man's Environment Inc., 66p, 1976. EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This publication is one of a six-part inventory of energy education materials. Included in this part is a listing of 16mm films. For each of the materials listed, the following information is included when available: (1) Title; (2) Author; (3) Availability; (4) Cost; (5) Grade Level; (6) Related Materials; and (7) Evaluation of the material.

ED 133 195 Energy Education Materials Inventory (e.e.m.i.). Part Four: Kits, Games & Miscellaneous Curricula. Portland: Energy and Man's Environment Inc., 25p, 1976. EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This publication is one of a six-part inventory of energy education materials. Included in this part is a listing of kits, games, and miscellaneous curricula. For each of the materials listed the following items are included when available: (1) Title; (2) Author; (3) Availability; (4) Cost; (5) Grade Level; (6) Related Materials; and (7) Evaluation of the material. Materials listed in this reference include both print and non-print items for teachers and students.

ED 133 196 Energy Education Materials Inventory (e.e.m.i.). Part Five: Reference Sources. Portland: Energy and Man's Environment Inc., 42p, 1976. EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This publication is one of a six-part inventory of energy education materials. Included in this part is a listing of bibliographies, computer sources of information, directories, educational programs, funded projects, periodicals, and journals. For each of the materials listed, the following information is included when available: (1) Title; (2) Author; (3) Availability; (4) Cost; (5) Grade Level; (6) Related Materials; and (7) Evaluation of the material.

ED 134 445 Magnoli, Michael A. and Wert, Jonathan M. A Composite of Energy Curriculum Guides and Enrichment Materials. Mobile, AL: Mobile County Public Schools, 16p, 1975. EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This bibliography was prepared to provide a listing of a variety of curriculum materials, instructional materials, and references related to energy. Each entry includes: (1) Source, (2) Title, and (3) Comments on grade level and price when available. Materials are primarily selected for relevance to grades K-12.

ED 153 821 Oklahoma Energy Awareness Education, Resource Materials. Oklahoma City: Oklahoma State Department of Education, 98p, 1977. EDRS Price MF-$0.83. HC-$4.67 Plus Postage.

This publication is the teacher's reference of a series of three energy education publications. This teacher's reference handbook provides background information and some materials to aid the teacher in using the activities in the other two publications. The many charts, graphs, and illustrations are designed to provide the teacher with graphic ways to assist students in understanding energy problems and concepts. The looseleaf construction of this publication will enable the teacher to remove specific pages for reproduction. Topics discussed in the twelve chapters of this publication include the energy conservation ethic, definition of energy, selected forms of energy used by man, future capital requirements for energy, and energy conservation in agriculture. Chapter 10 is a glossary of energy terms. Chapter 11 lists some selected sources of energy information.

ED 156 474 Energy Education Resource Guide. Providence: Rhode Island State Department of Education, 74p, 1978. (Available from—Dissemination Unit, Rhode Island Dept. of Education, 22 Hayes Street, Providence, RI 02908—no price quoted.) EDRS Price MF-$0.83. HC-$3.50 Plus Postage

To help fill the needs of Rhode Island teachers for useful energy education materials, the Dissemination Services Unit of this state's Department of Education has compiled this resource guide. The entries in this document are available either from ERIC or from the Dissemination Services Unit; ED numbers are given for ERIC documents. For all entries, a brief description along with the title and author information are given. The publication lists documents that may be of use in general energy education by grade levels: (1) elementary, (2) secondary, and (3) K-12. Selected journal articles are included along with a resources section including films, periodicals, organizations, and Rhode Island Resources entries. The 120-plus documents entered cover many aspects of the energy dilemma including economics, natural resource allocation and use, federal energy policy, nuclear power, and possible solutions to the problems. Some emphasis is given to the energy situation in Rhode Island, but this resource guide should be useful to educators nationwide.

Elementary School Teaching Resources

ED 127 160 A Teacher's Introduction to Energy and Energy Conservation: Elementary. Columbus, OH: Battelle Memorial Institute, Center for Improved Education; Ohio State Department of Education, 93p, 1975. EDRS Price MF-$0.83. HC-$4.67 Plus Postage.

This document is intended to give the elementary school teacher background information and general suggestions for teaching units and correlated learning activities related to energy and energy conservation. Sections are directed to: A Problem Shared by All, Causes, What is Energy?, Energy Sources, Searching for Solutions, Conservation: An Ethic for Everyone, a glossary, and an extensive bibliography.

ED 146 044 Bakke, Ruth. Energy Conservation Activity Packet, K-2. Des Moines: Iowa State Dept. of Public Instruction; Iowa State Energy Policy Council, 83p, 1977. (Available from—Iowa Energy Policy Council, State Capitol Complex, Des Moines, IA 50319 - $10.00 a set.) EDRS Price MF-$0.83. HC-$4.67 Plus Postage.

This book was developed in response to the concern for energy conservation. It contains activities that stress an energy conservation ethic and includes many values clarification activities for grades K-2. The teacher is provided with some background information on energy, an extensive teacher's annotated bibliography, and a list of resources. The topic of energy is divided into concepts and objectives, with activities interspersed where appropriate. There are over 40 pages of ditto and transparency masters, two posters, and a game for the teacher's use. Also included is an evaluation sheet for the teacher to assess the activity packet.

ED 146 045 Bakke, Ruth. Energy Conservation Activity Packet, Grade 3. Des Moines: Iowa State Dept. of Public Instruction; Iowa State Energy Policy Council, 81p, 1977. (Available from—Iowa Energy Policy Council, State Capitol Complex, Des Moines, IA 50319 - $10.00 a set.) EDRS Price MF-$0.83. HC-$4.67 Plus Postage.

This activity packet for grade 3 is one of a series developed in response to the concern for energy conservation. It contains activities that stress an energy conservation ethic and includes many values clarification activities for grade three. The packet is divided into two parts and provides the teacher with background information, concepts and objectives, and activities for each part. Two annotated bibliographies, one for teachers and the other for students, are also included. The teacher is provided with ditto and transparency master pages to use in the classroom. An evaluation sheet and a list of resources are also a part of this activity packet.

ED 146 046 Bakke, Ruth. Energy Conservation Activity Packet, Grade 4. Des Moines: Iowa State Dept. of Public Instruction; Iowa State Energy Policy Council, 102p, 1977. (Available from—Iowa Energy Policy Council, State Capitol Complex, Des Moines, IA 50319 - $10.00 a set.) EDRS Price MF-$0.83. HC-$6.01 Plus Postage.

This activity packet for grade 4 is one of a series developed in response to the concern for energy conservation. It contains activities that stress an energy conservation ethic and includes many values clarification activities for grade four. The packet is divided into two parts and provides the teacher with background information, concepts and objectives, and activities for each part. Part one is concerned with energy conversion and part two with energy production and use. Two annotated bibliographies, one for teachers and the other for students, are also included. The teacher is provided with pages for duplication. An evaluation form and a list of resources are also a part of this activity packet.

ED 146 047 Bakke, Ruth. Energy Conservation Activity Packet, Grade 5. Des Moines: Iowa State Dept. of Public Instruction; Iowa State Energy Policy Council, 94p, 1977. (Available from—Iowa Energy Policy Council, State Capitol Complex, Des Moines, IA 50319 - $10.00 a set.) EDRS Price MF-$0.83. HC-$4.67 Plus Postage.

This activity packet for grade 5 is one of a series developed in response to concern for energy conservation. It contains activities that stress an energy conservation ethic and includes many values clarification activities for grade five. The packet is divided into two parts and provides the teacher with background information, concepts and objectives, and activities for each part. Part one is concerned with fossil fuels and part two with the history of energy in Iowa. Two annotated bibliographies, one for teachers and the other for students, are also included. The teacher is provided with ditto and transparency master pages to use in the classroom. An evaluation sheet and a listing of resources are also a part of this activity packet.

ED 146 048 Bakke, Ruth. Energy Conservation Activity Packet, Grade 6. Des Moines: Iowa State Dept. of Public Instruction; Iowa State Energy Policy Council, 102p, 1977. (Available from—Iowa Energy Policy Council, State Capitol Complex, Des Moines, IA 50319 - $10.00 a set.) EDRS Price MF-$0.83. HC-$6.01 Plus Postage.

This activity packet for grade 6 is one of a series developed in response to the concern for energy conservation. It contains activities that stress an energy conservation ethic and includes many values clarification activities for grade six. The packet is divided into two parts and provides the teacher with background information, concepts and objectives, and activities for each part. Part one is concerned with the limits of energy sources and part two with alternative energy sources. Two annotated bibliographies, one for teachers and the other for students, are also included. The teacher is provided with ditto and transparency master pages for duplication. An evaluation sheet and a listing of resources are also a part of this activity packet.

ED 147 217 Allen, Rodney F., Ed. and LaHart, David E., Ed. Sample Energy Conservation Education Activities for Elementary School Students. Florida State University, Tallahassee; Palm Beach County Board of Public Instruction, West Palm Beach, FL, 59p, 1977. EDRS Price MF-$0.83. HC-$3.50 Plus Postage.

The booklet contains learning activities for introducing energy and conservation concepts into the existing elementary school curriculum. The activities were developed by Palm Beach County teachers during a one-week workshop. A framework of ideas is divided into three functional categories: universe of energy, living systems and energy, and social systems and energy. The first two categories outline scientific concepts fundamental to an understanding of basic energy ideas and energy flow models of which human beings are a part. The third category sets forth basic concepts in social systems, including governmental, economic, and moral systems, the understanding of which is vital in making decisions affecting production, distribution, and consumption of energy resources. Sixteen sample lessons are provided for grades 1-3 and 19 for grades 1-6. Activity ideas focus on topics such as the sun as a source of energy, fossil energy, and conservation of scarce resources. The majority of activities consists of scientific experiments; other activities include puzzles, drawing exercises, and cut and paste activities. The activities are suggestive, rather than prescriptive; teachers are encouraged to adapt and expand the activities.

ED 149 987 Environmental Education, Values for the Future: Energy. Grades 6-8. Springfield: Illinois State Office of Education, 47p, 1977. EDRS Price MF-$0.83. HC-$2.06 Plus Postage.

This booklet on energy is one of a series in environmental education for grades K-12. The activities contained within address the effect of culture in determining energy needs, energy loss, and forms of energy. Four basic concepts are listed, along with behavioral objectives, subject areas, key words, and definitions for each. The three activity options associated with each concept include the following information: materials and resources, procedures, discussion questions, further activities, and sample worksheets. These interdisciplinary activities are designed for students in grades 6-8.

ED 152 529 Science Activities in Energy: Chemical Energy. California University, Berkeley, Lawrence Hall of Science; Oak Ridge Associated Universities, TN, 30p, 1977. EDRS Price MF-$0.83. HC-$2.06 Plus Postage.

Presented is a science activities in energy package which includes 15 activities relating to chemical energy. Activities are simple, concrete experiments for fourth, fifth and sixth grades which illustrate principles and problems relating to energy. Each activity is outlined on a single card which is introduced by a question. A teacher's supplement is included.

ED 152 530 Science Activities in Energy: Electrical Energy. California University, Berkeley, Lawrence Hall of Science; Oak Ridge Associated Universities, TN, 34p, 1977. EDRS Price MF-$0.83. HC-$2.06 Plus Postage.

Presented is a science activities in energy package which includes 16 activities relating to electrical energy. Activities are simple, concrete experiments for fourth, fifth and sixth grades which illustrate principles and problems relating to energy. Each activity is outlined on a single card which is introduced by a question. A teacher's supplement is included.

ED 152 531 Science Activities in Energy: Conservation. California University, Berkeley, Lawrence Hall of Science; Oak Ridge Associated Universities, TN, 32p, 1977. EDRS Price MF-$0.83. HC-$2.06 Plus Postage.

Presented is a science activities in energy package which includes 14 activities relating to energy conservation. Activities are simple, concrete experiments for fourth, fifth and sixth grades, which illustrate principles and problems relating to energy. Each activity is outlined on a simple card which is introduced by a question. A teacher's supplement is included.

ED 152 532 Science Activities in Energy: Solar Energy. California University, Berkeley, Lawrence Hall of Science; Oak Ridge Associated Universities, TN, 27p, 1977. EDRS Price MF-$0.83. HC-$2.06 Plus Postage.

Presented is a science activities in energy package which includes 12 activities relating to solar energy. Activities are simple, concrete experiments for fourth, fifth and sixth grades, which illustrate principles and problems relating to energy. Each activity is outlined on a single card which is introduced by a question. A teacher's supplement is included.

ED 153 819 Oklahoma Energy Awareness Education, Energy Education Activities, Grades K-3. Oklahoma City: Oklahoma State Dept. of Education, 176p, 1977. EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This publication contains energy education activities for grades K through 3 and is part of a set of three publications. These activities are organized under five energy concepts: (1) energy is so basic that nothing moves without it; (2) conservation of energy; (3) there are other energy alternatives; (4) society depends on energy; and (5) the production and distribution of energy have environmental and economic consequences.

This publication is constructed in a looseleaf fashion to facilitate the reproduction of activities. Purpose, concept or objective, materials, and activity description are given for each activity. Activities involve students in games, values clarifications, and independent investigations. Activities may be selected and used in the curriculum as desired to achieve an interdisciplinary approach.

ED 153 845 Bloch, Lenore and Others. Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy: 5, Community Workers and the Energy They Use, Grade 2. Washington, DC: National Science Teachers Association, 77p, 1977. (Available from—U.S. Department of Energy, Technical Information Office, P.O. Box 62, Oak Ridge, TN 37830 (no price quoted). EDRS Price MF-$0.83. HC-$4.67 Plus Postage.

This instructional unit for the second grade is intended to stimulate the child's curiosity to know more and to grasp relationships through a blending of ideas about energy with a study of the effect of the use of energy on the livelihood of people in the community. There are four lessons in the unit. The first, Introduction to Energy, deals with the question, "What is energy and energy conservation?" The second lesson, Community Workers Who Work Directly With the Sources of Energy, discusses farmers, grocers, food processors, oil workers, gas station attendants, and meter readers. The third lesson is entitled Community Workers Whose Work Depends on a Continual Supply of Energy. The fourth lesson is Community Workers Who Make Decisions About Energy. Each lesson contains complete teacher and student materials including background readings, objectives, teaching strategies, and suggestions for extending the learning outside the classroom.

ED 153 846 Bloch, Lenore and Others. Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy: 6, The Energy We Use, Grade 1. Washington, DC: National Science Teachers Association, 47p, 1977. (Available from—U.S. Department of Energy, Technical Information Office, P.O. Box 62, Oak Ridge, TN 37830 (no price quoted).) EDRS Price MF-$0.83. HC-$2.06 Plus Postage.

This instructional unit contains a set of nine lessons on energy for grade one. Each lesson contains complete teacher and student materials. Reading skills and language experiences are reinforced in each activity. The lessons cover such topics as energy from food, energy from the sun, fossil fuels, the wind, moving water, and energy conservation. The children examine things such as cereal grains to learn about food energy, make clay dinosaurs to get some idea about the formation time of coal, oil, and natural gas, and become part of a pinwheel parade showing the energy in wind.

ED 153 859 Johnson, Bette and Swinton, Olivia. Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy. Networks: How Energy Links People, Goods and Services, Grades 4, 5. Washington, DC: National Science Teachers Association, 102p, 1978. (Available from—U.S. Department of Ener[illegible], Technical Information Office, P.O. Box 62, Oak Rid[illegible], TN 37830-no price quoted.) EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

The purpose of this unit is to investigate a simple energy network and to make an analogy with similar mutually supporting networks in the natural and man-made worlds. The lessons in this unit develop the network idea around a simple electrical distribution system that we depend on and also into further consideration of electrical energy itself. The network idea in the later lessons emphasizes the interdependence of the man-made network for producing and distributing electrical energy and the natural ecological network. In the final lesson, the consuming end of the network is examined and some strategies for consuming electrical energy are examined. Students should learn that energy networks such as the electrical circuits are a necessary part of modern life. They are also expected to learn about sources, conversions, and uses of electrical energy. There are six lessons in this fourth- and fifth-grade unit. Complete teacher and student materials are provided.

ED 153 872 Our World of Energy: An Interdisciplinary Curriculum Program for Elementary Schools. Teacher's Guide, Student Manual, 3 Filmstrips, and 3 Audio Cassette Tapes. Philadelphia Electric Co., Pennsylvania Energy Education Advisory Council. (Available from—Energy Education Advisory Council, Philadelphia Electric Co., 2301 Market

Street, P.O. Box 8699, Philadelphia, PA 19101—Teacher Guide $10.00; Student Guide $1.00; Request price on quantity orders.) Document Not Available from EDRS.

This collection of instructional materials for energy education in the elementary classroom includes a teacher's guide, a student workbook, and three filmstrip/cassette-tape programs. These materials are designed to introduce children, in an interdisciplinary fashion, to energy issues and to show them what energy is, where it comes from, and what we can do about the energy crisis. The student workbook contains lessons centering on a specific topic. Each lesson begins with a section that reviews the previous one. Each lesson ends with vocabulary words, both scientific and non-scientific, the student needs to know to understand the lesson. A set of energy activities to enable the student to have hands-on laboratory experiences to clarify concepts is included. The teacher's guide contains the lessons of the student workbook plus answers, teaching suggestions and other helpful information. These materials are organized into units entitled: (1) Energy - What Is It?; (2) Energy - Where Does it Come From?; and (3) The Energy Crisis. There is one filmstrip program for each unit. The filmstrip programs reiterate the concepts of the units.

Secondary School Teaching Resources

ED 119 992 Harder, Alma Jean and Newsom, Carolyn Clark. The Energy Situation. A Two-Week Self-Contained Unit for the Secondary School. Dover, DL: Del Mod System, 51p, 1975. EDRS Price MF-$0.83. HC-$3.50 Plus Postage.

A unit of study is presented in this monograph, intended to be self-sufficient, though teachers are urged to read as much material as possible. Overall objectives are presented. Time allotted is suggested at two weeks. The unit contains ten mini-units, plus class activities, class discussion questions, individual student projects, and possible quiz questions. A bibliography is included in the unit as well as five suggested field trips, possible films with information relating to cost, and place of procurement. Magazines and possible guest speakers are suggested.

ED 127 161 A Teacher's Introduction to Energy and Energy Conservation: Secondary. Columbus, OH: Battelle Memorial Institute; Center for Improved Education; Ohio State Dept. of Education, 97p, 1975. EDRS Price MF-$0.83. HC-$4.67 Plus Postage.

This document is intended to give the secondary school teacher background information and general suggestions for teaching units and correlated learning activities related to energy and energy conservation. Sections are directed to: A Problem Shared by All, Causes, What is Energy?, Energy Sources, Searching for Solutions, Conservation: An Ethic for Everyone, a glossary, and an extensive bibliography.

ED 137 100 Wert, Jonathan and Others. Ideas and Activities for Teaching Energy Conservation: Grades 7-12. Knoxville: Environment Center, Tennessee University, 223p, 1977. EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This publication contains a variety of ideas and materials for teaching about energy in grades 7-12. Topic areas include: (1) Historical Perspective on Energy; (2) Energy Resources; (3) Energy Conservation; (4) Ideas and Activities; and (5) Appendices. The first three sections provide background information on energy and conservation. The activities include ideas to use in science, social studies, language arts, and multidisciplinary areas. The appendices include a variety of useful tables of data, basic information on energy, a glossary, and a bibliography.

ED 149 994 Environmental Education, Values for the Future: Energy, Grades 9-12. Springfield: Illinois State Office of Education, 58p, 1977. EDRS Price MF-$0.83. HC-$3.50 Plus Postage.

This booklet on energy is one in a series on environmental education for grades K-12. The activities explore energy use and technology, along with their environmental impact. Five basic behavioral objectives are listed with activity options and appropriate subject areas. Three activities are given for each objective. Information for these includes materials and resources, procedures, and discussion questions. The activities are interdisciplinary and are designed for high school students, grades 9-12. They include role playing, games and simulations, physics experiments, and mathematical calculations. Illustrations, data sheets, worksheets, and tables are also given.

ED 151 297 Energy Activities for Junior High Social Studies. St. Paul: Minnesota State Energy Agency, 36p, 1977. EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

The document contains seven learning activities for junior high students on the energy situation. Objectives are to help students gain understanding and knowledge about the relationships between humans and their social and physical environments; solve problems and clarify issues; examine personal beliefs and values; and recognize the relationships between beliefs, values, and individual behavior. In the first unit, "For Peat's Sake," social studies and science teachers cooperate. In these experiments the heat value of peat is compared to other materials and it is suggested that peat be used for energy production.

Students collect information about the energy situation in the second unit. They play an energy game and develop a questionnaire to sample student and community opinions about energy. The third unit, "Implications," is a tool which helps students examine possibilities, complexities, interrelationships, and implications of trends and innovations. In the other four units students compare the differences energy has made in lifestyles; consider the implications of alternative living as energy conservation; discuss what they love and hate about power/energy; and explore the future in terms of their own life styles.

ED 153 820 Oklahoma Energy Awareness Education, Energy Education Activities, Grades 4-12. Oklahoma City: Oklahoma State Dept. of Education, 220p, 1977. EDRS Price MF-$0.83. HC-$11.37 Plus Postage.

This publication contains energy education activities for grades 4 through 12 and is part of a set of three publications. These activities are organized under five energy concepts: (1) energy is so basic that nothing moves without it; (2) conservation of energy; (3) there are other energy alternatives; (4) society depends on energy; and (5) the production and distribution of energy have environmental and economic consequences. This publication is constructed in a looseleaf fashion to facilitate the reproduction of activities. Grade level, objectives, materials, and a description are given for each activity. The variety of activities include laboratory experiments, values clarification exercises, simulations, games, and independent student investigations. Activities are included that may be used in one or more subject areas so that an interdisciplinary approach to energy education is achieved.

ED 153 841 Brock, Phyllis and Others. Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy: Agriculture, Energy, and Society, Grades 10, 11, 12. Washington, DC: National Science Teachers Association, 102p, 1978. (Available from—U.S. Department of Energy, Technical Information Office, P.O. Box 62, Oak Ridge, TN 37830-no price quoted.) EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This interdisciplinary instructional unit contains eleven lessons for grades 10-12 which focus on the energy component of food production. There are lessons which contrast food production systems in various cultures and also lessons which look at different systems and techniques in use in this country. There are lessons dealing with organic farming and with the use of wild foods. Each lesson gives an overview, target audience, objectives, materials, time allotment, and teaching strategies, in addition to student worksheets.

ED 153 843 Childs, Barbara and Others. Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy: 3, Energy, Engines and the Industrial Revolution, Grades 8, 9. Washington, DC: National Science Teachers Association, 80p, 1977. (Available from—U.S. Department of Energy, Technical Information Office, P.O. Box 62, Oak Ridge, TN 37830-no price quoted.) EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This instructional unit for grades 8-9 combines science and social studies in a look at the broad social and economic upheavals that took place during the industrial revolution, giving special emphasis to the role of energy. The invention and development of the steam engine is highlighted in one lesson. Other lessons show how the industrial revolution affected the location and growth of cities around sites of energy sources, and give greater understanding of the effects of technology on the daily lives of people. There are five lessons in all, two relating to science and three to social studies. Complete teacher and student materials are included.

ED 153 844 Childs, Barbara and Others. Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy: 4, Transportation and the City, Grades 8, 9. Washington, DC: National Science Teachers Association, 44p, 1977. (Available from—U.S. Department of Energy, Technical Information Office, P.O. Box 62, Oak Ridge, TN 37830-no price quoted.) EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This instructional unit for grades eight and nine tells why and how American small towns declined as a result of the availability and acceptance of automobiles, and it tells of the growth of suburbs and their effect on the city. The learning activities also relate the story of the demand for cars and explain the drain on the cities' sense of space, clean air, and safe streets. In one of the lessons, the students simulate a court trial on the charge - "The Car Has Done Permanent Injury to Humanity". There are four lessons in this unit. They are designed to fit into existing segments of instruction in U.S. history and civics courses. Complete teacher and student materials are provided.

ED 157 818 An Energy History of the United States. Grades 8-9. Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy. Washington, DC: National Science Teachers Association, 120p, 1978. (Available from—U.S. Department of Energy, Technical Information Office, P.O. Box 62, Oak Ridge, TN 37830-free, paper cover.) EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This instructional unit contains eight classroom lessons dealing with a history of energy in the United States for use in grade eight and nine social studies, science, and mathematics courses. The lessons were developed by teachers. The overall objective is to help students understand the present necessity to reexamine and perhaps alter our present energy patterns. Students study about the impact that the different types of energy used from colonial times to the present have had on U.S. culture and learn about the physical properties of wood, coal, and oil, particularly about the ability of these substances to give heat. The activities in which students are involved include answering questions based on short reading selections; gathering and interpreting materials from a picture; comparing the uses of energy by a colonial farm family and by a family of today; constructing a can calorimeter; learning how to determine the energy content of wood; applying the principles of scientific motivation to energy data; constructing and interpreting graphs; making a model of a steam turbine; and learning how to determine the heat content of oil. The amount of time needed to teach each lesson varies from one to four classroom periods. Each lesson is self-contained, and includes instructions for the teacher and student materials. The eight lessons are organized into three units: (1) America's Wooden Age (1650-1820); (2) The Coming of Coal (1840-1920); and (3) Oil: Bright Promise (1880-present).

ED 157 819 <u>Energy in the Global Marketplace</u>. Grades 9, 10, 11. Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy. Washington, DC: National Science Teachers Association, 54p, 1978. (Available from—U.S. Department of Energy, Technical Information Office, P.O. Box 62, Oak Ridge, TN 37830-free, paper cover.) EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This instructional unit contains six classroom lessons in which 9th, 10th, or 11th grade social studies students examine the effects of competition among nations and world regions as demand for oil outstrips supply. The overall objective is to help students understand the concept that energy is a commodity to be bought and sold like any other commodity but in a marketplace that is a global one. The lessons were written by teachers and can be integrated into social studies, economics, world history, contemporary issues, and world geography courses. The lessons are: (1) Why Some Nations Use More Energy; (2) Energy: Who Has It; Who Needs It?; (3) From Those Who Have To Those Who Want: The Oil Trade Routes; (4) What If... Everyone Wants More?; (5) Petrodollars: The Problem of Too Much Money; and (6) The Oil Price Game - Everybody Plays (A Simulation Of The World Market for Oil). The activities in which students are involved include analyzing maps, graphs, and charts; answering questions based on short reading selections; and playing games. Each lesson can be taught in one classroom period. All teachers and student materials are included.

ED 157 820 U.S. Energy Policy - Which Direction? Grades 11 and 12. Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy. Washington, DC: National Science Teachers Association, 92p, 1978. (Available from—U.S. Department of Energy, Technical Information Office, P.O. Box 62, Oak Ridge, TN 37830, free, paper cover.) EDRS Price MF-$0.83 Plus Postage. HC Not Available from EDRS.

This instructional unit for use in 11th and 12th grade social studies and science courses contains six classroom lessons dealing with United States energy policy. The overall objective is to help students understand how circumstances, present and proposed legislation, political action, and the Constitution itself become linked in the development of a national policy. The lessons, developed by teachers, are: (1) The Nightmare Life Without Fuel; (2) How Can the United States Reduce Its Dependence on Foreign Oil?; (3) The President's Powers: Where They Come From and How They Are Used; (4) Advantages and Disadvantages of Coal; (5) Toward the Future: The Advantages of Having a National Energy Plan; (6) An Energy Policy is Born. Activities in which students are involved include discussing the short reading selections; analyzing graphs and research; and analyzing a case study dealing with President Carter's energy policy. The time needed to teach each lesson varies from one to three classroom periods. All teacher and student materials are included. Also included for the teacher's reference is a brief summary of President Carter's energy policy.

ENVIRONMENTAL EDUCATION PUBLICATIONS

Unless otherwise noted, these publications are available in both microfiche and hard (paper) copy from Educational Document Reproduction Service (EDRS), and may be located in ERIC microfiche collections. Most are also available in printed form from:

Information Reference Center for Science, Mathematics, and Environmental Education
1200 Chambers Road, 310
Columbus, Ohio 43212

Exceptions to the above availability statements are noted with individual references. Prices quoted are those of the Information Reference Center (IRC) as of April 197?, and are subject to change. EDRS prices are based on page counts, as indicated in current issues of Resources in Education.

TEACHING ACTIVITIES

ED 091 172
John H. Wheatley and Herbert L. Coon, One Hundred Teaching Activities in Environmental Education. 1973: 204 pages. IRC price: $4.05.

ED 102 031
John H. Wheatley and Herbert L. Coon, Teaching Activities in Environmental Education, Volume II. 1974; 200 pages. IRC price: $4.65.

ED 125 868
John H. Wheatley and Herbert L. Coon, Teaching Activities in Environmental Education, Volume III. 1975; 195 pages. IRC price: $4.00.

ED 130 833
Herbert L. Coon and Michele Y. Alexander, Energy Activities for the Classroom. 1976; 155 pages, IRC price: $4.50.

ED 137 140
Mary Lynne Bowman and Herbert L. Coon, Environmental Education in the Urban Setting: Rationale and Teaching Activities. 1977; 208 pages. IRC price: $4.00.

ED 141 178
Judith M. Schultz and Herbert L. Coon, Population Education Activities for the Classroom. 1977; 196 pages. IRC price: $4.00.

ED 144 826
Robert H. McCabe, J. Terence Kelly, and Doris Lyons, Man and Environment Teaching Alternatives. 1977; 319 pages. IRC price: $6.00.

ED 150 026
Herbert L. Coon and Charles L. Price, Water-Related Teaching Activities. 1977; 149 pages. IRC price: $4.00.

ED 152 541
Mary Lynne Bowman and John F. Disinger, Land Use Management Activities for the Classroom. 1977; 260 pages. IRC price: $5.00.

ED 159 075
Mary Lynne Bowman and Herbert L. Coon, Recycling: Activities for the Classroom. 1978; 154 pages. IRC price: $4.50.

SE 025 423
William R. Hernbrode, Multidisciplinary Wildlife Teaching Activities. 1978; 96 pages. IRC price: $3.00.

SE 025 419
Richard L. Sagness and Rebecca L. Sagness, Selected Science Activities in Consumer Decision Making. 1976; 167 pages. IRC price: $3.00.